



MASTER INDEX
INSTALLATION OF NEW 2500 CUBIC METER
CAPACITY HORTON SPHERE FOR STORAGE OF
AMMONIA AT NFL, NANGAL

PC281-NFL-N/E-1/P-II/MI

0

DOC. NO.

REV.

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PART II: TECHNICAL



SECTION – 1.0

PROJECT DESCRIPTION

**PLANT: NATIONAL FERTILIZERS LIMITED, NFL, NANGAL,
PUNJAB**



**PROJECTS: INSTALLATION OF NEW 2500 CUBIC METER
CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA
ALONG WITH ITS REFRIGERATION SYSTEM AT NFL, NANGAL**

REV.	REV. DATE	EFF. DATE	PURPOSE	PREPD.	REVWD.	APPD.
0	17.04.2023	17.04.2023		UNM	KR	MN
P	06.12.2022	06.12.2022	FOR CLIENT REVIEW	UNM	KR	AKG

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1.0 INTRODUCTION:

- 1.1 National Fertilizers Limited (NFL) is one of the largest producers of nitrogenous fertilizer in the country having a capacity to produce 3.568 million tonnes of Urea per year along with various industrial products. NFL is presently operating fertilizer units at Panipat, Bathinda, Nangal and Vijaipur which are natural gas based plants with dedicated offsite and utility facilities.
- 1.2 NFL intends to install 1 (One) no. of new Ammonia Horton Sphere (Cap. 2500 m³) at Nangal along with its dedicated refrigeration system. New Horton sphere shall be interconnected with existing Horton Sphere (F2401) system through tie-in points at strategic locations. The scope also includes complete Mechanical, Civil, Electrical, Instrumentation work at NFL, Nangal.
- 1.3 For this purpose, NFL, Nangal retained services of Projects & Development India Ltd. (PDIL) as Consultant for providing Engineering Consultancy Services and Project Management Services for the project to prepare Invitation to Bid (ITB) on turnkey basis for the scope of job detailed in Section 2.0 of this ITB. The present ITB specifies the requirement of new ammonia Horton sphere and other associated facility.

2.0 PLANT LOCATION:



The proposed new Ammonia Horton Sphere with associated facilities shall be located inside the existing operating complex of NFL unit.

2.1. Site Location

Plant Location	NFL Nangal
State	Punjab
Nearest Important Town	Roopnagar
Nearest Railway Station	Nangal Dam which is about 3 km from the plant
Nearest Air port	Chandigarh which is about 110 km from the plant
Nearest National Highway	NH-21

2.2. Meteorological Data

Plant Location	NFL Nangal
Maximum Ambient Temperature	48 °C
Minimum Ambient Temperature	1 °C
Earthquake region / zone	IV

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Rainfall (Annually) (Min. /Max.)	1089.5 mm (2016)/1448 mm (2015)
Average Wind Speed	As per IS-875 (latest edition)
Site Elevation above Mean Sea Level	347.90 m

3.0 STORAGE CAPACITY & CONFIGURATION:

The bidder's scope of work under this project for installation of Ammonia Horton Sphere at NFL Nangal shall comprise of following facilities:

S.N.	Plants & Facilities	Capacity
1.	Ammonia Horton Sphere	Type : Horton Sphere Ammonia storage : 2500 m3 (water equivalent) Diameter : 17000 mm(ID) MOC : LTCS Design Pressure : 3.85 kg/cm2g Design temperature : (-) 30 °C
2.	Associated Facilities	i) Ammonia Compressor (2W+1S) ii) Ammonia condenser (2W+1S) iii) Inert gas cooler (1W) iv) Ammonia receiver (2W) v) Drain pot (2W) vi) Drain pit PUMP (1W) vii) Electrical & Instrumentation system- Renovation and integration with the existing switch boards. viii) Interconnected pipelines/piping as per requirement, etc. ix) Additional Fire fighting facilities

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PART II: TECHNICAL



SECTION – 2.0

BIDDER'S SCOPE OF WORK

PLANT: NATIONAL FERTILIZERS LIMITED, NFL, NANGAL, PUNJAB



PROJECTS: INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA ALONG WITH ITS REFRIGERATION SYSTEM AT NFL, NANGAL

1	28.12.2023	28.12.2023	PESO comments incorporated	ARVIND	SKM	SKM
0	15.02.2023	15.02.2023	Comments Incorporated	UNM	KR	AKG
P	06.12.2022	06.12.2022	FOR CLIENT REVIEW	UNM	KR	AKG
REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD

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1.0 BIDDER SCOPE OF WORK/ SUPPLY:

The Bidder's scope of work shall include Basic Design Engineering, Detailed Engineering including Hook-up with existing facilities for all equipment & accessories, Re-routing/Modification of any underground obstructions, above ground pipe rack and its piping, if any, procurement of complete materials & bought-out items whatever deemed necessary for mechanical, civil, electrical & instrumentation job, fabrication at shop/site as required, loading, unloading & transportation, storage at site, assembly, construction, civil & structural works, erection of mechanical, electrical & instrumentation system, Mechanical Completion, inspection, testing, painting, insulation, statutory approvals, Pre-commissioning, commissioning, trial runs and demonstration of guarantees, if any, calibration, interface & supply of complete new ammonia Horton sphere with new refrigeration system and its interconnection with existing Horton sphere system along with spares & maintenance tools etc. on single point responsibility basis.



1.1 SCOPE OF SUPPLY:

The Bidder's scope of supply shall include, but not limited to the following:



- a. Horton sphere of capacity 2500M3 and its refrigeration/liquefaction system with all required associated equipment/accessories to meet the requirements as specified in design basis & as per good engineering practices.
- b. Complete Design, Detailed engineering, preparation of P&I drawings and Control system, Isometrics, Piping Plan etc. for New Horton sphere system and Interconnection with existing Horton Sphere system. Further interconnection of the New Horton Sphere system with existing Horton Sphere system, as existing infrastructure of Ammonia Pumps has to be used for both the Horton Sphere existing one and proposed one. Further, existing refrigeration system and new Horton sphere system shall be interconnected.

Bidder shall be responsible for execution of tasks summarised below but not limited to the following:



- Detailed Design Engineering
- Compliance with applicable latest Codes and Standards
- Submission of Drawings and Documents
- Procurement of equipment & materials
- PESO/OISD and other statutory approvals / Environment Related Approvals during Construction, if any.
- Project Planning & Scheduling
- Spares (Commissioning and 2 years operational) and special maintenance tools, if any.
- Construction Tools including cranes and other special lifting equipments
- Port Clearance, if applicable, Transportation, Loading/Unloading and storing of equipment at site & Material Control
- Temporary Work (Construction of Temporary Facilities)
- Civil & Structural Works

	BIDDER'S SCOPE OF WORK INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/2.0		
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- Construction and erection of equipment, electrical, instrumentation and piping.
 - Insulation of equipment and piping
 - Surface preparation of piping/equipment/structure before painting as per specification.
 - Painting of piping/equipment/structures
 - CCTV servilience for new Horton sphere system
 - Safety and plant security
 - Progress Monitoring and Reporting
 - Quality Assurance
 - Technical information
 - Work of Sub-Contractors, if applicable
 - Co-ordination
 - Mechanical completion
 - HAZOP Study
 - Pre-commissioning
 - Commissioning
 - Performance Test Run
 - Insurance
 - Automobile Liability Insurance for personnel
 - Workmen's Compensation Insurance for personnel
 - Erection All Risk Insurance
 - Marine & Inland Transportation Insurance
 - Applicable Laws and Regulations
 - Operating & Maintenance Manual
 - Hard and soft copies shall be provided of each document as per approved DCI by PMC/Owner.
- c. Civil Work including Design & Engineering, Construction of Sphere Foundation, Pipe Rack Foundation as required, Pipe Sleepers as required, Foundation for following:
- Sphere Structures
 - Kerb wall adjoining Horton sphere and sump along with seal and pump for collection of ammonia contained water during routine test/commissioning/testing.
 - Foundations for Condensers (03 Nos),
 - Foundation of Ammonia Receivers (02 Nos),
 - Foundation for Inert Gas Cooler (01 No),
 - Foundation for Ammonia Compressors (03 Nos).
 - Foundation for rerouted pipe rack. Any other foundations as per requirement
- d. Design & Engineering, PESO Approval, Supply, Fabrication, Erection, Welding, NDT, Hydrotesting, Painting of 01 No New 2500m³ Water Capacity Ammonia Horton Sphere.
- e. PESO Approval for complete Horton sphere system.
- f. Bidder to take cognizance to PESO letter No. A/S/HO/PB/03/383(S109537) dated 14.12.2023 (Annexure- AA attached in Technical Part) for compliance.

	BIDDER'S SCOPE OF WORK INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/2.0		
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- g. The Horton Sphere shall be fabricated by a PESO (CCOE) India approved manufacturer of Pressure Vessels under SMPV (U) rules 2016 or any subsequent revisions as per design drawings approved by PESO under stage inspection by a recognized 3rd party inspection agency. Copy of valid PESO Approval should be enclosed along with the Technical bid.
- h. Control Room for Instrument Panels & Electrical Panels as per requirement.
- i. Relocation of existing roads, drains, pits, trenches etc., relocation of existing pipe rack and its piping falling under the proposed New Horton Sphere site including supply of all material and installation/erection as well as dismantling/removal of redundant pipe rack/its foundations (after relocation of pipe rack) etc. shall be in the scope of LSTK contractor.
- j. Installation of PSV on the top of Horton sphere for safety purpose.
- k. Supply and Installation of minimum 100 mm Thick PUF Insulation on Sphere (Pressure Part Only).
- l. Supply and Application of Fireproofing (2 Hrs Rating) of Sphere Column Legs & Sway Rods only.
- m. Supply, Fabrication, Erection of Sphere Structure (Ladder, Handrails and Platform etc).
- n. Supply & Erection of Ammonia condensers (03 Nos), Ammonia receivers (02 Nos), Inert Gas Cooler (01 No), Ammonia Compressors (03 Nos).
- o. Complete Instrumentation System including hook-up with existing system for new Horton sphere with refrigeration system.
- p. Complete Electrical System including hook-up with existing system for new Horton sphere with refrigeration system.
- q. Supply, Fabrication, Erection and Testing of Piping and Valves required for Interconnection with existing Horton sphere.
- r. Complete Integration of Electrical and Instrumentation with the existing system.
- s. All necessary Hoists / EOT / Overhead Crane and other lifting machines / tools of suitable capacity for carrying out future maintenance work Horton sphere & compressors.
- t. Complete Piping including hook-up with existing Horton sphere system and New Horton Sphere system including its refrigeration systems etc. as per P&I.
- u. Tentative location of all Hook Up / Tie-in points shall be identified during site visit and Tie-In point's installation is in scope of LSTK Contractor.
- v. Fire protection system for the complete equipment supplied and installed by the Bidder including Fire and smoke detection system, Fire Alarms & Fire suppression system.
- w. Obtaining necessary statutory approval for this plant.
- x. Pre- commissioning, Commissioning & Operational spares shall be as per Spare Parts Section 14.0
- y. Complete Fire Fighting facilities for New Horton sphere system.
- z. Submission of Final Documentation & As- Built Drawings.

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- aa. Any other item though not specified but required for say efficient operation and maintenance of New Horton sphere system along with refrigeration system shall be supplied by Bidder without any cost implication.



Note:

- i) Bidder to essentially visit NFL site before quoting, to understand scope, freedom/obligation of working in area, fabrication / construction / erection & assembly constraints, etc and also to have a clear picture of interrelated existing facilities available & any other specific requirements/data/document for successful execution of this job, prior to submission of offer. It is considered an essential pre-condition. No extra claim shall be entrained after the award of contract on account of ignorance of site conditions. Bidder shall submit confirmation letter for the same in their Bid.
- ii) Bidder must check site specific ammonia vapour and liquid quality in view of Existing Horton sphere and all protections to be taken care for offered Horton sphere along with its refrigeration System.

2.0 SCOPE OF SERVICES:

BIDDER'S scope of services shall include but not limited to the following:

- a. System engineering, preparation of heat and mass balance diagrams across all items along with calculations, system wise Design Criteria document, PFD, P&ID, Utility Balance Diagram, system interlock logic diagram with its description, Line list, Load List, Hazardous area classification diagram, All equipment and instrument data sheets, piping layout, Isometric, piping plan, Pre-commissioning, Commissioning operation & maintenance manual, Sensitivity Study, Plot Plan etc.
- b. Detailed engineering comprising of plant layout piping stress analysis, Dynamic Analysis, Civil and Mechanical structures etc., Electrical/Instrumentation layouts.
- c. Bidder shall carry out HAZOP Study for the entire New Horton Sphere package along with refrigeration system. The Independent chairman for the HAZOP study shall be appointed by the Bidder after consultation / Approval from Client. The Bidder shall incorporate all the recommended safe guards of HAZOP report.
- d. All civil foundation, Building, Pavement, drainage, & all other Civil works.
- e. Preparation of Documentation and obtaining OWNER / PMC reviews for the same.
- f. Overall Project Management and progress reporting to OWNER / PMC.
- g. Control write up with logic diagram for Horton sphere with Refrigeration System
- h. Coordination with statutory authorities and arranging all approvals well in time.
- i. Site clearing including removal/utilization of existing foundations, if any and cleaning
- j. Establishment of site office complete with all facilities and communication network.
- k. Dispatch and transportation of equipment, consumables, construction aids and other materials to site.
- l. Procurement of raw material and bought out components
- m. Manufacture, fabrication and assembly at site.
- n. Inspection and testing including third party
- e. ~~Storage, transportation, unloading, security and handling at site.~~

	BIDDER'S SCOPE OF WORK INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/2.0		
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- p. Complete civil work construction.
- q. Erection and installation of the complete Package.
- r. Surface preparation, Painting, Insulation, cladding.
- s. Flushing and cleaning
- t. Engineering for interfacing all the inputs and outputs.
- u. Hooking up of all services with battery limit INTERFACE.
- v. Mechanical completion
- w. Pre-commissioning activities and rectification
- x. Commissioning and reliability run
- y. Handing over the plant to the owner
- z. Performance guarantee testing
- aa. Discrepancy correction
- bb. EOT/Overhead Crane and other lifting machines/tools of suitable capacity for carrying out future maintenance work of Horton sphere.
- cc. Access road damaged during plant revamp will be repaired fully to the satisfaction of owner. During site visit bidder must check available roads and provide acceptance. Drain water system will be available as per site conditions. Bidder to provide discharge quantity of construction water and rain water and check existing system for accommodating same.
- dd. Construction power and water will be provided as per electrical and civil philosophy

3.0 BATTERY LIMIT INTERFACE



Bidder shall prepare piping interface drawing for all incoming & outgoing Feed & Utility lines. All incoming & outgoing lines shall be provided with double block & bleed valve with flow measurement.

3.1 Instrumentation interface and interlocking:

All instrument & controls, analysers with remote indication for safe, efficient operation and maintenance code requirement etc. For details, refer **Instrument Design Philosophy (Section -8.0)**.

3.2 Electrical System Interface:

Two (2) no of 415 V Outgoing feeder panels of 1600 A rating shall be provided by NFL rest all electrical system shall be under the scope of bidder. Electrical System Interface shall be as per Electrical Specifications and **Electrical Design Philosophy (Section – 7.0)**, which also includes complete supply system required for new Horton sphere with Refrigeration system. The battery limit interface defined above is minimum. BIDDER is cautioned to account for all the Battery Limit interface points that shall complete the package and thus are deemed to be in BIDDER's scope of services and supply. The Bidder/ Representative may visit the site to assess the existing electrical system and the space availability if necessary.

	BIDDER'S SCOPE OF WORK INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/2.0		
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4.0 OWNER'S OBLIGATION

- i) Utilities like – Nitrogen, Instrument Air (Dry Air), Service Air, Cooling Water, LP steam, Service Water, Electric power etc. which will be made available at the B/L (Hook-up with existing system). However Bidder to indicate requirement of these utilities along with offer.
- ii) Existing Ammonia Transfer Pumps and Product heaters to be used for both the Horton Sphere Existing one and proposed New Horton Sphere.

5.0 DELIVERABLES AFTER AWARD OF THE CONTRACT



The deliverables to be submitted after award of contract as applicable for new Horton sphere facilities shall include but not limited to the following:

5.1 Process Deliverables

- Process Description
- Basis of Design
- Process Flow Diagram with Material & Energy Balance
- Raw Material & Utility Balance Diagram
- P & I Diagram
- Line & Valve Lists
- Hydraulic Studies & calculations
- List of Equipment, Machinery, Motor & Instruments
- Process data sheets for equipment & machinery
- Trip Logic (cause & effect) Diagrams
- Environment Management Philosophy
- Process Control Philosophy
- Process data sheet for Instruments & control valves

5.2 Mechanical Deliverables

- Specifications for Equipment & Machineries with Material of Construction
- Piping layout General Arrangement Plan & Section Drawings
- Plot Plan
- Detailed Plan Layout (Plan and Elevation)
- Piping Isometrics
- Pipe Stress Analysis Report
- 3D Model for piping, instruments, equipments, structures etc
- Support drawings & support details/ schedule
- Material Take Off
- Purchase orders of all equipments/ machinery, all other items including piping items
- Vendor drawings of all equipment/ machinery and applicable piping items
- Noise Report
- Work order copies of all erection activities

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5.3 Materials/ Corrosion Deliverables

- Corrosion Engineering Report (including material selection guidelines)
- Painting Specifications including specification of paints as applicable.
- Cathodic protection for underground header, if applicable.
- Welding Procedures
- Insulation specifications

5.4 Electrical Deliverables



- Single Line Diagrams
- Electrical /Lighting/Cable Route Layout
- Area Layouts (Electrical Equipment, Area Lighting, Street Lighting, Cathodic Protection, Cable Layout & Earthing System etc.)
- Substation/Area Key Line Diagrams
- Hazardous Area Classification (Both Reports and Drawings)
- Electrical Control and Wiring Diagrams
- Electrical Material Take Off
- Purchase orders of all equipment/ machinery and all other items
- Vendor drawings of all equipment/ machineries and applicable electrical items
- Specifications of Motors & Electrical Equipment for main plant and off-sites / utilities plant.
- Work order copies of all erection activities

5.5 Instrumentation deliverables

- Purchase specification of all instruments, control valves, control and logic system
- Loop drawing, installation diagram, hook-up sketches, cable schedule, and junction box wiring details.
- Instrument layout drawings (Electronic insts, TC/RTD, Junction box, Air distribution pot)
- Vendor's drawing for instruments, valves and packages items
- Interconnection drawing
- Bill of materials for instrument erection materials like pipe, pipe fittings, cables, cable trays junction boxes, compression fittings, air filter regulators, instrument valves etc.
- Work order copies of all erection activities

5.6 Civil Deliverables

- Design Report (Including Calculations) for Foundations and Structures
- Detailed Foundation & Structural Construction Drawings
- Specification, MTO for Civil/Structural Materials
- Layout & Detailed Design Drawings for Foundations, Structures, Anchors, Supports,
- Platforms, Ladders, Stairways, Walkways & Buildings etc.
- Pipe Rack & Pipe Support Detailed Drawings
- Cable Trench Detailed Drawings
- Site Drainage Plan Drawings

	BIDDER'S SCOPE OF WORK INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/2.0		
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- Drawing for Foundations, Reinforcement & Reinforcing Bar Schedules
- Drawings for Cooling Tower Basin including specification of anti-corrosive paint.
- Building Drawings, if applicable.
- Detailed Drawings for Roads and Paving
- Detailed Drawings for Underground Services
- Bill of Quantities for Civil / Structural
- Soil Investigation Report
- Final Calculation for Piles, if required, Foundations, Buildings, Structures
- Work order copies of all erection activities

5.7 Operational Deliverables

- Commissioning, Operation & Maintenance Manuals for all facilities
- Vendor's Catalogue/Manuals
- HAZOP Study Report
- Emissions, Discharges & Wastes Study Report
- As Built Drawings / Documents
- Testing/Certification Documents
- Pre-Commissioning / Commissioning Report

BIDDER shall furnish complete list of drawings/documents to be submitted after award of contract indicating different categories e.g. For Owner's approval, for reference/information etc for the system. All documents need not be approved by the owner. The documents to be approved by owner shall be mutually agreed between owner and the successful bidder.



6.0 DRAWINGS AND DOCUMENTS ISSUED FOR CONSTRUCTION

Contractor shall provide, construction drawing/document, technical procedures and specifications signed & stamped as "APPROVED for Construction" to confirm that the drawings/documents are certified in all respects and in all details. Drawings and documents issued by Contractor for construction purposes, after review by Owner, shall be sufficient from all respects and shall be so detailed in order to perform and execute all activities satisfactorily for construction/erection, pre-commissioning, commissioning and all modes of operations of the Plants, Machinery and Materials included in the Plants.

7.0 PROCUREMENT

Contractor's scope includes ordering, all import formalities, fabrication/purchase of equipment and materials, port clearance, packaging and transportation to site, stores management. Items contemplated for fabrication at site to be submitted along with the bid although both these aspects would be covered under the Contractor's responsibility.

Vendor manuals relating to installation, operation and maintenance and test certificates should be necessarily sent along with equipment.

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Before ordering, approval for technical portion would be taken from OWNER/PMC in respect of the critical equipments (special equipments) comprising of mechanical static and rotary equipments, electrical and instrumentation items.

8.0 INSPECTION

The Contractor is required to organise a proper inspection and expediting system so as to ensure timely delivery of all the items/equipment meeting the specified quality criteria. This function has to be carried out by appropriate deployment of qualified personnel who have wide experience in their respective fields. Inspection of all items supplied under this contract shall be carried out by independent third party inspection agencies like Lloyds/ BV/ TUV/DNV. Third Party Inspection shall be done by owner approved third party inspection agencies.

9.0 EXPEDITING

Expediting is one of the vital activities of successful and efficient procurement system which enables timely execution on the project. Such expediting has to be carried out by deployment of expediting coordinator, to enable this function to be very effective and fruitful, following functions are to be carried out as a minimum.

9.1 Expediting Coordinator



Expediting Coordinator will liaison with various departments such as purchase, projects, engineering, transportation etc. on one hand and regional inspection/expediting offices and vendors on the other. The basic functions of such expediting coordinator would be:

- Maintain effective communication link between various departments of the Contractor including his regional offices and vendors on whom the orders are placed.
- Status maintenance of all the orders.
- Analyzing the order status in detail after identifying the critical order and initiation of suitable remedial measures.
- Acting as an effective instrument in final delivery of the item within contractual delivery date (CDD).

10.0 QUALITY ASSURANCE SYSTEM

All work/services to be performed by the Contractor under this contract shall be of specified/approved quality and Contractor shall have a quality assurance/quality control (QA/QC) system during the performance of various activities such as engineering, procurement, tendering, construction etc. Review/approval of activities by Owner/PMC shall not however dilute the responsibility of Contractor for maintaining quality.

The objective of the quality assurance scheme of the Contractor shall be to ensure the conformity of equipment, material, site construction (if any) to various standards, specifications, drawings and technical requirements that are being mutually agreed between the Contractor and Owner/PMC. Quality Assurance System should clearly indicate the organisational approach for quality control and quality assurance of the various equipment/construction activities (if any) and also provide a verifiable evidence of the Contractor having carried out all the activities laid down in the bid document and the procedure. Such conformity to

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quality level shall be ensured by controlling the quality level of purchased items at vendor's/sub-vendor's shop/site and shall cover from source surveillance to final inspection. The Contractor to submit a detailed inspection and testing plan for various shop/site activities for review by Owner/PMC/TPI.

10.1 Inspection through an Approved Third Party Inspection Agency:

Inspection requirements of supplied material / equipments etc. at various vendors inspection sites shall be fulfilled through Owner/PMC approved Third Party Inspection Agency. Further, the responsibility for inspection/testing as per specification approved documents and agreed Quality Assurance procedure and plans shall be that of the Contractor. Inspection activities of the Third Party Inspection Agency shall be coordinated by the Inspection Coordinator of Contractor.

11.0 PROJECT PLANNING, SCHEDULING & MONITORING:

The Contractor is required to institute and maintain a proper planning, scheduling and monitoring system and employ professionally qualified and experienced planning engineers for the project. The system shall have latest state of the art technique. To this effect, Contractor shall implement this system through the Prima Vera Project Planner. The system developed should be capable to support and enforce proper control mechanism in the project. It should be based on hierarchical breakdown of works with elaborate level of detailing and control. The levels of controls should be such that it supports and foster controls at activity level, function level and management level with greater emphasis on target, scope and commitment at various stages of contract for accountability and action planning. Such multi-level/ multi-tier system of planning, scheduling and monitoring, supports, effective information generation, assimilation, summarisation and reporting in proper and adequate manner.

Weekly Reports & Daily Reports, mainly consisting of important activities at site, Material/equipments receipts, Labour deployment report, etc. shall be prepared and submitted by the Contractor for Owner's/PMC's review/approval at various stages of the project.

12.0 TRAINING OF OWNER'S PERSONNEL

It is envisaged that implementing a comprehensive training scheme from the Contractor will enable the Employer to have a well equipped staff set up for carrying out the compressor, Horton sphere, PLC etc. operations and maintenance of the system. The Contractor shall provide training to owner's personnel for each installed specialised equipment / system and its maintenance & sustained operation of Horton sphere facilities before handing over the system to owner.

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PART II: TECHNICAL



SECTION – 3.0

PROCESS DESIGN BASIS

**PLANT: NATIONAL FERTILIZERS LIMITED, NFL, NANGAL,
PUNJAB**

**PROJECTS: INSTALLATION OF NEW 2500 CUBIC METER
CAPACITY HORTON SPHERE FOR STORAGE OF
AMMONIA ALONG WITH ITS REFRIGERATION
SYSTEM AT NFL, NANGAL**

REV.	REV. DATE	EFF. DATE	PURPOSE	PREPD.	REVWD.	APPD.
0	17.04.2023	17.04.2023	ISSUED FOR NIT	UNM	KR	MN
P	06.10.2022	06.10.2022	FOR CLIENT REVIEW	UNM	KR	AKG



 पी डी आई एल PDIL	PROCESS DESIGN BASIS INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/3.0	0	 एन एफ एल NFL A Navratna Company
		DOCUMENT NO	REV	
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CONTENTS

SECTION NUMBER	DESCRIPTION
1.0	Brief Specification
2.0	Horton Sphere Package
3.0	Design Data
4.0	Fire Fighting System
5.0	Utilities
6.0	Equipment List

LIST OF ATTACHMENTS

ATTACHMENT NUMBER	DESCRIPTION	NUMBER OF SHEETS
PC281-4040-PID-0020 Rev 0	Piping & Instrumentation Diagram	1

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	INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	DOCUMENT NO	REV	
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1.0 BRIEF SPECIFICATION

1.1. PLANT DESCRIPTION

The Horton Sphere Package for Nangal shall consist of 1 (One) No. Horton sphere along with refrigeration system including all hookups with existing system and associated facilities, as required.



Package Bidder's battery limit shall be considered from hookup points from existing facilities.

Capacity of Horton Sphere shall be 2500 m³ (Equivalent water capacity) at about 3.5kg/cm² (g).

Since the Hookup of all facilities from existing system is included in Bidder scope, Bidder shall calculate the temperature & Pressure required of Ammonia along with other utilities to take care pressure drop from Hook-up from existing system to proposed facility. (To be confirmed by Bidder based on pressure drop from Existing system to hook – up point to meet pressure / temperature requirement at hook – up point). Bidder shall confirm the same accordingly.

1.2. Process and utilities parameters at interconnections(Refer P&ID no PC281-4040-PID-0020 Rev 0):

Sr. No.	Existing Line Number with size & other detail which Hook - up is envisaged	Operating condition		Design condition		
		Pressure (Kg/cm2g)	Temp (°C)	Pressure (Kg/cm2g)	Temp (o C)	
1.	Liquid Ammonia in to New Horton Sphere from ammonia syn. unit	150-AL-24-003-40.8NA (6" – LTCS)	29	(-)4degC		
2.	Liquid ammonia at Existing Transfer Pumps suction	250-AL-24-008-40.8NA (10" – LTCS)	3.5	(+)1	3.85	(-)30
3.	For Vent Stack (PSV Discharge/ any other in line with existing system	150-V-24-032-16.6 (6" – CS)	0.1	(+)40	3.5	(-28) /206
4.	Cooling Water supply	200-WC-24-001-10.5 (8" –CS)	2.6	33	6	75
5.	Cooling water Return	200-WCR-24-001-10.5 (8" –CS)	1.4	43	6	75
6.	Instrument air	50-IA-24-001-16.3	7.13	40	10	120

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		(2"- SS)				
7.	Plant air	50-UA-24-001-16.6 (2" –CS)	6.5	43	9.9	75
8.	Service water		3	17	5	47
9.	Nitrogen	50-N-24-001-16.6 (2"-CS)	3.5	13	10	75
10.	L.P Steam	50-S-2.5-24-001-10.6S (2-CSIBR)	2.5	146	4.5	176
11.	Fire water	Existing header	8	25	10.5	65
12.	From Tanker Loading/unloading header	150-AL-24-001-40.8NA---(6"-LTCS)	17	1		
13.	Vapour line to ammonia tanker	80-AG-24-008-25.8NA (3"- LTCS)	17.5	1		
14.	Liquid ammonia line from condenser to Horton sphere	80-AL-24-032-40.8NA (3"- LTCS)	17.5	44		
15.	Ammonia vapour line for refrigeration compressor	150-AG-24-001-25.8NA-(6"-LTCS)	3.5	1		
16.	PV-29 pressure control line	150-AL-24-021-40.8NA (6"-LTCS)	39	1		
17.	Vapour line from inert gas chiller	80-AG-24-014-25.8NA (3"-LTCS)	17.5	1		
18.	Ammonia return line line from unit(i.e Nitric acid plant)	80-AL-24-007-40.8NA (3"-LTCS)	39	19		

Note:

- a) Instrument Air receiver along with safety valve, pressure indication shall be provided for safe shutdown of Horton Sphere system. Bidder to give the design calculation.
- b) All instrument air/ Instrument air receiver piping shall be of stainless steel.

2.0 HORTON SPHERE SPECIFICATION

2.1 Ammonia Horton sphere with associated facilities:

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Type	Horton sphere
Quantity	One (1) no.
Capacity	Capacity : 2500 m ³
Operating Pressure/Temp	3.5 Kg/cm ² g / (+) 1 deg C
Design Pressure/Temp	3.85 Kg/cm ² g / (-) 30 deg C
Size	17000 mm(ID)
MOC	LTCS
Design Code	ASME Section VIII Division 1 Latest edition
Fluid Handled	Ammonia

2.2 System Facilities:

Liquid ammonia is primarily received from as per existing philosophy from Ammonia synthesis section. Receipt of ammonia is also from existing truck unloading system. For new Horton spheres ammonia is received through tie-ins with existing pipelines for both the cases (Refer P&ID no PC281-4040-PID-0020 Rev P).

The Horton Sphere shall operate at about 3.5kg/cm² (g) pressure and shall be equipped with a dedicated package Refrigeration system.



Following operating conditions may be considered :

- In normal running condition ,The 39.5 t/h of ammonia produced in the ammonia synthesis section is expanded from 29kg/cm²g to the storage pressure of 3.5 kg/cm²g which corresponds to an evaporation temperature of (+) 1°C .
- Total 89.5 te/hr ammonia i.e 39.5 te/h of ammonia produced from the ammonia synthesis section at 29kg/cm²g and additionally 50 Te/hr receipt from LP storage are expanded
- Total 49.5 te/hr ammonia i.e The 39.5 t/h of ammonia produced in the ammonia synthesis section at 29kg/cm²g and additional 10 Te/hr ammonia transfer from Ammonia Road Tanker at 15-17 kg/cm²g pressure are expanded to 3.5kg/cm²g , which corresponds to an evaporation temperature of (+) 1°C.

In normal condition The 39.5 t/h of ammonia produced in the ammonia synthesis is expanded from 29 kg/cm²g to the storage pressure of 3.5 kg/cm²g, which corresponds to an evaporation temperature of (+) 1°C. By the expansion most of the inert-gases get free. Additional ammonia gas is formed by the expansion and heat transfer to the ammonia in the storage sphere.

Liquid ammonia from tanker is unloaded from tanker with the help of pressure reduction at storage condition and vapour generated in the process is taken to refrigeration system as described below.

These gases are sucked from the sphere F-2401A by the compressor (2W+1S) of ammonia refrigeration system and are compressed to a condensing pressure of 17.7 ata. The hot gases are cooled and the main part of ammonia is condensed in the

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ammonia condenser (included in ammonia refrigeration package). The condensation takes place by means of cooling water, which flows through the tubes of the condenser, whereas the ammonia condenses on the shell side from where it goes to the NH₃ receiver included in ammonia refrigeration package). The non-condensed gases are led to the inert gas cooler (included in inert gas cooler), where further ammonia condensation takes place. This gas from condensers flows through the tubes in the inert gas cooler whereas in the shell side ammonia liquid vaporizes at 1°C, which flows towards the sphere from where it is finally sucked to the compressor again. The inert gases still containing a small amount of ammonia gas are led to flare via pressure control, which controls the tube side pressure of the inert gas cooler i.e. the control of entire high pressure loop. The condensed ammonia is led to the shell side for this cooler. The ammonia liquid required on the shell side of the Inert gas cooler comes from the receiver and is controlled by level controller.

The excess of ammonia liquid in the receiver is expanded via a float valve to the Horton-sphere. The distribution of the ammonia is carried out by the transfer pumps G-2401/02/03/1.43PC1. These pumps take off the ammonia liquid from the Horton sphere and increase the pressure to 40 ata via the ammonia cooler (product heater), where the ammonia is heated up to 19°C. The ammonia liquid is distributed to the Urea and Nitric acid and ammonium Nitrate plants.

In the ammonia heater the ammonia liquid from the Ammonia refrigeration Receiver is sub-cooled to 6°C. The sub-cooled NH₃-liquid flows to the process ammonia chillers and ammonia vapors are again sucked by the Ammonia refrigeration compressor.

During normal operation, one of the compressors and refrigeration condensing system remains in line. Since the liquid ammonia pumps are in parallel operation, the emergency valve XV-24101 installed on pumps suction line shall close automatically only when all the pumps trips. Under normal operation two pumps are kept as standby.



New Horton sphere discharge line is hooked up with existing pump suction. In normal condition, Both the Horton spheres shall be inter-connected and shall be working in unison. When any Horton Sphere (Existing/new) is not running or under maintenance, the other Horton sphere shall be used for storage and supply of entire ammonia product with either new refrigeration system or existing refrigeration system.

Process safety and control for new Horton sphere system

Pressure & Level Control

Operation of the system is monitored and controlled with the following interlock & control system. The pressure of Horton sphere is being maintained at 3.4 Kg/cm² (g).

- I. F2402A Horton sphere pressure shall be monitored with the help of PT-24203A, PT-24203B & PT-24203C. High pressure alarm (PAH-2003) shall be generated when reaches to high limit value to the operator.
- II. When pressure reaches further higher (Horton sphere pressure High-High) PAHH with 2003 logic will start automatically the NH₃ compressor in ammonia refrigeration package system being used for Control Horton sphere pressure by converting vapour

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into liquid. At the same time, the annunciator lamp of high-high of Horton sphere pressure installed in local control room will glow.



- III. At low-low pressure of ammonia PALL-24203 shall stop NH₃ compressor in ammonia refrigeration package system through 2oo3 logic system & the annunciator lamp of Horton sphere installed in local control room will glow.
- IV. Level of Horton Sphere shall be monitored and indicated with the help of following.
 - a) Level Transmitter (DP type): Tag- LI-24201
 - b) Level Transmitter (Servo) : Tag- LI- 24202

When LI-24201 reaches to preset high limit value as mentioned above, it will generate alarms to the operator.
- V. Either Horton sphere pressure (PAHH-24202_2oo3) or level of Horton Sphere (LAHH-24201) or both reaches to High-High limit value as mentioned above, the unloading valve XV-24202 gets closed. The annunciator lamp of high-high of Horton sphere level installed in local control room will glow.
- VI. Two safety relief valves (PSV-24201 & PSV-24202) on new Horton sphere have been considered for release of any extreme over pressure situation and routed to existing flare stack. Safety relief valves shall be sized for fire case scenario.

2.3 Ammonia Storage Refrigeration Compressor System (New) (Re-liquefaction):

To control Horton sphere pressure and removal of inert present in NH₃ gas: The ammonia gas and the inert are sucked off from Horton sphere by the compressor and then compressed to a pressure of 17 Kg/cm²g at which it can be condensed by cooling water. First the main part of ammonia gas is condensed in ammonia condenser and sent back to Horton sphere, a further part is liquefied in the inert gas cooler (new) against vaporizing ammonia.

- I. New NH₃ compressors can be started manually from local panel and automatically through the logic of the compressor vendor.
- II. For starting compressors automatically, Auto On/Off button provided in local control panel has to keep in auto on.
- III. As per suction pressure/ Horton sphere vapor pressure, NH₃ compressors can be started (PAHH24202_2OO3) and stopped (PALL24202_ 2oo3). Further, the loading or unloading of compressors is being done through the logic specified by compressor vendor.
- IV. In ammonia condensation section, NH₃ liquid gets accumulated in NH₃ condenser (new) & Ammonia receiver (new) respectively. The level of NH₃ condenser is being controlled by level controller through level control valve. Accumulated NH₃ shall be sent to Horton sphere through level controller of ammonia receiver.
- V. The Compressor outlet pressure is being controlled by Pressure control valve installed at new Inert gas Cooler. The excess left over vapours of NH₃ & inert in inert

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gas cooler are being sent to cold flare stack through PIC control to maintain the compressor outlet pressure.

2.4 Horton Sphere Isolation:

- I. For isolation of new Horton sphere, isolation philosophy for existing Horton sphere shall be followed with trip buttons.
- II. On pressing any trip button, XV- 24201 gets (main outlet valve of Horton sphere) closed & all transfer pumps get tripped.

2.5 Unloading Of Tankers:

- I. The pressure and level of Horton sphere should be kept normal to open XV-24202.
- II. If pressure of ammonia tanker is low, the vapor left after ammonia condensation in re-liquefaction section can be used through the pressure control valve PIC- 24204 for unloading the tanker.
- III. The unloading of NH₃ is being done through XV-24202.

2.6 Plant Emergency Shut Down:

Plant emergency shutdown shall be done manually through trip button as per existing philosophy

Low temperature Carbon steel (seamless) Class piping for handling of Ammonia with insulation shall be provided as per Vendor's standard.

2.7 INSTRUMENTATION AND CONTROL

For details, refer Instrument Design Philosophy (Section -8.0)

3.0 DESIGN DATA



3.1 SITE CONDITION

Site Location

Country	India
State	Punjab
District	Roopnagar (Ropar)
Place	Nangal
Longitude	31 ⁰ 23"7.0656" N
Latitude	76 ⁰ 22"29.6148" E

Weather Conditions

Mid October to March	36.7 °C at humidity: 90% (max) and 11.1 °C at humidity: 92% (min)
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April to Mid June	46.7 °C at humidity: 69% (max) and 16.7 °C at humidity: 87% (min)
Mid June to Mid October	40.0 °C at humidity: 84% (max) and 26.7 °C at humidity: 84% (min)

Atmospheric Pressure, mbar

Maximum	735 Torr
Minimum	720 Torr
Design	725 Torr

Rainfall, mm

Annual Rainfall	1097.5 mm
Maximum Rainfall in 24 hrs	114 mm
Design Rainfall Intensity	94 mm on 01.09.2016
for 1 hr duration, mm/hr	Owner to Specify mm

Temperature, °C

max °C	48
min °C	1
Design / Humidity	
Winter % relative	Min 42%
Summer % relative	Max 100%

Design Air Temperature (For electrical equipment system)

Design Temperature	50°C
RH	100 %

3.2 POLLUTION CONTROL

Air Effluents & Water based effluents as per MINAS, CPCB and PPCB norms

3.3 NOISE LEVEL



Noise generated shall not exceed 85 dBA at 1 m distance from the source of individual equipment under normal range of operating conditions.

4.0 FIRE FIGHTING SYSTEM

Bidder shall provide electronically operated, fully automatic, latest extinguishing system for storage facility fire fighting with alarms and trip interlocks. Ultra Violet detectors as well as heat detectors are to be provided for Fire detection. For detail fire detection and protection system under this package refer the section - Design Philosophy – Fire Fighting System.

2 out of 3 voting logic of fire and gas detection system is to be considered for tripping of facilities.

5.0 UTILITIES

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All required Ammonia & Utilities shall be supplied at the battery limit (i.e. Hook up point) of HORTON SPHERE by client, Bidder to take hook-up from all Utilities & Ammonia. Ammonia & all utilities shall be provided with double block and bleed arrangement for positive isolation at HORTON SPHERE B.L. by Bidder. All tie-ins may be taken up in shutdown prior to Hook-up Shut down.

The following utilities shall be available for the HORTON SPHERE:



- i) Ammonia
- ii) Service water / Make up water
- iii) Cooling water
- iv) Service / Plant air
- v) Dry Instrument air
- vi) Nitrogen
- vii) LP Steam
- viii) Fire Water
- ix) Drinking water

Bidder to furnish all utilities consumption such as power, CW, Nitrogen as etc.

Incoming Ammonia, Instrument Air, Cooling water, etc shall be provided with DCS indication of Pressure, Temperature & Flow at HORTON SPHERE Battery Limit (Hook-up point).

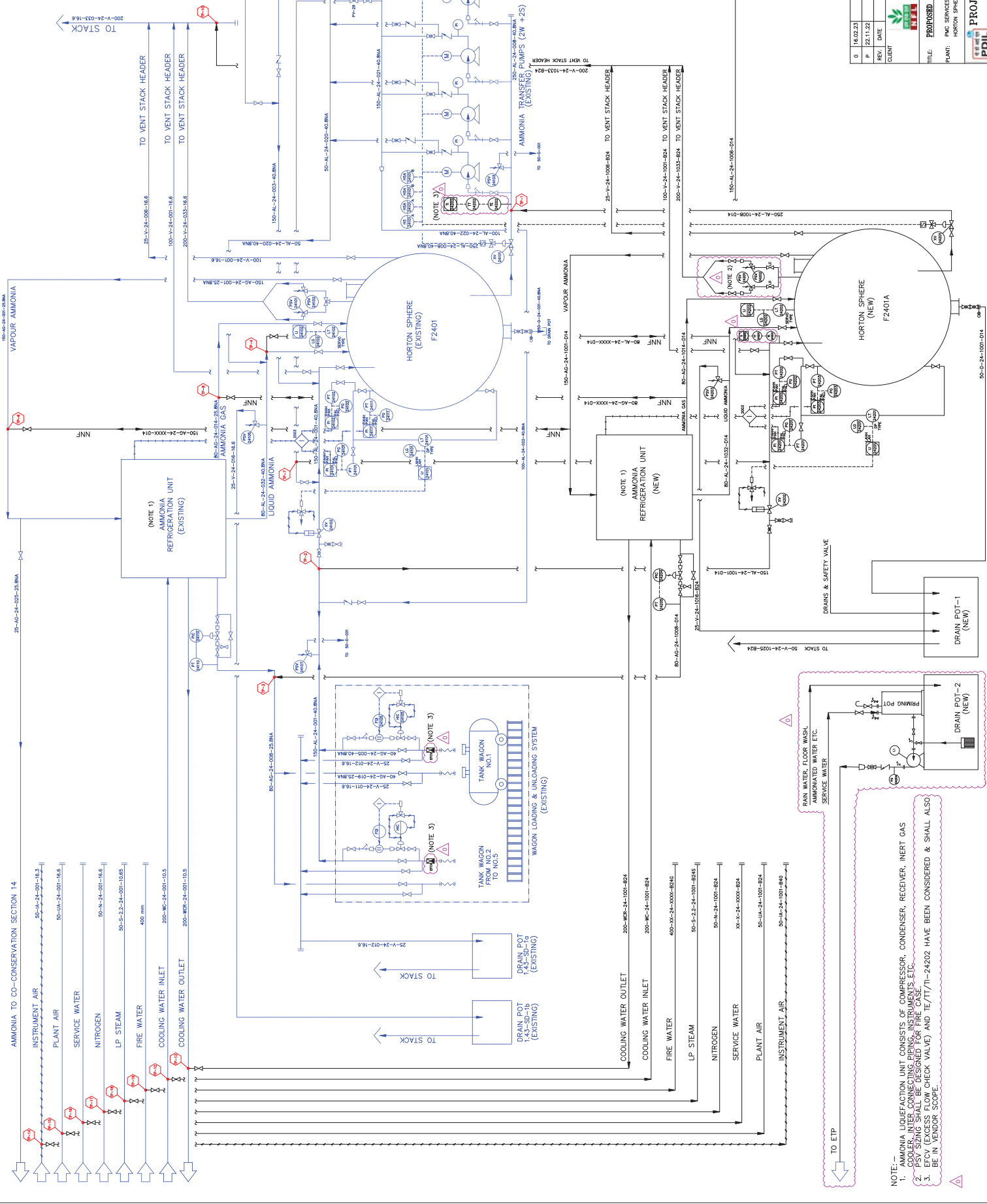
6.0 EQUIPMENT LIST:

Sr. No	Equipment tag no.	Equipment Name	Nos	Brief Description	Remarks
1.	F-2401(A)	Ammonia storage Horton sphere	1 W	Type : Horton sphere Capacity : 2500 m3 Size = 17000 mm(ID) Material of Construction: LTCS Working Pressure:3.5 kg/cm2g Design Pressure : 3.85kg/cm2g Design Temperature: (-)30 degC	
2.	1.43 AUF HE-I(A)/E2401(A)/E2401B(A)	Ammonia condenser	3(2W+1S)	Type: Capacity: 55m2 heat transfer area Size-0.5m IDX 5m length Material of Construction: (Shell, Partition Plate) SA 516 Gr70 (Tube)SA 179 (Tube Sheet) SA 516 Gr70 (Baffles) IS 226	
3.	E 2402 (A)	Inert gas cooler	1	Type: Capacity: 24m2 heat transfer area Diff. Pressure- Material of Construction:	

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				Shell, Partition Plate) SA 516 Gr70 (Tube)SA 179 (Tube Sheet) SA-516 Gr-70 (Baffles) IS-226	
4.	G 2401(A)/ G 2402 (A)/ G 2403 (A)	Ammonia compressor	3(2W+1S)	Type: Reciprocating compressor Capacity: 354 m3/hr Material of Construction: Cylinder-IS 2002 Gr.2A Piston-Aluminum Alloy	
5.	1.43 AUF SR1 (A)/ F 24020 (A)	Ammonia receiver	2	Type: Capacity :0.49m3 Material of Construction: SA 516 Gr70	
6.	1.43-SD- 1a/1.43-SD-1b	Drain pot	2	Capacity:-0.5m3 Material of Construction: Shell-DIN-17155 H II Operating pressure-0.3kg/cm2g Operating Temp.- (+)33 deg c Design Temp:(-)33 deg c	
7.	Drain Pit Pump		1	Capacity-by bidder Head-by bidder Moc-by bidder	

NEW EQUIPMENT / LINE
 EXISTING EQUIPMENT / LINE
 TIE IN POINT
 REVISION



NO	DATE	CLIENT	DESCRIPTION	REV	BY	CHK	APPD
0	14.02.24		CLIENT COMMENTS INCORPORATED				
1	22.11.22		PRELIMINARY ISSUE				
2							
3							
4							
5							
6							
7							
8							
9							
10							

CLIENT: **NFL, NANGAL**

TITLE: **PROPOSED PAID FOR NEW HORTON SPHERE**

PLANT: **PAC SERVICES/PRE & POST-LSTK AMARD-NEW 25000**

PROJECT: **HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL**

SCALE: **AS SHOWN**

PROJECT NO: **P241-440-PP-0090**

FILE:

NOTE: -
 1. AMMONIA LIQUEFACTION UNIT CONSISTS OF COMPRESSOR, CONDENSER, RECEIVER, INERT GAS SOLUBLE TANK, CONDENSING STRIPPER, WASHES ETC.
 2. DESIGN OF ALL EQUIPMENT SHALL BE AS PER DESIGNER'S REQUIREMENT.
 3. EFCV (EXCESS FLOW CHECK VALVE) AND TE/TIT/TL-24202 HAVE BEEN CONSIDERED & SHALL ALSO BE IN VENDOR SCOPE.

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PART II: TECHNICAL

SECTION – 4.0

DESIGN PHILOSOPHY – STATIC EQUIPMENT

**PLANT: NATIONAL FERTILIZERS LIMITED, NFL, NANGAL,
PUNJAB**

**PROJECTS: INSTALLATION OF NEW 2500 CUBIC METER
CAPACITY HORTON SPHERE FOR STORAGE OF
AMMONIA ALONG WITH ITS REFRIGERATION SYSTEM
AT NFL, NANGAL**

0	17.02.23	17.02.23	COMMENTS INCORPORATED	SK	RJ	RRK
P	13.12.22	13.12.22	ISSUED FOR CLIENT COMMENTS	SK	RJ	RRK
REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD

	DESIGN PHILOSOPHY – STATIC EQUIPMENT INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/4.0	0	
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2.0	Equipment Design Basis
3.0	Technical Requirements
4.0	Spare Parts
5.0	Documentation Schedule
6.0	Vendor List

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ATTACHMENT NUMBER	DESCRIPTION	NUMBER OF SHEETS
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Annexure - 2	Inspection (Guidelines)	5

	DESIGN PHILOSOPHY – STATIC EQUIPMENT INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/4.0	0	
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1.0 GENERAL

1.1 SCOPE

1.1.1 This document defines the design philosophy to be applied to the design of various types of static equipment i.e. Horton Sphere, Pressure Vessels, Heat Exchangers, Storage Tanks and Vessel Internals for a **New 2500 cubic meter capacity Horton Sphere for storage of ammonia along with its refrigeration system, interconnection with existing Horton Sphere (F2401) system, at NFL, Nangal.**

1.1.2 The complete design, material of construction/fabrication (shop/site as applicable), inspection, testing, painting, supply, transportation and erection of equipment etc. at project site shall conform to the specifications, drawings and internationally accepted codes / standards duly accepted by the Owner. In addition, all statutory rules & regulations shall also be complied with.

1.2 CODES AND STANDARDS

1.2.1 The equipment shall be designed & constructed as per the latest edition of the following codes and standards:

Code**	Description
ASME Section VIII Div 1 & 2	Rules for construction of Unfired Pressure Vessels
TEMA 'R' / API 660	Standards of Tubular Exchangers Manufacturer's Association / For Shell & Tube Heat Exchanger
ASME Section 1 & IBR	Rules for Construction of Power Boiler & Indian Boiler regulations
API 650	Welded Steel Tanks for Oil Storage
API-653	Tank Inspection, Repair, Alteration, and Reconstruction
API RP 2000	Venting Atmospheric and Low pressure storage Tanks
API 2550	Method for measurement and calibration of upright cylindrical Tanks
ASME Section II A&B/ASTM	Materials Specifications
ASME Section II PART C	Specification for welding rod, electrode & filler metal
ASME SEC II PART D	Properties
ASME Section V	Non-destructive Examination
ASME Section IX	Welding Qualification
EJMA *	Standard of Expansion Joint Manufacturers Association
NACE	National Association of Corrosion Engineers
ASME B 16.5	For flanges
ASME B 16.47	For large diameter flanges
ASME B 16.20	For gaskets
ANSI	Pipes, Flanges, Fittings and Valves
IS: 875/SITE DATA	For wind load consideration
IS: 1893 (Part 4):2015 / SITE DATA	For seismic design consideration
Factory Act, 1948 BS CP 3003	Factory Act & State Govt factory rules Code of Practice on

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Code**	Description
(Part 1)	lining of Vessels and equipment for Chemical Process.
PESO	Petroleum And Explosives Safety Organisation
SMPV (U)	Static and Mobile pressure vessels (unfired) rules 2016 or latest

*- Except for heat exchangers, while for heat exchangers the expansion bellows shall be designed as per TEMA standard.

** Any conflicts between documents, including regulations and codes, shall be brought to the Purchaser's Attention for resolution

NOTES:

- LSTK Contractor may select DIN, BS or any other well known international materials as substituted materials to ASTM/ASME ones, if they are equivalent or superior to ASTM / ASME ones. The chemical & mechanical properties of such equivalent or superior offered materials preferably comparison w.r.t. ASTM materials shall be furnished along the bid. LSTK Contractor shall also submit the references of past supplies of similar type of equipment w.r.t. the proposed materials offered by them in their bid.
- Process licensors guidelines / standards may be adopted complying minimum requirements of this design philosophy of static equipment. Details of such Selected guidelines/standards along with the list shall be furnished in the bid.
- Specifications of all critical equipments including those specified by the process licensor shall be furnished in the technical bid.

1.3 REGULATIONS

Besides codes & standards, LSTK Contractor shall follow National Laws and Regulations such as Indian Boiler Regulation and Department of Explosives, Nagpur, India together with Local by Laws for the state including statutory requirements as applicable. Static and Mobile Pressure Vessel (SMPV) rules as applicable shall also be complied with.

PUBLICATIONS:

NACE MR 0103	Materials Resistant to Sulfide Stress Cracking in Corrosive Petroleum Refining Environments
NACE MR 0175 / ISO 15156	Petroleum and natural gas industries - Materials for use in H ₂ S containing environments in oil and gas production
NACE TM 0284	Evaluation of Pipeline and Pressure Vessel Steel for Resistance to Hydrogen Induced Cracking
NACE TM 0177	Laboratory Testing of Metals for Resistance to Sulphide Stress Cracking in Hydrogen Sulphide Environment
WRC Bulletin # 107	Local Stresses in Spherical & Cylindrical Shells due to External Loadings.
WRC Bulletin # 297	Local Stresses in Cylindrical Shells due to External Loadings on Nozzles

1.4 SITE CONDITIONS

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1.4.1 Climatic and other site conditions as defined elsewhere.

1.5 OPERATING DUTY

1.5.1 As defined in process design basis or elsewhere

1.6 DESIGN DOCUMENTATION

1.6.1 Detailed design calculations considering different loadings shall be made as per code/standards and the additional requirements as mentioned below:-

1.6.2 Design of equipment inside the complex shall be in accordance with the PROCESS LICENSOR'S data sheets and specifications.

1.6.3 Strength calculation shall be performed in latest version of PV-elite software. LSTK contractor/ Vendor shall send soft copy of PV-elite (.pvdb file) along with equipment document submission during detail engineering to PMC/Owner.

1.6.4 LSTK Contractor shall consider the interfaces with other engineering disciplines w.r.t

- Piping Layout/Location Drawings
- Civil / Structural Drawings
- P & ID's
- Materials
- 3D PDS Model for Piping and Equipment Layout
- Hazardous Area Classification

1.6.5 Design philosophy of other disciplines shall be observed and shall be relevant to the extent applicable.

- Civil/Structural Design Criteria
- Piping Design Criteria
- Process Design Criteria
- Electrical and Instrumentation Design Criteria

1.7 SAFETY

1.7.1 Safety standards and features which are inherent in the specific mechanical equipment design codes, standards and regulations are applicable to this criterion. Job Hazard and Operability [HAZOP] as per OHSAS-18001 & Factory Act shall be done during design stage the equipment.

1.7.2 Safety features to be incorporated into the design include, but are not limited to, the following features for equipment:

- Ladder cages
- Safety chain across platform access
- Step-off platforms with Hand Railing where necessary
- Platform grating with adequate thickness
- Toe plates

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1.8 EQUIPMENT FABRICATION

- 1.8.1 Equipment design shall be based on maximizing shop fabrication and assembly where deemed practical. Fabrication in open yard shall be avoided.
- 1.8.2 The LSTK Contractor shall comply in all respects with the provision of the applicable codes / standards and specification during fabrication.
- 1.8.3 Impact test, when required as per code and specifications, shall be carried out on parent metal, weld and HAZ.
- 1.8.4 Production Control coupons, when required as per code and specifications, shall be subjected to all tests like impact, inter granular corrosion test etc., in addition to mechanical test as required. In case of heat treated equipment test coupons shall be given similar heat treatment as for the equipment.
- 1.8.5 Due provisions must be kept for venting out entrapped gases during welding of pads, flanges and liner plates etc.
- 1.8.6 In case of equipment involving site assembly/fabrication the entire site job including loading & unloading at site, fabrication, radiography, heat treatment, Inspection & testing etc. shall be included in the scope of work.
- 1.8.7 All nozzle connections up to DN 10" size shall be made of seamless pipes. For sizes above DN 10" nozzles connection may be rolled from plates with full radiography of welds.
- 1.8.8 No welding, hammering or deforming is permitted on the pressure retaining parts after post weld heat treatment except as permitted by the codes or standards and when approved by the purchaser.
- 1.8.9 Flange facing and thread connection shall be protected against oxidation during HT.
- 1.8.10 All welding shall be done by metal arc welding. For welding on thinner gauge sheets TIG welding is preferred.
- 1.8.11 Gas or Carbon arc welding shall not be used.
- 1.8.12 Welding electrodes of composition similar to Internals material shall be used except austenitic electrodes of higher chromium and nickel content such as AWS A5.4, ASME SFA 5.4 class E309 and E310 may be used for 12-Cr stainless steel. For dissimilar material welding, electrode composition shall be similar to nobler material being welded. Following electrodes shall be used unless specified otherwise:

E 7018	for all CS materials
E 308	for all SS 304 to SS 304
E 308L	for all SS 304L to SS 304L
E 309 MoL	For SS 410S to SS 410S, SS to CS, SS 410S to SS 304, 304L, 316, 316L
E 316	For all SS 316
E 316L	For all SS 316L
E Ni – Cu7	For Monel to Monel and Monel to CS/SS

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1.8.13 Welding wherever specified, is to be done by qualified and approved welders using the suitable fillers and fluxes recommended for the materials in the fabrication drawings. For welding the stud on tray decks and support beams, use of stud welding gun with suitable flux is acceptable. In manually welding of studs, care should be taken to minimize the weld spatter and the outside diameter of the weld so that it should not foul with tray deck or washer. For stud welding, proper welding procedure shall be established. Torque required for welding failure shall be higher than the torque required for failure of the stud.

1.8.14 A proposed Welding Procedure Specification (WPS) shall be submitted to approved inspection agency for approval. On approval, a Procedure Qualification Test (PQT) shall be conducted which shall be witnessed by approved inspection agency. 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, approved inspection agency may accept previously qualified WPS/PQR at his sole discretion.

1.8.15 Longitudinal and circumferential welded seams shall not interfere with nozzle openings, reinforcement plates, saddle pads, and other attachments as far as possible.

1.8.16 MISCELLANEOUS

1.8.16.1 All parts fabricated shall be smooth, true, clean and free from burrs, grease and dents. Openings for passage of workman must have exposed edges rounded.

1.8.16.2 All support rings, bolting bars, beams support brackets and other components which are integral and therefore welded to the column shell inside, shall be supplied and installed by column fabricator.

1.8.16.4 Seal welds shall have a throat thickness at least equal to the specified Corrosion allowance.

1.8.16.5 All stainless steel tray assemblies/internals and their components (e.g. Bubble caps, valves etc.) shall be pickled and Passivated. Pickling and Passivation shall be as per ASTM 380.

1.8.16.6 All parts shall be fabricated in accordance with good shop practice and in uniformity so that all corresponding parts will be inter-changeable.

1.8.16.7 For equipment coming under the purview of Static and Mobile Pressure Vessel rules, it shall be LSTK Contractor responsibility to get complete approval from Chief Controller of Explosives, PESO e.t.c, pertaining to design, drawings, material of construction, fabrication, inspection and testing etc.

1.9 CONSTRUCTION & ERECTION

1.9.1 LSTK Contractor shall follow standard established procedures for handling storage, construction & erection. LSTK Contractor shall strictly follow Manufacturer's/Principal's instructions, approved drawings and procedures for construction & erection and satisfy Principal in all respects of storage, handling, construction & erection of Package. All erection work shall conform to the working/erection drawings (to be prepared by LSTK Contractor) and shall be in conformity with codes & standards as applicable. The LSTK Contractor shall supply & arrange all necessary construction & erection tools and tackles, machinery, scaffolding etc.

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1.9.2 LSTK Contractor shall perform the following:

- i) Before installing the equipment, the foundations shall be checked and wherever necessary, chipping shall be done by the LSTK Contractor. All grouting materials, packing plates/wedges required for the levelling and alignment of equipment, structures & pipelines etc. shall be provided.
- ii) Top of the foundations shall be thoroughly cleaned to the satisfaction of Principal / LSTK Contractor before placing base plates.
- iii) All equipment & structure etc. shall be checked and inspected for its proper levelling and granting (grouting) shall be done with suitable grouting material as required.
- iv) After tightening the foundation bolts, the final level / alignment shall be rechecked and redone, if required.
- v) Installation of all supports and hangers, including concreting or welding as necessary.
- vi) To check correctness of the piping, instruments and other connecting points in the equipment and piping installed
- vii) The welding joints shall be stress relieved wherever necessary as per applicable codes, standards & specifications.

1.9.3 The following shall be arranged and supplied by LSTK Contractor for completion of job. Any other item whatsoever required shall also be included by LSTK Contractor in their scope.

- i) All construction & erection materials, equipment & machinery, scaffolding, consumable, and test equipment etc.
- ii) Cranes/Hydra, temporary lifting beams and spreaders etc.
- iii) Procedures for site assembly, construction & erection including lifting methodology for Owner/Third party approval.

1.9.4 As a minimum contractor shall comply the requirements indicated below:

- i) Fabricate, erect and align the equipment & internals as per applicable codes, standards & specifications. All internals shall be inspected before and after installation.
- ii) Carry out all NDT's required. The Personnel performing NDT's should have a minimum qualification as "NDT LEVEL-II" in the relevant Technique, certified by American Society for Non-destructive Testing.
- iii) Perform non-operating field pressure tests and leak tests on field fabricated equipment in accordance with the applicable codes, standards and specifications ensuring disposal of test media in accordance with instruction/recommendations.
- iv) Notify Owner / Third party of the test schedules for witness the tests by concerned inspector.

1.10 MATERIAL OF CONSTRUCTION

The minimum requirement of the materials shall be as per the plant equipment metallurgy covered under specific process design guidelines. However superior materials as per the recommendation of Process Licensor's may be selected which shall be indicated in the Bid by the LSTK Contractor.

1.10.1 All materials, whatsoever, required to complete the supplies shall be procured by LSTK Contractor and all such materials shall be covered with due identifiable material test certificate.

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1.10.2 Materials used in low temperature service shall be impact tested (charpy V) if required as per design code & specification. Impact test & energy value shall be in accordance with code requirement, unless specified otherwise.

1.10.3 For coarse grained & high tensile materials in carbon steels (UTS>45 Kg/mm²) & low alloy steel, guaranteed impact strength shall be ensured at a temperature 15 °C below envisaged hydraulic test temperature as a precaution against brittle fracture during hydraulic test.

1.10.4 **HEAT TREATMENT**

Heat treatment of formed parts shall be carried out as per following:

For Carbon Steel:

- a. Cold formed dished ends or knuckles upto 16 mm nominal thickness shall be stress relieved.
- b. Cold formed dished ends or knuckles above 16 mm nominal thickness shall be normalised.

For Low alloy Steel: -

- c. Cold Formed Dish ends or Knuckles shall be stress relieved.
- d. Hot formed dished ends or similar parts, which have not been uniformly heated in the normalising range in the final stages of manufacture shall be normalised.
- e. When the completed vessel involves post weld heat treatment, heat treatment recommended in (a) above shall not be applicable.
- f. Vessels in caustic service, Amine or Sour gas service shall be stress relieved.
- g. All internal and external attachments, clips, insulation studs, name plate bracket, and the like shall be welded to the vessel before post weld heat treatment.

1.10.5 All CS & LAS materials including forging used for pressure parts shall be procured in fully killed and normalized condition. CS & LAS materials above 50 mm thickness shall be vacuum degassed except for plate ring flanges.

1.10.6 All SS plates shall be hot rolled & solution annealed and pickled as per SA 480.

1.10.7 All plates above 50 mm thickness shall be examined by UT as per ASTM-A435 at mills for both at surface & edges.

1.10.8 The minimum thickness of weld overlay material (undiluted) shall be 1/8 inch (3 mm) except clad or weld overlay tube sheets and gasket surfaces.

1.10.9 Tube sheets shall have a nominal clad or weld overlay thickness of 3/8 inch (10 mm) but not less than 5/16 inches (8 mm)(undiluted) regardless of shell side or tube side face. The minimum thickness of clad or weld overlay at a pass partition groove shall be 1/8 inch (3 mm) minimum

1.10.10 Weld overlaid nozzle and girth flange gasket faces shall have a minimum thickness of 3/16 inch (4.8 mm) after machining.

1.10.11 All forgings except for flanges as per ANSI shall be UT tested as per ASTM A 388 for the thickness greater than 50mm and shall be procured in normalized / annealed

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condition. Acceptance standards shall be as per 3.3.4 of ASME Section VIII Div. 2. In case any defect is found, no repair by welding shall be allowed.

- 1.10.12 All forgings including nozzle flanges shall be examined for surface defects by MP/PT testing after machining as per ASTM A 275.
- 1.10.13 Tube sheet and Girth flanges must be made in one piece. Segmental butt-weld construction shall not be accepted.
- 1.10.14 Unless more restrictive prescription given by material specification the max. Content for carbon steel used for fabrication as shown by ladle analysis shall be 0.23% for plates, pipes & tubes 0.25% for forging.
- 1.10.15 When post weld heat treatment is required for pressure vessels, all material for pressure holding components shall be simulation tested with minimum additional two (2) heat treatment cycles. Additional two heat treatments are; one for PWHT after shop repairing and the other for future PWHT at site.
- 1.10.16 Unless otherwise specified Copper & Copper alloys shall not be used. Copper content up to 0.4% are acceptable in carbon steel & 0.6% in stainless steel.
- 1.10.17 Top portion of skirt (min. 500 mm height) welded to the bottom dished head shall be of same material as that of shell /head for LAS & SS materials.
- 1.10.18 All directly welded external/internal attachments shall be of same materials as that of equipment, unless specified otherwise.
- 1.10.19 Unless otherwise specified, all internal parts shall be removal type. Internal shall be designed in units as large as can be installed through the nearest upper manhole or opening. The weight of unit shall not generally exceed 40 Kg. except for support beams.
- 1.10.20 Trays, distributors, baffles and support beams shall be designed in such a way that deformation of shell due to operating pressure and thermal expansion does not occur.
- 1.10.21 Bolts and nuts for fixing internals shall be 18/8 S.S and minimum size of bolts shall be M10. All internal bolts shall be provided with locking nuts
- 1.10.22 External parts which are not strength welded to the shell, such as clips for insulation support rings, may be of carbon steel, provided if SS 304 stainless steel pads are furnished between shell & external parts.
- 1.10.23 PWHT of complete vessel shall be carried out in one go in a furnace. Local stress relieving of weld joint in piece meal shall be avoided as far as possible.
- 1.10.24 Steel for Hydrogen service at elevated Temperature & pressure shall be selected as per API 941 & API 934 .The following special requirements shall be met with for Hydrogen/Sour gas as per NACE standard.
- All pressure parts shall be post weld heat treated.
 - Root run shall be liquid penetrant tested. However, Radiography (RT) shall be carried out after completion of full welding of the joint for Pressure parts.
 - Hardness of base metals, weld and HAZ shall not exceed 22 HRC.

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- 1.10.25 For high pressure equipments, in shell & heads, the impurity limit shall be Copper $\leq 0.20\%$ & Nickel $\leq 0.30\%$ for Mo & Cr- Mo low alloy steels while Copper shall be $\leq 0.20\%$ & Vanadium $\leq 0.15\%$ for carbon steels.
- 1.10.26 Girth flanges must be made in one piece. Segmental butt-weld construction shall not be accepted.
- 1.10.27 Unless otherwise stated gaskets used during testing shall be same as specified for operating conditions. After testing, gaskets used during testing shall be replaced by new gaskets.
- 1.10.28 For equipment designed as per IBR, materials shall strictly comply with the requirement of the IBR code.
- 1.10.29 All directly welded external/internal attachments shall be of same materials as that equipment, unless specified otherwise.

1.11 QUALITY ASSURANCE & CONTROL

- 1.11.1 The quality assurance shall be as per the approved procedures, test methods & facilities to be developed by the LSTK Contractor to ensure that the supplied equipment shall be of highest quality. The quality control shall mean that all the tests, measurements, checks & calibration which are to be carried out may be compared with the actual specified characteristics of the equipments/unit /system.
- 1.11.2 Quality Assurance (QA) shall mean the organizational set up, procedures as well as test methods and facilities developed by LSTK Contractor in order to assure that Equipment leaving LSTK Contractor's shop are of the highest possible quality i.e. either equal to or better than the requirement specified.
- 1.11.3 Quality Control (QC), shall mean all the tests, measurement, checks and calibration which are to be carried out in LSTK Contractor's shop in order to compare the actual characteristics of the equipment/unit/system with the specified ones, along with furnishing of the relevant documentation (certificates/records) containing the data or result of these activities.
- 1.11.4 LSTK Contractor shall submit a comprehensive description (manual) of QA/QC measures contemplated by him for implementation with regard to this specification. It is contractual obligation of the LSTK Contractor to develop and implement adequate QA/QC systems.
- 1.11.5 QA/QC system shall cover all products and services required for the equipment as per scope of work including job sub contracted by the LSTK Contractor.

2.0 EQUIPMENT DESIGN BASIS

2.1 GENERAL

- 2.1.1 Design conditions for all equipment shall be in accordance with the Process Licensor's data sheets/specifications. However, in any case design pressure shall not be lower than 10% over the maximum anticipated operating pressure and design temperature should be 25°C higher than the maximum anticipated operating temperature for all equipment unless otherwise specified.

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- 2.1.2 Design pressure is normally specified at the top of vertical vessel or at the highest point of horizontal vessel. The design pressure at any lower point shall be determined by adding the maximum operating liquid head and any pressure gradient within the vessel.
- 2.1.3 Wind forces shall be increased by 20% to cater for the effect of piping system, platforms and ladders etc. Vertical vessels with height/diameter ratio equal to or greater than 10 shall be analyzed for vibration due to vortex shedding when critical wind speed does not exceed 30m/s. For guidelines of Dynamic Wind Analysis refer **Annexure-I**.
- 2.1.4 Forces and moments acting on nozzles shall be considered in the equipment design. Local load analysis of all process nozzles for all equipment shall be carried out as per WRC – 107(for nozzles on dish head) & WRC-297 (for nozzles on cylindrical shell). FEA shall be done for nozzles outside the purview of WRC standard. Forces and moments acting on nozzles shall be considered in the design of equipment and resultant stresses shall not exceed allowable stresses as per applicable codes /standards/specifications. Axial load (p) applied on the nozzle shall be calculated in both negative & positive direction (+/-) and maximum will govern. Nozzle loads applied on nozzles placed on head shall be evaluate with WRC 107 whereas nozzle loads applied on nozzle placed on shell shall be evaluate with WRC 297
- 2.1.5 All Carbon Steel (CS) and Low-Alloy Steel (LAS) pressure parts shall have 3 mm corrosion allowance unless specified otherwise. All internal CS & LAS parts shall have at least 1.5 mm Corrosion Allowance on either side. No corrosion allowance shall be considered for SS. In general, the recommendation of Process Licensor shall be adopted for construction.
- 2.1.6 Design of supports and anchor bolts considering soil and importance factors shall be performed for compressive and tensile loading. In no case shall diameter of anchor bolts be less than M24 for skirt support and M16 for other type of support.
- 2.1.7 Lifting lug, lifting trunion, tailing lug etc. shall be designed with shock factor 2.
- 2.1.8 Bolt of size M 48 and above shall be designed and spaced so as to permit tightening with a hydraulic stud-tensioner. The bolts shall have an extra threaded length at one end of approximately 1 bolt diameter, and shall be provided with threaded projection caps. Hex nuts shall have suitable holes for manual tightening. The requisite no. of hydraulic stud-tensioner device with necessary adopters/insertions based on varying sizes of studs shall be supplied by LSTK Contractor as per mechanical design of the equipment.
- 2.1.9 When shell thickness is 50 mm and above or equipment is under Hydrogen/Lethal service, self reinforced forged nozzle shall be provided.
- 2.1.10 In case of nozzle with butt-end construction, extra length shall be provided to facilitate hydraulic testing and subsequently cutting and edge preparation to suit piping welding at site.
- 2.1.11 Orientation of longitudinal seams and position of circumferential seams shall be clearly marked in the fabrication drawing. Nozzles, support and other attachments shall be located clear of welded joints.
- 2.1.12 LSTK Contractor shall mark tangent lines, the position of the main axis and the centre of gravity for orientation in a clearly identifiable and permanent way on the vessel. Centre of gravity shall be clearly marked.
- 2.1.13 MAWP (Maximum allowable working pressure) of each equipment shall be calculated by bidder .Design pressure for each nozzle shall be sum of maximum allowable working

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pressure and static head of corresponding nozzles. The opening reinforcement shall be so designed as not to limit the maximum allowable working pressure of the equipment. Nozzle also to be checked in deaerated condition as per UG-44 of ASME Sec VIII div-1.

2.2 INSPECTION AND TESTING

2.2.1 Equipment shall be inspected by TPIA (third-party inspection agency). The Inspection and testing shall be in accordance with the relevant codes, standards, specifications, including mandatory NDT requirements indicated under Inspection and Testing clause 2.2.3 & Inspection guidelines (**Annexure-2**). All equipment & bought -out items shall be inspected during various stages of manufacturing starting from identification of materials to final completion as per agreed QAP (Quality Assurance Plan) which shall be prepared by LSTK Contractor and shall duly approved by Owner/ It's authorised representative. In case of site fabricated/assembled equipment same inspection agency shall be responsible for inspection and testing at site. The guidelines for minimum inspection requirements are listed in **Annexure-2** & also defined under Inspection & Testing clause of the design philosophy.

2.2.2 All testing accessories, measuring instruments including NDT testing equipment, etc. shall be arranged by LSTK Contractor.

2.2.3 The following NDT requirements are mandatory in addition to code /spec requirements:

a) UT examination:

- i) All butt-welds in thickness greater than 50mm as supplement to radiography.
- ii) FPW of nozzle attachments of thk. above 50mm as supplement to radiography
- iii) Clad Plates and formed heads from clad plates in all thicknesses

b) MP/PT examination

- i) All edges of plates and opening in shell of CS having thk. above 40mm and LAS/SS having thk. More than 25mm
- ii) Root and final layer of all butt welds
- iii) Fillet welds of 3.5% Ni & SS
- iv) Each layer of weld deposit in SS overlay
- v) Knuckle surfaces of dished ends, expansion bellows and pipe bends

c) Radiography:

- i) All weld seams of formed head, if made in more than one segment shall be fully Radiographed after forming.
- ii) All the welded T- Joints shall be fully radiographed.
- iii) When spot radiography is specified all T-joints & min. 10% of total weld length excluding T-joints shall be radiographed

d) Hardness test on welds of Cr-Mo, Materials after final heat treatment. The value shall not exceed to:

- i) 215 HB for steel having Cr content less than 2%
- ii) 240 HB for steel having Cr content more than 2%

2.2.4 All completed equipment shall be tested hydraulically as per the requirements of Specification/codes in presence of the inspecting authority. Pneumatic test of completed Equipment shall be carried out only when specially mentioned in the specification sheets.

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Chloride content in water used for testing shall not exceed 30 ppm for SS equipment and 40 ppm for CS and low alloy steel equipment. Duration of test shall be 1 hour minimum. After hydro testing stainless steel vessels shall be dried thoroughly immediately after draining to prevent the possibility of evaporation & concentration of chlorides.

- 2.2.5 Hydro testing of all static equipments shall done as per UG 99b of ASME section VIII div. 1 code. Min duration of Hydrotest shall be 60 min.
- 2.2.6 All process equipments shall be supplied with Nitrogen filled. In case of equipment assembled and welded at site, it shall be filled with N₂ after testing at site. Dry Nitrogen shall be filled at a pressure of 0.5 Kg/cm²g and equipment shall be fitted with a pressure gauge and valve along with nitrogen cylinder.
- 2.2.7 Special tools/tackles as recommended by equipment manufacturer shall be included in the scope of contractor. Hydraulic bolt tensioners where specifically recommended by Process Licensor's specification shall be supplied with 4 bolt tightening heads.
- 2.2.8 Equipment under preview of statutory bodies shall be inspected during various stages of fabrication by their authorised inspecting agency. It is the responsibility of the LSTK Contractor to get the design calculations and fabrication drgs. approved by concerned statutory bodies before commencing fabrication.
- 2.2.9 All raw materials shall be inspected at source and test certificates to enable proper identification shall be submitted.
- 2.2.10 Unless otherwise stated gasket during testing shall be same as specified for operating conditions. After testing, gaskets used during testing shall be replaced by new gaskets.

2.3 PAINTING

- 2.3.1 All CS external surfaces of shop fabricated equipment shall be primer and final painted as Listed elsewhere in NIT document.

2.4 PICKLING AND PASSIVATION

All SS material shall be Pickled & Passivated as per following procedures:

2.4.1 PICKLING

Aqueous pickling solution shall be as follows:

Nitric acid (Tech grade)-10 to 25% plus Hydrofluoric acid-1 to 8% (to be used only for stabilized SS grades). Temperature 50 to 60° C for 10% Nitric acid and 20° C for 25% Nitric acid. When size and shape of product permit, total immersion in the pickling solution is preferred. Where immersion is impractical, pickling may be accomplished by wetting the surface by

- i) Swabbing or spraying
- ii) Partial filling the item with pickling solution and rotating or rocking so that the entire surfaces receive the required chemical treatment.

The maximum period for which the pickling solution shall be allowed to remain on the surface is 30 minute. During pickling removal of oxides may be hastened by brushing with a hard fibre or SS wire brush. Over pickling shall be avoided.

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The pickling agent shall be washed off with plenty of water so as to leave no trace behind.

2.4.2 PASSIVATION

After pickling and water rinsing, an aqueous caustic permanganate solution containing NaOH 10 weight % and $KMnO_4$ 4 weight % shall be used for neutralizing pickling solution. This shall be followed by thorough water rinsing.

Water used for pickling and washing shall not have chloride contents exceeding 30 ppm.

2.5 FIRE PROOFING

2.5.1 Fire proofing, if required shall be considered as per Process Licensor's recommendations.

2.6 INSULATION

2.6.1 The equipment shall be insulated as listed in NIT elsewhere.

2.7 OPERABILITY AND MAINTENANCE

2.7.1 Equipment design and layout shall provide for ease of access, operability and maintenance.

2.8 DESPATCH

2.8.1 Equipment intended for ship transportation shall be transported in the hatch of the ship. Suitable seaworthy packing/painting shall be applied to avoid any damage during transportation.

2.8.2 The complete transport, packing & forwarding of equipment shall be the responsibility of bidder. In case of inland transportation, equipment shall be properly lashed/fixd on the wagon/trailer to avoid any damage due to shocks during transport. In case of ODC (Over Dimensional Consignment) movement, ODC sanction for movement either by rail/road shall be arranged by bidder from appropriate authorities.

2.8.3 All spares shall be properly packed, marked & sent separately along with equipment.

2.8.4 Equipment shall be despatched with nitrogen filling. Dry nitrogen shall be filled at a pressure of 0.5 kg/cm²g and equipment shall be filled with a pressure gauge and a valve along with nitrogen cylinder.

2.8.5 Internal surfaces of purged equipment shall be thoroughly dried and free of moisture. All openings shall be sealed and capable of withstanding an internal purge pressure. Purged equipment shall display the warning:

**PURGED OF AIR NOT TO BE OPENED
WITHOUT THE CONSENT OF THE PURCHASER**

2.9 GUARANTEES

2.9.1 MECHANICAL GUARANTEE

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LSTK Contractor shall guarantee the equipment & their components against faulty design with regard to their mechanical adequacy, improper material of construction & poor workmanship for the period specified in contract.

2.9.2 PERFORMANCE GUARANTEE

LSTK Contractor shall stand Guarantee of equipment as per respective technical specifications/Process Data sheets.

3.0 TECHNICAL REQUIREMENTS

PART A - DESIGN PHILOSOPHY FOR PRESSURE VESSEL

3.1 GENERAL

SCOPE

This specification covers the minimum requirements for the design, materials, fabrication, and inspection of welded pressure vessels which are defined in U-I of ASME Code Section VIII, Division 1 Latest Edition and Addenda.

3.2 REGULATIONS, CODES AND STANDARDS

3.2.1 Unless otherwise specified, the design, materials, fabrication and inspection of welded pressure vessels shall comply with ASME Code Section VIII, Division 1 latest edition.

Process licensors guidelines/standards may be adopted complying minimum requirements of this design philosophy of static equipment. Details of such selected guidelines/standards along with the list shall be furnished in the bid.

Vessels will be sized according to inside diameter and 2:1 elliptical heads or hemispherical heads. Minimum inside diameter shall be 500 mm. Top cover shall be flanged if the ID is equal or less than 900 mm.

3.2.2 Vessels shall conform to the requirements of ASME Section VIII Division 1 & 2 Pressure Vessels codes and Technical Specifications mentioned in the design criterion.

3.2.3 Design of vessel skirt shall be based on seismic/wind/thermal considerations and fireproofing/insulation requirements.

3.3 ALLOWABLE STRESS

3.3.1 Vessel stresses during hydrostatic tests shall not exceed 90% of the minimum yield strength of the material.

3.3.2 Vessels to be hydrostatically shop tested in the horizontal position shall be supported adequately to keep local stresses in the shell not exceeding 90% of the yield strength of the material.

3.4 CORROSION ALLOWANCE

3.4.1 For an intermediate head, corrosion allowances shall be added to both sides.

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- 3.4.2 For the inside of shells, heads, nozzles and manholes, the specified corrosion allowances shall be added.
- 3.4.3 For non removable internal parts, the specified corrosion allowances shall be added to both sides.
- 3.4.4 For removable internal parts, the specified corrosion allowances shall be added to one side only.

3.5 HEAD / DISHED ENDS

- a) Dished ends shall be of seamless construction. However, dished ends with one chordal weld seam are acceptable. In such cases, the chordal seam shall preferably be in the middle one third of the blank. Intermediate heat treatment, if considered necessary, shall be carried out by the LSTK Contractor.
- b) Whenever a dished end is made of more than two plates, it must have a crown plate. Whenever a nozzle or a manhole is positioned at the centre of the dished end, the crown plate should be larger than the nozzle /manhole reinforcing pad.
- c) Tori spherical heads shall be used for Pressures up to 6.86 bar (g). For tori spherical heads, ratio of Knuckle to Inside Crown Radius shall not be less than 6 %.
- d) Beyond 6.86 bar g, heads shall be of ellipsoidal type having a ratio of major axis to minor axis 2:1 or hemispherical type. Alternatively, Hemispherical Heads with minimum weld joints may also be used.
- 3.5.2 Vessel skirts for carbon steel vessels shall be designed from the same material as the shell or the head. Vessel skirts for other than carbon steel vessels shall be the same material as the shell or the head for the top 500mm. All skirt supported equipment shall be provided with templates.
- 3.6 Local vessel stress calculations for external structural attachments, such as platform clips, pipe support clips and lifting lugs shall be performed.
- 3.7 Vessels with skirts having eight or more anchor bolts shall be required to be supplied with an anchor bolt template. The template shall be of box type (no annulus type) to avoid problem during final erection and installation. The template shall have adequate strength against deformation.
- 3.8 Design of supports and anchor bolts considering soil & importance factors shall be performed for compressive & tensile loading. In no case, diameter of anchor bolts shall be less than M24 for skirt support & M16 for other type of support.
- 3.9 The lifting lug, lifting trunion, tailing lug etc. shall be designed with shock factor 2.
- 3.10 Maximum permissible deflection for tall vessels/columns when subjected to design wind loadings shall not exceed 0.005 x Vessel height. For guidelines of Dynamic Wind Analysis refer Annexure-I.
- 3.11 For vessels, the minimum thickness of shell & heads, including corrosion allowance shall be as indicated below:

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S. No.	Shell Diameter (mm)	Thickness (Min.) mm	
		CS / LAS	HAS
1	ID < 500	5	3
2	501 < ID < 1200	5	4
3	1201 < ID < 2000	6	5
4	2001 < ID < 2600	8	6
5	ID > 2600	10	8

CS = Carbon Steel
LAS = Low-Alloy Steel
HAS = High-Alloy Steel

3.12 Use of structural steel shall be limited to non-pressure parts only.

3.13 Horizontal vessels of large size and thin wall shell on saddle supports shall be investigated for buckling, local circumferential bending and shear stress. The method of L. P. Zick (Supplement to Welding Research, 1971) may be used for this investigation.

3.14 Manhole/hand hole/blind holes covers shall be equipped with davits or hinges to facilitate handling.

3.15 INTERNALS

3.15.1 All necessary approval on Hydraulic design and internal drawings shall also to be obtained from Process Licensor as applicable.

3.15.2 All removable internals shall be designed so that they can pass through the vessel man-way internal diameter / shell flange if any.

3.15.3 The LSTK Contractor shall meet the process and hydrodynamic guarantee of towers along with their internals. All instruments including of special instruments required to verify the above requirements shall be arranged by the LSTK Contractor.

3.15.4 For an intermediate head, corrosion allowances shall be added to both sides.

3.15.5 Demisters shall be securely fastened to support ring by bolting or clamping.

3.16 ACCESSORIES

3.16.1 Clips for platforms, ladders and piping supports shall be furnished and attached to the vessel by the vessel manufacturer.

3.16.2 Top davits of vertical vessels shall be so designed and fabricated so that heavy valves around the vessels and internal parts of vessels can be removed and grounded without being interrupted by piping and steel structures.

3.16.3 INSULATION SUPPORT RINGS

i) Insulation support rings shall be suitable provided as per the specified insulation thickness.

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ii) Maximum longitudinal interval of insulation support rings shall be 3600 mm when preformed insulating material are used.

3.16.4 Lifting lugs of appropriate size shall be provided to ensure complete safety during erection of the Vessel.

3.16.5 Grounding lugs shall be attached to the vessel support for the ground connection.

3.16.6 **TEMPLATES**

- Templates for vertical vessels with skirts shall be provided for lying out of anchor bolts at site. The template shall have adequate strength against deformation. Template shall be identical to the Vessel Base Frame having double ring.
- It shall be confirmed that markings of the bolt hole orientation on the templates coincides With those shown on the approved drawings.

3.17 **PLATE LAYOUT**

- 1) Shell plate shall be laid out so that there will be minimum of welded seams.
- 2) Longitudinal and circumferential welded seams shall not interfere with nozzle openings, reinforcement plates, saddle pads, and other attachments as far as possible
- 3) Longitudinal welded seams on adjacent shell segments shall be separated by at least 4 times the wall thickness of the thicker plate but not less than 100 mm.

3.18 **CONNECTIONS**

3.18.1 Unless shown in data sheets, nozzles, manholes, and hand holes shall be ground flush and smooth inside the vessel. The edges of internal projections for both nozzles and manholes shall be rounded to a radius of 2 mm minimum. Reinforcement pads shall be external.

3.18.2 Main vessel seams shall not pass through openings for connections as far as possible. When unavoidable, the portion of the weld seam covered by a reinforcing pad shall be ground flush with the parent metal and 100% radio graphed prior to attachment of the pad.

3.18.3 All reinforcing pads shall be provided with at least one telltale hole of NPT 1/8".

3.19 **HEAT TREATMENT**

3.19.1 Fabricated vessels shall be post weld heat treated in accordance with ASME Code Section VIII, Division 1, and requirements specified in the data sheets.

3.19.2 The complete post weld heat treatment procedure including temperature and holding time shall be submitted to the purchaser for review.

- a. All machined surfaces shall be protected against scaling during post weld heat treatment.

3.19.3 All internal and external attachments, clips, insulation studs, name plate bracket, and the like shall be welded to the vessel before post weld heat treatment.

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3.19.4 No welding, hammering or deforming is permitted on the pressure retaining parts after post weld heat treatment except as permitted by the codes or standards and when approved by the purchaser.

3.19.5 Simulation Heat Treatment for the Alloy Steel Material shall be carried out as per the CODE Requirement.

3.20 PICKLING

When specified, all internal / external surfaces of stainless steel shall be cleaned by pickling before hydrostatic test.

- Care shall be taken so that stainless steel surfaces shall not be subject to any scratch or damage during pickling.
- Weld scale and other foreign material deposited on the surfaces shall be removed
- Pickled surfaces shall be completely neutralized, and washed by freshwater

3.21 FABRICATION TOLERANCE

Dimensional tolerances shall be in accordance with the design codes or standards, whichever is more stringent.

3.22 PREPARATION FOR SHIPMENT

3.22.1 All vessels shall be drained, clean, and free of grease, oil, scale, weld spatter, and any other foreign substance.

3.22.2 All flange faces and other exposed machined surfaces shall be properly protected with substantial metal shields or covering against damage during shipment.

3.22.3 All inside surfaces and internal parts of carbon steel shall be coated with suitable rust preventive before shipment.

3.22.4 Test holes of reinforcing pads for nozzles, manholes and saddle pads shall be plugged with steel or plastic plugs.

3.22.5 All threaded connections shall be plugged with threaded round bars or covered with standard pipe caps of the same material as the equipment. Covers, flanges, gaskets, bolts, and nuts furnished by the fabricator shall be shipped in place.

- a. Internals shall be tied or braced as necessary to avoid damage or dislodgment during Shipping and installation.
- b. Baselines indicating four directions with figures of 0°, 90°, 180° and 270° shall be marked by paint on the shell. The paint colour shall be white for carbon steel and black for stainless Steel.

PART B - DESIGN PHILOSOPHY FOR HEAT EXCHANGERS

3.23 SHELL AND TUBE HEAT EXCHANGERS

3.23.1 GENERAL

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a) SCOPE

This specification covers the minimum requirements for the design, materials, fabrication and Inspection of shell and tube type heat exchangers.

b) The Design Philosophy for the Shell & Tube Heat Exchangers shall be read in conjunction with the Design Philosophy for Pressure Vessels, as per Part – A above.

3.23.2 All tubular heat exchangers shall be of the type specified and shall be designed for the service and performance conditions given in the specification or data sheets.

3.23.3 Mean metal temperature of tube & shell be considered in the design of fixed tube sheet exchangers.

3.23.4 Parts such as tubes, tube sheets, floating heads etc. which simultaneously come in contact with both shell side and tube side fluids, shall be designed considering pressure acting on one side only or the combination of pressures, whichever results in higher thickness of parts.

3.23.5 Attachment of tube to tube sheet will be rolled and expanded (with seal welding), strength welded or seal welded as specified on data sheets. However, as a minimum following shall be adopted:

For tube sheet joint, tubes shall be expanded in grooved holes into the tube sheets. The expanding operation shall extend from the outer face of the tube sheets to a depth not < 90% of the tube sheet thickness. Welding shall be done in minimum two passes and each pass shall be DP checked. For tube-to-tube sheet joint GTAW (Gas-Tungsten Arc Welding) welding is required.

(A) Tubes shall be expanded and light seal welded if all the following conditions occur simultaneously:

- Design pressure of shell/tube < 20 kg/cm²
- Shell / Channel design temperature < 350 °C
- Fluid not containing lethal substances.
- Hydrogen partial pressure < 7 bars

(B) Tubes shall be strength welded & light expanded for any condition other than listed under (A).

3.23.6 Procedure shall be qualified for tube-to-tube sheet joints. Mock-up test shall be carried Out for heat exchangers having shell/tube side design pressure 100 Kg/Cm² & above to establish all the requirements.

3.23.7 The sample for tube sheet and tube for mock up test shall be drawn from the same heat Material from which the equipment shall be fabricated.

3.23.8 Process Shell and Tube Exchangers will comply with the requirements of ASME SEC VIII Div I & TEMA Class 'R'. TEMA Class 'C' may be used for auxiliary heat exchangers for rotating and packaged equipment exchangers.

3.23.9 ASME Section VIII, Div. 1, Appendix "S" shall be considered mandatory for bolted flange connections.

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- 3.23.10 All tube sheet for the exchangers shall be designed as per ASME Sec VIII Div 1 & also comply the requirement of section UHX of ASME Code.
- 3.23.11 Tube sheets in vertical exchangers shall be provided with drain and vent arrangement with threaded plug seal welded.
- 3.23.12 Exchanger saddle and foundation design shall include additional loadings generated from bundle pulling. The load shall be 1.5 times the bundle weight.
- 3.23.13 Lifting lugs for heads or bonnets shall be specified where frequent dismantling is required.
- 3.23.14 Bundle weights shall be limited to 10 tonnes. In case the bundle weight increases beyond 10 tonnes, bidder shall take care necessary precaution in the design and fabrication of exchanger e.g. by providing rollers arrangement, support plates etc. to avoid excessive loading on shell while pulling of tube bundle, proper reinforcement in equipment support etc.
- 3.23.15 Saddle wear plate material shall be the same as the shell material.
- 3.23.16 Tube sheets and Girth Flanges shall be shall be of Forged Quality & Ultrasonically tested. It shall not have any segmental joint.
- 3.23.17 All heat exchanger tubes shall be seamless, cold drawn and formed from single length. CS tubes shall be normalized. LAS tubes shall be normalized and tempered.
- 3.23.18 The minimum radius of U tubes shall be not less than 2xOD of tube. Thickness of 2 inner most rows will be higher than other rows with minimum difference of 2 gauges.
- 3.23.19 For U tube bundle, the following requirements shall also be met:
- i) Each U tube shall be formed from a single straight length.
 - ii) All U tubes shall be cold bent.
 - iii) All C.S, C-Mo, Cr-Mo tubes shall be heat treated after bending.
 - iv) Bent portion of all U tubes shall be examined by PT and hardness check on four opposite points of bent portion shall be carried out.
 - v) Unless otherwise specified, after bending each tube shall be tested hydraulically.
- 3.23.20 Where fixed tube sheet heat exchangers are specified, thermal stress shall be checked in accordance with the TEMA standard to determine if an expansion joint is necessary.
- 3.23.21 Tube to tube sheets joints shall be leak tested with air & soap solution at pressure of 2.0 kg/cm² g wherever specified leak testing with halogen shall be carried out.
- 3.23.22 Impingement plates shall be provided if required by TEMA or indicated as a part of Licensor's requirement.
- 3.23.23 For stack type Heat Exchangers, complete assembly shall be hydraulically tested as a single unit except when the test pressures for individual heat exchangers are different.
- 3.23.24 Stacked exchangers shall have the lower shell(s) designed to withstand the superimposed load of the upper exchanger(s) full of water without distorting the shell and causing binding of tube bundle(s).
- 3.23.25 The lower fixed support of stacked exchangers shall be designed for bundle pulling loads for removal of the upper bundle.
- 3.23.26 When two or more exchangers are stacked, the entire stack shall be shop-assembled and checked for accuracy of saddle and nozzle fit-up.

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- 3.23.27 Horizontal exchangers with removable tube bundles shall have the supports designed to withstand a horizontal pulling load equal to 150% of the bundle weight, applied at the centreline of the exchanger. The lower supports of stacked exchangers shall be designed for the loads of removing the upper bundle.
- 3.23.28 Removable tube bundle shall be provided with pulling York and suitable sliding arrangement.
- 3.23.29 Flow induced vibration analysis shall be carried out for all process heat exchangers.
- 3.23.30 Process Heat exchangers tubes shall be Eddy current tested at mill and the specified thickness of tube shall be minimum (and not average).
- 3.23.31 Dowels or match marks shall be provided to prevent misassemble of floating head covers and channels with pass partitions, channel covers with grooves, and stationary tube sheets to shell flange.
- 3.23.32 In horizontal exchanger cross baffles and support plates shall be provided with notches for draining and venting.
- 3.23.33 Copper & Copper Alloy tubes shall not be used for any Exchangers
- 3.23.34 Corrosion allowance shall be added to the inside diameter of flanges. Gasket surfaces of flange shall have no corrosion allowance

3.24 EXPANSION JOINTS

- 3.24.1 Where fixed tube sheet heat exchangers are specified, thermal stress shall be checked in accordance with the TEMA standard to determine if an expansion joint is necessary.
- 3.24.2 Expansion joints shall be designed for the most severe conditions of differential expansion that can occur during normal operations, start up, shutdown, or upset conditions.
- 3.24.3 Expansion joints shall be of the single layer standard one-piece construction unless otherwise approved by purchaser. Length of the bellow and preset shall be specified on the manufacturer's drawings.
- 3.24.4 Expansion bellows shall be designed for min. 5000 cycle, as per TEMA.

3.25 GIRTH FLANGES

- 3.25.1 All girth flanges joining two parts with different design conditions shall be designed for the severe condition.
- 3.25.2 All girth flanges for carbon and low-alloy steel exchangers shall be integrally forged welding necks, unless otherwise specified in the data sheets. i.e. Girth Flanges shall be WNRF/ WNRTJ type only.
- 3.25.3 All flanges designed with bolts greater than M 48 & above shall have sufficient clearance to permit the use of hydraulic bolt tensioning instrument. Bidder has to supply such hydraulic bolt tensioning instrument along with the supply of exchangers & its spares.

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3.25.4 The Contractor shall guarantee tightness compatibility of closure designs. The differential thermal growth of gasketed joints of dissimilar materials (including gaskets) shall be considered.

3.25.5 All girth flanges shall be provided with jack screws to facilitate dismounting.

3.26 PASS PARTITIONS

3.26.1 All pass partitions shall have a gasket contact surface of 9 mm width minimum, and shall be machined to a common plane at the gasket face.

3.26.2 The depth of pass partition grooves in tube sheets and flat cover plates shall be a minimum of 5 mm. For alloy cladding or facing, there shall be at least 3 mm of alloy after machining beneath the pass partition groove or gasket face.

3.26.3 When space permits, pass partitions shall be continuously welded from both sides. In cases where space is too small for both side welding, weld shall be continuous on one side in so far as possible.

3.26.4 Pass partitions shall be provided with a weep hole of about 6 to 12 mm in diameter at low points of pass partitions.

3.27 TEST RINGS

Floating head type heat exchangers as well as U-tube type without full diameter stationary tube sheets shall be provided with test rings and test gland so that the exchanger shells may be pressure tested with the channels removed. Drawing and calculations for test rings and test gland shall be provided by vendor for all exchangers of applicable type.

3.28 HYDRO TESTING

3.28.1 Each heat exchanger shall be hydro tested in accordance with applicable codes and standards.

3.28.2 The shell side test shall be performed in such a manner that the Tube-to- tube sheet joints can be adequately inspected during testing.

3.28.3 Stacked units shall be hydraulically tested in the fully assembled condition.

3.28.4 Air leak test shall be performed for tube to tube sheet joint for all exchangers. However Helium leak test shall be performed for critical heat exchangers/ wherever specified by Process licensor

3.28.5 After testing, all exchangers shall be completely dried.

3.28.6 Service bolts shall be used in all shop hydrostatic tests.

3.28.7 Unless otherwise stated gaskets used during testing shall be same as specified for operating conditions. After testing, gaskets used during testing shall be replaced by new gaskets.

3.29 STORAGE TANKS

3.29.1 The following design codes shall be adopted for tank design as applicable:
a) API 620:- Design and Construction of Large Welded Low Pressure Storage Tanks.

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- b) API 650:- Welded Steel Storage Tanks for Oil Storage.
c) API-625 Tank Systems for Refrigerated Liquefied Gas Storage.
d) API-653 Tank Inspection, Repair, Alteration, and Reconstruction
- 3.29.2 For Storage tanks the minimum thickness shall be based on stability considerations. Minimum thickness for roof & shell shall be 5 mm, and bottom plate 6 mm, excluding corrosion allowance.
- 3.29.3 Storage tanks up to 4meter in diameter shall be shop fabricated items. Tanks with diameters greater than 4 meter shall be field erected.
- 3.29.4 Shell seams shall be located to clear openings to the maximum extent possible in accordance with API 650.
- 3.29.5 Bottom plates may be lap-welded with the lap toward the direction of drainage. Butt-welded bottom plates shall be furnished when specified on the tank drawings or data sheets or when tanks are specified to have rubber lining.
- 3.29.6 For each surface in contact with product/vapour, the specified corrosion allowance shall be added to the required thickness of all load-carrying components including shell, roof, bottom and roof supports. & One-half the specified corrosion allowance shall be added to each surface of no-load-carrying internal components.
- 3.29.7 All walkways, stairways, and platforms shall be furnished with handrails on open or exposed sides.
- 3.29.8 Anchor bolts shall be provided based on design considering wind/seismic loads, uplift due to internal pressure etc. However, tanks having diameter ≤ 10 meter shall be provided with anchor Bolts and shall be spaced at approximately 1.8M of circumference.
- 3.29.9 All storage tanks shall be designed as per code considering liquid height up to top curb angle of shell.
- 3.30 FILTERS**
- 3.30.1 The filter vessels shall be designed, fabricated, inspected and tested as per ASME Section VIII Div.1.
- 3.30.2 Filter shall be equipped with all necessary instruments, i.e. pressure gauge, pressure safety valve, temperature gauge and differential pressure gauge/transmitter etc. if specified in P&ID/Data sheet.
- 3.30.3 Filter elements shall be of reputed/approved make with guaranteed performance requirement specified in the data sheet.
- 3.31 HORTON SPHERE**
- 3.31.1 This specification covers the minimum requirements for the design, materials, fabrication and inspection of Horton sphere. This specification shall be read in conjunction with the design philosophy for pressure vessel as per part-A above.
- 3.31.2 The sphere shall be designed, fabricated, erected, inspected and tested in accordance with the ASME Sec VIII Div.1, IS :2825.

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- 3.31.3 The sphere shall be designed to sustain stresses due to internal pressure and static head imposed corresponding to maximum permitted level of stored fluid plus the pressure equal to the vapour pressure of ammonia at the maximum design temperature together with any additional pressure which may result from the presence of inert gases and external loads etc.
- 3.31.4 Plate used for fabricating the sphere shall be impacted tested. Impact test shall also be carried out for weld metal and heat effected zone.
- 3.31.5 Top and bottom caps to be stress relived after nozzles are welded and equator plates shall be stress relived after column stubs are welded.
- 3.31.6 After all the plates have been formed they shall be trail assembled in shop. After trail, sphere to be dissembled and with all plates and other components match marked shall be dispatched to site.
- 3.31.7 To minimise the risk of stress corrosion cracking the welding consumables should overmatch the tensile properties of the plates by the smallest practicable amount. Furthermore, the tensile strength of the plates should not be 'allowed to exceed the maximum value laid down in the plate specifications. The individual plates for use in the sphere construction should be identified during the manufacture and testing and marked accordingly.
- 3.31.8 Sphere supports should be designed to withstand the weight of the vessel when filled with water. Particular care should be taken to ensure that water is not trapped in the supports during construction. The height above ground chosen for the sphere will depend partly on the ease of access required to the bottom fittings.
- 3.31.9 General openings should be in the form of flanged nozzles on reinforcing pads. The welds of adjacent openings should not be closer than 50 mm. Screwed connections should not be used.
- 3.31.10 All nozzles should be grouped together in the top and bottom crown plates.
- 3.31.11 Access openings should be in the top crown plate of the sphere. It is recommended that the covers for access openings be hinged or fitted with davit. The minimum inside diameter of any access/manhole opening should be 600 mm.
- 3.31.12 Spheres should be earthed at the supporting legs at two places as nearly diametrically opposite as possible.
- 3.31.13 All temporary attachments should be carefully removed after use, i.e. not knocked - off and scars made good and ground smooth. Such scars should be tested by magnetic particle crack detection methods after grinding. This work should be done before stress relieving.
- 3.31.14 A central platform should be provided on the top of the sphere, big enough to give convenient access to all the top mountings. This platform should be carried on brackets which are welded to the crown plate before it is stress-relieved; attachments should have full penetration welds.
- 3.31.15 A stairway should be provided to give access to the top of the sphere and it is preferable that this is independent of the sphere. The stairway and platform support cleats are welded on to top crown plate and stub ends of leg support at shop and are duly stress relieved. Stairway and platform are bolted to these cleats at site.

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- 3.31.16 100% magnetic particle crack detention examination should be carried out on all internal welds and at the location of removed toggle cleats, temporary attachments and scars before commissioning. This will provide base data for subsequent examinations. Full visual and magnetic particle crack detection examination along at least 10% of each butt weld should be made on the external surface of the sphere.
- 3.31.17 The insulation may require metal support rings, which should be so designed that they can be fixed to the shell at the crown plates and at plates carrying the leg supports only. Any cleats required to locate and secure the rings should be welded to the appropriate plate in accordance with the requirements of applicable design code. This should be done by the manufacturer before the plates are thermally stress relieved. The insulating contractor should not be allowed to weld fittings to shell plates either before or after fabrication in any circumstances.
- 3.31.18 When a sphere is supported on legs, the legs should be insulated for a minimum distance of 900 mm to reduce heat gain in those areas.
- 3.31.19 FEA analysis of Horton sphere shall be done in addition of mechanical design calculation considering various loading condition.

4.0 SPARE PARTS(Erection & commissioning, Mandatory spares):

4.1 Erection & commissioning Spares :

All Erection & commissioning spares shall be included by LSTK Contractor in their scope of supply and shall be part of the main equipment.

4.2 Mandatory spares:

Mandatory spares shall be supplied by the contractor as per Section-11 of NIT

5.0 DOCUMENTATION SCHEDULE

5.1 Documents shall be submitted as per “Documentation schedule” in Section-10 of ITB.

6.0 VENDORS LIST

All equipment shall be procured/ fabricated as per approved vendor list (Section -14). Any equipment for which vendor list is not enclosed, the LSTK Contractor may furnish a list of their proposed vendors along with their references for supply of similar type of equipment along with bid. However all the additional proposed vendors shall have well proven track record and shall be subjected to consultant/owner’s approval.

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ANNEXURE-1

CALCULATION METHOD

DYNAMIC WIND ANALYSIS (GUIDELINES)

FOR VERTICAL EQUIPMENT

Check of the towers for dynamic wind moments due to vortex shedding shall be performed based on following assumptions :

$$V_{cr} = f * D/St$$

V_{cr} = Critical wind velocity

D = Outside diameter of tower

F = First natural frequency of tower considering foundation complete rigid (s-1)

St = Strouhal number, may be taken as 0.15 for $Re > 10^6$ and 0.2 for $Re < 10^6$

Re = Reynolds number at critical wind velocity

For $V_{cr} < 30$ m/s following shall be considered:

The tower shall be checked for additional moments due to vortex shedding in 2 cases.

1. Operating condition
2. Shut down condition

Dynamic wind moment shall be calculated as follows:

$$M_d = P_d * C_k * S * \pi/d * H$$

P_d = Wind pressure at critical velocity = $0.5 * \rho * (V_{cr})^2$

C_k = Crosswind oscillatory force coefficient may be taken as $0.5 + (4 - \log_{10} Re)/5.7$ for $Re < 10^6$ and 0.17 for $Re > 10^6$

d = The logarithmic decrement of damping. For towers with trays or packing it is estimated 0.035

S = Surface on which dynamic wind forces are acting (height * diameter)

H = Height from base ring of point of application for dynamic wind force

π = 3.14

ρ = Density

For tapered construction only the tip diameter shall be considered in calculation.

Moments to be considered for dynamic wind:

$$M_{res} = \sqrt{(M_d)^2 + (M_{st})^2}$$

M_{st} = Static wind moment at critical wind velocity

Only if M_{res} exceeds moments due to static wind or earthquake moments, it shall be considered for equipment design.

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ANNEXURE-2

INSPECTION GUIDELINES

1.0 GENERAL

The min. Inspection to be carried out by Authorized approved Inspection agency:

1.1 VESSELS/HORTON SPHERE

- a) All carbon steel plates shall be identified against mill-test certificates at the VENDOR'S works before commencement of fabrication.
- b) Establish that welding procedure and welders are qualified and welding electrodes are approved before commencement of fabrication.
- c) Check fit-up and witness chipping-back of welded seams.
- d) Wherever applicable, select spots for radiography, D.P and M.P Tests.
- e) Witness any crack detection, hardness checks, ultrasonic tests etc. which may be specified. (1)
- f) Review radiographs and in case it is unsatisfactory re-radiograph. (1)
- g) Witness hydrostatic test.
- h) Dimensionally check and carry out final internal and external inspection for quality of workmanship.
- i) Check that all material test certificates and, where applicable, heat treatment charts are in order. Ensure that VENDOR is familiar with the requirements regarding data books and ensure that the documentation is submitted without any delay.
- j) Check internal lining of reactors and vessels (if applicable) to specifications.
- k) Witness any further test recommended by Process Licenser/Inspection agency and/or OWNER.

Note (1): X or Gamma rays

1.2 VESSEL INTERNALS

- a. Leak testing & final inspection only is required.
- b. Check one tray of each diameter and type, mock assembled in the shop.
- c. Spot check for interchangeability of parts, where applicable.
- d. Ensure that any uncommon down comers are fully assembled and offered along with their respective trays
- e. Where new designs and/or new VENDOR's are concerned, check that any applicable leakage tests have been carried out on prototype.

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- f. Check that materials including welding electrodes are in accordance with the requirements of the order and all applicable specifications and standards.


1.3 STORAGE TANKS

- a) Shell plates to be dimensionally checked (including diagonals for square-ness) before rolling to curvature.
- b) All shell plates to be inspected and dimensionally checked after rolling to curvature.
- c) Check material test certificates and ensure that all shell plates are clearly stamped with the cast and plate number, so that they can be identified against the relevant test certificates.
- d) Check material test certificates for roof and bottom plates.
- e) Select the spot radiographs, D.P M.P & Vacuum box test of bottom plate as per codes.
- f) Review the radiographs. (1)
- g) On completion of inspection of shell plates ensure that VENDOR provides a chart giving all plate numbers, tier by tier.
- h) Inspect fabrication of all fabricated fittings. This is to include checking of material test certificates also.
- i) Inspect tank gauging equipment.
- j) For shop fabricated tanks, witness hydrostatic tests to applicable standards.
- k) Check welding material electrodes.

Note (1): X or Gamma rays

1.4 SHELL AND TUBE EXCHANGERS

- a) All carbon steel plates shall be identified against mill test certificates at the VENDOR'S works before commencement of fabrication.
- b) Establish that welding procedure and welders are qualified before commencement of fabrication.
- c) Check fit-up and witness chipping-back of welded seams.
- d) Wherever applicable, select spots for radiography.
- e) Witness any crack detection, hardness checks, ultrasonic tests etc. which are specified in drawing, specification, data sheet etc.
- f) Review radiographs. (1)
- g) Witness all hydrostatic tests on shell and tube sides.

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- h) Complete dimensional check for stacked units. This is to be carried out in the full assembly stage.
- i) Check that all material test certificates and where applicable, heat treatment charts are in order. Ensure that VENDOR is familiar with the requirements regarding data books and see that the documentation is submitted without any delay.
- j) Witness any further test recommended by Process Licensor/ Inspection agency and/or OWNER.

Note (1): x or Gamma rays

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PART II: TECHNICAL



SECTION – 5.0

DESIGN PHILOSOPHY – PIPING

PLANT: NATIONAL FERTILIZERS LIMITED, NFL, NANGAL, PUNJAB



**PROJECTS: INSTALLATION OF NEW 2500 CUBIC METER
CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA
ALONG WITH ITS REFRIGERATION SYSTEM
AT NFL, NANGAL**

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REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD

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LIST OF ATTACHMENTS

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1	Table of Basic Span
2	Accessibility For Valves & Instruments
3	Vertical And Horizontal Guides Spacing
4	Clearances
5	Job Specific Requirements
6	Design Philosophy for Stress Analysis
7	Design Philosophy for 3D Modeling
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	DESIGN PHILOSOPHY- PIPING INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/5.0	0	
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1.0 SCOPE

The scope of this document is pertaining to the design philosophy, norms and specific requirements which shall be adhered to by LSTK contractor or his associates and representatives during the course of the project in designing, procurement & construction of piping material.

1.1 Applicable Standard & Codes

Standard No.	Title
ASME/ANSI B16.5	Pipe Flanges and Flanged Fittings
ASME/ANSI B16.9	Factory-Made Wrought Butt-Welding Fittings
ASME/ANSI B16.10	Face to Face and End to End Dimensions of Valves
ASME/ANSI B16.11	Forged Fittings, Socket- Welding and Threaded
ASME/ANSI B16.20	Metallic Gaskets for Pipe Flanges – Ring Joint, Spiral Wound and Jacketed
ASME/ANSI B16.21	Non-Metallic Flat Gaskets for Pipe Flanges
ASME/ANSI B16.25	Butt-Welding Ends
ASME/ANSI B16.34	Valves – Flanged, Threaded and Welding End
ASME/ANSI B16.47	Large Diameter Steel Flanges
ASME/ANSI B31.1	Power Piping
ASME/ANSI B31.3	Process Piping
ASME/ANSI B 31.3	Process piping-Dust Extraction piping
ASME/ANSI B31.5	Refrigeration Piping
ASME/ANSI B31.11	Slurry Transportation Piping Systems
ASME/ANSI B36.10M	Welded and Seamless Wrought Steel Pipe
ASME/ANSI B36.19M	Stainless Steel Pipe
API 5L	Specification for Line Pipe
API 6D	Specification for Pipe Line Valves (Gate, Plug, Ball and Check Valves)
API 6FA	Fire Test for Valves
API 501	Specifications for Metallic Gaskets for Refinery Piping
API 594	Check Valves:, Wafer-Lug and double flanged type
API 598	Valve Inspections and Testing
API 599	Steel Plug Valves Flanged and Butt-weld ends
API 600	Steel Gate Valves Flanged and Butt-welding ends, Bolted Bonnets
API 602	Gate, Globe, and Check Valves for Sizes DN 100 (NPS 4) And Smaller for the Petroleum and Natural Gas Industries

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API 603	Class 150 – Corrosion Resistant Flanged End gate valves.
API 604	Ductile Iron Gate valves – Flanged ends
API 606	Compact C.S. Gate Valve extended body
API 607	Fire Test for soft seated Ball Valve.
API-608	Metal Ball Valves, Flanged, Threaded & BW Ends.
API 609	Butterfly Valves, Lug type & Wafer type
API 610	Centrifugal pumps and centrifugal pumping systems
API 623	Steel Globe Valves—Flanged and Butt-welding Ends, Bolted Bonnets
API 941	Steels for Hydrogen Service at Elevated Temperatures and Pressures
IBR	Indian Boiler Regulations
AWWA C207-D	Large Dia. Steel Flanges (Ring Type).
EJMA	Expansion Joints Manufacture Association
MSS SP 6	Standard Finishes for Contact Faces of Pipe Flanges and Connecting End Flanges of Valves and Fittings
MSS SP 25	Standard Marking System for Valves, Fittings, Flanges & Unions
MSS SP 43	Wrought Stainless Steel Butt-weld Fitting
MSS SP 45	By-pass and Drain Connection
NACE MR0175-94	Sulphide Stress Cracking resistant Metallic Material
NFPA	National Fire Protection Association
EN 10204	Metallic Products - Types of Inspection documents

2.0 DESIGN PHILOSOPHY

2.1 Piping systems shall be in accordance with Clause 1.1, which permits the use of the following specifications:

ASME B31.1 Power Piping



ASME B31.3 Process Piping

ASME B31.5 Refrigeration Piping

Materials, design, construction, testing and inspection shall be fully in accordance with the selected specification.

2.2 The dimensions, manufacturing tolerances and marking of ferrous and non ferrous piping components shall conform to the applicable standards .The design shall comply with all applicable codes, laws and statutory regulations. The Contractor shall optimize the layout with the approval of the owner and include any changes resulting from HAZOP studies and taking into consideration the following:

- General site layout taking into account the topographical geo-technical aspect of the site
- Access for maintenance and fire appliances
- The interdependency of units and buildings with each other within the complex

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- Safety escape routes for personnel based on emergency or disaster management plans in the event of environmental upset or fire

- Suitable drainage system of Project site

2.3 Material of construction shall be suitable for specified process duty (both normal and abnormal operations) and have a projected life and corrosion/ erosion allowance in excess of minimum life of the project. Piping materials specified in piping materials specification shall be used for selection of material of construction of major services.

All materials under steam service shall be supplied with proper certificates in prescribed forms.

2.4 Design Pressure

The design pressure of each component in a piping system shall be the most severe condition of the followings:

- i) Design pressure of equipment to which it is connected
- ii) Set pressure of a pressure relieving device which protects the system
- iii) Shutoff discharge pressure of a centrifugal pump, not protected by a pressure relieving device.

If the shutoff discharge pressure is unknown, it may be determined by the largest of the followings:

- a) 1.2 times the differential pressure at normal flow plus the maximum pump suction pressure
- b) 1.1 times pump discharge pressure at normal flow
- c) Full vacuum for a system operating below atmospheric pressure

2.5 Design Temperature

The design temperature of a piping system shall be the design temperature of connected equipment, unless the equipment is obviously overrated. For un-insulated piping, the design temperature may be determined in accordance with the ASME B31.3.

The reducing coefficient for piping components not specified in the ASME B31.3 shall be 95% for the fluid temperatures over 37°C.

The design temperature for a steam traced or steam-jacketed piping shall be the higher of the followings:

- Fluid temperature
- Normal operating temperature of steam



3.0 CODES, STANDARDS AND SUPPLEMENTARY SPECIFICATIONS

3.1. The latest edition of codes listed in clause 1.1 shall be applicable for piping system design, materials, fabrication, manufacture, erection, construction and inspection etc. For any item not covered in the list of codes and standards / International Standards / proven design may be finalized based on discussion with OWNER/Consultant.

3.2 Where conflict occurs, the order of precedence shall be:

- a) Statutory Regulations
- b) National, International and Industry Standards and Codes of Practice.
- c) Technical Specifications

3.3 Standards, codes and supplementary specifications for piping design shall be applied as follows:

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- i) Process and utility piping to ASME B31.3 Process Piping
- ii) Power Plant piping to ASME B 31.1
- iii) Requirements of Anhydrous Ammonia Code
- iv) Sour service piping to NACE (National Association of Corrosion Engineers) specification MR0175.
- v) Plant layout and fire protection piping to Dangerous Goods Regulations and “Storage and Handling of Flammable and Combustible Liquids”, supplemented where required by NFPA (National Fire Protection Association) Code 30.
- vi) Fire protection system shall be designed and installed in accordance with applicable NFPA (National Fire Protection Association) Codes.
- vii) Piping fabrication tolerances to ASME B31.3 and PFI (Pipe Fabrication Institute) practice ES-3.
- viii) Colour coding for identification of piping material to PFI Practice ES-22/ as per owner's approval.
- ix) Pipe wall thicknesses shall be in accordance with ANSI B36.10 or B36.19.

4.0 GENERAL DESIGN



- 4.1 Valve shall be provided at battery limit for respective piping system.
- 4.2 Flanges for process and utility piping shall be in accordance with ANSI B16.5 and ANSI B16.47.
- 4.3 Wherever possible all purchased equipment shall be supplied with flanges that comply with ANSI B16.5.
- 4.4 The minimum size of piping to be used in pipe-racks shall be 2” NB.
- 4.5 With the exception of equipment connections the minimum size of piping shall be ½” NPS.
- 4.6 Pipe sizes 1 ¼”, 2 ½”, 3 ½” and 5” NPS shall not be used except as connections to purchased equipment.
- 4.7 Threaded pipe nipples between headers and vent, drain and instrument isolation valves shall be Schedule 160 for CS and Schedule 80S for SS in the size range ½” to 2” NPS.
- 4.8 Piping 2” NPS and above shall be butt-welded. All weld joints in piping 1½” NPS and below shall be socket welded using socket weld fittings.
- 4.9 In Class 900 and higher pressure rating double block valves shall be used for systems open to atmosphere, such as vents and drains. Piping in hazardous service shall have vents, drains and bleeds routed to a safe location. Category ‘M’ substances shall be vented to the flare system.
- 4.10 When a line of one material specification is connected to a line of higher material specification, the connecting line shall be constructed of the higher material specification or pressure rating up to & including the first block valve.
- 4.11 As a minimum, piping systems shall have isolation facilities as follows:

ASME B31.3 Category ‘M’ service and Normal service (Class 900 and above) shall have double block isolation valves with a downstream drop-out spool.

ASME B31.3 Normal service (Class 150 to 600) shall have a valve and downstream spectacle blind.

ASME B31.3 Category ‘D’ service shall have a valve and downstream spectacle blind.

Generally, equipment shall have provision for isolation of piping to each equipment connection by means of valving and /or blinds as determined by service conditions.

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4.12 Criteria for Isolation Valves

Installation (Class Rating)	Process Isolation	Drain/ Vent	Pressure Taping	Level Taping	Flow Element	Safety Valve	Control Valve
150 / 300#	Single	Single	Single	Single	Single	Single	Single
600 #	Single	Single	Double	Single	Double	Single	Single
Above 600#	Double	Double	Double	Double	Double	Double	Single

Note: For S/D & at battery limit, it will be as per process requirements

Piping flexibility shall be achieved by the use of piping offsets and expansion loops whenever possible. Expansion joints shall not be used without written permission of the Owner.

5. DESIGN PHILOSOPHY / GENERAL CRITERIA

5.1 Equipment Layout

5.1.1 Basis of Equipment Layout

Equipment Layout shall be finalised based on the following data:

- a) Site Location Plan
- b) P&I Ds
- c) Equipment Data Sheets
- d) Wind Direction
- e) Overall Plot Plan
- f) Safety Distance and Specific Distance mentioned in Piping Design Basis and as per statutory requirements.

5.1.2 Development of Equipment Layout



The following aspects shall be considered during development of equipment layout;

- a) Process Requirement -Proper interconnection between equipment as per P&IDs to achieve the intended process parameters.
- b) Economy of piping material- Minimize the quantity of costly piping.
- c) Erection & Construction requirements:

Erection scheme and schedule of all equipment must be considered during equipment layout to have smooth erection mainly in case of tall columns, heavy equipments like thick walled reactors, space for laying tall columns, approach roads for cranes / derricks for lifting the column or reactors and requirement of special foundation / pile etc.

d) Operation and Maintenance Requirement

- Overhead and side clearances for exchangers and pumps
- Provision of exchangers tube bundle pulling area
- Horizontal & overhead clearances for easy movement of working personnel
- Crane approaches for air coolers/fired heaters
- Provision of catalyst loading/unloading facilities.
- Provision of monorail for pumps and exchangers
- Provision of EOT crane for compressors.

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- Provision of operator's cabin.
- All coke chambers shall be having the lift provision.
- e) Similar equipment grouping - All columns, exchangers, pumps etc. should be grouped together for convenience of maintenance and safety wherever feasible.
- f) The technological structures should be interconnected for easy movement of operational personnel.
- g) U/G piping corridors for main headers should be marked in equipment layout for all underground piping.



5.2 Plant Layout & Design guidelines

5.2.1 General

- 5.2.1.1 The plant layout shall be based on ensuring adequate access, to allow construction, inspection, maintenance and operation to be performed in a safe and efficient manner. The alignment of equipment and pipe shall offer an organised appearance. The layout shall be in accordance with, but not limited to, the design practices described in this criteria.
- 5.2.1.2 Where dynamic loading, limited pressure drop or other severe service condition applies, particular care shall be taken in routing pipe lines.
- 5.2.1.3 Flushing connections shall be provided on all lines containing flammable or toxic material, slurries, and materials which solidify or lead to scaling or choking, when the line is idle or even in operation. Sufficient Nitrogen purging points shall also be provided. Supply piping of fuel gas shall be arranged for equal flow distribution.
- 5.2.1.4 Trolley beams, pipe davits, shall be provided with appropriate removable hoists mechanism for charging and discharging catalysts, chemicals, packing rings etc.
- 5.2.1.5 Piping and all other services shall be arranged so as to permit ready access of Cranes for removal of Equipment for inspection and servicing.
- 5.2.1.6 All utility and process piping shall be located above ground, and major lines shall be located in overhead pipe ways.

The following lines may be buried providing they are adequately protected.

- Cooling Water Lines 18" dia. and larger
 - Fire water mains
 - Drain and Sewer (oily and chemical) lines from catch basin to mains and manholes
- 5.2.1.7 Lines that must be run below grade, and must be periodically inspected or replaced, shall be identified on the P & ID's; these lines must be placed in covered concrete trenches. Sleeper-ways shall not be used in process areas where they may block access for personnel and equipment.
- 5.2.1.8 Fire protection system shall be designed as per NFPA, / TAC and as per statutory requirements. Refer Fire Fighting Design Basis.
- 5.2.1.9 Drip legs and dead ends shall be avoided, especially for piping where solids or fluids may congeal from corrosive condensate.
- 5.2.1.10 Where sleeper ways are used the elevations shall be staggered to permit ease of crossing or change of direction at intersections. Flat turns may be used when entire sleeper ways change direction. Flat turns must not be used within pipe racks.
- 5.2.1.11 All cooling towers shall have sunshades at top distribution decks to avoid algae growth. Cooling towers should be located away from process unit area, preferably downstream direction of wind.

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Orient the short side of the tower along the prevailing summer wind for maximum efficiency. Locate cooling towers a minimum of 30m away from process units, utility units, fired equipment, and process equipment.

- 5.2.1.12 Locate flare stacks upwind of process units, with a minimum distance of 90 m from process equipment, tanks and cooling towers.
- 5.2.1.13 Spacing and routing of piping shall be such that expanding/contracting lines (including insulation) will not clash with adjacent lines, structures, instruments and electrical equipment during warm up and cool down.
- 5.2.1.14 Piping to be sloped shall be indicated on the P&ID's.

5.2.2 **Pipe-Rack/T-Post/Small Portals**

- 5.2.2.1 In general, equipment layout shall be prepared considering straight pipe rack, however other shapes like L / T / U / H / Z etc can also be considered based on area available.
- 5.2.2.2 The width of the rack shall be 4M, 6M, 8M, 10M or 12M for single bay having four (4) tiers maximum. In general, the spacing between pipe rack portals (span) shall be taken as 8 M for main rack. However it can be decreased to 6 M depending on the size/number of the pumps to be housed below pipe rack. Intermediate Beams between two portals shall be provided to support smaller pipes $\leq 2"$. 20% extra space shall be provided on the pipe rack and portals on each tier for future expansion/modifications. Water lines more than 16" shall not be routed over rack.

-Clearance beneath pipe rack shall be 3.8 M minimum.

-Road clearance shall be 9 M minimum wherever heavy duty crane movement is required during construction and future maintenance.

-Road clearance shall be 7.5 M minimum for main roads.



-Road clearance shall be 5 M minimum for secondary roads.

-T-Portal's width shall not be more than 2.5 M and height shall not be less than 3.0M.

5.2.3 **Towers and Vertical Vessels**

- 5.2.3.1 Towers and vertical vessels shall be arranged in a row with common centre line, decided by the largest vessels, placing O.D. of the equipment minimum 4 M away from the pipe rack. A minimum clearance of 3 M shall be allowed between tower shells, but in any case adjacent towers shall be checked so that platforms do not overlap considering the deflection of towers (deflection of towers shall be considered minimum $L/200$ MM, WHERE, (L=height of tower). A minimum 100 mm horizontal gap shall also be provided between platforms of adjacent towers after deflection and that a minimum 900 mm is left between tower plinths. Also the gap between vertical vessels shall allow full opening of manhole covers without restriction.
- 5.2.3.2 Efforts shall be made to provide interconnecting platforms at suitable levels for adjacent towers and/or adjacent technological structure etc., Interconnections where ever feasible shall be done, after taking thermal expansions of towers into consideration.
- 5.2.3.3 The maximum vertical distance between platforms shall be 6 m. All level switches, LGs etc including their isolation valves shall be accessible from ladders or platforms. To handle heavy items (like relief valves, blinds etc.), davit of suitable capacity to lift higher weight of safety valves/ Blind/ Internals etc. is needed. The davit shall be on the side of the vessel away from the rack. The area at grade shall be kept clear for a dropout. Davit capacity shall be minimum 1 MT.
- 5.2.3.4 Chemical vessels to be located close to the dosing point to the extent possible, specially ammonia & corrosion inhibitors.

5.2.4 **Horizontal Vessels**

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5.2.4.1 The horizontal vessels shall be laid perpendicular to pipe rack and shall be placed minimum 4M away from the pipe rack. The clearance between horizontal vessel shells shall be minimum 2M or 900 mm clear aisle whichever is higher.

5.2.5 Pumps

5.2.5.1 Wherever practical, pumps shall be arranged in rows with the centre line of the discharge on a common line. In general, pumps shall be kept inside the pipe rack. However in case of smaller racks, pumps shall be kept on one side or outside the pipe rack to provide clear access under the rack as per clause 5.2.11.2.

5.2.5.2 Pump foundation height shall be 300 mm above H.P.P. Pumps which are handling hydrocarbon at temperature above 315°C and pumps for which specific notes are given in P&ID shall be necessarily housed outside the rack.

5.2.5.3 Gap between each pump foundation / and foundation of technical structure should be sufficient for easy removal of equipment after piping. Clearance between two adjacent pumps shall be such that clear 900 mm aisle is available.

5.2.5.4 No monorail should normally be provided for pumps outside rack and sufficient space below rack shall be available for pump maintenance.

5.2.6 Exchangers

5.2.6.1 In most of the cases floating head of exchangers are placed on a line minimum 4M away from pipe rack. Shell and tube type exchangers may have a removable shell cover with flanged head. Tube pulling or rod cleaning area must be allowed at the channel end. This shall be minimum the tube bundle length + 1.5M from the channel head. In case of vertical exchanger suitable platform shall be provided below the top flange of channel or bonnet.

5.2.6.2 Minimum clearance in between two horizontal exchangers shall be 2M or 900mm clear aisle whichever is higher.

5.2.6.3 Likewise Heat Exchanger train should be suitably spaced such that shell/ tube inlet/outlet piping do not foul floating Head Covers creating maintenance problem.

5.2.6.4 Hydro extractor is considered for exchanger bundle/ shell removal. Monorails to be provided for tube bundle removal only for exchangers not accessible to Hydro extractor. No special bundle removal arrangement will be provided for exchangers which are open to sky. Davit shall be provided for floating head cover for all exchangers.



5.2.7 Fin Fan Exchangers

5.2.7.1 Fin fan exchangers shall be located over the main pipe rack or on technological structure. 15.0 M horizontal distance shall be maintained from furnace/heater. Concrete floor shall be provided below the fin-fan coolers located above the pipe rack. The width of the structure from where Air Fin exchanger assembly is supported shall be minimum 2.0 M more than the Air Fin exchanger tube bundle length so that proper supporting of inlet/outlet piping manifolds can be done from the main members of pipe rack/technological structure to transfer piping load to main structural members. Monorail shall be provided at one end of air cooler platform area for lowering the gear boxes. Adequate headroom /clearance shall be provided between concrete floor and fan location.



5.2.8 Compressors and their Prime Movers

5.2.8.1 Two major types of compressors used in process plants:

1. Centrifugal compressors
2. Reciprocating compressors.

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- 5.2.8.2 Compressors shall be located to keep suction lines as short as possible. Drivers for compressor may be electric motor, gas engine, gas-fired turbine or steam turbines as per P& ID. The gas compressors shall be located downwind side of furnace so that leaks are not blown towards furnace. In general compressors are kept under shed. When compressors are kept under shed, sides are fully open for the low shed or partially closed from top for high shed to avoid accumulation of heavier gases in the shed.
- 5.2.8.3 In case of a turbine driven compressor, if exhaust steam is condensed, turbine and compressor to be located at an elevated level and condenser to be located below turbine.
- 5.2.8.4 A major consideration in centrifugal compressor location is the lube and seal oil console. It must be accessible from road and must be lower than the compressor to allow gravity drain of oil to the consoles oil tank.
- 5.2.8.5 Intercoolers are placed near compressor and are kept within/outside shed, keeping the safe distance. Knockout pots and after coolers may be kept outside the shed but near compressor house.
- 5.2.8.6 For compressors one electrically operated Crane to handle heaviest removable piece shall be provided for each compressor house. Maintenance bay for compressors shall be provided. Maintenance bay shall be accessible from road to facilitate unloading of load on to truck etc. For removal of bundles of exchangers located within building monorail arrangement shall be provided.
- 5.2.8.7 Compressor manufacturer may be consulted for better layout and additional requirement for maintenance. However licensor's requirement, if any, shall also be taken into consideration.
- 5.2.8.8 In case the compressors are located at grade level; the finished floor level for compressor house shall be 300 mm above HPP. However if the compressors are located at elevated structure the finished floor can be same as HPP.
- 5.2.8.9 Layout of compressor house for urea and ammonia plant shall be such as to have minimum distance of:
- a) When installed in a line
 - i) 5 meters on either side of compressor train
 - ii) 5 meters between compressors
 - b) When installed in parallel
 - i) 5 meters at both ends of compressor/turbine train.
 - ii) 5 meters between compressors
- 5.2.8.10 All distances are to be measured from the edge of base plate.
- 5.2.8.11 The bidder shall submit plan layout of the compressor house and the design of plant layout shall be in agreement with owner. The compressor house shall be covered. The drop down area shall be provided with removal grating and structure. All other area shall be covered.
- 5.2.9 **Clearance and Accessibility**
- 5.2.9.1 Crane Access & Tube bundle pulling
- Equipment, structures shall be arranged to permit crane access to service air coolers, compressors and exchangers. All exchanger tube bundles shall be "jacked out" against shell. A clear space for tube bundle removal shall be provided. Dropout bay may be considered for exchangers at elevated structures. For high pressure exchangers, shell pulling on rails should be considered.
- 5.2.9.2 Access to Pumps

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Clear access of 3.8M vertically and 4.5M horizontally shall be provided centrally under main pipe rack for small mobile equipment to service pumps, wherever these are put under pipe ways with prior specific approval. Pumps outside rack shall be approachable by small cranes etc. from under the pipe rack.

5.2.9.3 Access to lower items to grade (Lowering Area)

Clear access shall be provided at grade on the access side for lowering external and internal fittings from tall elevated equipment by providing pipe davits.



5.2.9.4 Layout & Access Requirements for Platforms ladders and Stairs

For providing platform ladder & staircase following guidelines shall be followed;



- Two means of access (i.e. two ladders or one ladder and one stair case) shall be provided at any elevated platform which serves three or more vessels & for B/L valves operating platform.
- Platforms, ladders and stairways shall be the minimum, consistent with access and safety requirements
- Stairway for tanks to be provided on upstream of predominant wind direction
- i) Platform at elevated structure
 - a) Dual access (i.e. one staircase and one ladder) shall be provided at large elevated structure if any part of platform has more than 22.65M (75 ft) of travel.
 - b) Air coolers shall have platforms with interconnected walk-ways provided to service valving, fan motors and instruments. Access requirements shall conform to paragraph (a) above.
 - c) When fired heaters are located adjacent to one another, they shall have inter-connecting platforms on the upper and lower section. Inter-connecting platforms between towers may be provided taking into consideration expansion of towers.
- ii) Platforms with stair access shall be provided for:
 - a) Location at which normal monitoring (once a day or more) is required or where samples are taken.
 - b) Locations where vessels or equipment items need operator attention "such as compressors, heaters, boilers etc.
- iii) Platforms with ladder access shall be provided for:
 - a) Points which require occasional operating access including valves, spectacle blind and motor operated valves, and heater stack sampling points.
 - b) Man ways above grade on equipment.
- iv) Ladder location
 - a) Wherever practicable, ladder shall be so arranged that users face equipment or platform rather than facing open space.
 - b) Landings shall be staggered. No ladder shall be more than 6 M in one flight.

5.2.10 Valves

- 5.2.10.1 Piping shall be so arranged that valves can be operated easily. Frequently operated valves shall be located in such a way that the valves are easily accessible from grade, platforms, stairs or ladders, and that the bottom of a hand wheel is located less than 1.8 m above the operating floor level.

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- 5.2.10.2 Other valves should also be accessible where they are located at more than 1.8 m above the operating floor level. Chain-operated valves shall not be used.
- 5.2.10.3 For valves in trenches, if hand wheels are located more than 300 mm below the cover plate, the valves shall be provided with extension stems extending to within 100 mm below the cover plate.
- 5.2.10.4 Manually operated valves, which are used in conjunction with locally mounted flow indicators, shall be placed at the same operating level and located where the instrument can be readily observed.
- 5.2.10.5 Double block valves with a bleeder connection shall be provided with interconnecting piping where intolerable contamination could result from valve leakage.
- 5.2.10.6 Where block valves are installed in branch lines from headers, the valves shall be located in horizontal runs at high points so that lines will drain both ways.
- 5.2.10.7 All valves shall be so installed that the stems are not below horizontal positions unless otherwise specified.
- 5.2.10.8 All valves shown on the piping and instrument flow diagrams as located at nozzles of equipment, such as towers and reservoirs, shall be connected directly to the nozzles.
- 5.2.10.9 Battery limit valves, if required, shall be grouped together and consideration shall be given to provide a common operation platform.
- 5.2.10.10 Vessel nozzles located below the normal or emergency liquid level shall be provided with the block valves, if practical. Other vessel nozzles shall be provided with block valves only if required for operation.
- 5.2.11 **Control Valves**
- 5.2.11.1 All control valves shall be easily accessible from grade or permanent platforms and conveniently located for operations and maintenance.
- 5.2.11.2 Control valves shall be provided with block valves, a bypass valve and a drain valve. Fitting (flange or pipe fitting) shall be provided between the control valve and the block valves for easy maintenance. The drain valve shall be provided with the fittings (flange or pipe fittings) upstream of the control valve.
- 5.2.11.3 Block valves, bypass valve and drain valve may be omitted at the following conditions:
- 1) Block valves
 - a) Where operating conditions are mild, and omission of the block valves will not jeopardize safety or operability of the unit.
 - b) Where continuous operation using a bypass valve is impossible.
 - c) For the downstream block valve of control valve, where discharged to atmosphere.
 - 2) Bypass valve
 - a) Where the block valve is omitted.
 - b) Where continuous operation using a bypass valve is impossible.
 - c) Where a globe valve is used instead of upstream block valve of a control valve, when discharged to atmosphere.
 - 3) Drain valve
 - a) Where operating conditions of piping for water, brine, non-flammable or nontoxic fluid are mild.

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5.2.11.4 Unless otherwise specified on piping and instrument flow diagrams, sizes of block valves and bypass valves shall generally be as follows:

(Unit: Inch)

Flange Size of Control Valve	Line Size	Block Valve Size	Bypass Valve Size
3/4	3/4	3/4	3/4
	1	1	1
	1-1/2	1-1/2	1-1/2
	2,3,4	2	1
1	1	1	1
	1-1/2	1-1/2	1-1/2
	2,3,4	2	1-1/2
1-1/2	1-1/2	1-1/2	1-1/2
	2,3,4	2	2
2	2	2	2
	3,4,6	3	3
2-1/2	3,4,6	3	3
3	3	3	3
	4,6,8	4	4
4	4	4	4
	6,8,10	6	6
6	6	6	6
	8,10,12	8	8
8	8	8	8
	10,12	10	10
10	10	10	10
	12,14	12	12

Control valves, where practicable, shall be installed with the stems vertical.



5.2.12 Orifice

5.2.12.1 The length of straight run piping upstream and downstream of the orifice shall be in accordance with API RP550, Manual on Installation of Refinery Instruments and Control Systems, unless otherwise specified.

5.2.12.2 The straight run shall be designed for a beta ratio of 0.7. The smaller ratio may be used where practical considerations preclude the longer straight run installation.

5.2.12.3 Orifice runs shall be located in the horizontal. Orifice flanges with a centre line elevation 4.5m above grade, including installed in pipe racks, shall be accessible from a platform with permanent ladder.

5.2.12.4 Orifice taps, in general, shall be located as follows: (Please also refer specs. for Instrumentation)

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- i) Air, Gas and steam
 - Top vertical centreline (preferred)
 - 45 degrees above horizontal centreline (alternate)
- ii) Liquid
 - Horizontal centreline (preferred)
 - 45 degrees below horizontal centreline (alternate)

Tap orientation shall be shown on piping isometrics. Finally all orifice impulse tapping / spare tapping will have to be seal run.

5.2.13 Clearances

Minimum clearances shall be as indicated in Annexure-4.

5.3 Unit Piping

5.3.1 Basis of Unit Piping



- Piping & Instrument Diagram
- Equipment layout
- Equipment Data sheet & Setting plan
- Line list
- Instrument Data sheet
- Structural & building drawings
- Topography of the plant
- Piping material specification
- Overall plot plan

The following objective shall be ascertained during piping layout;



- Proper access to all operating points including valves, and for all orifice tapping points and instruments in particular (refer Annexure-2).
- Proper access to interrelated operating points for specific purpose and for maintenance.

5.3.2 Pipe Ways/Rack piping



- 5.3.2.1 Racks shall be designed to give the piping shortest possible run and to provide clear head rooms over main walkways, secondary walkways and platforms.
- 5.3.2.2 Predominantly process lines are to be kept at lower tier and utility & hot process lines on upper tier.
- 5.3.2.3 Generally the top tier is to be kept for Electrical (if not provided in underground trench as per electrical design basis) and Instrument cable trays. Cable tray laying to take care of necessary clearances for the fire proofing of structure.
- 5.3.2.4 Generally the hot lines and cold lines shall be kept apart in different groups on a tier and bigger size lines shall be kept nearer to the column.
- 5.3.2.5 Minimum spacing between adjacent lines shall be decided based on O.D of bigger size flange (minimum rating 300# to be considered), O.D of the smaller pipe, individual insulation thickness and additional 25 mm clearance, preferably. Wherever, even if flange is not appearing, the minimum spacing shall be based on above basis only.

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- 5.3.2.6 Actual line spacing, especially at 'L' bend and loop locations, shall take care of thermal expansion / thermal contraction / non expansion of adjacent line. Non expansion / thermal contraction may stop the free expansion of the adjacent line at "L' bend location.
- 5.3.2.7 Anchors on the racks are to be provided on the anchor bay, if the concept of anchor bay is adopted. Otherwise anchors shall be distributed over two to three consecutive bays.
- 5.3.2.8 Anchors shall be provided within unit on all hot lines leaving the unit.
- 5.3.2.9 Process lines crossing units (within units or from unit to main pipe way) are normally provided with a block valve, spectacle blind and drain valve. Block valves are to be grouped and locations of block valves in vertical run of pipe are preferred. If the block valves have to be located in an overhead pipe way, staircase access to platform above the lines shall have to be provided.
- 5.3.2.10 Provision of block valves, blinds etc. shall be as per Process Design Basis and P & IDs.
- 5.3.2.11 All small bore piping shall be designed in a way so as to ensure adequate space for maintenance and operation. For small bore piping intermediate support shall be provided in between portals.
- 5.3.2.12 Stubs on saline water (if applicable) service shall be from top of main header.
- 5.3.2.13 Minimum branch size for tapping including for instruments e.g. PG/ PTI TE etc. shall be of 3" NPD and 150 mm height on internal cement lined pipes.
- 5.3.2.14 Aboveground lines shall be grouped to run on pipe racks or sleepers in so far as practicable.
- 5.3.2.15 Hot lines on pipe racks or sleepers shall be grouped and expansion loops shall be nested together. The number of expansion loops shall be kept to a minimum.
- 5.3.2.16 Piping handling corrosive fluids shall be run under piping handling non corrosive fluids, and shall not, where possible, be run overhead across walkways or normal passages for personnel.
- 5.3.2.17 All process and utility piping will be located aboveground within the plant battery limit, except water mains.
- 5.3.2.18 All piping shall be arranged in horizontal banks, where possible, to facilitate supporting. Banks running north-south shall be at different elevations from banks running east-west. Exceptions are permitted to avoid unnecessary change in elevation at change of direction or where essential to avoid pockets.
- 5.3.2.19 All piping shall be routed for the shortest possible run and have the minimum number of fittings consistent with provision for expansion and flexibility. All piping shall be arranged in a neat manner, providing free access around all operating equipment.
- 5.3.2.20 Vertical lines at vessels shall run close to the vessel shell to facilitate supporting. The line shall be arranged and grouped to allow the use of single support.
- 5.3.2.21 Lines carrying molten solids, slurries or highly viscous liquids shall have a sufficient slope for each gravity flow.
- 5.3.2.22 The shortest and most direct layout possible shall be provided for gravity flow lines, especially when the fluid is subject to solidification and when the differential pressure is small.
- 5.3.2.23 Piping shall be arranged to facilitate handling of equipment for inspection or maintenance.
- 5.3.2.24 Vapour collecting system shall be routed so that the vapor rises continuously from the vessel being vented to a higher point without pocketing.
- 5.3.2.25 Pockets shall be avoided in lines, particularly those carrying corrosive chemicals, slurries, vents, blow down lines, etc.
- 5.3.3 **Column / Vessel Piping Control Valves**

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- 5.3.3.1 Piping from column shall drop or rise immediately upon leaving the nozzle and run parallel and as close as practicable to vessel. Re-boiler outlet piping shall be as short as possible with minimum bends.
- 5.3.3.2 Piping shall be grouped as far as possible for the ease of supports and shall run on the rack side of the column.
- 5.3.3.3 Manholes shall be kept on the road side of the column and approachable from the platform. Platform width shall be such that minimum 1.0 M space is available beyond manhole for movement.
- 5.3.3.4 Piping shall be supported from cleats welded on the vessel as far as possible.
- 5.3.3.5 Proper guides at intervals shall be provided for long vertical lines.
- 5.3.3.6 Access platforms/ladders shall be provided along the column for valves and instruments. Minimum width of platform shall be 750 mm clear.
- 5.3.3.7 For ease of operation and maintenance, column and vessels which are grouped together, shall have their platforms at the same elevation interconnected by walkways wherever feasible. However each column \ vessel shall have an independent access also. Column vessel platforms should be designed in such a way so that all the nozzles should be approachable from platforms.
- 5.3.3.8 Unless specifically indicated in P&ID's control valves shall preferably be kept at grade instead of platform.
- 5.3.3.9 Piping intended for vacuum services shall be routed as short as possible, with minimum bends and flanged joints.
- 5.3.3.10 Piping support cleats shall be designed for safety valves considering impact loading during popping off.
- 5.3.4 **Exchanger Piping**
- 5.3.4.1 Exchanger piping shall not run in the way of built in or mobile handling facilities.
- 5.3.4.2 Wrench clearance shall have to be provided at exchanger flanges.
- 5.3.4.3 Piping shall be arranged so that they do not hinder removal of shell end and channel cover and withdrawal of tube bundle.
- 5.3.5 **Pump Piping**
- 5.3.5.1 Pump drives shall have clear access.
- 5.3.5.2 Pump suction piping shall be as short as possible and shall be arranged with particular care to avoid vapour pockets.
- 5.3.5.3 Reducers immediately connected to the pump suction shall be eccentric type flat side up to avoid the accumulation of gas pocket. For end suction pumps, elbows shall not be directly connected to the suction flange. A straight piece minimum 3 times the line size shall have to be provided at the suction nozzle.
- 5.3.5.4 Pump discharge check valve if installed in vertical lines shall be fitted with a drain connection as close as possible downstream of the valve.
- 5.3.5.5 When a suction vessel operates under vacuum, the vent connection of the pump has to be permanently connected to vapour space of the suction vessel to allow possible filling of the pump with liquid before it is started.
- 5.3.5.6 Unless otherwise specified T-type strainers shall be used on pump suction piping for sizes 2" and above.

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- 5.3.5.7 Y-type strainers to be used for all sizes in steam services and for pump suction lines 1½ and below.
- 5.3.5.8 All small bore piping connected to pump (drain to OWS & CBD, seat and gland leak drain) shall have provision for break up flanges for removal of pumps.
- 5.3.5.9 Piping shall be so arranged that forces and moments imposed on the pump nozzle do not exceed the allowable values as per API 610(centrifugal pumps and centrifugal pumping systems).
- 5.3.5.10 Pump discharge should preferably be routed away from the pump rather than towards the motor side.
- 5.3.5.11 Pump cooling water connection shall be taken from the top of circulating cooling water header.
- 5.3.6 Compressor Piping**
- 5.3.6.1 Suction lines shall be as short as possible.
- 5.3.6.2 Suction piping shall have adequate flanged joints for ease of erection and maintenance.
- 5.3.6.3 Lube oil cooler space shall be provided such as to facilitate tube bundle removal.
- 5.3.6.4 All operating valves on main suction and discharge piping shall be lined on one side as far as possible.
- 5.3.6.5 A minimum straight length of suction pipe is to be provided as per manufacturer's recommendation.
- 5.3.6.6 Piping shall be designed so that forces and moments imposed on the compressor do not exceed the manufacturer's recommendation.
- 5.3.6.7 Compressor suction lines between the knockout drum and the compressor shall be as short as practicable.
- 5.3.6.8 Where the line between knockout drum and the compressor cannot be routed without pocket, low point in compressor line shall be provided with drains to remove any possible accumulation of liquid. In no case accumulation at low point should be allowed to go towards the compressor.
- 5.3.6.9 Low points in the discharge line from an air compressor shall be avoided because it is possible for lube oil to be trapped and subsequently ignited. If low points are unavoidable, they shall be provided with drains- In case of reciprocating compressor, piping shall be suitably supported to avoid vibrations due to pulsating flow. Unless specific requirements of no pockets are there from the licensor, all the piping shall run at 500 mm above grade level so that proper. Supports can be provided and also to minimize vibrations.
- 5.3.6.10 Analog study shall be carried out for complete compressor piping including suction I discharge piping as per P&ID' s and the analog study recommendations if any, shall be implemented.
- 5.3.6.11 Reciprocating compressor piping should not be supported from compressor shed I platform structure.
- 5.3.6.12 Pulsation dampers or surge bottles at the suction and discharge of reciprocating and displacement type compressors shall be provided according to manufacturer's recommendations.
- 5.3.6.13 A suction filter shall be provided in each compressor suction line to completely remove debris from the system.
- 5.3.6.14 Whenever possible, suction and discharge piping in the immediate vicinity of a compressor shall be located at or close to grade level to minimize vibration.

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5.3.6.15 Spring loaded hangers or equivalent means shall be provided in compressor piping to minimize stress to nozzles. The allowable end reactions shall be based on manufacturer's recommendations.

5.3.7 Piping around Tanks Area

5.3.7.1 Nozzles for level controlling instruments shall be oriented within an angle not exceeding 60 degrees against the fluid inlet nozzles.

5.3.7.2 Nozzles shall be easily accessible from platforms or ladders, if provided with block valves, sampling valves, instruments, and all other devices to be manually operated.

5.3.7.3 Fluid inlet nozzles shall be located as far apart as possible from fluid outlet nozzles.

5.3.7.4 Vessel working platforms where man ways and hand holes are located shall preferably be provided with utility stations.

5.3.7.5 The first pipe support from tanks shall be located sufficiently away from the tank to prevent damage caused by settling.

5.3.7.6 The number of pipelines in the tank dyke shall be kept at minimum and shall be routed in the shortest practicable way to main pipe track outside the tank dyke, with adequate allowance for expansion. With nozzle tank Dyke the piping connected to that tank shall only be routed. Pad shall be provided at pipette sleeve interface at dyke wall entry point.

5.3.7.7 Manifolds shall be located outside the tank dyke & by the side of the roads, easily accessible by the walkway.

5.3.7.8 Plug valves whenever specified shall be of pressure balance type.

5.3.7.9 Analysis shall be carried out to prevent damage to lines and tank connection caused by tank settlement. If exceptionally high settlement is expected, Dressers coupling or flexible ball joint may be provided, after necessary analysis.

5.3.7.10 Special consideration shall be given as regards to spacing of nozzles while installing special item like hammer blind, MOV etc.

5.3.8 Relief System/blow down System Piping (CBD, OWS, FLARE)

5.3.8.1 Relief of liquids and easily condensable hydrocarbons are usually discharged to a closed system.

5.3.8.2 Wherever the inlet line size is higher than the safety valve inlet size, reducer shall be installed adjacent to inlet of safety valve.

5.3.8.3 Relief valve discharging steam, air or other non-flammable vapour or gas directly to atmosphere shall be equipped with drain and shall be suitably piped to prevent accumulation of liquid at valve outlet. Liquid phase blow down system piping connected to a closed system shall be self draining to the blow down drum. Closed blow down header shall be sloped towards the CBD drum to assure free drainage.



5.3.8.4 Liquid-vapour phase relief valves shall discharge into the flare header at an angle 45 degrees in the direction of header flow, to minimize the effect of kinetic energy and to avoid accumulation of liquid.

5.3.8.5 Pockets in the flare header and blow down system shall be prohibited.



5.3.8.6 Relief valve discharge piping shall be taken to safe location as per following;

5.3.8.7 3M above top platform of column or structure, within 6M radius for steam and 8M for Hydro carbon / toxic discharge.

5.3.8.8 25M horizontally away from furnace.

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- 5.3.8.9 Inlet and outlet piping of pressure relief valve shall be adequately supported to take care of the thrust induced by the relief valve during popping.
- 5.3.8.10 Reaction forces due to safety valve popping shall be ascertained in the connected piping. The effect of these forces on the piping supports and the anchors of the piping system shall be calculated to ascertain that the allowable limits at these locations are not exceeded. The supporting structure also shall be adequately designed so that when subjected to these reaction forces the supporting elements connected to piping as well as the basic supporting structure i.e. platform members etc. are capable of withstanding them. System stresses in the inlet and outlet piping portions at safety valves also shall be kept within the allowable limits, inclusive of the distribution branching points in the inlet portion. These reactive forces shall not lead to any leakage at the flanged joints present in the system. To ascertain these necessary calculations for checking leakage at the flanged joints shall be performed.
- 5.3.8.11 Safety and relief valves shall be accessible from platform or grade. For the valves weighing more than 45 kg, davits or other lifting devices shall be provided. Alternatively crane access shall be provided for these valves.
- 5.3.8.12 Safety and relief valves shall be installed in a vertical position and shall have a minimum of pipe length between the protected line or equipment and the valve inlet.
- 5.3.8.13 Safety valves discharging to atmosphere shall have the outlet piping extending at least 2.2 m above operating platforms or levels within a radius of 7.5 m. A 9 mm minimum weep hole shall be provided at the lowest point of the outlet piping.
- 5.3.8.14 Safety and relief valves connected to flare lines shall be located higher than the flare header, where the fluid discharged from valve is liquid or condensable.
- 5.3.8.15 Outlet piping or safety and relief valves, including flare lines, shall be designed to prevent excessive stresses in the line due to rapid temperature change or uneven temperature distribution.
- 5.3.8.16 All flare headers shall be sloped 1 m per 400 m to 1 m per 1000 m downward to the blow down drum.
- 5.3.8.17 Flare System shall be designed such that:
- a) There will be 1 Running + 1 standby Safety Valve. (For all process & utilities lines)
 - b) Each Valve shall have full relieving capacity.
 - c) Isolation Valve shall be provided on Up Stream side & Spectacle Blind with Valve on downstream side so that individual safety valve can be isolated for maintenance purpose.
- 5.3.9 **Steam Piping - Indian Boiler Regulations (IBR)**
- 5.3.9.1 Generally steam lines with conditions listed below fall in the scope of IBR;
- a) Lines having design pressure (maximum working pressure) Above 3.5 Kg/cm² (g)
 - b) Line sizes above 10" inside diameter having design pressure 1.0 Kg/cm² (g) & above.
 - c) Lines with pressure less than 1.0 Kg/cm² (g) are excluded.
 - d) Users of steam like steam tracing lines, jacket of the steam jacketed lines, and steam heating coil within the equipment are excluded from IBR scope.
 - e) Boiler feed water lines to steam generator, condensate lines to steam generator and flash drum as marked in P&I D shall be under purview of IBR.
- 5.3.9.2 IBR requirements (in brief)

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- a) All materials used on lines falling under IBR must be accompanied with IBR Inspection certificate in form IIIA/IIIC, as applicable, in original. Alternatively, photocopy of the original certificate duly countersigned and attested by local IBR inspector is acceptable.
- Chief inspector of boilers shall be the inspection authority for Indigenous (Indian) supply. However, for non - indigenous supply, IBR inspection shall be carried out by the inspection agencies approved by IBR (Central Boilers Board).
- b) Drawings like General Arrangement Drawings (GAD) and system isometrics / line wise isometrics of lines falling under IBR must also be approved by IBR authority of State in which the system is being installed.
- c) All welders used on fabrication of IBR system must possess IBR welding qualification certificate.
- d) IBR system must be designed to comply IBR regulations as well as ASME B31.3. All design calculations towards the same must be approved by IBR authority.
- e) IBR approval is obtained with requisite fees payable to Indian Boiler Board of the State concerned.
- f) Steam generators (boilers/heat exchangers) shall require exclusive IBR approval along with its integral piping up to the final isolation valve.
- g) The discretion of IBR authority of state is final and binding for the above cases.

5.3.10 **Steam Header & Supply Lines / Steam and Condensate Systems**

- 5.3.10.1 Steam piping shall be designed to have complete condensate removal. Drip legs shall be provided with steam traps at low points in the system.
- 5.3.10.2 All steam branch connections shall be taken from the top of the header.
- 5.3.10.3 Return exhaust steam / condensate lines shall connect to the top of the exhaust steam Condensate header.
- 5.3.10.4 Where block valves have been installed in the main steam header such that condensate can collect either side of the valve when closed, a safe means of draining the condensate prior to opening the valve shall be provided.
- 5.3.10.5 Steam header shall be located generally on the upper tier and at one end of the rack adjacent to columns.
- 5.3.10.6 Branch lines from horizontal steam header, except condensate collection points, shall be connected to the top of the pipe header.
- 5.3.10.7 Isolation valves (if provided) on the branch line shall preferably be provided on the horizontal run and outside the pipe rack.
- 5.3.10.8 All branch lines shall be drainable.
- 5.3.10.9 Drip legs & steam traps shall be provided at all low points and dead ends of steam header. Drip legs at low points shall be closer to downstream riser and shall be provided to suit bidirectional flows, if applicable.
- 5.3.10.10 All turbines on automatic control for startup shall be provided with a steam trap in the steam inlet line.
- 5.3.10.11 All traps shall be provided with strainers if integral strainers are not provided.
- 5.3.10.12 Steam traps discharging to atmosphere shall be connected to storm water drain/storm sewer, in case of open system. In case of condensate recovery, traps shall discharge into condensate header.

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5.3.10.13 Expansion loops are to be provided to take care of the expansions within units.

5.3.10.14 Wherever condensate is to be drained, proper condensate draining facility shall be provided.

5.3.11 Water Piping

5.3.11.1 Water piping shall be designed to minimize the possibility of water hammer.

5.3.11.2 Water main headers may run underground to prevent freezing.

5.3.11.3 Unless local code or regulation prohibits, firewater lines shall be underground to prevent freezing. Firewater piping system shall conform to regulations of the competent governmental authorities.

5.3.12 Instrument Air Piping

5.3.12.1 Instrument air lines shall not be connected to process lines, service lines, and other equipment.

5.3.12.2 Instrument air shall not be used as plant air or service air.

5.3.12.3 Branch lines from the instrument air header shall be taken from the top of the header and shall be provided with a block valve close to the header. Also in the upstream of Instrument manifold, Gate valve has to be provided

5.3.13 Supports and Anchors

5.3.13.1 Supports and/or anchors shall be provided close to changes in direction of lines, branch lines and, particularly, close to valves to prevent excessive sagging, vibration and strain.

5.3.13.2 Allowable spans between pipe supports shall be determined to keep the maximum deflection within 16 mm.

5.3.13.3 In cases where periodic maintenance requires removal of equipment, such as pumps and relief valves, and where lines must be dismantled for cleaning, piping shall be supported to minimize the necessity of temporary supports.

5.3.13.4 Spring-loaded hangers may be used on piping subject to thermal expansion or contraction. In cases where the movement is very large, or the limitation of reaction and stress are very severe, constant support spring hangers shall be used.

5.3.13.5 Suction and discharge lines of rotating equipment shall be supported as close as possible to equipment nozzles, and shall be relieved of excessive strains by using proper pipe supports.

5.3.13.6 Supports shall not be directly welded to pipes. Where welding is unavoidable, supports having the same chemical composition as pipe shall be carefully welded.

5.3.13.7 All piping shall be properly supported to minimize vibration.

5.3.13.8 Outlet piping of safety and relief valves shall be supported so that the inlet piping is capable of withstanding the reaction caused by operation of safety and relief valves. Furthermore, the supports shall be designed to minimize the stresses due to thermal expansion and the stresses in the valve body due to the weight of piping.



5.3.13.9 Expansion joints shall be guided and anchored to the extent necessary for their proper operation and alignment.

5.3.13.10 Anchors shall provide sufficient fixation to substantially transmit all load effects into the foundations.

5.3.13.11 Underground piping shall be given special anchoring consideration for differential settlement.

5.3.14 Utility Stations

5.3.14.1 Requisite number of utility stations shall be provided throughout the unit to cater for the utility requirement. Utility stations shall have four connections one for LP steam (SL), one for Plant Air

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(AP) and one for Service Water (WS) and one for nitrogen each of 1.0” with isolation valves unless otherwise specified in P&ID.

Utility connection with nitrogen shall be provided with NRV along with isolation valve kept at a separate location other than this cluster @ 15 M.

- 5.3.14.2 Air and water lines shall have quick type hose connection and steam line shall have flanged type hose connection. All connections shall be directed downward. All connections shall have globe valve for isolation purpose. An inter connection with valve shall be provided between steam and service water lines shall be provided. Inert gas hose, when required, shall have built in non return valve in quick connection coupling of piping end.
- 5.3.14.3 Number of utility stations shall be such that all equipments shall be approachable from at least one utility station. The approach of utility station shall be considered 15 M all around the station location.
- 5.3.14.4 The Utility stations shall generally be located adjacent to pipe-rack column.
- 5.3.14.5 The utility stations shall also be provided on elevated structures like – technological structure, operating platforms of vertical equipments etc.
- 5.3.14.6 Operating platforms having manholes must have a utility station. Utility station locations shall be limited to a height of 35 M from H.P.P.

5.4 Offsite & Yard Piping

- 5.4.1 In general, offsite piping (except tank ages area), electrical cable and instrumentation cable shall also be laid either on pipe rack or pipe sleepers.
- 5.4.2 Wherever piping is laid on pipe sleepers, it shall have hard surfacing below it keeping a gap of 300 mm from the bottom of the pipes. Hard surfacing should be completed before start of pipe laying. Width of hard surfacing shall be about 1.0 meter more than the piping corridor. This extra hard surfacing shall be for movement of operating personnel along the piping corridor.
- 5.4.3 Pipes at road crossing shall be under culverts in general. Overhead pipe bridges may be used for areas where pipe racks are provided. Where culverts are not provided, pipe sleeves shall be used for underground road crossing. Culverts / overhead pipe bridges shall be adequately designed to take care of future requirements. Minimum 20% extra width shall be provided in all such structures.
- 5.4.4 Clearances between lines shall be minimum “C” as given below:
 $C = (D_o + D_f) / 2 + 25 \text{ mm} + \text{Insulation thickness}(es)$ where,
 D_o – outside diameter of smaller pipe (mm)
 D_f – outside diameter of flange of bigger pipe (mm)
 However this ‘C’ spacing between the offsite piping on the rack/sleeper can be suitably increased so that the lines should not touch each other after insulation / lateral thermal expansion.
- 5.4.5 Adequate clearance shall be provided for every long & high temperature lines to avoid clashing at the bends. See 5.2.2 also for line spacing at ‘L’ bends and loops.
- 5.4.6 Expansion loops for all lines shall generally be kept at the same location.
- 5.4.7 Vents shall be provided on all high points & drains shall be provided at all low points. Drain valves at sleeper piping shall be kept outside the sleeper way if the same is not accessible and valves shall be put in horizontal only.
- 5.4.8 Places where piping is extended to make drain valves accessible – 2 nos. of stiffeners, irrespective of pipe rating, shall be provided.



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5.5 Flare Piping

- 5.5.1 Flare header shall be sloped towards flare knock-out drum. Only horizontal loop shall be provided as per requirement to accommodate thermal expansion. The desired slope shall be ensured throughout including flat loop. Flare header shall be supported on shoe of height ranging from 100mm to 300mm.
- 5.5.2 Proper thermal analysis temperature shall be established including the possibility of temperature gradient along the line before providing expansion loops. Efforts shall be made to minimize the number of loops. Flare line between knock out drum and water seal drum shall be designed for pressure fluctuations and adequately supported to avoid vibrations.

5.6 Underground Piping

- 5.6.1 Underground steel piping shall be protected from electric corrosion.
- 5.6.2 Underground piping passing under loaded areas, such as main roads in the plant, shall be protected from heavy traffic by casing pipes or covers extending at least 1 m on either side of the area or having the wall thickness sufficient to bear earth pressure.
- 5.6.3 Underground piping shall be sloped to all drain points with a downward slope of not less than 1 m in 150 m.
- 5.6.4 Expansion elbows or joints of underground piping for hot fluids, such as steam or heated heavy oil, shall be enclosed in a conduit from which they are separated to allow free longitudinal expansion.
- 5.6.5 The following points to be considered in designing of Underground piping;
- i) All Sewage lines (oily and chemical) from catch basin to mains and manholes shall be laid underground.
 - ii) Valve chamber wherever required shall be made of brick or concrete. Valve chamber should be spacious to attend valves during operation/Maintenance.
 - iii) All U.G. headers shall clear equipment foundations as far as possible. Under special cases, the C.W. header may be laid over the footing of foundations.
 - iv) Provide break flange at + 500 MM from floor level connection with cathodic protection to isolate underground pipe from above ground piping with insulating gasket KIT.
 - v) Pipes shall be laid below electrical cables if any.
 - vi) Top of underground piping shall be below grade level at least 1 meter deep in case of open areas and 1.5 meter deep for roads.
- 5.6.6 All underground pipe work shall be provided with following protection:
- i) At location where Underground Piping becomes above ground, Insulating Gasket with material Glass Filled Teflon shall be provided.
 - ii) Cathodic Protection shall be provided to all underground piping. Specification shall be submitted by the Contractor & shall be approved by the Owner.
 - iii) Underground piping shall be wrapped & coated and shall be "Holiday Tested" before Hydro Test. (For wrapping/coating specification- refer Design Philosophy-Construction/Erection, Pre-Commissioning, Commissioning and Start-Up).
 - iv) All underground pipes shall have Sand Bed, at least 150 MM all around the pipe.

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v) Underground pipe crossing roads, access ways, and rails shall have Hume Pipe Sleeves/casing pipe (R.C.C or C.S).

5.6.7 Piping in Trenches

Where it is impossible to run pipe aboveground or underground, trenches may be used. Trenches for piping close to process equipment should be avoided, whenever possible.

The following points to be considered in designing of trench pipes:

Piping located below grade, requiring inspection, servicing or provided with protective heating.

Fire water lines/Process lines. (Ref Fire Fighting Design Philosophy)

Drain lines requiring gravity flow trenches.

Sump for valves and trenches shall be provided.

Suitable draining scheme for trenches shall be provided.

5.7 Air Systems

Branch connections shall be taken from the top of the header. Low points shall be fitted with drains.

5.8 In-Line Instruments

5.8.1 Liquid level controllers and level glasses shall be located so as to be accessible from grade, platform or permanent ladder. The level glass shall be readable from grade wherever possible.

5.8.2 Relief valves shall be accessible. Relief valves with a centre line elevation over 4.5 M above grade (except in pipe racks) shall be accessible from a platform or permanent ladder.

5.8.3 Relief valves that discharge to a closed system shall be installed higher than the collection header, with no pockets in the discharge line.

5.8.4 Relief valves that discharge to atmosphere shall have tail-pipes extended to a minimum of 3.0 M above the nearest operating platform that is within a radius of 8 M.

5.8.5 Provide steam traps at pocketed low points and at dead ends of steam headers. Provide steam traps on excessively long runs of steam piping to ensure dry quality steam at destination. Steam traps located more than 4.5 M above grade, except in pipe racks, shall be accessible from a platform.

5.8.6 Control valves shall be accessible from grade or platforms. In general, the instruments or indicators showing the process variables shall be visible from the control valve.

5.8.7 Orifice runs shall be located in the horizontal. Orifice flanges with a centre line elevation over 4.5m above grade, except in pipe racks, shall be accessible from a platform or permanent ladder.

5.8.8 Orifice taps shall be located as follows:

i) Air, Gas and steam



Top vertical centreline (preferred)

45 degrees above horizontal centreline (alternate)

ii) Liquid

Horizontal centreline (preferred)

45 degrees below horizontal centreline (alternate)

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iii) Tap orientation shall be shown on piping isometrics.

5.9 Sample Connections

Sample connections shall be accessible from grade or platforms. In general, where liquid samples are taken in a bottle, locate the sample outlet above a drain funnel to permit free running of the liquid before sampling.

5.10 Vents and Drains



- 5.10.1 For hydrotest drain & vent philosophy refer annexure-9.
- 5.10.2 Process vents and drains shall be indicated on the P&ID's
- 5.10.3 Vent, drain and sampling valves on process lines, not connected to a piping system, shall be provided with appropriate end closures.
- 5.10.4 Vents shall be located at high points of pipelines when necessary.
- 5.10.5 Drains shall be located at low points to empty pipelines or equipment after testing or during maintenance (i.e. for every loop).
- 5.10.6 All drains and vents shall be provided with valve, except that vents for test purpose for flare lines (header), may be plugged. Exposed threads shall generally be seal welded.
- 5.10.7 Low-point hydrostatic drains and high-point hydrostatic vents shall be added as required; locations to be determined during the design review.
- 5.10.8 Vent valves shall be the globe or gate type and drain valves the gate type.
- 5.10.9 Valved bleeds shall be provided at control valve stations, level switches, level controllers, and gauge glasses.

5.11 Line Strainers

- 5.11.1 Provide temporary conical type strainers in 2" NB and above butt weld pump suction lines for use during start-up. Arrange piping to facilitate removal.
- 5.11.2 Provide permanent Y-type strainers for pump suction piping below 2" NB Thd Or SW.
- 5.11.3 Provide temporary basket type strainers located at the suction pulsation device inlet for start-up of reciprocating compressors. Arrange piping to facilitate removal of the filter.
- 5.11.4 Provide temporary basket type strainers and locate them as close as possible to the compressor inlet flange for start-up of centrifugal compressors. Arrange piping to facilitate removal of the filter.
- 5.11.5 Allowable pressure drop when specified shall be certified by vendor along with the offer. If asked specifically, vendor shall furnish pressure drop calculations
- 5.11.6 All 2" & higher sized Y type strainers shall be provided with 3/4" threaded ,tap and solid threaded plug as drain connection. For less than 2", this shall be 1/2 " size.
- 5.11.7 Bottom flange of Y-type strainer shall not have tapped hole. Full length standard size studs shall be used for joining blind flange.
- 5.11.8 For fabricated strainers, all BW joints shall be fully radiographed and fillet welds shall be 100% DP/MP checked.
- 5.11.9 All the strainers shall be hydrostatically tested at twice the design pressure

5.12 Spectacle Blinds

- 5.12.1 Spectacle blinds shall be provided to isolate equipment. In hazardous service flanged drop-out spools shall be provided for safety purposes. Both shall be shown on the P&ID's.

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5.12.2 Spectacle blinds shall be accessible from grade or platforms. Blinds located in a pipe-rack are considered to be accessible. Blinds that weigh over 40kg shall be accessible by mobile equipment. Where this is not possible davits or hitching points shall be provided.

5.13 Flexibility Analysis and Supporting

5.13.1 Pipe Supporting Criteria & General Guidelines

5.13.1.1 Piping system shall be properly supported taking into account the following points:

1. Load of bare pipe + fluid + insulation (if any).
2. Load of bare pipe + water fill.
3. Load of valves and online equipment and instrument.
4. Thermal loads during operation.
5. Steam-out condition, if applicable.
6. Wind loads for piping at higher elevation, e.g. transfer lines, column over head lines, flare headers, etc.
7. Forced vibration due to pulsating flow.
8. Vibration due to two phase flow.
9. Loads due to internal pressure.
10. Any external loads/concentrated loads and cold load of springs.

5.13.1.2 Pipe supporting shall preferably follow the minimum basic span as given in Annexure-1 except for flare line in off site on trestles in which case the maximum basic span shall be restricted to 18.0 meters, irrespective of line size.

5.13.1.3 For sizes not covered in Annexure-1, basic span shall be established based on project requirement. For piping on rack or sleeper, as a minimum, providing resting support on every grid of pipe rack / sleeper is mandatory. Depending on the pipe size, as a rule, guides shall be provided on straight run of pipes at intervals as specified in Annexure-3 unless specifically becomes non-viable due to flexibility problems.

5.13.1.4 Additional supports, guides, anchors, special supports like spring supports and sway braces shall be provided after detailed analysis of piping system to restrict the forces experienced on nozzles of critical items like pumps, compressors, turbines, exchangers, air fin coolers etc.



5.13.1.5 For lines which do not need any support otherwise but become unsupported by opening of flange, etc, during maintenance and thereby may transfer the total load on a small branch off, a permanent support shall be suitably provided which may be a spring support also. Bare pipes of size 14" and above on elevated structures shall be supported with pad or shoe. While bare pipes of size 6" and' above, on sleepers, corrosion pads shall be provided.

5.13.1.6 Pads shall be provided for insulated pipes before welding the shoes for sizes 8" & above.

5.13.1.7 Adequate stiffening shall be provided for the following:

- a) Lines in above 600#,
- b) Lines having two phases flow,
- c) Lines having Pulsating flow such as discharge of reciprocating compressors & reciprocating pumps.

5.13.1.8 For pulsating flow lines detailed thermal and vibration analysis by analog study shall be done to decide location of anchor supports and guides etc. Pulsating flow lines shall be as identified by licensor/owner.

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- 5.13.1.9 Wherever two phase flow in piping is expected, piping design shall be checked by dynamic analysis to prevent vibrations.
- 5.13.1.10 Pipe support design shall be such that deflection in piping systems due to sustained loads shall not exceed 15mm, in any case, between two adjacent supports.
- 5.13.1.11 As far as possible long trunnion types of supports (more than 0.5 metre) are to be avoided. In case long trunnion support is unavoidable in straight length of pipe, trunnion height to be restricted to 0.5 M and balance height to be made up by providing extended structure.
- 5.13.1.12 In the heaters where steam air decoking provision is there, the main lines and decoking lines should be supported in a way so that either of the lines should not be in the hanging position while connected to other one. Same philosophy shall be adopted for similar type of switch over arrangement.
- 5.13.1.13 Piping passing through the technology structure or passing near the concrete column etc. should have adequate annular space to avoid restriction of line movement during thermal expansion. The gap should take care the thermal expansion along with insulation thickness.
- 5.13.1.14 High density PUF blocks shall be considered for cold piping supports. Use of wood blocks shall be avoided.
- 5.13.1.15 All pipes supports shall be so designed that there is no undue tension on equipment flanges. Flange joints should not move away from each other in case of unbolting of the joint.

5.13.2 **Flexibility Analysis Criteria & General Guidelines**

Formal computer analysis shall be performed on piping systems as per design philosophy for stress analysis (Refer annexure)

The directions of forces and moments shall be in accordance with Welding Research Council Bulletin 107 (WRC 107), with the exception that the radial force (P) shall be away from the vessel. All forces and moments shall be assumed to act simultaneously and apply at the nozzle/vessel interface.

Air coolers to API 661 shall be specified with Fx forces and Mz moments increased to 1.2 times the value shown in Figure 8 of API 661 for nozzle sizes 6"NPS and larger to simplify piping flexibility analysis and facilitate piping layout.

Piping stress analysis and equipment nozzle loading analysis shall be in accordance with ASME B31.3 and the relevant API, ANSI/ISO and NEMA Codes.

5.13.2.1 **API 610 Pumps**

The allowable nozzle loads on centrifugal pumps shall meet the load criteria of API 610. Heavy duty base plate shall be specified where the pump design temperature is in excess of 150°C.

5.13.2.2 **ASME or Manufacturer's Standard Pumps**



The allowable nozzle loads on horizontal centrifugal pumps design to ASME B73.1 shall be specified by the manufacturer. For preliminary layout and analysis NEMA SM 23 criteria shall be used for individual nozzles.

5.13.2.3 **Other Horizontal Centrifugal Pumps**

The allowable nozzle loads shall meet the load criteria specified by the manufacturer.

5.13.2.4 **Vertical Turbine, Can-Types Pumps**

The combined bending and tensional thermal stress in the piping attached to the nozzle shall be limited to 25 percent of the allowable stress range shown in ASME B31.3. The combined stress due to dead load and other sustained loads shall be limited to 25 percent of the allowable hot stress.

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5.13.3 Method of Analysis

- 5.13.3.1 Formal computer analysis shall be performed on piping systems as per design philosophy for stress analysis.
- 5.13.3.2 The package used shall be latest version of CEASER / AUTO PIPE / SIMPLEX / CAEPIPE. Only one of these packages shall be used for the project & not a combination of the above packages.
- 5.13.3.3 All lines shall be analyzed at design I analysis temperature. In the absence of analysis temperature lines shall be analyzed at design temperature.
- 5.13.3.4 However in case of wide difference in design and operating temperature, temperature for analysis shall be established in process documents. (E.g. flare line)
- 5.13.3.5 All non-critical lines may be analyzed using other methods.
- 5.13.3.6 Special analysis methods shall be followed for lines involving pulsating flow such as those connected to reciprocating pumps & compressors which require acoustical plus analog study by approved agencies and shall require entire system analysis along with piping & equipments.
- 5.13.3.7 Seismic analysis shall be done for line sizes 12" and above.

5.14 Personnel Protection

- 5.14.1 Eyewash and emergency safety showers shall be provided in areas where operating personnel are subject to hazardous sprays, emissions or spills.
- 5.14.2 Personnel protection shall be provided on un-insulated lines and equipment operating above 70 deg C when they constitute a hazard to the operators during normal operation of the facility.
- 5.14.3 Leakage indicating tape and spray impingement shrouds shall be provided at flanged joints in hazardous service.



5.15 Mechanical Handling

Handling facilities such as davits and monorails shall be provided on vessels over 10m in height where the weight of removable internal and/or external equipment is greater than 35 Kg.



6. MATERIALS

6.1 General

- 6.1.1 Basic material selection of particular line depending on its service, temperature and corrosivity shall be spelt out in process package. Material specification shall follow the requirements as specified in PMS as per Licensor's requirement. PMS / VMS shall be supplied by bidder and will be approved by owner / PMC. PMS shall generally follow the requirements given in this section.
- 6.1.2 All materials for piping components shall be new and conform to the relevant code and/or specification.
- 6.1.3 All plate, sections, pipe, fittings, flanges, valves and special items shall have Material Test Certificates.
- 6.1.4 All alloy materials shall have Material Certificates verifying the alloy content.
- 6.1.5 All bolting and gasket material shall have Letters of Compliance as a minimum.
- 6.1.6 Only piping materials listed in ASME B31.3 shall be used.
- 6.1.7 All insulation and gaskets shall be asbestos free. Aluminium or copper alloys shall not be used for any component in the piping systems.
- 6.1.8 The use of 1.25Cr-0.5Mo alloy shall be a minimum requirement for piping systems having a design temperature above 425°C.

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- 6.1.9 All Austenitic Stainless Steel items/parts shall be supplied in solution annealed condition.
- 6.1.10 For Category 'D' utility piping, where scaling and impurities are to be avoided (such as potable water and deluge water) hot dipped galvanized and threaded fittings may be used in sizes up to and including 4" NB. Galvanized piping shall not be used in environments containing acids or other corrosive commodities. In corrosive environments stainless steel piping material shall be used for such utility systems.
- 6.1.11 In absence of specific requirement, Natural Rubber shall be used for lining in rubber lined piping items, wherever applicable. The Vendor shall confirm the suitability of Rubber Material for specified service. Unless otherwise specified, rubber lining shall be in accordance with IS4682 Part-I.
- 6.1.12 Unless otherwise specified, HDPE pipes & fittings shall be in accordance to ASTM D3035/ASTM D3261/ASTM D3350 or equivalent.
- 6.1.13 **Specification for FRP material**
- 6.1.13.1 Anticorrosion Barrier of Polymer veil having minimum thickness 2.5 mm shall be provided for chemical resistance. Mechanical resistance to be sustained by FRP.
- 6.1.13.2 The selected nominal pipe wall thickness will include manufacturers full under tolerance, and the specified corrosion and/or erosion allowance. The pipe thickness will be adequate to resist all external loads from thermal, mechanical and other sources in addition to the process pressure-temperature requirements. However the pipe thickness will be according to vendor's norms and standard calculations but not be lower than indicated in DIN 16965 Part 4. External FRP layer shall be protected against ultra-violet light.
- 6.1.14 Cast Iron shall not be used as Material of Construction for any piping items like Pipes, fittings, flanges, valves, fasteners, gaskets, etc.
- 6.2 PIPE**
- 6.2.1 General
- 6.2.1.1 Calculation of pipe thickness and branch reinforcement shall be based on requirements of ASME B31.3. Proper corrosion allowance and mill tolerance shall be considered to achieve the selected thickness.
- 6.2.2 Materials and manufacture
- 6.2.2.1 Furnace butt-welded, furnace lap-welded, and spiral/Helical welded pipes are not permitted.
- 6.2.2.2 Unless exempted, welded pipes shall be acceptable only with longitudinal weld made employing automatic welding with 100% radiography for all welds.
- 6.2.2.3 Double Longitudinal seam 180° apart is allowed for sizes 36" and larger only.
- 6.2.2.4 ERW Pipes shall not have any circumferential seam joint in a random length. However, in case of EFW pipe (48" & above), in one random length one welded circumferential seam joint of same quality as longitudinal weld is permitted which shall be at least 2 meters from either end. The longitudinal seams of two portions of same random length shall be staggered by at least 90 degree apart and all welds shall be 100% radiographed. However, circumferential seam joint is permitted only with one longitudinal seam.
- 6.2.2.5 When galvanizing specified, it shall be coated with zinc inside and outside by hot-dip process to ASTM A53.
- 6.2.3 Ends
- Unless otherwise specified, the ends of piping items shall be to the following standards:

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SW/SCRD	:	ASME B 16.11
FLANGED	:	ASME B16.5 and ASME B16.47
THREADING	:	ASME/ANSI B1.20.1 (NPT, Taper threads)
BW	:	ASME B16.25

Wall thicknesses 22 mm and smaller shall be as shown on Figure 2a and the 22 mm greater on Figure 3a in ANSI B16.25.

6.2.4 Inspection and Tests

- 6.2.4.1 Hydrostatic tests shall be applied to each length of pipe and be in accordance with the requirements of ASTM A530/A999, as applicable, unless otherwise specified.
- 6.2.4.2 Water for hydrostatic test of austenitic stainless steel pipes shall not contain chlorides more than 50 ppm in weight.
- 6.2.4.3 In case of seamless & welded pipes, parent material including weld and heat effected zone for low temperature service shall be impact tested (on charpy v notch) at the lowest design temperature in accordance with requirements of code/ specification.
- 6.2.4.4 All welded pipes indicated as 'CRYO' & 'LT' shall be impact tested, as per requirement and acceptance criteria of ASME B31.3. The impact test temp shall be -196°C, -80 °C & -45°C, for stainless steel, 3-1/2 Ni steel and Carbon steel respectively unless specifically mentioned.
- 6.2.4.5 Specified heat treatment for carbon steel and alloy steel solution annealing for stainless steel pipes shall be carried out after weld repairs; number of weld repairs at same spot shall be restricted to maximum two (2) by approved repair procedure.
- 6.2.4.6 Transverse tension test shall be carried out on pipes of nominal size 8" and above and thickness of Sch.120 and above as per supplementary requirements of respective standards.
- 6.2.4.7 Check analysis shall be carried out as per ASTM A530 for pipes as per ASTM A312 and pipe size > 8" and thickness > Sch120, Check analysis shall also be carried out as per supplementary requirement S1 of ASTM-A-312.
- 6.2.4.8 For seamless pipes, each length of pipe with following specifications shall be ultrasonically tested as per ASTM E 213 or ASTM A388.
- (a) Size upto 4 inches and Sch > 120
- (b) Size > 5 inches and thk > 12 mm.

Any defects producing signal greater than the appropriate reference groove shall be unacceptable. The allowable defect shall be longitudinal flat bottom groove on the outside or inside surface of the pipes and length not greater than 25 mm, width not greater than 1.6 mm and depth not greater than the smaller of 1 mm or 5% of the wall thickness.



6.2.5 Marking

Each pipe shall be legibly marked using stenciling or etching on the outer surface of pipes in accordance with the ASTM or API Standard.

6.3 Fittings



6.3.1 General

- 6.3.1.1 Thickness of fittings at ends to match pipe thickness for BW fittings. For reducing BW fittings having different wall thicknesses at each end, the greater one shall be employed and the ends shall be matched to suit respective thickness.
- 6.3.1.2 If the branch connections are made by welding the branch pipe directly to the run pipe, the required reinforcement shall be designed in accordance with the ASME B31.3. For underground

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pipng, all branches shall be with reinforcement pad of 2 D diameter & thickness similar to header shall be used.

- 6.3.1.3 Long radius butt welding elbows shall be used wherever possible. Unless otherwise specified, flanged elbows shall not be used.
- 6.3.1.4 All welded fittings shall have maximum negative tolerance equivalent to pipe selected.
- 6.3.1.5 All welded fittings shall be double welded for size 16" and above. Inside weld projection shall not exceed 1.6mm, and the welds shall be ground smooth at least 25mm from the ends.
- 6.3.1.6 For fittings made out of welded pipe, the pipe itself shall be of double welded type, manufactured with the addition of filler material and made employing automatic welding only.
- 6.3.1.7 All welded fittings shall be normalized for CS and normalized & tempered for AS.
- 6.3.1.8 All welded fittings shall be 100% radiographed by X-ray for all welds made by fitting manufacturer as well as for welds on the parent material.
- 6.3.1.9 Bevel ends of all BW fittings shall undergo 100% MP/DP test.
- 6.3.1.10 All pipes employed for manufacturing of fittings shall be required to have undergone Hydro test to ASTM A530/A999, as applicable.
- 6.3.1.11 When fluids have the possibility of causing corrosion in crevice, socket welded piping fitting will not be used.
- 6.3.1.12 Miters may be used in Category 'D' service above 6". For other than Category 'D' fluid in 150# and 300# Class miters can be permitted for sizes above 48". Miters to be designed as per ASME B31.3. However, use of miters shall be minimum. All miters shall be with 100% Radiography.
- 6.3.1.13 Miter bends may be used within the limitations in the ASME B31.3 only where they have been stress analyzed and subject to approval of OWNER.
- 6.3.1.14 Bushings shall not be used.
- 6.3.2 Materials and Manufacture
- 6.3.2.1 Elbows and tees shall not be machined direct from bar stock.
- 6.3.2.2 Caps shall be of one piece material without welded seams unless prior written approval by the Purchaser has been obtained.
- 6.3.2.3 Nozzle welded type tees (fabricated type tees) are not permitted except for NPS 60 and larger.
- 6.3.2.4 Swage nipples shall be manufactured from seamless pipe in accordance with ASTM A234 or ASTM A403 as applicable.
- 6.3.2.5 Galvanized fittings shall be coated with zinc inside and outside by hot-dip process to ASTM A153 after all forming and heat treatment has been completed.
- 6.3.2.6 All bevelling on galvanized fittings shall be made after galvanizing.
- 6.3.2.7 Large diameter fittings that the material standards (ASME/ANSI) do not cover in size or shape shall be designed in accordance with ANSI B31.3 and be manufactured to have the same quality as the requirements of the applicable material standards.
- 6.3.2.8 The gasket contact surfaces of stub ends shall be flat with face finish between 125 AARH to 200 AARH according to ANSI B46.1.
- 6.3.2.9 Seamless stub ends shall not have any welds on the body.
- 6.3.2.10 Threaded ends shall have NPT taper threads in accordance with ANSI B1.20.1 up to 1.5" NB & IS: 554 from 2" to 6" NB.

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- 6.3.2.11 Unless and otherwise specified in the requisition all socket weld and screwed fittings shall be in accordance with ANSI B16.11 to the extent covered in the specification except for unions which shall be in accordance with MSS-SP-83.
- 6.3.2.12 Special fittings like Weldolet, Sockolet, Sweepolet etc which are not covered in ANSI , MSS-SP, shall be as per Manufacturer's Std. Contours of these fittings shall meet the requirements of ANSI 31.3. Manufacturer shall submit drawings/catalogues for approval before manufacturing.
- 6.3.2.13 All welded fittings shall be double welded. Inside weld projection shall not exceed 1.6 mm. However 25 mm from the ends shall be flush smooth.
- 6.3.2.14 Specified heat treatment for carbon steel & alloy steel fittings and solution annealing for stainless steel fittings shall be carried out after weld repairs. Number of weld repair at same spot shall be restricted to maximum two by approved repair procedure.
- 6.3.2.15 All welded stainless steel fittings indicated as "CRYO" shall be impact tested as per requirement and acceptance criteria of ASME B31.3. The impact test temperature shall be -196 °C, -101°C & - 45°C. For Stainless Steel, 3-1/2 Ni steel and carbon steel respectively unless specifically mentioned otherwise in MR.
- 6.3.2.16 Thickness/Schedule lower or higher than specified shall not be accepted.
- 6.3.2.17 Finished dimensions shall be in accordance with ANSI B16.9, B16.11 and B16.28. Dimensions not specified in the standards may be to the Vendor's standards with the Purchaser's approval.
- 6.3.2.18 Outside diameters and wall thicknesses shall be in conformance with ASME B36.10 or ASME B36.19.
- 6.3.2.19 Unless otherwise specified on the purchase order documents, end connections shall be as follows:

Threaded Ends	Taper threads as per ASME B1.20.1
Socket-Welding Ends	ASME B16.11
Bevelled Ends	ASME B16.25, Figure 2a for wall thickness \leq 22mm ASME B16.25, Figure 3a for wall thickness \geq 22mm

- 6.3.2.20 Swage nipple dimensions shall be in accordance with MSS SP-95 unless otherwise specified on purchase order documents.
- 6.3.2.21 Dimensional tolerances on fittings shall be within the limit specified in the applicable ANSI or MSS standards, except that circumferential tolerance at the bevelled end in sizes NFS 26 and larger shall be within the range of -0.2 to +0.3 percent of the nominal circumferential length.
- 6.3.3 Marking
- 6.3.3.1 Each wrought steel fittings shall be legibly marked using stencilling or etching on the exterior surface of fittings in accordance with the applicable ASTM Standards and MSS SP-25.
- 6.3.3.2 Each forged steel fittings shall be marked using raised letter forging, low stress round nose stamps or etching on the collar portion of the forging, or the raised boss portion in accordance with the applicable ASTM Standard and MSS SP-25.
- 6.3.3.3 For fittings of NPS 1-1/2 and under, at least material identification shall be marked but other markings may be on a label or tag.

6.4 Flanges

6.4.1 General

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6.4.1.1 The number of flanges in piping systems shall be kept to minimum and should be installed only to facilitate maintenance and inspection and where construction or process conditions dictate. They are for instance:

- i) Where pipelines are connected to at connections with flanged equipment and valves.
- ii) Where frequent dismantling of piping is required.
- iii) Where clearance for dismantling equipment is required.
- iv) Where steel piping is connected to nonmetallic or nonferrous piping.
- v) Ring joint type flanges shall be used for flanges of 900 Lb rating or higher, or for design temperatures exceeding 450°C. This is applicable for all type of service. The flanges can also be used for lower ratings for service conditions which require higher degree of tightness.
- vi) Ring joint type flanges shall be used for services requiring higher degree of tightness, for sub zero temp, for ammonia service etc.
- vii) All flange joints on piping system including flanges on the equipment, manholes, etc shall be tightened using Torque wrench I hydraulic bolt tensioner depending upon service criticality.

6.4.2 Materials and Manufacture

6.4.2.1 All flanges shall be of forged one piece material (seamless), and plate may not be substituted without written approval from the Purchaser.

6.4.2.2 Ring type joint groove facing Roughness shall not exceed (side wall surface of gasket groove) 63 AARH.

6.4.2.3 When galvanizing is specified, forged flanges shall be coated with zinc inside and outside by hot-dip process to ASTM A153 after all forming and heat treatment has been completed.

6.4.2.4 All threads on galvanized forged flanges shall be cut after galvanizing.

6.4.3 Dimensions

Flanges shall be designed as follows:

NPS 24 and smaller : ANSI B16.5

Above NPS 24 : ANSI B16.47

Unless otherwise specified, end connections shall be as follows:

- Threaded : Internal taper pipe threads to ANSI B1.20.1

- Socket welding, Slip-on and Lapped joint: ANSI B16.5

- Bevelled : Figure 7 for wall thickness 22mm and smaller

Figure 8 for wall thickness greater than 22mm in ANSI B16.5.

Dimensional tolerances shall be within the limit specified in the applicable standards (ANSI/API).



6.4.4 Inspection and Tests

6.4.4.1 Any flanges do not require hydrostatic testing.

6.4.4.2 One tension test shall be carried out for each heat in each heat treatment charge.

6.4.4.3 Impact test for low temp service shall be carried out at the lowest design temperature and shall meet the requirements of the applicable material specifications.

6.4.5 Marking & Preservation

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Each flange shall be marked using low stress round nose stamps on the external rim of flanges in accordance with the applicable ASTM Standards and MSS SP-25.

6.5 Gaskets



- 6.5.1 Gasket material shall be asbestos free.
- 6.5.2 Full face gaskets shall have bolt holes punched out.
- 6.5.3 Non-metallic ring gaskets as per ASME/ANSI B16.21 shall match flanges to ASME/ANSI B16.5 up to 24", and ASME/ANSI B16.47 unless otherwise specified.
- 6.5.4 Spiral wound gaskets as per ASME B16.20 shall match flanges to ASME/ANSI B16.5 up to 24", and ASME B16.47 for sizes > 24" unless otherwise specified.
- 6.5.5 In case of RTJ gaskets, only octagonal section ring gaskets shall be used & shall have proper marking stamped. Material certificate shall be available for the gasket.
- 6.5.6 Hardness of RTJ gasket shall be 20 BHN (min) less than the corresponding flange groove hardness.

6.6 Stud, Bolts, Nuts and Jack Screws

- 6.6.1 All bolting shall be as per ASME/ANSI 18.2.1 for Studs, M/C Bolts and Jack screws, and ASME/ANSI B18.2.2 for nuts. Machine Bolts shall not be used in piping flange joint, except for Butterfly Valves, which shall be lug type, having UNC Threads in lugs facilitating opening of flanges from both sides.
- 6.6.2 Threads shall be unified (UNC for; 1" dia and 8UN for > 1" dia) as per ANSI B1.1 with class 2A fit for Studs, M/C Bolts and jack screws, and class 2B fit for nuts.
- 6.6.3 Stud bolts shall be threaded full length with two heavy hex nuts. Length tolerance shall be in accordance with the requirement of table F2 of Annexure 6 of ASME B16.5
- 6.6.4 The nuts shall be double chamfered, semi-finished, heavy hexagonal type and shall be made by the hot forged process.
- 6.6.5 The length of the studs/ bolts should be such that minimum two threads should be out of the nut on either side.
- 6.6.6 All the stud bolt should have metallurgical certificates in case of Alloy/ SS metallurgy with identified color marking at the stud ends/ bolt side face.
- 6.6.7 For Stainless steel flanges fasteners shall also be of Stainless Steel.
- 6.6.8 Heads of jack screws and M/C bolts shall be heavy hexagonal type. Jack screw end shall be rounded.
- 6.6.9 Tops and Bearing Surface of Nuts in size 5/8 inch nominal size and smaller shall be double chamfered. Larger size nuts shall be double chamfered or have washer faced bearing surface and chamfered top.
- 6.6.10 Wherever bolt tensioning is specified stud bolt length shall be longer by minimum one diameter do suit bolt tensioner. Excess threads shall be protected by a threaded cap.

6.7 Valves

- 6.7.1 General
 - 6.7.1.1 All flanged valves (except forged) shall have flanges integral with the valve body.
 - 6.7.1.2 Yoke material shall be at least equal to body material.
 - 6.7.1.3 Valves shall have pure graphite as gland packing material. Asbestos and other gland packing material shall not be used.

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- 6.7.1.4 Forgings are acceptable in place of Castings but not vice-versa.
- 6.7.1.5 No Cast Iron/Ductile Iron valves to be used in any service.
- 6.7.1.6 Valves in saline water (if applicable) service shall be with non ferrous trims and all wetted parts other than trims shall be epoxy coated.
- 6.7.1.7 All "IBR" valves shall be painted red in body–bonnet / body–cover joint.
- 6.7.1.8 Valve body basic MOC shall be equivalent or above basic MOC of connecting pipe.

6.7.2 Valve Dimensions

- 6.7.2.1 Face-to-Face/End-to-End dimension shall be as per ANSI B16.10. In case the same is not covered under B16.10, the dimension shall be as per BS 2080/manufacturer standard.
- 6.7.2.2 Hand wheel diameter shall not exceed 750mm and lever length shall not exceed 500 mm on each side. Effort to operate shall not exceed 35 kgf at hand wheel periphery. However, failing to meet the above requirement, vendor shall offer gear operation.
- 6.7.2.3 Quarter-turn valves shall have "open" position indicators with limit stops.

6.7.3 Inspection and Tests

- 6.7.3.1 Shop inspection and tests shall be carried out to API 598 and related MSS standards.
- 6.7.3.2 Radiography of Cast Valves
- 6.7.3.2.1 Radiography procedure, areas of casting to be radiographed, and the acceptance criteria shall be as per ASME B16.34.
- 6.7.3.2.2 The minimum requirement of radiography shall be as under:

Class	Size	Qty.
150	Up to 24"	10%
150	26" & above	100%
300	Up to 16"	10%
300	18" & above	100%
600 & above	All	100%



- 6.7.3.2.3 The welds of body-to-bonnet and body-to-end flange shall be subjected to 100% NDT; both radiographic and magnetic or liquid penetrant examinations.
- 6.7.3.2.4 Bevelled ends on each butt welding end valves shall be subjected to 100% radiographic examination and, magnetic particle or liquid penetrant examination.

6.7.3.3 Pressure Tests

- 6.7.3.3.1 Each Valve shall be pressure tested in accordance with API 598.
- 6.7.3.3.2 High pressure closure test shall be required for gate and globe valves.
- 6.7.3.3.3 Water for pressure tests on austenitic stainless steel valves and those having internals of austenitic stainless steel shall not contain chlorides more than 50 ppm in weight.

6.8 Special Valves (Orbit, Y-body Globe, Jacketed valves of all types)

- 6.8.1 Special Valves shall strictly follow the requirements of Valve data sheet, Process data sheet/Specialty data sheet.
- 6.8.2 Special Valves shall be made out of 100% radiographic casting/ 100% ultrasound forging.

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6.8.3 Jacketed Valves shall be tested to 100% DP/ MP check on Jacket welding, 100% radiography test of valve body, 100% hydro test of Jacket.

6.8.4 Large diameter swing check valves shall be equipped with an anti-hunting device, where closing of the check valve could cause a surge.

6.9 Traps

6.9.1 Vendor shall also furnish the performance curve indicating the capacity hi mass/hour at various differential pressures across the trap.

6.9.2 Parts subject to wear and tear shall be suitably hardened. Traps shall function in horizontal as well as in vertical installation.

6.9.3 Traps shall have integral strainers.

6.9.4 All traps shall be hydrostatically tested to twice the design pressure.

6.10 Hoses

6.10.1 Manufacturer shall guarantee suitability of hoses for the service and working conditions specified in the requisition, if the material is not specified in the Material Requisition for any particular service.

6.10.2 All hoses shall be marked with service and working pressure at minimum two ends clearly.

6.10.3 Hoses shall be resistant to ageing, abrasion and suitable for outdoor installations.

6.10.4 Complete Hose assembly shall be tested at two times the design pressure

6.10.5 Steam hoses shall be subject to steam resistance test.

6.11 Expansion Joints

6.11.1 The applicable codes are ASME B31.3 and EJMA (Expansion Joint Manufacturer's Association).

6.11.2 Bellows shall be formed from solution annealed sheet conforming to the latest ASTM Spec. Any longitudinal weld shall be 100% radiographed. The finished longitudinal weld must be of the same thickness and same surface finish as the parent material.

6.11.3 Circumferential welds are not permitted. Bellows are to be hydraulically or expansion (punched) formed. Rolled formed bellows are not acceptable. Noticeable punch or die marks resulting from expansion operation are not acceptable.

6.11.4 No repairs of any kind are allowed on the bellows after forming. Deep scratches and dents are not acceptable.

6.11.5 The out of roundness shall be limited to ± 3 mm. This is the max deviation between the max & min diameter.

6.11.6 The actual circumference of the welding end shall be maintained to ± 3 mm of the theoretical circumference.

6.11.7 Apart from the usual requirements, the vendor shall also furnish

-Design calculations to justify stiffness and fatigue life.



-Axial, lateral stiffness, angular stiffness, effective pressure thrust area.

-Installation/maintenance manual.

6.12 Supports & Spring Assemblies

6.12.1 The Material, Design, Manufacture and Fabrication shall be generally as per MSS-SP-58/ MSS-SP-89 and/or BS 3974.

6.12.2 Testing of springs shall be as per BS1726.

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6.13 NDT Requirements for piping

- 6.13.1 Classes in 150# for normal service shall be subjected to 10% radiography and 10%DP/ MP test (for CS&AS) or 10% DP test (for SS).
- 6.13.2 Classes in 300# for normal service shall be subjected to 20% radiography and 20% DP/MP test (for CS&AS) or 20%DP test (for SS).
- 6.13.3 Classes in 600# and above, 100% radiography on weld joints shall be employed. In 100% radiography classes any fillet welds employed shall have 100% DP/MP test in CS/AS classes and 100% DP test in SS classes.
- 6.13.4 For hydrogen and hydrogen bearing hydrocarbon services radiography and DP/MP shall be 50% in 150# and 300# class ratings.
- 6.13.5 All oxygen, NACE and any other lethal service shall have 100% radiography on weld joints in all class ratings. Castings used in these services shall have 100% radiography.
- 6.13.6 For fire water service, IBR, etc., any statutory NDT requirements, not covered above, shall also be complied.
- 6.13.7 Classes in Cat-D service shall be subjected to 5% radiography and 10% DP/ MP test (for CS&AS) or 10% DP test (for SS).

6.14 Special Service Requirements

6.14.1 IBR Service

- 6.14.1.1 IBR stands for Indian Boiler Regulation. For steam services, it is statutory obligation to meet IBR requirements.
- 6.14.1.2 For items under IBR, composition restrictions, test reports, painting, etc. shall be as per IBR's stipulations.
- 6.14.1.3 For carbon steel piping items under IBR, the chemical composition shall conform to the following:
- | | |
|-------------------|----------------------------------|
| Carbon (Max) | 0.25 % |
| Others (S, P, Mn) | As prescribed in IBR regulation. |
- 6.14.1.4 The chemical composition condition as indicated in this clause is not applicable for items other than IBR services.

6.14.2 CRYO & Fire-Safe

For items to be used under cryogenic conditions, temp below - 45°C and those required to be fire-safe, special designs and tests would be applicable. Pre-qualification criteria need to be specified before execution of job.

6.14.3 Low Temperature service



- 6.14.3.1 Low Temperature Carbon Steel shall be normalized & impact tested.

6.14.4 General requirements



- 6.14.4.1 All alloy steel piping items shall be Normalized & Tempered.
- 6.14.4.2 All alloy steel and higher alloyed piping material shall be subjected to PMI test.

6.14.5 Inspection of supply items

- 6.14.6 Inspection authority means the Third Party Inspection Agencies (TPIA) approved by the Owner to carryout inspection of materials.

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- 6.14.7 The inspecting authority shall have the right to select random samples for check test and reject materials, if samples furnished as above and tested as per the specifications fail to meet the requirement specified.
- 6.14.8 All the items shall be inspected and tested in the presence of one or more representatives of the purchaser during various stages of manufacturing. Material shall be considered acceptable for dispatch only after final certificate of acceptance is issued by the Inspector.
- 6.14.9 Testing performed in the presence of the purchaser's representatives shall not relieve the supplier of their own responsibilities and guarantees and any other contractual obligations.
- 6.14.10 Quality Assurance plan (QAP) / Inspection Test Plan (ITP) shall be submitted by bidder for approval by Third Party Inspection Agency (TPIA)/ Owner.
- 6.14.11 Scope of Inspection by TPIA:
- Review (R) of Chemical composition report, Heat treatment chart, Intergranular corrosion (IGC) test and Non Destructive Examination (RT/UT Report).
- Witness (W) of Mechanical Testing: Tensile test, bend test, hardness test, transverse tension test, Impact test, flattening test etc (as applicable).
- Random witness (10% RW): Hydrostatic test, Positive Material Identification (PMI) for Alloy/Stainless steels, Dye Penetration (DP) / Magnetic Particle (MP) Test, Galvanizing, Dimensional check, Marking, Visual check.
- 7. THERMAL INSULATION OF PIPING**
- 7.1 This consist of insulation for heat conservation, process stabilization, temperature maintenance, insulation for steam traced lines, jacketed lines, insulation for electrical traced lines insulation for fire protection for operating temperatures above ambient temperature for all sizes of lines. Wherever insulation for personnel protection is mentioned, the same shall be provided judiciously as per insulation specifications.
- 7.2 Prefomed pipe sections shall be used for all sizes of piping and inspection windows shall be provided in insulation at critical locations to be decided at the time of execution.
- 7.3 All materials shall be of high quality and good appearance. Insulation materials shall be of low chloride content, chemically inert, non sulphurous, rot proof, vermin proof, impervious to hot water and steam, non-injurious to health and non-corrosive to steel and aluminum (even if soaked in water at ambient temperatures for extended periods). The use of insulation or finishing materials containing Asbestos in any form is not permitted.
- 7.4 The insulation of piping, equipments and vessels shall be carried out with the recommended insulating materials and the thicknesses as per process design basis. Hot insulation over austenitic stainless steel surfaces shall be inhibited with sodium silicate as per ASTM C-795. The inhibited insulation material shall be tested as per ASTM C-692. Restriction of leachable chloride to 10ppm (max) shall be demonstrated as per the test method ASTM C-871.
- 7.5 For detailed specification of insulation refer Design Philosophy-Construction/Erection, Pre-Commissioning, Commissioning and Start-Up.
- 7.6 Extent of Insulation**
- 7.6.1 Extent of insulation shall be as per final approved P&ID/ Line list /General Arrangement drawing/Isometrics and vessel and equipment data sheets.
- 7.6.2 Insulated piping system shall have straight pipe, bends, tees and pipe fittings completely insulated.
- 7.6.3 For all cold lines, all steam and condensate lines, all hot oil lines and trace heated & jacketed lines, the extent of insulation shall include valves and flange joints also.

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- 7.6.4 For bucket and float type traps the inlet piping and trap shall be insulated.
- 7.6.5 For thermostatic and thermodynamic traps insulation shall terminate at approx 500mm before trap.
- 7.6.6 Instrumentation such as level gauges, level controllers, level switches, dp cells, etc., shall have their fluid containing sections and associated piping completely insulated.

8. Painting

8.1 Scope of Painting

8.1.1 The following surfaces and materials shall require painting.

- a) All un-insulated C.S & A.S piping, fittings, valves, columns, vessels, drums, & storage tanks, heat exchangers etc. including painting of identification marks on insulated lines.
- b) Identification colour bands on all piping as required including insulated aluminium clad, galvanized, SS and non ferrous piping.
- c) Pipes, fittings & valve surfaces under insulation of carbon steel and alloy steel insulated piping system.
- d) Pipes, fittings, valves surfaces under insulation of stainless steel insulated piping system.
- e) All structural steel works, supports, walkways, handrails and platforms etc.

8.1.2 The following surfaces and materials shall not require painting:

- a) Un-insulated austenitic stainless steel and higher alloy piping.
- b) Plastic and plastic coated materials.
- c) Non ferrous material like aluminum, galvanized, brass, bronze piping etc.

8.2 Colour Coding

Painting work shall require satisfying the requirements of the area where the plant is being setup. All painting and color coding shall be as per local painting manual.

8.3 Surface Preparation & Painting Application

Surface preparation and painting application shall be as per Std Specification

No surface shall be coated in rain, wind or in environment where injurious airborne element exists, where surface temperature is below 5 deg F above dew point, where relative humidity is greater than 90% and temperature is below 40 deg F.

Paint application shall follow the strict instruction of paint manufacturer whose paint is being employed.

All procedures from surface preparation to finish painting; including testing shall be well documented through a quality procedure approved by PMC/OWNER.

8.4 Painting Materials



As per STD Specification (Refer Civil/Construction Section of Document)

9.0 WELDING

9.1 Applicable Codes & Standards

All welding work, equipment for welding, heat treatment, other auxiliary functions and the welding personnel shall meet the requirements of the latest editions of the following accepted standards and procedures.

- a) Process Piping : ASME B31.3

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b) The Indian Boiler Regulations : IBR

In addition, the following codes and specifications referred in the code of fabrication shall be followed for the welding specifications, consumable qualifications and non destructive test procedures.

- i) Welding and Brazing Qualifications ASME BPV- Sec IX.
- ii) Non destructive examination ASME BPV Sec V.
- iii) Material specifications: Welding rods, electrodes and filler metals ASME BPV Sec II Part C.

The additional requirements mentioned in this specification, over and above those obligatory as per codes, shall be followed wherever specified.

9.2 Welding Processes

9.2.1 Welding of various materials shall be carried out using one or more of the following processes with the approval of the Engineer-in-charge.

- Shielded Metal Arc Welding process (SMAW)
- Gas Tungsten Arc Welding process (GTAW).

9.2.2 Automatic and semi-automatic welding processes shall be employed only with the express approval of the OWNER / PMC. The welding procedure adopted and consumables used shall be specifically approved.

9.2.3 A combination of different welding processes could be employed for a particular joint only after duly qualifying the welding procedure to be adopted and obtaining the approval of OWNER/ PMC.



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ANNEXURE – 1

TABLE OF BASIC SPAN

Pipe Size In.	SCH/Thk (in)	PIPE- VAPOR INSULATION			PIPE- LIQUID INSULATION			BARE PIPE EMPTY		BARE PIPE WATER FILLED		Pipe size in.
		BASIC SPAN (L)M			BASIC SPAN (L)M			SPAN(L) M	WEIGHT KG/M	SPAN(L) M	WEIGHT KG/M	
		UPTO 175° C	176° C TO 315° C	316° C TO 400° C	UPTO 175° C	176° C TO 315° C	316° C TO 400° C					
3/4"	SCH 40	3.5	3.5	2.5	3.5	3.0	2.0	4.5	1.68	4.0	2.04	3/4"
1"	SCH 40	4.5	4.0	3.0	4.5	3.5	3.0	5.0	2.52	4.5	3.07	1"
1-1/2"	SCH 40	5.0	5.0	4.5	5.0	4.5	3.5	6.0	4.08	5.0	5.4	1-1/2"
2"	SCH 40	5.5	5.0	4.5	5.0	4.5	3.5	8.5	5.47	5.5	7.65	2"
2-112"	SCH 40	6.5	6.0	5.0	6.0	5.5	4.5	7.5	8.7	6.5	11.79	2-112"
3"	SCH 40	7.5	6.5	5.5	6.5	6.0	5.0	8.0	11.35	6.5	16.15	3"
4"	SCH 40	8.0	7.5	6.5	7.5	7.0	6.0	9.0	16.2	7.5	24.45	4"
6"	SCH 40	10.0	9.5	8.5	9.0	8.0	7.5	10.5	28.3	9.0	46.7	6"
8"	SCH 40	12.0	11.0	10.0	10.0	10.0	9.0	12.0	42.84	10.0	75.22	8"
10"	SCH 40	13.5	13.0	12.0	11.5	10.5	10.5	14.0	60.74	11.5	111.9	10"
12"	3/8" w	14.5	13.5	13.0	12.0	11.5	11.0	15.0	74.40	12.0	147.5	12"
14"	3/8" w	15.0	14.5	13.5	12.0	12.0	11.5	16.0	82.5	12.5	172.05	14"
16"	3/8" w	16.0	15.5	14.5	13.0	12.5	12.0	17.0	94.5	13.0	213.15	16"
18"	3/8" w	17.0	16.5	15.0	13.5	13.0	12.0	18.0	106.5	13.5	258.3	18"
20"	3/8" w	18.0	17.5	16.0	14.0	13.5	12.5	19.0	118.5	14.0	307.5	20"
24"	3/8" w	20.0	19.0	17.5	14.5	14.5	13.0	21.0	142.5	15.0	418.2	24"
3/4"	SCH 80	3.5	3.5	2.5	3.5	3.0	2.0	4.5	2.20	4.0	2.49	3/4"
1"	SCH 80	4.5	4.0	3.0	4.5	3.5	3.0	5.0	3.25	4.5	3.72	1"
1-112"	SCH 80	5.0	5.0	4.5	5.0	4.5	4.0	6.0	5.45	5.0	6.60	1-112"
2"	SCH 80	6.0	5.0	4.5	5.5	5.0	4.0	6.5	7.53	6.0	9.45	2"
2-112"	SCH 80	6.5	6.0	5.5	6.0	6.0	5.0	7.5	11.49	6.5	14.25	2-112"
3"	SCH 80	7.5	6.5	6.0	6.5	6.5	6.0	8.0	15.37	7.0	19.66	3"
4"	SCH 80	8.0	8.0	7.0	7.5	7.5	6.5	9.0	22.47	8.0	29.94	4"
6"	SCH 80	10.5	10.0	9.0	9.5	9.0	8.5	10.5	42.90	9.5	59.85	6"
8"	1/2" w	12.0	11.5	10.5	10.5	10.0	10.0	12.0	65.10	11.0	94.8	8"

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10"	½" w	13.5	13.0	12.0	11.5	11.5	10.5	14.0	82.20	12.0	130.69	10"
12"	½" w	14.5	13.5	13.0	12.5	12.0	11.5	15.0	98.13	13.0	168.64	12"
14"	½" w	15.0	14.5	13.5	13.0	12.5	12.0	16.0	108.15	13.5	194.4	14"
16"	½" w	16.0	15.5	15.0	13.5	13.0	13.0	17.0	124.2	14.0	240.0	16"
18"	½" w	17.5	17.0	16.0	14.5	14.0	13.5	18.0	140.25	14.5	286.64	18"
20"	½" w	18.0	17.5	17.0	15.0	14.5	14.0	19.0	157.5	15.0	341.8	20"
24"	½" w	20.0	19.0	18.5	16.0	15.0	15.0	21.0	188.25	16.0	458.44	24"
1"	10S	4.0	3.5	3.0	4.0	3.0	2.5	4.5	2.08	4.0	2.7	1"
1-112"	10S	5.0	4.5	3.5	4.5	4.0	3.0	5.5	3.12	5.0	4.57	1-112"
2"	10S	5.0	4.5	3.5	4.5	4.0	3.0	6.0	3.94	5.5	6.33	2"
2-112"	10S	6.5	5.5	4.5	5.5	5.0	4.5	7.0	5.26	6.0	8.85	2-1/2"
3"	10S	7.0	6.0	5.0	6.0	5.5	5.0	7.5	6.45	6.0	11.91	3"
4"	10S	7.5	7.0	6.0	6.0	6.0	6.0	8.0	8.34	7.0	17.87	4"
6"	10S	9.5	9.0	8.0	8.0	7.5	7.5	10.0	13.82	8.5	34.54	6"
8"	10S	11.0	10.5	10.0	9.5	9.5	8.5	11.5	19.94	10.0	55.5	8"
10"	10S	12.5	12.0	11.0	10.5	10.0	9.5	13.0	27.53	11.0	83.4	10"
12"	10S	14.0	13.0	12.0	11.0	11.0	10.0	14.5	36.00	11.5	114.6	12"
14"	10S	14.5	14.0	13.0	11.5	11.0	11.0	15.5	41.18	11.5	132.6	14"
16"	10S	16.5	14.5	14.0	12.0	11.5	11.5	16.5	47.33	12.5	172.2	16"
18"	10S	16.5	15.5	14.5	12.5	12.5	11.5	17.5	53.18	13.0	212.1	18"
20"	10S	17.5	16.5	15.5	13.0	13.0	12.0	18.5	68.50	13.0	264.5	20"
24"	10S	19.0	18.0	17.0	14.0	13.5	12.5	20.5	94.37	14.0	376.8	24"

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ANNEXURE – 2

ACCESSIBILITY FOR VALVES AND INSTRUMENTS



VALVES, INSTRUMENTS, EQUIPMENT TO BE OPERATED	CENTRELINE OF ITEM TO BE OPERATED, LOCATED LESS THAN 3.6m ABOVE GRADE, 2.75 m ABOVE FLOOR OR PLATFORM OR 1.8m ABOVE WING PLATFORM	CENTRELINE OF ITEM TO BE OPERATED, LOCATED MORE THAN 3.6m ABOVE GRADE, 2.75m ABOVE FLOOR OR PLATFORM OR 1.8m ABOVE WING PLATFORM
EXCHANGER HEADS	NIL	PLATFORM
OPER.VALVES 2" & SMALLER	FIXED LADDER	FIXED LADDER
OPER. VALVES 3" & ABOVE	PLATFORM	PLATFORM
MOTOR OPERATED VALVES	PLATFORM	PLATFORM
CONTROL VALVES	PLATFORM	PLATFORM
RELIEF VALVES 2" & SMALLER	FIXED LADDER	FIXED LADDER
RELIEF VALVES 3" & ABOVE	PLATFORM	PLATFORM
BLOCK VALVES 2" & SMALLER	PORTABLE LADDER	PLATFORM
BLOCK VALVES 3" & ABOVE	PLATFORM (NOTE-1)	PLATFORM (NOTE-1)
BATTERY LIMIT VALVES	PLATFORM	PLATFORM
PRESSURE INSTRUMENT	FIXED LADDER IF ABOVE 2.2m HEIGHT	FIXED LADDER
TEMPERATURE INSTRUMENT	FIXED LADDER IF ABOVE 2.2 M Ht	FIXED LADDER
SAMPLE POINTS	PLATFORM	PLATFORM
GAUGE GLASSES	FIXED LADDER	FIXED LADDER
LEVEL CONTROLLERS	PLATFORM	PLATFORM
PROCESS BLINDS AND SPACERS 2" & SMALLER	PORTABLE LADDER / PLATFORM	PLATFORM
PROCESS BLINDS AND SPACERS 3" & ABOVE	PLATFORM	PLATFORM
MANWAYS/MANHOLES	PLATFORM	PLATFORM
HANDHOLES/INSPECTION HOLES	PLATFORM	PLATFORM
NOZZLES (process}	PLATFORM	PLATFORM

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VESSEL VENTS	PORTABLE LADDER	FIXED LADDER
LINE DRAINS & VENTS	PORTABLE LADDER	PORTABLE LADDER
ORIFICE FLANGES	PLATFORM (NOTE-1)	PLATFORM (NOTE-1)

NOTE-1: BLOCK VALVES / ORIFICE FLANGES, IF LOCATED, WITH CENTRE LINES GREATER THAN 2 METER FROM THE OPERATING FLOOR, OPERATING PLATFORM SHALL BE PROVIDED WITH PORTABLE PLATFORM OR CHAIN FOR OPERATION.

NOTE-2: PLATFORM SHALL BE PROVIDED FOR THE ORIFICE FLANGES ON PIPE RACK.

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ANNEXURE-3

MAXIMUM SPACING OF GUIDES FOR VERTICAL & HORIZONTAL PIPES

NOM PIPE SIZE IN INCHES	VERTICALSPACING METRES	HORIZONTAL SPACING METRES
1	6.0	6.0
1 ½	6.0	6.0
2	6.0	6.0
3	8.0	12.0
4	8.0	12.0
6	8.0	12.0
8	8.0	12.0
10	12.0	18.0
12	12.0	18.0
14	12.0	18.0
16	12.0	18.0
18	12.0	18.0
20	16.0	18.0
24	16.0	18.0
26 & ABOVE	16.0	18.0

NOTES:-

1. These spacings may be varied to suit column spacing of rack. The above spacing is for straight runs of pipe & does not include guides which are used for control of thermal movements, as decided by stress group.
2. The guide spacings given in the above table are indicative only.



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ANNEXURE – 4

CLEARANCES

Minimum clearances for piping, equipment, structures, platforms, and supports shall be in accordance with the following table:



Item	Description	
Roads	Headroom for primary access roads wherever heavy duty crane movement is required.	9 M
	Headroom for primary access roads	7.5 M
	Width of primary access roads excluding shoulders.	Refer Civil
	Headroom for secondary roads	5 M
	Width of secondary roads excluding shoulders.	Refer Civil
	Clearance from edge of road shoulders to platforms, equipment, pipe associated with equipment, or similar features.	1.5 M**
Maintenance Aisles at Grade	Horizontal clearances for equipment maintenance by hydraulic crane (12t capacity)	3 M
	Vertical clearance for equipment maintenance by hydraulic crane (12t capacity)	3.6 M
	Horizontal clearance for fork lift and similar equipment (2500 kgs capacity)	2.4 M
	Vertical clearance for fork lift and similar equipment (2500 kgs capacity)	2.4 M
	Horizontal clearances for equipment maintenance by portable manual equipment (A-frames, hand trucks, dollies or similar equipment)	1 M
	Vertical clearances for equipment maintenance by portable manual equipment (A-frames, hand trucks, dollies or similar equipment)	2.4 M
Walkways	Horizontal clearance (not necessarily in a straight line)	750 mm
	Headroom (except for hand wheels)	2.2 M
Platforms	Minimum width	1200mm
	Headroom from stairwell treads.	2.2 M
	Minimum clearance around any obstruction on the platform.	500 mm
Platforms	Headroom	2.2 M
	Maximum vertical distance between platforms	6 M

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Item	Description	
	Minimum toe clearance behind a ladder.	210 mm
	Minimum handrail clearance.	100 mm
Equipment	Minimum maintenance space required between flanges of exchangers or other equipment arranged in pairs.	500 mm
	Minimum maintenance space required for structural members or pipe.	300 mm
	Clearance from edge of road shoulder (the extreme projection)	1.5 M
Fired Equipment	Horizontal clearance from hydrocarbon equipment (shell to shell)	15 M
	Exception: Reactors or equipment in alloy systems shall be located for the most economical piping arrangement.	
	Clearance from edge of road to heater shell.	3 M
Valve Hand wheels	Clearance between the outside of the hand wheel and any obstruction.	25 mm*
Pipe (aboveground)	Clearance between the outside diameter of the flange and the outside diameter of pipe insulation.	25 mm*
	Clearance between the outside diameter of the pipe, flange or insulation and a structural member.	50 mm*
	Clearance between the outside diameter of the flange and the outside diameter of bare pipe.	25 mm*
	Minimum distance from underside of pipe to grade or platform.	300 mm
Control Valve Arrangement	Centreline of control valve above grade or platform.	450 mm
	Minimum centreline of control valve from face of column or wall.	600 mm
	Where process conditions require steam or hydrocarbon vapours to be discharged to atmosphere at a safe location, the tail pipe shall terminate as below:	
	Distance above nearest operating platform.	3 M
	Within radius of nearest operating platform.	7.5 M

** Verify conformance with local regulations.



* With full consideration of thermal movements

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ANNEXURE-5

JOB SPECIFIC REQUIREMENTS



SI No	ITEM	Job Requirement	Remarks
1	Equipment spacing (ISBL)	As per Piping Design basis.	
2	Minimum pipe rack width 4m/6m/8m/10m/12m in single bay	10 M for Main Rack 4M/ 6M/ 8M for Sub Racks.	
3	Spare capacity on Rack	Provision of 20% on each tier for future modifications.	
4	Cooling Water Lines	Generally on rack up to 16" Underground above 16"(in specific cases, lower sizes may also go Underground depending on layout)	
5	Minimum height of sleeper due to maintenance requirement	300 mm for pavement area 500 mm for unpaved area	
6	Fin-fan cooler location	On pipe rack and/or technological structure access to be provided	As per Equipment Layout.
7	Location of pumps: In units	- Inside pipe rack as far as possible with concrete slab below Air cooler. - For, smaller width (4M, 6M & 8M) rack, pumps shall be outside or on one side of rack portal.	Refer cl. 5.2.11.2
8	Requirements of monorail on Pumps: under pipe rack/shed- Open area-	Required for motor rating 45 KW and above for all pumps. None	
9	Requirement for exchanger bundle removal a) Hydro extractor b) Monorail & chain pulley block	Monorail & chain pulley block required at Technical Structures. Where Hydro extractor mobility is difficult in running plant.	However, required head Room for installing monorail shall also be kept in Technical Structures.
10	Battery limit valves operation a) At grade. b) At elevated Platform.	Elevated platform provided at Battery limit.	

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11	Pipe way road crossing	Overhead pipe bridges	At B/L with access.
12	Electrical cable routing underground Above ground: - ISBL - OSBL	Refer Electrical Design Basis.	
13	Any requirement of statutory approval.	All statutory requirements e.g. IBR/PCB/CCE and others	
14	Instrument cable routing ISBL & OSBL	Refer Instrumentation Design Basis.	
15	Safety shower / eye wash. (in case of chemical/catalyst handling system)	Required. As Per PID	
16	Requirement of elevators.	Yes.	
17	Connectivity of all platforms at higher elevations for tall columns (ie. between columns & technological structure and between columns & rack).	Yes.	Adjacent columns/ technological Structures/ rack must be connected at minimum two locations.
18	Compressor/blower house for ISBL as well as OSBL a) location b) Maintenance requirement	a) Under Shed b) E.O.T.	With additional auxiliary hook for light wt handling maintain ace platt shall be provided across full width with cat ladder at each end
19	Instrument Air Drier Shed	Yes	
20	Insulation material a) Hot /Tracing/safety b) Electrical tracing c) Cold	As per process design basis.	
21	Painting System	Refer Std Specification (Civil)	
22	Method of surface preparation a) Mechanical tools b) Blast cleaning	Blast Cleaning	
23	Sand blasting/Grit blasting	Grit Blasting	



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24	Painting of SS pipes below insulation	****As Per Specification	Wherever painting is not specified, Aluminum/ SS foil as per piping design basis shall be used.
25	Specific colour coding requirements.	Client agreed	
26	Usage of IS grade material.	No	
27	Usage of asbestos gasket.	No	
28	Provision for high settlement in tank farm: a) Usage of dresser coupling in tank farms. b) Flexibility of piping.	Flexibility of Piping.	
29	Steam tracing type	Standard module for steam distribution and condensate collection manifolds with integral glandless piston valve & trap and carbon steel tracer pipe.	
30	Bulk Material	Client agreed vendor list.	
31	Engineering Drawing Mode	Electronic & Hard Copies also required	
32	Specific software package for engineering drawings -AutoCAD and AP-ISO -PDS/SP 3D with Isogen -Auto Plant Designer with Isogen or AP-ISO -PDMS with Isogen -AutoCAD	3-D Models, capable of model review and walk through.	
33	Material Control System		
34	Item Coding system		
35	Stress Analysis Package	CEASER II (Latest Version)	
36	Access to Nozzles of columns	Platforms for all Nozzles.	

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37	Staircase / Ladders for tall column/reactors.	Ladders for columns/staircases for reactors	
38	Provision of breakup flanges for removal of tube bundles of heat exchangers.	Wherever necessary.	
39	Height of pipe support pedestals	150 mm from FGL	
40	Mandatory Bulk Material Escalation	As per mandatory spares.	
41	Cathodic Protection of Tankage and U/G Piping	Required (Refer Electrical Design Basis)	
42	Cast iron valves	Cast Iron Valves not to be used.	
43	Pump Suction strainers	As per Cl. 5.3.6.6 & 5.3.6.7	However, licensor's requirements, if any, may be considered with approval from owner / PMC.
44	Two phase flow line analysis	Both static and dynamic analysis required.	
45	Connectivity of the technological structure	Technological structure to be Interconnected.	
46	Usage of check valves.	Wafer dual plate and swing check valves	Unless specifically required by process
47	Traps on steam lines.	Thermodynamic for line traps and Thermostatic for steam	

NOTE:- THE JOB SPECIFIC REQUIREMENTS GIVEN ABOVE SHALL BE CONSIDERED FINAL IN CASE OF ANY CONFLICT WITH THE MAIN BODY OF DESIGN BASIS.

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ANNEXURE – 6

DESIGN PHILOSOPHY FOR STRESS ANALYSIS

1.0 PURPOSE

This design basis deals with the subject of Identification of Stress Critical pipelines and preparation of Critical line list. This procedure also defines the minimum requirements for performing stress analysis, design and location of spring, support and level of system analysis with the extent of documentation required for flexibility analysis.

Purpose of piping stress analysis is to ensure:

Safety of piping and piping components

Safety of connected equipment and supporting structure

Piping deflections are within the limits

2.0 SCOPE

This specification covers the supply of engineering services to perform a complete piping and pipe support analysis for piping systems.

3.0 DEFINITIONS

3.1 CRITICAL LINES / CRITICAL LINE LIST

Critical lines or Critical Line List as referred to in this procedure relates to Piping Stress Critical Lines and does not include or refer to process critical lines.

3.2 STRESS ANALYSIS TEMPERATURE

Stress Analysis Temperature refers to either “Maximum Operating Temperature” or “Steam-out temperature / hot nitrogen purging temperature” of the lines under review whichever is higher. In absence of the above values, it refers to the Design Temperature of the line under review. The Line List should be strictly followed in obtaining the above temperature values.



3.3 DESIGN PRESSURE

Design Pressure refers to the “Design Pressure” of the line under review as indicated on the Line List. Design Pressure is as defined in clause 301.2 of ASME B31.3.

3.4 TEMPERATURE FOR FLEXIBILITY ANALYSIS

The temperature to be used for the flexibility analysis shall be taken as the maximum / minimum temperature which the pipe will see under any combination of different normal / abnormal operating conditions, as defined in clause 301.3 of ASME B 31.3. Where piping is exposed to direct sunlight, solar radiation temperature of 70 0 C is considered in establishing the maximum temperature of piping. Even, for non-critical piping exposed to direct sunlight on pipe rack or elsewhere, expansion loops, wherever essential, are provided to take care of pipe movements resulting from piping skin temperature due to solar radiation.

In general, unless there is a difference of more than 50 0 C between working Temperature and the design temperature, the design temperature should be taken as Flexibility temperature. Ambient Temperature shall be considered as 21°C the assumed piping installation temperature. The displacement stress range from this installation temperature to the minimum recorded ambient temperature of 00 C being less than the same from installation temperature to the maximum operating temperature of hot piping in most cases, the later governs as per clause 319.2.3 of ASME B 31.3

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The temperature under fire condition is normally not considered for flexibility analysis.

4.0 **SELECTION**

A line is selected and listed as a Critical Line provided it falls under any one of the categories defined below and is intended to include the special requirements of Piping Stress Engineer. It is hence defined as any line for which a flexibility review is required or where pipe supporting is deemed to be critical and needs review by a Stress Engineer. Line DN 50 and smaller is inherently flexible and is not normally considered critical unless built from non-metallic or non-ferrous materials. In case of more than one applicable line size, larger line size governs. Lines are classified as Level I, Level II & Level III according to the criteria listed below.

4.1 Level I [EXTENSIVE ANALYSIS]

Piping systems or lines that meet Annexure-7A criteria are deemed to be extremely critical. These lines are categorized as Level I and require careful study to ensure that the code compliance is met and the accurate determination of nozzle and support loads have been made. The routing of these lines is very important. They must be analyzed in the early stages of the project during routing studies so that the impact on the location of less critical lines is minimized. Normally, these systems require computer analysis. The general intent of the Level I analysis criteria is to study lines size DN 80 & larger that are affected by thermal expansion and / or a dynamic response, and that can't be evaluated by a weight-only analysis (as per the general intent of Level II analysis). Consideration has to be given to other special situations that augment the Level I general intent guidelines such as for lines that are excessively large and stiff.

4.2 Level II [NORMAL ANALYSIS]

Piping systems or lines that meet Annexure-7B criteria are moderately critical lines and often do not require such rigorous study to ensure code compliance or accurate determination of nozzle and support loads. These lines are smaller in size and operate at lower temperatures (in general) than the lines to be analyzed using Level I Criteria. Normally, only manual calculations, by use of appropriate monographs are required for analysis of these systems.

4.3 Level III [MINIMUM ANALYSIS]

All lines that are outside the purview of Level I or Level II criteria will be classified as level III and shall be reviewed by the Piping Engineer during the squad check of the piping drawings and or fabrication Iso's. If more detailed analysis is required, the Piping Engineer may change the level of analysis during the squad check as applicable. Normally, only visual analysis is required for these systems.

4.4 LINES DEEMED TO BE SUPPORT CRITICAL

Lines subjected to two-phase flow.

Cross country pipelines.

Lines with pipe thickness Sch 160 or greater.

Lines DN 400 and above with pipe thickness less than 8 mm.

Lines DN 250 and above with corrosion allowance 3 mm and above.



Lines with high concentrated loads such as heavy valves or fittings etc.

Lines downstream of Relief Valve / letdown Control Valves / bursting (rupture) discs.

Connecting to vent or flare systems or discharging to atmosphere

Liquid Blow down Lines.

Lined pipes

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Non-metallic pipes

4.5 LINES NEEDING DYNAMIC ANALYSIS

There are instances where in the frequency of the applied load is comparable to the natural frequency of the piping system. Such systems tend to store the energy and release it according to certain scientific laws. Such a system is dynamic in nature and the study of the response of such a system is referred to as "Dynamic Analysis". Examples of such kind of systems are Relief Valve discharge lines, water hammer and surge in pipe lines, two phase flow in pipelines, reciprocating pumps and compressor piping, submarine piping etc.

4.6 SPECIAL PIPING

Special piping forming part of heater internal piping, etc. are treated as proprietary piping and nozzle loading at the Interface connections are to be co-ordinated with vendor.

5.0 RELATED DOCUMENTATION

5.1 CRITICAL LINE LIST FORMAT

The critical line list shall be prepared from the project line list document by inserting following relevant fields such as Stress level, stress package no., stress analysis temperature, support critical nature of the line, dynamic loadings, steam out / purge temperature etc.

The list shall reflect analysis status of line that includes its input received date from design & output handover date to design and specific remark if any.

5.2 LINES AFFECTING THE FLEXIBILITY OF CRITICAL LINES

Non-critical Lines found to affect the flexibility of critical lines which have not been included during the initial review are subsequently added to the Critical Line List.

Non-critical Lines on which advice may be sought by the Lead Piping Engineer are not normally entered into the Critical Line List but covered verbally, or by a memorandum if a record is required.

6.0 PIPE STRESS ANALYSIS AND SUPPORTING



6.1 Piping system shall be properly supported taking in to account of the following points:

Piping stress analysis shall follow ASME B 31.3 and shall be complete to prevent overstressing of the pipe during operating conditions with wind and seismic loadings. During sustained, occasional (wind and seismic) & thermal expansion loading on piping, the material allowable stresses shall be as per ASME B 31.3 for ASTM materials. For DIN material specifications the allowable stress values shall be calculated as per ASME B 31.3 clause 302.3.2(d), wherein yield strength and ultimate strength values at temperature shall be taken from DIN material standards. For DIN material specifications, the other material properties viz. elastic modulus, density, coefficient of thermal expansion shall be taken from the respective DIN material standards.

6.2 Analysis shall include, but not be limited to the following; thermal, dead weight, internal pressure, wind and seismic, and a combination of these based on ASME B 31.3.

6.3 Piping shall be designed in accordance with the Indian Standard criteria for earthquake resistance design for structures IS: 1893 for seismic zone-IV (refer project design basis). As a minimum, two (2) orthogonal horizontal components and a vertical component of ground motion will be considered in the seismic analysis. For American standard, loading applied to piping would be in accordance with uniform building code (UBC).

The equivalent horizontal static force method shall apply in general .The contractor shall also carry out special designs and provisions as necessary for piping which is considered to be dynamically sensitive to earthquake.

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Seismic analysis to be performed for lines equal to and above 12". Seismic load case shall ALGEBRIC combination with operating cases.

Heavy rigid masses like valves shall be restrained in their vicinity to avoid large seismic movements. Guides or snubbers as the case may be used for this purpose.

Horizontal seismic coefficient (A_h) to be considered as 0.26 and Vertical (A_v) to be considered as 0.173.

- 6.4 Wind loads shall be calculated in accordance with IS-875 code of practice for structural safety of building – Loading Standards for Indian code requirement using basic wind speed as mentioned in project design basis. For American standard, wind load in accordance to ASCE 07 shall be calculated. Reduction in velocity pressure due to apparent shielding afforded by buildings and structure or terrain shall not be permitted.

Wind loading shall only be considered for lines larger than 20" OD at elevation higher than 10m above grade. Displacements due to wind and earthquake should be limited to 50 mm.

Both the horizontal directions shall be analyzed independently in two cases

+X, -X, +Z, -Z

Wind and seismic loading will not occur simultaneously.

Analysis of all nozzles loading on vessels within the piping boundaries is covered in this specification. Nozzle analysis shall follow the guidelines of ASME Section VIII, Division 1, and WRC 297 & 107 (latest editions). Nozzle stresses shall fall within the allowable per ASME.



6.6 Piping system shall have sufficient flexibility to avoid leakage at joints. Flanged joints imposed by external moments may be analyzed and the stresses evaluated by using the methods of equivalent pressure given in the ASME boiler and pressure code section III. Flange leakage shall be assessed as per "Pressure Equivalent Method". In case of Failure in Pressure Equivalent Method, the Flanges shall be checked for leakage using Caesar Flange leakage Module. Flange leakage shall be assessed for all PSV flanges, Control valve flanges, High Pressure lines, and all steam lines. Also for equipment flanges where loads are high.

- 6.7 All forces on connections to equipment shall not exceed maximum allowable as specified by equipment vendor.

- 6.8 Pipe supports loads shall be based on the maximum loads determined by the piping analysis. Adjustments shall be made to the piping system and model such that the pipe supports loads are within a reasonable uniformity throughout the piping system.

- 6.9 Various Load cases built in Caesar II to check stress in piping system are listed below.

1	WW+HP	HYD	
2	W+T1+P1	OPE	
3	W+T2+P1	OPE	
4	W+T1+P1+U1	OPE	
5	W+T1+P1+U2	OPE	
6	W+T1+P1+U3	OPE	
7	W+T1+P1+U1	OPE	
8	W+T1+P1+U2	OPE	
9	W+T1+P1+U3	OPE	
10	W+T1+P1+WIN1	OPE	

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11	W+T1+P1+WIN2	OPE	
12	W+P1	SUS	
13	W+P2	SUS	
14	L2-L12	EXP	
15	L3-L12	EXP	
16	L4-L2	OCC	
17	L5-L2	OCC	
18	L6-L2	OCC	
19	L7-L2	OCC	
20	L8-L2	OCC	
21	L9-L2	OCC	
22	L10-L2	OCC	
23	L11-L2	OCC	
24	L12+L16	OCC	
25	L12+L17	OCC	
26	L12+L18	OCC	
27	L12+L19	OCC	
28	L12+L20	OCC	
29	L12+21	OCC	
30	L12+L22	OCC	
31	L12+L23	OCC	

P1- Maximum Operating Pressure

W- Dead Weight

T1- Maximum Operating Temperature

WW- Water Weight

P2- Design Pressure

WIN- Wind Load

T2- Design Temperature

U- Uniform Load

HP- Hydro test Pressure

L2- Load case

SUS, EXP, OCC, HYD, OPE- Various load types, viz., sustained, occasional, hydro test, operating etc.

7.0 CODES AND STANDARDS

The following codes and standards shall apply in the design and analysis of the piping systems covered under this specification:



Allowable Stress: ASME B 31.3

Piping: ASME B 31.3

Nozzle Loadings: PMC's Standard, WRC297/107(Welding Research Council)/

Allowable Vendor

Wind Analysis: ASCE-07 and/or IS 875

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IBR piping system: ASME B31.1 & IBR

8.0 SOFTWARE USED

The package used shall be latest version of CEASER-II.

9.0 DOCUMENT REQUIREMENT

9.1 A written report shall be submitted on the piping and equipment analysis. The report shall include all pertinent information that shall include but not be limited to the following:

Location and type of pipe supports with loads and movements

Location of expansion joints and movements

Vertical and horizontal loads including moments at all support points.

Vertical and horizontal loads including moments on all equipment and Vessel connections.

Caesar II analysis report, which shall include as a minimum, restraint forces, movements and stresses for all load cases. For flange connection, loaded with high bending moments and/or tensile forces in piping or at equipment connections, Caesar II flange leakage report will be provided. For piping analyzed, if subjected to hydro test, hydro test load case will be made in Caesar II to check for loading under hydro test & the requirement of any additional temporary supports for hydro test.

Detailed nodal model used for the stress analysis

All assumptions and limitations applied to the analysis

9.2 All dimensions and analysis shall be performed using metric and SI units.

9.3 The final report / stress package folder shall be submitted as follows:

1. Front sheet with Approval status
2. Isometrics with following information

Node numbers

Type of supports selected by stress engineer

Springs / Bellows data required for procurement like spring rate, loads, tide/untied information and SM (special material) identification.

Maximum Expansion and sustain stress values with node number

Nozzle/Anchors initial movements and piping imposed forces and moments on the same

Support loads (anchors, guides or rest) only they are above limit (The limit is defined in the beginning of the project in consultation with civil)

Design and maximum operating conditions

Coordinate axis system considered for inputs

Dimensional details for piping designer to locate supports in piping model/layout.

3. Checklist as per Work instructions



4. Following outputs

Load Cases

Restraint summary

Spring hanger report, if any

5. Stress critical line list extract for the lines analysed

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- 6 Piping material specifications
7 Equipment drawings with allowable loads, if available
8 PID



ANNEXURE-7-A

CRITERIA FOR IDENTIFYING EXTREMELY CRITICAL LINES (LEVEL I)

Temperature T, Degree C	Pipe Diameter DN (mm)	Piping Material	Service and Description
All	All	All	Piping which will undergo hydraulic shock, auto-ignition or is in service.
All	DN≥80	All	Category M (Lethal) fluid service per ASME B31.3 (No cyclic service).
All	DN≥80	All	Piping which is openly exposed to winds > 75 mph.
T < -29	DN≥80	Carbon Steel	All Services.
T < -45	DN≥80	All	All Services
T ≥ 65	DN≥80	Non-Metallic	All Services
T ≥ 65	DN≥80	All	Lines with pressure ≥ 900 psig.
T ≥ 150	DN≥80	All	All Services
ALL	DN≥400	All	All Services.
T ≥ 260	ALL	ALL	ALL Services.
-29 ≥ T ≥ 65 OR -7 ≥ T ≥ 50	DN≥80 DN≥100	All	Piping connected to nozzle load sensitive equipment, air-cooled exchangers and rotating equipment (see note 1).
ALL	ALL	All	Lines requiring expansion joints or flexible connectors.
DELTA T ≥ 27 (NOTE 2)	DN≥80	All	Jacketed piping.
-29 ≥ T ≥ 65	DN≥100	All	Internally lined pipe (except glass).
All	ALL	All	Glass lined piping.
All	DN≥80	All	Differential Tank Settlement (Upto 3 supports from nozzle).
-40 ≥ T ≥ 80 -29 ≥ T ≥ 70	DN≥100 DN≥200	Metallic Metallic	Underground Piping

NOTES:

Load sensitive equipment include fired heaters, lined vessels with lining of brittle material, non-ferrous equipments, graphite heat exchangers, plate & frame heat exchangers, etc.

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This criterion is not to be applied to auxiliary piping such as seal flush; bearing cooling, etc. delta T refers to the differential temperature between the process piping and jacket.

ANNEXURE-7-B

CRITERIA FOR IDENTIFYING MODERATELY CRITICAL LINES (LEVEL II)

Temperature T, Degree C	Pipe Diameter DN (mm)	Piping Material	Service and Description
All	DN<80	All	Lethal fluid service.
T<-29	DN<80	Carbon Steel	All Services.
T<-46	DN<80	All	All Services
95<T<150	80<DN<200	All	All Services
T≥65	DN<80	Non-Metallic	All Services
T≥65	DN<80	All	All Services
T≥65	DN<80	All	Lines with pressure≥900 psig.
T≥150	DN<80	All	All Services
ALL	200<DN<400	All	All Services.
T≥260	ALL	ALL	ALL Services.
ALL	ALL	ALL	Piping connected to nozzle load sensitive equipment, air-cooled exchangers and rotating equipment (see note 1 of Table-1).
DELTA≥27(NOTE 2 of Table-1)	DN<80	All	Jacketed piping.
All	ALL	All	Internally lined pipe (except glass).
All	DN<80	All	Differential Tank Settlement (Upto 3 supports from nozzle).
All	ALL	All	Underground Piping
All	ALL	All	Piping connected to pressure relief valves
All	ALL	All	Close coupled interconnecting piping between equipment with differential movement greater than 6.0mm.

ANNEXURE-7

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DESIGN PHILOSOPHY FOR 3-D MODELLING

1.0 INTRODUCTION

The LSTK Contractor shall carry out Detailed Engineering of the plant areas specified in the scope elsewhere using 3D intelligent software.

2.0 SOFTWARE

Anyone of the following two software with Oracle database shall be used by the LSTK Contractor.

- i) PDS/SP3D by Intergraph USA on Windows with design review through dynamic walkthrough.
- ii) PDMS by AVEVA UK on Windows with design review through dynamic walkthrough.

Isometrics shall be generated using ISOGEN Software. Latest version of all the software released as on the date of ITB shall be used by the Contractor. The LSTK Contractor shall clearly specify in his bid the software to be used with version number.

3.0 OBJECTIVE

The objective of 3D modelling is to carry out detail engineering and produce deliverables using 3D tools and conduct reviews for obtaining approvals from Owner/PMC. 3D model shall be developed and demonstrated with dynamic walk through facility to check any interference requirements of operation and maintenance for getting the approval of the Owner. LSTK contractor shall deliver to Owner/PMC a complete 3D model which shall be utilised for all future maintenance, operation, revamping and any de-bottlenecking of the plant. The 3D Design Reviews through dynamic walkthrough, through LCD projector system shall assist the Owner's operation and maintenance personnel in reviewing the project prior to construction and suggest modifications for efficient operation of the plant. Owner/PMC/ shall use it for review of design.

4.0 DEFINITIONS

4.1 EXACT GEOMETRY

The geometry of the object should be exactly as shown in vendor drawings or as per standard drawings as given in codes e.g. Pipes, Flanges, Valves, beams, etc. the geometry of the items to be modelled should be such that it serves the purpose of clash checking as well as identification of object in 3D.

4.2 NEAR EXACT GEOMETRY

SPECIAL items like bellows, traps, etc does not call for exact geometry. The provision should be made for clash checking and 3D representation of the item. A box. instead of bellows, traps, etc is not acceptable.



4.3 APPROXIMATE GEOMETRY

Items like transmitters, floor stand mounted instruments where boxes instead of exact shape can be shown. The nomenclature of such items should be clearly distinguishable for easy identification.

5.0 EXTENT OF MODELLING / SCOPE OF WORK



5.1 PIPING

- 5.1.1 All design within Unit, Facility battery limit above ground and underground piping inclusive of fire fighting lines and sprinkler system, big bore and small bore, except tubing, for all piping materials shall be modelled. Details shall include all pipes, valves, flanges, fittings, reducers, spectacle blinds, drains, temperature/pressure connections, sample points, drip legs jacketed pipes, fittings



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and flanges etc. Existing lines inside the battery limit (If any) along with tie-in points shall also be modelled.

- 5.1.2 All in line instruments like control valves, safety valves, rotameters, orifice plate etc. with near exact geometry.
- 5.1.3 All piping special items like expansion bellows, slide valves, special valves with purge points, steam traps, strainers etc. with near exact geometry.
- 5.1.4 Complete vessel trims with level gauges, level switches, level transmitters, equipment, instrument, vent/drains utility connections, pressure gauges etc. with exact geometry.
- 5.1.5 Steam supply and condensate recovery stations up to the first valves in tracer lines
- 5.1.6 All pipe supports to be Physical modelled for all sizes with secondary steel sleeper way as follows.
- a) All spring hangers, roller supports to be modelled with all details.
 - b) Pipe supports along with concrete pedestals, Type of support
 - c) Details of the spring hanger's i.e. operating load, travel, spring constant should be keyed in as user-defined attributes.
 - d) Details of expansion bellows i.e. type, axial/lateral deflections, stiffness etc to be keyed in as user defined attributes.
 - e) Structural steel members used for the pipe supports to be modelled in complete details.
- 5.1.7 All equipment to be modelled with exact geometry including but not limited to: manholes with davits, pipe davits on top platforms, nozzles, stiffener rings, bellows, break flanges, platforms, ladders, handrails, lifting lugs, etc. for all the equipment in the plant like vessels, columns, reactor, receivers, pumps with motors, compressors with details of volume bottles, cylinders etc., blowers, centrifugal compressors, furnaces with soot blowers, fired heaters, burners and peep holes, air coolers with motors and fans, filters, blow down drums, all equipment within packages and heat exchangers etc.
- a) Maintenance areas around equipment, davit swing areas, swing elbows sweep areas, tube bundle removal areas for heat exchangers, rotor removal areas, drop out areas to be modelled as soft envelopes and should be used for clash detections.
 - b) Equipment supports: skirts, support legs/lugs, saddles to be modelled along with the equipment
 - c) Insulation type (hot, cold, tracing, jacketed, etc), Insulation thickness, operating/design Pressure /temperature, hydro test medium/pressure to be given.
 - d) Equipment 3D model shall include all attachments like platforms, nozzles, ladders, pipe supports, etc.
- 5.1.8 Skid mounted Equipment / Package units (if applicable) shall be modelled as a Block and Piping connections at Skid/Package unit battery limit to be precisely modelled depicting complete connectivity.
- a) Skid to be tagged as main equipment.
 - b) All sub-equipment of all skids to have skid tag as a prefix.
 - c) All sub-equipment to be modelled with exact geometry.
 - d) Complete internal Piping of the skid with all inline and online instruments to be modelled as per the details in 5.1.1 to 5.1.7
 - e) All pipe supports with the skids are to be modelled as per para 5.1.7

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- 5.1.9 Tagging of all line nos., Instrument nos., special items, equipment nos. shall be as marked in the P&IDs.
- 5.1.10 Complete underground piping man hole vent piping to atmosphere. catch pits, cable trays etc. to be modelled. Envelopes to be modelled on top of manholes and catch pits and shall be used for interference detection.
- 5.1.11 Material handling equipment e.g. drums etc to be modelled in near exact geometry.
- 5.1.12 Hard stands, fabrication space for tall columns, erection access for tall structures considering crane boom and movement, crane access, unit approaches from main roads, main roads outside the units shall also be modelled.
- 5.1.13 Line information required in 3-D model;
The following attributes must be keyed in while modelling:
- Line operating/design, temperature/pressure in deg. C and kg/cm²g respectively
 - Liquid state i.e. vapour, liquid, 2-phase.
 - Insulation thickness and type i.e. IH/IC/IJ/IC etc.
 - Hydro test pressure in kg/cm²g and medium.
 - Line number label should be as per the P&ID with the following attributes: Line size + unit no + line sequence no + sub-line no + piping material specification + insulation type. User Defined Attributes (UDA's) to be generated for keying in this information in PDMS.
 - Hydro test loop no.
 - Piping stress analysis system number allocated at the time of generation of critical line list for stress analysis (through UDA's in PDMS)
- 5.1.14 Incorporation of site changes during fabrication and erection with 3D Model in order to deliver a complete as built model to Owner.
- 5.1.15 General Arrangement Drawing Extraction
- Piping General Arrangement Drawings are to be extracted from the 3D model on AO size with a scale of 1 :33 / 1 :50 for rack Vital installations and battery limits shall be marked with coordinates.
 - All locating dimensions like spacing for equipment, structural columns, pipe-to-pipe etc. shall be marked on the GAD's. Equipment tag numbers, line numbers, instrument and speciality item tag numbers shall be marked on the GAD's. Electrical instrument ducts shall be marked and labelled. Access ways, maintenance corridors, dropout areas, bundle removal areas catalyst-handling areas shall be marked on the GAD's.
- 5.1.16 ISOMETRIC EXTRACTION
Isometrics shall be extracted from 3D model using ISOGEN Software along with Bill of Material and logical pipe supports.
- 5.1.17 Interference Detection shall take care of Hard-Hard clashes and Hard-Soft clashes for all the disciplines.
- 5.2 STRUCTURAL
The scope of modelling for structural shall include but not limited to the following:
- Main steel/secondary steel equipment support beams, bracing, columns with footings, stiffener plates, platforms, ladders, pipe racks, stair cases, walkways, supporting structure for all coolers with operating platforms ,handrails and staircase, monorails, EOT support

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including fire proofing shall be modelled in exact geometry. Existing structures inside the working battery limit to be modelled.

- ii) Equipment and structure foundations, technological buildings, equipment supporting structure, flue gas stack and any other concrete structure to be modelled in exact geometry with exact locations of all insert plates.
- iii) Foundation and structure for platforms, gratings, handrails etc. for packaged item and items are also included.

5.3 INSTRUMENTATION

- i) Instrument ducts, cable trays greater than or equal to 300 mm width, Instrument Junction boxes to be modelled in exact geometry.
- ii) Transmitters and other floor stand mounted instruments on grade/platform to be modelled in approximate geometry with tag nos. as per P&ID's.

5.4 ELECTRICAL

- i) Electrical cable trays greater than or equal to 300 mm width. Electrical cable trenches all sizes, junction boxes to be modelled in exact geometry.
- ii) Electrical stop/start switches for motors, to be modelled in approximate geometry.
- iii) Lighting details, earth pits.
- iv) Fire alarm system, e.g. fire detection point, hooters, etc.

6.0 MODEL SPLIT

6.1 Separate models to be generated for each discipline.

Sl.No.	Discipline	Model Identifier	Sl.No.	Discipline	Model Identifier
1	Piping above ground	P	5	Structural	S
2	Piping underground	U	6	Architectural	A
3	Equipment	E	7	Electrical	L
4	HVAC	H	8	Instrumentation	I

6.2 Within each discipline, models are to be generated based on the area division in piping key plan. The naming conventions for model in the PDS and Database in PDMS shall be as follows.



X	X	=	XX
Model identifier as given in 6.1	Model Identifier as Levels (given below)	Under score	Area number form Key Plan

A – Grade	B – First Level above grade
C – Second Level above grade	X – All levels in one model
U – Under ground	

- Above ground and underground piping shall always be in different models.

6.3 Database Hierarchy in PDMS

- i) Piping

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a) PIPE NAME:

Line no. Label	--	P X	XX

b) Branch Name:

PIPE NAME / B1, B2

c) TAX NOS. For all Inline Instruments, Special Items as component Name in PDMS. Same tag numbering philosophy to be followed in PDS.

XXX	XXX	XXXX	X
UNIT No.	INST. Type i.e. PSV, FV, PV	INST. No. / special item no.	Only if same no. is getting repeated.

- Comments to be written in components S Text attribute.

ii) Other Disciplines

Basis shall be similar to that given for piping. LSTK Contractor shall develop the Hierarchy and submit it for Owner/PMC approval prior to start of modelling

7.0 DELIVERABLES

7.1 Complete 3D model as built along with as built GAD's, Isometrics, and MTO reports, all extracted from the model, nozzle orientations for Piping and 3D models for all disciplines as specified in 7.1 to 7.6 with any other document generated from 3D model and naming conventions as per 7.0 to 7.3 with "As built" updates along with complete reference databases, component catalogues for all the size range in the approved specifications shall be furnished by the LSTK Contractor in electronic form.

In addition, contractor shall submit the 3D model in electronic form after completion of final review of 3D model duly updated as per comments/observations and agreed of MOMs of review sessions.

7.2 Review Models shall be installed at site having latest version of design review software and all other pre requisite software and any other software required for smooth running) and minimum configuration as stated in by the Contractor sufficiently at start of Mechanical work and & plotter at site shall be decided in consultation with Owner.

Model and Isogen will not be installed at site. Only review data will be available on review station

In addition, LSTK Contractor to Minimum Install;

- ▶ One number of A3/A4 duplex laser printer
- ▶ One number of A0 inkjet plotter



7.3 Reference Data Bases

7.3.1 P.D.S.

The complete reference Data base developed for the FACILITIES by the LSTK Contractor on PDS and delivered shall include but not limited to the following:

7.3.1.1 Piping

1. Piping material class
2. Piping Commodity data files.

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3. Short or Long material description library.
4. Specialty material description library.
5. Standard note library.
6. Label description library.
7. Piping assembly library.
8. Graphic commodity library.
9. Physical data library.
10. Formats files for MTO
11. Isometric set-up (option) files.
12. Piping job specification library.
13. Write-up of all project specific code lists, which have been, added to the standard code lists.

7.3.1.2 Other disciplines

Complete reference database with all the libraries. LSTK Contractor shall prepare a comprehensive list of these files separately for each discipline and submit it for PMC review prior to start of 3D modelling.

7.3.2 PDMS

The complete material specifications and component catalogues developed by the LSTK Contractor on PDMS and delivered shall include but not limited to the following.

7.3.2.1 Piping



1. Piping material specifications.
2. Insulation specifications
3. Bolt specification
4. Nozzle specifications
5. Complete Piping component catalogues with write-up on naming conventions used for CATALOGUE references, component references for Property Database. Bolt References for single and multiples.
6. Detail texts along with the symbol keys & R Texts
7. Material texts with X Texts
8. Any symbol key library developed for special items where Isometric Symbols by CAD Centre were not available.
9. Property database with nominal bore and outside diameter developed for the project.

7.3.2.2 Other Disciplines

Complete reference database with all the libraries. LSTK Contractor shall prepare a comprehensive list of these files separately for each discipline and submit it for PMC review prior to start of 3D modelling.

7.4 During the period of construction the above workstations and software at site shall be manned and maintained by LSTK Contractor personnel up to the completion of the Project.

7.5 Costs for all the hardware, software, networking, model transfers, ISDN link etc shall be borne by the LSTK Contractor.

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7.6 Review by PMC/Owner/Licensor

LSTK Contractor shall be responsible for arranging 3D review sessions at his design center with Dynamic walkthrough with overhead projector system, for Owner/ PMC/ Licensor comprehensive review of the 3D Models. Simultaneously a Technical Audit of the Reference Database, Component Libraries and Project Database shall be carried out by PMC. LSTK

Contractor shall make one workstation available for the entire duration of the Technical Audit to the audit team along with Contractors support team, without any extra cost to PMC/Owner. Incorporation of the comments of the Technical Audit shall be done by the LSTK Contractor without any cost or time impact. LSTK contractor shall send fortnightly updates of the model using latest version of 3D modelling software (compatible to the one at OWNER /PMC Office) for the review status monitoring of the models. LSTK Contractor shall propose the dates and duration at least 4 weeks in advance for these 3D reviews by Owner/PMC.

7.7 REVIEW STAGE

There shall be minimum 3 review stages to be done as follows. 4th and 5th further reviews shall be required after all comments are incorporated by the LSTK Contractor.

1. Equipment layout review from erection, construction, operation and maintenance point of view & Conceptual review of critical lines (thermal & process critical) (30%).
2. Before issue of model for engineering (60%).
3. Before issue of model for construction (before isometric generation commences) (90%).

3-D modelling review for sprinkler system for pumps where monorail is provided shall be done with sprinkler system in place.

3-D modelling review for material requirement has to be fine tuned as per 3D modelling and report of such material requirement shall be forwarded to PMC/OWNER for their information on regular interval.

Any operational requirements such as platforms, approaches for equipment I technological structure if required during the 3D model review as above, the same shall be provided by the LSTK contractor without any time delay and cost implications.

8.0 PROVEN TRACK RECORD

The LSTK Contractor or his Engineering sub-Contractor must have carried out extensive 3D modelling and data base management for a project of similar nature with the following as a minimum.

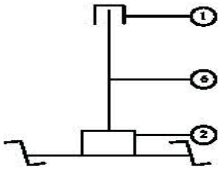
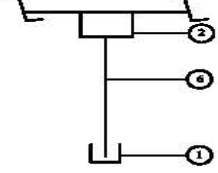
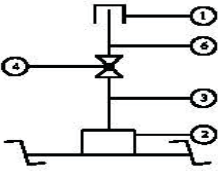
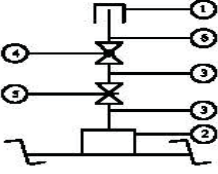
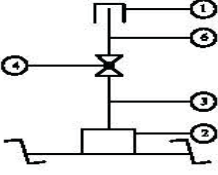
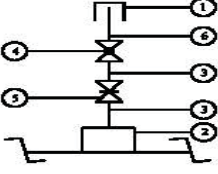
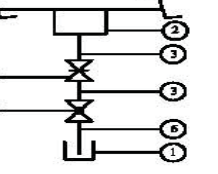
LSTK Contractor should demonstrate their capability through walk through of one such 3D model developed by them.

Owner/PMC reserves the right to verify the above at the premises (as applicable) including experience of personnel deployed on the project.

Owner/PMC decision shall be final and binding on the LSTK Contractor in this regard.

ANNEXURE-8

HYDROTEST DRAIN & VENT

Fluid	Pressure rating	3/4" Vent	3/4" Drain
Gas	NP < = CLASS 2500	* 	* 
	NP < = CLASS 600		For steam trap installation See separate specification
Steam	NP > = CLASS 900		
	Liquid	NP < = CLASS 600	
NP > = CLASS 900			

1. 3/4 " Thd. Cap.
2. 3/4" Branch Fitting acc. to Pipe Class.
3. 3/4" Nipple (P).
4. 3/4" Globe Valve (SW).
5. 3/4 "Gate Valve (SW).
6. 3/4" Nipple (P/T).

* For Hydrostatic test only. For process purpose use installation as for liquid service.

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SECTION – 5.1

DESIGN SPECIFICATION – FIRE FIGHTING SYSTEM

PLANT: NATIONAL FERTILIZERS LIMITED, NFL, NANGAL, PUNJAB

**PROJECTS: INSTALLATION OF NEW 2500 CUBIC METER
CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA ALONG
WITH ITS REFRIGERATION SYSTEM**

AT NFL, NANGAL

0	21.12.22	21.12.22	ISSUED FOR NIT	ARVIND	SKM	SKM
REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD





	DESIGN SPECIFICATION FIRE FIGHTING INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/5.1	0	
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1.0	Purpose
2.0	Scope
3.0	Design Criteria
4.0	Fire Protection Systems
5.0	Material specifications
6.0	First aid fire fighting equipments
7.0	Safety equipments/ Personnel protective equipments
8.0	Emergency escape route
9.0	Execution, Inspection & Testing
10.0	Quality assurance system
11.0	Inspection
12.0	Testing
13.0	Documentation

LIST OF ATTACHMENTS

ATTACHMENT NUMBER	DESCRIPTION	NUMBER OF SHEETS
PC281-4611-921-Rev_PA	Conceptual fire hydrant layout for new Horton sphere	01

	DESIGN SPECIFICATION FIRE FIGHTING INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/5.1	0	
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1.0 PURPOSE

The purpose of this document is to establish the requirements of the fire fighting system for applicable facilities of the package plant.

This document is a general specification providing typical requirements of layout, material, testing, etc. for various fire fighting systems.

This specification covers design basis and execution requirements for fire protection system for fertilizer plant. The provisions shall be made, in order of precedence, as per statutory regulations, TAC guidelines, job specifications and safe engineering practices.

2.0 SCOPE

Contractor shall provide fire fighting system as mentioned in this document in accordance with TAC/NFPA/NBC 2016 (and/or Latest Edition) for applicable facilities of the package plant.

3.0 DESIGN CRITERIA

The Fire Protection Philosophy is based on Loss Preventive and Control. The adequacy of fire protection facilities for fertilizer plant is very important because of the inherent hazard it carries. A fire in one part/section of the plant can endanger other sections of plant as well. If fire breaks out, it must be controlled / extinguished as quickly as possible to minimise the loss to life and property and to prevent further spread of fire. In this job, the design of the package plant is a part of Ammonia, Urea which is considered in high hazard (B), as per NBC 2016.

Unless otherwise specified in the NIT the design shall meet requirement of applicable standard over and above the standards mentioned below:

IS 3034: 1993 - Fire Safety of Industrial Buildings: Electrical Generating and Distributing Stations - Code of Practice [CED 36: Fire Safety]

IS 12459: 1988 Code of Practice for Fire Safety in Cable Runs [CED 36: Fire Safety]

IS 1646: 1997 Code of Practice for Fire Safety of Buildings (General): Electrical Installations CEA (Measures relating to Electrical Safety) Regulations 2010

IS 15394: 2003 - Fire Safety in Petroleum Refineries and Fertilizer plants

IS 3844: Installation and maintenance of internal fire hydrants and hose reels on premises

National Building Code 2016 (and/or Latest).

The fire fighting system shall be designed on the basis of only major fire with a single fire contingency at a time.



Hydrant/water monitor should be provided across Ammonia Horton Sphere.

Spray system for cooling a tank in case of fire.

Water curtains shall be installed around Ammonia Horton Sphere kerb wall

Water curtains shall be provided for the compressors bay of Ammonia refrigeration section.

Fire Water System shall be designed as per IS Code and complied with Local Law/ Civil Defense requirements.

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The proposed new Ammonia Horton Sphere is located in the area near to the existing Horton sphere at a distance complying with the safe distance requirement at Nangal Plant. For Fire Water requirement, necessary hook-up from existing Fire Water headers of Ammonia Urea Plant has been considered for supply of required Fire Water. Two independent sources have been considered from two different fire water headers available near the proposed Ammonia Horton Sphere. The fire water network shall be laid in closed loop to ensure multidirectional flow in the system. Isolation valves shall be provided near the loop junction in the network for isolation purpose (Ref: P&ID no: PC281-PID-091 Rev 0).

3.1 Fire Water Demand

The fire water demand shall be determined based on the single fire contingency in the proposed installation. The estimated firewater demand shall be the sum of water required for fire-fighting equipment (e.g. fire monitor, hose stream) based on fire breaking out in fire risk area/s at any one time over the entirety of the site. The biggest firewater demand of the fire risk areas shall be the total firewater demand.

4.0 FIRE PROTECTION SYSTEMS

The following fire protection facilities shall be provided depending upon the nature or the installation and risk involved wherever applicable.



- a) Fire hydrant system
- b) Water spray/sprinkler system
- c) Gas flooding system
- d) Fire detection, alarm & communication system
- e) First aid fire fighting equipments including Portable fire extinguishers
- f) Personnel protective equipments (PPE)

4.1 Fire Hydrant System

The engineering (sizing, material thickness, supports, etc.,) of fire fighting network for the above mentioned fire protection systems / fire protection facilities, shall be provided by bidder, on the basis of codes, standards, specifications, drawings of this document.

Fire water network shall consist of mostly aboveground and/or underground, if required, piping systems.

Around units the fire water mains shall be laid aboveground and directly buried and/or in trenches, if it is laid underground. The underground ring main network system shall be laid at minimum one meter earth cushion. Top of casing pipe (RCC Hume pipe) of underground piping crossing roads (peripheral road, package unit road, access road/ways) shall be at min. 1.5 metre depth.

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All underground fire water piping shall be externally protected from corrosion by wrapping and coating of cold tape as per attached specification, for underground CS pipe which shall extend up to min. 500 mm, above / beyond grade wherever applicable.

Above ground fire water piping shall be painted as per painting specification and the paint shall be conforming to shade as per IS 5.

Wherever fire water line will cross the roads, same shall be put under a suitable hume pipe or culvert, with proper wrapping, coating as a anticorrosive treatment (Cold Tape Type, as per detailed specification provided elsewhere in NIT).

Flushing point with isolation gate valve and pressure gauge points (approx at the rate 300mtr. and at all battery limit tie in points) with isolation gate valve shall be provided on all headers.

Network shall be laid in closed loops to ensure multidirectional flow. Isolation valve to be provided at every 300m (max) and at crossings (Junctions) to ensure easy maintenance and uninterrupted water supply in case of break down and shall be planned in such a way that outage of any section of fire water line should not affect other section.

Hydrant posts shall be installed with a branch "L" shape piping to avoid directly fall of leaking water on main header.

RCC slabs (Minimum 1500mmX1500mmX100mm thk.) shall be provided at the grade level beneath of each Hydrant/Monitor/HVLR post and respective hose box.

Up to 2.0 m portions of the headers (if above ground) on both sides of hydrant branching and the entire branch piping near of hydrants shall be epoxy painted.

Isolation valves (gate valves, rising spindle) shall be provided below monitors and at all hydrants. Suitable restriction orifice shall be provided at downstream of isolation valve of hydrant post to maintain the pressure requirements as per TAC / IS15394.

Fire water pressure at the farthest point shall be a minimum of 7 kg/cm² after installation of headers and sub headers.

All fire water piping shall be tested to hydraulic test pressure of 18 kg/ cm² (g) and/or as calculated considering pump shut-off pressure.



Radiography requirements shall be as per TAC (minimum 10%).

For process units, external ring header with hydrants and an internal distribution with monitors and hose reels shall be installed. Hydrant heads shall be placed at a minimum distance of 15m from process equipment.

Monitors around heater areas, if any, shall be necessarily provided and located in such a manner that the heater can be isolated from the plant.

Monitors shall be provided to cover the high rise columns, equipments etc. of height 15 mtr. and above, unless otherwise specified in layout drawing.

There may be cases where due to horizontal obstruction, a particular vessel/ process column may not be approachable by ordinary monitor or hydrant, elevated monitors shall be provided to take care of such conditions.

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Tall columns, structure, towers and equipment where it may not be possible to provide access staircases with hydrants on landing, will be considered as protected by hydrants at ground level, provided they are less than 15 m in height. When the height exceeds 15 m, the concerned hydrants shall be replaced by monitors.

Alternate hydrants for protection of loading unloading bays, rail/truck gantries shall be replaced by water/foam monitors.

Number of hydrants shall be based on one hydrant post with two hydrant valves for every 30m (max.) of external perimeter of process units and storage tank area. For utility and other building areas, this distance shall be a maximum of 45m.

Hydrants and/or water monitors shall be located keeping in view the different risks within the premises which are to be protected and ensuring effective coverage.

Double hydrants (IS: 5290 type A, hydrant valve with single outlet) on each hydrant post (i.e. two hydrant valves mounted on each stand post) and at every 30m centre to centre, along the hydrant mains, shall be provided.

Extension of hydrants/monitors for spill fire (as required by TAC/ IS15394) shall also to be provided.

Indoors hydrants with hydrant valves (landing valves), hose reels and hose box containing accessories, for plant buildings and non-plant buildings, shall be provided as per IS-3844. In case of buildings, hydrants shall be located at not be less than 2 m and not more than 15 m from the face of building.

Double headed landing valves (two numbers, type-A, Landing valves on single stand post), shall be provided on the landing of first floor and above on all the buildings/Tech structure/platforms etc. with isolation valve at each tapping for landing valve assembly.



The monitors shall have isolation valve. Monitor location shall be given special consideration for protection of cluster of towers, heaters and other high structures, where it may not be possible to approach the higher levels. Minimum of two monitors shall be provided for each such area.

Field adjustable variables flow type remote operated monitors shall be provided for the protection of inaccessible equipment.

Contractor to finalise hydrant layout on plot plan, with all the requirements such as number of Hydrants, Monitors, Foam system, sprinkler system etc., based on all statutory requirements & Code Guidelines, considering ease of maintenance and safe approach for fire fighting. Due consideration is to be given for providing Emergency escape routes also. Hydrants are to be strategically located to obtain maximum advantage of layout.

Fire brigade connection (3 way & 4 way) points with Isolation gate valve as per TAC/ IS shall be provided at strategic locations

Above ground pipe shall be supported on RCC pedestals (refer attached drawing). wrapper plate (thickness same as pipe & covering approx. 120 degree at bottom portion of pipe) shall be provided at each support for above ground pipe (6" NB and above). Supports for piping system and structures shall be provided as per support specifications of NIT. If support specification not provided in NIT, safe adequacy calculations shall be submitted by bidder for review/approval by PMC/owner.

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4.1.1 Buried Pipes

The following points to be considered in designing of buried pipes

- i) All underground buried metallic piping shall be coated and wrapped with cold tape and laid at minimum one meter earth cushion.
- ii) Underground pipe at crossing roads, access ways shall have RCC casing pipe (Culvert or Hume pipe). Underground piping at rail crossing shall be as per Indian railways.
- iii) Valve chamber wherever required shall be made of brick or concrete. Valve chamber should be spacious to attend valves during operation/maintenance.
- iv) All U.G. headers shall clear equipment foundations.
- v) Provide break flange at + 500 MM from floor level to isolate underground pipe from above ground piping with insulating gasket kit.
- vi) Pipes shall be laid below electrical cables, if any.
- vii) Buried Pipes shall be laid in trenches after excavation, covered with 150mm sand bed all around them, backfilled and properly rammed.
- viii) RCC thrust blocks shall be provided as per engineering requirement.
- ix) Cathodic protection shall be provided for buried pipes.

4.1.2 Piping in Trenches

The following points to be considered in designing of trench pipes:

- i) Piping located below grade, requiring inspection, servicing or provided with protective heating.
- ii) Fire water lines/Process lines.
- iii) Drain lines requiring gravity flow trenches.
- iv) Sump for valves and trenches shall be provided.
- v) Suitable draining scheme for trenches shall be provided.
- vi) Valves in trenches shall be provided with extended stems. If hand wheels of the valves are located more than 300 mm below the cover plate, the valves shall be provided with extended stems extending to within 100 mm below the cover plate.
- vii) The trenches shall be lined with RCC, then provided with 150mm sand bed and also shall be covered with RCC cover after laying of wrapped and coated pipes in them. Top of pipe shall be at min one meter depth.
- viii) RCC thrust blocks shall be provided as per engineering requirement.



4.2 Water Spray System, water sprinkler system and water curtain system

Water spray systems shall be provided as per TAC / job specifications.

Water spray, water curtain systems, permanently connected to fire water network, shall be provided with piping system, detectors, spray nozzles (chrome plated brass), deluge valves (dry type, pneumatically & hydraulically operated (only use where air is not available) with manual by pass valve, remote automatic and local manual operation), isolation valves, strainer, low point drain with valve and suitable restriction orifice to maintain the pressure requirements as per TAC/ IS.

Instrument air service Piping/ Tubing shall be SS304.

Downstream of deluge valve shall be provided with galvanized carbon steel piping system.

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Water spray application rates shall be as per TAC/IS/NFPA.

4.2.1 Medium velocity Water Spray (MVWS) System

- To be provided for the followings locations, but not limited to.
- Compressor seals
- Lube oil consoles
- Knock out drums (with hydrocarbon bearing service)
- Cable cellars
- Diesel/Petrol/Kerosene oil or any hydrocarbon liquid / oil tank
- Coal/ Pet coke/ solid hydrocarbon material handling plant area
- Pumps under racks.
- Empty bag storage area

4.2.2 High velocity Water Spray (HVWS) System

To be provided for the followings locations, but not limited to.

- Transformers of minimum 10MVA rating or with oil content of minimum 2000 litres.

4.2.3 Water curtain system

To be provided for the followings locations, but not limited to.

- Ammonia/ Toxic gas/ vapour compressor and pumps
- Ammonia/ Toxic gas/ vapour storage tank
- Ammonia liquid tanker loading area

4.2.4 Sprinkler System

The sprinkler system, with galvanized carbon steel piping, shall be designed and installed at the following locations, but not limited.

Sprinkler system with deluge valves (dry type), shall be installed at the following location/ buildings, if applicable.



- All Buildings as per NBC 2016 (and/or latest edition)
- Laboratory
- Chemical room/storage area.

Sprinkler system (wet type with QBD), shall be installed at the following location/ buildings, if applicable.

- All buildings as per NBC 2016 (and/or latest edition)
- Admin Building
- Workshop building
- Technical Building
- Meeting Room/Hall
- Canteen
- Fire brigade building

4.3 Foam System

Foam system shall be provided for transformer area and hydrocarbon oil tank area.

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The transformer area shall be surrounded by at least 2 foam monitors strategically installed. Hydrocarbon oil tank area and LPG/NG gas skid area shall be surrounded by at least 3 foam monitors strategically installed, so that each tank or each gas skid is fully covered within the monitors throw range.

Water cum foam monitors (SS304 body & nozzle, fixed stand post type, manual operation, 500-750 USGPM variable type flow, self inducing foam induction mechanism) along with portable type foam cans (each 200 Litres capacity) with 3% AFFF Foam, shall be provided for above areas.

The foam system shall be considered for protecting tanks and other applicable equipments for hydrocarbon services as per NFPA requirements. The foam system shall comprise of foam concentrate proportioning equipment, foam makers, piping system and foam discharge devices, as applicable, as per NFPA. The system shall automatically actuate foam on detection of fire.

4.4 Clean agent flooding system

Gas flooding system with clean agent, diverter valve (if feasible), detectors & accessories for Control Room, Computer room, Computer console room, UPS room, Battery room, server/database rack room etc. shall be protected by clean agent system as per NFPA-2001(Inergen/ Argonite/ Novec 1230).

4.5 Pump House & Pumping System

4.5.1 Pumps

Wherever practicable pumps shall be arranged in rows with the centre line of the discharge on a common line. In general, pumps shall be kept inside the pipe rack / Shed. However in case of smaller racks, pumps shall be kept on one side or outside the pipe rack to provide clear access under the rack.

Pump foundation height shall be 300 mm above H.P.P.

Gap between each pump foundation / and foundation of technical structure should be sufficient for easy removal of equipment after piping. Clearance between two adjacent pumps shall be such that clear 900 mm aisle is available.

All pumps, Engines. Motors along with their accessories shall be inside Pump house & provided with EOT crane, and lifting device of suitable capacity. (Min 10 Ton)



4.6 Pump Piping

4.6.1 Pump drives shall have clear access.

4.6.2 Pump suction piping shall be as short as possible and shall be arranged with particular care to avoid vapor pockets.

4.6.3 Reducers immediately connected to the pump suction shall be eccentric type flat side up to avoid the accumulation of gas pocket.

4.6.4 For end suction pumps, elbows shall not be directly connected to the suction flange. A straight

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- piece minimum 3 times the line size shall have to be provided at the suction nozzle.
- 4.6.5 Unless otherwise specified T -type strainers shall be used on pump suction piping for sizes 2" and above.
- 4.6.6 All small bore piping connected to pump shall have provision for break up flanges for removal of pumps.
- 4.6.7 Piping shall be so arranged that forces and moments imposed on the pump nozzle do not exceed the allowable values as per API 610.
- 4.6.8 Pump discharge should preferably be routed away from the pump rather than towards the motor / Engine side.
- 4.6.9 Pump cooling water connection if any, shall be taken from the circulating cooling water header.

5.0 MATERIAL SPECIFICATION



- Materials & equipments used for fire protection system shall be in accordance with NFPA/TAC requirements and/or attached specifications of NIT.
- Pipes(API 5L Gr. B, SMLS upto 6"NPS and welded for higher sizes) fittings(ANSI/ASME), Valves(API), flanges(ANSI/ASME), Spray nozzles and deluge valves, quartzoid bulb detectors(QBD), Detector piping, Hydrant, Monitors, Hose Boxes, Hoses shall be as per piping material specifications (PMS), and/or attached specifications of NIT.
- Cast Iron valves or any cast iron piping component like pipes, fittings, flanges, valves, fasteners, gaskets, etc. shall not be used for fire fighting system or for any service.
- Spiral welded pipes shall not be used.
- Seamless pipes/fittings are acceptable in lieu of welded pipes/fittings, but welded pipes/fittings are not acceptable in lieu of seamless pipes/fittings.
- LSAW pipes are acceptable in place of ERW pipes, for same thickness.
- Double seam , 180 degree apart , is allowed for pipe sizes 36" and larger only.
- Circumferential seams (minimum 2 meter apart) is allowed for pipe sizes 36" and larger only.
- Flanges shall be in one piece material, without any joints.
- All flanged valves (except forged) shall have flanges integral with the valve body.
- Forgings are acceptable in place of castings but not vice-versa.
- Valves in saline water (if applicable) service shall be with non ferrous trims and all wetted parts other than trims shall be epoxy coated.
- Generic material of valves body, required as per process/service conditions but not specifically mentioned, shall not be lower in chemical composition than the connecting pipe material.
- PN equivalent rating for Class150# valves shall be minimum PN16.

5.1 Hydrant Valve shall be BIS approved (IS-5290) with following detail:

Inlet	: 3"-ANSI 150 # RF
Outlet	: 63mm
Pipe Size & material	: 4" CS
Capacity	: 36 cum/hr
Type	: Oblique angle type as per TAC requirement
Material	: SS304

5.2 Water Monitor

Nozzle bore size	: 38mm (Aqua fog /foam with arrangement of jet and spray).
End connection	: 4"- 150 # RF

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Run Pipe Size : Min. 6", CS
Capacity : 2580 LPM
Material : SS304
Approval : IS-8442

5.3 Water cum Foam Monitor:

Nozzle bore size : 38mm (Non aspirating type-Aqua fog / foam with Arrangement of jet and spray)
Run Pipe Size : Min. 6", CS
Capacity : 750 GPM
Material : SS304
Approval : UL

5.4 Long Range Water monitor

Capacity : 2000/1000/750/500 GPM (as required)
Horizontal Range : 50 m approx.
Material : SS304
Approval : UL

5.5 Hose Reel

Fire hose reels (IS-444) shall be considered at strategic locations around block as first aid fire contingency. These shall be indoor wall mounted and outdoor floor mounted type on structure and shall have water connection from hydrant network. Each hose reel shall have 30 metre long hose with nozzle. Hose reel shall be minimum 30m long x 20mm bore.

Hose reel shall cover all process areas in ground floor. Indoor wall mounted Hose reel shall be provided with each landing valve. Outdoor floor mounted type on structure at strategic locations @ 01 no.(minimum) for each package area.

5.6 Hose Box

Hose boxes shall be made of M.S. material and painted red with dimensions 18 SWG thick M.S. sheet, size 900 mm x 600 mm x 250 mm. Each box shall contain 2 nos.x 15 m of 2 1/2" fire hose (IS-636 Type-B) with gun metal nozzle, coupling, universal branch pipe (IS-903), MS spanner. 1no. Hose Box with accessories shall be provided for each hydrant post and each fire brigade connection (3 Way, 4 Way with isolation gate valve).



5.7 Portable Fire Extinguishers

Portable fire extinguishers (IS-2190, BIS marked / BIS approved) as per TAC shall be provided for plant & non plant buildings & areas, at strategic locations. Portable extinguishers of 9 kg (wheeled) & 50kg (wheeled) DCP (ABC type), 4.5kg (mounted), 6 kg (mounted) & 22.5kg and above (wheeled) CO2 type shall be provided. Contractor shall specify the numbers and location for Owner's review and approval.

5.8 Deluge valve

Deluge valve shall have flanged body/housing & cover (Cast Steel ASTM 216 Gr. WCB), Internal Metallic parts SS304, Diaphragm Rubber/ Non metallic) UL listed, Red Painted, pneumatically actuated.

6.0 FIRST AID FIRE FIGHTING EQUIPMENTS

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The selection of safety equipment should be such that it is correctly related to the type of fire expected in the area.

The general guideline for selection and use shall be as per TAC/IS requirements. Fire extinguishers shall be provided as per TAC/IS.

Contractor shall provide the Fire extinguishers items (BIS approved) as specified in tender.

6.1 Fire extinguisher

Fire extinguishers as per TAC shall be provided for process risk and at each landing of operating platform of technological structures, for the protection of equipment as a means to cope up with fire at incipient stage. Supply of all Fire Extinguishers shall be with BIS Mark.

Powder used in DCP type fire extinguishers shall be MAP 90% ABC powder, UL listed & BIS approved.

The number should be determined based on the max. travelling distance of 15 M. At least one fire extinguisher shall be provided for every 250 m² of hazardous operating area.

Chemicals/ Consumables used in the fire extinguisher shall UL listed.

Following Fire Extinguisher types shall be provided, as applicable :

- 1) 6 Kgs., 9 Kgs. Capacity DCP Extinguishers (ABC type) shall be provided on Technological platforms/process ground floor and Control rooms.
- 2) 4.5 Kgs. Capacity Co₂ Extinguishers shall be provided for buildings, sub stations & control rooms.
- 3) 22.5 Kgs Capacity Co₂ Extinguisher shall be provided near transformer bay.
- 4) 50 Kgs capacity DCP Extinguishers (ABC type) shall be provided at critical operating area in plant.
- 5) 2 Kgs, 4 Kgs capacity clean agent Extinguishers shall be provided for Control Room, Computer room, Computer console room, UPS room, Battery room, server/database rack room etc.

6.2 Sand Bucket



Sand buckets filled with sand along with scoops, mounted on structural support stand each with at least 3 sand buckets), shall be provided in Transformer bay, Sub Station, buildings, Technical structure, platforms, Pump house, etc.

The sand buckets shall have round bottom with bottom handle having 9 liter water capacity conforming to IS: 2546. The sand stored in bucket shall be fine and free from oil, water or rubbish. Rain protection of suitable design shall be provided for all sand buckets.

6.3 SAFETY SIGNAGES

Contractor shall provide the safety signages (in English & Hindi language) as per NBC/TAC , at strategic locations, for plant/ non plant areas buildings, technological structure, areas. Safety signages must be visible under both lighted & darkness conditions.

7.0 SAFETY EQUIPMENTS/PERSONNEL PROTECTIVE EQUIPMENTS (PPE)

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Contractor shall provide the following safety items with quantity specified for their scope of work:

- a) Safety helmets – 05 nos.
- b) Stretcher – 1 no.
- c) Fibre glass First Aid Box with all necessary items/kit & anti snake serum -01 set.
- d) Rubber hand gloves for electrical jobs– 05 pairs per type for each substation and each control room. (min. 02 pairs per type irrespective of facility requirement).
- e) Hand operated siren - 1 no.
- f) Hand held battery loaded Emergency light, each with 1 set spare battery- 02 nos.
- g) Sand Bucket & accessories - 02 sets.
- h) Self-contained Breathing Apparatus Set (30 minute duration) with a spare cylinder (filled-up) & accessories- 01 No.
- i) Cold/low temperature protective suit - 01 No
- j) Cryogenic gloves-- 01 No

8.0 EMERGENCY ESCAPE ROUTE

Escape route shall be marked with signage, exit point. Escape route shall not be obstructed in any way. No single accident should be capable of blocking both alternatives. Escape route should take shortest route to assembly point defined within plant.

In case of process structure, satisfactory access shall be provided to all parts of each floor by means of incombustible internal or external staircases.

Exact numbers, width, location, etc. of such staircases and ramps for basements shall depend on travel distance requirements given under National Building code of India.

9.0 EXECUTION, INSPECTION AND TESTING



All execution, inspection and testing for completion of fire protection system shall be carried out based on codes, standards and specifications. Contractor shall develop detail inspection and testing procedures for review by owner. Contractor shall carryout demonstration test for each installed system as per scope of work.

The Contractor shall meet all requirements for inspection and testing of the systems.

10.0 QUALITY ASSURANCE SYSTEM

All work/services to be performed by the Contractor under this contract shall be of specified/approved quality and Contractor shall have a quality assurance/quality control (QA/QC) system during the performance of various activities such as engineering, procurement, tendering, construction etc. Review/approval of activities by Owner/PMC shall not however dilute the responsibility of Contractor for maintaining quality.

The objective of the quality assurance scheme of the Contractor shall be to ensure the conformity of equipment, material, site construction (if any) to various standards, specifications, drawings and technical requirements that are being mutually agreed between the Contractor and Owner/PMC/TPI. Quality Assurance System should clearly indicate the organizational approach for quality control and quality assurance of the various equipment/construction activities (if any) and also provide a verifiable evidence of the Contractor having carried out all the activities laid down in the bid document and the procedure. Such conformity to quality level shall be ensured by

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controlling the quality level of purchased items at vendor's/sub-vendor's shop/site and shall cover from source surveillance to final inspection. The Contractor to submit a detailed inspection and testing plan for various shop/site activities for review by Owner/PMC/TPIA.

11.0 INSPECTION

The Contractor is required to organize a proper inspection and expediting system so as to ensure timely delivery of all the items/equipment meeting the specified quality criteria. This function has to be carried out by appropriate deployment of qualified personnel who have wide experience in their respective fields. Inspection of all items supplied under this contract shall be carried out by independent third party inspection agencies like Lloyds/ BV/ TUV/DNV. Third party inspection charges for foreign origin items shall be quoted by bidder. Third Party Inspection shall be done by owner approved third party inspection agencies.

Inspection authority means the Third Party Inspection Agencies (TPIA) approved by the Owner to carryout inspection of materials.

The inspecting authority shall have the right to select random samples for check test and reject materials, if samples furnished as above and tested as per the specifications fail to meet the requirement specified.

All the items shall be inspected and tested in the presence of one or more representatives of the purchaser during various stages of manufacturing. Material shall be considered acceptable for dispatch only after final certificate of acceptance is issued by the Inspector. Testing performed in the presence of the purchaser's representatives shall not relieve the supplier of their own responsibilities and guarantees and any other contractual obligations.

Quality Assurance plan (QAP) / Inspection Test Plan (ITP) shall be submitted by bidder for approval by Third Party Inspection Agency (TPIA).



The Contractor shall make arrangement for inspection and testing by statutory authorities, if applicable, at various stages of the work.

11.1 Scope of Inspection by TPIA:

- i) Review of MTC (all batches).
- ii) Visual check for surfaces, external appearance (10% random witness).
- iii) Dimensional check (10% random witness).
- iv) Positive Material Identification (PMI) for alloy steels/austenitic steels (10% random witness).
- v) Hydrostatic test (10% random witness for pipes, fittings, valves, strainers, traps, collecting heads, draw off connection, hoses, hose reels, extinguishers, bellows, personnel protective equipments (if applicable for any item), fire fighting/protection equipments. Hydrostatic test shall be 10% random review for other items.
- vi) Any testing/demonstration required as per relevant code/standard/specification: 10% random review.
- vii) Packing: Report review.
- viii) Documentation (MTC, Inspection Release Note): 100% Review.

12.0 TESTING

All testing shall be done, as per relevant specifications and/or NIT specifications.

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12.1 Non Destructive Testing

10% radiography of butt welds and 10% DP/ MP test of fillet welds shall be done for pipe classes in 150# & 300#.

100% radiography on butt weld joints and 100% DP/MP for fillet welds test shall be done for pipe classes in 600# & above.

Radiography procedure, areas of casting to be radiographed, and the acceptance criteria of valves shall be as per ASME B16.34.

The minimum requirement of radiography shall be as under :

Pipe Class	Size (NPS)	Qty
150	Up to 24"	5%
150	26" & above	100%
300	Up to 16"	10%
300	18" & above	100%
600 & above	All	100%

13.0 DOCUMENTATION

Drawings and documents (4 hard copies, 1 electronic copy & 1 as-built copy of each drawing/document), for fire fighting/fire protection system, design basis, general arrangement/layout drawings of fire water/ spray system/ sprinkler system/fire extinguishers/fire fighting equipments, design adequacy calculations, material specifications, material take-offs (linewise/consolidated), supplier drawings/specifications, inspection test plans, test certificates, spares list, etc. shall be submitted by the Contractor for review/approval/information of Owner/PMC/ Statutory authorities.

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PART II: TECHNICAL

SECTION – 6.0

DESIGN PHILOSOPHY – ROTATING EQUIPMENTS

**PLANT: NATIONAL FERTILIZERS LIMITED, NFL, NANGAL,
PUNJAB**

**PROJECTS: INSTALLATION OF NEW 2500 CUBIC METER
CAPACITY HORTON SPHERE FOR STORAGE OF
AMMONIA ALONG WITH ITS REFRIGERATION SYSTEM
AT NFL, NANGAL**





	DESIGN PHILOSOPHY ROTATING EQUIPMENT INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/6.0	0	
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LIST OF ATTACHMENTS

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1.0 SCOPE

1.1 General

1.1.1 This Philosophy states that contractor's scope of work shall include basic & detailed engineering, procurement, supply, manufacturing, fabrication, transportation, loading, unloading, insurance during transit, storage, construction, erection/ installation of all **Mechanical Rotating Equipment** with allied electrical, instrumentation and civil works, obtaining all necessary statutory approvals from concerned government authorities as applicable, testing, mechanical completion, pre-commissioning, commissioning, performance guarantee test runs including total project management and handing over of **New 2500 Cubic meter capacity Horton Sphere** for storage of Ammonia along with its refrigeration system, interconnection with existing Horton Sphere (**F2401**) system including complete Mechanical, Electrical, Civil, Instrumentation work at **National Fertilizers Limited (NFL) Nangal** on Single point responsibility basis.

1.1.2 In addition, all statutory rules & regulations shall also be complied with.

2.0 DESIGN PHILOSOPHY FOR MACHINERY

2.1 Codes and Standards

The **Latest Edition** of codes and standards as listed below shall be followed for design and manufacturing of different machinery items. Generally the manufacturer will comply with these codes and standards as indicated therein with minor deviations that are normally adopted by manufacturer and are reasonably accepted as per good engineering practice.

A list of such deviations, if any, shall be furnished by the LSTK Contractor along with offer.

Code	Description
API 618	Reciprocating Compressors for Petroleum, Chemical and Gas Industry Services



**DESIGN PHILOSOPHY
ROTATING EQUIPMENT
INSTALLATION OF NEW 2500 CUBIC
METER CAPACITY HORTON SPHERE FOR
STORAGE OF AMMONIA AT NFL, NANGAL**

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API 614	Lubrication, Shaft-Sealing, and Control Oil System for Petroleum, Chemical and Gas Industry Services
API 670	Vibration, Axial-Position, and Bearing- Temperature Monitoring Systems.
API 671	Special Purpose Coupling for Refinery Services, Petrochemical and Gas Industry .
API 677	General Purpose Gear unit for Petroleum, Chemical & Gas Industry
API 686	General practice for Machinery Installation and Installation design
API 613	Special Purpose Gear Units for Petroleum, Chemical and Gas Industry Services
API 678	Accelerometer and Vibration Systems.
<u>Boiler & Pressure Vessel Code</u>	
Section V	Non-destructive Examination
Section VIII Division-1	Rules for Construction of Pressure Vessel
Section IX	Welding & Brazing Qualification
<u>ASTM</u>	
A 193	Alloy steel & Stainless Steel Bolting material for High Temperature or High Pressure Services
A194	Carbon & Alloy Steel Nuts for High Temperature or High Pressure Services
A 668	Carbon and Alloy Steel Forging Specification
A 503	Ultrasonic testing of Forged Crankshaft
<u>Performance Testing (ASME Codes)</u>	
PTC 9	Displacement Compressors
ISO 1217	Displacement Compressors – Acceptance test
<u>AGMA Standard</u>	
420	Practise for Enclosed Reducers or Increases using Spur, Helical, Herringbone and Spiral Bevel Gears.
421	Practise for High Speed Helical Gear Units.

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2.2 Design Life

All equipment shall be designed for a minimum service life of 20 years and at least 3 years of uninterrupted operation under normal operating conditions. This requirement excludes specialised components requiring periodic maintenance and replacement.

2.3 Essential Project Reference Documents

The following documents shall be observed, and relevant aspects incorporated into specifications and datasheets:

- Process Description, Specifications and Data Sheets from Licensor
- Hazardous Area Classification
- Electrical and Instrumentation Design Criteria

2.4 Regulations

Besides codes & standards, LSTK Contractor shall follow National Laws and Regulations together with Local by Laws for the state including statutory requirements as applicable.

2.5 Site Conditions

Site conditions shall be as defined elsewhere.



2.6 Material of Construction

Generally Materials of construction shall be as per the process licensor's recommendation. However, API guideline may be adapted to the extent applicable.

Use of equivalent & superior material may be selected & shall be furnished with the offer along with chemical composition.

2.7 Quality Assurance & Control

2.7.1 The quality assurance shall be as per the approved procedures, test methods & facilities to be developed by the LSTK Contractor to ensure that the supplied

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equipment shall be of highest quality. The quality control shall mean that all the tests , measurements, checks & calibration which are to be carried out may be compared with the actual specified characteristics of the equipments/unit /system.

- 2.7.2 Quality Assurance (QA) shall mean the organizational set up, procedures as well as test methods and facilities developed by LSTK Contractor in order to assure that the machines & associated auxiliaries leaving LSTK Contractor's shop are of the highest possible quality i.e. either equal to or better than the requirement specified.
- 2.7.3 Quality Control (QC), shall mean all the tests, measurement, checks and calibration which are to be carried out in LSTK Contractor's shop in order to compare the actual characteristics of the equipment/unit/system with the specified ones, along with furnishing of the relevant documentation (certificates/records) containing the data or result of these activities.
- 2.7.4 LSTK Contractor shall submit a comprehensive description (manual) of QA/QC measures contemplated by him for implementation with regard to this specification. It is contractual obligation of the LSTK Contractor to develop and implement adequate QA/QC systems.
- 2.7.5 QA/QC system shall cover all products and services required for the complete machine unit as per scope of work including job sub contracted by the LSTK Contractor.

3.0 DESIGN REQUIREMENTS

3.1 General

- 3.1.1 All machines shall be directly coupled to their prime movers. If not, specifically mentioned, the drivers shall have rated output at least 10% greater than the power requirement at design operating condition of the driven equipment.
- 3.1.2 Copper (Cu) or Cu-alloy shall not be used for any components in Ammonia Plant & in other plant for ammonia services.
- 3.1.3 All process pumps shall have Mechanical Seals. Single seals will be used in most cases, however, for ignitable or hazardous fluids, double, or Inside Wet and Outside Dry running seals will be used.

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3.1.4 Special tools and wrenches required for installation and maintenance shall be provided.

3.1.5 **LSTK Contractors have to submit the reference list for similar equipment's models (minimum 2 nos.) supplied in past for similar duty conditions of the fluid . Reference list must contain at least the following: Fluid handled Capacity, Suction Pressure/ Inlet Condition, Discharge Pressure/ Discharge condition, Model No., Speed, Power consumption, Drive, Client Name, Address, and Year of supply.**

3.1.6 Provision of Coast down tank shall be made in the Lube Oil System.

3.2 Reciprocating Compressors

The reciprocating compressors shall confirm to National/ International standard, latest edition. In addition to the above, the following shall be applicable:

3.2.1 Normal operating point of the compressor is as per process description and data sheet. The capacity at Normal operating point shall have no negative tolerance. The compressor performance shall be guaranteed for specified Normal operating point, rated for process.



3.2.2 The Compressor shall have the maximum allowable sound pressure level of 85 dbA , measured at a distance of 1 Meter.

3.2.3 The equipment shall run continuously at relief valve setting without any difficulties or damage.

3.2.4 Equipment should run satisfactory with stated performance at site. Any specific requirement with respect to anchor bolt layout and foundation, input from vendor to be communicated.

3.2.5 The compressor with auxiliaries shall be capable of operating under the environment condition specified including indoor or outdoor installation, unusual humidity, dusty or corrosive condition. All the equipment should operate satisfactorily under refinery/ chemical plant atmosphere.

3.2.6 The compressor should be capable of operating continuously at any full load, part load or fully unloaded condition and should capable of start up.

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3.2.7 Maximum predicted discharge temperature; for all specified operating and loading condition; should not be greater than 135 deg C.

High discharge temperature alarm and shutdown device to be provided with each cylinder with provision of 100% unloading.

High discharge temperature alarm set point	20 K greater than Maximum predicted discharge temperature
Shutdown temperature set point	30 K greater than Maximum predicted discharge temperature

The vendor shall provide predicted and adiabatic discharge temperature rise for each cylinder.

3.2.8 The maximum piston rod loading shall be calculated considering safety valve set pressure of each stage and corresponding lowest specified suction pressure.

3.2.9 Lateral and Torsional critical speed analysis shall be carried out to ensure the elimination of any lateral and torsional vibration that may hinder the operating speed range.

3.2.10 The piston speed for lubricated cylinder shall not exceed 4 m/s and for non-lubricated cylinders it shall be limited to 3 m/s.



3.2.11 Machine shall be balanced to minimise lateral loads.

3.2.12 Safety relief valve set pressure shall be greater than 10% of maximum discharge pressure or 1.7 bar greater than maximum discharge pressure, whichever is higher.

3.2.13 Non-lubricated compressors shall be provided with piston rings, packing made of carbon filled PTFE or equivalent.

3.2.14 The design of compressor valve shall be such that the valve assembly cannot be inadvertently interchanged or reversed e.g. Suction valve cannot be fitted into the discharge port nor valve assembly upside down.

3.2.15 Valve plates and springs shall be made of stainless steel. PEEK may be used for valve plates in case the vendor has experience of using it for similar service and duty conditions.

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- 3.2.16 Distance piece of non-lubricated compressor shall of sufficient length to ensure that no oil is in contact with gland packing.
- 3.2.17 The packing boxes shall be provided with atmospheric vents to minimize gas leakage.
- 3.2.18 Pulsation dampeners shall be provided for meeting the residual pulsation requirements as per API.
- 3.2.19 To minimise the need for heavy overhead pipe structures, suction and discharge piping to and from the knockout drums should run close to grade, supported on sleepers.
- 3.2.20 Frame lubrication system shall be provided with auxiliary pump driven by electric motor for initial lubrication.
- 3.2.21 Cylinder lubrication, if required, shall be provided by a separate forced feed mechanical lubricator complete with necessary tubing/piping, check valve and sight flow indicator.
- 3.2.22 Full flow twin oil filter shall be provided.
- 3.2.23 The compressor shall be capable of developing maximum differential pressure specified (minimum specified suction to maximum specified discharge pressure).
- 3.2.24 Bidder/Manufacturer is to provide the details of utility requirement.

4.0 INSPECTION & TESTING

All the compressors shall be subjected to inspection by Inspector of Purchaser or authorised Third Party Inspection agency.

The Inspection and testing shall be in accordance with the all relevant codes, standards, specifications, including the minimum guide line given in Annexure – 1 (attached).

- 4.1 All testing accessories, measuring instruments including NDT testing equipment, etc. shall be arranged by LSTK Contractor. DM water shall be used for hydro testing of the equipment which shall be supplied by client on chargeable basis.
- 4.2 In general, following tests shall be conducted for all rotating equipments:

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- Material test
- Non-destructive test
- Hydrostatic test for all the pressure containing parts
- Dynamic balancing of rotor
- Helium leak test of compressor casing (if required as per API Code)
- Mechanical running test of compressor
- Barring over check for reciprocating compressor
- NPSHR test for pumps
- Performance Test
- Disassembly Test

The tests required to be conducted and witnessed shall be specified in the equipment data sheet. Disassembly test for Fans, Blowers & small Pumps can be waived –off in case no problem occurs during mechanical / performance Test.

5.0 SPARES



- 5.1 All erection & commissioning spares shall be supplied by LSTK Contractor & cost shall be included in the cost of main equipment.
- 5.2 2 years operation spares shall be supplied by the contractor as per ITB.

6.0 PAINTING

- 6.1 All exterior non-stainless steel surfaces subject to atmospheric corrosion with the exception of machined surfaces shall be epoxy painted.
- 6.2 All exterior machined surfaces shall be coated with suitable rust preventives.

7.0 VENDORS LIST



All equipment shall be procured / fabricated as per approved vendor list. However, LSTK contractor may have to furnish Proven track record / reference record of any vendor opted for specified services / equipment, if, owner desires.

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For Any equipment for which vendor list is not enclosed, the LSTK Contractor may furnish a list of proposed vendors along with their references for supply of similar type of equipment along with bid. However all proposed additional sub-vendor shall have well proven track record and shall be subjected to consultant / owner's approval.

8.0 LSTK CONTRACTOR/VENDOR DOCUMENTATION:

Drawings & Documents of machinery items/ rotating equipment shall be as mentioned elsewhere in the ITB.

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ANNEXURE-1

INSPECTION & TESTING GUIDE LINES – ROTATING EQUIPMENT

1.0 SCOPE



This document covers the minimum guide lines for the Inspection & Testing for the rotating Equipments.

All the compressors shall be subjected to inspection by PDIL Inspector/Inspector of Purchaser or authorised Third Party Inspection agency.

The Inspection and testing shall be in accordance with the all relevant codes, standards, and specifications as specified in Specification sheet.

2.0 COMPRESSORS AND DRIVERS

- 3.1 Material of casings or cylinders to be checked against test certificates.
- 3.2 For fabricated casings, inspection shall be as per API 618.
- 3.3 Hydrostatic test on casings or cylinders to be witnessed.
- 3.4 Dynamic balancing of rotor.
- 3.5 Non- destructive test.
- 3.6 For fabricated impellers, welding procedure and welder's qualifications to be established and impellers to be inspected before assembly. Impellers overspeed, NDT after overspeed and dimensional inspection.
- 3.7 Ensure that overspeed tests on impellers have been carried out and related certificate for dynamic balancing of impellers and subsequently the complete rotating assembly shall be provided. The over speed test shall be carried out to prove the impeller proper balancing and relevant certificate shall be provided.
- 3.8 Witness leakage test on lube oil tank and carry out internal and external inspection. Tank to be finally inspected after internal coating and /or painting.
- 3.9 Inspect prefabricated lube oil piping.
- 3.10 Witness performance tests shall be done and check all safety and alarm devices when contact instrumentation is fitted.
- 3.11 If spare rotating assembly is ordered, any running tests with spare fitted or the dropping of the spare into the casing, as may be specified, to be witnessed.

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- 3.12 Strip inspection on completion of running tests. To include examination of all running surfaces, checking of critical clearances, and examination of lube oil filters in the tests.
- 3.13 Final inspection and dimensional check of compressors mounted on base plates.
- 3.14 Gearing, pinion forgings and main wheel forgings or castings to be inspected at forge shop or foundry.
- 3.15 Any dynamic balancing of gearing rotors to be witnessed.
- 3.16 Fabricated gear cases to be inspected at sub-supplier's works.
- 3.17 Light or full load running tests, as specified to be witnessed on gearing.
- 3.18 Final inspection and dimensional check of gearing to be done at manufacturer's works.

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PART-II, TECHNICAL

SECTION – 7.0

DESIGN PHILOSOPHY – ELECTRICAL

FOR

INSTALLATION OF A NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA ALONG WITH ITS REFRIGERATION SYSTEM AND INTERCONNECTION WITH EXISTING HORTON SPHERE (F-2401) SYSTEM

AT

NFL, NANGAL



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CONTENT

SECTION NUMBER	DESCRIPTION
1.0	Scope
2.0	Basis of Design
3.0	Area Classification
4.0	System Details & Utilisation Voltages
5.0	Power Supply Distribution
6.0	Sub Station
7.0	Protection & Metering
8.0	Control and Monitoring
9.0	Equipment Specification
10.0	Cabling
11.0	Illumination System
12.0	Earthing and Lightning Protection
13.0	Cathodic Protection System
14.0	Communication System
15.0	Fire Alarm System
16.0	Electrical Heat Tracing System
17.0	Spares
18.0	Vendors' Services
19.0	Testing & Inspection
20.0	Documentation
21.0	Training
22.0	Vendor List
23.0	Installation, Testing and Commissioning
24.0	Coordination With Other Contractors
Annexure- I	Illumination Levels & Type of Fixtures

LIST OF ATTACHMENTS

Technical Specification No.	Description	No. of Sheets
TS-8037	Public Address System	8
TS-8048	Auxiliary Service Transformer	8
TS-8060	Medium Voltage Switch Boards	19
TS-8080	Sheet Steel Distribution Boards	14
TS-8083	Lighting Sub Distribution Boards	8
TS-8102	Induction Motors	14
TS-8120	Interlocking Sw. Socket and Plug	8
TS-8123	Lighting Fixtures & Accessories	13
TS-8160	Cables	7
TS-8161	Prefabricated Ladder Type Cable Racks	6
TS-8200	Local Control Stations	9
TS-8201	Junction Box	7
TS-8208	Electricals for Over Head Cranes and Hoists	12
TS-8301	Soft Starter	8
TS-8302	Variable Frequency AC Drives	20
TS-8303	Cathodic Protection for Plant Piping and Buried Facilities	23
TS-8304	Cathodic Protection Power Supply Module (CPPSM)	14
TS-8305	Cathodic Protection Transformer Rectifier Unit	14
TS-8306	Fire Detection and Alarm System	21
TS-8307	Communication & Fire Alarm Cables	10
TS-8308	High Mast	10

Schematic Diagram	Description	Sheets
PC281-1201	Schematic Diagram for 415V switch Board	16

Electrical PDS No.	Description	Sheets
PDS:E 119	Typical Foundation Arrangement for Panels in Sub-Station	1
PDS:E 120	Typical Foundation Details for HT/LT Circuit Breaker Panels	1
PDS:E 203	Steel Tubular Lighting Pole	3
PDS:E 204	Installation of Electrical Poles	1

Electrical PDS No.	Description	Sheets
PDS:E 206	Installation Arrangement Street Lighting Fixtures	1
PDS:E 207	Details of Bracket Arm for Street Lighting Pole	1
PDS:E 208	Installation Arrangement Area Lighting Fixtures	1
PDS:E 210	Junction Box for Street Lighting Pole	1
PDS:E 211	Installation of Junction Box for Street Lighting Pole	1
PDS:E 213	Typical Street Lighting Pole	1
PDS:E 402	Component rating for DOL starter	1
PDS:E 404	Component rating for AC feeders	1
PDS:E 412	Schematic Diagram AC Control Supply through Control Transformer for Switch Boards with bus coupler	1
PDS:E 464	Schematic Diagram Panic Light	1
PDS:E 510	Details of Concrete Cable Trench	1
PDS:E 511	Cable Rack Arrangement in Trenches	1
PDS:E 512	Fabrication Details of Cable Rack in Trench & Duct	1
PDS:E 516	Typical Arrangement of Cables burried in slit	1
PDS:E 525	Fixing Arrangement of Perforated Cable Tray (Horizontal Formation Ceiling Supported)	1
PDS:E 526	Fixing Arrangement of Perforated Cable Tray Horizontal Formation Wall / Structure Supported	1
PDS:E 527	Fixing Arrangement of Perforated Cable Tray Vertical Formation	1
PDS:E 530	Pre-Fabricated Cable Tray Straight Run	1
PDS:E 531	Pre-Fabricated Cable Tray Horizontal Tee	1
PDS:E 532	Pre-Fabricated Cable Tray Horizontal Cross	1
PDS:E 533	Pre-Fabricated Cable Tray 90 ⁰ Horizontal Bends	1
PDS:E 534	Pre-Fab. Cable Tray 90 ⁰ Vertical Bend Bending Rad. 1000 mm	1
PDS:E 535	Pre-Fabricated Cable Tray 90 ⁰ Vertical Bend Bending Radius 600 mm	1
PDS:E 536	Pre-Fabricated Cable Tray Coupling Arrangement	1
PDS:E 537	Pre-Fabricated Cable Tray Fixing Arrangement	1
PDS:E 538	Pre-Fabricated Cable Tray Reducing Coupler Plate	1
PDS:E 602	Earthing Conductor Details	2
PDS:E 603	Arrangement of Connections of Earth Conductors	6
PDS:E 604	Typical Details of Connection in Earth Pit	1
PDS:E 605	Earth Pit Details	2
PDS:E 606	Typical Arrangement of Earthing for Motor and Start	2



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Electrical PDS No.	Description	Sheets
	Stop Push Button	
PDS:E 610	3.8 M GI Electrode for Earthing	1
PDS:E 611	GI/Al Accessories for Earth Electrode	2
PDS:E 613	Earthing of storage tank & vessel	1
PDS:E 615	GI Earth Bus	1
PDS:E 617	Typical Arrangement for Neutral and Equipment Earthing	1

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1.0 SCOPE

- 1.1 This scope of works covers the complete design, engineering, manufacture, testing at works, supply of all electrical equipment, dispatch, storage, handling, erection, testing and commissioning at site of complete electrical system required for installation of a new 2500 cubic meter capacity Horton Sphere for storage of Ammonia along with its refrigeration system and interconnection with existing Horton Sphere (F-2401) system at NFL, Nangal, India.
- 1.2 The electrical system shall comprise of receiving power, distribution up to consuming apparatus, lighting, earthing, lightning protection, cathodic protection system etc. necessary for satisfactory and safe operation of complete plant.
- 1.3 Owner will provide the followings. Further distribution shall be in LSTK contractor's scope. Owner's feeder modification/retrofitting to meet the system / NIT requirement, cable supply, laying, cable termination at both end, relay setting, etc. shall be in contractor's scope. Contractor may visit the site for better understanding.
- 2 nos. normal power feeder from existing 415V LT Board in MRSS (Feeder No. 23 & 32 of 1600A rating ACB). LSTK contractor to consider new PMCC to feed the new consumers including lighting. For emergency lighting owner will provide one no. emergency power feeder from emergency 415V MCC-1 in MRSS.
 - One no. emergency spare motor feeder (18.5 kW) from emergency 415V MCC-1 in MRSS however retrofitting of the switchgear [SFU + Power Contactor + Overload Relay + Control Contactor (if required)] as per KW rating of motor shall be in LSTK contractor's scope and rest normal feeders shall be fed through new PMCC.
 - Owner will also provide 2 nos. feeders from their existing AC UPS DB and 1 no. feeder from their existing 110V DCDB.
- 1.4 This design philosophy contains specifications of the major equipments to indicate the basic requirement and serve as a guideline. However, it shall be the responsibility of the contractor to offer a complete electrical system of superior quality, even if the specifications of certain items are not given.
- 1.5 The bidder shall offer the best and most suitable type of energy efficient equipments manufactured by well known reputed manufacturers as per vendor list appended elsewhere in this bid package. However for the sake of standardization of the electrical equipment and material used for the electrical installation, the bidder shall be ready to supply the equipment of a particular type and or make.
- 1.6 Construction power shall be provided free of cost by the owner at one point. Further distribution through adequately rated distribution and sub distribution boards/feeder pillars, power supply cables and other associated materials for feeding loads to carry out construction and fabrication activities shall be in LSTK Contractor's scope.



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Bidder to indicate the construction power requirement with the bid. LSTK contractor shall arrange emergency power (suitably rated DG Set) at his own cost during construction in case of construction power failure to ensure the safety of personnel at site.

- 1.7 Contractor shall provide adequate area lighting at site of construction, fabrication yards and office etc. by means of suitable lighting fixture, lighting masts, flood lighting poles etc. which are to be supplied and maintained by the contractor as per safety aspect.
- 1.8 Electrical system studies like load flow study, short circuit study, motor starting study, relay co-ordination study & relay setting of the electrical installation shall be conducted by the contractor at appropriate stage of design-engineering. Contractor shall also check the feasibility of existing transformer & 415V LT Board in MRSS feeding the switchboard. Contractor shall ensure that the fault level of existing switchboard shall not go beyond its design fault level.
- 1.9 Mandatory Electrical spares for operation and maintenance of the electrical system shall be supplied by the contractor as listed elsewhere in this bid package.
- 1.10 Spares and consumables required and first oil fills including short fall during erection, testing, cold trials, commissioning, performance evaluation tests, guarantee tests etc. and till handing over of installation.
- 1.11 The scope shall also include obtaining all required statutory approval from all statutory bodies. Contractor shall carry out all modifications/alterations required by local statutory bodies.
- 1.12 Sub stations shall be provided with following equipment:
- CO₂ fire extinguishers (4.5 litre capacity) as per applicable NFPA.
 - Synthetic insulating mats on front and back side of the switchboards as per latest IS.
 - Framed single line diagram in Aluminium frame with glass.
 - Do's & Don't chart as per Indian Electricity Rules in Aluminium frame with glass.
 - Shock treatment chart written in English and Local language duly framed and approved by engineer-in-charge.
 - Caution boards / dangers boards written in ENGLISH & HINDI for all the voltage levels.
 - CPR (CARDIO PULMONARY RESUSCITATION) Charts.
 - Low Voltage danger signage (Skull & bones).

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- Exit Route / Emergency Exit Route Signage.
- Earthing rod- Minimum 1 No. for each Voltage level.
- Set of Sand buckets with stand (each with at least 3 sand buckets).
- LT megger
- Earth megger
- LT hand Gloves (1 Set)
- First Aid Box

Other requirement or any other unforeseen which may arises during detailed engineering shall also be in LSTK Contractor's scope

1.13 In case of any discrepancies between Design Philosophy – Electrical and Technical Specification of equipment / item / work in respect of description of equipment / item / work, the details indicated in the Design Philosophy – Electrical shall prevail.

2.0 BASIS OF DESIGN

2.1 General

2.1.1 The electrical installation shall be designed to provide:

- Necessary amount of power
- Flexibility
- Service reliability
- Ease of expansion
- Ease of operation and maintenance & inter changeability of equipment
- Safety of personnel

The design of electrical installation shall ensure provision of a safe, efficient and reliable supply of electricity at all times. Safe conditions shall be ensured under all operating conditions including those associated with start up and shut down of plant as well as those arising out of failure of electrical equipment. The isolation of part of system of electrical equipment due to either maintenance or shut down shall not compromise safety.

2.1.2 System shall be designed considering following aspects in general:-

- To facilitate inspection, cleaning and maintenance with the care to safety in operation and personnel protection.
- To minimise turnaround times.



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- To provide safety, reliability and flexibility of service.
 - Adequate provision for future extension and modification.
 - Maximum interchangeability of equipment.
 - Desired level of operator interface to achieve coordinated efficient and fail-safe operation, data logging and maintenance of the equipment.
 - To decide redundancy, stand by, spares and overload capacities to achieve desired reliability and flexibility requirement.
 - To get cost effective and techno commercially proven technology. Economic considerations shall cover capital and running costs and an assessment of the reliability and consequent availability of the system.
- 2.1.3 All the electrical consumers within the battery limit shall be correctly identified and listed to have complete details of rating, efficiency, power factor, operating duty cycle (continuous, intermittent, standby), category of supply required (emergency, normal, critical) etc.
- 2.1.4 Required redundancy (based on specific process/operating needs) shall be built in substation which feeds power supply to process units/important facilities so that in case of tripping of one feeder, the unit may not be adversely affected and continuity in operation at full capacity is achieved.
- 2.1.5 While sizing the system necessary consideration shall be given to restrict the system voltage drop within permissible limits during starting of large rated motor. At the same time, the short circuit current shall be kept within limits keeping in view of the market availability of switchgears. For this purpose current limiting reactors/unit ratio transformers if required may be used. Reduced voltage starting (soft starter feature) for motors may be considered as per system requirements.
- 2.1.6 LSTK contractor while performing design and engineering activities shall adhere to following guidelines.
- a) If any equipment is not covered in this design philosophy but required for successful operation of the project, LSTK contractor shall prepare additional specifications for equipment or bulk material taking reference of Indian/International Codes and good engineering practices prevalent in fertilizer industry and obtain owner's approval for the same.
 - b) The standard drawings attached with this package define the basic system design and distribution philosophy for the package. This is for guidance purpose only. LSTK contractor shall develop detailed drawings and submit for owner's approval.
 - c) LSTK contractor may note that equipment ratings, wherever specified in the bid package, shall be considered indicative. LSTK contractor shall be responsible to

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verify the rating and consider providing equipment with adequate rating but not less than the specified rating. Compliance should be without any extra cost and time implications.

- d) LSTK contractor shall consider any other requirement which is not covered in this bid package, but required for successful operation of the plants without any extra cost and time implications.
- e) Contractor shall obtain approval from all statutory authorities such as Central Electricity Authority (CEA)/Electrical Inspectorate, Chief Controller of Explosives (CCoE), CPCB etc. for all electrical facilities including electrical switchboards & panels supplied and installed by LSTK contractor.
- f) LSTK contractor shall assist in Liaison and in all interface coordination with contractors of other units of project at construction, erection, testing & commissioning phase for any common facility.
- g) Equipment specification sheet/data sheets for all equipment shall be prepared by the contractor based on relevant codes and specifications. Data sheet shall contain all technical data and information which are essential for review and technical acceptability, detailed engineering, installation, testing, repair and maintenance, replacement etc.
- h) Contractor shall clearly specify in their purchase specifications, the requirement of conducting other special tests/type tests, which are envisaged for various electrical equipment, which shall have no impact on cost and time.
- i) Bidder shall visit the site and collect all relevant information required for designing of complete system before quoting.
- j) All the electrical equipments shall be of proven design and technology.



Load Summary shall be prepared by LSTK contractor to determine ratings of electrical equipments (switchgears, cables etc.). All calculation shall be necessarily reviewed / approved by Owner / Consultant.

The maximum normal running load and the peak load shall be calculated as follows:

Maximum Normal Running Load and Peak Load = (100% of sum of all continuous load) + (40% of sum of all intermittent loads or largest intermittent load, whichever is higher) + (10% of sum of all standby loads or largest standby load, whichever is higher).

All the electrical equipments shall be designed / sized considering motor input power (i.e. BKW divided by motor efficiency).

Line loss of 2% to be considered for equipment sizing.

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Electrical equipment shall be suitable for starting of the largest motor, while other loads are running, considering peak load condition.

- k) PMCC shall have capacity for future requirements. PMCC shall be rated for 125% of peak load.

2.2 Statutory requirement Codes and Standards



The design and the installation shall be in accordance with established codes, good engineering practices and shall conform to the statutory regulations applicable in the country. LSTK contractor shall be responsible for obtaining necessary approvals from the statutory authorities e.g. Electrical Inspectorate, PESO (earlier CCoE) as applicable before commissioning of electrical facilities. The CEA clearance for electrical equipment and components thereof shall be obtained by the contractor.

2.2.1 Latest version of main codes, standards and statutory regulations shall be considered as minimum requirements are as given below:

- Indian Standard Specification
- Indian Electricity Act
- Indian Electricity Rules
- International Electro-Technical Commission
- The Factory Act
- API Standards/IEEE

2.2.2 Some of the bare minimum relevant Indian Standards are as listed below. However, system/equipment design shall be in line with latest edition of all applicable standards.

- IS: 722 AC electricity meters
- IS: 732 Code of practice for electrical wiring installations system voltages not exceeding 650V
- IS: 1248 Direct acting analogue electrical measuring instruments and their accessories: Part. 1 General requirements
- IS: 1646 Code of practice for fire safety of buildings and electrical installations
- IS: 1913 General and safety requirements for Luminaires (Tubular fluorescent Lamp)
- IS: 2148 Electrical apparatus for explosive gas atmospheres - Flameproof enclosures "d"
- IS: 2409 Code of practice for the protection of buildings and allied structures against lightning
- IS: 2705 Current Transformers
- IS: 3034 Code of practice for fire safety of industrial buildings, electrical generating & distributing stations

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- IS: 3043 Code of practice for earthing
- IS: 3156 Voltage Transformers
- IS: 3646 Interior illumination: Part I & Part II
- IS: 3716 Application guide for insulation co-ordination
- IS: 4691 Degree of protection provided by enclosure for rotating electrical machinery
- IS: 5571 Guide for selection of electrical equipment for hazardous areas
- IS: 5572 Hazardous areas other than mines for electrical insulations area having flammable gases and vapours
- IS: 5578 Guide for marking of insulated conductors
- IS: 6362 Designation of methods of cooling of rotating electrical machines
- IS: 6381 Construction and testing of electrical apparatus with type of protection “e”
- IS: 6665 Code of practice for Industrial lighting
- IS: 7689 Guide for control of undesirable static electricity
- IS: 8084 Interconnecting Bus bars for AC voltage above 1 KV upto and including 36 KV
- IS: 9628 Specification for three phase induction motor with type of protection “n”
- IS: 9676 Reference ambient temperature for electrical equipment
- IS: 11353 Guide for uniform system of marking & identification of conductor & apparatus terminals
- IS: 12360 Voltage bands for electrical installations including preferred voltage and frequency
- IS: 12459 Code of practice for fire protection of cable runs
- IS: 13234 Guide for short circuit calculations
- IS: 13346 General requirements for electrical apparatus for explosive gas atmosphere
- IS: 13408 Code of practice for the selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres
- SP: 30 National Electrical Code (NEC) - BIS Publication
- 2.2.3 Any other standard may be followed provided it is equivalent or more stringent than the standards specified above.
- 2.2.4 In case of any conflict/deviation amongst various documents the order of precedence shall as be as follows:
- Statutory Rules/Regulations
 - Design Philosophy
 - Engg. Standard Specifications/Technical Specification/Installation Standards etc.
 - Applicable IS/IEC standards

In case of contradiction / conflict among documents and statutory requirement, LSTK Contractor shall refer to Owner for clarification. However, most stringent specification shall be followed with Owner's approval. Owner decision shall be considered as final.

2.3 Site Conditions

The equipment shall be designed for the following site conditions:-

- | | |
|----------------------------------|--|
| A. Maximum ambient temperature | 46°C |
| B. Minimum ambient temperature | 2°C |
| C. Design Reference Temperature | 50°C |
| D. Relative Humidity | 100% |
| E. Altitude above mean sea level | < 1000 M |
| F. Atmospheric pollution | Dusty and corrosive due to presence of vapours of Ammonia and Urea Dust. |
| G. Seismic Zone | Zone-IV, IS: 1893-2002 |
| H. Design Wind Speed | 170 Km/hr |

3.0 AREA CLASSIFICATION

3.1 The hazardous zones within the project area shall be classified according to the requirement of IS/IEC. The bidder shall furnish area classification drawing.

3.2 All electrical equipments installed in the areas classified as hazardous shall be certified for such use by a recognized international certifying authority such as CIMFR (earlier CMRI), Dhanbad/PESO (earlier CCoE), Nagpur etc.

For those items where overseas OEM vendor will supply the electrical equipment certificate from international authority can be accepted but the certification shall be approved by PESO (earlier CCoE), Nagpur India.

4.0 SYSTEM DETAILS AND UTILIZATION VOLTAGES

4.1 The various voltage levels for power distribution shall be as follows:

In this Design Philosophy LV system voltages have been indicated as 415V, 3 phase and 240V, single phase. However, LSTK contractor shall consider system voltage 400V or 415V as per latest amendment of relevant Indian Standard.

A. Normal Power	2 nos. feeder at 415V \pm 10%, 50Hz \pm 5%, 3 Ph, 4 W, Fault Level 31MVA
B. Emergency Power	1 no. motor feeder at 415V \pm 10%, 50Hz \pm 5%, 3 Ph 1 no. power feeder at 415V \pm 10%, 50Hz \pm 5%, 3 Ph Fault Level 31MVA
C. Distribution Equipment	a) 415V \pm 10%, 50 Hz \pm 5%, 3 Ph, 4 W solidly grounded neutral.

	b) 415V ± 10%, 3 Ph, 4 W/240V ± 10%, 1 Ph, 2W, 50 Hz ± 5% solidly grounded neutral.
Combined variation in voltage & frequency	± 10%
Control Supply for: - 415V motors	AC 240V ± 10%, 50 Hz ± 5%, 1Ph (For contactor controlled motors) DC 110V ± 5% (For breaker controlled motors)
- Switch Gear: a. Closing & tripping b. Auxiliary power	DC 110V ± 5%, 2 W AC 240V ± 10%, 50 Hz ± 5%, 1Ph, 2W
- Instrumentation and Automation, DCS & auxiliaries	AC 115V ± 5%, 50 Hz ± 2% 1Ph, 2W
Voltage Ratings - Motors upto 150 KW - Heaters - Space heaters - Lighting - Panic Lights - Power Sockets/Receptable - Portable safety lamps & Tools	415V, 3 Ph AC To Manufacture's requirement 240V, 1 Ph AC 415V/240V AC 110V DC 415V, 3 Ph AC/240V, 1 Ph AC 24V AC

4.2 Electrical System Studies

4.2.1 Contractor shall carry out following Electrical System Studies of the electrical installation using latest software preferably ETAP latest version and the result of the same shall be furnished. ETAP Native file (editable copy) along with its base file & complete library shall also be submitted for owner's review as well as with final documentation.

Load Flow Studies
Short Circuit Studies
Motor Starting Studies
Relay Co-ordination & Relay Settings

4.2.2 Contractor shall also check the feasibility of existing transformer & 415 V LT Board in MRSS feeding the switchboard in Contractor's scope. Contractor shall ensure that the fault level of existing switchboard shall not go beyond its design fault level (31MVA).

4.3 System Earthing

The neutral of 415V supply system shall be solidly earthed. The DC system shall have positive pole earthed through high impedance. Prospective touch voltage earthing shall comply with the requirements of relevant Indian/IEC Standards.

5.0 POWER SUPPLY DISTRIBUTION

5.1.1 Owner will provide the followings from their existing system:



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- 2 nos. normal power feeder from existing 415V LT Board in MRSS (Feeder No. 23 & 32 of 1600A rating ACB). LSTK contractor to consider new PMCC to feed the new consumers including lighting. For emergency lighting owner will provide one no. emergency power feeder from emergency 415V MCC-1 in MRSS.
- One no. emergency spare motor feeder (18.5 kW) from emergency 415V MCC-1 in MRSS however retrofitting of the switchgear [SFU + Power Contactor + Overload Relay + Control Contactor (if required)] as per KW rating of motor shall be in LSTK contractor's scope and rest normal feeders shall be fed through new PMCC.

Owner will also provide 2 nos. feeders from their existing AC UPS DB and 1 no. feeder from their existing 110V DCDB.

Further distribution including laying of cable, cable termination at both end, owner's feeder modification/retrofitting to meet the system / NIT requirement, relay setting etc. shall be in LSTK contractor's scope.

Contractor may visit the site for better understanding.

- 5.1.2 The electrical system shall be designed for a high degree of reliability and availability.-
- 5.1.3 Power distribution to equipment at 415/240 V, 115 V (UPS) AC, 110 V DC etc. through proper type and size of cables, their supply, erection, testing and commissioning etc. shall be in Contractor's scope. The supply system shall be designed for maximum power requirement of the plant.
- 5.1.4 Emergency power shall cater to the load of emergency lighting, Fire alarm system, PA & Paging system etc. in addition to the process loads as per detail design.
- 5.1.5 Emergency power distribution to all emergency equipments at 415V/240V AC through proper type and size of cables, their supply, erection, testing & commissioning etc. shall also be in contractor's scope.
- 5.1.6 Each incoming feeder shall be sized for 125% load of the switch board. The outgoing feeders shall be sized for the nominal load.
- 5.1.7 The entry of cables in the switchboards shall be from bottom only.
- 5.1.8 All switchboards shall be provided with minimum two incoming feeders and one bus tie having auto/manual changeover facility.
- 5.1.9 It shall be possible to have momentary paralleling of power sources at 415 V PMCC and trip the desired circuit breakers.
- 5.1.10 The normal operation of the Power-cum-Motor Control Centre (PMCC) shall be as under:

- i) Bus coupler shall be provided between all the sources. Incomer and bus coupler breaker rating shall be same for all the switchboards.
- ii) Each incoming feeder shall independently feed the loads on respective buses with full rated bus tie breaker open and the load on each bus balanced. In order to ensure maximum degree of reliability and continuity, automatic transfer from one incoming feeder to other shall be possible through auto/manual closing of bus tie breaker in case of sustained loss of power on any bus section.
- iii) The bus tie breaker shall be provided with auto/manual selection. The bus tie breaker shall be independent in manual mode. In auto selection mode, the bus tie breaker is electrically interlocked with incoming circuit breakers, so that it cannot be closed unless one of the incoming breakers is open.
- iv) When one of the incoming feeder trips, the bus tie breaker is closed automatically based on the philosophy described below and the total load is transferred to other healthy incoming feeder which is capable of carrying the entire load. Sufficient switchgear capacity is to be provided. Time for changeover is suitably selected based on downstream system requirement of reacceleration of motors etc.
- v) Auto Change Over scheme shall be provided for incomer feeders and bus coupler feeder of 415V Switchboards (PMCC). Under normal operating conditions, incomer-1 and incomer-2 breakers shall be closed and bus coupler breaker shall remain open with 'Local-Remote-Off' switch in 'Remote' position. The bus coupler breaker shall close automatically under the following conditions being fulfilled:
 - Either of the incoming breaker trips due to under voltage (70% or below).
 - Voltage on the healthy bus is more than 80% for the set period.
 - Residual voltage on the bus with no power supply comes down to 30% or below.

Required nos. of bus PT, line PT and under voltage relays shall be provided to achieve the desired automatic changeover.
- vi) Auto transfer shall take place only on sustained loss of power on either of bus sections. Auto transfer shall be blocked in case of fault on either of bus sections or no power on both incomers.
- vii) Paralleling of two incoming feeders is not foreseen. However, facility for momentary paralleling shall be provided for intentional changeover without interruption of supply with synchro check relay in Bus Coupler panel. There shall also be provision of selective tripping of one feeder out of three feeders (two incoming feeders and one Bus Coupler).
- viii) Tripping of incomer breakers shall be prevented in case of loss of power of both the incomers.



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- 5.1.11 EPMCC shall have 3 incomers (2 nos. normal power incomers & 1 no. emergency incomer) and 2 bus couplers for feeding critical load of plant whereas PMCC shall have 2 nos. normal power incomers.
- 5.1.12 HVAC for control room shall be fed from emergency switchboard.
- 5.1.13 An Auxiliary Services Power Board (ASPB) having essential and non-essential bus shall be provided in the plant for supplying power to welding switch sockets, lighting load, EOT crane and other auxiliary loads.
- 5.1.14 Separate MCCs shall be provided for air conditioning and ventilation system.
- 5.2 Instrumentation Power**
- 5.2.1 Owner will also provide 2 nos. feeders from their existing AC UPS DB. The power supply for instrument shall be made available at 115V, 1Ph.
- 5.2.2 New 115V AC UPS DB (by the bidder) shall be located in the control room.
- 5.2.3 Provision for 240V, 1 Ph power for lighting of instrument panels shall be provided from LSDB.
- 5.3 Lighting Distribution**
- 5.3.1 In each substation a Main Lighting Distribution Board (MLDB) shall be provided. The MLDB shall consist of two bus sections, namely Normal and Emergency. The normal lighting bus shall receive power from non-essential bus of ASPB and emergency lighting bus from essential bus of ASPB through 415/433 V lighting transformers of suitable rating. However, in the areas where ASPB is not envisaged, the Lighting Distribution Boards shall receive power from PCC/MCC through 415/433 V lighting transformers of suitable rating. One-third lighting load shall be connected to the emergency power to provide certain light during failure of normal power.
- 5.3.2 Both normal and emergency section of MLDB shall have separate sections of bus bars for indoor and outdoor lighting. Outdoor bus sections shall be connected by means of suitably rated contactor operated through photo-cells/clock timer.
- 5.3.3 Manual by-pass circuit for outdoor lighting shall be wired up to a switch located in electrical control room/shift office, so that outdoor lighting can be switched ON or OFF manually to override the automatic switching.
- 5.3.4 All outdoor lighting fixtures including outside lighting of Sub-Stations, Control Rooms etc., shall receive power from outdoor lighting bus.
- 5.3.5 Main Lighting Board shall feed Lighting Sub Distribution Board having 63A TPN MCB as incomer and 16 Amp as SPN MCB and RCCB as outgoing. 6, 9, 12 or 18 way Lighting Sub Distribution Board shall be used.

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5.3.6 Both the lighting transformers feeding MLDB and their respective circuit breakers shall have same rating. Both the lighting transformers shall be designed for 100% load of MLDB.

5.4 **DC Power**

5.4.1 110 V DC system shall be provided for control of circuit breaker feeders and panic lighting.

5.4.2 Owner will 1 no. feeder from their existing 110V DCDB. New 110V DCDB (by the bidder) shall be located in the existing substation.

6.0 **SUB-STATION**

6.1 The Sub-Stations shall be located near the load centres but away from hazardous areas as per IS/IEC. The substations shall also be provided with toilet with wash room facility. Tentative sizes of the substations marked on plot plan indicate minimum dimensions required. However, actual size of substations shall be based on the final dimensions of substation equipment. If more space is required during detail engineering the contractor may increase the size as per the actual requirement.

6.2 The sub-station building shall have single storey construction. The switch room shall have Kota stone flooring. False ceiling and air conditioning shall be provided in VFD room, staff room & Engineers room. Cable entry to the substation shall be through cable trench.

6.3 Substation shall have rolling shutter of adequate size at one side for equipment shifting.

6.4 The layout of equipment shall be such that it shall have adequate space for installation, operation, maintenance and future expansion.

The clearance of equipment from the walls/other equipment shall be adequate to ensure safety of working personnel. Generally the following norms shall be maintained:

i. PMCC:

- a) A clear space of 1.25M behind the deepest panel.
- b) A clear space of 3M between the two boards facing each other.
- c) A clear space of 2.5M on either side at entrance / exit.
- d) A clear space of 1.5M between two boards in same line.

ii. Distribution Boards:

- a) A clear space of 1.5M behind the double front switchboards and 1M for single front.
 - b) A clear space of 2.5M between the two boards facing each other.
 - c) A clear space of 2.5M on either side at entrance/exit.
 - d) A clear space of 1.5M between two boards in same line.
- 6.5 The substation shall be provided with AC (Air Conditioning Ventilation System) and temperature of substation shall be maintained 25 ± 2 deg C.
- 6.6 All doors and windows shall have anodised aluminium frame and provided with toughened glass.
- 6.7 Staircases and other rooms shall be paved with Kota stone.
- 6.8 Continuous fixed type glass ventilators on all sides shall be provided near the ceiling height for natural lighting.
- 6.9 Arrangement shall be provided for lifting heavy equipment to be brought into the sub-station.
- 6.10 Sufficient nos. of entrances (min. 2) shall be provided.
- 6.11 The sub-station shall house all the electrical power, control and monitoring equipment except those required for operation in the field. The equipment shall broadly include the following:-
- Power cum Motor Control Centres
 - Auxiliary Service Panel Boards
 - Lighting Transformer (Indoor / Outdoor as per requirement)
 - Lighting Distribution Boards
 - DC Distribution Boards
 - Input / Output Panels
 - VFD System
 - Any other equipment required
- 6.12 All static devices such as Variable Speed Drive Panels etc., shall be housed in air conditioned room. Heat load for panel to be taken by panel manufacturer.
- 6.13 In substation, space for future extension of switchboard shall be provided. One panel extension space on each side (for each bus section) or two panel extension space on



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one side (in exceptional cases) shall be provided for PMCC and ASPB. In addition, space for future extension of the substation building shall be considered.

- 6.14 Fire protection for switchgear room shall be provided to comply with requirements of Indian Standard.

Substations shall be provided with smoke detectors and fire alarm system as specified elsewhere in the ITB and as per relevant Indian Standard.

- 6.15 Fire barriers shall be provided at cable entry/exit point. Cables shall have fire protection paint for 1 m length at building entry points for above ground cables.

7.0 PROTECTION & METERING

- 7.1 Selection and co-ordination of protection and metering system shall be such as to ensure:

- Selective, sensitive and reliable protection of equipment against damage due to internal or external faults or atmospheric discharge.
- Isolation of fault in the shortest possible time.
- Simplicity of the scheme with maximum protection.
- Uninterrupted operation of healthy system.
- Personnel & plant safety.

- 7.2 Protective relays shall be of latest version, microprocessor based numerical type with communication port. 100% redundancy shall be provided for communication. Numerical Relay shall have communication on IEC-61850 protocol in redundant mode and meters shall have communication on MODBUS protocol.

- 7.3 Numerical relay shall have future provision for connecting with substation HMI. Separate multifunction meter with communication shall be used and shall not be part of protective device.

- 7.4 Relays shall support features like remote relay parameterization, disturbance recorder etc. It shall be possible to set/operate the relay from the front facia. Lock out relay shall be conventional type with hand reset facility.

- 7.5 Special protection if required for any feeder such as differential, restricted earth fault, directional distance power relays etc. shall also be through numerical relay having serial port for monitoring.

- 7.6 Trip circuit supervision relay shall be VAX-31 and Lock out relay shall be VAJHM.

- 7.7 In general, fast acting relays (with time delays if required) shall be used and all fault tripping shall be done through high speed tripping relays.

7.8 Bare minimum protection for power distribution system shall be as indicated below. However, LSTK contractor shall provide any other necessary protection required for complete protection of system:

Type of Protection	Outgoing Feeder	Incomer
	PMCC	PMCC
51 - IDMTL over-current	Yes	Yes
51N - IDMTL earth-fault	Yes	Yes
51G - backup E/F (secondary neutral)	No	No
Motor protection with locked rotor feature 50, 50N, 46, 49, 50L/R etc.	Yes (5)	No
64R - instantaneous restricted earth-fault (secondary side)	No	Yes (17)
50 - instantaneous over-current	No	No
50N - instantaneous earth-fault	No	No
87 - differential protection	No	No
86 - tripping	Yes (10)	Yes
95 - trip circuit supervision	Yes	Yes
63 - Auxiliary Relay including pressure release device (Transformer)	No	No
27, 2- under-voltage with timer	-	Yes (3)
25 - check synchronisation relay	-	Yes (6)

Notes :-

1. –
2. –
3. For switchgears where auto transfer feature is provided.
4. –
5. For motor feeders rated 75 KW and above.
6. For switchgears having bus transfer scheme. Where continuous or momentary paralleling is envisaged. Check synchronising relay shall be integrated with overall paralleling scheme.
7. The bus tie feeder in switchboards shall be provided with 51, 51N, 86 and 95 relays.



8. --
9. One no. DC supply supervision relay (80) shall be provided for each incoming DC supply to the switchboard with audio/visual annunciation.
10. Two sets of 86 relays shall be considered for each motor feeder. One for electrical tripping and other for process tripping. 86 relay for process trip shall be of self reset type with flag.
11. Pilot wire protection (85) shall be provided for inter substation incomer cables.
12. PT fuse failure relays in LT panels and busbar differential supervision relay (VTX31) shall be provided.
13. Value of stabilising resistor for differential relay (CAG 14) to be selected suitably based on fault level.
14. The breaker contacts for critical logic (upstream/downstream tripping, changeover etc.) shall be provided directly from breaker auxiliary contacts and not from auxiliary contactors.
15. Memory/History of the Numerical relay shall not get erased due to loss of auxiliary supply of the relay. Preferably similar make of relays to be installed in one particular substation.
16. --
17. --

7.9 Metering instruments shall be provided to keep record of power consumption and supervision of all concerned parameters like current, voltage, power (Active, Apparent and Reactive), frequency, power factor, Energy (Active & Reactive) etc. All the instruments shall be flush mounted. All meters shall be digital multifunctional meters with communication port. Additionally analogue type ammeter, voltmeter and Hour Meter shall be provided separately for various feeders as indicated below:

Feeder Type	A	V	Hour Run	Digital Multifunctional Meter	Tri Vector Meter (TVM)
PMCC Incomer	✓	✓	-	✓	✓
PMCC Bus Tie	✓	-	-	✓	-
PMCC Bus P.T.	-	✓	-	-	-
ACB Outgoing	✓	✓	-	✓	-
LT Motor (ACB Controlled)	✓	-	✓	✓	-
MCC/ASB Incomer	✓	✓	-	✓	-
MCCB/SFU Outgoing (≥ 250 A)	✓	-	-	-	-
LDB Incomer	✓	✓	-	✓	-

8.0 CONTROL AND MONITORING

The following provision shall be made for control and monitoring of following electrical equipments.

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8.1 Motors Controlled Through Circuit Breakers

- Ammeter in LCS and in switchgear.
- Current monitoring at DCS, where required from process point of view.
- Indication Lamps in switchgear for 'ON', 'OFF', 'Auto-trip' and 'Trip Circuit Healthy'.
- Emergency trip in switchgear.
- Winding and bearing temperatures of motors shall be available at DCS in control room.
- Process interlock in CCR, where required.
- Motor Space Heater Ammeter
- TNC switch, L/R switch, Indication lamp for ON, OFF, Trip, Space Heater ON, Motor Ready to Start shall be provided on LCS.

8.2 Medium Voltage Motors Controlled Through Contactors

- Ammeter in LCS for motors of 5.5 KW and above or as required from process point of view.
- Current monitoring in DCS, where required from process point of view.
- Emergency Trip in PCC/MCC.
- Process interlock in CCR, where required.
- Indication lamp for 'ON', 'OFF' and 'Fault' in switchgear.
- Indication lamp for 'ON', 'OFF' in remote (DCS/PLC etc.)
- Start PB, Stop PB, L/R switch, Indication lamp for ON, OFF, Space Heater ON (motor rated 30KW & above), Motor Ready to Start (for all critical motors) shall be provided on LCS.

9.0 EQUIPMENT SPECIFICATION



9.1 General Constructional Features

- 9.1.1 The equipment shall be suitable for tropical climate conditions and corrosive and saline atmosphere.
- 9.1.2 The equipment to be installed in indoor plant area shall be enclosed in dust, damp and vermin proof enclosure equivalent to IP 54 as per relevant Indian Standards/IEC.
- 9.1.3 The equipment to be installed in outdoor plant area shall have IP 55 enclosure.
- 9.1.4 All external hardwares shall be of stainless steel.

- 9.1.5 All electrical equipment installed outdoor shall be provided with rain protection hood / canopy (2 mm thick aluminium sheet bent to shape). PA stations shall have acoustic hood.
- 9.1.6 The LV switchboards, to be installed inside the substation building shall have degree of protection IP 52 up to 1600A rating and IP-4X above 1600A rating. Equipment located in air conditioning room may have IP 43 enclosure however, opening for the ventilation shall be covered with fine wire mesh.
- 9.1.7 Creepage distance shall be 31mm/kV (for highest system voltage) for all equipment.
- 9.1.8 The equipments to be located in hazardous areas shall be suitable for hazard involved and shall have the following additional explosion protection:

<u>Equipment</u>	<u>Zone-1</u>	<u>Zone-2</u>
i) Motors	Exd	HV motor - Exd LV motors - Exe
ii) Starter panels	Exd	Exd
iii) Control panels	Exd/Exp	Exd
iv) Local Control Stations	Exd	Exd
v) Lighting fixtures, hand lamps	Exd	Exe/Exd
vi) Switch sockets	Exd	Exd
vii) Switches/Isolators	Exd	Exd
viii) Junction Boxes	Exd	Exd
ix) Exhaust Fan	Exd	Exd
x) Other equipments producing sparks under normal operation	Exd/Exp	Exd
xi) Other equipments not producing sparks	Exd/Exp	Exn/Exe



- 9.1.9 Motors for hazardous area application, when fed from VFD shall have enclosure protection flameproof Ex'd' irrespective of area classification.
- 9.1.10 All electrical equipment installed inside a compressor shed where hydrogen is being processed/handled shall be flameproof type suitable for gas group-IIC irrespective of gas group (IIA/IIB/IIC) and area being classified as Zone-1 or Zone-2.
- 9.1.11 All the electrical equipment shall be provided with stainless steel heavy duty double compression industrial type cable glands and crimping lugs for the cable terminations.
- 9.1.12 The outside surface of all equipment shall be painted after suitable pre-treatment by the application of two coats of anti-rust and corrosion resisting epoxy based paints.

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9.2 Switchboards

9.2.1 General

- 9.2.1.1 Design and manufacturing of LT Switchboard by channel partner, franchise or sub-vendor of the OEM shall not be acceptable in any case.
- 9.2.1.2 There shall be three positions for Breaker/Contactor trolley: - Service, Test and Isolate. In service position, the power connections shall be made; but in test and isolate mode, the power connection of bus bars shall be automatically removed.
- 9.2.1.3 ACB feeder for PCC, PMCC & MCC shall be single front for ease of operation & maintenance. Non-ACB feeders for motors or power may be double front type.
- 9.2.1.4 LV circuit breaker shall be 4 Pole type except for outgoing motor feeders which shall be 3 Pole type.
- 9.2.1.5 Suitable shutter arrangement shall be provided to protect the person from accidental contact with live bus in trolley chamber.
- 9.2.1.6 Degree of protection for LV switchboards shall be IP-52 for rating up to 1600A and IP-4X above 1600A.
- 9.2.1.7 All Switchboards shall be LOTO compliance.
- 9.2.1.8 All switchboards shall be suitable for closed door operation.
- 9.2.1.9 LV switchboard shall conform to IEC 60947. LV switchboard shall be TOTAL TYPE TESTED (TTA) design as per IEC 61439-1/2. Type Test Certificates for short circuit withstand of 50kA for 1 sec. along with ACB mounted in the switchboards shall be provided.
- 9.2.1.10 LV switchboards shall comply with Internal Arc Containment test as per IEC 61641.
- 9.2.1.11 Bus bars shall be made of high conductivity aluminium alloy of rectangular cross-section and shall be provided with heat shrinkable Raychem sleeves.
- 9.2.1.12 FRP supports shall be used for bus bars with adequate clearances and creepage distance to prevent flash over due to effect of dust moisture.
- 9.2.1.13 Protective relays shall be mounted on the front of the switchgear panel.
- 9.2.1.14 Protective relays for incoming feeders, bus ties, outgoing feeders and motor feeders shall be microprocessor based numerical type with communication facility. Drawout type relays shall be used.

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- 9.2.1.15 All meters shall be digital multifunctional meters with communication port. Additionally analogue type ammeter, voltmeter and hour meter shall be provided separately for various feeders as indicated under clause No. 7.9 above.
- 9.2.1.16 A continuous ground bus shall be provided at the bottom of the switchgear and in cable connection side for grounding the switchgear, breaker trolley as well as to ground the cable glands.
- 9.2.1.17 The minimum thickness of sheet steel used in LV switchgear including ASPB etc. shall be as under:-
- a) Base Channel minimum 3.0 mm
 - b) Load Bearing Members minimum 2.0 mm
 - c) Doors and covers minimum 1.6 mm
- 9.2.1.18 Switchboards shall have adequate short-circuit ratings and be suitably sized for the load and spare capacity foreseen. The short time rating of busbar shall be 1 second for LV Switchboards & Distribution Boards.
- 9.2.1.19 LV switchboards shall have sufficient no. of spare outgoing feeders to the extent of min. 20% for each type & rating rounded off to next higher digit.
- 9.2.1.20 The switchboards shall have PVC insulated busbar system suitable for rated voltage. At joints of these busbars removable shrouds shall be provided.
- 9.2.1.21 All switch boards shall generally have two sections operating independently with two 100% rated incoming feeders and with bus coupler open having facility for changeover in the event of failure of either of the incoming circuit breakers.
- 9.2.1.22 No common alarm circuit (except hooter/bell) in bus coupler feeders as each feeder will have its own microprocessor based annunciator.
- 9.2.1.23 Auto changeover scheme shall be provided for incomers and bus couplers on PMCC. Under normal operating conditions, incomer-1 and incomer-2 breakers would be closed and bus coupler breaker would remain open with 'auto-manual' switch in 'auto' position. The bus coupler switch would close automatically under the following condition being fulfilled:-
- i. Either of the incoming breaker trips due to under voltage (70% or below).
 - ii. Voltage on the healthy bus is more than 80% for the set period.
 - iii. Residual voltage on the bus with no power supply comes down to 30%.
 - iv. Auto change over shall be locked on loss of power on both the incomers.
- 9.2.1.24 Auto changeover shall also be provided on switchboards catering to emergency loads.
- 9.2.1.25 Paralleling of two incoming feeders is not foreseen. However, facility for momentary paralleling shall be provided for intentional changeover without interruption of supply.

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- 9.2.1.26 Every enclosure door that provides access to live parts operating at 240 V AC and above shall be mechanically interlocked with a circuit interrupting device on the supply side such that when the door is open, the equipment is de-energised.
- 9.2.1.27 Control supply for motor feeders having switch-fuse units in PMCC/MCC and VFD panels etc., shall be taken from panel itself and motor controlled with breaker shall have 110 V DC control supply.
- 9.2.1.28 For motors with auto-starting provision, trip of a running motor will start standby motor automatically.
- 9.2.1.29 For all other specifications, refer TS-8060, TS-8080 and TS-8083. Schematic diagram {PDS-1201 (Sh. 1 to 16)} shall also be referred as general guideline for designing the control schemes for various types of feeders.

9.2.2 Low Voltage Switchgears

- 9.2.2.1 415V switchboards shall include the following:
- Power-cum-Motor Control Centres (PMCCs)
 - Main Lighting Distribution Boards (MLDBs)
 - Auxiliary Services Power Boards (ASPBs)
 - Emergency Power Distribution Boards
- 9.2.2.2 Low voltage switchboards shall be metal clad, arranged with self supporting units and assembled together in a row.
- 9.2.2.3 The switchboards shall be suitable for extension at both the ends.
- 9.2.2.4 The main bus bars of LV switchboards shall have heat shrinkable insulated sleeves and shall be made of high conductivity aluminium alloy.
- 9.2.2.5 Bus bars shall be of uniform cross section and supported on non-hydroscopic FRP insulators with adequate clearances and creepage distance to prevent flash over due to effect of dust/moisture.
- 9.2.2.6 Sufficient bus supports shall be given to give adequate mechanical strength during short circuits.
- 9.2.2.7 A continuous ground bus shall be provided at the bottom in the PCC/MCC for grounding the PCC/MCC.
- 9.2.2.8 Rated short circuit breaking capacity shall be minimum 50 KA for 1 sec.
- 9.2.2.9 All feeders of PCC and incoming and bus coupler feeders of PMCC shall be provided with draw out type air circuit breakers.

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- 9.2.2.10 Motor rated below 75 KW rating shall be contactor controlled and 75 KW and above shall be ACB controlled with combined motor protection relay. All other feeders of 415 V switchboards shall be provided with switch-fuse units. All outgoing feeders shall be drawout type in all the switchboards.
- 9.2.2.11 Switchboards shall be provided with thermostatically controlled anti-condensation heaters.
- 9.2.2.12 All units in the MCC shall be completely accessible and removable from front. Both power and control connections shall be plug-in/stab-in type.
- 9.2.2.13 Busbar clearances shall conform to relevant Indian Standard/IEC for equipment voltages up to and including 500 V AC.
- 9.2.2.14 The draw out modules shall be standardized and it shall be possible to interchange any module with a module of same size. The components to control the equipment like switch, starter, fuse, auxiliary relay etc. shall be wired as a unit on the individual module. Safety shutter shall be provided to prevent direct access to live parts when the chassis is removed.
- 9.2.2.15 The entire draw out construction should be designed for safe operation during placement or removal of chassis. An earthing arrangement shall be provided which will make contact first before the power contacts are made and break last. Each module shall control one motor in general.
- The door shall be interlocked so that it cannot be opened unless the isolating switch on that module is OFF. However, it shall be provided with a door defect mechanism for intentional opening when on line for testing and inspection purpose.
- 9.2.2.16 Control switches for breaker control shall be provided in each breaker cubicle. Circuit breaker shall be interlocked to prevent withdrawal of a closed breaker or insertion of a closed breaker. Each breaker shall be provided with anti pumping device.
- 9.2.2.17 Provisions shall be made to manually close/trip circuit breakers on loss of control voltage.
- 9.2.2.18 All low voltage switchboards shall be provided with 20% spare outgoing feeders rounded off to next higher digit of each type & rating (fully wired) and with all the components.
- 9.2.2.19 All ACB feeders shall be provided with ON, OFF, Trip, Trip Circuit Healthy indications.

9.2.3 **Auxiliary Supply Power Board**

The ASPB shall generally be double front, non-drawout type having essential and non-essential bus. Non-essential bus shall be disconnected in case of failure of

normal supply through a contactor. ASPB in single front execution also may be adopted.

9.2.4 **Distribution Boards**

The Distribution Boards shall be single/double front, non-drawout type and shall feed the auxiliary supplies as per requirement.

9.3 **Direct Current Distribution Boards**

9.3.1 The Direct Current Distribution Boards (DCDBs) shall be single front, non-drawout type for supply of 110 V DC control power to switchgears and panic lighting.

9.4 **Motors**

9.4.1 The rating of LV shall be selected from the sizes as recommended in relevant Indian Standard/IEC.

9.4.2 The margin between the installed power and absorbed power shall be as recommended by the driven machine supplier but shall not be less than the following:-

<u>Motor Rating</u>	<u>Margin above Driven M/C Absorbed Power</u>
Less than 22 KW	25%
22 KW to 55 KW	15%
75 KW and above	10%

9.4.3 Voltage rating for the motors of different ratings shall be as below:

Up to 150 KW : 415 V, 3-phase, 50 Hz AC

9.4.4 The motors shall have maximum rated duty as per relevant Indian Standard/IEC. Consideration shall be given for special duty motors wherever required e.g. cranes etc.

9.4.5 All LV motors shall be TEFC type as per relevant Indian Standards/IEC. All motors shall be Class-F insulated with temperature rise limited to that of Class-B.

9.4.6 Normally the motors shall be suitable for DOL starting. However, motors started through VFD shall be suitable to run at 30% to 100% of rated speed and compatible with the VFD.

9.4.7 All motors 30 KW and above shall have space heater provision.

9.4.8 All LV motors shall be energy efficient type having efficiency class of 'IE2' as per IS 12615: 2011 and high power factor type.

9.4.9 The starting current i.e. breakaway current of 415 V Motors shall not exceed the values indicated in IS: 12615. Also there shall be no further positive tolerance on the values of breakaway current.



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- 9.4.10 Type test certificate of similar motor for use in specified hazardous area (if applicable) shall be furnished.
- 9.4.11 The duty cycle of the motor shall meet the process and driven machine requirement.
- 9.4.12 The mechanical parameters such as duty, mounting type, shaft extension, direction of rotation, starting torque requirements etc. shall be adequate for the application. Sleeve or anti friction type bearings shall be used. Vertical motors shall have thrust bearings suitable for the load imposed by the driven machinery. Motors with sleeve bearings may require proximity probes to measure shaft vibration adjacent and relative to the bearings. Generally, all motors, except for application such as crane, hoist, turbine/engine starting, shall be designed for continuous duty with rated load.
- 9.4.13 Motor rated above 30 KW shall have on line greasing provision and for motor rated above 45 KW, grease outlet feature shall be provided.
- 9.4.14 For all other specifications of EOT crane, refer TS-8208.
- 9.4.15 For all other specifications, refer TS-8102.
- 9.5 Variable Speed Drives (VSD/VFD)**
- 9.5.1 Microprocessor based variable speed drive shall be communicable type and shall be able to communicate with ECS/DCS. It shall be possible set speed from process DCS for optimum performance through 4-20 mA signal. Speed/current/status feedback to DCS may be provided. Drive will run at preset speed in the event of loss of signal from DCS.
- 9.5.2 System shall be highly reliable, efficient and shall provide high power factor, low harmonic distortion, low noise level etc.
- 9.5.3 System shall be provided with complete by pass circuit to ensure the power supply reliability in case of VSD/VFD failure.
- 9.5.4 The system shall be suitable for load characteristics, continuous speed control and shall be with soft start feature. Drive shall be able to accelerate the load over the full speed range (0–100 %) with incoming line voltage regulation of 10%.
- 9.5.5 The system shall be designed for 150% over current withstand for 1 minute. The system shall be equipped with an automatic restart facility which will restart the system in case of voltage dip over 20% or power interruptions less than 4 seconds and recovery of voltage to 95% with a facility to block the automatic restart.
- 9.5.6 The system shall be suitably designed with due care for long length of cables, output filters, chokes, motor insulation, cable voltage grades etc.



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- 9.5.7 The VSD panel shall be located in the clean air conditioned room in the sub-station. Required local control equipment shall have start, stop speed raise and lower push buttons, ammeter, speed indicator, ON/OFF/READY status selector switches as required and shall be installed near the motor.
- 9.5.8 The VFD shall be provided with Input and Output Choke.
- 9.5.9 "Auto Restart" facility for drive system within preset time, typically 0-15 seconds, in case of supply system dip or complete loss of power shall be provided.
- 9.5.10 Preferably screened type cables or cables as recommended by VSD/VFD vendors shall be used for VSD/VFD systems.
- 9.5.11 The VSD/VFD panels to be supplied shall be of proven model.
- 9.5.12 Training of VSD/VFD shall be provided to owner personnel
- 9.5.13 For all other specifications, refer TS-8302.
- 9.6 Local Control Stations**
- 9.6.1 Local Control Stations shall be provided for all motors except motors controlled through Local control panels. LCS enclosure shall be certified for Ex-d with internal components suitable for safe area.
- 9.6.2 Provision for pad locking in OFF position shall be provided.
- 9.6.3 Local control stations for breaker controlled LV motors shall be provided with T-N-C switch, L/R Switch, Indication lamp for ON, OFF, Trip, Space Heater ON, Motor Ready to Start and ammeter. Moreover, space heater ON indication lamp, trip indication lamp shall also be provided at the switchgear panel.
- 9.6.4 Local control stations for contactor controlled LV motors shall be provided with start push button, stop push buttons, L/R switch and ammeters for the motors rating 5.5 KW and above. If required from process point of view, ammeter shall be provided for motors below 5.5 KW also. Space Heater ON indication lamp shall be provided for motor rated 30KW and above. Indication lamp for ON, OFF, Motor Ready to Start (for all critical motors) shall be provided on LCS.
- 9.6.5 Each element for start and stop shall be provided with 1 NO + 1 NC contact. The push button construction shall be such to avoid mal-operation due to vibrations.
- 9.6.6 All local control stations shall have weather proof IP-55 enclosure and be suitable for installation in relevant hazardous area, gas group and temperature class. Canopies of suitable size shall be provided with all local control stations.



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- 9.6.7 Two numbers of LCS shall be provided for the motors, which are installed at elevated platforms. One shall be installed at ground level and the other near the motor.
- 9.6.8 The ammeter shall be flush mounting, moving iron spring controlled type, of accuracy class 1.5 as per IS: 1248, with square face of minimum size 72 mm x 72 mm having scale range 0-240 degree. The ammeter shall be provided with uniform scale up to CT primary current and compressed end scale up to the 6 times the C.T. primary current. Adjustable red pointer shall be provided to indicate the full load current of the motors. Zero adjusters shall be provided for operation from the front of the meter. All ammeters shall be operated through 1 Amp. CTs only.
- 9.6.9 For all other specifications, refer TS-8200.
- 9.7 **Soft Starters**
- 9.7.1 Soft Starter shall be considered for large sized motors to overcome the problems of voltage drop during starting and also over sizing of transformer and generator.
- 9.7.2 The soft starters shall be solid state microprocessor control/Flux Compensated Magnetic Amplifier (FCMA) type with self torque adjustment (during controlled start) feature with bypass contactor. Soft starters shall be communicable type and shall be able to communicate with ECS.
- 9.7.3 Soft starter shall be designed with starting current limited to 350% to 415% (However LSTK contractor shall ensure that this reduced starting voltage is suitable to develop necessary starting torque requirement of the respective motor). The soft starters shall be designed for the optimum voltage drop during starting such that the drive motor and the load get the required accelerating torque.
- 9.7.4 Soft starter shall be as per standards IEC 34/BS 4999/IS 325/BS 5000.
- 9.7.5 The LSTK contractor shall super impose the motor torque vs speed curve at reduced voltage (to motor terminals at starting) on torque vs speed characteristics of the driven equipment to confirm correct operation i.e. acceleration to rated speed. The LSTK contractor shall also calculate acceleration time at reduced voltage (based on these torque vs speed curves) required for accelerating the drive, to full rated speed. This acceleration time shall be sufficiently less than the hot withstand time of the motor.
- 9.7.6 For all other specifications, refer TS-8301.
- 9.8 **Switch Sockets**
- 9.8.1 Sufficient number of inter-locked type 125A/63A, 415V, 3 Ph and 16A, 240V, 1 Ph switch sockets shall be provided in various plant locations as per hazardous area classification to facilitate the maintenance work. Supply to switch-sockets shall be taken from ASPB through suitably rated RCCB.

9.8.2 3 Phase switch sockets shall be provided at 50 M interval and 1 Phase at 25 M interval. Maximum 2 Nos. 125A switch sockets, 3 Nos. 63A switch sockets and 4 Nos. 16A switch sockets shall be connected in one circuit through suitably rated RCCB.

9.8.3 For all other specifications, refer TS-8120.

10.0 CABLING

10.1.1 All LV power and control cables for LV switchgear shall be supplied and laid by the contractor. Terminations at switchgear end and at the equipment end shall be in contractor's scope. Supporting and laying of these cables shall also be in contractor's scope.

10.1.2 Cables shall be sized considering the following factors.

- Maximum continuous load current
- Voltage drop
- System voltage
- Laying conditions
- Derating due to ambient air temperature, ground temperature, grouping and proximity of cables with each other, thermal resistivity of soil etc. shall be taken into account

10.1.3 All LV power cables shall be with stranded aluminium/copper conductor with XLPE insulation, PVC inner sheathed, armoured, PVC outer sheathed FRLS type and construction as per IS: 7098 (Part 1). Power cables with conductor size upto and including 6 sq. mm shall be with copper conductor, conductor size above 6 sq. mm shall be aluminium conductor. LV cables shall be 1.1kV grade and suitable for earthed & unearthed system.

10.1.4 All control cables shall be with 2.5 sq. mm, stranded copper conductor with XLPE insulation, PVC inner sheathed, armoured, PVC outer sheathed FRLS type and construction as per IS: 7098 (Part 1). Control cables shall be twisted pair or shielded wherever electro-magnetic/electrostatic interference is anticipated. Control cables shall be 1.1kV grade and suitable for earthed & unearthed system.

10.1.5 All control cables shall have 20% spare cores. All cores shall be identified with numerical core numbers printed on core instead of colours.

10.1.6 All cables shall be armoured and shall have extruded inner and outer sheath.

10.1.7 Cables connected in parallel shall be of the same type, cross section and terminations.

10.1.8 All power and control cables shall be in continuous lengths (except for very long feeders) without any joints. The cables used for lighting and wires in conduits shall have appropriate junction boxes with adequately sized terminals. Cable joints in hazardous areas shall not be permitted.

10.1.9 The maximum voltage drops in various sections of the electrical system shall be within limits stated in the following table:

Sr. No.	System Element	Maximum Permissible Voltage Drop
1.	Cables between PMCC and MCC or auxiliary switchboard i) Location of switchboard: Near PMCC ii) Location of switchboard: Remote	0.5% 2.5% (Max.)
2.	Maximum Voltage drop up to LV motor terminal: During running condition During starting condition	5% 10%
3.	Cables between auxiliary switchboard and lighting panel	Max. 1.5%
4.	Circuit between lighting panels and lighting points	4%
5.	DC supply circuits/UPS circuits	5% and/or as per instrumentation requirement

The voltage available at the motor terminals during start-up must be sufficient to ensure positive starting or re-acceleration of the motor (even with the motor fully loaded, if required) without causing any damage to the motor.

For LV motors, the voltage available at the motor terminals must not be less than 80% of the rated value during start-up or re-acceleration.

10.1.10 For FO cables (Electrical application) refer Design Philosophy-Instrumentation attached with the NIT.

10.1.11 Design Criteria for Cables & Short Circuit Withstand Time

a) Design criteria for cables

Sr. No.	Design Criteria	415V
1.	Loads located beyond 1 KM	N.A.
2.	Loads located up to 1000 M	Cable
3.	Recommended limiting size of multi-core cable (mm ²)	4 Core x 300

4.	Insulation voltage grade	1100V Earthed
5.	Type of cable insulation	Power: XLPE Control: XLPE

Suitable derating factors based on the site ambient conditions, method of laying and the no. of cables laid together shall also be applied.

b) Short circuit withstand time (seconds) shall be as follows for Breaker controlled feeders.

Feeders to motors	0.25 sec
Feeders from PMCC to MCC/PMCC	0.5 sec

10.1.12 The minimum size of power cables shall be 2.5 sq. mm (Cu).

10.1.13 The control cables shall be 2.5 sq. mm (Cu). However, wiring in the panel/switch boards may be by means of 1.5 sq. mm (Cu) cables except for CT wiring which shall be 2.5 sq. mm.

10.1.14 For all other specifications, refer TS-8160.

10.2 Cable Laying

10.2.1 The cables shall generally be laid in cable trench (refer attached PDS). Pipe racks where available, shall be used to support the cable racks.

10.2.2 The cable racks shall be ladder type, pre-fabricated from suitable aluminium alloy/hot dip galvanised steel.

10.2.3 LT power & control cable and space heater cable shall be laid in single layer in touching formation.

10.2.4 FO cable (Electrical application) laying shall be as per Design Philosophy-Instrumentation attached with the NIT.

10.2.5 Cable trays shall be designed considering 25% margin for future use.

10.2.6 Cable tray vertical support shall be provided at every 1 meter.

10.2.7 GI Tray cover allowing adequate ventilation shall be provided.

10.2.8 All cables shall be terminated using suitable cable lugs.

10.2.9 For all other specification of cable racks, refer TS-8161 & PDS attached.



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11.0 ILLUMINATION SYSTEM

11.1 General

11.1.1 LED type lighting shall be provided. Average illumination levels and type of fixtures in the various sections of the plants shall be as indicated in Annexure-I. All the plants and area lighting shall be energy efficient.

11.1.2 The specified illumination level shall be maintained after considering maintenance factor 0.6 for plant & outdoor areas & 0.7 for indoor areas and utilisation factor as per manufacture catalogues for size of room & type of fixture.

11.1.3 Separate area wise panic lights, fed from 110 V DCDB, shall be provided at strategic locations for safe evacuation of operation personnel. These shall be switched 'ON' automatically on failure of power supply to main lighting board and shall switch 'OFF' automatically on resumption of mains or after 1 hour of power failure to avoid draining of the battery. Location of these lights shall be judiciously decided from safety considerations. The outdoor lighting shall be photocell/timer controlled.

11.1.4 Plant lighting circuits shall be single phase (Phase & Neutral) rated 240 V AC. Each circuit shall be rated to 16A. A minimum of 25% of MCBs of each board shall be left as spares. The load on one lighting sub-circuit of lighting sub-distribution board and junction box shall be limited to 500W approx.

11.1.5 The lighting sub-distribution board for control of lighting shall be standardized as 18-way, 15-way, 12-way, 9-way and 6-way type.

11.1.6 In plant office rooms, wall mounting boards shall be installed to control the lighting. These boards shall include switches for lights, fans, 15A/5A plug sockets and fan regulators etc.

11.1.7 15A plug sockets shall be fed through separate circuit of lighting sub-distribution boards/junction box.

11.1.8 For more details, refer PDS attached.

11.2 Street Lighting And Security Lighting

11.2.1 63A TPN outlet from outdoor lighting bus of main lighting board shall be taken direct to the TPN junction box to be mounted on pole through cable and looped from pole to pole.

11.2.2 Hot dip GI octagonal poles of suitable mounting height shall be used for street light. However, for plant lighting (platforms / structures / access ways / walk ways / pump house / pump bay etc.), steel tubular poles of suitable mounting height shall be used

11.2.3 The poles shall be subjected to min. following tests:



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- Thickness of galvanising
 - Drop test as per IS: 2713
 - Deflection test as per IS: 2713
- 11.2.4 Hot dip galvanized octagonal high mast lighting shall be used for yard and general area lighting. LED type fittings may be used.
- 11.3 **LED LIGHTING FIXTURES & ACCESSORIES**
- 11.3.1 **General**
- 11.3.1.1 The fixtures shall be complete with all accessories including the lamps, driver, heat sensor and all other accessories. The lighting fixtures shall also conform to the specification sheet for lighting fixture of this specification.
- 11.3.1.2 The fixtures shall be provided with cable glands and a terminal block suitable for termination of copper conductor up to 2.5 sq. mm size.
- 11.3.1.3 The fixture shall be so designed that it shall be possible to maintain or replace different accessories without difficulty, including replacement of lamps.
- 11.3.1.4 Unused holes in control gear box and junction box shall be packed with blanking plugs.
- 11.3.1.5 All lighting fixtures shall be provided with suitable double compression Al cable glands along with termination lugs and blanking plugs for unused entry.
- 11.3.1.6 All hardware used in lighting fitting, JB's shall be of Stainless Steel only.
- 11.3.1.7 LED Luminaries shall be suitable for single phase 240V±10%, 50Hz±5% AC input and ambient condition indicated elsewhere in the NIT.
- 11.3.1.8 Minimum Impact Resistance for outdoor fittings shall be IK-05.
- 11.3.1.9 The fixture shall be so designed that it shall be possible to maintain or replace the different accessories without difficulty, including the replacement of the lamp.
- 11.3.1.10 Flameproof light fittings shall be certified for use in specified hazardous area and the flameproof certificate shall be submitted along-with the offer. Explosion proof certificate from PESO shall be submitted before or along-with supply of such light fittings.
- 11.3.1.11 For High Mast specification refer TS: 8308.



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11.3.2 LED CHIPS

- 11.3.2.1 LED efficacy shall be greater than 140 Lumens/watt at 350mA driver current. In respect of higher power rating LED, driver current greater than 350 mA can be accepted if LED's LM 80 / IS: 16105 test reports are attached.
- 11.3.2.2 LED type can be SMD (surface mounted device) of COB (chip on board) type depending on the application. COB type to be considered only for applications such as Highbays, Flood Lights & Flameproof Light Fittings.
- 11.3.2.3 Test report/LM80 report for ambient temperature of 55/85/105 Deg. C at rated and maximum current shall be submitted.
- 11.3.2.4 TM 21 life projection calculations along with LM80 for ambient temperature of 55/85/105 Deg. C as per applicable standard shall be submitted to substantiate life of LED. Reported Life span of LEDs shall be greater than 50000 Hrs at a soldering temperature of 85 Deg. C at rated driver current.
- 11.3.2.5 Colour temperature of white colour LED shall be from 5700K (5665K+/-355K) to 6500K as per ANSI standard C78.377A.
- 11.3.2.6 Colour rendering Index for colour ranges from R1 to R15 shall be greater than 80.
- 11.3.2.7 LED shall comply to Photo biological safety norms as per IEC 62471/EN62417/IS: 16108 and should fall in the exempt group for indoor luminaires and in exempt of low risk category for outdoor LED luminaires.

11.3.3 LED DRIVER

- 11.3.3.1 Minimum efficiency of LED driver shall be 85% for driver output rating of $\leq 40W$ and 87% for driver power output rating of $> 40W$.
- 11.3.3.2 Power factor of complete fitting shall be greater than 0.90.
- 11.3.3.3 In built high voltage cut-off for voltage above 290 Volt shall be provided.
- 11.3.3.4 Short circuit protection and Open load protection shall be provided.
- 11.3.3.5 Surge protection device shall be provided for minimum of 2 KV in indoor luminaires and minimum of 10 KV for outdoor luminaires. SPD should be series type with fail safe.
- 11.3.3.6 Total Harmonic distortion (THD) shall be less than 10%.
- 11.3.3.7 Isolated LED driver should be used. The input (AC side) and output (LED side) are separated by power transformer for galvanic isolation.
- 11.3.3.8 Power supply of LED PCB should be through proper connectors.

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11.3.3.9 Driver shall comply EMI/EMC standards CISPR 15/ IS 6873 (CE, RE, CDN) and IS 61547.

11.3.3.10 Driver shall comply with safety standards IEC 61347-2-13/EN 61347-2-13/IS: 15885-2-13.

11.3.3.11 Driver shall comply with performance standards IEC: 62384/IS: 16104.

11.3.4 LUMINAIRE

11.3.4.1 Circuit boards and electronic components rating/type should be suitable to provide reliable functioning.

11.3.4.2 Luminaire shall have LM-79/IS: 16106 test report from a NABL accredited laboratory.

11.3.4.3 Minimum system efficacy of luminaire shall be greater than 100 Lumens/watt.

11.3.4.4 Potting of LED luminaire along with driver is mandatory.

11.3.4.5 Average Duty cycle to be 12 hours (Dusk to Dawn).

11.3.4.6 Working temperature to be in the range of – 5 Deg. C to 60 Deg. C.

11.3.4.7 Working humidity to be in the range of 10% to 100 % RH

11.3.4.8 Housing of indoor fixtures to be made of CRCA/PC/Aluminium Extrusion and for outdoor fixtures shall be pressure die cast LM6/ADC12/LM24.

11.3.4.9 Lumen maintenance of fixtures shall be 50,000 Hrs at L70.

11.3.4.10 LED luminaires shall be completely glare free.

11.3.4.11 View Angle should be typical 120 Deg.

11.3.4.12 Cover type of indoor fixtures shall be UV stabilised poly carbonate type and outdoor type fixtures to be Toughened glass or UV stabilised poly carbonate type as applicable.

11.3.4.13 Temperature rise for driver at soldering point should not exceed 85 Deg. C. For Heat shrink temperature rise, maximum of 20 Deg. C over ambient temperature is allowable. Heat shrink to be designed accordingly.

11.3.4.14 Flameproof light fittings shall be certified for use of hazardous area as per area classification and flameproof certificate shall be submitted along with the offer. Explosion proof certificate from PESO shall be submitted before or along with supply of fittings.

11.3.4.15 Luminaire should have BIS approval for surface mounted luminaire as applicable.

11.3.4.16 Housing ingress protection shall be as per table below:

Application Type	Minimum Ingress Protection Required
LED Street Light, Flood Light, Outdoor Industrial	IP66
Industrial Indoor (High Bay, Medium bay)	IP54
Toilet Fixtures	IP44
Domestic & Commercial Indoor type LED	IP20

11.3.4.17 Approve makes for different LED technologies to be as per table below:

LED Technology/type	Approved make
LED Chips SMD (Surface Mounted) type	Nichia, Osram, Lumileds, CREE
LED Chips COB (Chip on Board) type	Citizen, Bridgelux
Domestic/Decorative	Everlight Taiwan, Edison Taiwan, Samsung Korea
Luminaries	Osram, Nichia, Lumileds, CREE

11.3.5 OTHER CONDITIONS

- 11.3.5.1 Type Test Report/Certificate from NABL accredited labs as per relevant standards on selected sample including endurance test as per IS10322 and safety test on drivers as per IS 15885.
- 11.3.5.2 Vendor shall carry out third party inspection from NFL approved TPI agency. TPI to be carried out on 10% material of each item on random basis as per scope of tender.
- 11.3.5.3 Vendor shall guarantee for full replacement of material (free of cost) due to any failure in 24 months from date of commissioning. Failures shall include failure/deterioration of LED's in terms of performance like guaranteed luminous efficiency as per LM80 report, abnormal lumen depreciation, failure of driver unit, etc.

12.0 EARTHING AND LIGHTNING PROTECTION

12.1 Earthing

- 12.1.1 Complete earthing installation shall be done as per IS: 3043.
- 12.1.2 Common underground earthing grid shall be provided covering generating station, sub-stations and plants. The overall earth resistance (dry) shall be limited to 1 ohm.
- 12.1.3 Earthing rings shall be provided around sub-stations and plants which in turn shall be connected to the common earthing grid. Minimum size of main grid shall be 75mmx10mm.
- 12.1.4 Earthing grid/ring shall comprise of buried GI earth strips and GI pipes/electrodes.

- 12.1.5 Separate earth electrodes shall be provided for system neutral earthing. For equipment earthing, minimum two numbers of electrodes shall be provided around each plant/section. However, all these earth electrodes shall be inter-connected.
- 12.1.6 Inter-connecting pits having an earth bus in an enclosed brick chamber without earth electrode shall be provided in the common underground earthing grid for convenience of taking earth conductors inside the plants.
- 12.1.7 As far as possible, the reinforcement rods inside concrete column shall be connected to the earthing grid/ring to reduce the overall earth resistance.
- 12.1.8 Individual electrical equipment shall be earthed by GI strip/GI wire/Cu/Al cable. Earth buses shall be provided in plants for earthing groups of electrical/non-electrical equipment to earthing grid/rings.
- 12.1.9 Size of earthing grid/ring and earth conductors of equipment for generating station and sub-stations shall be as per relevant standards. The fault current magnitude shall be decided based on system fault level. The time duration shall be taken as 1 second.
- 12.1.10 All equipment rated above 250 V shall have two external earth connections and those rated up to 250 V shall have one external earth connection. However, for lighting fixtures, earthing shall be done through 3rd core of the cable in safe as well as in hazardous area.
- 12.1.11 Flameproof equipment, in addition, shall have one internal earth connection. This means that 4 core cables to be used for all the flameproof equipments and 3.5 core cables to be used for all flameproof motors located at hazardous area.
- 12.1.12 All steel structures, tanks, vessels, pipes, pipe joints, valves etc. shall be earthed against static charge accumulation by 50x6 mm GI strip. The no. of earth connections shall be as follows:
- | Equipment having diameter | Hazardous area | Non hazardous area |
|---------------------------|----------------|--------------------|
| 30 M | 2 | 2 |
| More than 30 M | 3 | 2 |
- 12.1.13 Wherever process equipment are mounted on steel structures, the structures shall be earthed instead of earthing the individual equipment.
- 12.1.14 The pipe structures shall be earthed at not more than 25M apart.
- 12.1.15 For all equipment in hazardous area, in addition to external earthing one internal earthing shall be provided.

- 12.1.16 Minimum sizes of earth conductors to be used shall be as given below. However, vendor to calculate the actual size:-



Sl. No.	Equipment	GI conductor size	Al conductor size
1.	LV switch board	50mmX8mm	150 sq. mm
2.	Motors rated 75 KW and above	--	150 sq. mm
3.	Motors rated 30 KW to less than 75 KW	--	95 sq. mm
4.	Motors rated 5.5 KW to less than 30 KW	--	25 sq. mm
5.	Motors less than 5.5 KW	--	6 sq. mm
6.	All minor equipment rated 250V & below	--	6 sq. mm

All GI conductors shall meet the galvanizing requirement as per IS.

- 12.1.17 Cables racks/risers/trays shall be electrically continuous by bonding the joints between the runner members of the adjacent sections. The cable racks shall be connected to the earthing grid at suitable intervals.
- 12.1.18 Spacing between two earth pits shall not be less than 10 m & these may be located about 4m away from the building / structure.
- 12.1.19 As far as possible, the earth conductors shall be taken along power & control cable routes.

12.2 Lightning Protection

- 12.2.1 All structure shall be protected against lightning strokes by suitable lightning protection system to be designed and installed as per IS/IEC-62305.
- 12.2.2 The number of down conductors shall be minimum two.
- 12.2.3 Bare metallic structures shall not have any air termination rods at the top. The earth connections shall be welded to the bottom of structure at 300 mm above floor level. However, tall metallic columns with insulation at top shall be provided with air termination rods. Separate earth electrodes shall be provided for each down conductor of lightning protection. However, these shall be inter-connected with the other electrodes in main grid.
- 12.2.4 In case earth pits for connecting the down conductors are not available in the beginning of fabrication/erection of such structures/vessels/tanks, their bases shall temporarily be connected to nearby steel column. Electrical continuity of the structures, however, shall be checked and ensured.

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12.2.5 For all high rise concrete structures, temporary lightning protection need to be provided during construction and maintained till permanent lightning protection is installed. For this purpose the vertical reinforcement, projecting over each lift, shall be connected to earth pits by means of 2 nos. flexible copper conductor cables each of the flexible cable shall be of 95 sq. mm. size having one end permanently connected to earth pit and other end provided with a clamp for connecting to the exposed reinforcement.

13.0 CATHODIC PROTECTION SYSTEM

13.1 Entire underground pipe work including those laid in concrete trench and filled with sand, the steel structures, tank bottom of above ground storage tanks, underground vessels etc. shall be provided with cathodic protection. The scope shall include, site surveying to collect required information, design, detailed engineering, supply, installation, testing, commissioning, maintenance & monitoring till the site is handed over to the owner and performance guarantee of impressed current cathodic protection system as per relevant Indian/IEC/BS/NACE Standards and codes of practices.

13.2 Following shall be excluded from Cathodic Protection System:

- a) Underground Pipes with SS material,
- b) Above Ground reinforcements bars of reinforced concrete,
- c) Reinforcements bars of reinforced concrete Foundations,
- d) Reinforcement bars in concrete piles.

13.3 SACP shall be provided during the construction period till ICCP starts working.

13.4 For all other specifications, refer TS-8303, TS-8304 & TS-8305.

14.0 COMMUNICATION SYSTEM

14.1 Public Address system suitable to provide reliable and quick source of communication among operating personnel shall be provided. The system shall be microprocessor based with modular construction for ease of expansion of capabilities and capacity. The system shall have speakers, calling points etc. suitable to area of classification for that location. PA system shall be located in respective control room. All required furniture, PC console with chairs for complete PA System shall be in scope of LSTK Contractor.

14.2 New PA System shall be hooked up (seamless integration) with the existing centralised PA System. Details of existing PA System (Make, model etc.) may be collected from the site for seamless integration with the existing system.



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- 14.3 Close talk mode shall be provided for conversation between two or more stations through close talk channel. Speeches from any hand set shall be heard over all the speakers. The system shall have the following facility:-
- Alert tone facility
 - Paging facility
 - Private conversation facility
 - Loud speaker mute facility
 - Emergency tone facility
- 14.4 Paging speakers provided in areas having ambient noise levels shall produce a paging sound level at least 10 dB above the anticipated ambient noise level. Where it is not possible to achieve the sound level of above 10 dB above the ambient, rotating beacons shall be installed such a way that that the operator is alerted in the area. Acoustic hoods shall be provided for call stations located in high noise areas.
- 14.5 The design of the system shall be such as to provide two channel communication i.e. Page & Party in each zone. Page & Party system shall comprise of one channel for paging & one channel for party talk.
- 14.6 The system may be centrally located at a particular plant but the location shall in no way affect the performance of system. If required separate but interconnected system shall be provided. The microphone system shall be capable to suppress the environmental noise which will be present in the plant due to machineries.
- 14.7 It shall be possible to have automatic testing, monitoring, fault diagnosis etc. through interface PC. The system programming shall be user friendly through interface PC.
- 14.8 It shall be possible to communicate between two field stations without the interference of the MCS / operator. Also it shall be possible to have direct communication with the MCS.
- 14.9 The equipment shall be sturdy, impact resistant, dust & damp proof generally conforming to minimum IP 55 degree of protection. For classified hazardous areas flameproof equipment shall be provided duly certified by recognised certifying authority for the area of installation.
- 14.10 A few sets of explosion proof walkie talkie shall be provided for convenience of installation, operation and maintenance of equipment.
- 14.11 Communication system shall be able to work automatically from standby DC source when AC supply is 'OFF'.
- 14.12 Paging system shall be interfaced with EPABX and Fire Alarm System.
- 14.13 PA System shall have 20% spare capacity.

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14.14 For all other specifications refer TS-8037.

15.0 FIRE ALARM SYSTEM

15.1 LSTK contractor shall provide the Fire Detection and Alarm System which shall be an independent system comprising of individual break glass type manual call points, automatic sensors e.g. smoke and heat detectors, main panel, repeater panel, battery, battery charger and any other hardware and same shall be hooked up (seamless integration) with the existing centralised Fire Alarm & Detection System. Details of existing Fire Alarm System (Make, model etc.) may be collected from the site for seamless integration with the existing system.

15.2 An addressable type of Fire Alarm System shall be provided for the plant. The design shall be as per OISD and applicable local requirements.

15.3 The system shall be designed to provide audio-visual indication at the main panel to be located in sub-station and repeater panels shall be provided in fire station.

15.4 The manual call points shall be provided at strategic locations with access of 60 M along all exit routes and roads.

15.5 Hooters & exit lights shall be provided at required locations in the buildings.

15.6 Panel design and component selection shall be done for future extension upto 10% of specified zones or one zone, whichever is maximum in each panel. The design of common facility and hardware shall be provided for required future extension of zones.

15.7 The fire detection system shall be interfaced with fire suppression system, wherever specified.

15.8 Supply, installation, testing and commissioning of above mentioned components/equipment for plant area, substation & control room shall be by the LSTK contractor along with necessary supply and laying of required signals cables.

15.9 The required nos. of MCPs and detectors in substation & control room shall be calculated as per IS norms and contractor shall get approval from owner during detailed engineering stage.

15.10 Any other specifications refer TS-8306 & TS-8307.

16.0 ELECTRIC HEAT TRACING SYSTEM

16.1 Electrical trace heating of pipelines, instruments and equipment for process temperature maintenance shall be considered if required from process point of view.



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- 16.2 Electrical trace heating system shall be designed according to IEC 60079-30 and shall be based on the use of self-regulating cables, suitable for installation in accordance to hazardous area classification.
- 16.3 Mineral insulated cables shall be used only where process temperature maintenance high values would not allow the use of self-regulating cables.
- 16.4 All self-limiting parallel resistance type heater cables shall be covered with a metal braid and a polymer over jacket for mechanical protection and corrosion resistance.
- 16.5 Cable sheaths, conductor and termination materials, and cable support clamps shall withstand the maximum operating temperature, temperature cycling and thermal expansion of the piping or equipment to which is applied.
- 16.6 The design of the heating system shall be such that the heater element temperature does not exceed the temperature classification of the hazardous area.
- 16.7 Heat tracing system shall be fed through a separate control station approachable to operator and suitable ammeter shall be provided to ascertain that heat tracing cables are working.
- 16.8 System shall be designed for tripping in case of leakage to earth or pipe for human safety.

17.0 SPARES

- 17.1 Contractor shall supply mandatory spares for electrical equipments for operation and maintenance as per the list attached with this bid package.
- 17.2 LSTK Contractor shall recommend 2 years Operational Spares for all the equipment (item-wise) with recommended quantity & unit price. The item-wise price shall be with validity of 2 years. The same shall not be part of LSTK price.
- 17.3 All spare parts shall be identical to the parts used in the equipments.
- 17.4 Any other spare parts or special tools not specified, but required, shall also be quoted along with the offer.

18.0 VENDORS' SERVICES

- 18.1 The bidder shall consider the services of major equipment suppliers during installation and commissioning in their scope as required.
- 18.2 The services of engineers of following equipments' manufacturers are envisaged required during installation and commissioning:

Switchgears



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Numerical relay

Variable Speed Drives

Soft Starter

Cathodic Protection System

Public Address System

Fire Alarm System

18.3 Site testing, parameterization and commissioning of the Numerical relays shall be done by OEM expert only.

19.0 TESTING & INSPECTION

19.1 Testing of electrical equipments shall be done in accordance with relevant IEC/BIS codes.

19.2 The bidder shall submit the certificates of type tests performed on identical equipment as evidence of the compliance of the equipment with the type tests.

19.3 The bidder shall submit the certificates of routine and acceptance tests conducted on the purchased equipments.

19.4 All the routine/acceptance tests shall be performed at the manufacturer's works in the presence of owner's representative.

19.5 The owner or their representative shall be allowed to visit the manufacturing works for stage inspection during manufacturing stage.



19.6 The bidder shall intimate the owner 4 weeks in advance of the tests and submit the detailed schedule of tests.

20.0 DOCUMENTATION

20.1 The bidder shall submit the documents for electrical equipments as per the drawing and documentation schedule as given in this bid package.

20.2 A dedicated PC with licensed copy of documentation software shall be included in the scope of bidder for documentation of Electrical Engineering.

20.3 The software shall be used for preparing and updating the various documents such as general arrangement drawings, cable schedules, single line diagrams, control system drawings and equipment specifications etc.

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- 20.4 The documentation software shall be same which is used by the bidder for electrical documentation.
- 20.5 The details of the documentation software shall be furnished in the technical offer.
- 20.6 Native files (editable copy) of all the electrical equipment sizing calculations or any other calculations, Load List etc. shall be submitted for owner's review and as final documentation.
- 20.7 Native file (editable copy) of AutoCAD or any other software used for preparing Engineering drgs. & docs. of all Engineering drgs. & docs. shall be handed over as final documentation.
- 20.8 ETAP Native file (editable copy) along with its base file & complete library or of any other software used for Electrical System Study shall also be submitted for owner's review as well as with final documentation.

21.0 TRAINING



- 21.1 Training shall be imparted to owner's personnel at manufacturer's works as under:
- Variable Speed Drive: Two persons for one week.
 - Soft Starter: Two persons for one week.
 - Numerical relay: Two persons for one week.

22.0 VENDOR LIST

- 22.1 Make of all electrical equipment shall be as per the vendor list attached with this bid package.
- 22.2 Any other vendor shall be subject to PDIL/owner's approval.
- 22.3 Bidder shall indicate the make of all equipment in their offer.

23.0 INSTALLATION, TESTING AND COMMISSIONING

- 23.1 The bidder shall undertake installation of all electrical equipment in accordance with latest code of practices, in conformity with recommendation of the respective equipment manufacturers, drawings approved by the owner or owner's representative, direction of engineer-in-charge, statutory regulations and to the entire satisfaction of the owner.
- 23.2 The bidder shall arrange all the necessary erection tools and tackles, testing and measuring instruments and shall supply the required erection materials including structural steel.

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- 23.3 Bidder shall furnish field inspection and test data sheets for all equipments for owner's approval.
- 23.4 The bidder shall obtain the necessary certificate of compliance/completion certificate with test results from statutory authorities as required. All necessary drawings and test certificates as required by them shall be furnished by the vendor.
- 23.5 At least following tests shall be specifically conducted before commissioning in presence of owner's representative. All the test results shall be recorded and submitted to the owner.
- a) Insulation Test
 - b) Continuity Test
 - c) High Voltage Test
 - d) Simulation Test
 - e) Earth Resistance Test

24.0 COORDINATION WITH OTHER CONTRACTORS

- 24.1 The successful vendor shall coordinate with Owner's other vendors and shall freely exchange all technical information required for this purpose.
- 24.2 All civil works connected with electrical installation shall be under the bidder's scope.



ANNEXURE-I

ILLUMINATION LEVELS & TYPE OF FIXTURES



Average illumination levels and type of fixtures to be used for various areas shall be as follows:

Sl. No.	AREA	LUX	TYPE OF LED FIXTURES
1.0	<u>ROADS</u>		
1.1	Plant roads	15	90W LED street lighting fixtures
1.2	Security roads	6	90W LED street lighting fixtures
2.0	<u>YARD</u>		
2.1	Marshalling yard	12	90/125W LED flood light
2.2	Loading/unloading areas	15	90/125W LED flood light
2.3	Open areas	5	90/125W LED flood light
3.0	<u>PLANT</u>		
3.1	Operating platforms	100	50W LED
3.2	Non-operating platform / general process areas & walk ways	50	50W, 2X18W LED
3.3	Compressor house	150	50/90/125W, 2X18W LED
3.4	Turbine Hall	150	90/125 W LED
3.5	Pump house/Pump bay	150	90/125W LED
3.7	Boiler gallery	50	90W LED
4.0	<u>SUB-STATION</u>		
4.1	Switch room - Front of panel	100	2X18W mirror optics surface mounted LED type
	- Back of panel	100	2X18W mirror optics surface mounted LED type
	- Battery room	70	2X18W corrosion proof industrial LED type
4.2	Transformer room, cable room.	70	2X18W industrial LED type
4.3	Outdoor/transformer bay	70	45/90W street lighting LED fixtures
5.0	<u>CONTROL ROOMS</u>		
5.1	Front of panel	400	2X18W Recessed Mounting Decorative LED
5.2	Back of panel	200	2X18W Recessed Mounting Decorative LED
6.0	OFFICES	300	2X18W Recessed Mounting Decorative LED
7.0	<u>STORES, BATH ROOM</u>	100	2X18W LED
8.0	<u>STAIR CASES</u>		
8.1	Safe areas	100	2X18W LED
8.2	Hazardous areas	100	90W LED
9.0	<u>PANIC LIGHTING</u>	-	18W LED suitable for 110V DC



Wattage of LED fixture is tentative and may be changed to meet LUX requirement and necessary calculations shall be furnished during detailed engineering for review / approval.

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SECTION – 7.0
TECHNICAL SPECIFICATION – ELECTRICAL

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Technical Specification No.	Description	No. of sheets
TS-8037	Public Address System	8
TS-8048	Auxiliary Service Transformer	8
TS-8060	Medium Voltage Switch Boards	19
TS-8080	Sheet Steel Distribution Boards	14
TS-8083	Lighting Sub Distribution Boards	8
TS-8102	Induction Motors	14
TS-8120	Interlocking Sw. Socket and Plug	8
TS-8123	Lighting Fixtures & Accessories	13
TS-8160	Cables	7
TS-8161	Prefabricated Ladder Type Cable Racks	6
TS-8200	Local Control Stations	9
TS-8201	Junction Box	7
TS-8208	Electricals for Over Head Cranes and Hoists	12
TS-8301	Soft Starter	8
TS-8302	Variable Frequency AC Drives	20
TS-8303	Cathodic Protection for Plant Piping and Buried Facilities	23
TS-8304	Cathodic Protection Power Supply Module (CPPSM)	14
TS-8305	Cathodic Protection Transformer Rectifier Unit	14
TS-8306	Fire Detection and Alarm System	21
TS-8307	Communication & Fire Alarm Cables	10
TS-8308	High Mast	10



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TECHNICAL SPECIFICATION PUBLIC ADDRESS SYSTEM

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1.0 SCOPE

- 1.1 This standard covers the technical requirements of design, manufacture, testing, delivery installation at site and commissioning of Public Address System along with all accessories on turn-key basis.

2.0 STANDARDS TO BE FOLLOWED

- 2.1 The design, manufacture and testing of public address system and their accessories covered by this standard shall comply with the latest issue of the following and other relevant Indian Standards Equipment complying with equivalent IEC standards shall also be acceptable.

- IS: 1881 - Code of practice for installation of indoor amplifying and sound distribution systems.
- IS: 1882 - Outdoor installation of public address system-code of practice.
- IS: 1301 - Code of safety requirements for electric mains-operated audio amplifiers.
- IS: 8061 - Code of practice for design, installation and maintenance of service lines up to and including 650 V.
- IS: 3043 - Code of practice for earthing.
- IS: 1490 - Recommendation for minimum performance requirements of mains-operated public address amplifiers.
- IS: 1819 - Recommendation for general requirements of public address amplifiers.
- IS: 1031 - Methods of measurements of loudspeakers and loudspeaker systems.
- IS:1554 (Part1) - PVC insulated (heavy duty) electric cables for working voltages up to and including 1100 V.
- IS: 694 - PVC insulated cables for working voltage up to and including 1100 volts.
- BS: 2004 - Electric cables for working voltage up to and including 1100 volts.



- 2.2 The design and operational features of all the equipments offered shall comply with the provisions of the latest issue of the Indian Electricity Rules and other Statutory Acts and Regulations. The supplier shall, wherever necessary, make suitable modifications in the equipment to comply with the above.

- 2.3 Wherever any requirement, laid down in this standard, differs from that in Indian Standard specifications, the requirement specified herein shall prevail.

3.0 SERVICE CONDITIONS

3.1 Ambient Conditions

These shall be as indicated in Design Philosophy-Electrical.

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3.2 System Details

These shall be as indicated in Design Philosophy-Electrical.

4.0 OPERATIONAL REQUIREMENTS

The public address system and their associated accessories shall be suitable for operating continuously under the ambient conditions and with the voltage and frequency variation indicated in Design Philosophy-Electrical without exceeding temperature rise limits as per relevant standards and without detrimental effect on any part.

5.0 TECHNICAL REQUIREMENTS

5.1 The public address system shall be microprocessor based, non-EPABX distributed amplifier type. It should be designed for communication between various process units and office areas of an industrial plant and various control room(s).

5.1.1 The band width of the communication system shall not be less than 9 KHz for intelligible speech reproduction required for industrial environment.

5.1.2 The system shall comprise of:

- i) Microprocessor based central exchange
- ii) Master control station(s)
- iii) Field stations and junction boxes, if any
- iv) Power supply unit
- v) Cables
- vi) Loudspeaker

5.1.3 All other items not specifically mentioned, but required for the completeness of the system shall be supplied.

5.2 Microprocessor based central exchange

5.2.1 The exchange shall be rack mounted microprocessor controlled. It should be designed such that future extensions or modification can be easily carried out.

5.2.2 The actual control of communication shall be from the exchange. From the exchange, various system information and data shall be acquired, processed and communication links between stations shall be established as per user requirement through master control station.

5.2.3 The exchange shall be 100% redundant in hot standby mode. The exchange shall have facility for hooking up with the existing EPABX system. It shall have two independent lines of communication viz. page & party.



5.3 Master control stations (MCS)

5.3.1 The MCS shall be desk mounted type and shall comprise of a keyboard with LEDs, a built-in loudspeaker and a built-in dynamic noise cancelling goose neck microphone. It should have facility for duplex mode of communication.

5.3.2 The MCS shall have a key to initiate an EPABX call and should have facility to receive EPABX call.

5.3.3 The MCS shall have features to initiate the following type of call:

- i) All call

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- ii) Alarm call
- iii) Conferencing
- iv) Inter MCS call
- v) Call from MCS to field station & vice-versa
- vi) Global call
- vii) Call from field station of one MCS to field station another MCS

5.3.4 The MCS shall have drop out facility i.e. after connecting two field stations, the MCS, if required, may drop out of the ongoing conversation. Priorities shall be assigned to the various calls (Alarm & Global) shall have higher priority than other calls.

5.4 **Field Station**

5.4.1 It shall be of cast aluminium (LM-6) enclosure and shall consist of adequate capacity amplifiers for page channel, telephone type handset (but made of unbreakable material and of different size to make it pilfer proof), cradle switch and all other necessary control switches & push buttons required for satisfactory operation of the system.

5.4.2 Handsets shall be completely factory wired up to terminal blocks and shall be provided with cable termination accessories for connecting external cables.

5.4.3 The field stations shall be suitable for hazardous area classification defined as zone I/II, gas group IIA/IIB/IIC & temperature class T3. All master control station shall be suitable for outdoor installation with IP-65 protection.

5.5 **Loudspeaker (LS)**

5.5.1 Loudspeaker shall be highly efficient, high power driver unit designed for non-ringing to deliver clear reproduction. The driver unit shall be lockable type to avoid pilferage.

5.5.2 Loudspeaker shall be provided with impedance matching transformer. Transformer shall have the minimum "frequency characteristic" required for public address system.

5.5.3 Loudspeaker for indoor mounting shall be direct radiator, permanent magnet moving coil type rated for 15W. However, loudspeaker for outdoor mounting and in areas with high ambient noise level shall be pressure unit operated, projector or horn type, weatherproof, rugged die-cast aluminium construction rated for 15W.

6.0 **POWER SUPPLY**



6.1 Power supply single phase, 240 V, 50 Hz shall be made available at one point only by owner. Further distribution, if required, shall be arranged by the vendor.

6.1.1 DC supply, if required, shall be arranged by the vendor from the dedicated power supply unit working on single phase 240 V, 50 Hz supply. DC supply shall have redundancy, Additional SMPS shall be provided.

6.1.2 The system shall be provided with a transistorised type UPS of one hour back-up and the battery used shall be Nickel-Cadmium type.

7.0 **CABLES**

7.1 Signal and loudspeaker cables shall have annealed tinned copper, twin twisted & colour coded, PVC sheathed, GI round wire armoured and PVC overall sheathed. Loudspeaker cables shall be of 24 / 0.2 mm copper and signal cable shall be of 16 / 0.2 mm copper.

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7.1.1 For power cables, 3 core 2.5 sq. mm annealed tinned copper, PVC insulated armoured cables are required.

7.1.2 The bidder shall indicate the details & quantity of cables required in tabular form.

8.0 CABLING

The contractor shall supply, lay & connect at both ends all the cables with accessories. The cables shall be accommodated in the existing overhead cable racks / structures as far as possible; where racks are not available, the cables shall be laid underground by using GI protection pipes.

9.0 JUNCTION BOXES

The junction boxes shall be of die cast aluminium powder coated. These shall be complete with inspection cover, conduit glands and terminal stripes. The cover shall be gasketed to make it dust & vermin proof and IP-55 protection. Holes for screwing the covers shall have stainless steel inserts.

10.0 EARTHING

All the equipment and their associated accessories of public address system shall be provided with earthing terminals and shall be connected to the owner's ground mat by vendor as per relevant Indian Standard.

11.0 ERECTION & COMMISSIONING

The bidder shall quote for complete, testing & commissioning along with fittings & accessories. Good engineering practice in conformity with latest Indian Standard & code of practice shall be followed for erection & commissioning of all the accessories of public address system.

12.0 DRAWINGS AND DOCUMENTS

12.1 Drawings and documents as per Annexure-I shall be supplied unless otherwise specified.

12.2 All drawings and documents shall have the following description written boldly.

- i) Name of client
- ii) Name of consultant
- iii) Enquiry / order number with plant / project name
- iv) Equipment Code no. and Description



13.0 SPARES

13.1 Spares for operation and maintenance

Item wise unit prices of spare parts with recommended quantity shall be quoted along with the equipments.

13.2 Commissioning Spares

Commissioning spares, as required, shall be supplied with the main equipment. Item wise list of recommended commissioning spares shall be furnished for approval.

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13.3 Any other spare parts not specified, but required, shall also be quoted along with the offer.



13.4 All spare parts shall be identical to the parts used in the equipments.

14.0 PACKING

The public address system shall be properly packed to safeguard against weather conditions and handling. It shall be wrapped in polythene bag with an additional wrapping of bitumen paper to make it completely waterproof before the equipment is packed in wooden crates.

15.0 DEVIATIONS

15.1 Deviations, if any, from this standard shall be clearly indicated in the offer with reasoning.

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ANNEXURE - I



DOCUMENTATION FOR PUBLIC ADDRESS SYSTEM

Sl. No.	Documentation	Documents Required (Y / N)		
		With Bid	For Approval	Final
1.	Guaranteed technical particulars	Y	Y	Y
2.	Outline drawing showing dimensions and other details.	Y	Y	Y
3.	Complete assembly drawings of equipments showing plan, elevation and cross section.	Y	Y	Y
4.	Schematic of field stations of each type.	Y	Y	Y
5.	Cable schedule with complete layout drawings	N	Y	Y
6.	Illustrative and descriptive catalogues	Y	N	Y
7.	Installation, operation & maintenance manual	N	N	Y
8.	Quality assurance program	Y	N	N
9.	Type test certificate for			
	i) Hose proof items	Y	N	Y
	ii) Flame proof items	Y	N	Y
10.	Test certificates	N	N	Y
11.	Guarantee certificates	N	N	Y



Note:

- 4 hard copies & 1 soft copy shall be supplied with bid.
- 4 hard copies & 1 soft copy shall be supplied for approval after order within 4 weeks from the date of LOI.
- 8 hard copies & 2 soft copies in pen drive shall be submitted as final documents prior to despatch of the equipment. These shall be made in sets and supplied in fine plastic coated folder.

Y - Yes, N - No



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**TECHNICAL SPECIFICATION
AUXILIARY SERVICE TRANSFORMER**

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1.0 SCOPE

- 1.1 This standard covers the technical requirements of design, manufacture, testing at works and despatch in well packed condition of auxiliary service transformers.
- 1.2 This standard shall be applicable for 3 phase / single phase, separate winding transformers of rating below 315 KVA used for Auxiliary services such as lighting, control, Instrument supply etc.

2.0 STANDARDS TO BE FOLLOWED

- 2.1 The design, manufacture and testing of the equipment covered by this standard shall comply with the latest issue of following Indian Standards. Equipment complying with equivalent IEC standards shall also be acceptable.

IS: 1180 Part -- Outdoor type 3 phase distribution transformers up to and
- 1 & 2 including 100 KVA, 11 KV

IS: 2026 -- Power transformers

IS: 11171 -- Dry type power transformers

- 2.2 The design and operational features of the equipment offered shall comply with the provisions of the latest issue of the Indian Electricity Rules and other relevant statutory acts and regulations. The supplier shall, wherever necessary, make suitable modifications in the equipment to comply with the above.
- 2.3 Wherever any requirement, laid down in this standard, differs from that in Indian Standard Specifications, the requirement specified herein shall prevail.

3.0 SERVICE CONDITIONS

3.1 Ambient Conditions

These shall be as indicated in Design Philosophy-Electrical.

3.2 System Details

These shall be as indicated in Design Philosophy-Electrical.

4.0 OPERATING REQUIREMENTS

- 4.1 The transformer shall be suitable for operating at the rated capacity continuously at any of the taps, under the ambient conditions and with the voltage and frequency variations as indicated in Design Philosophy-Electrical without exceeding the permissible temperature and without any detrimental effect on any part.



5.0 GENERAL DESIGN FEATURES

5.1 Rated voltage and frequency

These shall be as indicated in Design Philosophy-Electrical.

5.2 Phase connections

5.2.1 Three phase transformer

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The primary winding shall be connected in delta and secondary winding in star with neutral point earthed (Vector group Dyn-11)

5.2.2 Single phase transformer

Primary winding shall be connected between two phases of a 3 phase system or to the three phases in open delta execution and secondary single phase winding shall have one terminal earthed with the tank through link inside the secondary terminal box.

5.3 Tapping

5.3.1 The transformers shall be provided with off circuit tap changer with tapping of $\pm 2.5\%$ and $\pm 5\%$.

5.3.2 For transformers having primary 3.3 KV and above, tap changing shall be effected with an externally operated handle, capable of being padlocked in any position on the primary side.

5.3.3 For transformers having primary 415V and below, tap changing shall be effected by means of links in the terminal chamber on the primary side.

5.4 Impedance voltage

The impedance voltage of the transformer at 75°C shall be 4%.

5.4.1 Losses

The losses shall be indicated by the vendor and shall be guaranteed, within tolerable limits specified in IS: 2026 at rated voltage and frequency.

5.4.2 Terminal Arrangement

The primary and secondary side terminals shall be brought outside the tank through porcelain bushing in dust and weather proof terminal boxes, with links for tap changing where required and suitable heavy duty double compression type rolled aluminium cable glands and cable lugs for receiving cables. The neutral point of the secondary winding shall be brought out separately and earthed to the transformer body through test link. Terminal board for the primary and the secondary winding shall be amply sized and made of SRBP/ FRP materials.

5.4.3 Resistance to short circuit

The transformers shall be able to with stand electrodynamic stresses due to terminal short circuit of the secondary assuming primary side fed from the infinite bus.



5.4.4 Cooling System

Transformers rated up to 50 KVA shall be natural air cooled type and above 50 KVA shall be natural oil cooled / natural air cooled type.

6.0 CONSTRUCTIONAL FEATURES

6.1 Core

The transformer core shall be of high grade non ageing electrical silicon cold rolled magnetic sheet steel of low hysteresis loss and high permeability. The maximum flux

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density in any part of the core and yoke at rated voltage and frequency shall not exceed 1.7 Tesla for oil cooled transformers and 1.3 Tesla for air cooled transformers.

- 6.1.1 The tank for oil cooled transformer shall be made of mild steel plate of adequate thickness. Cooling tubes, where necessary, shall be provided.
- 6.1.2 Air cooled transformer shall be sheet steel enclosed having minimum thickness of 2.0 mm and shall be provided with suitable reinforcement as required. The minimum degree of protection for the enclosure shall be IP: 31. Ventilating louvers, if provided, shall be covered by fine wire mesh.
- 6.1.3 All external hardware shall be zinc passivated steel.

6.2 Windings



- 6.2.1 Coil shall be made out of electrolytic grade copper conductor.
- 6.2.2 Class-F / class-H insulating material shall be used for air cooled transformers.
- 6.2.3 For oil cooled transformer class-A insulating material shall be used. Mineral oil shall comply with IS: 325. 10% extra oil shall be supplied along with transformer in non-returnable drums.
- 6.2.4 Winding assembly shall be dried and impregnated in vacuum with tested insulating oil / varnish.

6.3 Bushing

The bushing insulators shall be rated for the maximum system voltage and shall comply with the requirement laid down in IS: 2099 / IS: 7421. The minimum current rating shall be 250A.

7.0 FITTINGS

- 7.1 Following fittings shall be provided for air cooled transformers.
- i) Rating and diagram plate
 - ii) Lifting lug
 - iii) Primary and secondary cable boxes with heavy duty double compression type aluminium cable glands and lugs.
 - iv) Earthing terminals
 - v) Rollers (for 25 KVA and above)
- 7.2 In addition to the above following fittings shall be provided for oil cooled transformer.
- i) Oil conservator complete with drain plug, oil filling hole with cover and oil level indicator with minimum marking.
 - ii) Silica gel breather
 - iii) Dial type thermometer
 - iv) Oil sampling cum drain valve
 - v) Explosion vent
 - vi) Air release plug
- 7.3 Any other fittings which may be necessary for satisfactory operation of the transformer shall also be provided.

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7.4 All fittings shall conform to relevant Indian Standards.

8.0 PAINTING

8.1 The surface shall be painted after removing all dust, scale and foreign adhering matter. All traces of oil and greases should be removed by suitable treatment.

8.2 All steel surfaces in contact with insulating oil shall be painted with heat resistant oil insoluble insulating varnish.

8.3 All steel surfaces exposed to outside shall be painted with suitable anti rust and anti corrosive paints. Epoxy paints shall be used.

8.4 All paints shall be carefully selected to withstand tropical heat and extremes of weather. The paint shall not scale off, crinkle or be removed by abrasion due to normal handling.

8.5 Unless otherwise specified, the finishing shade shall be light grey shade no. 631 as per IS: 5.

8.6 1 litre paint per air / oil cooled transformer shall be supplied for touch up at site.

9.0 TESTS AND INSPECTION

9.1 All transformers shall be routine tested as per IS: 2026.

9.2 Additional tests, wherever specified, shall be carried out on one transformer of each rating.

9.3 All the above mentioned tests shall be carried out in the presence of purchaser's representative. In addition, the transformer shall be subjected to stage inspection at works and inspection at site for final acceptance.

9.4 These inspections shall, however, not absolve the vendor from his responsibility for making good any defect which may be noticed subsequently.

10.0 DRAWINGS AND DOCUMENTS

10.1 The drawings and documents as per Annexure-I shall be supplied, unless otherwise specified.



10.2 All drawings and documents shall have the following descriptions written boldly.

- Name of client
- Name of Consultant
- Enquiry / Order No. with plant / project name
- Equipment Code no. and Description

11.0 SPARES

11.1 Spares for operation and maintenance

Item wise unit prices of following items as applicable shall be offered along with the main equipment with recommended quantity.

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- i) Bushing with accessories for all voltage grades
- ii) Complete set of gaskets
- iii) Oil level gauge (for oil cooled transformer only)
- iv) Complete charge of silica gel with glass container (for oil cooled transformer only)
- v) Gland packing / O-ring for every valve (for oil cooled transformer only)

11.2 Commissioning Spares

Commissioning spares, as required, shall be supplied with the main equipment. Item wise list of recommended commissioning spares shall be furnished for approval

11.3 Any other spare parts not specified, but required, shall also be quoted along with the offer.

11.4 All spare parts shall be identical to the parts used in the equipment.



12.0 PACKING

12.1 The transformers shall be suitably packed in wooden crates to avoid damage in transit. Oil cooled transformers shall be properly sealed so as to completely exclude oxygen and moisture from coming in contact with oil.

12.2 The packing box shall contain a copy of the installation, operation and maintenance manual.

13.0 DEVIATIONS

13.1 Deviations, if any, from this standard shall be clearly indicated in the offer with reasoning.

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ANNEXURE – I



DOCUMENTATION FOR AUXILIARY SERVICE TRANSFORMERS

Sl.No.	Description	Documents Required (Y / N)		
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1.	Specification Sheet, duly completed	Y	Y	Y
2.	Technical Particulars, duly filled-in	Y	Y	Y
3.	Dimensional drawing with terminal arrangement details	Y	Y	Y
4.	Illustrative and descriptive literature	Y	N	Y
5.	Installation, Operation and maintenance manual	N	N	Y
6.	Test Certificates	N	N	Y
7.	Guarantee certificate	N	N	Y
8.	Spare parts list with identification marks	Y	N	Y

Note:

1. 4 hard copies & 1 soft copy shall be supplied with bid.
2. 4 hard copies & 1 soft copy shall be supplied for approval after order within 4 weeks from the date of LOI.
3. 8 hard copies & 2 soft copies in pen drive shall be submitted as final documents prior to despatch of the equipment. These shall be made in sets and supplied in fine plastic coated folder.

Y - Yes, N - No

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TECHNICAL SPECIFICATION MEDIUM VOLTAGE SWITCH BOARDS





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ANNEXURE - II	LIST OF SPARES

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1.0 SCOPE

- 1.1 This standard covers the technical requirements of design, manufacture, testing at works and delivery in well-packed condition of Medium Voltage Switchboards.
- 1.2 This standard shall be applicable for the Power Control Centres, Power cum Motor Control Centres and Motor Control Centres.
- 1.3 This standard shall be read in conjunction with relevant Schematic diagrams etc.

2.0 STANDARDS TO BE FOLLOWED

- 2.1 The design, manufacture and testing of the equipment shall comply with the latest issue of the following Indian Standards, unless otherwise Specified. Equipment complying with equivalent IEC standards shall also be acceptable.

- | | |
|--------------|--|
| IS 8623 | - Specification for low voltage switchgear and control gear assemblies |
| IS/IEC 60947 | - Low-voltage switchgear and control gear (General Rules) |
| IS 5578 | - Guide for marking of insulated conductors |
| IS 10118 | - Code of practice for selection, installation and maintenance of switchgear and control gear |
| IS 11353 | - Guide for uniform system of marking and identification of conductors and apparatus terminals |

Various components housed in the switchboards shall conform to the Indian Standard specifications as mentioned against the component details or IEC specifications.

- 2.2 The design and operational features of all the equipment offered shall also comply with the provisions of the latest issue of the Indian Electricity Rules and other Statutory Acts and Regulations, as applicable. The supplier shall, wherever necessary, make suitable modifications in the equipment to comply with the above.
- 2.3 Wherever any requirement, laid down in this standard, differs from that in Indian Standard Specification / IEC Specification, the requirement specified herein shall prevail.

3.0 SERVICE CONDITIONS

3.1 Ambient Conditions



These shall be as indicated in Design Philosophy-Electrical.

3.2 System Details

These shall be as indicated in Design Philosophy-Electrical.

4.0 OPERATING REQUIREMENTS

The Medium Voltage Switchboards shall be suitable for operating at the specified rating continuously, with the specified voltage and frequency variations under the ambient

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conditions indicated in Design Philosophy-Electrical, without exceeding the permissible temperature rise and without any detrimental effect on any part.

5.0 DESIGN AND CONSTRUCTIONAL FEATURES



5.1 General

- 5.1.1 The switchboards shall consist of an assembly of a series of floor mounting, identical, metal clad, dead front type sheet steel panels of unitized design. The panels shall be placed side by side to form a compact assembly and shall be extensible on either side.
- 5.1.2 The complete assembly shall be dust, damp and vermin proof having minimum degree of protection equivalent to IP-52 as per IS/IEC 60947.
- 5.1.3 The frame work of the cubicles shall be of bolted/welded construction. The minimum thickness of sheet steel shall be 2 mm for load bearing members, 1.6 mm for non-load bearing members and 3 mm for base channel. The doors and covers shall be fabricated from cold rolled sheets. Suitable reinforcement, wherever necessary, shall be provided.
- 5.1.4 The door hinges shall be concealed type.
- 5.1.5 All external hardwares shall be zinc passivated steel. The hardwares for fixing the removable parts shall be provided with retaining devices.
- 5.1.6 The doors and the removable covers shall be provided with non-deteriorating neoprene gaskets. Gaskets without any discontinuity shall be preferred. Gaskets shall be held in position in groove, in shaped sheet steel work or these shall be of U type. Adhesive cement, if used, shall be of good quality so that the gaskets do not come off during service.
- 5.1.7 All the components shall be accessible for inspection and maintenance without the necessity for removal of the adjacent ones.
- 5.1.8 The layout of the component inside the module shall be liberal to facilitate maintenance and interconnecting wiring between the components shall not be subjected to any undue stresses at the bends.
- 5.1.9 Mounting height of components requiring operations and observation shall not be lower than 300 mm and higher than 1800 mm.
- 5.1.10 Inter panel barriers shall be provided.
- 5.1.11 All the live parts which are accessible after opening of front cover/cable alley cover/back cover shall be properly insulated or provided with insulating barrier to prevent accidental contact. Removal facility shall be provided for all such parts.
- 5.1.12 Adequate arrangement for earthing shall be provided to safeguard the operator or other personnel from electric hazards under all conditions of operation.

5.2 Panel Arrangement

The Switchboards shall be in drawout, single front/double front execution, fully compartmentalised type and divided into distinct panels, each comprising of:

- i) A completely metal enclosed bus-bars compartment running horizontally the top.
- ii) Individual feeder modules.
- iii) Enclosed vertical bus-bars serving all modules, in case of multi-tier panels.
- iv) A vertical cable alley.
- v) Separate horizontal enclosure for all auxiliary power and control buses.



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5.3 Circuit Breaker Controlled Feeders

- 5.3.1 The panels housing circuit breaker feeders shall be in single front draw out execution. The incoming and bus coupler circuit breaker feeders shall be in single tier formation while the outgoing circuit breaker feeders may be in double tier formation.
- 5.3.2 A suitable barrier shall be provided between the circuit breaker and the associated control, protective and indication devices including instrument transformers.
- 5.3.3 All the protective relays and meters shall be flush mounted type. The relays and meters pertaining to a particular circuit breaker shall be mounted on the same panel. Where it is not possible to accommodate all the relays and meters in the same panel, one metering panel shall be provided adjacent to the circuit breaker panel exclusively for that feeder. Location of these in the adjacent panel of other feeders shall not be acceptable.
- 5.3.4 A spacious cable chamber suitable for accommodation, support and termination of required number of power cables shall be provided at the back. No bare bus-bars or live connection shall intrude into the cabling space.
- 5.3.5 The switchboard shall be provided with following inter locks and safety features:
- i) It shall not be possible to open the compartment door unless the breaker is drawn to isolated position.
 - ii) The withdrawn and engagement of a circuit breaker shall not be possible unless it is in open position.
 - iii) The operation of a circuit breaker shall not be possible unless it is in fully service, test or isolated position.
 - iv) It shall not be possible to close the circuit breaker in service position unless all auxiliary and control circuits are connected.
 - v) A breaker of the lower rating shall be prevented from engaging with the stationary element of higher rating.
 - vi) Insertion of the manual mechanism shall render the motorised mechanism in operation.
 - vii) Circuit breaker 'ON', 'OFF' indication shall be provided at the back of each panel. Alternatively, alarm shall be provided in case panel back door is opened with breaker "ON".
 - viii) Caution nameplate shall be provided at the back of incomer's panels where terminals are likely to remain live and isolation is possible only from remote end.
 - ix) Automatic safety shutter, with Padlocking facility for locking in closed position, to completely cover the spouts for the bus-bars and cable connection when the breaker is withdrawn.

5.4 Switch/MCCB Controlled Feeders

- 5.4.1 The panels housing motor starter or other feeders shall be draw out type in single front or double front execution.
- 5.4.2 All components of one feeder shall be mounted on a rigid sheet steel chassis.
- 5.4.3 Each panel shall be divided into a number of modules in tier formation placed one above the other. These modules shall be closed on all sides.
- 5.4.4 The modules shall be so placed that largest one is placed at the bottom of the panel. Type modules shall be at least 300 mm from the base channel.
- 5.4.5 The number of modules shall be so decided that the cables in the cable alley are not over crowded. However the number of module in any panel shall not exceed six.

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- 5.4.6 The minimum size of module shall be 300 mm and 200 mm for starter and switch fuse feeders respectively.
- 5.4.7 The minimum clear width of cable alley shall be 250 mm.
- 5.4.8 For MCC rated above 630 Amp. The incomer and bus coupler modules shall be located in individual single panel. For MCC rated for 630 Amp. and below the incomer and bus coupler modules shall be half the panel size.
- 5.4.9 The module door shall be so interlocked that it shall not be possible to open the door with switch in closed position and close the door unless the module is fully plugged in. Defeat interlock facility shall be provided.

5.5 Special Features of Draw out Modules

- 5.5.1 The module shall be fully draw out type with sheet steel chassis moving freely on the guides. Chassis of the same size shall be fully interchangeable.
- 5.5.2 The module shall have the following distinct mechanical positions:
- i) Service -- In which both power and control contacts shall be made.
 - ii) Test -- In which power contacts shall be isolated but control contacts shall be made.
 - iii) Isolated -- In which both power and control contacts shall be Isolated.
- Maintenance position shall be preferred.
- 5.5.3 Each position shall be clearly marked. Padlocking facility shall be provided to padlock the chassis in any of the position.
- 5.5.4 The movement of the chassis from one position to the other shall be controlled by using an appropriate racking mechanism. Stopper shall be provided to prevent over travel of the chassis beyond the isolated position.
- 5.5.5 The guiding system shall permit smooth movement of the module and the power and control contacts shall be self-aligning type so that accurate alignment of the contacts is ensured.
- 5.5.6 No wiring shall be taken to the door. Only the actuators of the push buttons and switches, lenses for the indicating lamps and Perspex cover for meters shall be mounted on the door.
- 5.5.7 The power contacts shall be of plug-in/stab-in type made of silver plated copper, spring loaded and of adequate current carrying capacity. The contacts shall be so designed that contact pressure is maintained both under normal and short circuit conditions.
- 5.5.8 The parting contacts, both on bus-bar side and outgoing cable side, shall always be copper to copper and both sides silver plated. A bimetallic strip shall be used where two dissimilar materials are in contact.

5.6 Bus-Bars and Connections

- 5.6.1 The bus-bars shall be for three phase and neutral. The main bus-bars and connections shall be made of high conductivity Aluminium alloy conforming to grade E 91 E of IS 5082 / electrolytic grade copper of rectangular cross-section. Auxiliary bus-bars for control supply, space heater supply etc. shall be made of electrolytic copper.
- 5.6.2 The horizontal bus-bars shall be insulated with heat shrinkable PVC sleeves of reputed make to protect against approach to live parts. The vertical bus-bars shall be sleeved or

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shrouded by barriers. Removable type insulating shrouds shall be provided for all joints of horizontal bus-bars.

- 5.6.3 The bus-bars shall be amply sized to carry the rated continuous current under the specified ambient temperature without exceeding temperature limits specified in IS: 8084. The thermal rating of the bus-bars shall be designed to withstand the system fault current for 1 second without exceeding the limiting temperature of 200°C for bare Aluminium/Copper. Calculation for bus-bars sizing shall be furnished along with the offer.
- 5.6.4 Horizontal bus-bars shall be of the same cross-section through out. Stepped bus-bars shall not be acceptable.
- 5.6.5 The bus-bars shall be arranged and colour coded according to IS: 5578 / IS: 11353.
- 5.6.6 The bus-bar chamber shall be sufficiently spacious and shall have separate screwed covers for maintenance purpose.
- 5.6.7 The bus-bars shall be rigidly supported at equal intervals to withstand maximum short circuit stresses. The supports shall be of moulded construction with built-in anti-tracking barriers. The support materials shall be of DMC or fibreglass reinforced thermosetting plastic.
- 5.6.8 Bus-bar joints shall be between the two transporting sections only.
- 5.6.9 A minimum of two bolts shall be used in bus-bar joints. Only high tensile electric galvanized bolts, nuts and washers shall be used.
- 5.6.10 In case of Aluminium bus-bars, all joints shall be suitably treated to avoid oxidation of contact surfaces and bimetallic corrosion.

5.7 **Earth Bus**



A continuous earth bus of Aluminium, running along the entire length of the lower part of the switchboard shall be provided with lugs at two ends for external connections. The minimum size of earth bus shall be suitable for carrying three phase fault current for 1 sec.

5.8 **Bus Duct**

- 5.8.1 Suitable extension of bus-bars in proper phase sequence on the top or bottom, with the connecting bolts shall be provided where connection of transformer to switchboard is specified to be through bus duct.
- 5.8.2 Bus duct between two halves of a switchboard, if required, shall be supplied by the switchboard manufacturer. The bus-bars of interconnecting bust duct shall be similar to the main bus-bars of the switchboard and as specified above.
- 5.8.3 Bust duct between transformer and incoming breaker panel, if included in Vendor's scope, shall conform to TS-8062.

5.9 **Clearances and Creepage Distances**

- 5.9.1 The clearances and creepage distances shall not be lower than the values specified below:
- i) Minimum clearance between two live conductors -- 20 mm
 - ii) Minimum clearance between live parts and accidentally dangerous part -- 20 mm

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iii) Minimum creepage distance -- 28 mm

5.9.2 The clearances and creepage, as specified above, shall definitely be maintained in the bus-bar system. Provision of bus-bar insulation, separators or barriers shall not be considered to reduce the clearance from the values specified above.

5.9.3 At the termination points in the equipment e.g. switches, contactors, thermal relays etc. It is realized that above clearances may not always be possible to be maintained. All such points, where above clearances and creepage distances are not possible to be maintained, shall be insulated or taped.

5.10 Insulation

5.10.1 The insulation used shall be non-hygroscopic and may be of porcelain, epoxy resins or fibreglass moulded with plastic. It shall be of adequate electrical, mechanical and thermal strength to give trouble free service during normal operation and short circuit conditions.

5.10.2 The insulation shall be treated suitably to withstand the tropical conditions and atmospheric pollution.

5.11 Power Wiring

5.11.1 The connections from bus-bar to individual functional unit on the modules shall be of PVC insulated flexible copper cables or taped Copper/Aluminium strip.

5.11.2 The power wiring size shall be decided based on rating of the switch/breaker after using a rating factor of not more than 50% over the current rating in free air.

5.11.3 Power wiring size selected for breaker controlled module shall also be able to withstand full short circuit current for duration of 0.25 sec.

5.11.4 In any case minimum size of power wiring shall not be less than 4 sq. mm copper.

5.11.5 The size of connection from incomer to horizontal bus-bar and from horizontal bus-bar to bus-coupler shall not be less than the size adopted for horizontal bus-bar.

5.12 Control Wiring

5.12.1 The switchboard shall be completely factory wired and ready for external connections.

5.12.2 The wiring shall be carried out with flexible stranded PVC insulated copper conductor cables of 1100 Volt grade. The size of wires shall be as follows:

C.T. Circuit -- 2.5 sq. mm



V.T. and Control Circuits -- 1.5 sq. mm

5.12.3 All wiring shall be provided with dependent both ends marking as per IS: 5578. Numbered ferrules, reading from the terminals outwards, shall be provided at both ends of all wiring for easy identification. These shall be interlocking type plastic ferrules.

5.12.4 Control wiring circuits, fed from a supply common to a number of panels, shall be so protected that failure of a circuit in one panel does not effect the operation of the other panels.

5.12.5 The wiring to the equipment mounted on the doors shall be carried out with flexible multi strand copper conductor cable and so supported that on opening of the door there is no undue strain on wire leads.

5.12.6 The control cables shall be neatly arranged and property supported.

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5.13 External Cable Termination

- 5.13.1 All power and control cables shall enter the switchboard from the bottom. Sufficient space shall be provided for ease of connection and termination of cables.
- 5.13.2 The type, number and sizes of cables shall be as indicated in Feeder details.
- 5.13.3 Double Compression type cable glands along with the cable lugs as required shall be provided for termination of cables.
- 5.13.4 The cable glands shall be of rolled Aluminium or nickel plated brass heavy duty double compression type and shall be mounted on a removable gland plate, provided at a minimum height of 75 mm from the bottom of the switchboard. Two number spare knockouts of size 20 mm shall also be provided on the gland plates for future use. Gland for termination of single core cables shall be nonmagnetic type.
- 5.13.5 For all power cables, crimped type Aluminium lugs for Aluminium cables and tinned Copper lugs for Copper cables shall be provided.
- 5.13.6 The terminal blocks shall be pressure clamp type up to 35 sq. mm cable sizes and bolted lug type for higher sizes of cables. These shall be protected type and rated for 1100 Volts service. The minimum current rating of terminal block shall be 16 Amp. The construction shall be such that after the connection of cables by means of lugs, necessary clearance and creepage distance are available.
- 5.13.7 Where more than two cables in parallel are required to be terminated, a system of bus links shall be provided with adequate clearance and spacing.
- 5.13.8 Suitable clamps to support the vertical run of cables shall be provided.
- 5.13.9 The terminal block shall be grouped according to circuit functions and suitably numbered. 20% extra terminals shall be provided in the terminal block.
- 5.13.10 For power connections, suitable marking on the terminals shall be provided to identify the phases.

5.14 Feeder Details



- 5.14.1 The requirements of incomer, bus coupler and outgoing feeders shall be as indicated in the single line diagram, feeder details and corresponding schematic diagrams.
- 5.14.2 Interlocks shall be provided between incomers and bus section panels. The interlocks shall be either electrical or mechanical type. In addition, arrangement for defeating the interlock shall also be provided to facilitate manual changeover.
- 5.14.3 Auto changeover scheme, wherever specified, shall be provided.

5.15 Dummy Panels

Dummy panels complete with bus-bar system in 400 mm width may be required for which unit price shall be indicated.

5.16 Control Power Supply

- 5.16.1 D.C. Power required for closing, tripping and indication of circuit breaker feeders shall be supplied at the bus coupler panel through two completely separate circuits by owner, one for tripping and other for closing and indication.
- 5.16.2 For receiving each external control supply, a double pole miniature circuit breaker shall be provided. This power shall be distributed inside the switchboard for each circuit breaker feeder having its MCB unit.

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5.17 Space Heater Power Supply



- 5.17.1 Panel space heater shall be fed from a separate bus common for the whole board. This bus shall be fed from owner's supply for which a double pole MCB shall be provided in bus section panel.
- 5.17.2 Power supply for space heaters of motors shall be tapped from this bus by means of a MCB located in the motor feeder compartment. These MCBs shall be of triple pole and rated for 15 Amp.

6.0 COMPONENT DETAILS



Components of the switchgear shall ensure type of coordination 'C' as per IS:60947 (Part 4/ Section 1). The make of the components shall be as specified elsewhere in the NIT.

6.1 Circuit Breaker

- 6.1.1 The circuit breakers shall comply with the requirement of IS/IEC 60947.
- 6.1.2 All circuit breakers shall be of P2 (0-3 min - CO - 3 min - CO) category, capable of carrying the specified current at the site conditions and making/breaking of the system fault current.
- 6.1.3 Type test certificates from an independent testing authority shall be furnished along with the offer for each circuit breaker rating and type.
- 6.1.4 The circuit breakers controlling motors shall be suitable for DOL starting and stopping of induction motor a number of times.
- 6.1.5 The circuit breakers controlling capacitors shall be suitable for energizing and de-energizing the rated capacitor bank.
- 6.1.6 The circuit breakers shall be of the 3 phase, 4 pole horizontal draw out, horizontal isolation, air break type.
- 6.1.7 The circuit breaker shall be suitable for electrical or manual closing as specified. Manual operated breakers shall have independent manual spring closing mechanism. In case of electrically operated breaker, it shall have motor wound spring mechanism. In all cases tripping shall be by means of shunt trip coil.
- 6.1.8 All circuit breaker units of the same rating shall be physically and electrically interchangeable.
- 6.1.9 The circuit breakers shall be electrically and mechanically trip free and provided with anti-pumping feature.
- 6.1.10 Provision shall be made for slow closing for maintenance purposes. A suitable handle shall be provided one for each board for this purpose.
- 6.1.11 The circuit breakers shall have three positions i.e. service, test and isolated with the cubicle door closed. Necessary stoppers shall be provided to prevent the excessive movement of the breaker cradle than desired for the position. Service and test positions of the breaker shall have monitoring switch having 1NO+1NC contacts.
- 6.1.12 The circuit breaker shall be provided with emergency manual trip device, mechanical 'ON', 'OFF' and 'ISOLATED' position indicators and operation counter.
- 6.1.13 A maintenance truck/device for raising, lowering and withdrawal of the circuit breaker shall be supplied for each switch board.

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- 6.1.14 The arc interrupting devices shall be capable of interrupting satisfactorily current from zero to the rated interrupting current when used on predominantly capacitive or inductive circuits, without requiring excessive maintenance of the contacts. The arc shall be restricted within the interrupting chamber and no emission of flame shall be allowed which may cause electrical breakdown or damage to insulation on the apparatus.
- 6.1.15 The main contacts shall be self aligning, adjustable and replaceable type.
- 6.1.16 The arcing contacts shall be easily accessible for maintenance and inspection and shall be easily replaceable type. They shall be provided with, contact face of special arc-resisting and non-pitting metal.
- 6.1.17 Mechanical safety interlock shall be provided for safe operation and movement of the breaker.
- 6.1.18 The circuit breakers shall be provided with minimum of four normally open and four normally closed auxiliary switch contacts, over and above those required for its own control scheme, for Owner's use. The contacts shall be wired separately to the terminal board.
- 6.2 Moulded Case Circuit Breakers**
- 6.2.1 The circuit breaker shall conform to IS/IEC 60947 and shall be of P2 category having rupturing capacity as specified and mounted on a draw out chassis.
- 6.2.2 The circuit breaker shall be provided with spring assisted quick make quick break type manually operated trip free mechanism, mechanical 'ON', 'OFF' position indicators, thermal tripping devices of inverse characteristics, instantaneous short circuit tripping devices and necessary auxiliary and alarm switches. The MCCB Chassis shall be provided with service, test and isolated position and automatic safety shutter.
- 6.2.3 The thermal and short circuit tripping devices shall be adjustable type.
- 6.2.4 When used for motor circuits, shunt trip device shall be provided and the let through power of controlling MCCB shall be lower than the respective contactor.
- 6.2.5 In addition, under voltage trip shall be provided.
- 6.3 Switches**
- 6.3.1 The switches shall be motor duty type AC 23 Category and shall comply with the requirements laid down in IS/IEC 60947. Switches up to 63 Amps shall be rotary type and those of 100 Amps. & above, link type.
- 6.3.2 'ON' and 'OFF' position of the switches shall be indicated on the module. Provision shall be made to lock the switch in the 'OFF' position.
- 6.3.3 The fixed contacts shall be shrouded type. All contacts shall be silver plated.
- 6.4 Fuses**
- 6.4.1 The fuses shall be of non-deteriorating HRC cartridge link type and shall conform to IS: 13703. They shall be suitable for the load and service required in the circuit.
- 6.4.2 One fuse puller shall be supplied along with each board.

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6.5 Air Break Contactors

- 6.5.1 The Air Break Contactors shall be of Category AC3/AC4, unless otherwise specified, conforming to IS: 60947 and flapper type.
- 6.5.2 The dropout voltage shall not exceed 65% of rated voltage.
- 6.5.3 Each contactor shall be provided with auxiliary contacts as required. The rating of the auxiliary contacts shall be 5 Amps. AC or 1 Amp DC at the specified control voltages. The spare auxiliary contacts shall also be wired up to the terminal blocks.

6.6 Bimetal Thermal Overload Relays



- 6.6.1 The contactor shall be provided with three pole bimetal thermal overload relays, unless other-wise specified. The bimetal relays shall be of suitable range, ambient temperature compensated and shall be separate mounting type. They shall be adjustable through graduated scale and shall be provided with changeover contact. Thermal relays having long time/current characteristics, operated through saturated C.T.s shall be supplied, wherever required.
- 6.6.2 Bimetal thermal relays shall conform to IS: 3231 and IS/IEC 60947 and shall have built-in single phasing preventor.
- 6.6.3 The bimetal relays shall be provided with a manual resetting device resettable after opening module door. Auto reset thermal relays are not acceptable.

6.7 Current Transformers

- 6.7.1 The current transformers shall conform to IS: 2705.
- 6.7.2 C.T.s shall be Class F insulated and vacuum impregnated or resin cast. The C.T.s shall be rigidly mounted and shall be easily accessible for maintenance and testing.
- 6.7.3 The short time thermal withstand ratings of C.T.s shall be same as the thermal withstand rating of the breakers.
- 6.7.4 The C.T.s output shall be minimum 15VA for breaker feeders and 7.5 VA for the other feeders per phase and in any case, the output shall be adequate for the protection and metering duties involved with sufficient margin. The C.T.s shall have the following accuracies for the various applications:

Application	Class of accuracy as per IS: 2705
i) For metering service	- 1
ii) For use with protective relays	- 5P
iii) For use with restricted earth fault and differential relays	- PS

- 6.7.5 The C.T. cores for metering and protection shall be separate.
- 6.7.6 The ratio of C.T.s shall be as specified in Feeder details.
- 6.7.7 All the C.T.s shall be provided with terminals and shorting links. One of the terminals of the C.T. shall be earthed. The polarity of the C.T.s shall be clearly marked.
- 6.7.8 Provision of Interposing C.T.s is not acceptable.

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6.7.9 The C.T.s shall be capable of withstanding momentary open circuit on the secondary side without injurious effects.

6.8 Voltage Transformers

6.8.1 The V.T.s shall be Class F insulated and vacuum impregnated or resin cast conforming to IS: 3156.

6.8.2 The primary nominal voltage shall be equal to the system nominal voltage. The secondary terminal voltage shall be 110 V.

6.8.3 The primary and secondary winding shall be protected by HRC fuses in each phase except in the ground phase of the secondary side.

6.8.4 The V.T.s shall be mounted on separate withdrawable carriage. The accuracy Class of V.T.s shall be 1.

6.8.5 The rated output of each V.T. shall be adequate for the relays, meters and associated wiring connected to it and shall not be less than 50 VA per phase.

6.9 Control Transformers

These shall be air cooled Class F insulated and vacuum impregnated. The rating of control transformer shall be twice the hold on VA of all contactor/relays or 2.5 KVA whichever is high. It shall be free from hum and rigidly mounted. Epoxy cast transformers shall be preferred.

6.10 Transformers for Kondorffer Starting

These shall be three phase core type, Class F insulated and vacuum impregnated. Tapping at 90%, 80%, 70% & 60% shall be provided and terminals shall be brought out for easy change of tapping at site. The operating temperature shall not exceed 80°C. The transformers shall be suitable for taking 7.5 times the specified full load current of the motor continuously for 120 secs.

6.11 Relays

6.11.1 All protective relays shall be of latest version, microprocessor based numerical type with communication port and interlinked with online energy management system. 100% redundancy shall be provided for communication.



6.12 Timers

The timers shall be electronic pneumatic or synchronous type with manual/auto reset features as per the functional requirements. The time delay shall be 'ON' delay or 'OFF' delay type as specified. The repeat accuracy shall be 0.5% or better.

6.13 Single Phasing Preventor

6.13.1 Single phasing preventor relay shall be of the current operated type, suitable for the system voltage. The relay shall not operate for normal system voltage but operate positively in the event of unbalanced voltage more than the normal. The relay shall not operate in case of total interruption of power.

6.13.2 The relay shall be fail safe, self reset type and provided with flag indication. The relay operation shall be independent of the motor rating, loading and speed.

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6.14 Instruments and Meters

- 6.14.1 All instruments shall be flush mounting type with square face of 96 mm x 96 mm. They shall be tropicalized and dust tight.
- 6.14.2 Meters shall be digital multifunctional meters with communication port for energy management at remote location.
- 6.14.3 All ammeters and voltmeters, to be provided separately, shall have 0-90° scale and shall be moving iron spring controlled type of class 1.5 accuracy as per IS: 1248. The scale range of the ammeters and voltmeters shall be as indicated in the Feeder details.
- 6.14.4 In case of motor feeders, the ammeters shall be graduated uniformly upto C.T. primary current and with compressed end scale upto 6 times C.T. primary current. Red pointer shall be provided, which shall be adjusted at site for indicating full load current of the motor.

6.15 Push Buttons and Control Switches



- 6.15.1 The switches and push buttons shall conform to utilization category AC11/DC11 as per IS: 60947. The contact shall be rated to make, break and carry inductive current of 5 Amp at 415 V AC and 1 Amp at 220 V DC.
- 6.15.2 The control switches shall be spring return rotary type, unless otherwise specified and provided with pistol grip type handle. The control switches for circuit breakers shall be additionally fitted with lost motion devices and sequencing devices.
- 6.15.3 The selector switches shall be stay put rotary type and provided with oval shape handles.
- 6.15.4 The push buttons shall be of momentary contact spring loaded type with a set of normally close and open contacts. The push button for 'Start' shall be shrouded type and coloured green, stop push button shall be un-shrouded type and coloured red and other push buttons shall be un-shrouded type coloured black. The fixing ring shall be metallic white.
- 6.15.5 Emergency stop push buttons, if specified, shall be lockable in pushed position.

6.16 Miniature Circuit Breakers

- 6.16.1 The miniature circuit breakers shall conform to IS: 8828 and shall be of duty category M-9.
- 6.16.2 It shall be provided with overload and short circuit protective devices in a heat resistant housing.
- 6.16.3 A certificate for short circuit rating and Current-Time tripping curve shall be furnished along with the offer.

6.17 Signal Lamps

- 6.17.1 Signal lamps shall be provided to indicate the various circuit conditions as shown in scheme drawings. The colour of the lamps for various functions shall be as follows :
- | | | |
|-------|----|--|
| Red | -- | Circuit breaker/switch/contactor closed. |
| Green | -- | Circuit breaker/switch/contactor open. |
| White | -- | Trip circuit healthy. |
| Amber | -- | Alarm and auto trip. |
| Blue | -- | Non-Trip |
- 6.17.2 All lamps shall be of LED type with lumen output of 200 mili candela in axial direction.

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7.0 ACCESSORIES

7.1 The supply shall include the following accessories:

- Maintenance truck/device for raising, lowering and withdrawal of circuit breaker, if required.
- Fuse puller.
- Test plug for relays.
- Test plug for kWh meters.

7.2 Space Heater

Each vertical section shall be provided with a thermostatically controlled space heater, rated for 240 V, 50 Hz and controlled through double pole miniature circuit breaker.

7.3 Name Plates

7.3.1 The switchboard shall have large name plate on the top indicating its Name, Designation and Code No.

7.3.2 Each feeder shall be provided with name plate. Each single front panel shall have name plate indicating panel number both in front and back.

7.3.3 All control switches, push buttons, lamps etc. shall have functional identification labels.

7.3.4 Name plate shall be of black Perspex with white engraving and of minimum 3mm thick.

7.4 Any other accessories required, but not specified, shall also be supplied to make the switchboard complete in all respects and ensure safe and proper operation.

8.0 PAINTING

8.1 The enclosure, after degreasing, pickling in acid, cold rinsing, phosphatising, passivating etc. shall be painted with two coats of anti-rust paint followed by two coats of anticorrosive paint.

8.2 Epoxy based paint shall be used.

8.3 All paints shall be carefully selected to withstand tropical heat and extremes of weather. The paint shall not scale off, crinkle or be removed by abrasion due to normal handling.

8.4 Unless otherwise specified, the finishing shade shall be light grey having Shade No.631 as per IS: 5.



8.5 One litre of paint shall be supplied along with each board for touch up at site.

9.0 TESTS AND INSPECTION

9.1 All the switchboards shall be subjected to routine test as per IS: 8623 and their components as per relevant standards.

9.2 Additional tests, wherever specified, shall be carried out.

9.3 All the above tests shall be carried out in presence of Purchaser's representative. In addition, the equipment shall be subjected to stage inspection during process of manufacture at works and site inspection.

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9.4 These inspections shall however, not absolve the vendor from their responsibility for making good any defect which may be noticed subsequently.

10.0 DRAWINGS AND DOCUMENTS

10.1 Drawings and documents as per Annexure-I shall be supplied, unless otherwise specified.

10.2 All drawings and documents shall have the following description written boldly:

- Name of Client
- Name of Consultant
- Enquiry / Order Number with Project / Plant Name
- Code No. & Description

11.0 SPARES

11.1 Spares for operation and maintenance

Item wise unit prices of spare parts with recommended quantity shall be quoted along with the main equipment as listed in Annexure-II.

11.2 Commissioning Spares

Commissioning spares, as required, shall be supplied with the main equipment. Item wise list of recommended commissioning spares shall be furnished for approval.

11.3 Any other spare parts not specified, but required, shall also be quoted along with the offer.

11.4 All spare parts shall be identical to the parts used in the switch boards.

12.0 PACKING



12.1 The board shall be properly packed before despatch to avoid damage during transport, storage and handling.

12.2 The packing box shall contain a copy of the installation, operation and maintenance manual.

12.3 A sign to indicate the upright position of the panels to be placed during transport and storage shall be clearly marked. Also proper arrangement shall be provided to handle the equipment.

13.0 DEVIATIONS

13.1 Deviations, if any, from this standard shall be clearly indicated in the offer with reasoning.

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ANNEXURE - I



DOCUMENTATION FOR MEDIUM VOLTAGE SWITCHBOARDS

Sl.No.	Documentation Description	Documents Required (Y / N)		
		With Bid	For Approval	Final
1.	Specification Sheets, duly completed	Y	Y	Y
2.	Technical Particulars, duly filled in	Y	Y	Y
3.	Feeder Details	Y	Y	Y
4.	General arrangement and Foundation Drgs.	N	Y	Y
5.	Schematic and Wiring Diagrams	N	Y	Y
6.	Calculation for Bus-bar sizing	Y	Y	N
7.	Terminal Arrangement Drgs.	N	Y	Y
8.	Illustrative and Descriptive Literature	Y	N	Y
9.	Catalogues for bought out accessories.	Y	N	Y
10.	Installation, Operation and maintenance manual.	N	N	Y
11.	Test Certificates			
	i) Type -- Switchboard	Y	N	N
	-- Circuit Breaker	Y	N	N
	-- MCCB's	Y	N	N
	ii) Routine	N	N	Y
12.	Guarantee Certificates	N	N	Y
13.	Spare Parts List	Y	N	Y

Note:

- 4 hard copies & 1 soft copy shall be supplied with bid.
- 4 hard copies & 1 soft copy shall be supplied for approval after order within 4 weeks from the date of LOI.
- 8 hard copies & 2 soft copies in pen drive shall be submitted as final documents prior to despatch of the equipment. These shall be made in sets and supplied in fine plastic coated folder.

Y - Yes, N - No



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ANNEXURE - II

LIST OF SPARES

The following spare parts shall be quoted along with the offer:

- A. Panels with Bus-bars.
- B. Modules of various motor ratings and types of outlets.
- C. BREAKERS (OF EACH RATING)
 - i) Fixed Arcing Contact Assembly
 - ii) Moving Arcing Contact Assembly
 - iii) Mechanism Reset Spring
 - iv) Trip bar spring and any other spring used in the circuit breaker mechanism
 - v) Cluster Contacts
 - vi) Arc Chute Assembly
 - vii) Shunt trip Coil
 - viii) Closing Coil
 - ix) Motors for MWS operated breakers
 - x) Secondary Isolating Contact Blocks
 - xi) Release Devices, if any
 - xii) Shutter Assembly
- D. SWITCHES (OF EACH RATING)
 - i) Assembled Switch in Open Execution
 - ii) Single Pole moving Blade Assembly
 - iii) Single Pole Base Assembly
- E. FUSES (OF EACH RATING)
 - i) Fuse Link
 - ii) Fuse Fittings
- F. CONTROL SWITCHES
 - i) Trip-Neutral-Close Control Switch
 - ii) Local-Remote Selector Switch
 - iii) Thermostat
 - iv) Ammeter Selector Switch
 - v) Voltmeter Selector Switch

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- vi) Push Button Element
- vii) Push Button actuator of each type

- G. CONTACTOR (OF EACH RATING)
 - i) Contactor with Auxiliary Contacts
 - ii) Operating Coil
 - iii) Auxiliary Contact Block

- H. RELAYS
 - i) Relays of each type
 - ii) Glass cover of each case.



- I. INDICATION LAMPS
 - i) Indicating Lamp Globes of each colour.
 - ii) Indication Lamp Fittings
 - iii) Indicating Lamp Bulbs

- J. METERS
 - i) Ammeter
 - ii) Voltmeter

- K. TRANSFORMERS
 - i) Current Transformer of each rating.
 - ii) Potential Transformers

- L. MCB (OF EACH RATING)

- M. MISCELLANEOUS
 - i) Alarm Bell
 - ii) Alarm Buzzer

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**TECHNICAL SPECIFICATION
SHEET STEEL DISTRIBUTION BOARDS**





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REFRIGERATION SYSTEM AT NFL, NANGAL
TECHNICAL SPECIFICATION – SHEET STEEL
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1.0 SCOPE

1.1 This standard covers the technical requirements of design, manufacture, testing at works and delivery in well-packed condition of Sheet Steel Distribution Boards.

2.0 STANDARDS TO BE FOLLOWED

2.1 The design, manufacture and testing of the equipment shall comply with the latest issue of the following Indian Standards, unless otherwise specified. Equipment complying with equivalent IEC standards shall also be acceptable.

- IS: 8623 - Specification for low voltage switchgear and control gear assemblies.
- IS: 13947 - Specification for Low-voltage Switchgear and Control gear
- IS: 5578 - Guide for marking of insulated conductors.
- IS: 11353 - Guide for uniform system of marking and identification of conductors and apparatus terminals.
- IS: 10118 - Code of practice for selection, installation and maintenance of switchgear and control gear.

Various components housed in the distribution board shall conform to the Indian Standard Specification as mentioned against the component details.

2.2 The design and operational features of the equipment offered shall also comply with the provisions of the latest issue of the Indian Electricity Rules and other Statutory Acts and Regulations. The supplier shall, wherever necessary, make suitable modifications in the equipment to comply with the above.

2.3 Wherever any requirement, laid down in this standard, differs from that in Indian Standard Specification the requirement specified herein shall prevail.

3.0 SERVICE CONDITIONS

3.1 Ambient Conditions



These shall be as indicated in Design Philosophy-Electrical.

3.2 System Details

These shall be as indicated in Design Philosophy-Electrical.

4.0 OPERATING REQUIREMENTS

The distribution board shall be suitable for operating at the specified rating continuously with the specified voltage and frequency variations under the ambient conditions indicated in Design Philosophy-Electrical, without exceeding the permissible temperature rise and without any detrimental effect on any part.

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5.0 DESIGN AND CONSTRUCTIONAL FEATURES

5.1 General

- 5.1.1 The distribution board shall consist of an assembly of a series of floor mounting, identical, metal clad, dead front type panels of unitized design. The panels shall be placed side by side to form a compact assembly and shall be extensible on either side.
- 5.1.2 The complete assembly shall be dust, damp and vermin proof having minimum degree of protection equivalent to IP-52 as per IS: 13947.
- 5.1.3 The frame work of the cubicles shall be of bolted/welded construction. The minimum thickness of steel shall be 2 mm for load bearing members, 1.6 mm for non-load bearing members and 3 mm for base channel. The doors and covers shall be fabricated from cold rolled sheet steel. Suitable reinforcement, wherever necessary, shall be provided.
- 5.1.4 The door hinges shall be concealed type.
- 5.1.5 All external hardware shall be zinc passivated. The hardware for fixing the removable parts shall be provided with retaining devices.
- 5.1.6 The doors and the removable covers shall be provided with non-deteriorating neoprene gaskets. Gaskets without any discontinuity shall be preferred. Gaskets shall be held in position in groove of shaped sheet steel work or these shall be of U type. Adhesive cement, if used, shall be of good quality so that the gaskets do not come off during service.
- 5.1.7 All the components shall be accessible for inspection and maintenance without the necessity for removal of the adjacent ones. In case of single front design all components shall be accessible from the front for maintenance and back opening doors/ openable covers for maintenance shall not be acceptable.
- 5.1.8 The layout of the components inside a module shall be liberal to facilitate maintenance and the interconnection of wiring between the components shall not be subjected to any undue stress at the bends.
- 5.1.9 Mounting height of components requiring operation and observation shall not be lower than 300 mm and higher than 1800 mm.
- 5.1.10 Inter panel barriers shall be provided.
- 5.1.11 Adequate arrangement for earthing shall be provided to safeguard the operator or other personnel from electric hazards under all conditions of operation.

5.2 Panel Arrangement

- 5.2.1 The distribution board shall be drawout / non-drawout type in single front/double front configuration.
- 5.2.2 Each Panel shall have its horizontal bus-bar chamber running on the top with multi-tier module units in the centre and having vertical bus-bar chamber and cable alley on either side.
- 5.2.3 The modules shall be enclosed on all sides and shall be so arranged that larger ones are placed at the bottom portion of the panel. Fixed type modules shall be at least 300 mm from the base channel.
- 5.2.4 The number of modules in the panel shall not exceed six for motor starter feeders and eight for switch fuse/MCB/MCCB feeders. The minimum size of module shall be 300 mm and 200 mm for starter and switch fuse feeders. The incomer and bus coupler module sizes for ratings up to 400 A shall be half the panel size. For higher ratings they shall be housed in single panel.

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5.2.5 The module door shall be so interlocked that it shall not be possible to open the door with switch in closed position. Defeat interlock facility shall be provided.

5.2.6 The relay, meters, switches and lamps shall be flush mounted. All components of one module shall be mounted on the same module on a rigid sheet steel chassis. A 20 mm dia. rotating knob on the door shall be provided for closing and opening.

5.3 Bus Bars and Connections

5.3.1 The bus-bar shall be suitable for the supply system as indicated in the Design Philosophy-Electrical. The bus-bar and connections shall be made of electrolytic copper or high conductivity aluminium alloy conforming to Grade E91E of IS: 5082.

5.3.2 The bus-bar shall be amply sized to carry the rated continuous current under the specified ambient temperature without exceeding the temperature of 90°C. The bus-bars shall also be designed to withstand the system fault current for 1 second without exceeding the temperature of 200°C for bare aluminium and 250°C for bare copper. The minimum acceptable size of bus-bars shall be 250 sq. mm (Al). Calculation for the bus-bar sizing shall be furnished along with the offer.

5.3.3 In case of double front arrangement of distribution boards, different sets of vertical bus-bars shall be provided. The vertical bus-bars shall be PVC sleeved or shrouded by insulating barriers which shall have cut-outs to permit entry of power wires. It shall be possible to remove the shroud for inspection and maintenance. Neutral-bars shall be provided in this chamber.

5.3.4 Horizontal bus-bars shall be of same cross-section through out. Stepped bus-bars shall not be acceptable.

5.3.5 All bus-bars shall be arranged and colours coded according to IS: 5578/11353.

5.3.6 The horizontal bus-bar shall run in a separate bus chamber located at the top shall have separate screwed cover for inspection purpose.

5.3.7 The bus-bars shall be rigidly supported at equal intervals to withstand maximum short circuit stresses. The supports shall be of moulded construction with built in anti tracking barriers. The support material shall be of fibre glass reinforced thermosetting plastic.

5.3.8 All joints shall be suitably treated to avoid oxidation of contact surfaces and bimetallic corrosion. A minimum of two bolts with spring washers shall be used for horizontal bus-bar joints.



5.3.9 Horizontal bus bars shall be insulated with heat shrinkable PVC sleeves of reputed makes. Insulating shrouds shall be provided for all joints of insulated bus-bars.

5.4 Clearance and Creepage Distances

5.4.1 The clearance and creepage distances shall not be lower than the values specified below :

- | | | |
|---|----|-------|
| i) Minimum clearance between two live conductors | -- | 20 mm |
| ii) Minimum clearance between live part and accidentally dangerous part | -- | 20 mm |
| iii) Minimum creepage distance | -- | 28 mm |

5.4.2 The clearances and the creepage, as specified above, shall definitely be maintained in the bus-bar system. Provision of bus-bar insulations, separator or barriers shall not be considered to reduce the clearance from the values specified above.

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5.4.3 At the termination points in the equipment, e.g. switches, contactors, thermal relays, etc. it is realized that above clearance shall not always be possible to be maintained. All such points where above clearance are not possible to be maintained shall, therefore, be insulated or taped.

5.5 Insulation

5.5.1 The insulation used shall be non-hygroscopic and shall be of porcelain, Epoxy- resins or fibre glass moulded with plastic. It shall be of adequate electrical and mechanical strength to give trouble free service during normal operation and short circuit conditions.

5.5.2 The insulation shall be treated suitably to withstand the tropical conditions and atmospheric pollution.

5.6 Power Wiring

5.6.1 The connections from bus-bar including neutral to individual units on the modules shall consist of PVC insulated flexible copper cable or tapped copper strip.

5.6.2 The power wiring size shall be decided based on the rating of the switch, after using a rating factor of not more than 50% over the current rating in free air. In any case the minimum size of power wiring shall not be less than 4 sq. mm copper.

5.6.3 The size of connection from incomer to horizontal bus-bar and from horizontal bus-bar to bus coupler shall not be less than the size adopted for horizontal bus-bar.

5.7 Control Wiring

5.7.1 The switch board shall be completely factory wired and ready for external connections.

5.7.2 The wiring shall be carried out with flexible stranded PVC insulated copper conductor cables of 1100 Volt grade. The size of wires shall be as follows:

C.T. Circuit -- 2.5 sq. mm

V.T. and Control Circuits -- 1.5 sq. mm

5.7.3 All wiring shall be provided with dependent both end marking as per IS: 5578. Numbered ferrules, reading from the terminals outwards, shall be provided at both ends of all wiring for easy identification. These shall be interlocking type plastic ferrules.

5.7.4 Control wiring circuits, fed from a supply common to a number of feeders, shall be so protected that failure of a circuit in one feeder does not affect the operation of the other feeders.



5.7.5 The wiring to the equipment mounted on the doors shall be carried out with flexible multi strand copper conductor cable and supported so that opening of the door, there is no undue strain on wire leads.

5.7.6 The control cables shall be neatly arranged and properly supported.

5.8 External Cable Termination

5.8.1 All power and control cables shall enter the distribution board from the bottom. Sufficient space shall be provided for ease of connection and termination of cables.

5.8.2 All cables shall be of 1.1 KV grade PVC insulated armoured and PVC sheathed except for single core cable which shall be unarmoured. The number and sizes of cable shall be as indicated in Feeder details.

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- 5.8.3 Compression type cable glands along with the cable lugs as required shall be provided for termination of cables.
- 5.8.4 The cable glands shall be of rolled Aluminium or Nickel plated brass heavy duty double compression type and shall be mounted on a removable gland plate, provided at a minimum height of 75 mm from the bottom of the distribution board. Two numbers spare knockouts of size 20 mm shall also be provided on the gland plates for future use.
- 5.8.5 For all power cables crimped type aluminium lugs for aluminium cables and tinned copper lugs for copper cables shall be provided.
- 5.8.6 The terminal blocks shall be pressure clamp type up to 35 sq. mm cable and bolted lug type for higher sizes of cables. These shall be protected type and rated for 1100 Volts service. The minimum current rating of terminal block shall be 16 Amp. The construction shall be such that after the connection of cables by means of lugs, necessary clearance and creepage distance are available.
- 5.8.7 Where more than two cables in parallel are required to be terminated, a system of bus links shall be provided with adequate clearance and spacing.
- 5.8.8 Suitable clamps to support the vertical run of cables shall be provided.
- 5.8.9 The terminal block shall be grouped according to circuit functions and suitably numbered. 20% extra terminals shall be provided in the terminal block.
- 5.8.10 For power connections, suitable marking on the terminals shall be provided to identify the phases.

5.9 Feeder Details



- 5.9.1 The requirements of incomer, bus coupler and outgoing feeders shall be as indicated in the single line diagram, feeder details and corresponding schematic diagram.
- 5.9.2 The bus coupler shall be so located that it is possible to maintain half of the bus-bars while the other half is still alive. Complete segregation of bus-bar connections to bus coupler shall be provided.
- 5.9.3 Castle key type mechanical interlocks shall be provided between incomers and bus section modules to avoid paralleling of incomers. In addition padlocking facilities shall be provided in OFF position.
- 5.9.4 Single phase loads shall be distributed as far as possible on all the three phases.

6.0 COMPONENT DETAILS

- 6.1 The make of the components shall be as specified elsewhere in the NIT and shall conform to type of co-ordination C as per IS: 13947.

6.2 Moulded Case Circuit Breakers

- 6.2.1 The circuit breaker shall conform to IS: 13947 (Part 2) and shall be of P2 category having rupturing capacity as specified.
- 6.2.2 The circuit breaker shall be provided with spring assisted quick make quick break type manually operated trip free mechanism, mechanical ON/OFF position indicators, thermal tripping devices of inverse characteristics, instantaneous short circuit tripping devices and necessary auxiliary and alarm switches. The MCCB cubicle shall be provided with service, test and isolated position and automatic safety shutter.
- 6.2.3 The thermal and short circuit tripping device shall be adjustable type.

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6.2.4 When used for motor circuit shunt trip devices shall be provided and the let through power of controlling MCCB shall be lower than the respective contactor.

6.2.5 In addition, under voltage trip shall be provided, if specified.

6.3 Switches

6.3.1 The switches shall be Motor duty type AC23 category and shall comply with the requirements laid down in IS: 13947 (Part 3). Switches up to 63 Amps shall be rotary type and those of 100 Amp and above shall be link type.

6.3.2 'ON' and 'OFF' positions of the switches shall be indicated on the panel. Provision shall be made to lock the switch in the 'OFF' position.

6.3.3 The fixed contacts shall be shrouded and the contacts shall be silver plated.

6.3.4 Two Pole switches shall also isolate the neutral circuit along with phase circuit. 4 Pole / 2 Pole switches shall be used for 3 Phase/1 Phase circuits respectively.

6.4 Fuses

The fuses shall be of non-deteriorating HRC cartridge link type and conform to IS: 13703. They shall be suitable for the load and the service required in the circuit.

6.5 Air Break Contactors

6.5.1 The Air Break Contactor shall be of AC3 category unless otherwise specified, conforming to IS: 13947 (Part-4) and flapper type. Gravity operated contactors are not acceptable.

6.5.2 The dropout voltage shall not exceed 65% of rated voltage.

6.5.3 Each contactor shall be provided with auxiliary contacts as required. The rating of the auxiliary contacts shall be 5 Amps. AC or 1 Amp DC at the specified control voltages. The spare auxiliary contacts shall also be wired terminal block.

6.6 Bimetal Thermal Overload Relays

6.6.1 The contactor shall be provided with three pole bimetal thermal overload relays unless otherwise specified. The bimetal relays shall be of suitable range, ambient temperature compensated and shall be separate mounting type. They shall be adjustable through graduated scale and shall be provided with changeover contact.

6.6.2 Bimetal relays shall conform to IS: 3231 and shall have built in single phasing preventor.



6.6.3 The bimetal relays shall be provided with a manual reset device resettable after opening the cubicle door. Auto reset thermal relays are not acceptable.

6.7 Current Transformers

6.7.1 The current transformers shall conform to IS: 2705.

6.7.2 Current Transformers shall be Class-F insulated and vacuum impregnated. The Current Transformers shall be rigidly mounted and shall be easily accessible for maintenance and testing.

6.7.3 The Current Transformers shall be of 7.5 VA output. The output shall be adequate for the instrument and metering duties involved with sufficient margin. The Current Transformers shall have the accuracy Class-1 for the metering duty.

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6.7.4 All the Current Transformers shall be provided with terminals and shorting links. One of the terminals of C.T. shall be earthed. The polarity of the C.T. shall be clearly marked.

6.7.5 The C.T.s shall be capable of withstanding momentary open-circuit on the secondary side without injurious effects.

6.8 Instruments and Meters

6.8.1 All instruments shall be flush mounting type with square face and shall be tropicalized and dust tight.

6.8.2 The size of the instruments shall be 96 mm x 96 mm for full and half size modules and 72 mm x 72 mm for lower size modules.

6.8.3 Dials shall be parallax free with scale marked in black on white background and shall be suitable for direct reading.

6.8.4 Zero adjusters shall be provided for operation from the front of the cases.

6.8.5 All ammeters and voltmeters shall have 0 - 240° scale moving iron spring controlled type and of Class 1.5 accuracy as per IS: 1248. The scale range of the ammeter and voltmeter shall be as indicated in the feeder details.

6.8.6 In case of motor feeders, the ammeter shall be graduated uniformly upto C.T. primary current and with a compressed end scale upto 6 times the C.T. primary current. Red pointer shall be provided, which can be adjusted at site for indicating full load current.

6.8.7 KWH meter shall be 3 phase 4 wire type. These shall conform to the requirements of relevant IS and shall be C.T. operated. The current coil shall be rated for 5 Amp.

6.8.8 All kWh meters shall be provided with test blocks for current and voltage coils for testing them at site without interrupting their recording while in service.

6.9 Push Button and Control Switches

6.9.1 The switches and push buttons shall conform to utilization category AC 11/DC 11 as per IS: 13947 (Part-5). The contact shall be rated to make, break and carry inductive current of 5 Amp. at 415 V AC and 1 Amp at 220 V DC.

6.9.2 The control switches shall be spring return rotary type unless otherwise specified and provided with pistol grip type handle. The control switches for circuit breakers shall be additionally fitted with lost motion devices and sequencing devices.

6.9.3 The selector switches shall be stay-put rotary type and provided with oval shape handles.



6.9.4 The push buttons shall be of momentary contact spring loaded type with a set of normally close and open contacts. The push button for 'Start' shall be shrouded type and coloured green, stop push button shall be un-shrouded type and coloured red and other push buttons shall be un-shrouded type coloured black. The fixing ring shall be metallic white.

6.9.5 Emergency stop push buttons, if specified, shall be lockable in pushed position.

6.10 Miniature Circuit Breakers

6.10.1 The miniature circuit breakers shall conform to IS: 13032 and shall be of duty category M-9.

6.10.2 It shall be provided with overload and short circuit protective devices in a heat resistant housing.

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6.10.3 A certificate of short circuit rating and current time tripping curve shall be furnished alongwith the offer.

6.11 **Signal Lamps**

6.11.1 Signal lamps shall be provided to indicate the various circuit conditions as shown in scheme drawings. The colour of the lamps for various functions shall be as follows:

Red -- Switch/Contactor closed.
Green -- Switch/Contactor open.

6.11.2 The lamps shall be LED type having lumen output 200 milli candela in axial direction.

6.11.3 It shall be possible to remove the globe from outside for replacement of lamps.

7.0 **ACCESSORIES**

7.1 The supplier shall include the following accessories.

-- Fuse Puller.
-- Test plug for kWh meters.

7.2 **Space Heater**

Each vertical section shall be provided with a thermostatically controlled space heater, rated for 240 V, 50 Hz and controlled through double pole miniature circuit breaker.

7.3 **Name Plates**

7.3.1 The distribution board shall have large name plate on the top to indicate its name and designation.

7.3.2 Each feeder shall be provided with name plate. Each single front panel shall have name plate both in front and back.

7.3.3 All control switches, push buttons, lamps etc. shall have functional identification labels.

7.3.4 Name plate shall be of black perspex with white engraving and of minimum 3 mm thick.

7.3.5 Any other accessories required, but not specified shall also be supplied to make the distribution board complete in all respects to ensure safe and proper operation.

8.0 **PAINTING**



8.1 The enclosure after degreasing, pickling in acid, cold rinsing phosphatising, passivating etc. shall be painted with two coats of anti-rust paint followed by two coats of anticorrosive paint.

8.2 Epoxy based paint shall be used.

8.3 All paints shall be carefully selected to withstand tropical heat and extremes of weather. The paint shall not scale off, crinkle or be removed by abrasion due to normal handling.

8.4 Unless otherwise specified, the finishing shade shall be light grey Shade No.631 as per IS: 5.

8.5 One litre of paint shall be supplied along with each board for touch up at site.

	HORTON SPHERE ALONG WITH ITS REFRIGERATION SYSTEM AT NFL, NANGAL TECHNICAL SPECIFICATION – SHEET STEEL DISTRIBUTION BOARD (TS-8080)	PC281-NFL-N/E-1/P-II/7.0	0	
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9.0 TESTS AND INSPECTION

- 9.1 The distribution boards shall be subjected to routine test as per IS: 8623.
- 9.2 Additional tests, wherever specified, shall be carried out.
- 9.3 All the above tests shall be carried out in presence of purchaser's representative. In addition, the equipment shall be subjected to stage inspection during process of manufacture at works and site inspection.
- 9.4 These inspections shall however, not absolve the vendor from his responsibility for making good any defect which shall be noticed subsequently.

10.0 DRAWINGS AND DOCUMENTS



- 10.1 Drawings and documents as per Annexure-I shall be supplied unless otherwise specified.
- 10.2 All drawings and documents shall have the following description written boldly:
- Name of client
 - Name of consultant
 - Enquiry / Order Number with plant / project name
 - Code No. and Description

11.0 SPARES

- 11.1 Spares for operation and maintenance
- Item wise unit prices of spare parts with recommended quantity shall be quoted along with the equipments as listed in the Annexure-II.
- 11.2 Commissioning Spares
- Commissioning spares, as required, shall be supplied with the main equipment. Item wise list of recommended commissioning spares shall be furnished for approval.
- 11.3 Any other spare parts not specified, but required, shall also be quoted along with the offer.
- 11.4 All spare parts shall be identical to the parts used in the equipments.



12.0 PACKING

- 12.1 The distribution board shall be properly packed before despatch to avoid damage during transport, storage and handling.
- 12.2 The packing box shall contain a copy of the installation, operation and maintenance manual.
- 12.3 A sign to indicate the upright position of the panels to be placed during transport and storage shall be clearly marked. Also proper arrangement shall be provided to handle the equipment.

	HORTON SPHERE ALONG WITH ITS REFRIGERATION SYSTEM AT NFL, NANGAL TECHNICAL SPECIFICATION – SHEET STEEL DISTRIBUTION BOARD (TS-8080)	PC281-NFL-N/E-1/P-II/7.0	0	
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13.0 DEVIATIONS

13.1 Deviations, if any, from this standard shall be clearly indicated in the offer with reasoning.

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ANNEXURE - I



DOCUMENTATION FOR SHEET STEEL DISTRIBUTION BOARDS

Sl.No.	Documents	Documents Required (Y / N)		
		With Bid	For Approval	Final
1.	Specification Sheet, duly completed	Y	Y	Y
2.	Technical Particulars, duly filled-in	Y	Y	Y
3.	Feeder Details	Y	Y	Y
4.	General Arrangement and Foundation Drawings	Y	Y	Y
5.	Schematic Diagrams with Terminal arrangement drawings	N	Y	Y
6.	Calculation for Bus-bar sizing	Y	Y	N
7.	Illustrative and Descriptive literature	Y	N	Y
8.	Catalogues for bought out accessories	Y	N	Y
9.	Installation, Operation and Maintenance Manual	N	N	Y
10.	Test Certificates			
	-- Type (for MCCB & MCB)	Y	N	N
	-- Routine	N	N	Y
11.	Guarantee Certificates	N	N	Y
12.	Spare Parts List	Y	N	Y

Note:

1. 4 hard copies & 1 soft copy shall be supplied with bid.
2. 4 hard copies & 1 soft copy shall be supplied for approval after order within 4 weeks from the date of LOI.
3. 8 hard copies & 2 soft copies in pen drive shall be submitted as final documents prior to despatch of the equipment. These shall be made in sets and supplied in fine plastic coated folder.

Y - Yes, N - No

	HORTON SPHERE ALONG WITH ITS REFRIGERATION SYSTEM AT NFL, NANGAL TECHNICAL SPECIFICATION – SHEET STEEL DISTRIBUTION BOARD (TS-8080)	PC281-NFL-N/E-1/P-II/7.0	0	
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ANNEXURE - II

LIST OF SPARES

The following spare parts shall be quoted along with the offer.

- A MOULDED CASE CIRCUIT BREAKER (OF EACH RATING)**
- i) Complete Breaker Assembly
 - ii) Complete Breaker Assembly.
- B SWITCHES (OF EACH RATING)**
- i) Assembled switch in open execution
 - ii) Single pole moving blade assembly
 - iii) Single pole base assembly
- C FUSES (OF EACH RATING)**
- i) Assembled switch in open execution
 - ii) Single pole moving blade assembly
 - iii) Single pole base assembly
- D CONTROL SWITCHES**
- i) Trip-Neutral-Close Control Switch
 - ii) Local-Remote Selector Switch
 - iii) Heater Switch
 - iv) Thermostat
 - v) Ammeter Selector Switch
 - vi) Voltmeter Selector Switch
 - vii) Push Button
 - viii) Push Button Element
 - ix) Push Button Actuator of each type
- E CONTACTOR (OF EACH RATING)**
- i) Contactor with Auxiliary Contacts
 - ii) Operating Coil
 - iii) Auxiliary Contact Block
- F INDICATING LAMPS**
- i) Indicating lamps globes of each colour
 - ii) Indicating lamp fittings
 - iii) Indicating lamp bulbs
- G METERS**
- i) Ammeter
 - ii) Voltmeter
- H PROTECTIVE RELAYS**
- i) Relays
 - ii) Thermal overload relay of each type

NOTE: 1. All spare parts shall be identical to the parts used in the distribution boards.

	HORTON SPHERE ALONG WITH ITS REFRIGERATION SYSTEM AT NFL, NANGAL TECHNICAL SPECIFICATION – LIGHTING SUB DISTRIBUTION BOARDS (TS-8083)	PC281-NFL-N/E-1/P-II/7.0	0	
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TECHNICAL SPECIFICATION LIGHTING SUB DISTRIBUTION BOARDS



**HORTON SPHERE ALONG WITH ITS
REFRIGERATION SYSTEM AT NFL, NANGAL
TECHNICAL SPECIFICATION – LIGHTING SUB
DISTRIBUTION BOARDS (TS-8083)**

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SECTION NUMBER	DESCRIPTION
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3.0	SERVICE CONDITIONS
4.0	OPERATING REQUIREMENTS
5.0	GENERAL DESIGN AND CONSTRUCTIONAL FEATURES
6.0	SPECIAL FEATURES FOR FLAME PROOF LIGHTING SUB DISTRIBUTION BOARDS
7.0	COMPONENT DETAILS
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9.0	TESTS AND INSPECTION
10.0	DRAWINGS AND DOCUMENTS
11.0	SPARES
12.0	PACKING
13.0	DEVIATIONS
ANNEXURE - I	DOCUMENTATION FOR LIGHTING SUB DISTRIBUTION BOARDS

LIST OF ATTACHMENTS

ATTACHMENT NUMBER	DESCRIPTION
SD: 8083	TYPICAL WIRING DIAGRAM FOR LIGHTING SUB-DISTRIBUTION BOARDS

	HORTON SPHERE ALONG WITH ITS REFRIGERATION SYSTEM AT NFL, NANGAL TECHNICAL SPECIFICATION – LIGHTING SUB DISTRIBUTION BOARDS (TS-8083)	PC281-NFL-N/E-1/P-II/7.0	0	
		DOCUMENT NO.	REV.	
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1.0 SCOPE

- 1.1 This standard covers the technical requirements of design, manufacture, testing at works and delivery in well packed condition of lighting sub distribution boards.

2.0 STANDARDS TO BE FOLLOWED

- 2.1 The design, manufacture and testing of the equipment covered by this standard shall comply with the latest issue of the following Indian Standards. Equipment complying with equivalent IEC standards shall also be acceptable

IS: 13947 - Low voltage switchgear and control gear

IS: 8623 - Specification for low voltage switchgear and control gear assemblies

- 2.2 The design and operational features of the equipment offered shall also comply with the provisions of latest issue of the Indian Electricity Rules and other relevant statutory acts and regulations. The supplier shall, wherever necessary, make suitable modification in the equipment to comply with the above.

- 2.3 Wherever any requirement, laid down in this standard, differs from that in Indian Standard Specifications, the requirement specified herein shall prevail.

3.0 SERVICE CONDITIONS

3.1 Ambient Conditions

These shall be as indicated in Design Philosophy-Electrical.

3.2 System Details

These shall be as indicated in Design Philosophy-Electrical.



4.0 OPERATING REQUIREMENTS

The lighting sub-distribution boards shall be suitable for operating continuously under the ambient conditions and with the voltage and frequency variations indicated in Design Philosophy-Electrical, without exceeding the specified temperature rise and without any detrimental effect on any part.

5.0 GENERAL DESIGN AND CONSTRUCTIONAL FEATURES

- 5.1 The lighting sub distribution boards shall be fabricated out of 2.5 mm thick cold rolled sheet steel and shall be suitable for mounting on wall/structure. These shall have dust and vermin proof construction conforming to IP-54 as per IS: 13947. For outdoor installation, the enclosure shall conform to IPW-55, suitable canopy made out of 2 mm thick Aluminium sheet shall be supplied along with the board.

- 5.2 The miniature circuit breakers shall be so mounted inside the enclosure that their operating knobs project outside for easy operation. The cut-out for the knobs on the enclosure shall be lined with gasket for dust proofness. For further protection against ingress of dust, the portion where the knobs have protruded out, shall be provided with another external front cover, internally hinged at the top, gravity operated and with a knurled knob at the bottom. The external cover shall be flushed with the main cover.

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Continuous neoprene gasket shall be provided to make the board completely dust and weather proof.



- 5.3 All external hard ware of diameter less than 8 mm shall be of stainless steel and those of diameter 8 mm and above shall be of mild steel zinc passivated.
- 5.4 The sub-distribution boards to be located indoors shall have top entry arrangement for outgoing cables and bottom entry for incoming cable. However for outdoor locations, all cable entries shall be from the bottom only.
- 5.5 Three phase and neutral bus bar system of adequate size shall be provided to which all outgoing and incoming MCB's shall be connected.
- 5.6 The internal wiring shall be carried out by means of single core PVC insulated 2.5 sq. mm stranded copper conductor cables.
- 5.7 Two earthing terminals outside the board shall be provided.
- 5.8 Suitable label inscription consisting of black perspex with engraving for the board and circuit nos. of all outgoing feeders shall be provided. The label inscription of the board shall contain description and code no.. The circuit nos. of outgoing feeders shall be serially indicated as 1L, 2L.....17L, 18L.
- 5.9 The board shall be complete with terminal block, cable glands, cable lugs and other accessories as specified.

6.0 SPECIAL FEATURES FOR FLAME PROOF LIGHTING SUB DISTRIBUTION BOARDS

- 6.1 The enclosure shall be in addition of flame proof execution as per IS: 2148.
- 6.2 The enclosure group and temperature class shall be as indicated in Design Philosophy.
- 6.3 The enclosure shall be of cast iron/cast Aluminium alloy (4600 as per IS: 617).
- 6.4 Cables shall enter the terminal chamber through flame proof compression type cable glands. From terminal chamber to the main enclosure connection shall be made through bushings. Direct entry of external cables into the main enclosure shall not be accepted.
- 6.5 The sub-distribution board shall be of 6 way type.
- 6.6 Individual earth terminals shall be provided for the earth conductor of the outgoing cables beside the phase and neutral terminals.
- 6.7 The sub-distribution board must be certified by Central Mining Research Institute, Dhanbad or other statutory authority for use in specified hazardous area.

7.0 COMPONENT DETAILS

- 7.1 The lighting sub-distribution board shall be wired and have components as per SD-8083 (copy attached).

	HORTON SPHERE ALONG WITH ITS REFRIGERATION SYSTEM AT NFL, NANGAL TECHNICAL SPECIFICATION – LIGHTING SUB DISTRIBUTION BOARDS (TS-8083)	PC281-NFL-N/E-1/P-II/7.0	0	
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7.2 Miniature Circuit Breaker (MCB)

- 7.2.1 The MCB shall be of duty category M-9 and shall conform to IS-8828. It shall be provided with overload and short circuit protective devices.
- 7.2.2 The incoming MCB's or switches shall be of triple pole and switched neutral type and outgoing MCB's of single pole and switched neutral type, single phase earth leakage protection in each phase of the incomer shall be provided.

7.3 Terminal Block

Pressure clamp type terminal blocks shall be provided both for incoming and outgoing cables. The rating of the terminal block shall be at least 1.5 times the rating of the MCB.

7.4 Cable Glands

Heavy duty double compression type Aluminium cable glands suitable for XLPE insulated, armoured and PVC sheathed 1.1 KV grade incoming and outgoing cables shall be provided.

8.0 PAINTING



- 8.1 The enclosure after suitable pre-treatment shall be painted with two coats of anti rust paint followed by two coats of anticorrosive paint.
- 8.2 Epoxy based paint shall be used.
- 8.3 All paints shall be carefully selected to withstand tropical heat and extremes of weather. The paint shall not scale off, crinkle or be removed by abrasion due to normal handling.
- 8.4 The finishing shade shall be light grey shade no.631 as per IS: 5.

9.0 TESTS AND INSPECTION

- 9.1 All the lighting sub-distribution boards shall be subjected to routine tests as per IS: 8623.
- 9.2 Additional tests, wherever specified, shall be carried out on one lighting sub-distribution board of each type.
- 9.3 The above mentioned tests shall be carried out in the manufacturer's works in the presence of purchaser's representative. In addition, the equipment shall be subjected to stage inspection at works and inspection at site for final acceptance.
- 9.4 The purchaser's inspection shall, however, not absolve the vendor from his responsibility for making good any defects which may be noticed subsequently.

10.0 DRAWINGS AND DOCUMENTS

- 10.1 Drawings and documents as per Annexure-I shall be supplied, unless otherwise specified.
- 10.2 All drawings and documents shall have the following description written boldly.
- Name of client
 - Name of consultant

	HORTON SPHERE ALONG WITH ITS REFRIGERATION SYSTEM AT NFL, NANGAL TECHNICAL SPECIFICATION – LIGHTING SUB DISTRIBUTION BOARDS (TS-8083)	PC281-NFL-N/E-1/P-II/7.0	0	
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- Enquiry / Order Number with plant / project name
- Code No. and Description

11.0 SPARES

11.1 Spares for operation and maintenance

Item wise unit prices for the following items, along with recommended quantity for the period, shall be quoted along with the main equipment.

- i) MCB
- ii) Terminal blocks
- iii) Terminal bushings

11.2 Commissioning Spares

Commissioning spares, as required, shall be supplied with the main equipment. Item wise list of recommended commissioning spares shall be furnished for approval.

11.3 Any other spare parts not specified, but required, shall also be quoted along with the offer.

11.4 All spare parts shall be identical to the parts used in the equipment.



12.0 PACKING

12.1 The equipment shall be properly packed to safeguard against weather conditions and handling during transit. It shall be wrapped in polythene bags and an additional wrapping of bitumen paper shall also be provided to make it completely water proof before the equipment is packed in wooden crates.

12.2 The packing box shall contain a copy of the installation, operation and maintenance manual.

13.0 DEVIATIONS

13.1 Deviations, if any, from this standard shall be clearly indicated in the offer with reasoning.

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ANNEXURE - I

DOCUMENTATION FOR LIGHTING SUB DISTRIBUTION BOARDS

SL. NO.	Description	Documents Required (Y / N)		
		With Bid	For Approval	Final
1.	Specification Sheet, duly completed	Y	Y	Y
2.	Technical particulars, duly filled-in	Y	Y	Y
3.	General arrangement Drgs.	Y	Y	Y
4.	Certificate for flameproofness from statutory testing authority wherever applicable	Y	N	Y
5.	Schematic diagram	N	Y	Y
6.	Descriptive literature of Various equipment	Y	N	Y
7.	Guarantee certificate	N	N	Y
8.	Test certificate	N	N	Y

Note:

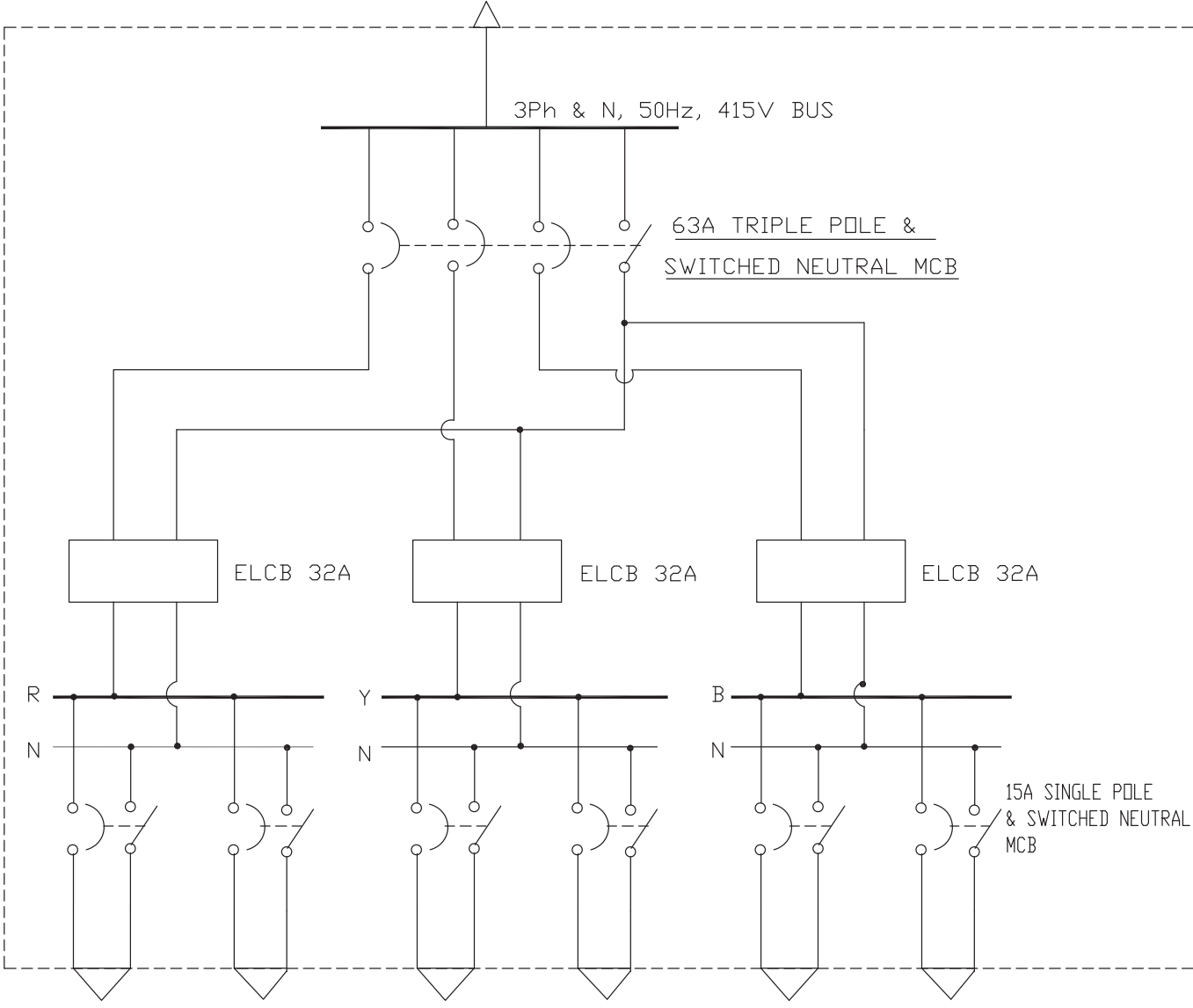
1. 4 hard copies & 1 soft copy shall be supplied with bid.
2. 4 hard copies & 1 soft copy shall be supplied for approval after order within 4 weeks from the date of LOI.
3. 8 hard copies & 2 soft copies in pen drive shall be submitted as final documents prior to despatch of the equipment. These shall be made in sets and supplied in fine plastic coated folder.

Y - Yes, N - No





TYPICAL WIRING DIAGRAM
FOR
LIGHTING SUB-DISTRIBUTION BOARDS



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SL. NO.	LIGHTING SUB-DIST. BOARD TYPE	NOS. OF OUTGOING FEEDERS
1.	A	6
2.	B	9
3.	C	12
4.	D	15
5.	E	18



 पी डी आई एल PDIL	HORTON SPHERE ALONG WITH ITS REFRIGERATION SYSTEM AT NFL, NANGAL TECHNICAL SPECIFICATION – INDUCTION MOTOR (TS-8102)	PC281-NFL-N/E-1/P-II/7.0	0	 एन एफ एल NFL
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**TECHNICAL SPECIFICATION
INDUCTION MOTOR**

	HORTON SPHERE ALONG WITH ITS REFRIGERATION SYSTEM AT NFL, NANGAL TECHNICAL SPECIFICATION – INDUCTION MOTOR (TS-8102)	PC281-NFL-N/E-1/P-II/7.0	0	
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6.0	COUPLING DETAILS
7.0	ACCESSORIES
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9.0	NOISE LEVEL
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ANNEXURE - I	DOCUMENTATION FOR INDUCTION MOTORS

	HORTON SPHERE ALONG WITH ITS REFRIGERATION SYSTEM AT NFL, NANGAL TECHNICAL SPECIFICATION – INDUCTION MOTOR (TS-8102)	PC281-NFL-N/E-1/P-II/7.0	0	
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1.0 SCOPE

- 1.1 This standard covers the technical requirements of design, manufacture, testing at works and delivery in well-packed condition of medium voltage and high voltage induction motors.

2.0 STANDARDS TO BE FOLLOWED

- 2.1 The design, manufacture and testing of the equipment covered by this standard shall comply with the latest issue of IS-325 and other relevant Indian Standards, unless otherwise specified. Equipment complying with equivalent IEC standards shall also be acceptable.
- 2.2 The design and operational features of the equipment offered shall also comply with the provisions of latest issue of the Indian Electricity Rules and other relevant Statutory Rules & Regulations. The supplier shall, whenever necessary, make suitable modification in the equipment to comply with the above mentioned rules.
- 2.3 Flame proof motors shall, in addition, comply with the requirements laid down in IS: 2148.
- 2.4 Increased safety motors shall, in addition, comply with the requirements laid down in IS: 6381.
- 2.5 Motors with type of protection “n” shall, in addition, comply with the requirements laid down in IS: 9628.
- 2.6 Wherever any requirement laid down in this standard differs from that in Indian Standard Specifications, the requirement specified herein shall prevail.

3.0 SERVICE CONDITIONS

3.1 Ambient Conditions

The ambient conditions shall be as indicated in the Design Philosophy-Electrical.



3.2 System Details

- 3.2.1 The details of power system to which the motors will be connected shall be as indicated in the Design Philosophy-Electrical.
- 3.2.2 The motors shall be suitable for connection to a power system where transient disturbances are very likely to occur. During the transient disturbances, voltage of the system may completely disappear and return in a short time with the motors still running and connected. Under this condition, the return of voltage may occur at such an instant that the induced e.m.f. in the motor is in phase with the applied voltage giving rise to current surges which may reach a value equal to 1.6 times the starting current and also cause transient torques of large magnitudes.

4.0 GENERAL DESIGN FEATURES

4.1 Enclosure

- 4.1.1 The enclosure of motors for indoor and outdoor services shall be IP-54 and IPW-55 respectively as per IS: 4691, unless otherwise specified.

	HORTON SPHERE ALONG WITH ITS REFRIGERATION SYSTEM AT NFL, NANGAL TECHNICAL SPECIFICATION – INDUCTION MOTOR (TS-8102)	PC281-NFL-N/E-1/P-II/7.0	0	
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4.1.2 Motors for outdoor service shall be provided with special seals for the enclosure, joints, bearing housing, terminal boxes etc. so that no extra protective covering for ingress of water shall be required.

4.1.3 Vertical motors for outdoor installation shall be provided with a rain protective hood.

4.1.4 All external hardwares shall be zinc passivated.

4.1.5 The enclosure shall be provided with threaded metallic plug to permit drainage of condensed water from the inside.

4.2 **Cooling**

4.2.1 All motors shall be totally enclosed fan cooled conforming to IC-0141 as per IS: 6362 unless otherwise specified.

4.2.2 In case of CACA construction, the same shall conform to IC-0161 as per IS: 6362.

4.2.3 In case of CACW construction, the same shall conform to ICW 37A 91 as per IS: 6362.

4.2.4 Wherever service conditions are such that corrosive agents are present in the surroundings, the following materials of construction for cooling tubes shall be adopted, unless otherwise specified.

For CACA motor - Aluminium tubes having minimum thickness of 1.6 mm

For CACW motor - Low carbon alloy steel

4.2.5 In case of CACW motors, the cooling tubes and flanges shall also be suitable for the cooling water analysis. Trays shall be provided for collection of leaking water with arrangement for its drainage.

4.2.6 The cooling fans shall be suitable for bidirectional rotation of motors. These shall be fastened to the motor shaft by means of compensating rings or will be balanced independent of the motor. Guide key or reference points shall be supplied to prevent wrong assembly. The cooling air shall be sucked from the non-driving end.

4.2.7 The cooling fans shall be made of non-sparking materials such as cast Aluminium (LM-6 alloy) / cast iron.



4.3 **Direction of Rotation**

4.3.1 Motors shall be suitable for both directions of rotation. In case of any design limitation, the same shall be indicated in the offer.

4.3.2 In either case, a plate showing the direction of rotation corresponding to the phase terminal markings shall be fitted at the driving end shield of the motors.

4.4 **Stator**

4.4.1 The stator laminations shall be made from suitable magnetic sheet iron varnished on both sides. Where ventilation is required, these shall be arranged in suitable packs, each pack being separated by spacers to form ventilating ducts for circulation of air.

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4.4.2 The slot shall be open type with coils so arranged that the coils can be easily removed for inspection and repair.

4.5 **Rotor**

4.5.1 The rotor shall be of squirrel cage construction, unless otherwise specified.

4.5.2 For small motors, the squirrel cage shall preferably be of pressure die-cast construction. For large motors, the rotor bars and the end rings shall be of copper or copper alloy. The bars shall be firmly placed in slots to prevent vibration during start up / locked rotor condition. Conductor ends shall be securely fixed to the end rings using the latest brazing techniques. Retaining rings shall be provided for high speed machines for the end rings. The rotor cage shall be designed for the required starting and duty cycles.

4.5.3 Wherever wound rotor is specified, the windings shall have the same features as detailed for the stator windings. The rotor voltage shall not exceed the stator voltage.

4.5.4 The rotor shall be dynamically balanced and shall rotate perfectly with no preferential stop points. The rotor shall be constructed such as to allow the removal or addition of material for balancing.

4.5.5 The rotor shaft shall be electrically and magnetically so balanced that the induced shaft voltage does not exceed 200 millivolt. Otherwise the bearing housing at non-driving end shall be insulated for 2 KV.

4.6 **Windings and Insulation**

4.6.1 The motor coils shall be made out of insulated electrolytic grade copper conductor. Successive coils shall be connected by accessible joints, well brazed and finished smooth to prevent damage to insulation.

4.6.2 The motors shall be insulated assuming the power system neutral as isolated.

4.6.3 All motors shall be insulated with class B or F insulation with tropical and fungicidal treatments.



4.6.4 Wherever class F insulation is specified, the windings shall be easily replaceable type and the temperature rise shall not exceed that of class B insulation.

4.6.5 The winding coils shall be dried, properly impregnated with suitable varnishes to withstand the site conditions and properly baked. At least two additional impregnations and baking shall be applied to the assembled stator coil, making a total of three impregnations and baking. Finally the windings shall be painted with special anti-acid and anti-alkali paints to withstand the site conditions.

4.6.6 The windings shall be well brazed and capable of withstanding thermally and mechanically the transient disturbances specified under clause 3.2.2.

4.6.7 Lead-in wire between the windings and the outside terminals shall be made through bushings in H.V. motors. For M.V. motors, heat resistant insulated conductors shall be used as lead-in wire.

4.6.8 The windings shall be star connected for high voltage motors and delta connected for medium voltage motors.

	HORTON SPHERE ALONG WITH ITS REFRIGERATION SYSTEM AT NFL, NANGAL TECHNICAL SPECIFICATION – INDUCTION MOTOR (TS-8102)	PC281-NFL-N/E-1/P-II/7.0	0	
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4.7 Slip Rings and Brushes



- 4.7.1 Slip rings shall be located in the non-driving side. The material of construction shall be copper alloy. The slip rings and the brush gear shall be cooled by the motor cooling fan.
- 4.7.2 For explosion proof motors, the slip rings and brush gear shall be housed in a flameproof housing. In case this is not possible, the housing shall be pressurised type with flameproof pressure switch for interlocking with the motor. In either case, glass covers shall be provided for inspection.
- 4.7.3 The starting rheostats shall be designed for intermittent duty and rated for 10 minutes. Where speed regulation is required, the rheostats and the controllers shall be suitable for such duty and be continuously rated. Auxiliary contacts shall be provided on the controllers for connections to the motor supply controls to prevent wrong operations during starting.

4.8 Bearings



- 4.8.1 All motors shall be provided with bearings suitable for the application. The bearings must be guaranteed to ensure a smooth operation and a life not shorter than 30,000 hrs.
- 4.8.2 Where external thrusts are specified, the motors shall be fitted with special roller thrust bearings capable of withstanding the specified thrust. In such cases, the guaranteed life of the bearings shall not be less than 20,000 hours.
- 4.8.3 The bearing housing shall be effectively sealed against ingress of dust and water and creep age of lubricants along the shaft.
- 4.8.4 The bearing shall be suitable for both directions of rotation of the motor.
- 4.8.5 All motors shall be provided with on-line grease lubrication arrangement for both DE and NDE side bearings except for motors of frame size 112 and less and flange mounted M.V. motors. The arrangement shall be complete with grease nipple and drain plug located at convenient locations.
- 4.8.6 All oil lubricated bearings shall be fitted with oil level indicator and resistance temperature detector/dial type thermometer with alarm and trip contacts.
- 4.8.7 Self cooled bearing system shall be preferred.
- 4.8.8 The manufacturer shall specify the type of lubricant and the time interval of lubrication for the bearings of each motor.
- 4.8.9 The bearing temperature shall not exceed 90°C for grease lubricated bearings and 70°C for oil lubricated bearings.
- 4.8.10 Wherever shaft end-play has been specified, the bearings shall be capable of providing the specified end-play.

4.9 Terminal Box

- 4.9.1 All the terminal boxes shall have identical degree of protection as that of the motor.

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- 4.9.2 The power terminal box shall be mounted on the right hand side of the motor as viewed from the coupling end. For M.V. Motors, design of terminal boxes shall be such that it may be possible to arrange top/bottom/side entry of cables at site.
- 4.9.3 The power terminal boxes shall be as follows:
- a) For H.V. motors - Phase segregated type capable of with standing the system fault level for 0.2 Sec. or more.
 - b) For M.V. motors - Manufacturer's standard box with epoxy or SRBF moulded terminal board.
- 4.9.4 The mounting arrangement of power and neutral side terminal boxes for HV motors shall be identical so that it shall be possible to interchange the boxes at site.
- 4.9.5 In case of H.V. motors, all the six leads of the motors shall be taken out, three on one side and three on the other side to separate terminal boxes. However, neutral shorting link shall be provided on the neutral box for star connection.
- 4.9.6 In case of M.V. motors, all the six leads of the motors shall be taken out to a common terminal box. Shorting links for delta connections shall be provided in the terminal box for motors 112 frame and above.
- 4.9.7 For increased safety motors and for motors with type of protection "n", the terminals shall be provided with positive locking device so that they do not become loose during normal operation.
- 4.9.8 The power terminal boxes shall have adequate clearances in between the terminals and also between the terminals and cable gland for proper termination of cables. Where more than one cable is required to be terminated in parallel, the spacing in the box shall be adequate for easy termination.
- 4.9.9 Separate terminal boxes shall be provided for connection of power, control and space heater cables.
- 4.9.10 All terminal boxes shall be complete with heavy duty double compression type cable glands and lugs/connectors to receive the external cables.
- 4.9.11 Where cross linked polyethylene cables are specified, the terminal box shall be suitably designed for proper termination of such cables.
- 4.9.12 The cable lugs shall be of tinned copper and suitable for crimping.
- 4.10 **Geared Motors**
- Where geared motors are specified, the gears shall be oil lubricated, heavy duty as per AGMA class III and capable of transmitting the rated motor power continuously. They shall be capable of withstanding moderate shock loads having a service factor of 2 and the starting duties. They shall be silent and smooth in operation. Inspection glass shall be provided to indicate the oil level in the gear box.

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5.0 PERFORMANCE

5.1 Starting



- 5.1.1 The motors shall be capable of being started direct-on-line, unless otherwise specified.
- 5.1.2 The starting torque of each motor shall be higher than the initial resisting torque of the driven load through out the starting period even at a feeding voltage of 85% of the rated voltage for normal purpose motor and 80% of the rated voltage for special purpose motor.
- 5.1.3 The starting current shall not be greater than 6 times the rated current when the motors are started at full voltage including tolerances, unless otherwise specified.
- 5.1.4 The motors shall be suitable for the following starting cycle:
- With the motor at ambient temperature - 2 successive starts and 3rd start after 5 minutes.
 - With the motor at steady state load temperature - 1 immediate start and 2nd start after 5 minutes. This sequence shall be repeated in the next hour.
- 5.1.5 Speed switch shall be provided, wherever required, to fulfil the starting conditions.

5.2 Locked Rotor Condition

- 5.2.1 The locked rotor withstand time (t_E), under hot condition at 110% of rated voltage shall be more than the starting time of the motor coupled to the load even at the lowest stipulated starting voltage by 2 secs. for motors, having starting time up to 10 secs. and by 5 secs. for motors, having starting time more than 10 secs.
- 5.2.2 For increased safety motors, t_E under hot condition shall not be less than 10 secs. The value of t_E shall be determined in the presence of purchaser's representative unless test certificate from an independent testing authority is submitted for similar motors. The time t_E and the locked rotor current shall be stamped on the name plate as well as indicated in the test certificates.
- 5.2.3 For deciding the time t_E in all cases, the temperature of the insulated stator and rotor shall not exceed the value stipulated under clause no. 5.4.3.

5.3 Running

- 5.3.1 All motors shall be continuous maximum rated (S1 duty as per IS: 325), unless otherwise specified.
- 5.3.2 The motors shall be capable of delivering the rated output without exceeding the specified temperature rise under the system voltage and frequency variation conditions as specified in the Design Philosophy-Electrical.
- 5.3.3 The motors shall be suitable for running at the rated load for 5 minutes duration at 80% voltage and for 1 Sec. duration at 70% voltage, without exceeding the specified temperature rise.



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5.4 Temperature Rise

- 5.4.1 The total temperature of the stator winding under full load running condition shall not exceed the values permissible for the specified insulation class. For increased safety motors, the total temperature shall be 10°C less than for normal motors.
- 5.4.2 For explosion proof motors, the maximum surface temperature shall not exceed the values applicable for temperature class of the hazardous gases / vapours present in the surrounding area. However for type 'n' motors, the maximum allowable temperature shall not exceed 200°C.
- 5.4.3 In case of starting and locked rotor conditions stipulated under clause nos. 5.1.4 and 5.2.1 respectively, the maximum temperature in the rotor shall not exceed the following values:
- For squirrel cage rotor - 300°C
 - For wound rotor - As applicable to the insulation class
 - For explosion proof motor - As per temperature class of the hazardous gases / vapours, without exceeding the above temperature as applicable

6.0 COUPLING DETAILS

- 6.1 Unless otherwise specified, all motors shall be coupled to the driven equipment through flexible coupling.
- 6.2 Normally the coupling half for the motor shaft shall be supplied by the driven equipment supplier. The coupling half shall be keyed on the shaft with a tapered joint or shrunk with a straight joint. For this purpose, the motor manufacturer shall coordinate all details of the coupling system with the driven equipment manufacturer, wherever required.
- 6.3 Where rigid coupling is specified, the motor shaft shall have the desired class of accuracy.
- 6.4 For all vertical flange mounted motors, the limitations on shaft extension, run out, perpendicularity and eccentricity, as required by the driven machine supplier shall be complied with by the motor supplier.
- 6.5
- i) If the motor is to be coupled to a reciprocating pump or compressor requiring fluctuating torque, the motor supplier shall ensure that the inertia of the driving and driven machine assembly shall be such that the variation in the armature current shall not exceed $\pm 66\%$ of the rated current while delivering full load.
 - ii) The measurement of armature current shall be done with the oscillograph.
 - iii) The additional fly wheel, if any, shall be assembled at such a distance from the motor so as to allow easy inspection of the windings.
 - iv) All necessary coordination with driven equipment manufacturer shall be carried out by the motor manufacturer.
- 6.6
- i) Wherever belt drive is specified, the motor supplier shall ensure that the shaft extension and the bearings are suitable for the duty specified.
 - ii) Unless otherwise specified, the slide rails for all belt driven motors shall be supplied by the motor manufacturer.

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7.0 ACCESSORIES

The motors shall be complete with the accessories.

7.1 Space Heaters

7.1.1 Space heaters rated for 240 V A.C. shall be provided to keep the winding dry for all high and medium voltage motors, except for motors rated below 30 KW which shall be suitable for space heating by connecting 24 V A.C to any of the two motor winding terminals.

7.1.2 The location of the space heaters shall be such as to allow easy access for inspection, maintenance and replacement.

7.2 Name Plates

7.2.1 The name plates shall be of stainless steel with letters embossed on them.

7.2.2 The name plate shall contain all the relevant details as per IS: 325 and in addition shall indicate the following:

- i) The description and code no. of motor
- ii) Degree of protection of enclosure
- iii) Temperature rise of windings under running condition
- iv) Designation of bearings
- v) Recommended type of lubricant and interval of lubrication
- vi) Direction of rotation
- vii) Mounting Arrangement

7.2.3 Flameproof motors shall have additional name plate containing relevant particulars as per IS: 2148.

7.2.4 Increased safety motors shall have additional name plate containing relevant particulars as per IS: 6381.



7.2.5 Motors with type of protection “n” shall have additional name plate containing relevant particulars as per IS: 9628.

7.3 Embedded Temperature Detectors

7.3.1 All high voltage motors shall be provided with 6 nos. of evenly distributed embedded resistance temperature detectors for measurement of winding temperature. These shall be located in positions at which the highest temperatures are likely to occur.

7.3.2 In addition, the high voltage motors shall be provided with

- i) 1 no. RTD for hot air temperature measurement
- ii) 2 nos. RTDs (1 on each side) for bearing temperature measurement of oil lubricated bearings. For grease lubricated bearings, RTD shall be provided only where specified

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7.3.3 These RTDs shall be of platinum having 100 ohm resistance at 0°C and temperature coefficient as 3.850×10^{-3} .

7.3.4 The RTDs shall be 3 lead type having power frequency insulation level of 2KV.

7.3.5 The RTDs shall comply with the requirements laid down in IS: 2848.

7.4 Dial Type Thermometers

7.4.1 In high voltage motors, the measurement of hot air and bearing temperature (of oil lubricated bearings) by dial type thermometers shall be provided wherever specified.

7.4.2 The arrangement shall consist of a dial type of mercury-in-steel thermometer so mounted that its stem shall be located in the maximum temperature region.

7.4.3 The thermometer shall have two potential free contacts for alarm and trip.

7.4.4 All contacts shall be rated for 2 Amps. at 110 V D.C.

7.4.5 For bearing temperature measurement, separate thermometers shall be provided for each bearing.

7.4.6 For grease lubricated bearings, temperature measurement arrangement shall be provided only where specified.

7.5 Oil Supply System

7.5.1 For large sized motors, where forced oil lubrication system is considered, a common oil supply system for the motor and the driven equipment shall be provided by the driven equipment manufacturer.

7.5.2 However, the motor supplier shall quote separate price for the complete oil system of the motor.



7.5.3 The system shall be suitable for location near the motor.

7.5.4 The oil supply system for each motor shall include:

- i) 2 Nos. 100% rated motor driven pumps with motors
- ii) 1 No. oil tank complete with oil level gauge and thermometer
- iii) 1 No. oil cooler
- iv) 1 No. oil filter
- v) 1 No. differential pressure switch for filter
- vi) 2 Nos. pressure switches
- vii) Necessary piping
- viii) Necessary control and interlocks

8.0 VIBRATIONS

The motor vibrations measured at the bearings must not exceed the limits specified in IS: 12075.

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9.0 NOISE LEVEL

The motor noise level shall not exceed 85 dB measured at a distance of 1 metre from the motor.

10.0 PAINTING

10.1 Enclosures of the motor and its accessories shall be painted with two coats of anti-rust paint and two coats of anti-corrosive paint after suitable pre-treatment.

10.2 Epoxy paint, wherever specified, shall be used.

10.3 Unless otherwise specified, the finishing shade shall be light grey having shade No. 631 as per IS: 5.

11.0 TESTS AND INSPECTION

11.1 All motors shall be routine tested as per relevant standards.

11.2 Additional tests, wherever specified, shall be carried out on one motor of each rating.

11.3 For high voltage motors of each rating, polarization index test shall also be carried out.

11.4 All the above mentioned tests shall be carried out in the presence of purchaser's representative. In addition, the motor shall be subject to stage inspection at works and inspection at site for final acceptance.

11.5 These inspections shall, however, not absolve the vendor from their responsibility for making good any defects which may be noticed subsequently.

12.0 PACKING

12.1 The motors shall be properly packed to safeguard against weather conditions and handling during transit.

12.2 The shaft shall be properly clamped / supported.

12.3 Rust inhibiting agents shall be applied to fittings and sliding surfaces.

12.4 All flanges shall be closed with blanking plates to avoid entry of foreign materials.



12.5 The loose pieces of the motor / spare parts / Instruments shall be separately wrapped in moisture resistant paper and marked with identification marks and name plate of the corresponding motors.

12.6 The packing box / crate shall include a copy of installation, operation and maintenance manual.

13.0 DRAWINGS AND DOCUMENTS

13.1 Drawings and documents as per Annexure-I shall be supplied, unless otherwise specified.

13.2 All drawings and documents shall have the following descriptions written boldly:

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- Name of client
- Name of consultant
- Enquiry / order number with plant / project name
- Motor Code No. and Description

14.0 SPARES

14.1 Spares for operation and maintenance

Item wise unit prices of spare parts with recommended quantity shall be quoted along with the motors.

14.2 Commissioning Spares



Commissioning spares, as required, shall be supplied with the main equipment. Item wise list of recommended commissioning spares shall be furnished for approval.

14.3 Any other spare parts not specified, but required, shall also be quoted along with the offer.

14.4 All spare parts shall be identical to the parts used in the motors.

15.0 DEVIATIONS

15.1 Deviations, if any, from this standard shall be clearly indicated in the offer with reasoning.

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ANNEXURE - I
DOCUMENTATION FOR INDUCTION MOTORS

Sl. No.	Document Description	Documents Required (Y / N)		
		With Bid	For Approval	Final
1.	Specification Sheet and Technical Particulars completely filled-in	Y	Y	Y
2.	Dimensional Drawings	Y	Y	Y
3.	Drawings and data for air / water heat exchangers, if necessary	N	Y	Y
4.	Drawings and data for oil system, if necessary	N	Y	Y
5.	Characteristic curves			
	a) Thermal withstand curve	N	Y	Y
	b) Load Vs FL current	N	Y	Y
	c) Load Vs Efficiency	N	Y	Y
	d) Load Vs Power factor	N	Y	Y
	e) Load Vs Speed	N	Y	Y
	f) Voltage Vs Thermal Withstand time	N	Y	Y
	g) Starting current Vs Time	N	Y	Y
6.	Connection diagram for RTDs, thermometer etc.	N	Y	Y
7.	Terminal Box drawings	Y	Y	Y
8.	Illustrative and Descriptive catalogues	Y	N	Y
9.	Catalogues of bought out accessories	Y	N	Y
10.	Spare parts list	Y	N	Y
11.	Installation, Operation and Maintenance manual	N	N	Y
12.	Test certificates			
	a) Routine	N	N	Y
	b) Type	N	N	Y
	c) For enclosure	Y	N	Y
13.	Guarantee Certificates	N	N	Y



Note:

1. 4 hard copies & 1 soft copy shall be supplied with bid.
2. 4 hard copies & 1 soft copy shall be supplied for approval after order within 4 weeks from the date of LOI.
3. 8 hard copies & 2 soft copies in pen drive shall be submitted as final documents prior to despatch of the equipment. These shall be made in sets and supplied in fine plastic coated folder.

Y - Yes, N - No



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TECHNICAL SPECIFICATION INTERLOCKING SWITCH SOCKET AND PLUG

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ANNEXURE - I	DOCUMENTATION FOR INTERLOCKING SWITCH SOCKET AND PLUG

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1.0 SCOPE

- 1.1 The standard covers the technical requirements of design, manufacture, testing at works and delivery in well packed condition of interlocking switch socket and plug.

2.0 STANDARDS TO BE FOLLOWED

- 2.1 The design, manufacture and testing of the equipment covered by this standard shall comply with the latest issue of IS-4160/ IEC-309 and other relevant Indian Standards, unless otherwise specified. Equipment complying with equivalent IEC standards shall also be acceptable.
- 2.2 The design and operational features of the equipment offered shall also comply with the provisions of latest issue of Indian Electricity Rules and other statutory acts and regulations. The supplier shall, wherever necessary, make suitable modifications in the equipment to comply with the above.
- 2.3 Wherever any requirement, laid down in this standard differs from that in Indian Standard Specifications, the requirement specified herein shall prevail.

3.0 SERVICE CONDITIONS

3.1 Ambient conditions

These shall be as indicated in Design Philosophy-Electrical.

3.2 System details



These shall be as indicated in Design Philosophy-Electrical.

4.0 OPERATING REQUIREMENTS

The equipment shall be suitable for operating at the rated capacity continuously, under the ambient condition indicated in Design Philosophy-Electrical, without exceeding the specified temperature rise and without any detrimental effect on any part.

5.0 GENERAL DESIGN AND CONSTRUCTIONAL FEATURES

- 5.1 The switch socket shall be heavy duty industrial type. The interlocking arrangement shall be such that it is not possible to insert or withdraw the plug with the switch in 'ON' position.
- 5.2 The switch sockets shall have dust, hose and weather proof construction conforming to IPW55 as per IS: 13947 and shall be suitable for outdoor use without any extra protection. All jointing surfaces shall be smoothly machined and of sufficient width to prevent ingress or dust. Further the covers shall be provided with continuous gaskets made of neoprene to prevent ingress of dust and moisture.
- 5.3 The enclosure of switch sockets and plugs shall be of cast aluminium alloy 4600 and suitable for fixing on wall / structure.
- 5.4 The enclosure shall be largely dimensioned in order to avoid temperature rise inside it which may damage the insulating materials and gaskets employed therein.

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- 5.5 The insulating materials used shall be non-hygroscopic, mould proof and treated with suitable varnish to withstand the ambient conditions.
- 5.6 All external hardware of diameter less than 8 mm shall be of stainless steel and those of diameter 8 mm or above shall be of mild steel zinc passivated.
- 5.7 Suitable arrangement for looping of cables from one switch socket to the other shall be provided. For switch sockets rated above 63A, looping shall be done from busbars and for switch sockets rated 63A and below, looping may be done from terminal block. Necessary terminals, cable glands and lugs for looping shall be provided. Also one no. The readed plug for each switch socket shall be supplied loose.
- 5.8 All the relevant information shall be provided on engraved name plate made of aluminium.
- 5.9 The enclosure shall be provided with two earthing terminals outside the body.

6.0 SPECIAL FEATURES FOR FLAME PROOF SWITCH SOCKET AND PLUGS

- 6.1 The enclosure shall be in addition of flame proof execution as per IS: 2148.
- 6.2 The enclosure group and temperature class shall be as indicated in Design Philosophy.
- 6.3 Cable shall enter the terminal chamber through flame proof compression type cable glands. From the terminal to the main enclosure, the connection shall be made through proper bushings. Direct entry of external cables into the main enclosure shall not be accepted.
- 6.4 An additional earthing terminal inside the terminal chamber shall be provided.
- 6.5 Switch socket, plug and cable glands must be certified by the Central Mining Research Institute, Dhanbad or any other statutory authority for use in the specified hazardous area.
- 6.6 Further interlocking shall be provided so that the contacts cannot be energised when the plug and socket are separated.



7.0 COMPONENT DETAILS

7.1 Air Break Switches

- 7.1.1 The switches shall be quick make, quick break rotary type and of utilisation category AC-23 as per IS: 13947.
- 7.1.2 Switches shall be hand operated from outside the cover. The switch handle shall remain fixed to the front cover while removing the front cover.

7.2 H.R.C. Fuses

- 7.2.1 The sockets shall be provided with link type HRC fuses.
- 7.2.2 The fuses shall be capable of withstanding a short circuit current of 50 KA and shall be delayed action type conforming to IS: 13703. These shall be mounted on a shrouded base.

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7.3 Socket Outlets

- 7.3.1 The socket outlet shall be located in the lower part of the enclosure and shall be provided with a threaded aluminium cover attached to the body with G.I. chain, to protect the socket after extraction of the plug. Spring loaded automatic shutter shall not be acceptable.
- 7.3.2 The socket contacts shall maintain satisfactory spring pressure and contact with the corresponding plug under normal service conditions.
- 7.3.3 The socket contacts shall be sunk well below the surface of the socket- outlets so as to make it impossible to be touched unintentionally.
- 7.3.4 An earthing contact shall be provided in the socket outlet which shall ensure making and breaking respectively of its contact with the earthing pin of the plug before and after making and breaking of the corresponding current carrying contacts.

7.4 Plugs



- 7.4.1 The plugs shall be so constructed so that these can be easily fitted in to the socket outlets.
- 7.4.2 These shall be provided with knurled knob arrangement for screwing on the body of the socket so that it can be securely fixed on the top.
- 7.4.3 The plug base and cover shall be firmly secured to each other and shall be sufficiently robust in construction to withstand normal usage.
- 7.4.4 The plug pins shall preferably be of single part. The earthing pin shall be slotted with a single slot and shall be larger in dimension than other pins.
- 7.4.5 The plug and socket contacts shall be self aligning type with best electrical continuity.
- 7.4.6 The plug shall be provided with dust proof cable entry suitable for receiving TRS flexible heavy duty copper conductor cable of specified size. The arrangement shall be such that the conductors are relieved from strain including twisting where they are connected to the terminals and that the outer surface of the cable at the place of entry is not damaged.
- 7.4.7 Insulating barriers forming an integral part of the plug shall ensure separation of metals and bare flexible conductors at different potentials.

7.5 Cable Termination

- 7.5.1 Switch socket shall have cable termination arrangement on the upper part of the housing and shall be provided with side entries, one on either side, through heavy duty double compression type rolled aluminium cable glands suitable for 1.1 KV grade XLPE insulated armoured and PVC sheathed cables.
- 7.5.2 The terminal blocks shall be pressure clamp type for switch socket rated up to 63A and bolted lug type for higher ratings. The terminals shall be rated for at least 1.5 times the switch rating.

8.0 PAINTING

- 8.1 The enclosure after suitable pre-treatment shall be painted with two coats of anti-rust paint followed by two coats of anti-corrosive paint.
- 8.2 Epoxy based paint shall be used.

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8.3 All paints shall be carefully selected to withstand tropical heat and extremes of weather. The paint shall not scale off, crinkle or be removed by abrasion due to normal handling.

8.4 The finishing shade shall be light grey shade no.631 as per IS: 5, unless specified otherwise.

9.0 TESTS AND INSPECTION

9.1 The switch sockets and plugs shall be subjected to routine tests as per IS-4160 and other relevant standards.

9.2 Wherever specified, additional tests shall be carried out on one switch socket and plug of each rating.

9.3 The tests shall be carried out in the manufacturer's works in the presence of purchaser's representative. In addition to the above tests, the equipment shall be subject to stage inspection at works and inspection at site for final acceptance.

9.4 These inspections shall, however, not absolve the vendor from their responsibility for making good any defect which may be noticed subsequently.

10.0 DRAWINGS AND DOCUMENTS

10.1 Drawings and documents as per Annexure-I shall be supplied, unless otherwise specified.

10.2 All drawings and documents shall have the following descriptions written boldly.

- Name of client
- Name of consultant
- Enquiry / Order Number with plant / project name
- Code No. and Description

11.0 SPARES

11.1 Spares for operation and maintenance



Item wise unit prices of spare parts for the following items as applicable shall be offered along with the main equipment with recommended quantity.

- i) Switch
- ii) Fuse base
- iii) Fuse
- iv) Terminal blocks
- v) Terminal bushings

11.2 Commissioning Spares

Commissioning spares, as required, shall be supplied with the main equipment. Item wise list of recommended commissioning spares shall be furnished for approval.

11.3 Any other spare parts not specified, but required, shall also be quoted along with the offer.

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11.4 All spare parts shall be identical to the parts used in the equipment.



12.0 PACKING

12.1 The switch socket and plug shall be properly packed to safeguard against weather conditions and handling during transit. It shall be wrapped in polythene bags and an additional wrapping of bitumen paper shall also be provided to make it completely water proof before the equipment is packed in wooden crates.

12.2 The packing box shall contain a copy of the installation, operation and maintenance manual.

13.0 DEVIATIONS

13.1 Deviations, if any, from this standard shall be clearly indicated in the offer with reasoning.

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ANNEXURE – I



DOCUMENTATION FOR INTERLOCKING SWITCH SOCKET AND PLUG

Sl.No.	Description	Documents Required (Y / N)		
		With Bid	For Approval	Final
1.	Specification Sheet	Y	Y	Y
2.	Technical Particulars	Y	Y	Y
3.	General arrangement and foundation drawing	Y	Y	Y
4.	Schematic / wiring diagram	N	Y	Y
5.	Illustrative and descriptive literature	Y	N	Y
6.	Catalogue for bought out accessories	Y	N	Y
7.	Installation operation and maintenance manual	N	N	Y
8.	Test Certificates			
	a) Type	N	N	Y
	b) Routine	N	N	Y
9.	Guarantee Certificate	N	N	Y
10.	Certificate of flameproofness from statutory testing authority wherever applicable.	Y	N	Y
11.	Spare parts list with identification marks	Y	N	Y

Note:

1. 4 hard copies & 1 soft copy shall be supplied with bid.
2. 4 hard copies & 1 soft copy shall be supplied for approval after order within 4 weeks from the date of LOI.
3. 8 hard copies & 2 soft copies in pen drive shall be submitted as final documents prior to despatch of the equipment. These shall be made in sets and supplied in fine plastic coated folder.

Y - Yes, N - No

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TECHNICAL SPECIFICATION LIGHTING FIXTURES AND ACCESSORIES





**HORTON SPHERE ALONG WITH ITS
REFRIGERATION SYSTEM AT NFL, NANGAL
TECHNICAL SPECIFICATION – LIGHTING
FIXTURES AND ACCESSORIES (TS-8123)**

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3.0	SERVICE CONDITIONS
4.0	OPERATIONAL REQUIREMENTS
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1.0 SCOPE



- 1.1 This standard covers the technical requirements of design, manufacture, testing at works, and despatch in well packed condition of lighting fixtures and their accessories.

2.0 STANDARDS TO BE FOLLOWED

- 2.1 The design, manufacture and testing of the lighting fixtures and their accessories covered by this standard shall comply with the latest issue of the following and other relevant Indian Standards, unless otherwise specified. Equipment complying with equivalent IEC standards shall also be acceptable.

- IS:1913(Part 1) -- General and safety requirements for Luminaries Part-1: Tubular fluorescent lamps
- IS:6665 -- Code of practice for Industrial lighting.
- IS:1777 -- Industrial luminaries with metal reflectors.
- IS:5077 -- Decorative lighting outfits.
- IS:10322 -- Luminaries.
- IS:4012 -- Dust proof electric lighting fittings
- IS:3528 -- Waterproof electric lighting fittings.
- IS:13947 (Part-1) -- Specification for Low-voltage Switchgear and Control gear – Part-1 : General Rules
- IS:2148 -- Electrical Apparatus for Explosive Gas Atmospheres - Flameproof Enclosures “d”
- IS:2206 (Part 1) -- Flameproof electric lighting fittings Part-1: Well glass and bulk head types.
- IS:2206 (Part 2) -- Flameproof electric lighting fittings Part-2: Fittings using glass tubes
- IS:8224 -- Electric lighting fittings for division-2 areas.
- IS:1534 (Part 1) -- Ballasts for fluorescent lamps: for switch start circuits.
- IS:6616 -- Ballasts for high pressure mercury vapour lamps.
- IS:1569 -- Capacitors for use in tubular fluorescent high pressure mercury and low pressure sodium vapour discharge lamp circuit.
- IS:2215 -- Starters for fluorescent lamps.
- IS:3323 -- Bi-pin lamp holders for tubular fluorescent lamps.
- IS:1258 -- Bayonet lamp holders.
- IS:10276 -- Edison screw lamp holders.
- IS:3324 -- Holders for starters for tubular fluorescent lamps.

- 2.2 The design and operational features of the equipment offered shall comply with the provisions of the latest issue of the Indian Electricity Rules and other relevant Statutory Acts and Regulations. The supplier shall, wherever necessary, make suitable modifications in the equipment to comply with the above.

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2.3 Wherever any requirement, laid down in this standard, differs from that in Indian Standard Specifications, the requirement specified herein shall prevail.

3.0 SERVICE CONDITIONS

3.1 Ambient Conditions

These shall be as indicated in Design Philosophy-Electrical.

3.2 System Details

These shall be as indicated in Design Philosophy-Electrical.

4.0 OPERATIONAL REQUIREMENTS

The fixtures and their associated accessories shall be suitable for operating continuously under the ambient conditions and with the voltage and frequency variations indicated in Design Philosophy-Electrical without exceeding temperature rise limits as per relevant standards and without detrimental effect on any part.

5.0 GENERAL CONSTRUCTIONAL REQUIREMENTS FOR FIXTURES

5.1 The fixtures shall be complete with all accessories including the control gear box but excluding the lamp.

5.2 The control gear box for fluorescent lamp fixtures shall consist of starter, ballast and capacitor for power factor improvement and for correction of stroboscopic effect.

5.3 The control gear box for mercury vapour fixtures shall consist of ballast and capacitor for power factor improvement. The control gear box for sodium vapour fixtures shall comprise ballast, capacitor and an electronic ignitor.



5.4 The fixture housing control gear box shall be made of CRCA sheet steel, aluminium sheet or cast aluminium.

5.5 The fixtures shall be provided with cable glands wherever specified and a terminal block suitable for termination of copper conductor up to 2.5 sq. mm size. Looping facility shall be provided wherever indicated.



5.6 The control gear box shall normally be mounted separate / integrally. Where the control gear box is to be mounted separately, the same shall be housed in an enclosure made of CRCA sheet steel / cast aluminium. The control gear box shall additionally contain HRC fuse (except for FLP fittings), suitable terminals with lugs, three numbers cable glands and a spare threaded plug.

5.7 The control gear box shall be suitable for location in the same area as the fixture and shall have the same degree of protection.

5.8 All external hardware such as bolts and nuts of below 8 mm size, toggle lever, hinge pins etc. shall be of stainless steel and bolts and nuts of higher sizes shall be zinc passivated with sufficient thick layer capable of withstanding the operating conditions.

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- 5.9 Neoprene gaskets shall be provided where necessary to prevent ingress of dust, moisture and insects inside the fixture and to make the fixture suitable for outdoor installation.
- 5.10 The fixture / control gear box shall have minimum degree of protection equivalent to IP-55 for outdoor installation and IP-43 for indoor installation as per IS-13947 (Part-1).
- 5.11 The fixture shall be so designed that it shall be possible to maintain or replace the different accessories without difficulty, including the replacement of the lamp.
- 5.12 The insulation of wiring conductor for fixture and control gear box (where provided separately) shall be selected considering the maximum temperature due to the heat generation by ballast, lamp, etc. under normal operating condition and its proximity with the same. Wherever necessary, heat resistant type insulated conductor shall be used for the wiring of the fixture and control gear box.
- 5.13 The wiring between different components of the fixture and control gear box shall be properly secured to avoid loosening of the connection due to vibration.
- 5.14 The fixture / control gear box shall be provided with an internal earthing terminal.
- 5.15 The fixture shall be designed to maximise the downward throw of luminous flux.
- 5.16 The fixture / control gear box shall be suitable for type, number and wattage of lamp.
- 5.17 Where integral control gear box is not provided, maximum rating and type of the lamp which can be used with the fixture shall be indicated on the name plate.
- 5.18 **Painting**
- 5.18.1 All metal surfaces shall be made completely free from any scale and rust by suitable processes of degreasing and pickling. The thoroughly cleaned surface shall be pre-treated by phosphatising and passivating.
- 5.18.2 Aluminium surfaces shall be pre-treated by anodisation.
- 5.18.3 Two coats of zinc chromate primers shall be applied on all metal surfaces before application of two coats of finishing paint as specified for different types of fixtures. Where epoxy paint is specified, epoxy based primers.
- 5.19 **Supporting Arrangement**
- 5.19.1 Fixture shall be suitable for mounting on the ceiling / structure as required. A mounting bracket shall be supplied, where necessary.
- 5.19.2 Sketch showing the mounting arrangement and dimension for each type of fixture shall be furnished.
- 6.0 TYPE OF FIXTURES**
- 6.1 **Commercial Decorative Type**
- 6.1.1 Channel / Rail Mounting Fluorescent Fixtures
- 6.1.1.1 The fixtures shall be provided with CRCA sheet steel enclosure housing all electrical accessories, mounting channel, good quality clear acrylic cover/ opal diffuser / louver of

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non-yellowing type and high impact polystyrene black end plates. The mounting channel shall be provided with a reflector plate to hold the cover / diffuser / louver, so that the same shall not come out when the end plates are removed.

- 6.1.1.2 Where continuous mounting is specified, instead of end plates at the two consecutive ends of the fixtures, one 25 mm wide aluminium strip painted with black epoxy paint with proper fixing arrangement shall be provided to cover the gap between the two fixtures. The strip shall be so shaped that it can be easily fitted or removed without difficulty.
- 6.1.1.3 The channel housing and the reflector plate shall be epoxy stove enamelled.
- 6.1.1.4 The fixtures shall be suitable for 2x36 W fluorescent tube / 15W compact fluorescent (CFL) lamps.

6.2 Recess Mounting Fluorescent Fixture

- 6.2.1 The fixtures shall be suitable for recess mounting on false ceiling. The fixtures shall have CRCA sheet steel enclosure housing all electrical accessories, reflector plate and good quality non-yellowing type clear acrylic cover / opal diffuser / louver.
- 6.2.2 The fixtures shall be suitable for 2x36W fluorescent tube / 15W compact fluorescent (CFL) lamps.
- 6.2.3 The housing and the reflector plate shall be stove enamelled white.
- 6.2.4 Mirror optics fixtures shall be suitable for recess mounting on false ceiling. The fixtures shall have CRCA sheet housing, stove enamelled, white and containing all electrical accessories.
- 6.2.5 Mirror optics fixture where specified shall have high purity anodised aluminium reflector for high photometric performance and specially designed V-shaped parabolic cross louvers for better glare control.
- 6.2.6 Mirror optics fixtures shall be suitable for 2x36W fluorescent tube / 15W compact fluorescent (CFL) lamps.



6.3 Industrial Type

6.3.1 Channel / Rail Mounting Fluorescent Fixtures

- 6.3.1.1 The fixtures shall be provided with CRCA sheet steel mounting channel containing all the accessories, suitably covered with CRCA sheet steel and epoxy stove enamelled.
- 6.3.1.2 The fixture without reflector shall be with epoxy stove enamel finish. Where reflector is specified the same shall be CRCA sheet of minimum 20 SWG thickness and vitreous enamelled white inside and grey outside.

6.4 Hose Proof Fluorescent Fixtures

- 6.4.1 The fixtures shall be totally enclosed type, suitable for outdoor installation having enclosure equivalent to IP-55 as per IS-2147. Test certificate in respect of the IP-55 enclosure shall be submitted.
- 6.4.2 The fixtures shall have aluminium housing having control gear tray containing all electrical accessories wired up to terminal block.
- 6.4.3 The Fixtures shall have clear acrylic front cover, properly sealed in the metallic door frame which shall have hinges at one side and arrangement on the opposite side for proper fixing of the front cover by application of sufficient pressure on the frame cover

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gasket. The gasket shall be of such quality that it shall not deteriorate during opening and closing of the front door, for replacement of lamps or maintenance of the fixtures.

6.4.4 The fixtures shall have epoxy stove enamel finish, white inside and grey outside.

6.5 Corrosion Proof Fluorescent Fixtures

6.5.1 The fixtures shall be suitable for installation in an area laden with corrosive chemical dusts and vapours.

6.5.2 The ballast, capacitor and terminal block shall be housed in a cast aluminium enclosure which shall be made dust and vapour proof with the use of neoprene rubber gaskets. The internal connecting wires shall run inside 2 nos. seamless aluminium pipes properly screwed and sealed on either side of the control gear housing. The end boxes shall be made of cast aluminium fixed at the ends of the seamless pipes which shall contain the starter holder, starter and the lamp holders.

6.5.3 The lamp holders shall be so designed that when the lamps are fitted, ingress of corrosive dust and vapour inside the lamp holders is prevented to protect lamp pins.

6.5.4 The fixtures shall be epoxy stove enamelled.

6.6 Bulk head Type Incandescent / Mercury Vapour Fixtures

6.6.1 The fixtures shall be made of cast aluminium alloy in weather proof execution finished in epoxy stove enamel grey outside and white inside, provided with prismatic heat resistant glass cover and 3 mm G.I. wire guard.

6.6.2 For use with H.P.M.V. lamp, separate control gear box shall be supplied.

6.7 Well Glass Type Incandescent / Mercury / Sodium Vapour fixtures.

6.7.1 The fixture housing shall be made of cast aluminium alloy in dust, vapour and weather proof execution finished in epoxy stove enamel, grey outside and white inside, provided with clear heat resistant glass which shall be fitted with neoprene gasket and 3 mm G.I. wire guard.

6.7.2 Where top entry is specified for suspension, the fixture shall be suitable for 19 mm NB G.I. pipe.

6.7.3 Where additional dispersive reflectors are specified to be supplied with the fixtures, the same shall be of CRCA sheet steel vitreous enamelled.

6.8 High Bay Type Mercury / Sodium Vapour Fixtures



6.8.1 The fixtures shall be in dust and vapour proof execution with a reflector and heat resistant glass cover and shall be provided with separate / integral control gear.

6.8.2 The control gear and lamp holder housings shall be of cast aluminium so designed as to achieve better heat dissipation and proper cooling of the unit.

6.8.3 The reflector shall be made of anodised aluminium epoxy enamelled outside and electrochemically brightened inside.

6.8.4 The canopy shall be of cast aluminium having terminal block for external connection and provided with suspension hook.

6.8.5 The canopy, control gear and lamp holder housings shall be epoxy stove enamelled.

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6.9 Street Lighting Fixtures

- 6.9.1 The fixtures shall be suitable for fluorescent / mercury vapour / sodium vapour lamp as specified and shall be made of cast /sheet aluminium epoxy enamelled housing, anodised aluminium reflector and non-yellowing type acrylic cover.
- 6.9.2 The fixture shall be totally enclosed type suitable for outdoor installation having enclosure equivalent to IP-43 as per IS-13947 (Part-1).
- 6.9.3 The fixtures shall have light distribution same as that of semi-cut off type as specified.
- 6.9.4 The fixtures shall be provided with side entry for the supporting pipe. The cable shall be taken inside through the supporting pipe of 25 mm dia.
- 6.9.5 The clamping arrangement for the supporting pipe shall be designed to suit the weight of the fixture and wind load for mounting height upto 16 M as specified in the relevant Indian Standard Specification. The clamping arrangement shall provide wide range flexibility in the use of supporting pipe by the purchaser.
- 6.9.6 Unless otherwise specified, fixture for use with mercury / sodium vapour lamp shall be provided with arrangement of adjusting the position of lamp holder to have a cut off or semi-cut off light distribution.

6.10 Flood Lighting Fixtures



- 6.10.1 The fixtures shall be in weatherproof execution suitable for high pressure mercury / sodium vapour lamp and shall comprise of epoxy stove enamelled, cast aluminium alloy body, a clear heat resistant flat toughened glass, an anodised mirror polished aluminium reflector and a focussing device.
- 6.10.2 The fixtures shall be having an arrangement for rotation on both horizontal and vertical planes and locking in any desired position.
- 6.10.3 The complete unit shall be mounted on a heavy base of cast iron for fixing the fixture on a structural platform.
- 6.10.4 All cast iron and M.S. structural provided in the fixture shall be epoxy painted.
- 6.10.5 A separate control gear box suitable for the rating of the lamp specified shall be supplied along with the fixture.

6.11 Post Top Lantern Type Fixture

- 6.11.1 The fixtures shall be suitable for mercury / sodium vapour lamps having cast aluminium spigot, circular opal non-yellowing type acrylic diffuser and cast aluminium pole mounting base with integral control gear.
- 6.11.2 The fixtures shall be suitable for outdoor installation.
- 6.11.3 The canopy and the mounting base shall be epoxy stove enamelled.

6.12 Air Obstruction Lighting Fixtures

- 6.12.1 The fixtures shall be suitable for neon cold cathode helix and shall be complete with neon lamp, transformer, red glass dome, necessary terminal box and other accessories.
- 6.12.2 The fixtures shall have body of corrosion resistant aluminium alloy casting and shall be suitable for outdoor use and mounting on 40 mm NB G.I. pipe. Necessary electrical threading shall be tapped in the fixture for mounting.

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6.12.3 The optical system of the glass should give a symmetrical light distribution with intensity not less than 10 candles. The intensity shall be uniform between 10° and 90° above horizontal.

6.13 **Fixtures for use in Hazardous Area**

6.13.1 The fixtures for use in hazardous area shall be in cast aluminium (alloy 4600) / cast iron enclosure which shall be epoxy stove enamelled.

6.13.2 The fixtures shall have general constructional features as per clause 5.0 and type conforming to clause nos. 6.4 to 6.12 unless indicated otherwise and shall also comply with relevant Indian standard for the type of fixtures specified viz. flameproof / increase safety fittings for division 2 areas.

6.13.3 The fixtures shall be suitable for hazardous area for enclosure group and temperature class.

6.13.4 Flameproof fixture / control gear box shall be provided with flameproof cable glands.

6.13.5 Lighting fixture / control gear box for division-2 area shall be provided with increased safety cable glands.

6.13.6 One internal earthing terminal shall be provided.

6.13.7 The vendor shall confirm that the fixture and control gearbox, where supplied separately, have been tested and certified by relevant statutory authorities for use in the hazardous area as offered by them and shall submit the relevant documents along with the offer.

7.0 **ACCESSORIES**

7.1 **Ballast**

The ballast shall be highly inductive silicon steel laminated, copper wire wound polyester filled heavy duty type.

7.2 **Capacitors**

7.2.1 The capacitors shall be constant value type hermetically sealed in metal enclosure to ensure long trouble free service.

7.2.2 The value of capacitors for power factor improvement shall be so selected that the corresponding lamp circuit power factor does not fall below 0.95 lag.



7.3 **Starter**

The starter shall be suitable for igniting fluorescent lamp having bi-metal electrodes and radio interference suppression capacitor in an enclosure of high mechanical strength.

7.4 **Lamp Holder**

7.4.1 The lamp holders shall ensure proper contact with the lamp during continuous operation, preventing extinguishing of the lamp due to small vibration.

7.4.2 The material of the lamp holder shall be suitable to withstand the operating temperature without any deterioration.

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7.4.3 The lamp holder for fluorescent lamp shall be spring loaded rotor type, suitable for bi-pin lamp, so designed to prevent contact with live parts of the lamp holder after the lamp has been taken out or during insertion / removal of the lamp.

7.4.4 The lamp holder for mercury / sodium vapour and incandescent lamp shall be Edison screw type, excepting for incandescent lamps rated up to 100 watt, which may be bayonet type.

7.5 **Starter Holder**

The starter holders used for fluorescent lamp shall ensure good electrical contact with the starter pin with strong spring action for trouble free operation. It shall be possible to insert or remove the starter with ease.

7.6 **Cable Glands**

Cable glands shall be of rolled aluminium, double compression type suitable for XLPE insulated armoured and PVC sheathed 1.1 KV grade cables.

8.0 **TESTS AND INSPECTION**

8.1 The following tests shall be carried out on the lighting fixtures and their accessories as per relevant IS.

8.1.1 Routine tests - On each lighting fixture and its accessories.

8.1.2 Acceptance tests - On one sample of each type.

8.1.3 Type tests - Wherever specified on one lighting fixture of each type and its accessories.

8.2 All the above mentioned tests shall be carried out in the presence of purchaser's representative. In addition, the fixtures shall be subjected to stage inspection at works and inspection at site for final acceptance.

8.3 These tests and inspection shall however, not absolve the vendor from his responsibility for making good any defect which may be noticed subsequently.

9.0 **DRAWINGS AND DOCUMENTS**



9.1 Drawings and documents as per Annexure-I shall be supplied unless otherwise specified.

9.2 All drawings and documents shall have the following description written boldly.

- Name of client
- Name of consultant
- Enquiry / Order Number with plant / project name
- Code No. and Description

10.0 **SPARES**

10.1 Spares for operation and maintenance

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Item wise unit prices of spare parts with recommended quantity shall be quoted along with the equipments.

10.2 Commissioning Spares

Commissioning spares, as required, shall be supplied with the main equipment. Item wise list of recommended commissioning spares shall be furnished for approval.

10.3 Any other spare parts not specified, but required, shall also be quoted along with the offer.

10.4 All spare parts shall be identical to the parts used in the equipments.



11.0 PACKING

11.1 The lighting fixtures shall be properly packed to safeguard against weather conditions and handling. It shall be wrapped in polythene bag with an additional wrapping of bitumen paper to make it completely waterproof before the equipment is packed in wooden crates.

11.2 The packing box shall contain a copy of the installation, operation and maintenance manual.

12.0 DEVIATIONS

12.1 Deviation, if any, from this standard shall be clearly indicated in the offer with reasoning.

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ANNEXURE - I



DOCUMENTATION FOR LIGHTING FIXTURES AND ACCESSORIES

Sl.No.	Description	Documents Required (Y / N)			
		With Bid	For Approval	Final	
1.	Specification Sheets, duly completed	Y	Y	Y	
2.	Technical particulars, duly filled-in	Y	Y	Y	
3.	Illustrative and descriptive catalogues indicating general arrangement, light distribution, light absorption and utilisation factors, full load currents, power factors and power requirement for each type of fixture including control gear losses.	N	Y	Y	
4.	Sketch showing mounting arrangement with dimensions.	Y	Y	Y	
5.	Type Test Certificates for				
	(a) Hose proof fixtures	}			
	(b) Flame proof fixtures		Y	N	Y
	(c) Division-2 area fixtures				
6.	Spare parts list	Y	N	Y	
7.	Test certificates	N	N	Y	
8.	Guarantee certificates	N	N	Y	

Note:

1. 4 hard copies & 1 soft copy shall be supplied with bid.
2. 4 hard copies & 1 soft copy shall be supplied for approval after order within 4 weeks from the date of LOI.
3. 8 hard copies & 2 soft copies in pen drive shall be submitted as final documents prior to despatch of the equipment. These shall be made in sets and supplied in fine plastic coated folder.



Y - Yes, N - No

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ANNEXURE - II

LIST OF SPARES

1. Reflector of each type.
2. Lamp holder of each type
3. Starter for fluorescent tubes
4. Starter holder for fluorescent tubes
5. Capacitor for each type
6. Ballast of each type
7. Fuse of each type
8. Acrylic cover / Diffuser / Louvre of each type
9. Terminal block of each type
10. Transformer for air obstruction light fittings
11. Neon lamp of each type
12. Electric Ignitor for sodium vapour lamps
13. Heat resistant toughened glass cover of each type
14. Cable glands of each type
15. Allen keys of different sizes as applicable



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TECHNICAL SPECIFICATION CABLES

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6.0	SPECIAL PURPOSE CABLES
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10.0	DEVIATIONS
ANNEXURE - I	DOCUMENTATION FOR CABLES

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1.0 SCOPE

1.1 This standard covers the technical requirements of design, manufacture, testing at works and dispatch in well packed condition of power and control cables.

2.0 STANDARDS TO BE FOLLOWED

2.1 The design, manufacture and testing of cables covered by this standard shall comply with the latest issue of following Indian Standards, unless otherwise specified. Equipment complying with equivalent IEC standards shall also be acceptable.

IS: 1554 Part (I) -- PVC insulated (heavy duty) electric cables for working voltages upto and including 1100 volts.

IS: 1554 Part (II) -- PVC insulated (heavy duty) electric cables for working voltages from 3.3 KV upto and including 11 KV.

IS: 7098 Part (I) -- Cross linked polyethylene insulated PVC sheathed cables for working voltages upto and including 1100 volts.

IS: 7098 Part (II) -- Cross linked polyethylene insulated PVC sheathed cables for working voltages from 3.3 KV upto and including 33 KV

IS: 694 -- PVC insulated cables for working voltages upto and including 1100 volts

IS: 5831 -- PVC insulation and sheath of electric cables

2.2 The design and operational features of the cables offered shall also comply with the provisions of latest issue of the Indian Electricity Rules and other relevant Statutory Rules & Regulations. The supplier shall, whenever necessary, make suitable modification in the cables to comply with the above mentioned rules.

2.3 Wherever any requirement, laid down in this standard, differs from that in Indian Standard Specifications, the requirement specified herein shall prevail.

3.0 SERVICE CONDITIONS

3.1 Ambient Conditions



These shall be as indicated in Design Philosophy-Electrical.

3.2 System Details

These shall be as indicated in Design Philosophy-Electrical.

4.0 OPERATING REQUIREMENTS

The cables shall be suitable for operating continuously at the rated capacity as specified in relevant I.S. under the ambient conditions in Design Philosophy-Electrical without exceeding the permissible temperature rise and without any detrimental effect on any part.

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5.0 GENERAL DESIGN AND CONSTRUCTIONAL FEATURES

5.1 The design, manufacture and workmanship of cables shall be in accordance with the latest practice.

5.2 All materials to be used shall be new, unused and of the best quality.

5.3 Conductors

The power cables shall be of stranded Aluminium / copper round or shaped conductors and control cables shall be of annealed high conductivity stranded copper round conductors. The conductors shall comply with the requirements of IS: 8130.

5.4 Insulation

The conductor insulation shall be type A/C and shall comply with relevant IS.

5.5 Fillers

The cables shall have suitable fillers wherever required, laid up with conductors to provide substantially circular cross section before the inner sheath is applied.

5.6 Inner Sheath

Inner sheath, wherever applicable shall be ST1/ ST2 type compound applied by extrusion process except for paper cables for which it shall be of lead or lead alloy.

5.7 Armouring

All power and control cables shall be armoured. The single core cables shall be armoured with hard drawn Aluminium taps / wires or any other suitable nonmagnetic material. All other cables shall have galvanized steel wire / strip armouring.

5.8 Outer Sheath



The outer sheath shall be ST1/ ST2 type compound applied by extrusion process and suitable to withstand atmospheric pollution, resistance to termites, fire retardant and coloured black.

5.9 Screening

Screening over conductor and insulation shall be provided as per relevant standard unless specified otherwise. The screening for control cables if specified shall be of aluminium, mylor or equivalent and provided with tinned drain wire which shall be continuous and permanently connected to the screen.

5.10 Identification

The individual cores of cables shall be coloured as per relevant IS. Where it is not possible to distinguish the cores by colour, coloured strip shall be applied on the cores or core nos. shall be marked on each core at regular intervals. All cables shall carry the manufacturer's name or trade mark, the cable size, voltage rating and year of manufacture at intervals not exceeding 100 meters. Running meter markings shall also be provided throughout the length of the cable.

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5.11 Dimension

The overall dia. and dia. under armour of the cables shall be indicated by the vendor in the technical particulars. These shall be guaranteed with a tolerance of $\pm 5\%$ but not exceeding 2 mm.

5.12 The cut ends of the cables shall be sealed by means of non-hygroscopic materials.

6.0 SPECIAL PURPOSE CABLES

6.1 Flame Retardant Low Smoke Cables

Flame retardant low smoke cables shall have outer sheath of PVC having following values.

- Minimum oxygen index	- 29%
- Minimum temperature index	- 250°C
- Maximum acid gas generation	- 20%
- Maximum smoke density rating	- 60%

6.2 Heat Resistant Cables

Heat resistant cables, shall be of silicon rubber insulated laid circular with asbestos worming and overall glass fibre braided and varnished. Silicon rubber insulating compound shall conform to IS: 6380 and the constructional features shall conform generally to IS: 9968.

7.0 CABLE DRUM

7.1 The cables shall be supplied in non-returnable wooden drums (or steel drums if specified) of heavy construction. The wood used for construction of the drums shall be properly seasoned, sound and free from defects.

7.2 Cables shall be supplied in specified drum lengths. Where no such indication is given, standard drum lengths may be offered.

7.3 The tolerance on each drum of cable shall not exceed $\pm 2.5\%$. However, no negative tolerance on HV cables is acceptable.



7.4 All cable drums shall have stencilled data as per relevant IS as well as the purchaser's order no., item no. & drum no.

8.0 TESTS AND INSPECTION

8.1 The following tests shall be carried out on the cables as per relevant IS.

i) Routine Tests	- On all cables
ii) Acceptance tests	- On representative length of each size
iii) Type tests	- Wherever specified on one cable drum of each size

8.2 In addition, the following tests shall be carried out on all fire retardant low smoke cables as per IS or as per the following standards:

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- i) Oxygen and temperature index test as per ASTM-D-2863
- ii) Acid gas emission test as per IEC-754 Part-I
- iii) Smoke density test as per ASTM-D-2843
- iv) Flammability test as per IEC-332 Part-I or IS-10810

8.3 All the above mentioned tests shall be carried out in the presence of purchaser's representative. In addition, the cables shall be subjected to stage inspection at works and inspection at site for final acceptance.

8.4 These tests and inspections shall, however, not absolve the vendor from their responsibility for making good any defect which may be noticed subsequently.

9.0 DRAWINGS AND DOCUMENTS



9.1 Drawings and documents as per Annexure-I shall be supplied, unless otherwise specified.

9.2 All drawings and documents shall have the following descriptions written boldly.

- Name of client
- Name of consultant
- Enquiry / Order Number with plant / project name
- Code No. and Description

10.0 DEVIATIONS

10.1 Deviations, if any, from this standard shall be clearly indicated in the offer with reasoning.

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ANNEXURE - I



DOCUMENTATION FOR CABLES

Sl. No.	Document Description	Documents Required (Y / N)		
		With Bid	For Approval	Final
1.	Specification Sheet, duly completed	Y	Y	Y
2.	Technical Particulars, duly filled-in	Y	Y	Y
3.	Illustrative and Descriptive catalogues	Y	N	Y
4.	Installation, Termination and Jointing Instructions	N	N	Y
5.	Test certificates			
	a) Routine	N	N	Y
	b) Type	Y	N	Y
6.	Guarantee Certificates	N	N	Y



Note:

1. 4 hard copies & 1 soft copy shall be supplied with bid.
2. 4 hard copies & 1 soft copy shall be supplied for approval after order within 4 weeks from the date of LOI.
3. 8 hard copies & 2 soft copies in pen drive shall be submitted as final documents prior to despatch of the equipment. These shall be made in sets and supplied in fine plastic coated folder.

Y - Yes, N - No

	HORTON SPHERE ALONG WITH ITS REFRIGERATION SYSTEM AT NFL, NANGAL TECHNICAL SPECIFICATION – PREFABRICATED LADDER TYPE CABLE RACKS (TS-8161)	PC281-NFL-N/E-1/P-II/7.0	0	
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**TECHNICAL SPECIFICATION
PREFABRICATED LADDER TYPE CABLE RACKS**



	HORTON SPHERE ALONG WITH ITS REFRIGERATION SYSTEM AT NFL, NANGAL TECHNICAL SPECIFICATION – PREFABRICATED LADDER TYPE CABLE RACKS (TS-8161)	PC281-NFL-N/E-1/P-II/7.0	0	
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ANNEXURE - I	DOCUMENTATION FOR PREFABRICATED LADDER TYPE CABLE RACKS

LIST OF ATTACHMENTS

ATTACHMENT NUMBER	DESCRIPTION
PDS: E 530	Pre-Fabricated Cable Tray Straight Run
PDS: E 531	Pre-Fabricated Cable Tray Horizontal Tee
PDS: E 532	Pre-Fabricated Cable Tray Horizontal Cross
PDS: E 533	Pre-Fabricated Cable Tray 90 ⁰ Horizontal Bends
PDS: E 534	Pre-Fabricated Cable Tray 90 ⁰ Vertical Bend Bending Radius 1000mm
PDS: E 535	Pre-Fabricated Cable Tray 90 ⁰ Vertical Bend Bending Radius 600 mm
PDS: E 536	Pre-Fabricated Cable Tray Coupling Arrangement
PDS: E 537	Pre-Fabricated Cable Tray Fixing Arrangement
PDS: E 538	Pre-Fabricated Cable Tray Reducing Coupler Plate

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1.0 SCOPE

- 1.1 This standard covers the technical requirements of design, fabrication, testing at works and delivery in well-packed condition of prefabricated ladder type cable racks.
- 1.2 The standard shall be read in conjunction with Drawing Nos. PDS: E 530 to 538 (9 Sheets) attached with this standard.

2.0 STANDARDS TO BE FOLLOWED



- 2.1 The design, manufacture and testing of the cable racks covered by this standard shall comply with the latest issue of following and other relevant Indian Standards, unless otherwise specified. Equipment complying with equivalent IEC standards shall also be acceptable.

- IS: 733 -- Wrought aluminium and aluminium alloy bars, rods and sections for general engineering purposes
- IS: 2629 -- Recommended practice for hot dip galvanising on iron and steel
- IS: 4759 -- Hot dip zinc coatings on structural steel and other allied products

- 2.2 Wherever any requirement, laid down in this standard, differs from that in Indian Standard Specifications, the requirement specified herein shall prevail.

3.0 GENERAL DESIGN AND CONSTRUCTIONAL FEATURES

- 3.1 Ladder type cable racks shall be fabricated as per attached Drawing Nos. PDS: E 530 to PDS: E 538 (9 Sheets).
- 3.2 Cable racks and accessories such as coupler plate, tees, bend, elbows etc. shall be fabricated from 3 mm thick mild steel galvanised sheet or 4 mm thick aluminium 19000 H2 alloy sheet extrusion conforming to designation No. 64430 and condition WP as per IS: 733.
- 3.3 G.I. racks and accessories shall have zinc coating of 800 gm/sq. metre applied by hot dip galvanising process. Galvanising shall be uniform, adherent, smooth and free from defects.
- 3.4 The finished rack and accessories shall be free from sharp edges and corners, burrs and un-evenness. Stepped arrangement of bending is not acceptable. The channel members in the bending shall have uniform curvature and shall be made out of single piece.
- 3.5 The racks shall be supplied in minimum length of 2.4 metre.
- 3.6 Each straight length and bend shall be supplied with two coupling plates fitted at each side channel at one end. The coupling plates shall be supplied with bolts, nuts and washers fitted at the other four holes for fixing to adjoining member.

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- 3.7 Coupling plate shall be designed to permit longitudinal adjustment upto ± 10 mm and skew upto 10° .
- 3.8 Clamping arrangement as per attached drawings shall be provided for fixing the rack with the cross support as required.
- 3.9 All the bends, tees and junctions shall be made sufficiently rigid by providing suitable reinforcement on rungs as required.
- 3.10 The rungs shall be connected to the side channels by continuous welding alongwith three sides of rung. Aluminium rack shall be welded by TIG welding process.
- 3.11 All hard wares such as nuts, bolts, washers and crank bolts shall be zinc passivated.
- 3.12 Tolerances in various dimension shall be follows:
- | | | |
|-----------|----|--------------|
| Length | -- | ± 5 mm |
| Width | -- | ± 2 mm |
| Height | -- | ± 1 mm |
| Bend | -- | ± 1 mm |
| Thickness | -- | ± 0.2 mm |
- Positive tolerance on total quantity upto $\pm 5\%$ is acceptable. However, negative tolerance on total quantity is not acceptable.

4.0 MARKING

The packing shall be clearly marked on the outside (on top side & ends) in indelible ink with the following minimum details:



- Part No.
- Size of Tray (Length x Width x Height)
- No. of Tray / Section, Total Weight
- Material Specification
- Client's Name
- Purchase Order No.
- Manufacturer's Name

5.0 TESTS AND INSPECTION

- 5.1 Following tests shall be carried out on prefabricated cable racks:

Visual inspection and checking for

- i) Quality and thickness of raw material
- ii) Dimensions as per drawing.
- iii) Quality of welding (before galvanising for G.I. racks)
- iv) Preparation of metal surfaces (for G.I. racks).

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- 5.2 After galvanising, G.I. cable racks shall be subjected to following tests as per IS:4759.
- i) Mass of galvanising coating -- At any location the thickness of zinc coating shall not be less than 90 micron. However, average thickness of zinc coating shall not be less than 113 micron.
 - ii) Uniformity of galvanising coating.
 - iii) Adhesion of galvanising coating.
 - iv) 3 samples from each lot shall be taken for testing.
 - v) From each lot and size of rack, measure length of 10 trays and average length to be multiplied by number of trays to arrive for total length.

5.3 All the above tests shall be carried out in the manufacturer's works in the presence of Purchaser's representative. In addition to the above tests, the cable racks and its accessories shall be subjected to stage inspection at works and inspection at site for final acceptance.

5.4 These tests and the Purchaser's inspection shall, however, not absolve the vendor from their responsibility for making good any defect which may be noticed subsequently.

6.0 DRAWINGS AND DOCUMENTS



6.1 Drawings and documents as per Annexure-I shall be supplied.

6.2 All drawings and documents shall have the following descriptions written boldly.

- Name of client
- Name of consultant
- Enquiry / Order Number with plant / project name
- Code No. and Description

7.0 DEVIATIONS

7.1 Deviations, if any, from this standard shall be clearly indicated in the offer with reasoning.

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ANNEXURE - I



DOCUMENTATION FOR PRE-FABRICATED LADDER TYPE CABLE RACKS

Sl. No.	Document Description	Documents Required (Y / N)		
		With Bid	For Approval	Final
1.	Illustrative and Descriptive catalogues	Y	N	Y
2.	Installation, Termination and Jointing Instructions	N	N	Y
3.	General Arrangement Drawings, showing details of rack, coupling pieces, fasteners, etc.	Y	Y	Y
4.	Test certificates	N	N	Y
5.	Guarantee Certificates	N	N	Y

Note:

1. 4 hard copies & 1 soft copy shall be supplied with bid.
2. 4 hard copies & 1 soft copy shall be supplied for approval after order within 4 weeks from the date of LOI.
3. 8 hard copies & 2 soft copies in pen drive shall be submitted as final documents prior to despatch of the equipment. These shall be made in sets and supplied in fine plastic coated folder.

Y - Yes, N - No

	HORTON SPHERE ALONG WITH ITS REFRIGERATION SYSTEM AT NFL, NANGAL TECHNICAL SPECIFICATION – LOCAL CONTROL STATION (TS-8200)	PC281-NFL-N/E-1/P-II/7.0	0	
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TECHNICAL SPECIFICATION LOCAL CONTROL STATION





**HORTON SPHERE ALONG WITH ITS
REFRIGERATION SYSTEM AT NFL, NANGAL
TECHNICAL SPECIFICATION –
LOCAL CONTROL STATION (TS-8200)**

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ANNEXURE - I	DOCUMENTATION FOR LOCAL CONTROL STATIONS

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1.0 SCOPE

- 1.1 This standard covers the technical requirements of design, manufacture, testing at works and delivery in well-packed condition of Local Control Stations.

2.0 STANDARDS TO BE FOLLOWED

- 2.1 The design, manufacture and testing of the equipment covered by this standard shall comply with the latest issue of IS: 13947 and other relevant Indian Standards, unless otherwise specified. Equipment complying with equivalent IEC standards shall also be acceptable.
- 2.2 The design and operational features of the equipment offered shall also comply with the provisions of latest issue of the Indian Electricity rules and other relevant statutory Acts and Regulations. The supplier shall, wherever necessary, make suitable modification in the equipment to comply with the above.
- 2.3 Wherever any requirement, laid down in this standard differs from that in Indian Standard Specifications, the requirement specified herein shall prevail.

3.0 SERVICE CONDITIONS

3.1 Ambient Conditions

These shall be as indicated in Design Philosophy-Electrical.

3.2 System Details



These shall be as indicated in Design Philosophy-Electrical.

4.0 OPERATIONAL REQUIREMENTS



This equipment and associated components shall be suitable for operating satisfactorily under the specified ambient and system conditions.

5.0 GENERAL DESIGN AND CONSTRUCTIONAL FEATURES



- 5.1 The Control Stations shall be suitable for control voltage not exceeding 500V, 50 Hz AC or 220V D.C.
- 5.2 The enclosure shall be of die cast Aluminium alloy LM-6. As an alternative to cast Aluminium, fibre glass enclosure is also acceptable.
- 5.3 The equipment shall have dust, hose and weather proof construction equivalent to IPW-55 as per IS: 13947. These shall be suitable for outdoor location without any additional protection or cover.
- 5.4 A rain-hood shall be offered as an additional item. It shall be made of 14 gauge Aluminium sheet bent to shape. In case of fibre glass enclosure, these can be made of fibre glass.
- 5.5 All external hardware of diameter less than 8 mm shall be of stainless steel and those of diameter 8 mm and above shall be of mild steel zinc passivated. For fibre glass enclosure Nylon PVC bolts of diameter 8 mm may be used.

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- 5.6 The control station shall preferably be with bolted cover. The bolts for retaining the cover in position shall be provided with 10 mm dia. stainless steel and these shall be so arranged that they do not pierce into the door gasket.
- 5.7 All the components shall be mounted on a base plate inside the enclosure. Necessary actuating system for control switch, push button, non yellowing acrylic/ glass cover for ammeter and indication lamps shall be provided on the front cover. No wiring shall be carried out on the front cover.
- 5.8 The layout of components in the control station shall be liberal and standardised.
- 5.9 All mating surfaces shall be smoothly machined and shall be of sufficient width of at least 6 mm. The covers shall be provided with continuous gasket made of neoprene or synthetic rubber to prevent ingress of dust and moisture. The gasket shall be held in position in groove provided in the enclosure and shall be pressed all around uniformly by suitably shaped projection of the door. Gaskets simply glued to the surface are not acceptable.
- 5.10 The enclosure shall be suitable for mounting on wall or on steel structure. 4 Nos. holes suitable for 12 mm bolts shall be provided outside the enclosure for fixing the control stations.
- 5.11 The internal wiring shall be carried by means of single core PVC insulated 1.5 sq. mm stranded copper conductor cable. All termination shall be made with crimping type proper size lugs and shall be properly ferruled.
- 5.12 The control stations shall be completely factory wired and ready for external cable connection.
- 5.13 For easy identification, numbering ferrules shall be provided on all wiring at both ends i.e. equipment end and terminal block end. Terminals for external wiring shall be numbered
- 5.14 The enclosure shall be provided with two earthing terminals with studs of 8 mm. dia. projecting outside the enclosure for connection to earth. These terminals shall not pierce through the enclosure and shall be marked with earthing symbol.
- 5.15 Each control station shall be provided with minimum 2 mm thick stainless steel name plates or consisting of black Perspex with white engraving indicating the code number and description of the equipment controlled by it. Similar labels shall be provided for all indication lamps, push buttons and control switches. The name plate and label shall be fixed with screws only.
- 6.0 SPECIAL FEATURES FOR FLAME PROOF LOCAL CONTROL STATION**
- 6.1 The enclosure shall be in addition, of flameproof execution as per IS: 2148.
- 6.2 The control stations shall be suitable for hazardous area of enclosure group and temperature class.
- 6.3 Cables shall enter the terminal box through flame proof cable gland. From the terminal chamber to the main enclosure, the connections shall be made through proper bushings. Direct entry of external cables into the main enclosure shall not be accepted. All entries shall be provided with stainless steel inserts.

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- 6.4 An additional earthing terminal inside the terminal chamber shall be provided.
- 6.5 Local control stations and cable gland must be certified by the Central Mining Research Institute, Dhanbad or any other statutory authority for use in the specified hazardous area.
- 7.0 COMPONENT DETAILS**
- 7.1 Local control stations shall be provided with controlling and indicating elements.
- 7.2 Trip-Neutral-Close Switch**
- TRIP-NEUTRAL-CLOSE switch shall be double pole, 3 position, pistol grip, rotary type having self spring return feature to neutral position. The contacts shall be of phosphor bronze and shall be provided with two breaks in series. Mechanical sequence device to prevent two successive movements to the same position shall be fitted. The switch shall be capable of being padlocked in the 'TRIP' position.
- 7.3 'Auto-Manual' Switch**
- 'Auto-Manual' switch shall be single pole stay put type having three positions "AUTO-OFF-MANUAL". Provision shall be made to padlock the switch in the "OFF" position.
- 7.4 Selector Switch / Lock Service Switch**
- These shall be single pole stay put type having two position with a pistol grip handle and capable of being padlocked in one of the position.
- 7.5 All the switches shall be rotary type with snap or wiping action contact and having a set of normally open and closed contacts in each position. All switches shall be provided with pistol grip handle.
- 7.6 'Off-Auto-On' Switch**
- 7.6.1 'OFF-AUTO-ON' switch shall be in minimum three stack configuration, each stack having three positions with spring return from 'ON' to 'Auto' position and lockable in 'OFF' position by means of padlock.
- 7.6.2 The switch shall have sliding contact between 'AUTO' and 'ON' position. In 'OFF' position the contact shall be completely broken from 'AUTO' position.
- 7.7 Push Buttons**
- These shall be spring loaded, with a set of normally closed and open contacts. The push buttons for 'start' shall be shrouded type and coloured green while 'stop' push buttons shall be un-shrouded type and coloured red. Provision shall be made to padlock the 'stop' push button in 'OFF' position. The fixing ring shall be metallic white. An oil proof rubber cap shall preferably be provided.
- 7.8 The switches and push buttons shall conform to utilization category AC11/ DC11 as per IS: 13947. The contact shall be rated to make, break and carry inductive current of 5 Amp. at 415 V AC and 1 Amp of 220V DC. The contact arrangement shall be as shown in the terminal drawings. Built in locks instead of padlocking are not acceptable.

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7.9 Indication Lamps

7.9.1 LED type indication lamps shall be provided to indicate the various circuit conditions as shown in the terminal drawings.

7.9.2 The LEDs shall provide good illumination through a viewing angle of 180°. The LEDs shall have lumen output of 200 milli Candella in the axial direction.

7.9.3 The colour of the LED indication for various functions shall be as follows:-

RED : For 'ON' Indication
GREEN : For 'OFF' Indication
WHITE : For "Ready for Service" Indication

7.10 A.C. Ammeters

The ammeter shall be flush mounting, moving iron spring controlled type, of accuracy class 1.5 as per IS:1248, with square face of minimum size 72 mm x 72 mm having scale range 0-240°. The ammeter shall be provided with uniform scale up to CT primary current and compressed end scale up to 6 times the CT primary current. Adjustable red pointer shall be provided to indicate the full load current of the motors. Zero adjusters shall be provided for operation from the front of the meter. All ammeters shall be operated through 1Amp. CTs only.

7.11 D.C. Ammeters

The D.C. ammeter shall be shunt operated. These shall be moving coil or moving iron type of accuracy class 1.5 as per IS: 1248.

7.12 Terminal Blocks

All control stations shall be provided with terminal blocks. Terminal blocks shall be located at a minimum distance of 50 mm from the bottom of the enclosure. The terminal blocks for the control station shall be suitable for conductor sizes of 2.5 mm². These shall be of pressure clamp type design mounted on the base channel. The minimum rating of terminal block shall be 16 Amp.

7.13 Cable Glands



The cables for the external connections, shall enter the terminal chamber through heavy duty double compression type rolled Aluminium cable glands suitable for 2.5 sq. mm PVC insulated, armoured, and PVC sheathed copper conductor 1.1 KV grade cables. The cable gland shall be fitted in a threaded hole.

8.0 PAINTING

8.1 The enclosure after suitable pre-treatment shall be painted with two coats of anti-rust paint followed by two coats of anticorrosive paint.

8.2 Epoxy based paint shall be used.

8.3 All paints shall be carefully selected to withstand tropical heat and extremes of weather. The paint shall not scale off, crinkle or be removed by abrasion due to normal handling.

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8.4 Unless otherwise specified, the finishing shade shall be of light grey having shade no. 631 as per IS: 5.

9.0 TESTS AND INSPECTION

9.1 All equipment shall be routine tested as per relevant standards.

9.2 Additional tests, wherever specified, shall be carried out.

9.3 All the above mentioned tests shall be carried out in the presence of purchaser's representative. In addition, the equipment shall be subjected to stage inspection at works and inspection at site for final acceptance.

9.4 These inspections shall, however, not absolve the vendor from their responsibility for making good any defect which may be noticed subsequently.

10.0 DRAWINGS AND DOCUMENTS

10.1 Drawings and documents as per Annexure-I shall be supplied, unless otherwise specified.

10.2 All drawings and documents shall have the following descriptions written boldly.

- Name of client
- Name of consultant
- Enquiry / Order Number with plant / project name
- Code No. and Description

11.0 SPARES



11.1 Spares for operation and maintenance

Item wise unit prices of spare parts for the following items as applicable shall be offered along with the main equipment with recommended quantity.

- i) Trip-Neutral-Close switch
- ii) Auto-Manual switch
- iii) Selector switch
- iv) OFF-Auto-ON switch
- v) Ammeters of different ranges
- vi) Push buttons of different types
- vii) Indication lamps of different types
- viii) Terminal blocks
- ix) Terminal bushings

11.2 Commissioning Spares

Commissioning spares, as required, shall be supplied with the main equipment. Item wise list of recommended commissioning spares shall be furnished for approval.

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11.3 Any other spare parts not specified, but required, shall also be quoted along with the offer.

11.4 All spare parts shall be identical to the parts used in the equipment.



12.0 PACKING

12.1 The local control stations shall be properly packed to safeguard against weather conditions and handling during transit. It shall be wrapped in polythene bags and an additional wrapping of bitumen paper shall also be provided to make it completely water proof before the equipment is packed in wooden crates.

12.2 The packing box shall contain a copy of the installation, operation and maintenance manual.

13.0 DEVIATIONS

13.1 Deviations, if any, from this standard shall be clearly indicated in the offer with reasoning.

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ANNEXURE - I



DOCUMENTATION FOR LOCAL CONTROL STATIONS

Sl. No.	Document Description	Documents Required (Y / N)		
		With Bid	For Approval	Final
1.	Specification Sheet, duly completed	Y	Y	Y
2.	Technical Particulars, duly filled-in	Y	Y	Y
3.	General Arrangement Drawings	Y	Y	Y
4.	Schematic Diagrams	N	Y	Y
5.	Illustrative and Descriptive catalogues	Y	N	Y
6.	Catalogues of bought out accessories	Y	N	Y
7.	Spare parts list	Y	N	Y
8.	Installation, Operation and Maintenance manual	N	N	Y
9.	Test certificates			
	a) Routine	N	N	Y
	b) Type (only for flameproof equipment)	N	N	Y
	c) For enclosure	Y	N	Y
10.	Guarantee Certificates	N	N	Y



Note:

1. 4 hard copies & 1 soft copy shall be supplied with bid.
2. 4 hard copies & 1 soft copy shall be supplied for approval after order within 4 weeks from the date of LOI.
3. 8 hard copies & 2 soft copies in pen drive shall be submitted as final documents prior to despatch of the equipment. These shall be made in sets and supplied in fine plastic coated folder.

Y - Yes, N - No



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TECHNICAL SPECIFICATION JUNCTION BOX

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ANNEXURE - I	DOCUMENTATION FOR JUNCTION BOXES

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1.0 SCOPE

- 1.1 This standard covers the technical requirements of design, manufacture, testing and inspection at works and delivery in well packed condition of junction boxes.

2.0 STANDARDS TO BE FOLLOWED

- 2.1 The design, manufacture and testing of the equipment covered by this standard shall comply with the latest issue of relevant Indian standards unless otherwise specified. Equipment complying with equivalent IEC standards shall also be acceptable.
- 2.2 Flameproof & increased safety junction boxes shall in addition, comply with the requirement as laid down in IS: 2148 & IS: 6381 respectively.
- 2.3 The design and constructional features of the junction boxes offered shall also comply with the provision of latest issue of the Indian Electricity Rules and other relevant Statutory Rules & Regulations. The supplier shall, whenever necessary, make suitable modification in the equipment to comply with the above mentioned rules.
- 2.4 Wherever any requirement laid down in this standard differs from that in Indian Standard specifications, the requirement specified herein shall prevail.

3.0 SERVICE CONDITIONS

3.1 Ambient Conditions



These shall be as indicated in Design Philosophy-Electrical.

3.2 System Details

The details of power supply system shall be as indicated in Design Philosophy-Electrical.



4.0 GENERAL DESIGN & CONSTRUCTIONAL FEATURES

- 4.1 The junction boxes shall be dust and weather proof and suitable for installation outdoors without extra protection. The degree of protection shall be IP-55 as per IS: 4691.
- 4.2 The junction boxes shall be of die cast aluminium alloy LM-6 with domed / suspension covers. As an alternative to cast aluminium, fibre glass enclosure is also acceptable.
- 4.3 The casting of the junction boxes and their cover shall be pressure die cast. The casting shall be uniform and free from blow holes. All mechanical surfaces shall be free from burrs, dents and internal roughness.
- 4.4 All external hardware of diameter less than 8 mm shall be of stainless steel and those of diameter 8 mm and above shall be of mild steel zinc passivated. For fibre glass enclosure Nylon PVC bolts of diameter 8 mm may be used.
- 4.5 The clearances and creepage distances shall be maintained inside the junction boxes as per relevant Indian standard.
- 4.6 The junction boxes shall be suitable for wall / structure / ceiling mounting and necessary arrangement for mounting the same shall be provided.
- 4.7 The junction boxes shall be provided with continuous gasket made of neoprene or synthetic rubber to prevent ingress of dust. The gasket shall be held in position in groove provided in

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the enclosure and shall be pressed all around uniformly by suitably shaped projection of the door. Gaskets simply glued to the surface are not acceptable.

- 4.8 The junction boxes housing terminal block shall be moulded type made of DMC / Fibre glass. Threaded terminals shall be made of brass (nickel plated or tinned) and provided with two tightening threaded nuts and four washers all made of brass (nickel plated or tinned). The terminals shall have two shorting links each horizontally placed connecting three terminals.
- 4.9 The terminal block shall be fitted with junction boxes base by means of 2 nos. 1/2" long nickel plated brass screws.
- 4.10 The junction boxes shall be provided with two nos. external earthing terminals and 1 no. internal earthing terminal.
- 4.11 All live parts inside the junction boxes shall be insulated and shall withstand a test voltage of 2.5 KV for 1 minute.
- 4.12 The junction boxes shall be provided with heavy duty double compression type rolled Al cable glands to suit the cable entries.
- 4.13 Threaded blanking plugs shall be provided for junction boxes to plug out the entries not in use as indicated in bill of quantities enclosed.
- 4.14 The junction boxes shall be provided with a blank stainless steel tag plate fastened to the junction box top cover with two stainless steel screws. The plate shall be at least 25 mm wide, 100 mm long and 1 mm thick.
- 4.15 For flameproof / increased safety junction boxes, the manufacturer shall submit copies of test certificates from statutory authorities clearly stating that the junction boxes as well as cable glands / blanking plugs are suitable for specified hazardous area.
- 4.16 **15 Amp. Junction Box**
- 4.16.1 The junction boxes shall be 4 way dome cover type.
- 4.16.2 The dimensions of the junction boxes with their cover and accessories shall be generally as per PDS: E-547.
- 4.16.3 The junction boxes housing terminal block shall be moulded type made of DMC / Fibre glass as per Drg. no. PDS: E-557.
- 4.17 **63 Amp. Junction Box**
- 4.17.1 The junction boxes shall be 3 / 4 way dome cover type.
- 4.17.2 The minimum internal diameter of the box shall be 240 mm.
- 5.0 SPECIAL FEATURES FOR JUNCTION BOXES FOR HAZARDOUS AREA**
- 5.1 For increased safety junction boxes, the terminals shall be provided with positive locking device against loosening.
- 5.2 The enclosure shall be in addition, of increased safety execution, Exe, as per relevant standard and shall be suitable for installation.

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- 5.3 The junction boxes shall be liberally dimensioned in order to avoid temperature rise inside the enclosure which may damage the insulating materials or gaskets employed therein.
- 5.4 Cables shall enter the terminal box through increased safety compression type cable glands. From the terminal chamber to the main enclosure, the connections shall be made through proper bushings.
- 5.5 An additional earthing terminal inside the terminal chamber shall be provided.
- 5.6 The junction boxes shall be provided with Brass-Nickel plated shorted links. The terminal block shall be made of non-hygroscopic compound. Bakelite / Hylam shall not acceptable.
- 5.7 All screws / bolts and nuts shall be of stainless steel.
- 5.8 Junction boxes and cable glands must be certified by Statutory Authorities for use in the specified hazardous area. Equipments certified by overseas authorities shall obtain certificate of compliance / letter of opinion from respective statutory authorities.
- 5.9 Duly wired prototype samples for junction boxes shall be submitted for scrutiny as and when called for.
- 5.10 Type Test certificates for increased safety type junction boxes and cable glands along with blanking plugs shall be supplied.

6.0 PAINTING



- 6.1 Epoxy based electrostatic powder coating paint shall be provided on exterior surface while the interior of junction boxes shall be painted with anti-condensate paint. The painting shall be able to withstand corrosive atmosphere.
- 6.2 Unless otherwise specified, the finishing shade shall be grey having shade no. 632 as per IS-5.
- 6.3 The terminal block of junction boxes shall be painted with Red, Yellow, Blue & Black colour for phase indication.

7.0 TESTS AND INSPECTION

- 7.1 The junction boxes shall be routine tested as per relevant standards.
- 7.2 Additional tests, wherever specified, shall be carried out on one unit of each rating.
- 7.3 The procedure & extent of the physical checks, routine & type test shall be governed by Quality Assurance Plan mutually agreed and approved by Inspection Authority.
- 7.4 All the above mentioned tests shall be carried out in the presence of purchaser's representative. In addition, the equipment shall be subjected to stage inspection at works and inspection at site for final acceptance.
- 7.5 These inspections shall, however, not absolve the vendor from their responsibility for making good any defect which may be noticed subsequently.

8.0 PACKING

Each junction box and cable gland shall be suitably packed and protected from damage due

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to transportation, loading and unloading. Threaded fittings shall have plastic caps to protect the threading.

9.0 DRAWINGS AND DOCUMENTS

9.1 Drawings and documents as per Annexure-I shall be supplied, unless otherwise specified.

9.2 All drawings and documents shall have the following descriptions written boldly:

- Name of client
- Name of consultant
- Enquiry / order number with plant / project name
- Motor Code No. and Description

10.0 SPARES

10.1 Spares for operation and maintenance

Item wise unit prices of spare parts for the following items, as applicable, shall be offered along with the main equipment with recommended quantity.

- i) Cable glands
- ii) Threaded Plug
- iii) Terminal blocks
- iv) Terminal bushings

10.2 Commissioning Spares



Commissioning spares, as required, shall be supplied with the main equipment. Item wise list of recommended commissioning spares shall be furnished for approval.

10.3 Any other spare parts not specified, but required, shall also be quoted along with the offer.

10.4 All spare parts shall be identical to the parts used in the equipment.

11.0 DEVIATIONS

11.1 Deviations, if any, from this standard shall be clearly indicated in the offer with reasoning.

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**ANNEXURE - I
DOCUMENTATION FOR JUNCTION BOXES**

Sl. No.	Document Description	Documents Required (Y / N)		
		With Bid	For Approval	Final
1.	Specification Sheet, duly completed	Y	Y	Y
2.	Technical Particulars, duly filled-in	Y	Y	Y
3.	Certified dimensional drawing, including mounting details	Y	Y	Y
4.	Drawing showing constructional details	Y	Y	Y
5.	Illustrative and Descriptive catalogues	Y	N	Y
6.	Spare parts list	Y	N	Y
7.	FLP/Exe certificates for junction boxes and terminals conforming to IEC/ISS (CMRI, CCE, DGFASLI and BARC for terminals)	Y	N	Y
8.	Certificate for weather proof construction for junction boxes as per IPW-55	Y	N	Y

Note:

1. 4 hard copies & 1 soft copy shall be supplied with bid.
2. 4 hard copies & 1 soft copy shall be supplied for approval after order within 4 weeks from the date of LOI.
3. 8 hard copies & 2 soft copies in pen drive shall be submitted as final documents prior to despatch of the equipment. These shall be made in sets and supplied in fine plastic coated folder.

Y - Yes, N - No

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**TECHNICAL SPECIFICATION
ELECTRICALS FOR OVERHEAD CRANES & HOISTS**



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1.0 SCOPE

- 1.1 This standard covers the technical requirements of design, engineering, manufacture, testing at works, supply at site, erection, site testing and commissioning of the complete electrical equipment and accessories as required for the overhead travelling crane and hoists.
- 1.2 This standard shall be read in conjunction with relevant mechanical specifications, other relevant standards / specifications.
- 1.3 The scope of work shall include but not limited to the following items:
- i) Drive motors
 - ii) Starting resistors (in case of slip ring motors)
 - iii) Power control panel
 - iv) Control stations
 - v) Limit switches
 - vi) Electromagnetic brakes
 - vii) Power and control cables with accessories
 - viii) Earthing of all equipment
 - ix) All other items, not specified but, required for safe and proper operation
- 1.4 The owner shall provide one no. medium voltage feeder for each crane / hoist and terminate the feeder cable in an isolator located at one end of the bay at a height of 1.5 m from the operating floor. The vendor shall indicate the exact power requirement (running and peak) to enable the owner to size and provide the power supply feeder.
- 1.5 Further distribution of power from this isolator onwards shall be in the vendor's scope.

2.0 STANDARDS TO BE FOLLOWED

- 2.1 The design, manufacture, testing and installation of the equipment shall comply with the latest issue of IS-6547, IS-807 and other relevant Indian Standard specifications and codes of practices. Equipment complying with equivalent IEC standards shall also be acceptable.
- 2.2 The equipment and installation shall also comply with the provisions of latest issue of Indian Electricity rules and other statutory acts and regulations.
- 2.3 Wherever any requirement, laid down in this standard, differs from that in Indian Standard Specification, the requirement specified here-in shall prevail.



3.0 SERVICE CONDITIONS

3.1 Ambient Conditions

These shall be as indicated in Design Philosophy-Electrical.

3.2 System Details

These shall be as indicated in Design Philosophy-Electrical.

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3.3 The owner shall provide only three phase power at the specified medium voltage. For lighting, control and plug supply the vendor shall provide necessary single phase step-down transformers.

3.4 All the electrical equipment shall be so designed that enable the crane / hoist to operate at its rated capacity and specified duty cycle with the system variation under the ambient conditions indicated in Design Philosophy-Electrical without exceeding the permissible temperature rise and without any detrimental effect on any part.

4.0 GENERAL DESIGN AND CONSTRUCTIONAL REQUIREMENTS

4.1 The electrical system and installation shall be designed as per latest practice to provide maximum reliability, flexibility, safety to personnel and equipment and ease of operation and maintenance.

4.2 All equipment shall have adequate and standard ratings as per ISS.

4.3 All electrical equipment to be located in indoor plant area shall be enclosed in dust, damp and vermin proof enclosure equivalent to IP-54 as per IS: 13947 / IS: 4691.

4.4 Equipment to be located outdoor shall be weather proof and have IPW-55 protection as per IS: 13947 / IS: 4691 and shall also be provided with canopy as far as practicable.

4.5 The equipment to be located in hazardous area shall have additional protection as follows:

- a) Zone – I All the equipment shall be in flameproof execution.
- b) Zone – II The equipment producing sparks under normal operation shall be in flameproof execution and others shall be in increased safety execution.

The equipment shall be suitable for the enclosure group and temperature class as indicated in Design Philosophy-Electrical. The equipment selected shall conform to relevant Indian Standard Specification and must be certified by Central Mining Research Institute, Dhanbad or any other statutory authority for use in the specified hazardous area.



4.6 The pendant push button shall be light weight enclosure of aluminium/ polypropylene etc. In case of hazardous areas, the loop between the pendant push button and the crane control panel shall be made intrinsically safe by using suitable isolators. Alternatively certified flame proof components and increased safety terminals can be hosed in the hose proof aluminium / polypropylene enclosure.

4.7 Special care shall be taken to ensure that the parts to be opened for inspection and maintenance retain their dust tightness even after repeated opening and closing operations.

4.8 All mating surfaces shall be properly machined. Neoprene gaskets shall be used for dust and weather proofing. The gaskets shall be without any discontinuity.

4.9 Only non-hygroscopic materials shall be used for insulation. All insulation shall be specially impregnated to withstand ambient conditions and atmospheric pollution.

4.10 All live parts shall be adequately protected to prevent inadvertent or accidental contact.



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- 4.11 The minimum clearance and creepage distance of M.V. equipment shall be 20 and 28 mm respectively and shall be positively maintained after connections.
- 4.12 All external hardware of diameter less than 8 mm shall be of stainless steel and those of diameter 8 mm and above shall be of mild steel zinc passivated.
- 4.13 Earthing terminals complete with sockets and identification marks shall be provided on the enclosure of all electrical equipment. The number of terminals shall be two for equipment rated above 240V and one for those rated 240V and below. Additional internal earthing arrangement shall be provided for flameproof equipment.
- 4.14 All equipment shall be provided with stainless steel name plates containing the particulars as per relevant IS along with the description and code nos. of equipment
- 4.15 All the electrical equipment shall be provided with separate terminal box, heavy duty double compression type rolled aluminium cable glands, proper crimping lugs and anti-vibration type terminals suitable for the cable sizes required.
- 4.16 Enclosure for limit switches, pendant push button, junction boxes and magnets etc. shall be of cast aluminium. Enclosure for control panel, transformer and resistors may be of sheet steel. The thickness of the sheet steel for the enclosure shall not be less than 2.5 mm. All enclosures shall be suitably painted to withstand atmospheric pollution.
- 4.17 The doors or inspection covers shall be provided with threaded knobs or butterfly nuts made of plated carbon steel. Copper or copper alloys shall not be used outside the enclosures.
- 4.18 To facilitate maintenance and testing of all electrical equipment:
- a) Disconnecting links shall be provided where necessary.
 - b) All cable lugs and terminals shall be numbered in a permanent form corresponding to the wiring diagram.
 - c) Easy access and adequate working space shall be provided around all motors, panels, limit switches etc. safety railing shall be provided, where necessary.

5.0 EQUIPMENT SPECIFICATION

5.1 Power Connection

- 5.1.1 The main supply shall be obtained by flexible cable.
- 5.1.2 In case of overhead bare conductors, they shall be of copper and mounted on side of the crane bridge. Four number of gunmetal type current collector with renewable carbon inserts shall be used for power connection. One end of the bare conductor shall be connected to the owner's isolator by means of fixed cable.
- 5.1.3 In case of flexible cable arrangement, the cable shall be connected at one end of the crane and the other end to owner's isolator. The cable shall be hung at intervals by festooned type arrangement.
- 5.1.4 In either case the power fed to the trolley shall be by means of flexible cables fixed and supported by festooned arrangement.
- 5.1.5 The arrangement of fixing and supporting the flexible cables shall be such that the cable is not damaged due to repeated travelling of the crane and trolley. Supporting G.I. wire shall be provided, wherever required.

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5.1.6 The collector rollers and shoes shall be designed to avoid sparking.

5.2 Power Control Panel

5.2.1 The panel shall house all the necessary electrical equipment for distribution of power and control of individual equipment / circuit.

5.2.2 The panel shall be totally enclosed, floor mounting, dead front, free standing type in cubicle construction.

5.2.3 The panel shall house the following:

i) For incoming supply

- Triple pole switch fuse units
- Supply 'ON' signal lamps (LED Type)

The above switch shall cut off all power driven and associated equipment on the crane except lighting and plug supply circuits.

ii) For motors

- Reversing type starter with necessary contactors and timers.
- Other controlling relays and devices.

iii) For lighting, control and plug supply

- Single phase transformers
- Isolating switch fuse units on primary and secondary sides.

5.2.4 All switches shall be motor duty type (AC 23) and rated for 1.5 times of the full load current of the circuit. The incoming switch shall be interlocked with the panel door.

5.2.5 All contactors shall be air break type and of AC4 utilization categories. The thermal rating of the contactor shall be 1.5 times the full load current of the circuit.

5.2.6 The power contactors shall be interlocked electrically and mechanically so that there shall be no possibility of simultaneous operation of two contactors for the same motor.

5.2.7 Electrical interlock shall be provided between main hoist and micro hoist motors.

5.2.8 All thermal overload relays shall have in-built single phasing feature and ambient compensated, separately mounting and hand reset type. The reset push bottom for thermal overload relays shall be provided on the cover of the control panel so that it is possible to reset the relay from outside without opening the cover of the panel. Also indication shall be provided for hoisting/travel motors tripping on overload.



5.2.9 The panel shall be installed on properly levelled base frame fabricated out of channels of suitable size.

5.3 Motors

5.3.1 The design and specification of all motors shall comply with requirements stated elsewhere in the specifications.

5.3.2 The power rating of the motors shall be 25% higher than the design requirement of the driven equipment, under the specified service and duty conditions.

5.3.3 All motors shall preferably be of squirrel cage type and so designed that smooth acceleration or deceleration of the load is possible without any jerks. Further a maximum displacement of 2 mm when starting and stopping the motor in quick succession shall be guaranteed.

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5.3.4 The motors for main hoist and micro hoist shall be suitable for intermittent duty type S4 with 60% C.D.E. and 300 starts / stops per hour. The motors for long travel and cross travel shall be suitable for S2 duty for 60 minutes.

5.3.5 The motors shall be so located that all parts are accessible for inspection and maintenance without affecting normal ventilation.

5.4 Brakes

5.4.1 The brakes for each motor shall be suitable for duties as specified below:

- a) Main / Micro hoist S4 duty
- b) Long / cross travel S2 duty

5.4.2 The coil of the brake shall be wound with fibre glass covered annealed copper conductor suitable for class H application. An additional covering with glass taps shall be provided over the coil. The maximum temperature of the coil for continuous operation shall be limited to 140° C. The coil shall be vacuum impregnated.

5.4.3 For other design details refer mechanical engineering standard.

5.5 Limit Switches

5.5.1 Limit switches of both shunt and series type shall be used in control and power circuit.

5.5.2 These shall be heavy duty type and of sturdy construction in cast aluminium enclosure.

5.5.3 The mode of operation of these limit switches shall be positive and direct acting type.

5.5.4 The contacts shall be rated 50% more than the required current ratings.

5.5.5 The width of the roller of limit switches shall be sufficient to avoid slippage of contact with the striker.

5.5.6 The striker provided for operating these limit switches shall have rubber padding on surface which will make contact with roller to actuate it. The limit switches and its roller should be designed to withstand the frequent impact pressure.

5.5.7 Switches in which the contacts are operated by spring or gravity or both on the withdrawal of a chain or similar devices, shall not be used.

5.6 Transformers



5.6.1 These shall be of dry type, class H insulated, air cooled, double wound and mounted inside the panel.

5.6.2 The transformers shall be provided with switch fuse unit on their primary side of suitable rating. One side of secondary windings of the transformers shall be earthed and other shall be provided with fuse of suitable rating.

5.6.3 The rating of the transformers shall be at least 2.5 times the continuous load.

5.7 Junction Box

Junction boxes shall be of cast aluminium construction and adequately sized to enable easy termination of cables.

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5.8 Hand Lamps



- 5.8.1 Provision shall be made in the crane for use of hand lamps by installing 2 nos. 24 volts, 2 pin metal clad switch sockets. One of the sockets shall be on the bridge (outside the panel) and the other on the trolley.
- 5.8.2 The transformer primary and secondary voltage shall be 250V and 25V respectively.

6.0 CABLES, CABLE TERMINATION AND CONNECTIONS

- 6.1 The cables used for fixed wiring shall be 1.1 KV grade XLPE insulated armoured and PVC sheathed overall, and shall conform to IS: 7098 Part-I.
- 6.2 The flexible cable used for power supply to crane and also for interconnection of equipment mounted on moving and fixed part of the crane shall be 1.1 KV grade heavy duty type.
- 6.3 All cables shall be properly laid and supported with adequately sized aluminium clamps at 500 mm interval.
- 6.4 Cable entry on all electrical equipment e.g. panels, motors, limit switches, brakes, junction boxes etc. shall be through double compression type rolled aluminium cable glands.
- 6.5 The internal power wiring of panels shall be carried out by PVC insulated stranded copper flexible cable.
- 6.6 The wiring shall be arranged in a neat fashion and supported on PVC channel or PVC stand of screw support.
- 6.7 For equipment mounted on the doors, the wiring shall be carried out with flexible stranded copper cables in such a way that no strain is put on the wires and equipment when the door is opened for inspection and maintenance.
- 6.8 External looping of wires shall be done through separate dust tight junction boxes.
- 6.9 The sizes of power cables to be used shall be subject to owner's approval. The minimum size of power and control cables shall be 16 sq. mm (Al) & 2.5 sq. mm (Cu) respectively.

7.0 EARTHING

- 7.1 The earthing of all electrical equipment shall be carried out in accordance with IS: 3043.
- 7.2 The enclosures of electrical equipment shall be connected to an aluminium earth ring on the crane which in turn shall have effective electrical connection with the bridge.
- 7.3 The crane bridge shall be earthed through the bridge travel runway rails on both sides which in turn shall be earthed to owner's earth ring located on the ground floor.
- 7.4 Further the power supply cable for the crane shall have an additional conductor for earth connection. Both sides of this conductor shall be earthed.
- 7.5 All earth conductors shall be of aluminium.

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7.6 This size of earth conductor shall be equal to half the size of the power conductor subject to a minimum size of 10 sq. mm.

8.0 CONTROL DESK / CONTROL STATION

8.1 The crane shall be controlled either from the floor by means of a pendant control station or from bridge mounted control desk as indicated in the mechanical data sheet.

8.2 In either case, the units shall have the following control devices:

- Main off push button with padlocking arrangement.
- Indication lamps for supply 'ON'
- Control push buttons, as specified in the mechanical data sheet.
- All other devices required for safe and proper operation of the crane / hoist.

8.3 All push buttons shall be momentary contact type, coloured as per IS: 6875 and have 1 NO and 1 NC contacts.

8.4 The bridge mounted control desk, where specified, shall be of totally enclosed and dust tight construction. All controlling equipment shall be mounted on the top. It shall be located at most convenient location to allow movement of the operator. The installation shall be equipped with adjustable chair, fan, light and main isolating switch.

8.5 The pendant control station, where specified, shall be in a single enclosure and in totally enclosed dust light execution. The unit shall be suspended and supported from the bridge platform by flexible steel wire rope. The connection shall be made with a multi core flexible copper conductor cable and shall have 20% spare cores. One core shall be provided for earth connection of the circuit.

9.0 PAINTING

Enclosures of all electrical equipment shall be painted with two coats of epoxy based primers after suitable pre-treatment. Two coats epoxy based paint of approved colour.

10.0 MAKE OF ELECTRICAL ITEMS

The make of the electrical items shall be as indicated elsewhere in the NIT.

11.0 TESTS AND INSPECTION



11.1 All equipment shall be routine tested as per relevant Indian Standard Specifications.

11.2 Additional tests, wherever specified, shall be carried out on one equipment of each rating.

11.3 All the above mentioned tests shall be carried out in presence of owner's representative.

11.4 The owner's inspection shall, however, not absolve the vendor from his responsibility for making good any defects which may be noticed subsequently.

11.5 Despatch of materials shall be subject to written consent of owner or his representative.

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12.0 INSTALLATION, TESTING AND COMMISSIONING

- 12.1 The vendor shall undertake installation of all electrical equipment in accordance with latest code of practices, in conformity with recommendation of the respective equipment manufacturer, drawings approved by the owner or owner's representative, direction of Engineer-in-charge, statutory regulations and to the entire satisfaction of the owner.
- 12.2 The vendor shall arrange all the necessary erection tools and tackles, testing and measuring instruments and shall supply the required erection materials including structural steel.
- 12.3 Following tests shall be specifically conducted before commissioning in presence of owner's representative. All the test results shall be recorded and submitted to the owner.
- i) Insulation test.
 - ii) Continuity test.
 - iii) High voltage test.
 - iv) Simulation test.

13.0 DRAWINGS AND DOCUMENTS



- 13.1 Drawings and documents as per Annexure-I shall be supplied unless otherwise specified.
- 13.2 All drawings and documents shall have the following description written boldly :
- Name of client
 - Name of consultant
 - Enquiry / Order Number with plant / project name
 - Code No. and Description

14.0 SPARES

- 14.1 Spares for operation and maintenance
- Item wise unit prices of spare parts with recommended quantity shall be quoted along with the equipments as listed in Annexure-II.
- 14.2 Commissioning Spares
- Commissioning spares, as required, shall be supplied with the main equipment. Item wise list of recommended commissioning spares shall be furnished for approval.
- 14.3 Any other spare parts not specified, but required, shall also be quoted along with the offer.
- 14.4 All spare parts shall be identical to the parts used in the equipments.

15.0 DEVIATIONS

- 15.1 Deviations, if any, from this standard shall be clearly indicated in the offer with reasoning.

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ANNEXURE - I



DOCUMENTATION FOR ELECTRICALS FOR OVERHEAD CRANES & HOISTS

Sl. No.	Description	Documents Required (Y / N)		
		With Bid	For Approval	Final
1.	Specification sheet and technical particulars completely filled in	Y	Y	Y
2.	Composite schematic diagram	Y	Y	Y
3.	Dimensional drawing showing the mounting details and general arrangement for the following equipment			
	a) Motors	N	Y	Y
	b) Power control panel	N	Y	Y
	c) Control station	N	Y	Y
	d) Limit switches etc.			
4.	Down shop lead and power supply arrangement with civil scope.	N	Y	Y
5.	Inter-connection with terminal diagram and cable details	N	Y	Y
6.	Operating and maintenance instruction manual	N	N	Y
7.	Catalogues of bought out items	Y	N	Y
8.	Test certificates	N	N	Y

Note:

1. 4 hard copies & 1 soft copy shall be supplied with bid.
2. 4 hard copies & 1 soft copy shall be supplied for approval after order within 4 weeks from the date of LOI.
3. 8 hard copies & 2 soft copies in pen drive shall be submitted as final documents prior to despatch of the equipment. These shall be made in sets and supplied in fine plastic coated folder.

Y - Yes, N - No

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ANNEXURE-II

LIST OF SPARES



- 1) Bearings of each type & no.
- 2) Contactor coil of various ratings.
- 3) Complete set of contactor of each rating.
- 4) Moving & fixed contact blocks of contactors of each rating.
- 5) Limit switches of each type.
- 6) Push button elements.
- 7) Push button actuators.
- 8) Fuses of various ratings.
- 9) Fuse fittings of various ratings.
- 10) Indicating lamp fittings.
- 11) Indicating lamps.
- 12) Over load relays of various ranges.
- 13) Brake coils.
- 14) Set of carbon brushes in case of S.R. motors.
- 15) Set of resistors for S.R. motors.
- 16) Any special tools and tackles required for maintenance

NOTE :

- i) All the spare parts shall be identical to original parts.
- ii) The tenderer shall also quote for any other spares as deemed necessary to be kept in stock for stipulated time.



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TECHNICAL SPECIFICATION SOFT STARTER

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1.0 GENERAL

1.1 Scope

This specification covers the general requirements for design, manufacture, assembly, inspection and testing at the vendor's works of high voltage indoor soft starters above 1100V grade.

1.2 Data sheet



Along with the offer, Bidder shall submit the data sheet.

1.3 Codes and standards

The design, manufacture, testing and performance of soft starter panel shall comply with all current statutes, regulations and safety codes in the locality where the equipment will be installed.

Unless otherwise specified, the soft starter shall conform to the relevant Indian, IEC or British Standards. Nothing in this specification shall be construed to relieve the vendor of his responsibility. The relevant Standards are:

- | | |
|--|---|
| <ol style="list-style-type: none"> 1. IS: 2705 (1992) 2. IS: 3156 (1992) 3. IS: 1248 (1993) 4. IS: 13703 (1993) 5. IS: 5578 (1985) 6. IS: 11353 (1985) 7. IS: 694 (1990) 8. IS: 6875 (1973) 9. IS: 3700 (1972) 10. IS: 4411 (1967) 11. IS: 5469 (1969) 12. IS: 10482 (1983) 13. IS: 12448 (1988) 14. IS: 12970 (1990) 15. IS: 13648 (1993) 16. IEC 297 17. IEC 352 18. IEC 446 19. IEEE 444 | <ol style="list-style-type: none"> Current Transformers. (Part - I to IV) Voltage Transformers. (Part - I to IV) Direct acting indicating analogue electrical measuring instruments and their accessories. (Part - I to IV) Low Voltage fuses for voltages not exceeding 1000V Ac. (Part - I and II) Guide for marking of insulated conductors. Guide for uniform system of marking and identification of conductors and apparatus terminals. PVC insulated cables for working voltage upto and including 1100V. Control switches for voltages upto and including 1000VAC and 1200V DC. (Part - I to IV) Essential ratings and characteristics of semi-conductor devices. Codes of designation of semi-conductor devices. Codes of practice for use of semi-conductor junction devices. Connectors for printed wiring board. Basic testing procedures and measuring methods for Electro-mechanical components for electronic equipment. Semi-conductor devices – Integrated circuits. Power electronic capacitors. Dimensions of panels and racks. Solderless wrapped connections. Semi-conductor converters. Protection standards for Thyristor converters. |
|--|---|

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2.0 GENERAL TECHNICAL REQUIREMENTS

2.1 Design features



- (1) The thyristorised starter shall be used for starting of large induction motors.
- (2) The soft starter shall give an excellent voltage control during soft starts, smooth steeples acceleration.
- (3) The soft starter shall be used during starting for smooth and stepless acceleration only. Once motor gains its full speed bypass vacuum contactor shall be operated to bypass thyristors. The thyristor shall be short time rated (2 min.).
- (4) The soft starter drive shall consist of the following.
 - Isolation vacuum contactor.
 - Bypass vacuum contactor.
 - Thyristor unit.
 - Motor protective devices.
 - Indicating / Metering / Control circuits and accessories.
 - Cooling / ventilation equipments / accessories.
- (5) Soft starter shall have following minimum in built protection and alarm, but not limited to,
 - Electronic over load.
 - Line fault.
 - Under voltage.
 - Over voltage.
 - Stall.
 - Phase reversal.
 - Open gate for thyristor.
 - Over temperature for thyristor.
 - Over load for thyristor.
- (6) Soft starter panel shall be provided with following indicating, metering and control devices.
 - Motor starting / protection devices.
 - Selector switch – Auto / Manual.
 - Start / Stop push buttons for manual operation.
 - Input voltmeter and ammeter.
 - Meters to indicate power in MW.
 - Current and potential transformers.
 - Auxiliary relays.
 - Audio-visual alarms / fault indicators.
 - Alarm acknowledge / reset / test push buttons.
 - Provision for wiring external sequential / process interlock / signals for starting / running / tripping.
 - Terminals for remote control / indication.
 - Space heater and ventilating fans / cooler, if required.

2.2 Performance requirement

Soft starter panel shall be designed for operation at design temperature of 46°C. Vendor shall provide the necessary arrangement within the panel for satisfactory operation of soft starter.

2.3 Construction

- (1) Soft starter panel shall be industrial type (Non-hazardous), totally enclosed, dust and vermin proof, floor mounted, free standing cubicle type of construction confirming to the degree of protection as specified in data sheet.

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- (2) The panel cubicle shall comprise rigidly welded structural frame enclosed completely by sheet steel of minimum 14 SWG (cold rolled) thickness, smooth finished, leveled and free from flaws. All doors and removable covers shall be provided with neoprene gasket all around to make the cubical dust and vermin proof.
- (3) The panel shall be provided with bottom sheet steel plates of minimum 2mm thick. Panel shall be fitted with removable gland plates of sufficient thickness at the bottom of the panel for fixing cable glands for power and control cable termination. Sufficient space shall be provided for termination of power cable sizes, as specified in data sheet.
- (4) Louvers shall be provided at front, rear, top and bottom of the panel to dissipate heat developed inside.
- (5) Degree of protection shall not be less than IP 4X.
- (6) Panel shall be fitted with a label and serial number on the front and rear. In addition, panel shall be fitted with a label indicating panel designation and rating. All devices shall be provided with separate labels to indicate the function and also device numbers as marked in wiring diagrams.
- (7) Main equipment of the panel shall be accessible for maintenance from the front and rear. All insulating material shall be flame resistant, non-hygroscopic and antitracking.
- (8) All hardware's used inside the panel shall be zinc passivated.

3.0 EQUIPMENT SPECIFICATIONS

3.1 HT Fuses



- (1) High voltage fuses shall be of HRC link type for the 6.6 KV voltage and shall comply with the requirements of relevant standards.
- (2) The fuse link shall have a striker pin for indication and also for trip mechanism.
- (3) It is vendor's responsibility to precisely co-ordinate these fuses with contactors and upstream protective devices in the same system and shall be adequately rated for short circuit capacity.
- (4) The type of fuse chosen by vendor shall be subject to approval by the purchaser. Vendor to furnish fuse pre-arcing time shall be furnished by along with the offer.
- (5) Thyristor units shall be protected by fast acting semiconductor fuses

3.2 Vacuum contactors

- (1) Vacuum contactors of adequate rating for the compressor motor starting at 6.6 kV Voltage to match the bypass & isolation application and shall conform to relevant India / IEC standards.
- (2) Vacuum contactor shall be provided with properly designed and co-ordinated HRC fuses as mentioned in clause no. 3.1 above.
- (3) AC or DC operating coil for the contactor shall be informed to vendor at later stage. This operating coil shall be rated to operate satisfactorily between 80% and 110 % of the rated voltage. The contactor shall not drop out, if the voltage drops to 70% of rated voltage shall make arrangements to derive the auxiliary power, using necessary control transformer, for operating the contactor.
- (4) The vacuum contactors shall have exclusively for Purchaser's use minimum 1 NO & 1 NC auxiliary potential free contacts, rated for 10 amps, 240V AC and 0.5 Amp (inductive breaking) 220V DC or as specified and shall be wired upto the terminal blocks.

3.3 Instrument transformers

- (1) The current transformers and Voltage transformers shall conform to the requirements stipulated in relevant standards. It shall be vendor's responsibility to ensure adequate

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- size of CT & VT
- (2) The CTs & VTs shall be of cast resin type (insulation class “E” or better) and shall be able to withstand the thermal and mechanical stress resulting from the maximum short circuit and momentary current ratings of the switchgear.
 - (3) CTs shall have polarity marks on each transformer and at the associated terminal block. Facility shall be provided for short-circuit and earthing the CT secondary at the terminal blocks.
 - (4) VTs shall be protected on the primary side by limiting fuses and by MCBs on secondary side with 9kA interrupting ratings.
 - (5) The MCBs shall have min 1 NO + NC auxiliary potential free contacts, for annunciation and interlocks.
 - (6) CTs shall withstand specified system fault current for 1 sec.

3.4 Measuring and recording instruments



- (1) Microprocessor based measuring and recording instruments shall be provided. The unit shall have RS-485 port at the output for serial communication.
- (2) These instruments shall be standalone type, shall be configurable and shall be compatible with higher level computer.
- (3) The instrument shall be rectangular in shape and not greater than 150mm (W) x 150mm (H). The accuracy class shall be as per IS or international standards.

3.5 Control wiring and terminals

- (1) Feeders for Control (DC) / Auxiliary supply shall be provided at one point of the panel and voltage level shall be as specified in data sheet. Terminals to receive AC/DC control and auxiliary power shall be provided in cubicle and the terminals shall adequately rated (min. 20A).
- (2) Adequate rated 2 pole MCBs shall be provided for each of the AC/DC control circuits.
- (3) Internal wiring shall be done with 650V grade PVC insulated, stranded copper conductor of minimum size 2.5mm² size.
- (4) Separate colour coding shall be used for AC / DC control and power circuits and earth wire.
- (5) All incoming and outgoing and control wire connection shall be wired to adequately rated (min.20A), elmex type terminal blocks about 20% spare terminals shall be provided in cubicle. All terminals shall be easily accessible.
- (6) All wire shall be bunched together and routed through wire ways inside cubicle.
- (7) Separate schematics, wiring diagrams and termination schedule for external and internal cable/wire connections shall be furnished by the vendor. External connections shall include Purchaser’s remote equipment, which will be furnished by Purchaser to the successful vendor.
- (8) Low watt consumption LED type indicating lamps shall be provided.
- (9) All wires, terminals and all other devices shall be provided with appropriate ferrules to correspond with wiring diagrams, for circuit identifications Termination lugs to be provided wherever necessary.

4.0 EARTHING

- (1) An earth bus having cross section as specified in data sheet A shall be provided and extended through the length of the panel. All electrical equipment shall be connected to this earth bus.
- (2) Suitable clamp type terminals with hardware at each end of the panel shall be provided to suit the size of the OWNER’s earthing conductor of size 75 x 10 mm GI
- (3) Hinged doors shall be earthed through flexible copper braid of adequate size paint at

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earthing points shall be removed for proper contact star washers for door earthing are not acceptable.

- (4) Bolted joints, splices, taps. etc to the earth bus shall be with at least two bolts

5.0 NAME PLATES AND RATING PLATES

5.1 Name plate

- (1) Nameplate with engraved letters shall be provided for both front and rear side of panel function of every instrument, relay fuse etc shall be indicated by labels fixed near each device.
- (2) Non-corrosive name plates shall be manufactured in anodized aluminium sheet and the letters shall be engraved on black lettering on white background. The name plates/labels shall be held in position by self-tapping screws.
- (3) All devices mounted inside the cubicle and instruments etc., shall be identified by marking the device numbers inside cubicle as per the wiring drawing.

5.2 Rating plates

- (1) The panel shall have a rating plate fixed to the non-removable part of the enclosure.
- (2) All electrical equipment like VTs, CTs, etc and all other electrical devices shall be provided with rating plate made of stainless steel which can be easily seen.
- (3) The rating plates shall give all the relevant information as specified in relevant standards.
- (4) Danger boards, caution boards, operating instruction plates, shall be fixed to panel as per the standard engineering practice and regulations.

6.0 ACCESSORIES

6.1 Heater

Soft starter panel shall be equipped with space heaters to prevent moisture condensation within the enclosure and shall be suitable for continuous operation on 240V, 1 phase, 50 Hz AC supply. The space heaters shall be controlled through thermostats. Supply for motor space heater shall be brought to separate terminals in respective cubicle.

6.2 Cooling



Soft starter panel shall be provided with necessary ventilation / cooling equipment's for smooth operation of soft starter at given design temperature.

6.3 Plug Point

A 240V, 1 phase, 50Hz AC plug point shall be provided in the interior of each cubicle with an on-off switch.

7.0 PAINTING

- (1) Oil grease, dirt and rust from the sheet steelwork shall be thoroughly Cleaned and removed. Rust and scale shall be removes by picking process with dilute acid and alkaline solution. Phospating and thorough rinsing with clear water followed by final rinsing with dilute dichromate solution and oven drying shall follow this.
- (2) The under surface shall he prepared by applying a coat of phosphate paint and coat of yellow zinc chromote primer. The under surface shall be made free from all imperfections before under taking the finishing coat.

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- (3) After application of Primer, two coats of finish epoxy paint shall be applied with each coat followed by stoving. The colour shade for the finish paint shall be shade 631 (Light Gray) as per IS 5, unless otherwise specified.

8.0 INSPECTION AND TESTS

- (1) Routine tests shall be carried out at works in the presence of OWNER/PMC/ CONTRACTOR/Third party inspector as per relevant IS / IEC Standards.
- (2) Vendor shall furnish type and routine test certificates for all bought out components for the panel, as per relevant standards.
- (3) Test certificates for type test carried out on similar equipment of identical design, if available, shall be submitted along with the offer.

9.0 INFORMATION REQUIRED BY PURCHASER FROM THE BIDDER



The vendor shall submit with his offer following information: -

- (1) Full technical description and performance details of the equipment accessories and components offered including heat losses for all components in kW.
- (2) Overall dimensions and shipping dimensions and weight.
- (3) Deviation taken by the vendor from the requirements of this specification.
- (4) Guaranteed technical particulars.
- (5) Man-day rates for commissioning supervision.



10.0 MISCELLANEOUS

Each panel shall be provided with the following

- (1) Two sets of clearly identifiable key for all panel-locking devices.
- (2) Complete set of special tools and equipment for installation maintenance and testing of each panel.



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TECHNICAL SPECIFICATION
VARIABLE FREQUENCY AC DRIVE

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1.0 SCOPE

- 1.1 The scope of this specification is to define the minimum technical requirements for the design, manufacture, testing and supply of High Voltage, AC Variable Frequency Drive system. The VFD system shall be complete with Squirrel Cage Induction Motor, Converter, Converter input transformer, drive output transformer, DC link reactor with associated auxiliaries, harmonic filters and field mounted local motor control panel.
- 1.2 The vendor shall be responsible for engineering and functioning of the complete system, meeting the intent and requirement of this specification. This shall include but not be limited to inverter sizing, transformer sizing, transformer impedance selection, vector group, input and output harmonic filter design and sizing, output dv/dt filter sizing, motor cable selection and motor sizing/selection.
- 1.3 This specification applies to drives connected to line voltage up to 1000 V AC for MV VFD.
- 1.4 This specification applies to drive systems having converter input voltage above 1000 V AC and up to and including 11000V AC for HV VFD.

2.0 CODES AND STANDARDS



- 2.1 The equipment shall comply with the requirements of latest revision of the following standards issued by BIS, unless otherwise specified:
- | | |
|-----------------|---|
| IS: 325 | Three-phase Induction Motors |
| IS: 3700 | Essential Ratings and Characteristics of Semiconductor Devices |
| IS: 3715 | Letter symbols for semi-conducting devices |
| IS: 4411 | Code of designation of semi-conducting devices |
| IS: 5001 | Guide for preparation of drawings of semiconductor devices and Integrated Circuits |
| IS: 5469 | Code of practice for the use of semiconductor Junction Devices |
| IS: 14901 | Semi-conductor devices- Discrete devices & Integrated Circuits |
| IS: 15880 | Three Phase Cage Induction motors when fed from IGBT Converters Application Guide |
| IS: 8789 | Values of Performance characteristics for Three Phase induction motor |
| IS: 12615 | Energy Efficient Induction Motors - Three Phase Squirrel Cage |
| IS/IEC: 60947 | Low Voltage Switchgear and Control gear |
| IS: 12729 | Common specification for High-Voltage Switchgear and Control gear standards |
| IEC: 60 146-1-3 | Semiconductor Convertors general requirements and line commutated convertors-Transformer & reactors |
| IEC: 61800 | Adjustable speed electrical power drive systems |
| IEEE: 519 | Recommended Practices and requirements for Harmonics Control in Electrical power system |

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- 2.2 In case of imported equipment, standards of the country of origin shall be applicable, if these standards are equivalent or stringent than the applicable Indian standards.
- 2.3 The equipment shall also conform to the provisions of Indian Electricity rules and other statutory regulations currently in force in the country.
- 2.4 In case Indian standards are not available for any equipment, standards issued by IEC/BSNDE/IEEE/NEMA or equivalent agency shall be applicable.
- 2.5 In case of any contradiction between various referred standards/specifications and statutory regulations the following order of priority shall govern:
- Statutory regulations
 - Specification
 - Codes and standards

3.0 GENERAL REQUIREMENTS

- 3.1 The offered equipment shall be brand new with state of art technology and proven field track record. No prototype equipment shall be offered.
- 3.2 Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment for at least 15 years from the date of supply
- 3.3 Vendor shall give a notice of at least one year to the end user of equipment before phasing out the product/spares to enable the end user for placement of order for spares and services.
- 3.4 The vendor shall be responsible for design, engineering and manufacturing of the complete VFD system to fully meet the intent and requirements of this specification.
- 3.5 Vendor shall ensure proper co-ordination with the driven equipment supplier in selection/sizing of offered variable frequency drive system.
- 3.6 The VFD drive shall consist of the following:-
- (a) Incomer
 - (b) By pass
 - (b) Power module
 - (c) Transistorised Inverter Unit
 - (d) Motor protective devices
 - (e) Indicating/metering/control circuits and accessories
- 3.7 The VFD drive shall be provided as a complete package and shall be controlled from three different locations viz., (a) VFD panel (b) Local operator panel and (c) D.C.S.
A four position lockable selector switch shall be provided on the VFD panel for selecting operation from VFD panel/local operator panel/DCS/STOP position.
- 3.8 Local operator panel shall be suitable for outdoor installation with degree of protection for enclosure IP-55 and provided with the following:-
- (a) START/STOP push buttons
 - (b) RAISE/LOWER push buttons/potentiometer for speed variation

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- (c) ON/OFF/TRIP indicating lamps
- (d) Speed Indicator
- (e) Ammeter

3.9 VFD panel shall be provided with the following:-



- (a) Standard options (to be stated by vendor)
- (b) Incomer
- (c) By pass
- (d) Power module
- (e) Transistor inverter unit
- (f) AC reactor
- (g) Motor starting/protective devices
- (h) Selector switch (4 position)
- (i) START / STOP P.B.
- (j) Speed controller
- (k) Input voltmeter and ammeter
- (l) Output KW meter/Ammeter and frequency meter
- (m) Instrument, current, potential and control transformers
- (n) Auxiliary relays
- (o) Audio-visual alarms/fault indicators
- (p) Alarm acknowledge/reset/test PBs.
- (q) Provision for wiring external sequential/process interlocks/signals for
- (r) starting/running/tripping.
- (s) Terminals for remote control/indication
- (t) Space heater and ventilating fans, if required.

3.10 Besides VFD panel shall include the following operating adjustments:-

- (a) Acceleration and deceleration time-range in seconds.
- (b) Current limit-range in percent of rated output current.
- (c) Maximum and minimum frequency range in Hertz.
- (d) Volts/Hertz ratio
- (e) Voltage boost ratio in percentage.
- (f) Starting torque setting adjustment.
- (g) Starting current setting adjustment

3.11 Vendor shall propose setting ranges consistent with the operating conditions required.

3.12 Motor winding temperature detectors shall be monitored on VFD panel.

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4.0 SITE CONDITIONS

- 4.1 The AC drive system shall be designed to operate under specified site conditions. If not specifically mentioned therein, a design ambient temperature of 50°C. and an altitude not exceeding 1000 metres above mean sea level shall be considered.
- 4.2 The AC drive shall be installed indoors in a non-hazardous, air-conditioned room. Transformer installation (outdoor / indoor) shall be as indicated in design philosophy. Motor shall be installed outdoors in safe or hazardous area as specified.
- 4.3 All the equipment shall be designed for continuous duty as per nameplate rating under the specified ambient conditions.



5.0 DESIGN AND FABRICATION REQUIREMENTS

5.1 Performance Requirement



- 5.1.1 The unit shall be capable of proper operation for voltage variations of $\pm 10\%$, frequency variations of $\pm 5\%$, and combined variations of $\pm 10\%$. Besides, the VFD unit shall be able to ride through voltage dips down to 80% of nominal, such as those experienced during motor starting. Also VFD shall be capable of riding through voltage outages of minimum 2 seconds duration.
- 5.1.2 Regulation of output voltage shall not be more than $\pm 2\%$ under steady state and $\pm 8\%$ under transient conditions.
- 5.1.3 Maximum drift in set frequency shall be $\pm 0.1\%$. The unit should be able to hold a set speed, regardless of load torque variations.
- 5.1.4 The unit shall be suitable for 150% overload capacity for one minute.
- 5.1.5 The maximum noise level of the unit shall not exceed 85 dB(A) at a distance of 1 meter.
- 5.1.6 The unit shall have independently adjustable/automatic load dependent voltage boost at low end of frequency. There should not be any torque fluctuations at low speed.
- 5.1.7 The system shall be energy efficient, designed as standard product and shall provide very high reliability, high power factor, low harmonic distortion and low vibration/ wear / noise. It shall be easy to install in minimum time and expense and no special tools shall be required for routine maintenance.
- 5.1.8 The system shall be designed to deliver the motor input current and torque for the complete speed torque characteristics of the driven equipment, with input supply variation of $\pm 10\%$ and frequency variation of $\pm 3\%$. The system shall be suitable for the load characteristics and the operational duty of the driven equipment. It shall be capable of withstanding the thermal and dynamic stresses and the transient mechanical torque, resulting from short-circuit.
- 5.1.9 The drive system shall be designed to operate in one or more of the following operating modes as to suit characteristics of the driven equipment:
- a. Variable torque changing as a function of speed i.e. Speed squared
 - b. Constant torque over a specific speed range

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- c. Constant power over a specific speed range where the torque decreases when speed Increases
- d. Any other as specified
- 5.1.10 The drive controller shall be equipped with microprocessor based digital regulator with programmable functions. The power control regulator logic shall provide for an acceleration/deceleration current limit curve and shall be capable of field adjustments without shutting the system down. Linear acceleration and deceleration shall be separately programmable from 0.1 to 20 seconds.
- 5.1.11 The MV VFD System shall be suitable for single quadrant operation and the speed variation shall be with range 1:100 with speed set accuracy of $\pm 1\%$ of rated maximum speed and steady state regulation of $\pm 0.5\%$ of rated speed.
- 5.1.12 The HV VFD System shall be suitable for single quadrant operation and the speed variation shall be with range 10-100 % with speed set accuracy of $\pm 1\%$ of rated maximum speed and steady state regulation of $\pm 0.5\%$ of rated speed.
- 5.1.13 The total harmonic distortion (THD) of the voltage and current at inverter output shall be as per IEC 61800 and same shall be considered in the design of the motor. The dv/dt limits & Vpeak shall also be as per IEC-61800-2.
- 5.1.14 Harmonics at the supply side of the drive system at primary of the main input transformer shall be restricted within the maximum allowable levels of current and voltage distortion as per recommendations in the latest edition of IEEE-519. The vendor shall perform design calculation for harmonic filter system considering VFD connected to the power system and including the supply of harmonic filters along with all accessories. These harmonic studies shall be conducted with maximum and minimum system fault level, cable capacitance, system equipment reactance etc. The studies shall highlight but not be limited to maximum load current, expected resonant frequencies, need of harmonic filters, sequence of switching of filters, voltage wave form, rating of equipments/ feeder for feeding filters etc.
- 5.1.15 Unless otherwise specified, the overload capacity of the controller shall be 150% of rated current of motor for one minute for constant torque applications, and 110% of rated current for one minute for variable torque applications at rated voltage. If the motor load exceeds the limit, the drive shall automatically reduce the frequency and voltage to the motor to guard against overload. If load demands exceed the current limit for more than 1 minute, the drive shall shutdown to prevent over heating of the motor and damage to the drive.
- 5.1.16 During operation, the system shall be capable of developing sufficient torque under all load conditions to respond to a 20% alteration in speed set point within a time limit upto 60 seconds.
- 5.1.17 The integrator action of the speed set point alteration shall be independently adjustable for both an upward and a downward alteration. The minimum time interval between set point adjustments by the distributed control system shall be considered as 10 seconds.
- 5.1.18 The drive shall trip in case the speed exceeds 105% of the maximum operational speed or reduces to 95% of the minimum operational speed for more than 10 seconds.
- 5.1.19 Maximum noise level from the drive at 1-meter distance, under rated load with all normal cooling fans operating shall not exceed 85 dBA.

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- 5.1.20 Variable frequency drive shall be arranged so that it can be operated in an open circuit mode, disconnected from the motor for start up adjustments and troubleshooting/maintenance.
- 5.1.21 Voltage at motor neutral shall be maintained at ground potential for the total operating condition.
- 5.2 **Control Requirement**
- 5.2.1 The system shall operate on constant V/f supply with required voltage boost capability in low frequency mode of operation.
- 5.2.2 Short time voltage dips up to 20% of nominal voltage (e.g. in case of a large motor start up connected to the same bus as VFD) shall not cause the control system to stop functioning and shall not trip the drive system.
- 5.2.3 The system shall also be equipped with a momentary powerloss ride through feature which will restart the system in case of voltage dip over 20% or power interruptions for less than 2 seconds, with recovery of the voltage to its nominal value .. The drive shall have the facility to block this feature, if required by the operator. Upon restart, the converter shall be capable of synchronizing onto a rotating motor and develop full acceleration torque within 10 seconds.
- 5.2.4 The system shall be suitable for number of starts as per attached specification for High/Medium Voltage Motors.
- 5.2.5 The power controller shall be controlled to always start the motor in the forward direction. Logic shall be provided to prevent the motor from being started in the reverse direction.
- 5.2.6 The drive motor shall be speed controlled corresponding to 4-20mA or 0-10 V reference input signal. Upon complete loss of the user's speed reference signal, the drive shall automatically run at constant speed as at 80-100% of the last speed reference available prior to the loss of signal.
- 5.2.7 It shall be possible to vary the speed of the drive in either manual or auto mode. Auto/Manual selection shall be from VFD panel unless otherwise specified.
- a. With the selector switch in "manual" mode, the operator shall be able to set the speed through key pad (mounted on front of the drive panel) or from speed increase/decrease push buttons (from the field). Motor operated potentiometer shall be provided as a speed set point device.
 - b. With the selector switch in "auto" mode, speed of the motor shall be controlled from a 4-20 mA signal, from owner's PLC/DCS (Process Control) system. Necessary equipment required for interfacing with PLC/DCS shall also be provided in the VFD panel.
 - c. Local/Remote selector switch shall be provided in local control station (in Field). With the selector switch in "Local" mode, the operator shall be able to start and set the speed through local control station (in Field). With the selector switch in "Remote" mode, speed of the motor shall be controlled either from VFD panel or from Owner's PLC/DCS as explained in a) and b) above.
- 5.2.8 The required provision for the interface with remote PLC/DCS located at control room shall be either through hardwired connection (with potential free contacts and transducers as described elsewhere in this specification) or through serial communication link.

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5.2.9 Drive system shall have provision for interface with upper level automation such as Substation monitoring system or electrical control system.

5.2.10 The closed loop control feedback for the drive system having output transformer shall be tapped from the secondary side of the output transformer.

5.3 Panel Construction

5.3.1 For MV VFD: The panel shall include suitable isolating device (i.e. Circuit breaker/MCCB/Switch fuse) for main supply, contactors, semi conducting power devices (Diodes / IGBT) modules with protective devices, reactors, filters, output isolating device, control circuit, control accessories, indication and annunciation etc.

Main isolating device shall function as a manual disconnect and shall be an AC thermal magnetic circuit breaker or a fused switch with dual element fuse to trip automatically on fault currents. Devices shall be lockable in the open position and shall have a minimum interrupting capacity. Interlock shall be provided between the door, so that door cannot be opened unless the breaker/switch is open.

5.3.2 For HV VFD: The panel shall include suitable semi conducting power devices (Diodes/IGBT/IGCT/ IEGT/SGCT) modules with protective devices, reactors (if required), filters, control circuit, control accessories, indication and annunciation etc. The construction of the panel shall provide effective protection against electromagnetic emissions and shall meet the design requirement of relevant standards.

Upstream breaker 'ON/OFF/TRIP' indications and remote breaker closing and trip push buttons shall be provided on the front door.



5.3.3 Safety Interlock shall be provided so that power cabinet can't be opened unless the upstream breaker is disconnected, safety-grounding switch is closed and DC link capacitor is discharged. Power source breaker can only be closed once the earthing switch is open and panel door is closed with lock defeat facility.

5.3.4 The drive shall be suitably housed in sheet steel panels and shall be fabricated using cold rolled sheet steel. The sheet steel used for the panel shall be of minimum 2 mm CRCA. The panel shall be suitable for indoor installation, if not otherwise specified. The panel shall be free standing with degree of enclosure protection as IP-31. Maximum and minimum operating height shall be 1800 mm and 300 mm respectively.

5.3.5 Bolted un-drilled gland plate shall be provided at bottom. Clamp type terminals shall be used for connection of all wires up to 10 mm², and terminal for higher sizes shall be bolted type suitable for cable lugs. Minimum space for power cable termination shall be 300mm clear for MV & 600mm clear from HV from bottom of the cable gland plate.



5.3.6 Bus bars shall be of electrolytic copper/aluminium, sleeved, color coded separately for AC and DC system. All the live parts shall be sleeved / shrouded to ensure complete safety to personnel intending to carry out routine inspection by opening the panel doors. All the equipment inside the panel and on the doors shall be provided with suitable nameplate. All wires shall be ferruled and terminals shall be properly numbered, minimum 20% spare terminals shall be provided.

5.3.7 All the power & control switches, component and accessories which are essential for normal and emergency operation shall preferably be mounted on the door and shall be operable externally. All the analogue instruments, where provided, shall be switchboard

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type, back connected & of size 96x96mm. Scale shall have red mark indicating maximum permissible operating rating.

- 5.3.8 Each panel shall be provided with illuminating lamp/11 W CFL with switch and fuse. 5/15A, 240V power socket with switch and fuse shall be provided. Each panel shall have space heater with switch fuse and variable setting thermostat.
- 5.3.9 Copper earth bus of min. 30x6 sq.mm. upto short circuit withstand capacity of 31.5kA and 50x6 sq.mm. for a short circuit withstand capacity above 31.5kA shall be provided in the panel with provision for connection to plant earth grid. All the non-metallic components/parts shall be connected to the main earth bus bar. Separate earth bus bar and stud for electronic control system if required shall be provided.
- 5.3.10 All panels shall be of same height so as to form a uniform line-up, to give good aesthetic appearance.
- 5.3.11 All the control wiring shall be enclosed in plastic/ metal channel. Each wire shall be identified at both ends by self-sticking wire marker tapes or PVC ferrules. Power and control wiring inside the panel shall be done with BIS approved, PVC insulated, fire retardant, low smoke, copper conductor wire 1.5mm² size wire shall normally be used provided the control fuse rating is 10 Amps or less and 2.5 mm² size for control fuse rating above 16 A for electrical circuits and 0.5mm² for electronic circuits. All wires shall be ferruled and terminals shall be properly numbered, minimum 20% spare terminals shall be provided.
- 5.3.12 All electronic modules and components shall be accessible from front of panel only. Modular assemblies for both the system control electronic equipments and power electronic equipments shall be used.
- 5.3.13 Low voltage compartment and cabling shall be electrically and physically separated from the high voltage compartment.
- 5.3.14 DC link capacitor and pre-charging & discharging circuit shall be preferably mounted in the rear of the panel.
- 5.3.15 Suitable eyebolts/ lifting clamps/ strap & cradle arrangement shall be provided for lifting of the panel/shipping section. The bolts, when removed shall not leave any opening in the panel.
- 5.3.16 Acrylic type transparent insulating material shall be used for covering live components.
- 5.3.17 Drive keypad, operator control panel required for control, monitoring and measurements shall be supplied and installed outside the panel on the front door. It shall be accessible for operation without opening the front door and shall be non-removable type.
- 5.3.18 All equipment shall be complete with cable glands, lugs etc. and cable glands shall be single or double compression type for indoor and outdoor equipment respectively. Cable glands shall also be suitable for the hazardous area application.
- 5.4 **Cooling**
- 5.4.1 For MV Drive: Cooling system shall include well-dimensioned panel, adequate cooling airflow path, module cooling fan and if necessary, panel cooling fan. Vendor shall ensure that the panel dimensions and flow paths have been designed for continuous running at the specified ambient without overheating. For fan cooled drives, redundant ventilating

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fans (N+1) shall be provided. Necessary starters shall be provided within the VFD panels for these fans. In case redundant cooling fan is not possible to be mounted, same shall be supplied loose.

- 5.4.2 **For HV Drive:** The drive panel shall be naturally cooled or water cooled type as per manufacturer's standards. However, it is preferred to have natural air cooled system. If unavoidable, forced type-cooling system shall be provided. Cooling system shall include well-dimensioned panel, adequate cooling airflow path, modular cooling fan and if necessary, panel cooling fan or water-cooling system shall be considered. Vendor shall ensure that the panel dimensions and flow paths have been designed for continuous running at the specified ambient without overheating. For fan cooled drives, redundant ventilating fans (N+ 1) shall be provided. In case redundant cooling fan is not possible to be mounted in the panel, same shall be supplied loose.

For water-cooled drives, entire cooling system including but not limited to heat exchanger, flow and pressure meters and pumps shall be in vendor's scope. The system shall be provided with closed circuit water cooling system, requiring only make up water required for topping up. The cooling water pumps, in case provided, shall have 100% redundancy. Water quality/characteristics shall be as defined and selected cooling water system components/material shall be suitable for the same. Adequate safety measures shall be incorporated in water cooled drives such that no leakage is there which results in malfunctioning of electronic devices. Proper segregation between water cooling system and other equipment shall be provided. It is preferred that cooling cabinet panel shall be separated from the main panels.

Necessary starters shall be provided within the VFD panels for the Ventilation fans, Cooling Water circulation pumps, any other auxiliary motor etc. The system provided shall be interfaced with drive starting and shutdown so that safety interlocks such as start permit from cooling system to drive and trip signal from cooling system to drive in case of cooling system failure etc., are incorporated in the overall sequence logic.



- 5.4.3 MCB for motor space heater, auxiliary power supply if required for local panel, drive panel space heater etc. shall be included and mounted in easy accessible location.

5.5 **Equipment/ Component Specification**

5.5.1 **Motor**

The motor shall be designed, constructed and tested in accordance with the latest revision of Specification for Medium/High Voltage Induction Motor, in addition to the following requirements:

- a. The motor shall be suitable for operation with a solid-state power supply consisting of an adjustable frequency inverter for speed control.
- b. The motor shall be suitable for the current waveforms produced by the power supply including the harmonics generated by the drive.
- c. The motor shall be designed to operate continuously at any speed over the range (10-100%) of rated speed.
- d. The permitted voltage variation should take into account the steady state voltage drop across the AC drive and all other system components upstream of the motor.

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- e. The motors shall be provided with Class 'F' insulation with temperature rise limited to Class 'B'.
- f. Motors required to be transferred to DOL by-pass mode shall be rated for specified variations in system line voltage and frequency. Starting current of motor in DOL bypass mode shall be limited to value specified in motor specifications.
- g. The motor shall be constructed to withstand torque pulsations resulting from harmonics generated by the solid-state power supply.
- h. The motor insulation shall be designed to accept the applied voltage waveform, within the V_{peak} and dv/dt limits as per IEC-61800-2 for MV / IEC-61800-4 for HV and necessary co-ordination between the VFD manufacturer & motor manufacturer w.r.t. incorporation of VFD output parameter in the design of motor shall be carried out.
- i. The drive manufacturer shall be solely responsible for proper selection of the motor for the given load application and the output characteristics of the drive.
- j. MV Motors shall be provided with thermistor type temperature detector & HV Motors shall be provided with Resistance Temperature Detectors (RTDs).
- k. Induced voltage at the shaft end of the motor at no load shall not exceed 250 mV rms for roller and ball bearings and 400 mV for sleeve bearings. The non driving end bearing shall be insulated from the motor frame to avoid circulating current. The insulated bearing end shield or pedestal shall bear a prominent warning.



5.5.2 Converter Transformer/ Output transformer

For MV System

The converter transformer shall be suitable for use with the variable frequency drive system. The impedances of transformers with two secondary windings for 12 pulse systems shall be selected to ensure equal load/current sharing between the two secondary windings, the converters and the motor windings under all operational conditions including starting and restarting. The transformer shall be provided with $\pm 5\%$ off circuit taps in steps of $\pm 2.5\%$.

For HV System

- a. The converter transformer shall be dry type or oil filled type. In case of the dry type transformer, it shall be mounted in the drive system panel. Offered transformer shall be as per enclosed Specifications.
- b. The impedances of converter input transformers with more than one secondary windings for 12/18/24/36 pulse systems shall be selected to ensure equal load/current sharing between the secondary windings, the converters and the motor windings under all operational conditions including starting and restarting.
- c. Drive output transformer considered only for the purpose of meeting standard rated motor voltage i.e. 3300, 6600V, 11000V shall not be provided unless otherwise agreed between purchaser and the manufacturer.



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5.5.3 Power Converter

- a. The static power converter shall consist of a line side power converter for operation as a rectifier and a load side power converter for operation as a fully controlled inverter. Power converter shall be fast switching, most efficient and low loss type.
- b. Normally, for all output short circuits, the inverter shall interrupt the current before any semi-conductor fuse blows. For internal short circuits, semi-conductor fuse protection shall be provided, and for faults upstream of semi-conductor fuses, the converter shall be able to withstand a three-phase short circuit current until interrupted by normal breaker operation. In case of fuseless design, the failure shall be limited to the particular device, without causing any damage to other parts of the power module. There must be clear annunciation of the failure of the device.
- c. Adequate short circuit and over voltage protection shall be provided for the converter and inverter system.
- d. All power converter devices shall include protective devices, snubber networks and dv/dt networks as required.
- e. The current rating of the converter's semi-conductor components shall not be less than 120% of the nominal current flowing through the elements at full load of the VFD through the entire speed range.
- f. All power diodes shall be of silicon type with minimum V_{BO} rating as 2.5 times the rated operating voltage.
- g. The power converter circuit shall be designed so that motor can be powered at its full nameplate rating continuously without exceeding its rated temperature rise due to harmonic currents generated by the inverter operation.
- h. The conversion devices and associated heat sinks shall be assembled such that individual devices can be replaced without requiring the use of any special precautions/tools.
- i. The cooling system of the electronic components, if provided, shall be monitored and necessary alarms shall be provided to prevent any consequential damage to the power control devices.
- j. Offered system shall also take into account the distance between Drive panel and motor and system shall include all material and accessories to make system suitable for a distance of 350m.
- k. All the power transistors, thyristors and diodes shall be protected with high-speed semiconductor grade fuse. I^2t particulars of the power controller devices and the fuses shall be properly co-ordinated for the selection of fuses.

5.5.4 DC Link Reactor

- a. Smoothing reactors for the DC link shall be designed to sufficiently decouple the rectifier and inverter portion of the converter and to limit fault currents in this circuit. AC line reactors, if provided as per standard vendor design in MV system, shall be suitable for harmonic suppression and fault current limitation.

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- b. Unless otherwise specified, the reactor shall be air-cooled or fan cooled type located within the panel. In case of fan cooled type, operation of fans shall be monitored.
- c. Reactor shall be suitable for operation with the non-sinusoidal current wave shapes and DC components under all operational conditions of the system without exceeding its temperature limits.

5.5.5 Output Filter

VFD output current waveform should be inherently sinusoidal at all speeds, with harmonic limits as specified in this specification. Output filter shall be provided, if required. Output filter capacitors shall be provided with discharge circuits to ensure that all residual stored charge is reduced to less than 50 V DC within 60 seconds for MV system & 300 seconds for HV System after a loss of AC voltage. All capacitor shall be maintenance-free and self-healing type. The VFD system shall inherently protect motor from high voltage dv/dt stress, independent of cable length to motor. Output filter shall be an integral part of the VFD system and included within the VFD enclosure.

5.5.6 Bypass Feature

MV System:



- 5.5.6.1 Output contactor/Load Break Switch shall be provided for isolation between the output of the controller and the motor for VFD systems with Bypass feature.
- 5.5.6.2 Bypass feature shall be provided. Accordingly Bypass feature with Bypass starter shall meet the following requirements:-

Bypass starter shall comprise of switch-fuse, contactor, bimetal relay meeting the requirements of Type-2 coordination as per IS/IEC-60947. CBCT and ELR shall be provided for motors rated above 22kW & up to 55kW. Heavy duty starters shall be provided with saturable type current transformer operated overload relay only, which shall be suitable for motor starting time of 15-60 seconds. For motors rated above 55kW, MCCB and motor protection relay along with necessary metering shall be provided and for motors rated above 75kW and above, ACB and motor protection relay along with necessary metering shall be provided.

Bypass starter shall be in separate compartment and it shall be possible to isolate and maintain the VFD while drive motor runs in Bypass mode. Three contactors / breakers shall be used for this purpose, one contactor in the bypass and two contactors across the drive, such that in case of drive mal-operation, the motor could be taken on bypass control, while the drive could be attended by opening its contactors. Suitable interlock shall be provided such that bypass mode and VFD mode shall not operate simultaneously.

HV System:

- a. Bypass feature along with motor protection relay and output side breaker shall be provided. All necessary interlocks as required for safe and reliable operation of VFD system along with bypass feeder and output side breaker shall be provided in VFD system.
- b. Bypass starter shall be in separate compartment and switching scheme shall be such that in case of drive mal-operation, the motor could be taken on bypass control manually, while the drive could be attended independently. Suitable interlock shall be provided such that bypass mode and VFD mode shall not operate simultaneously.

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5.5.7 Local Motor Control Station

- a. The local motor control station, to be installed in the field near the motor shall conform to the attached specifications. Components and accessories that are required in the local motor control station may be mounted on the local field mounted panel envisaged for the driven equipment.
- b. Meters in the local control station shall be suitable for 4-20mA transducer outputs and shall be calibrated for the actual motor current. Further, for drives with bypass facility, the meters shall be capable of reading bypass mode full load and starting currents as well as the VFD mode drive current.

5.6 Protection, Control, Metering, Indication and Annunciation

5.6.1 The system vendor shall provide all the necessary system control, protection, alarm and metering equipment for the entire drive system and its auxiliary equipment.



5.6.2 Automatic sequence control shall include start-up of cooling system, auxiliary system of the motor, interlock checking, automatic start and run-up of drive, planned and emergency shutdown. The same shall be processed through microprocessor-based system.

5.6.3 Operator Control Panel

- a. Each drive shall be equipped with a front mounted operator control console consisting of a backlit alphanumeric display and a keypad with keys for parameterization and adjusting parameter which shall not be limited to Start/Stop, Local/Remote, Auto/Manual, Increase/Decrease, menu navigation and protection and measurement parameter selection, etc.
- b. All parameter names, fault messages, warnings and other information shall be displayed in complete English words or standard English abbreviations to allow the user to understand the display without the use of a manual or cross-reference table. This shall also be used for the modification of all electrical values, configuration parameters, drive menu parameters, application and activity function access, faults, local control, adjustment storage, self test and diagnostics. Keypad shall be operable with password for changing the protection setting, safety interlock etc. However, the parameters such as measurements, setting, mode of drive etc. shall be allowed to be viewed without any password.
- c. Operator console shall have facility/ port to connect external hardware such as Laptop etc. Console shall have facility to upload and download all parameter settings from one drive to another identical drive for start-up and operation.
- d. Drive system control shall also have facility to receive tripping signal from upstream breaker for tripping and also provision for closing upstream breaker after all required process parameters are achieved.
- e. User-friendly software for operation and fault diagnostic shall be loaded in the drive system panel before commissioning.

5.6.4 Protective Features

The system shall incorporate adequate protective features, properly coordinated for the drive control and for the motor but not limited to the following:

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- I. Incoming line surge protection
- II. Under / Over voltage protection
- III. Phase loss protection.
- IV. Programmable over current protection and under load protection.
- V. Inverter Fault.
- VI. Over frequency/Over speed of motor
- VII. Ventilation loss (In case same is not provided, drive shall generate an over temperature fault alarm and suitable sensors, as required for same, shall be provided).
- VIII. Over temperature of equipment.
- IX. Specific motor protection, including motor winding, bearing temperatures, over current, overload, negative phase sequence and earth fault protections etc.
- X. System earth fault protection.
- XI. Excitation system protection for synchronous motor
- XII. Over and under frequency, rotor earth fault (if applicable), field failure protection for synchronous motor
- XIII. Additional protection, if any for the drive system

5.6.5 Alarms

The system shall incorporate protection alarms, required for various fault conditions, for the Drive motor, Supply cables, Converter Transformer, DC Reactor and the Converter. Alarms shall also be included for the failure of various auxiliaries together with identification of the failing unit, loss of cooling system, various protection devices provided for converter transformer etc.

5.6.6 Control



The following controls shall be provided as a part of the Operator Control Panel or through separate switches.

- I. Start/Stop
- II. Speed control (Raise/Lower)
- III. Forward/Reverse (if specified)
- IV. Auto/Manual /Test mode
- V. Local/Remote
- VI. Emergency stop
- VII. Start/Stop for bypass starter (where specified)
- VIII. Trip-Remote Breaker
- IX. Excitation control system for synchronous motors
- X. Sequential switching of filters

5.6.7 Indications

Vendor shall provide indications as required for normal operation and for ease of maintenance, which shall not be limited to the following indications.

- I. Motor running
- II. Motor stopped
- III. VFD System Fault
- IV. System ready to start
- V. AC mains ON
- VI. Motor over speed
- VII. Rectifier output 'ON'
- VIII. Motor zero speed

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- IX. Remote breaker trip
- X. Excitation system healthy for synchronous motors

Above indications may be provided as a part of the operator control panel, i.e. door mounted keypad or through hardwired LEDs. LEDs provided for indication shall be cluster type with adequate brightness and minimum 2 nos. LEDs chips per light. LEDs shall be connected in parallel and each LED chip having diameter not less than 3mm. Potential free contacts for items i to iv shall be wired separately for remote indications in DCS system.

5.6.8 Metering

Digital display of the following parameters shall be as a part of the Operator Control Panel, selectable by the operator.

- I. Output voltage
- II. Output current-VFD model Bypass mode
- III. Output frequency
- IV. Drive thermal state
- V. Motor speed
- VI. Motor energy meter
- VII. Hour Run
- VIII. Voltage and current meter for excitation system of synchronous motor
- IX. KVAR, power factor meter for synchronous motors
- X. Necessary transducer shall be provided with 4-20mA output for indicating motor speed and motor current in DCS unless otherwise specified for other parameters.

5.6.9 Annunciations



Potential free contacts shall be provided for following annunciations and shall be wired up to terminal block for owner's use for remote monitoring:

- I. Rectifier fuse failure/Drive fault
- II. Main AC failure
- III. Inverter fuse failure/Drive fault
- IV. Inverter overload
- V. Inverter high temperature/Drive fault
- VI. Failure of panel cooling system
- VII. Motor failed to start/Drive fault

All drive internal faults will be annunciated as drive fault.

5.7 Fault Diagnostic

Fault diagnostic shall be built into the system to supervise the operation and failure of the system. The information regarding failure of any of the system including, shutdown of the system, shall be available for a period of minimum 4 days (96 hours) after a shutdown, even though no supply would be available to the system. The system may be totally de-energized for maintenance or otherwise. It shall be possible to retrieve the record of events prior to tripping of the system or de-energisation. Auxiliary supply to the system components or to the electronics (firmware) for the diagnostics / display shall be taken care by the manufacturer for this purpose.

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5.8 External Power supply for auxiliary and Control Circuit

Auxiliary power supply for devices external to VFD module, space heater supply for Motor, VFD panel space heater, auxiliary power supply for transformers, cubicle 11W CFL lamps, indicating lamps, digital meters (Ammeter, Speedometer) etc. shall operate on 240 volts single phase AC supply provided by purchaser.

All control circuit shall operate at maximum voltage of 240V AC or 220V DC. Vendor shall include supply of all control transformers, protective devices, associated accessories etc. and any other control supply voltage required for the system shall be derived by the vendor from the power supply made available by purchaser.

5.9 Reliability Features

The expected lifetime of the drive system shall be min. 20 years. The system including all individual components forming part of the system shall have an availability of minimum 0.997 and a minimum MTBF of 4 years.

The controller design shall incorporate the following reliability features:

- Pre-tested components with power components to be 100% tested under dynamic conditions.
- Printed circuit boards shall be computer tested and adjusted.
- Printed circuit boards shall be temperature cycled for a minimum of 40 hours.
- Printed circuit boards shall be treated for tropical, humid and corrosive environment.

5.10 Maintenance features

The controller design shall incorporate the following maintenance features:

Modular construction

All components shall be easily accessible.

Standard diagnostics to aid maintenance personnel. These shall include LED or alphanumeric displays, test or measurement points.

5.11 Painting



5.11.1 After preparation of the under surface, the panel shall be spray painted with two coats of epoxy based final paint or shall be powder coated. The colour shade of final paint shall be as RAL 7032, unless specified otherwise. Panel finish shall be free from imperfections like pinholes, orange peels, runoff paint, etc.

5.11.2 All metal surfaces shall be thoroughly cleaned and de-greased to remove mill scale, rust, grease and dirt. Fabricated structures shall be pickled and then rinsed to remove any trace of acid. The under-surface shall be prepared by applying a coat of phosphate paint and a coat of yellow zinc chromate primer. The under-surface shall be made free from all imperfections before undertaking the finishing coat.

5.11.3 All unpainted steel parts shall be zinc passivated, cadmium plated or suitably treated to prevent rust and corrosion. If these parts are moving elements, then these shall be greased.

6.0 INSPECTION, TESTING AND ACCEPTANCE

6.1 During fabrication, the drive shall be subject to inspection by PDIL / Owner, or by an agency authorized by the Owner, to assess the progress of work, as well as to ascertain that only quality raw material is used.

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- 6.2 All tests shall be carried out at the manufacturer's works under his care and expense. The tests shall be witnessed by an inspector of PDIL/Owner or of an agency authorized by the owner. Prior notice of minimum 4 weeks shall be given to the inspector for witnessing the tests.
- 6.3 All Routine & Type Tests shall be conducted as per the NIT for HV variable frequency drive 6-81-1050 as per IEC 61800-2.
- 6.4 Combined test for VFD and motor shall be carried at vendor's works.
- 6.5 String Test with driven equipment
- If a string test with driven equipment is specified in the datasheet of the driven equipment, it shall be carried out with the job equipment.

7.0 SPARES

- 7.1 Commissioning Spares: Commissioning spares, as required, shall be supplied with the main equipment. Item-wise list of recommended commissioning spares shall be furnished for approval.
- 7.2 Spare Spares for 2 Years operation (Mandatory), as specified shall be supplied.
- 7.3 Recommend 2 years Operational Spares (other than mandatory spare) along with recommended quantity & item-wise unit price shall be furnished.
- 7.4 All spare parts shall be identical to the parts used in the equipment

8.0 DRAWINGS

- 8.1 Vendor shall submit to Purchaser, for approval, before completion of manufacturing and assembly of equipment following drawings and literature.
- (i) Installation and maintenance manual including trouble-shooting chart.
 - (ii) Panel drawings and cable schedule
 - (iii) Block diagram and control logic.



4 hard copies & 1 soft copy of drs. & doc. shall be supplied with bid.

4 hard copies & 1 soft copy of drs. & doc. shall be supplied for approval after order within 4 weeks from the date of LOI.

8 hard copies & 2 soft copies in pen drive shall be submitted as final documents prior to despatch of the equipment. These shall be made in sets and supplied in fine plastic coated folder.

9.0 CERTIFICATION



The motors and associated Variable frequency drive system equipment shall have test certificates issued by recognized independent test house (CIMFRI BASEEFA/LCIE/UL/FM or equivalent). All indigenous motors shall conform to Indian Standards and shall be certified by Indian testing agencies. All motors (indigenous and imported) shall also have valid statutory approvals as applicable for the specified hazardous location. All indigenous flameproof motors shall have valid BIS license and marking as required by statutory authorities.

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Also the motor nameplate shall clearly indicate that the motor is suitable for operation with variable frequency drive along with VFD make and model number.

10.0 PACKING AND DESPATCH

All the equipment shall be divided in to several shipping sections for protection and ease of handling during transportation. The equipment shall be properly packed for selected mode of transportation i.e. ship/rail or trailer. The equipment shall be wrapped in polyethylene sheets before being placed in wooden crates/cases to prevent damage to the finish. Crates/cases shall have skid bottoms for handling. Special notations such as 'Fragile', 'This side up', 'Weight', 'Owner's particulars', 'PO nos.' etc., shall be clearly marked on the package together with other details as per purchaser for scrutiny. The equipment may be stored outdoors for long periods before installation. The packing shall be completely suitable for outdoor storage, in areas with heavy rains/high ambient temperature.



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**TECHNICAL SPECIFICATION
CATHODIC PROTECTION FOR PLANT PIPING AND BURIED
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1.0 SCOPE OF WORK

1.1 The scope of work of CP contractor shall comprise of survey, design, detailed engineering, supply, installation, testing and commissioning of Impressed Current Cathodic Protection System for soil side corrosion prevention of all underground buried plant piping, u/g vessels and tank bottoms of above ground storage tanks.

1.1.1 **U/G Piping:** Long line linear MMO Titanium wire anode or polymeric anode pre-packed with coke breeze at anode manufacturer's factory and /or close distributed MMO Titanium tubular anode pre-packed with coke breeze at anode manufacturer's factory shall be considered as anodes for impressed current CP System for all underground piping.



For U/G piping in congested areas, long line linear anodes shall be used and for other area long line linear anodes or close distributed MMO tubular anodes shall be used. For close anode bed MMO tubular anode design, the MMO tubular anodes shall be distributed along the buried piping such that all sections of the buried piping are in within each anode's voltage gradient. This anode configuration causes the electrolyte around the structure to become positive to remote earth.

1.1.2 **Buried Vessels:** Long line linear MMO Titanium wire anode or polymeric anode pre-packed with coke breeze at anode manufacturer's factory and /or close distributed MMO Titanium tubular anode pre-packed with coke breeze at anode manufacturer's factory shall be considered as anodes for impressed current CP System for all underground piping.

1.1.3 **Above Ground Storage Tank Bottoms:** Long line linear MMO Titanium wire anode or polymeric anode pre-packed with coke breeze at anode manufacturer's factory and /or close distributed MMO Titanium tubular anode pre-packed with coke breeze at anode manufacturer's factory shall be considered as anodes for impressed current CP System for all underground piping. The depth of the linear anodes shall not exceed 1 meter from the tank bottom plate and the maximum spacing between the anode strings shall not exceed 1.5 meters.

1.2 The CP contractor need to supply all materials, consumables in their scope of supply and provide all construction tools, tackles equipment and personnel necessary for the work and prepare detailed engineering package including construction drawings before starting of the work.

1.3 After commissioning of the system, commissioning report along with as built drawings including soft copies in latest version of AutoCAD and operating manuals to be prepared and submitted to owner/PMC.

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2.0 APPLICABLE STANDARDS



2.1 The cathodic protection system design, performance and materials to be supplied shall, unless otherwise specified, conform to the requirements of the following latest relevant applicable standards & codes as below:

Standard	Description
DIN EN-14505	Cathodic Protection of Complex Structures
NACE SP-0169-2013	Control of external corrosion on underground or Submerged metallic piping system
NACE SP-0286-2007	Electrical isolation of cathodically protected pipelines
NACE TM0101-2012	Measurement Techniques Related to Criteria for Cathodic Protection of Underground Storage Tank Systems
NACE TM0497-2012	Measurement techniques related to criteria for cathodic protection on submerged metallic piping system
ISO 15589-1: 2016	Petroleum and natural gas industries-CP of pipe line transportation systems- on land pipelines
IS 8062 part-2: 2006	Code of Practice for Cathodic Protection of Steel Structures, Part II: Underground Pipelines [MTD24: Corrosion Protection
IS 3043: 2007	Code of practice for Earthing
BS EN 12954: 2001	Cathodic Protection of Buried or Metallic structure – General Principles and application for pipelines
BS EN 16299: 2013	Cathodic protection of external surfaces of above ground storage tank bases in contact with soil or foundations
BS EN 13636:2004	Cathodic protection of buried metallic tanks and related piping

3.0 PRE-DESIGN SURVEY, TESTING AND CONSIDERATIONS

3.1 The CP specialist shall review the construction drawings to determine the feasibility and design requirements of the CP system, and its compatibility with the structure's design and construction.

3.2 For successful operation of a CP system, the structure shall be electrically continuous, otherwise the discontinuous structures will be subject to stray current

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corrosion. Therefore, structure layout drawings shall be checked for theoretical continuity. The discontinuous structures in areas to be cathodically protected shall be identified.

3.3 The design shall avoid the stray current interference with adjacent structures.

3.4 **Electrolyte Resistivity**

3.4.1 Resistivity of soil or liquid in areas of buried structure to be cathodically protected shall be measured using Wenner four pin method.

3.4.2 For CP of plant piping, soil resistivity measurements shall be conducted at 200 m intervals over the full length of the proposed anode ground bed location. The CP contractor shall take a minimum of ten (10) readings in each section of the facility to obtain an average of layer resistivity value for each section. Soil resistivity survey shall be measured with the terminals spaced at 1, 2, 3, 4 and 5 m intervals to assess variation in resistivity with depth.

3.5 **Site Visit & Survey Report**

3.5.1 Before proceeding with CP design of system, the CP contractor shall submit a written report documenting site survey findings to Owner. The written report shall include methodology, test conditions, observations, and resistivity values. The CP contractor shall also prepare an overall plan drawing of the facility showing proposed location of CP equipment.

3.5.2 The site visit is required to collect the data for cathodic protection design calculations and select suitable location for installing anode ground beds. It shall be the CP contractor's responsibility to have a thorough understanding of the reference documents, site conditions and specification included therein. The CP contractor shall be deemed to have visited the site and have studied the conditions before submitting the Bids. Non-familiarity with the site conditions will not be considered a reason either for extra claims or for not carrying out the work in strict conformity with the drawings and specifications.



4.0 **DESIGN BASIS**

4.1 **U/G Piping:** Design guidelines for cathodic protection of piping network in plant complex:

4.1.1 All buried pipelines/piping shall be cathodically protected by impressed current cathodic protection (ICCP).



4.1.2 The current density to be considered for Polymeric tape/ High build Liquid Epoxy or equivalent coated piping is 3mA/m^2 and for bare structures, incidental structures 20mA/m^2 .

4.1.3 The CP System for piping network in plant complex shall be designed and installed in two stages by providing first preliminary or basic design and then supplementary



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design if required based on actual site performance of CP system as per preliminary/basic design.



- 4.1.4 Supplementary design: After energising CP System as per preliminary design, the unprotected/ under protected and over protected areas shall be identified and a supplementary design is to be made to bring all structures intended to be protected within acceptable potential limits.
- 4.1.5 The impressed current anode system in which anodes are distributed along the structure at relatively close intervals such that the structure is within the anode's voltage gradient anodebed system
- 4.1.6 Following types of anodes can be used for ICCP of plant piping:
1. MMO tubular anodes (In shallow horizontal/vertical configuration)
 2. Close distributed Continuous MMO wire / polymeric with pre-packed factory fitted coke breeze
- 4.1.7 Linear anodes-MMO wire or polymeric shall be installed for the protection of buried pipelines/piping in the congested area, where the distributed anodes can't be installed due to shielding by concrete foundations, parallel piping/pipelines, etc i.e. there should be no foreign structure between the anode and the buried piping.
- 4.1.8 The CP contractor shall locate such congested area and non congested area and obtain approval from the Owner for using linear anode and distributed anodes.
- 4.1.9 Distance of close, distributed beds from underground piping in congested areas of process units shall be maximum 3 m (such that there is no foreign structure between piping and anode) and anode to anode separation for close, distributed beds shall be such that the complete piping structure shall be within anode voltage gradient.
- 4.1.10 For linear anodes, the length of anode string shall be same as length of U/G pipe for single run of pipe. In case of parallel run of pipes, the no. of continuous anode strings to be considered shall be as per discretion of Owner depending on factors such as diameter of pipes, congestion of the area etc. However following general guideline shall be considered while deciding the number of anode strings for parallel run of pipelines:
- i. One string for max. two lines when any one or all the lines are up to 6 inch diameter pipe.
 - ii. One string for max. one line for above 6 inch diameter and up to 30 inch diameter pipeline.
 - iii. Two strings for each line for line size above 30 inch diameter and up to 70 inch Dia. pipeline.

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- iv. When pipeline diameter is more than 70 inch and number of pipeline is one or more, the number of string anode to be considered shall be decided by considering cathode structure current requirement and anode current capacity 30mA/m. When more than one string is considered for parallel run of pipes, each string shall be preferably laid in different trench with suitable markers for their easy retrieval in future.
- v. Each continuous linear anode string shall be of 200m (max.) length and shall be fed at both ends from a single T/R Unit using same or different anode junction box. String anode shall be laid laterally along the pipe axis at a distance 2D or 500mm from the pipe whichever is decided by Owner/ Consultant during review of detailed engineering.
- 4.1.11 The cathodic protection current requirement for plant piping designed using linear / distributed anodes shall be governed by ensuring
- For coated structures such as pipelines, coating defects / holidays of 50% shall be considered at the end of life for calculation of current.
 - Earthing system shall be considered for ICCP designing of plant piping as 100% bare.
 - Incidental structures to be considered as 100% of total known calculated piping surface area to be protected and shall be considered bare for current calculation purposes.
 - Current required so that all sections of the buried piping are in within each anode's voltage gradient in case of design by distributed anodes.
- 4.1.12 Safety margin of 30% in current calculations shall be considered while designing.
- 4.1.13 Electrical continuity shall be ensured for all underground pipelines through bonding across the manholes if applicable and other pipelines.
- 4.1.14 As a matter of design philosophy, the underground piping network intended to be cathodically protected shall be considered in electrical continuity with many foreign structures within plant complex such as RCC pavement, earthing grids, other U/G piping which are not intended to be protected.
- 4.1.15 Unless otherwise specified in data sheet, no insulating joint shall be installed to isolate any incidental structure/ above ground piping within battery limit of plant from underground piping network intended to be cathodically protected.
- 4.1.16 Adjacent anode beds protecting different structures and powered from separate power sources shall be separated such that there is no interference.



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- 4.1.17 Minimum two drainage cables and two measurement cables from each pipeline or from each structures to be protected shall be terminated in one cathode junction box (Cathode JB).
- 4.1.18 Structures protected or influenced by CP systems shall be electrically continuous. Bonds shall be installed (where required) to ensure electrical continuity.
- 4.1.19 For mechanical protection of the string at unpaved areas one layer of brick shall be laid along the string after back filling with soil by 150mm. The axis of the brick shall be perpendicular to the axis of the anode string.
- 4.1.20 For future access of each anode string at paved areas, concrete slabs sealed with cement shall be laid along the string after back filling with soil. Care should be taken to ensure that anode string does not touch the structure to be protected or any foreign structure.
- 4.1.21 Continuity test of the string and short circuit test of the string with structure intended to be protected as well as foreign structure shall be carried out before energizing the CP System. In case any abnormality is found during this test, CP contractor needs to do the needful to rectify the fault before energizing the system.
- 4.1.22 Buried reference electrodes shall be a saturated copper/copper sulfate electrode if the soil resistivity is greater than 2,000 ohm.cm or silver/silver chloride (Saturated KCl) if soil resistivity is less than 2,000 ohm-cm.
- 4.1.23 Minimum 10 no. of reference cells to be installed for piping at equidistant locations for each TR Unit.
- 4.1.24 Coupon assemblies with buried reference electrodes shall be installed within the piping network for true CP polarized potential measurement at every test station location.
- 4.1.25 A number of test stations with soil access holes (for every 70 m pipeline/piping length) shall be provided in each area of the pipeline/piping network for potential measurement using portable reference electrode. These test stations shall be located midway between CP anodes. Each test station shall be provided with buried reference electrodes and coupons.
- 4.1.26 Soil access holes along with test stations provided with shunt resistance shall be provided for potential measurements.
- 4.1.27 CP contractor shall work in close coordination with plant installation contractors.
- 4.1.28 **Additional guidelines for Sacrificial anode cathodic protection in plant complex**
- 4.1.28.1 Temporary CP system is required for ICCP systems when period between installation of structure intended to be protected and commissioning of the CP system exceeds 6 months. The same may be obtained either by installing



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temporary power to the Transformer-Rectifier unit and energizing the impressed current system or by installation of sacrificial anodes.

- 4.1.28.2 CP contractor shall provide Zinc/ Magnesium ribbon anodes for temporary protection and ensure that protection of the plant piping in the period prior to commissioning of permanent ICCP system is attained.
- 4.1.28.3 Zinc anodes shall be used if the layer soil resistivity is less than 1,000 ohm.cm. Magnesium anodes shall be used when the layer soil resistivity is greater than 1,000 ohm.cm.
- 4.1.28.4 Electrically isolated short buried sections of piping, small isolated coated structures or buried sections of normally above-grade pipelines/piping such as road crossings may be cathodically protected with galvanic anodes.
- 4.1.28.5 Short pipes, which are less than 300 meters, can be protected by SACP if the piping is not electrically continuous with any other buried structures and if all piping parts are 75 meters away from the nearest impressed anodes.
- 4.1.28.6 Buried fire hydrants, risers, valves, gas accumulators, electrically isolated pipe casings, sleeves, fence crossings and pipe vents, thrust anchors, thrust bore, shall be protected by SACP using Mg or Zn galvanic anodes. The net weight of each magnesium or zinc anode shall be 27 Kg excluding the anode backfill. Impressed anodes may be used for these structures if the use of galvanic anodes is not practical, especially when impressed current distributed anodes are within 75 meters from the structure to be protected.
- 4.1.28.7 Special design considerations (e.g., additional CP current) are also required for buried pipelines/piping at and inside the fence for plants. CP contractor to coordinate these designs with site, and obtain approval from the Owner.
- 4.2 **FOR U/G VESSELS:** All u/g vessels shall be cathodically protected by impressed current cathodic protection (ICCP):
- 4.2.1 The current density to be considered for coated u/g vessel shall be 3 mA/m², for bare structures - 20 mA/m².
- 4.2.2 Consider coating breakdown factor: Initial- 5% and end of life:30%
- 4.2.3 Anode material shall be mixed metal oxide coated on titanium wire anode, piggyback connected with anode lead cable, factory pre-packed with coke breeze OR Conductive Polymer Anode factory prepacked with coke breeze (carbonaceous material).
- 4.2.4 These vessels can be directly buried or installed inside RCC pits. If underground vessel are installed in RCC pit backfilled with sand then the RCC structure have to be isolated from the vessel by installing PE sheets in inner surface of RCC walls to prevent Cathodic protection current drainage.

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- 4.2.5 No anode to cable joints shall be permitted in the vessel, all the cable joints shall be performed outside the RCC pit through soil holes in the wall for future maintenance.
- 4.2.6 The anode strings shall be located within the RCC pit. Specific installation requirements of String Anode shall be as follows:
- Anode strings shall be installed in the sand cushion surrounding the vessel at a distance of 300mm from the vessel.
 - Separation distance between consecutive String anode loop shall be uniform.
 - Length of each longer side of the loop string anode shall be same as the length of the vessel + 0.6m.
 - Minimum 4 No. of strings should be considered for each vessel.
- 4.3 **Above Ground Storage Tanks:** All tank bottom plate- soil side shall be cathodically protected by impressed current cathodic protection (ICCP):
- 4.3.1 The current density to be considered for tank bottom plate shall be 20 mA/m², considering 100% bare.
- 4.3.2 Anode material shall be mixed metal oxide coated on titanium wire anode, piggyback connected with anode lead cable, factory pre-packed with coke breeze OR Conductive Polymer Anode factory prepackaged with coke breeze (carbonaceous material).
- 4.3.3 The anode strings shall be laid in the sand cushion or soil under the tank bottom plate extending straight from one end to other end of the tank rim. Following guide lines shall be considered for installation of String Anode for coated tank bottom plates:
- Separation distance of String anode from bottom plate to be protected shall be 1000mm.
 - Maximum spacing between consecutive anode strings = 1.5m.
- In case 1m space is not available between bottom plate and string anode, suitable shielding arrangement to be provided on string anode so that it does not touch the bottom plate. For such case, Maximum spacing between consecutive anode strings shall depend on available separation distance of String anode from bottom plate
- 4.3.4 Dedicated TRU with suitable rating to be considered for each tank more than 20 meter diameter. However, common power supply unit with suitable rating may be considered if tanks are installed in same location/ area of less than 20 meter dia.

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- 4.3.5 No anode to cable joints shall be permitted in the tank foundation, all the cable joints shall be performed outside the tank ring wall through soil holes in the ring wall for future maintenance.
- 4.3.6 Cathodic protection is not required for tank bottom installed on full reinforced concrete foundation.
- 4.3.7 Min. 5 nos. of saturated copper/Copper sulphate reference electrodes shall be installed under tank bottoms. One RE shall be placed at the center of the tank base and the balance one in each quadrant.
- 4.3.8 A perforated high density PE pipe (1 ½ inch dia) properly encapsulated in the geotextile fiber/cloth shall be placed under the tank bottom. This pipe shall be crossing the center of the tank bottom and extended either side of the concrete ring wall. This monitoring tube shall not run parallel to the anode strings. If tank diameter is more than 20 meters, two monitoring tubes shall be installed.
- 4.3.9 Minimum 4 no. of soil access holes (1½ inch in diameter) under the bottom through the ring-wall shall also be provided for potential measurements using portable reference electrodes.
- 4.3.10 In case tank is mounted on RCC pile foundation, one insulating PE film is to be laid on the pile cap before sand filling of the cap to ensure minimum C.P. system current is diverted to the pile cap.
- 4.3.11 Contractor need to lay one layer of insulating P.E. film of thickness 1.2mm on the concrete surface of the RCC cap before sand filling for the tanks mounted on RCC pilling. The Roll size of the P.E. film shall be decided by the contractor. While laying, overlap of 5mm is to be made between consecutive longitudinal P.E. strips. Also, the overlaps need to be sealed using blow lamp or plastic welding method.

5.0 PROTECTION CRITERIA

- 5.1 Acceptance criteria to demonstrate the effectiveness of the CP system shall be the most stringent of those specified in the standards listed in this specification. All representative monitoring points for structures to be protected shall meet the following criteria:
- 5.1.1 An instant off potential (measured between 0.1 s and 1 s after switching off the DC circuit) more negative than -850 mV and less negative than -1,200 mV with respect to a saturated copper/copper sulphate (Cu/CuSO₄) reference electrode.
- 5.1.2 A minimum of 100 mV of cathodic polarization between the structure surface (surface of the tank bottom in case of tank) and a stable reference electrode contacting the electrolyte. This criterain based on measurement of formation or decay of polarization may be used only in rare circumstances with prior approval of owner.

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5.2 After Commissioning of the C.P. System, if it is found that structure to electrolyte potential achieved at some location is in the range which is below acceptable limit as per code, then a supplementary C.P. System need to be installed to bring the potential level at such locations within acceptable limit without any additional cost to Owner.

5.3 Any positive shift of 50 - 100mV will be investigated for interference and mitigation measures shall be taken.

6.0 EQUIPMENT AND MATERIALS

6.1 DC Power supply and Transformer-Rectifier (TR) unit

DC Power supply & the TR units control system equipment shall confirm Transformer rectifier as per design datasheet and the following:

6.1.1 Each rectifier unit shall be complete with instrument cabinet, enclosure, transformer, voltage control taps, and necessary appurtenances.

6.1.2 The TR units shall be natural air cooled or shall be oil cooled silica gel breather as per the hazardous area requirement.

6.1.3 The TR units shall have switchable constant current, constant voltage mode, Automatic Potential Control Mode (shall be provided only as option if so specified).

6.1.4 Transformer shall be double wound fully isolated with earthed electrostatic shield between both the windings.



6.1.5 All TR units shall be supplied with a synchronisable built-in current interrupter. The interrupter shall be capable of switching the full load current at maximum output on a variable time cycle of up to 10 seconds "on" and 10 seconds "off". Programmable interrupter ON/ OFF cycle varying ratio from 1s to 999s shall be made available in TR unit.

6.1.6 TR unit shall be installed in non-hazardous area as far as possible. For units located in classified areas, the instrument control cabinet and circuit breaker enclosures shall be made of corrosion resistant explosion-proof enclosures in accordance with Hazardous area classification.



6.1.7 For units located in unclassified areas, the instrument control cabinet shall be bolted to the oil tank and readily accessible to conduits and monitoring. Enclosures shall be IP55 protected as a minimum and fabricated thick mild steel sheet with all external surfaces shall be protected against corrosion.

6.1.8 Each rectifier shall be suitable for concrete pad mounting. All mounting/bolting hardware & accessories shall be stainless steel.



6.1.9 All rectifier units shall be provided with an integral shield to protect the unit and control cabinet for direct sunlight impingement.

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- 6.1.10 TR shall be selected with 50% excess capacity to allow for adjustments during the life of the cathodic protection system and to prevent damage due to voltage overload.
- 6.1.11 Transformer efficiency at full load shall not be less than 95%.
- 6.1.12 Temperature rise test shall be run for 48 hours (at least) till getting stable readings. The maximum acceptable rise in that period from ambient temperature shall be less than 25°C. Maximum temperature of oil shall not exceed 85 Deg C at full load. Temperature test points shall be placed top, middle side, middle back and bottom of the enclosure. Temperature measurement shall be made by thermocouple or resistance change method.
- 6.1.13 The TR components shall be mounted on a slide out, or tilt out removable air cooled chassis. Lower compartment shall contain main transformer, auto transformer, chokes and oil while upper compartment shall contains SCRs, Diodes, meters, protective devices, electronic control & cards etc.
- 6.1.14 Conduit/ Gland entries shall be provided for AC and DC conductors. The conduit size shall be 1^{1/2} inch, unless otherwise specified. Conduit entries shall be located directly in line with the conductor termination to avoid cable bending inside the enclosure.
- 6.1.15 Cables and wires shall be stranded copper conductors with XLPE as per standards. Different voltage level wires with different colour coding as per standards shall run in different cable trough / duct inside TR unit.
- 6.1.16 Wires shall not be taped or spliced between termination points. Wiring shall be bundled and secured with plastic ties. Only one conductor per terminal shall be permitted.
- 6.1.17 The positive and negative terminal posts shall be screw terminal type machined from brass and shall be positioned to permit ready and easy connection of the DC cables. All the live terminals shall be shrouded.
- 6.1.18 DC output terminal posts shall have a minimum 76 mm (3 in) clearance from each other and from all other metal parts and be located at least 200 mm (8 in) above their conduit entries.
- 6.1.19 Each DC terminals shall be double post type shall be supply with two nuts, two flat washers, one lock washer and compression lugs. The compression lugs and the post shall be made of a copper alloy, plated with tin, silver or electro less nickel. For DC outputs, the socket terminals for measurement shall be red for the DC positive terminal connections and black for the DC negative terminal connections
- 6.1.20 DC output current shall be measured with a 50 mV precision block shunt. Shunt size for the current measurement shall be 25, 50, 75, 100, etc. ampere ratings, to provide a whole number ratio of current to mV.

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- 6.1.21 A variable timer controlled D.C. relay system interrupting the output to facilitate “instantaneous off” structure potential measurement shall be provided. The current circuit breaker on the output shall be capable of interrupting the DC output in a period of less than seconds at any load. The interrupter shall be capable of switching the full load current at maximum output on a variable time cycle of up to 10 seconds "on" and 10 seconds "off". The operation of the interrupter shall not affect the electrical supply to, or accurate operation of, any of the other circuits during its operation.
- 6.1.22 A separate isolating unit shall be connected between the AC power input cable and the TR to allow the safe removal of the TR if necessary.
- 6.1.23 Power rectifying diodes and Silicon Control Rectifiers (SCRs) shall be mounted on aluminium heat sink size to limit device case temperature to 90°C at 50°C ambient conditions at rated load. Heat sink for air cooled shall be anodized.
- 6.1.24 The peak inverse voltage rating of diode and SCR shall be 1200 volt (rms) minimum. The diode forward current rating shall be a minimum of 50% greater than the full load conducted current.
- 6.1.25 DC fuses shall be rated at not more than 120% of rate current output, 250 volts, and shall be installed in each positive phase leg.
- 6.1.26 Fuses for hazardous area TR shall be placed inside the oil tank.
- 6.1.27 Design life of TR unit shall be 30 years of continuous operation with minimum level of maintenance.
- 6.1.28 Each Diodes/ SCRs shall be provided with surge suppressors & shall be designed for 400% excess current capacity. Surge and transient suppression protection for the diode and SCR shall consist of MOV across each AC input terminal to rectifying element and electronics board to protect the semiconductors and across the DC output terminals. The MOV shall be voltage coordinated for the circuit and component to be protected. Each MOV shall be rated of 15% minimum above nominal line voltage.
- 6.1.29 The electronic modules shall be built on PCBs of fiberglass reinforced cards & all cards shall be tropicalized by providing suitable coating.
- 6.1.30 All internal components such as electronic cards, fuses, MCBs, relays, contactors, timers etc. shall be identified with either painting marks or with nameplates as per schematic drawings. Identification with stickers is not acceptable. Nameplates shall be of anodized aluminum 3mm thick.
- 6.1.31 Auxiliary wiring shall have copper. Wires shall not be taped or spliced between termination points. Wiring shall be bundled and secured with plastic ties. Only one conductor per terminal shall be permitted.

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- 6.1.32 Reference electrode input shall be tested from local control unit, master control unit and digital multimeter. The readings shall be accurate and the error % shall be less than 0.5%.
- 6.1.33 Each TR unit shall include two pairs of socket terminals to facilitate measurement using external hand held devices.
- 6.1.34 TR unit shall be provided with steel channel under the base plinth mounting, lifting lugs, sunshade/ canopy, Oil filling arrangement & drain plug, Oil sight gauge, removable type dial thermometer and lockable control cabinet with viewing window.
- 6.1.35 Each rectifier shall be provided with a bolted or riveted stainless steel 304, engraved or stamped nameplate. This nameplate shall be located for easy visibility on the outside of the enclosure door on all units. For hazardous area TRs, the nameplate shall be located on the oil enclosure or associated fixtures. Each nameplate shall indicate the following as a minimum:
- Manufacturer and Address
 - Descriptive Name
 - Manufacturer's Serial Number:
 - Input Rating:
 - kVA
 - Nominal Voltage
 - Current
 - Single or three phase
 - Frequency (Hz) - 60
 - Minimum Power Factor
 - Output Rating:
 - kW
 - Voltage
 - Current
 - Oil Capacity: Liters
 - Maximum Operating Temperature
 - Date of Manufacture

6.2 ANODES

6.2.1 ICCP Anodes

6.2.1.1 Mixed Metal-Oxide (MMO) Coated Titanium Tubular Anodes:

- a. They are available in solid rods, tubes.
- b. The consumption rate of these anodes shall not be more than 1.0 mg/amp-yr.

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- c. Length, diameter, quantity and distribution pattern of these anodes shall be selected to meet the current requirement locally, and to also conform to the anode design and the maximum anode current density.
- d. The MMO coating thickness shall be minimum 6 gm / m² sufficient to provide a service life of 25 years.
- e. Calculations shall be provided to verify their service life.
- f. The anode cable connection to the anode shall be crimped made using hydraulic compression. The connection shall be appropriately covered with moisture resistance tapes and sealed with heat shrink sleeve.

6.2.1.2 Mixed Metal Oxide (MMO) Coated Titanium wire anodes



- a. The anode shall be factory prepackaged with coke breeze with acid resistance fabric and protective braid to prevent mechanical damage. Splices between the MMO anode wire and anode cable shall be at 3 meter interval.
- b. The MMO coated titanium wire diameter shall be of minimum 1.5 mm.
- c. The minimum MMO coating thickness shall not be less than 6 gm/ m².
- d. The net diameter of the wire anode shall be 35 mm minimum.
- e. Anodes shall be surrounded with a minimum calcined coke breeze of 1.15kg/m encapsulated with acid resistant fabric and nylon braid

6.2.1.3 Polymeric anodes

- a. Conductive polymer anodes shall be used for new tank bottoms, underground pipelines/piping in congested areas.
- b. Conductive polymer anodes shall be surrounded with a minimum calcined coke breeze of 1.15kg/m encapsulated with acid resistant fabric and nylon braid.
- c. The total diameter with anode backfill shall be 35mm minimum.
- d. The max current output of this type of anode shall be 40 mA/m for a life of 25 years.
- e. The coke breeze weight shall be 1.15 kg/m.

6.2.2 Sacrificial Anodes

- a. The weight of sacrificial solid anodes installed in soil shall be 27Kg excluding the anode backfill.

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- b. Sacrificial anode backfill that is installed in soil shall be 75% hydrated gypsum, 20% bentonite clay and 5% hydrated gypsum. Zinc anodes can also be packaged in a backfill consisting of 50% hydrated gypsum and 50% bentonite clay.
- c. Sacrificial anodes shall be one of the following:

6.2.2.1 Magnesium

Magnesium anodes shall exhibit an open circuit potential of -1550 mV or more negative with reference to an Cu/CuSO₄ electrode.

Magnesium anodes shall conform to the following Specification:

Cu	0.02% Maximum
Al	0.01% Maximum
Fe	0.03% Maximum
Mn	0.5 - 1.3%
Ni	0.001% Maximum
0.05%	Maximum, any one other impurity and
0.30%	Maximum, total of all other impurities
Mg	Balance.



6.2.3 Zinc

Zinc anodes for 50 °C or less operation shall conform to the following Specification:

Al	0.005% Maximum
Cu	0.002% Maximum
Fe	0.0014% Maximum
Pb	0.003% Maximum
Cd	0.003% Maximum
Zn	Balance.

Zinc anodes operating at temperatures between 50 °C and 70 °C shall conform to the following Specification:



Al	0.10% - 0.25%
Mg	0.05% - 0.15%

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Cl	0.001% Maximum
Fe	0.002% Maximum
Cu	0.001% Maximum
Pb	0.006% Maximum
0.10%	Maximum, total of all other impurities
Zn	Balance.

6.3 Reference electrodes



- 6.3.1 Performance and effectiveness of the CP system shall be monitored and recorded using permanently buried reference electrodes. These electrodes shall be commercially available devices, with a proven track record of use in soil or water, particularly in hot climate environments.
- 6.3.2 All permanent reference electrodes shall be supplied with a test certificate and fitted with a suitable length of cable, so that no splices are required between placement location and test stations.
- 6.3.3 Buried reference electrodes shall have a life expectancy of over 25 years. The half-cells shall have a predicted accuracy of +/-20mV for the 25 year electrode life expectancy and shall have a tested accuracy of +/- 5 mV against a calibrated sulphate reference electrode (same type).
- 6.3.4 Reference electrode shall be designed to operate in an environment between 0°C and 60°C. The manufacturer shall also provide the temperature coefficient and its temperature range.
- 6.3.5 The connection between the cable and the electrode shall only be factory fitted and completely sealed, and capable of total burial/immersion without leakage.
- 6.3.6 The CP contractor shall use reference electrodes of those manufacturers which have proven track record in use for a minimum of 10 years.
- 6.3.7 Reference electrodes shall be installed in a backfill material, such as gypsum, that provides a stable, uniform environment, capable of retaining moisture.
- 6.3.8 Permanent Cu/CuSO₄ reference cells :
- Shall be installed at a distance of 300mm from the UG Piping for monitoring of C.P. System.
 - Minimum 10 no. of reference cells to be installed for piping at equidistant locations for each TR Unit.
 - Minimum 4 no. of reference cells to be installed for each Vessel.

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- iv. Minimum 16 no. of reference cells to be installed for each mounded bullet at equidistant locations.



6.4 Cables

- 6.4.1 The positive DC feed cable from the rectifier shall feed a multi-terminal resistor controlled junction box.
- 6.4.2 Each terminal from this positive junction box shall feed an individual anode.
- 6.4.3 The negative cables from the rectifier shall be connected to the structure.
- 6.4.4 The negative from the rectifier shall be connected to the tank at two points 180 degrees apart.
- 6.4.5 All cables shall be stranded copper and shall have a minimum of seven strands.
- 6.4.6 All cables shall have a minimum of one layer of insulation and a single layer of sheathing. DC cables shall be copper conductor. The insulation shall be high molecular weight polyethylene (HMWPE) insulation or XLPE with PVC sheathing. Anode tail cables for MMO long line wire anodes the insulation shall be Halar or Kynar with HMWPE as sheath. For shallow / deep /semi deep anode beds the anode lead cable shall be EPR/CSPE/Halar/Kynar insulated with HMWPE as sheath. The minimum insulation thickness shall be 0.8 mm.
- 6.4.7 Color coding shall be same for all areas.
- 6.4.8 Multi-core cables shall be color or number coded.
- 6.4.9 All cables shall be run in appropriate size conduits between the structure and the junction box / test station and also between the junction box and the power supply or TR unit.
- 6.4.10 All cables shall be clearly labelled at termination points with permanent labels.
- 6.4.11 All underground wire attached to the positive rectifier terminal is at a positive potential with respect to ground. If not completely insulated, the wire may discharge current (act as an anode), which will result in corrosion of the wire and rapid failure of the cathodic protection installation.
- 6.4.12 Splices in the anode lead wires, positive cable from the transformer rectifier to the junction box and negative cables from the TR to structure are not allowed. Cable insulation shall be carefully inspected prior to backfilling.
- 6.4.13 Backfill shall be sifted sand free of sharp stones or other material that could damage wire insulation. All cables between the protected structure, the junction box and /or the transformer rectifiers shall be run in appropriately sized conduits. Cable conduits below grade level shall be rigid PVC, above grade level shall be

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PVC coated rigid galvanized steel. All fittings and accessories shall meet the conduit type specification respectively.

- 6.4.14 Test lead wires should be color coded, numbered, or otherwise permanently identified.
- 6.4.15 Sufficient slack should be left to avoid strain on all wires.
- 6.4.16 Cable sizes for tanks, underground pipelines/piping and other isolated structures shall be as follows:
- 6.4.17 Minimum 10/16 mm² for anode tails and negative cables connected to structures.
- 6.4.18 Minimum 25 mm² from anode junction boxes to rectifiers.
- 6.4.19 In case if there are main positive and negative junction boxes, 35 or 50 mm² shall be used to connect between these boxes and rectifiers.
- 6.4.20 Minimum 10 mm² cables for testing.
- 6.4.21 Minimum 16 mm² for bonding between structures.
- 6.4.22 Minimum 6 mm² for buried reference electrodes, monitoring and coupon cables.
- 6.4.23 Cable shall be encased in conduit or other protective method at road crossing and where area subject to frequent excavation.
- 6.4.24 If armoured cable is used then the same shall be isolated from any earthing system.
- 6.4.25 All anode cable connections, splices, test lead connections, surge arrestor etc. shall be made in junction/ test/ bond boxes, certified for hazardous area classification in which they are installed.
- 6.4.26 Connections of cable to structures shall ensure that an electrically conductive and mechanically secure bond is made. Fusion welding, thermit welding, stud welding or thermit brazing are acceptable. Where connections are to be made to structures that have an internal protective coating or lining, they shall be made prior to the installation of the internal protective coating/ lining.
- 6.4.27 To avoid cable damage in the long run, all cables are to be laid at the cable trays wherever possible; underground cable laying should be considered only when no cable trays are available nearby. All C.P. System cables need to be laid at power cable trays, all multi core-monitoring cables may be laid in either electrical or instrumentation cable trays whichever is available. For road crossing of C.P. System cables, suitable RCC duct or PVC PIPE duct embedded in concrete at proper depth need to be prepared by CP contractor. CP contractor should get the construction drawing approved by Owner before execution of the work.

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6.4.28 At R.C.C covered areas a narrow trench shall be cut in the existing concrete. The cables shall be installed in a properly sized G.I. conduit (to accommodate the cables) the minimum trench dimension for a single 2" diameter G.I. conduit shall be 150mm wide by 750mm deep. The trench dimension shall be increased to accommodate larger diameter conduit pipe or multiple conduit pipe. After the conduit and cable has been installed, trench shall be properly paved to restore the R.C.C. to its original condition.

6.4.29 The cable routes shall be identified with permanent cable markers.

6.5 Test Coupon

6.5.1 The test coupon shall consist of a bare surface and a coated surface equivalent to the coating of piping¹ with two cables of 1c x 6 sq mm for connection to the piping and potential measurement. The coupon test station to the piping shall be through a magnetic reed switch for measurement of instant OFF potential. A 50mm PVC tube shall be inserted alongside the coupon. The PVC tube shall shields the reference electrode from potential gradients.

6.6 Test Station

6.6.1 MOC & type of test station shall be as as per hazardous area classification.

6.6.2 Each test station shall be visibly marked by permanent ink in red color. This shall be followed by the date of installation. Test station numbering, Symbols and other notations used for sequence of the test stations shall be approved by owner/consultant.

6.6.3 Test station enclosure shall meet the appropriate degree of protection/ explosion protection depending on their location.

6.6.4 Permanent monitoring facilities shall be installed at the following locations as a minimum:

- Piping as defined in earlier part of document
- At each buried vessel or tank.



6.7 Junction boxes

6.7.1 Each Anode & Cathode junction box shall be complete with enclosure MOC as per hazardous area classification.

6.7.2 Anode (positive) junction box shall have variable resistors, current measuring shunts, and necessary appurtenances in accordance with IP-65 protection as a minimum.

6.7.3 Each box shall be designed for outdoor installation.

6.7.4 Each box shall be provided with a sunshade/ canopy.

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6.7.5 Each box shall have a stainless steel permanent nameplate which shall include, as a minimum, the following items :

- Manufacturer's name and address
- Model and serial numbers
- Resistor manufacturer's name and address
- Resistor model and serial numbers (Resistor ratings).
- Ambient temperature rating
- Nameplate shall be affixed to the outside of the door

6.7.6 Each box shall have a stainless steel plate indicating the connection scheme

6.7.7 Junction boxes shall be sized to dissipate heat generated by the variable resistors at their maximum output in an outdoor environment.

6.7.8 All doors shall be lockable and locks shall be capable of being opened with the same key.

6.7.9 Junction box enclosures shall be explosion proof if installed in hazardous area.

6.7.10 All junction boxes shall be marked clearly with tags.

6.7.11 Cathode junction box shall be provided for multiple pipelines connections.

7.0 DRAWINGS AND DOCUMENTS



7.1 4 hard copies & 1 soft copy of drgs. & doc. shall be supplied with bid.

4 hard copies & 1 soft copy shall be supplied for approval after order within 4 weeks from the date of LOI.

8 hard copies & 2 soft copies in pen drive shall be submitted as final documents prior to despatch of the equipment. These shall be made in sets and supplied in fine plastic coated folder.

7.2 All drawings and documents shall have the following description written boldly.

- i) Name of client
- ii) Name of consultant
- iii) Enquiry / order number with plant / project name
- iv) Equipment Code no. and Description

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8.0 SPARES

8.1 Spares for operation and maintenance

Item wise unit prices of spare parts with recommended quantity shall be quoted along with the equipments.

Mandatory spares as specified elsewhere in the NIT shall be quoted.

8.2 Commissioning Spares



Commissioning spares, as required, shall be supplied with the main equipment. Item wise list of recommended commissioning spares shall be furnished for approval.

8.3 Any other spare parts not specified, but required, shall also be quoted along with the offer.

8.4 All spare parts shall be identical to the parts used in the equipments.



9.0 DEVIATIONS

9.1 Deviations, if any, from this standard shall be clearly indicated in the offer with reasoning.

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TECHNICAL SPECIFICATION

CATHODIC PROTECTION POWER SUPPLY MODULE (CPPSM)

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1.0 SCOPE

This specification covers the requirements for the design, manufacture and testing of Cathodic Protection Power Supply Module (CPPSM) working on controlled switch mode principle intended to supply power to cathodic protection system

2.0 CODES AND STANDARDS

2.1 The system design, performance and materials to be supplied shall conform to the requirements of the latest revision of following standards:

IS: 1248 (Parts-I, 2, 8 & 9)	Direct acting indicating analogue electrical measuring instruments and accessories.
IS: 3700 (Parts-I to 11)	Essential rating and characteristics of semiconductor devices
IS: 3715 (Parts-I to 4)	Letter symbols for semiconductor devices
IS: 4411	Code of designation of semiconductor devices.
IS: 5469 (Parts-I to 4)	Code of practice for the use of semiconductor junction devices.
IS: 6619	Safety code for semiconductor rectifier equipment.
IS:7204 (Parts-I to 4)	Stabilised power supplies DC output.
IS: 12021 (Parts-I to 4)	Control transformers for switchgear and control gear for voltages not exceeding 1000 V AC.
IS: 13703 (Parts-I to 4)	Low voltage fuses for voltages not exceeding 1000 V AC or 1500 V DC.
IS: 13947 (Parts-4, section-I)	Low voltage switchgear and control gear.

2.2 In case of imported equipment, standards of the country of origin shall be applicable if these standards are equivalent or stringent than the applicable Indian standards.



2.3 The equipment shall also conform to the provisions of Indian Electricity rules and other statutory regulations currently in force in the country.

2.4 In case of any contradiction between various referred standards/ specifications/ and statutory regulations the following order of priority shall govern:

- Statutory regulations.
- This specification.
- Codes and standards.

3.0 SITE CONDITION

The CPPSM shall be suitable for installation in non air-conditioned room with restricted ventilation or in outdoor kiosk in locations having generally corrosive, warm, humid and dusty atmosphere. Service conditions shall be as per actual site conditions. If not specifically mentioned therein, a design ambient temperature of 45°C and an altitude not exceeding 1000 m above mean sea level shall be considered.

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4.0 GENERAL REQUIREMENTS

The offered equipment shall be brand new with state of art technology and proven field track record. No prototype equipment shall be offered.



- 4.1 Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment for at least 15 years from the date of supply.
- 4.2 Vendor shall give a notice of at least one year to the end user of equipment and owner before phasing out the product / spares to enable the end user for placement of order for spares and services.

5.0 TECHNICAL REQUIREMENTS



5.1 Fabrication and General Details

CPPSM shall be housed in sheet steel enclosure. The front, rear walls and doors shall be made by using minimum 2 mm thick sheet steel and side walls shall be made of minimum 1.6 mm thick sheet steel. Wherever required, suitable stiffeners shall be provided. The Unit shall be freestanding type. Hinged doors "Shall be provided at the front and back as required. The unit shall be natural cooled type. Louvered openings with wire mesh for natural ventilation may be provided. Degree of protection for the panel shall be minimum IP-41. The CPPSM panel shall, preferably, not need rear access for operation, maintenance and shall be suitable for mounting flushed to the wall.

- 5.1.2 Suitable hooks shall be provided for lifting the panel. These hooks when removed shall not leave any hole in the panel or imperfection in the paint finish.
- 5.1.3 All instruments shall be panel mounted type and back connected. All fuses shall be provided inside the panel and shall be of link type. 660 V grade PVC insulated BIS approved wires with stranded copper conductor of size minimum 2.5 mm² shall be used for power and auxiliary wiring. Control wiring for electronic circuits shall be through flat ribbon cable or through copper wire of minimum 0.5 mm diameter. All wirings shall be ferruled with PVC ferrules at both ends for ease of identification. Clamp type terminals suitable for termination up to 10 mm" conductor shall be provided for all control cable connection. Suitable power terminals shall be provided for power cables. Minimum 20% spare terminals shall be provided. The terminal blocks shall be mounted minimum 300 mm above the gland plate.
- 5.1.4 All live parts shall be properly shrouded. This shall ensure complete safety to personnel intending routine maintenance by opening the panel doors.
- 5.1.5 CPPSM shall be suitable for bottom cable entry unless otherwise specified and shall be supplied complete with crimping type tinned copper lugs and cable glands. Cable glands shall be of brass, nickel plated, single compression type for indoor installations and double compression type for outdoor installations. The space in the terminal chamber shall be adequate for termination of required number and sizes of cables.
- 5.1.6 The CPPSM shall be field proven. The design, internal component layout and rating of component shall ensure high MTBF and low MTTR. Prototype equipment shall not be acceptable. Layout of panel components shall enable easy access to the components for maintenance.

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- 5.1.7 All the control equipment like switches, push buttons, potentiometers etc. shall be located at a convenient height of minimum 300 mm and maximum 1800 mm from the bottom of the panel.
- 5.1.8 The printed circuit boards (PCBs) shall be of copper clad glass epoxy laminate. PCB tracks shall be tinned and solder masked. The PCB shall be coated with suitable lacquer to make it immune to dust, moisture and fungal growth. Where plug in type of PCBs are used gold plated male-female connectors shall be used for the purpose.
- 5.1.9 The panel shall be provided with space heater to prevent moisture condensation. The space heaters shall be located at the bottom of the panel and shall be provided with a manually operated switch and HRC fuse. The space heater shall have porcelain-insulated connectors. Where space heater is not provided, the electronic PCBs/components and other control devices shall be made immune to moisture condensation.
- 5.1.10 Panel shall be provided with integral base frame channel. The integral base frame of panel shall be suitable for directly bolting with the help of foundation bolts and shall also be suitable for tack welding to purchaser's insert plate/flat/channel embedded in the floor. Amply dimensioned oblong holes shall be provided at the bottom of the panel for its bolting to the embedded insert plate/channel.
- 5.1.11 An earth bus bar of minimum (25 x 3) mm² copper or equivalent aluminium shall be provided throughout the length of the panel. Provision shall be made for connecting this earth bus at two ends with the plant earth grid by means of (40x5) mm" GI flat. All non-current carrying metallic parts of the panel and mounted equipment shall be connected to the panel earth bus. All doors and movable parts shall be connected to the earth bus by flexible copper cables.
- 5.1.12 All panel mounted equipments (e.g. lamps, push buttons, switches, meters, PCBs, etc.) shall be provided with suitable nameplates. Nameplates shall be engraved out of 3-ply (black-white-black) lamicoide sheets or anodised aluminium. Back-engraved perspex sheet nameplates may also be acceptable. Engraving shall be done with groove cutters. Hard paper or self-adhesive plastic tape nameplates shall not be acceptable. Nameplates shall be fastened by screws and not by adhesive. Labels shall be provided for every component on the cards, connecting wires as well as for the terminals in the terminal strip inside the panel.
- 5.1.13 Where specified, the CPPSM shall be housed in an outdoor kiosk. The kiosk shall be made of sheet steel of minimum 3 mm thick and epoxy painted on both internal and external surfaces. Hinged lockable doors shall be provided at the front and back. Acrylic transparent glass window shall be provided on the front door of the kiosk so that the meters, indications and positions of the control switches on the CPPSM can be seen without opening the door of the kiosk. The kiosk shall be suitable for outdoor mounting and shall give proper protection to the CPPSM against rain, other harsh weather conditions. Necessary ventilation arrangement with louvers and wire mesh shall be provided for proper operation of the CPPSM. The cable entry to the kiosk shall be from bottom through cable glands. Suitable canopy shall be provided on the top of the kiosk.
- 5.1.14 **Painting**
- All metal surfaces shall be thoroughly cleaned and degreased to remove mill scale, rust, grease and dirt.

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Fabricated structures shall be pickled and then rinsed to remove any trace of acid. The under surface shall be prepared by applying a coat of phosphate paint and a coat of yellow zinc chromate primer. The undersurface shall be made free from all imperfections before undertaking the finishing coat.

After preparation of the under surface, the panel shall be spray painted with two coats of final paint or shall be powder coated. Colour shade of final paint shall be approved by the purchaser before final painting is started. The finished panels shall be dried in stowing ovens in dust free atmosphere. Panel finish shall be free from imperfections like pin holes, orange peels, run off paint, etc.

All unpainted steel parts shall be cadmium plated or suitably treated to prevent corrosion. If these parts are moving elements, then they shall be greased.

6.0 EQUIPMENT DESCRIPTION

The CPPSM shall be complete with following main sections:

- Input controls.
- Power converter and filters.
- Output protections
- System controls
- Current interrupter
- Control, indication and metering



6.1 Input Controls

6.1.1 A moulded case circuit breaker with thermal over load and short circuit release (rated for the input power supply short circuit current) shall be provided at the input for power supply control.

6.2 Power Converter and Filters

6.2.1 The CPPSM shall convert and control the input DC power supply voltage/current into variable DC output voltage/current through switching power semiconductor devices (Thyristor/power transistor/power MOSFET, etc.). The variation in the output voltage/current shall be achieved through control of duty cycle of conduction of the switching power semiconductor devices. The current and voltage ratings of the power semiconductor devices shall be at least two times the maximum device current and min. two times the maximum voltage coming across it respectively. The voltage rating of the power semi-conductor devices shall be co-coordinated with the breakdown voltage of lightning arrestor provided at the output so that the power semiconductor devices are protected from any voltage surge coming from the pipeline. Shunt zeners / MOV shall be provided across the power semiconductor devices for protection. The power semiconductor devices shall have humidity/moisture resistant finish and mounted in sufficiently sized heat sink designed to provide adequate cooling under worst conditions of operation. The power semiconductor devices shall have adequate protection against high dv/dt and di/dt.

6.2.2 Where specified, the converter shall electrically isolate the input power to CPPSM from its output so that the grounding of the positive output of the CPPSM through anode

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ground bed shall not affect the grounding system of the input power supply. Alternatively, a separate DC to DC converter having electrical isolation between input and output power supply shall be provided at the input of the CPPSM.

- 6.2.3 The power semiconductor devices shall be protected by semiconductor fuses or the system shall have instantaneous short circuit-current limit feature to protect the devices against output short circuits. An adjustable output over current limit feature shall be provided.
- 6.2.4 Filter shall be provided in the input power supply circuit to minimise the AC injected into the DC input power supply system.
- 6.2.5 Adequate filtering shall be provided on the DC output of the converter to limit the ripple content in the output to less than 5% at rated output.
- 6.2.6 The converter system shall be of natural air cooled type.
- 6.2.7 For CPPSMs with multiple output circuits, each output circuit shall have independent output converter and output filters.

6.3 Output Protections

Two pole moulded case circuit breaker or miniature circuit breaker rated for the DC output current, short circuit current and having thermal over load, short circuit release shall be provided in the output. A lightning arrestor rated for minimum 10KA impulse current discharge capacity and rated voltage & max. spark over voltage rating suitable to protect the CPPSM components against lightning and switching surges shall be provided at the output. For CPPSMs with multiple output circuits, each output circuit shall have independent protections.

6.4 System Controls



- 6.4.1 The CPPSM shall have two distinct modes of operation (independent for each output circuit) as below:

a) Constant Voltage - Constant Current Mode (CVCC)

In this mode the output voltage (V_{os}) of CPPSM shall be continuously adjustable from 0.5V DC to the rated output voltage. Current limit feature shall be provided in this mode of operation. The current limit (I_{os}) shall be continuously adjustable from zero to rated output current.

For constant voltage mode of operation the output current limit shall be set at maximum and output voltage setting shall be varied. Irrespective of output current demand the chosen value of the output voltage shall be maintained by the control system till the current limit is reached. After that the output current limit shall be maintained and output voltage shall decrease to keep the current constant.

For constant current mode of operation the output voltage shall be set at maximum and output current shall be varied through varying the setting of output current limit. Irrespective of output voltage requirement the control system shall maintain the output current to the set current limit value till the voltage limit is reached. After that the output voltage limit shall be maintained and output current shall decrease to keep the voltage constant.

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b) **Auto PSP Mode**

In this mode of operation the output of the CPPSM shall operate in an external closed loop with pipe-to -soil potential (PSP) in feedback loop. The CPPSM control shall adjust the output voltage such that the PSP as measured by reference cell always remains equal to the set potential on the unit. The set potential (V_{ps}) shall have high long time stability and minimum temperature drift. The set potential shall be continuously adjustable over the range as required. An adjustable over current limit shall be provided to limit the maximum output current.

The unit shall be designed to operate with the number of reference cells connected to it (to be provided by others). In case of more than one reference cell being specified, CPPSM shall have feature to automatically select the reference cell having less negative potential than the others and use the same for auto control of the unit (e.g. (-) 0.8 V is less negative than (-) 0.9 V). Adequate hysteresis shall be provided in selecting the less negative potential reference cell, to avoid hunting between the reference cells at change over conditions.

In case of open circuit or short circuit of the reference cell or potential being less negative than a minimum set potential (V_{rs}), for the controlling reference cell, the unit shall sense these conditions as reference cell failure and shall automatically switch over to the other healthy reference cell for control. Should fault occur in all the reference cells, the output voltage or current of the CPPSM shall adjust automatically to a preset value (V_{as}/I_{as}), which shall be adjustable.

In both CVCC and auto PSP modes of operation the electronic over current limit shall be fast enough to protect the active devices of the unit and fast enough to act before tripping of MCCB/MCB or blowing of fuse.

6.4.2 The unit shall continuously monitor the PSP and necessary annunciation shall be provided in case of PSP either exceeding the specified maximum limit (V_{pm}) or remaining lower than the specified minimum limit (V_{pn}).

6.4.3 The output voltage regulation for no load to full load variation with input voltage variation from maximum to minimum shall not be more than 2.5 % of rated voltage throughout the range of output voltage and over the specified ambient temperature variation, in CVCC-constant voltage mode of operation. In auto PSP mode the closed loop PSP regulation for no load to full load variation with input voltage variation from maximum to minimum shall be within 20mV throughout the PSP setting range specified.



In CVCC- constant current mode of operation, the current regulation for minimum to maximum output voltage and minimum to maximum variation in input voltage shall not be more than 2.5% throughout the range of output current.

6.4.4 The output of the unit shall be ungrounded and shall allow grounding of positive terminal of the output through the anode ground bed.



6.4.5 For CPPSMs with multiple output circuits, each output circuit shall have independent control system.

6.5 **Current Interrupter**



6.5.1 A current interrupter for CPPSM output current interruption shall be provided.

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- 6.5.2 The current interrupter shall have an output contactor with current rating minimum 125% of the output current rating of the CPPSM and a digital timer to operate it.
- 6.5.3 The timer shall have 'ON' and 'OFF' timings. When the timer is turned on the 'ON' timing shall start and shall close the output contactor till the end of the 'ON' timing. At the end of the 'ON' timing the 'OFF' timing shall start and keep the contactor open till the end of the 'OFF' timing. At the end of the 'OFF' timing the 'ON' timing shall start again. This process of 'ON' and 'OFF' timing shall continue.
- 6.5.4 The 'ON' and 'OFF' timings of the timer shall be settable by separate 2 digit thumbwheel switches, each settable from 1 to 99 seconds. The timing error of the timer shall be less than 5 parts per million. In case of microprocessor based system keypad with display may be provided in place of thumbwheel switches.
- 6.5.5 Whenever the timer is switched on it shall always start with ON 'timing'. A timer-reset push button shall be provided. On pressing this pushbutton during operation of the timer, the timer shall get reset and upon release of the button, the timer shall restart with 'ON' timing.
- 6.5.6 The power required for operation of the timer and contactor shall be derived from the main power supply to the CPPSM.
- 6.5.7 The following controls and indications shall be provided for current interrupter. The controls shall be housed in a lockable cover, so that normally they are not accessible. The indications shall be mounted on the door.
- a) Controls
- Timer power 'ON' / 'OFF'
 - Timer reset
 - Thumb wheel switch for 'ON' timing
 - Thumb wheel switch for 'OFF' timing
- In case of microprocessor based system, keypad with display may be provided in place of thumbwheel switches.
- b) Indications (LED)
- Timer power 'ON'
 - 'ON' timing
 - 'OFF' timing
- 6.5.8 The output contact of the current interrupter contactor shall be wired in the positive DC output of the CPPSM. A link shall be provided for shorting these terminals whenever the current interrupter is not in use.
- 6.5.9 The current interrupter shall be an independent unit of portable type. The interrupter unit shall have terminals for input power supply and terminals of the contactor in the timer output. The input power supply and the rating of the timer output contactor shall be as required.

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- 6.5.10 Where the current interrupter is not specified with CPPSM or is specified as portable type external to the CPPSM, then the CPPSM shall have provision for connection of input power supply terminals and output contacts of external current interrupter for current interruption test. A link shall be provided for shorting the output terminals provided in CPPSM for current interruption, whenever the current interrupter is not connected.
- 6.5.11 For CPPSMs with multiple output circuits, each output circuit shall have independent current interrupter.
- 6.6 Controls, Indication and Metering
- 6.6.1 Following controls shall be provided on CPPSM front door.
- a) ON/OFF control for input through MCCB.
 - b) ON /OFF control for output through MCCB/MCB.
 - c) Auto/CVCC mode selector switch.
 - d) Potentiometers for Vos, Vps and los settings.
 - e) Selector switch for selecting indication of PSP set and PSP actual for all the reference cells.
- 6.6.2 Following controls shall be provided inside the module at user accessible common location:
- a) Potentiometer for Vrs, Vpm, Vpn and Vas/las settings.
 - b) Controls for current interrupter:
 - Timer power 'ON' / 'OFF'
 - Timer reset
 - Thumb wheel switch for 'ON' timing
 - Thumb wheel switch for 'OFF' timing
- 6.6.3 CPPSM shall have following indicating lights (lamps or minimum 5 mm dia LEDs):
- a) CPPSM ON/OFF
 - b) Unit in auto/CVCC (2 lamps)
 - c) Reference cell controlling the closed loop control of the CPPSM (number of lamps same as number of reference cells).
 - d) Reference cell faulty (number of lamps same as number of reference cells).
 - e) Pipeline over protected.
 - f) Pipeline under protected
 - g) Indications for current interrupter:
 - Timer power 'ON'

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- 'ON' timing
- 'OFF' timing

It shall be possible to switch-off all the indication lamps by a single switch. In case of LED indication lights this facility may not be provided.

6.6.4 Following meters having min cl. 1.5 accuracy shall be provided on the CPPSM:

- a) Digital meter for output voltage
- b) Digital meter for output current
- c) Digital voltmeter to measure PSP set (Vps) and PSP actual for all the reference cells. The meter shall have range from (-) 4 V to 0 V and shall have cl. 0.5 accuracy.
- e) Digital meters for measuring Vrs, Vpm, Vpn and Vas/las settings.
- f) Meters for input voltage and current



It shall be possible to switch-off all the digital meters preferably by a single switch.

6.6.5 If specified, CPPSM shall incorporate provision for remote monitoring of the unit through SCADA system as below:

- a) Potential free contacts for the following:
 - All the reference cells failed. (Contact open on alarm condition)
 - Pipeline overprotected. (Contact open on alarm condition)
 - Pipeline under protected. (Contact open on alarm condition)
 - System in auto-mode. (Contact close in auto condition)
 - System in CVCC mode. (Contact close in CVCC mode)
- b) 4 to 20 mA electrically isolated signal for the following:
 - PSP (-4V to 0V)
 - CPPSM output voltage
 - CPPSM output current

The transducers shall have electrical isolation between input and output. The isolation insulation shall withstand 2 kV, 50 Hz for minimum 1 minute. The accuracy class of the transducer shall be 0.5. The transducers shall be protected against input and output voltage surges. The transducer shall be suitable for driving upto 600 ohms load impedance located upto 500 m away and wired with 0.5 mm- copper conductor cable. The transducers shall be suitable for minimum 125% continuous over load in the input voltage/current parameter.

6.6.6 For units having multiple outputs, each output circuit shall have independent controls, indication and metering.

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7.0 TESTS AND ACCEPTANCE

7.1 During fabrication, the equipment shall be subjected to inspection by owner or his authorised representative to assess the progress of the work as well as to ascertain that only quality raw materials are used for the same. He shall be given all assistance to carry out the inspection.

7.2 Final acceptance test shall be carried out at manufacturer's works under his care and expense. Instruments and equipments required for testing shall be arranged by manufacturer. Owner's representative shall be given minimum 2 weeks prior notice for witnessing the tests. Test certificates indicating test results shall be furnished by the manufacturer. Acceptance tests shall include but not be limited to the tests listed below.

7.2.1 Visual Inspection

This shall include-

- Completeness of the equipment in line with specification.
- Checking of all settings.
- All labels provided and satisfactory.
- Dimensional checking.
- Proper mounting of components and neatness of wiring etc.
- Model number.

7.2.2 Insulation tests



The voltage specified in the table below shall be applied for one minute to the circuits indicated:

Withstand voltage	Control electronics <60V	Power electronics U_{n1}	Auxiliary circuits U_{n2}
To earth	700V D.C.	$2xU_{n1} + 1000V$	$2xU_{n2} + 1000V$
To control electronics	-	$2xU_{n1} + 1000V$	$2xU_{n2} + 1000V$
To power electronics	$2xU_{n2} + 1000V$	-	$2xU_{n2} + 1000V$
To auxiliary circuits	$2xU_{n2} + 1000V$	$2xU_{n1} + 1000V$	-

(U_n , and U_{n2} are nominal voltage rating of power electronics and auxiliary circuits respectively).

D.C. test voltages may be applied instead of A.C. The magnitude of D.C. test voltages to be applied shall be 2 times the above-mentioned A.C. (r.m.s) Values.

Insulation resistance test shall be conducted before and after heat run test.

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7.2.3 Heat run test

All CPPSMs shall be subjected to a heat run test performed at rated voltage for period not less than 16 hours prior to execution of functional tests.

At least one CPPSM of each rating shall be loaded to its rated output throughout 16 hour test period. All other CPPSMs shall be energized under partial load or zero load current condition throughout the test period.

7.2.4 Functional tests

Functional tests as below shall be performed on each CPPSM. If during execution of functional tests, any electronic component of the unit is required to be replaced e.g. due to malfunction or failure of the unit to fulfil the performance requirements of the specification, then the load test shall be repeated at rated current following which functional tests shall be carried out.

7.2.4.1 CVCC mode operation testing

a) Constant voltage operation

During the test, current limit shall be set to rated output current. Performance testing shall be carried out for various output voltage settings and load varying from zero to maximum. The verification of operation of the control functions, measurement of output voltage, current, input voltage, current, ripple in the output, input, evaluation of output voltage regulation and efficiency of the unit shall be carried out during the testing.

b) Constant current operation



During the test, voltage limit shall be set to rated output voltage. Performance testing shall be carried out for various output current limit settings and load resistance varied to achieve output voltage from minimum to maximum. The verification of operation of the control functions, measurement of output voltage, current, input voltage, current, ripple in the output, input, evaluation of output current regulation of the unit shall be carried out during the testing.

7.2.4.2 Auto PSP mode operation

Suitable set-up shall be arranged for output loading and reference cell feedback. The closed loop performance and regulation shall be checked with the PSP set voltage varied from 0.85V to 1.2V.

Disconnecting the reference cell feedback connection in the above set up shall simulate the reference cell failed condition. The output voltage/current of the unit shall go to the value set on the potentiometer V_{as}/I_{as} provided inside the CPPSM. The settings on V_{as}/I_{as} shall be varied and the output voltage/current shall be observed.

7.2.4.3 Operation of sensors for pipeline over protection, under protection, reference cell failure and reference cell selection logic in auto PSP mode shall be verified by connecting variable external voltage sources to reference cell inputs of the CPPSM. The number of external voltage sources shall be same as number of reference cell inputs specified for the CPPSM.

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7.2.4.4 The unit shall be checked for operation of the current limit by over loading the unit in both CVCC and auto PSP modes of operation. For Units where semiconductor fuses are not provided for protection of the power semiconductor device, the protection of same shall be tested as below:

A switch rated for making and carrying CPPSM output short circuit current shall be connected to the output terminals of the unit. The output voltage and the output current limit settings of the unit shall be set to the maximum rated values. The switch connected in the output shall be shorted quickly.

The unit shall go to current limit mode and shall not damage any active component of the unit.



7.2.4.5 The current interrupter shall be tested for time interval settings and specified operation.

8.0 PACKING AND DESPATCH

The equipment shall be properly packed for selected mode of transportation i.e. by ship/rail or trailer. The panels shall be wrapped in polythene sheets before being placed in crates to prevent damage to finish. Crates shall have skid bottom for handling. Special notations such as



'Fragile', 'This side up', 'Center of gravity', 'Weight' etc., shall be clearly marked on the package together with Tag nos., P.O. Nos. etc.

The equipment may be stored outdoors for long periods before erection. The packing shall be completely suitable for outdoor storage in areas with heavy rains/high ambient temperature.

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TECHNICAL SPECIFICATION

CATHODIC PROTECTION TRANSFORMER RECTIFIER UNIT

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1.0 SCOPE

This specification covers the requirements for the design, manufacture and testing of Cathodic Protection Transformer Rectifier units (CPTR units) working on controlled rectification principle intended to supply power to cathodic protection system for underground pipelines/ structures.

2.0 CODES AND STANDARDS

2.1 The system design, performance and materials to be supplied shall conform to the requirements of the latest revision of following standards:

IS: 1248 (Parts-I, 2, 8 & 9)	Direct acting indicating analogue electrical measuring instruments and accessories.
IS: 3700 (Parts-I to 11)	Essential rating and characteristics of semiconductor devices
IS: 3715 (Parts-I to 4)	Letter symbols for semiconductor devices
IS: 4411	Code of designation of semiconductor devices.
IS: 5469 (Parts-I to 4)	Code of practice for the use of semiconductor junction devices.
IS: 6619	Safety code for semiconductor rectifier equipment.
IS:7204 (Parts-I to 4)	Stabilized power supplies DC output
IS: 12021 (Parts-I to 4)	Control transformers for switchgear and control gear for voltages not exceeding 1000 V AC.
IS: 13703 (Parts-I to 4)	Low voltage fuses for voltages not exceeding 1000 V AC or 1500 V DC.
IS: 13947 (Parts-4, section-I)	Low voltage switchgear and control gear.

2.2 In case of imported equipment, standards of the country of origin shall be applicable if these standards are equivalent or stringent than the applicable Indian standards.



2.3 The equipment shall also conform to the provisions of Indian Electricity rules and other statutory regulations currently in force in the country.

2.4 In case of any contradiction between various referred standards/ specifications and statutory regulations the following order of priority shall govern:

- Statutory regulations.
- This specification.
- Codes and standards

3.0 SITE CONDITIONS

The CPTR unit shall be suitable for installation in non air-conditioned room with restricted ventilation or in outdoor kiosk, in locations having generally corrosive, warm, humid and dusty atmosphere. Service conditions shall be as actual site conditions. If not specifically mentioned therein, a design ambient temperature of 45°C and an altitude not exceeding 1000 m above mean sea level shall be considered

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4.0 GENERAL REQUIREMENTS

- 4.1 The offered equipment shall be brand new with state of art technology and proven field track record. No prototype equipment shall be offered.
- 4.2 Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment for at least 15 years from the date of supply.
- 4.3 Vendor shall give a notice of at least one year to the end user of equipment and PDIL before phasing out the product/spares to enable the end user for placement of order for spares and services.



5.0 TECHNICAL REQUIREMENTS

5.1 Fabrication and General Details

- 5.1.1 CPTR unit shall be housed in sheet steel enclosure. The front, rear walls and doors shall be made by using minimum 2 mm thick sheet steel and side walls shall be made of minimum 1.6 mm thick sheet steel. Wherever required, suitable stiffeners shall be provided. The Unit shall be freestanding type. Hinged doors shall be provided at the front and back as required. The unit shall be natural cooled type. Louvered openings with wire mesh for natural ventilation may be provided. Degree of protection for the panel shall be minimum IP-41. The CPTR unit panel shall, preferably, not need rear access for operation, maintenance and shall be suitable for mounting flushed to the wall.
- 5.1.2 Suitable hooks shall be provided for lifting the panel. These hooks when removed shall not leave any hole in the panel or imperfection in the paint finish.
- 5.1.3 All instruments shall be panel mounted type and back connected. All fuses shall be provided inside the panel and shall be of link type. 660 V grade PVC insulated BIS approved wires with stranded copper conductor of size minimum 2.5 mm² shall be used for power and auxiliary wiring. Control wiring for electronic circuits shall be through flat ribbon cable or through copper wire of minimum 0.5 mm diameter. All wirings shall be ferruled with PVC ferrules at both ends for ease of identification. Clamp type terminals suitable for termination up to 10 mm conductor shall be provided for all control cable connection. Suitable power terminals shall be provided for power cables. Minimum 20% spare terminals shall be provided. The terminal blocks shall be mounted minimum 300 mm above the gland plate.
- 5.1.4 All live parts shall be properly shrouded. This shall ensure complete safety to personnel intending routine maintenance by opening the panel doors.
- 5.1.5 CPTR unit shall be suitable for bottom cable entry unless otherwise specified and shall be supplied complete with crimping type cable termination lugs and cable glands. Cable glands shall be of brass, nickel plated, single compression type for indoor installations and double compression type for outdoor installations. The space in the terminal chamber shall be adequate for. termination of required number and sizes of cables.
- 5.1.6 The input power factor of the unit at rated load shall be 0.8 lag or better.
- 5.1.7 The CPTR unit shall be field proven. The design, internal component layout and rating of component shall ensure high MTBF and low MTTR. Prototype equipment shall not be acceptable.

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- 5.1.8 All the control equipment like switches, pushbuttons, potentiometers etc. shall be located at a convenient height of minimum 300 mm and maximum 1800 mm from the bottom of the panel .
- 5.1.9 The printed circuit boards (PCBs) shall be of copper clad glass epoxy laminate. PCB tracks shall be tinned and solder masked. The PCB shall be coated with suitable lacquer to make it immune to dust, moisture and fungal growth. Where plug in type of PCBs are used gold plated male-female connectors shall be used for the purpose.
- 5.1.10 The panel shall be provided with space heater to prevent moisture condensation. The space heaters shall be located at the bottom of the panel. and shall be provided with a manually operated switch, HRC fuse and link for phase and neutral respectively. The space heater shall have porcelain connectors. Where space heater is not provided the electronic PCBs/components and other control devices shall be made immune to moisture condensation.
- 5.1.11 Panel shall be provided with integral base frame channel. The integral base frame of panel shall be suitable for directly bolting with the help of foundation bolts and shall also be suitable for tack welding to purchaser's insert plate/flat/channel embedded in the floor. Amply dimensioned oblong holes shall be provided at the bottom of the panel for its bolting to the embedded insert plate/channel.
- 5.1.12 An earth bus bar of minimum (25 x 3) m² copper or equivalent aluminium shall be provided throughout the length of the panel. Provision shall be made for connecting this earth bus at two ends with the plant earth grid by means of (40x5) mm- GI flat. All non-current carrying metallic parts of the panel and mounted equipment shall be connected to the panel earth bus. All doors and movable parts shall be connected to the earth bus by flexible copper cables.
- 5.1.13 All panel mounted equipments (e.g. lamps, pushbuttons, switches, meters, PCBs, etc.) shall be provided with suitable nameplates. Nameplates shall be engraved out of 3-ply (black-whiteblack) lamicoid sheets or anodised aluminium. Back-engraved Perspex sheet nameplates may also be acceptable. Engraving shall be done with groove cutters. Hard paper or self-adhesive plastic tape nameplates shall not be acceptable. Nameplates shall be fastened by screws and not by adhesive. Labels shall be provided for every component on the cards, connecting wires as well as for the terminals in the terminal strip inside the panel.
- 5.1.14 Where specified, the CPTR unit shall be housed in an outdoor kiosk. The kiosk shall be made of sheet steel of minimum 3 mm thick and epoxy painted on both internal and external surfaces. Hinged lockable doors shall be provided at the front and back. The kiosk shall be suitable for outdoor mounting and shall give proper protection to the CPTR unit against rain, other harsh weather conditions. Necessary ventilation arrangement with louvers and wire mesh shall be provided for proper operation of the CPTR unit. The cable entry to the kiosk shall be from bottom through cable glands. Suitable canopy shall be provided on the top of the Kiosk.
- 5.1.15 **Painting**
- All metal surfaces shall be thoroughly cleaned and degreased to remove mill scale, rust, grease and dirt.
- Fabricated structures shall be pickled and then rinsed to remove any trace of acid. The under surface shall be prepared by applying a coat of phosphate paint and a coat of yellow

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zinc chromate primer. The under surface shall be made free from all imperfections before undertaking the finishing coat.

After preparation of the under surface, the panel shall be spray painted with two coats of final paint or shall be powder coated. Colour shade of final paint shall be approved by the purchaser before final painting is started. The finished panels shall be dried in stowing ovens in dust free atmosphere. Panel finish shall be free from imperfections like pin holes, orange peels, run off paint, etc. All unpainted steel parts shall be suitably treated to prevent corrosion. If these parts are moving elements, then they shall be greased.

6.0 EQUIPMENT DESCRIPTION

The CPTR unit shall be complete with following main sections:

- Transformer and input controls.
- Rectifier and filter
- Output protections
- System controls
- Control, indication and metering

6.1 Transformer and Input Controls



6.1.1 The transformer shall be natural cooled dry type with separate primary and secondary windings.

An intermediate earth screen shall be provided between primary and secondary windings. CPTR Units having multiple output circuits shall have separate secondary windings for each output circuit. Transformer shall be vacuum impregnated with epoxy varnish and baked. The safety factor for transformer rating shall be minimum 125%.

6.1.2 Single-phase transformers may be provided up to 50V, 50A DC output rating of the CPTR units. Beyond this rating, 3 phase transformers shall be provided. A moulded case circuit breaker with thermal over load and short circuit release shall be provided at the input of the transformer. Miniature circuit breaker with thermal overload and short circuit release in place of moulded case circuit breaker may be provided, where the miniature circuit breaker rated for the incoming AC supply short circuit current.

6.2 Rectifier and Filters

6.2.1 The rectifier shall be made of thyristors and diodes as basic components. The CPTR unit shall be suitable for 415 V AC, 3-ph power supply. Rectifier shall be 3 phase full wave type and controlled type. For CPTR units rated 50V, 50A DC or less, the unit may be suitable for 240V AC, 1 ph power supply and the rectifier shall be full wave type and controlled type. Alternatively, for single phase AC CPTR units, diode rectifier of full wave type in the secondary of the transformer and triac or back to back connected thyristors in the transformer primary AC supply circuit may be provided. The current and voltage ratings of thyristors, diodes shall be at least two times the actual maximum device current and minimum two times the actual maximum voltage coming across the device respectively. The thyristors/ triac/ rectifier elements shall be protected against voltage surges coming from the incoming power supply and from output side from the pipeline. Required shunt zeners / MOV shall be provided across the rectifier elements for protection.

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The rectifier elements shall have humidity/moisture resistant finish and mounted in sufficiently sized heat sink designed to provide adequate cooling under worst conditions of operation. The rectifier elements shall have adequate protection against high dv/dt and di/dt. 6.2.2 The thyristors/triacs shall be protected by semiconductor fuses. For units rated 50V, 50A DC or less, if the thyristors or triacs are adequately over rated and system has enough inductance so that in case of sudden output short circuit the over current limit feature comes into action before short circuit current rises beyond the rating of the thyristors/triacs, then the semiconductor fuses may not be provided. This feature shall be demonstrated during testing of the unit at works.

6.2.3 Adequate filtering shall be provided on the DC output of the rectifier to limit the ripple content in the output to less than 5% at rated output.

6.2.4 The rectifier system shall be of natural air cooled type.

6.2.5 For CPTR units with multiple output circuits, each output circuit shall have independent rectifier and filter.

6.3 Output Protections

Two pole moulded case circuit breaker or miniature circuit breaker (if available) rated for the DC output current, short circuit current and having thermal over load, short circuit release shall be provided in the output. A lightning arrestor rated for minimum 10KA impulse current discharge capacity and rated voltage & maximum spark over voltage rating suitable to protect the CPTR unit components against lightning and switching surges shall be provided at the output. For CPTR units with multiple output circuits, each output circuit shall be provided with circuit breaker and lightning arrestor.

6.4 System Controls



6.4.1 The CPTR unit shall have two distinct modes of operation (independent for each output circuit) as below:

a) Constant Voltage and Constant Current Mode (CVCC)

In this mode the output voltage of CPTR unit shall be continuously adjustable from 0.5V DC to the rated output voltage. The set output voltage (V_{os}) shall remain constant irrespective of output current. Current limit feature shall be provided. The current limit (I_{os}) shall be continuously adjustable from zero to rated output current.

For constant voltage mode of operation the output current limit shall be set at maximum and output voltage setting shall be varied. Irrespective of output current demand the chosen value of the output voltage shall be maintained by the control system till the current limit is reached. After that the output current limit shall be maintained and output voltage shall decrease to keep the current constant.

For constant current mode of operation the output voltage shall be set at maximum and output current shall be varied through varying the setting of output current limit. Irrespective of output voltage requirement the control system shall maintain the output current to the set current limit value till the voltage limit is reached. After that the output voltage limit shall be maintained and output current shall decrease to keep the voltage constant.

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b) Auto PSP Mode

In this mode of operation the output of the CPTR unit shall operate in an external closed loop with pipe to soil potential (PSP), measured by reference cell, in feedback loop. The CPTR unit control shall adjust the output voltage such that the PSP as measured by reference cell always remains equal to the set potential on the unit. The set potential (Vps) shall have high long time stability and minimum temperature drift. The set potential shall be continuously adjustable over the range required.

The unit shall be designed to operate with number of reference cells connected to it (to be provided by others). In case of more than one reference cell being specified, CPTR unit shall have feature to automatically select the reference cell having less negative potential than the others and use the same for auto control of the unit (e.g. (-) 0.8 V is less negative than (-) 0.9 V). Adequate hysteresis shall be provided in selecting the less negative potential reference cell, to avoid hunting between the reference cells at change over conditions.

In case of open circuit or short circuit of reference cell or potential being less negative than a minimum set potential (Vrs), the unit shall sense these conditions as reference cell failure and shall automatically switch over to the other healthy reference cell for control. Should fault occur in all the reference cells, the output voltage or current of the CPTR unit shall adjust automatically to a preset value (Vas/las), which shall be adjustable.

In both CVCC and auto PSP modes of operation a fast acting electronic over current limit protection shall be provided. This protection shall be fast enough to protect the active devices of the unit and fast enough to act before tripping of MCCB/MCB or blowing of fuse.

6.4.2 The unit shall continuously monitor the PSP and necessary annunciation shall be provided in case of PSP either exceeding the specified maximum limit (Vpm) or remaining lower than the specified minimum limit (Vpn).

6.4.3 The output voltage regulation for no load to full load variation with input voltage variation from maximum to minimum shall not be more than 2.5 % of rated voltage throughout the range of output voltage and over the specified ambient temperature variation, in CVCC-constant voltage mode of operation. In auto PSP mode the closed loop PSP regulation for no load to full load variation with input voltage variation from maximum to minimum and PSP feedback varying over the specified range shall be within Zf mV.

In CVCC- constant current mode 'of operation, the current regulation for minimum to maximum output voltage and minimum to maximum variation in input voltage shall not be more than 2.5% throughout the range of output current.



6.4.4 The DC output of the CPTR unit shall be floating (ungrounded) in the Unit. However the CPTR Unit shall allow grounding of positive output terminal through the anode ground bed.

6.4.5 For CPTR units with multiple output circuits, each output circuit shall have independent control system.



6.5 Current Interrupter

6.5.1 A current interrupter for CPTR Unit output current interruption shall be provided.

6.5.2 The current interrupter shall have an output contactor with current rating minimum 125% of the output current rating of the CPTR unit and a digital timer to operate it.



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- 6.5.3 The timer shall have 'ON' and 'OFF' timings. When the timer is turned on the 'ON' timing shall start and shall close the output contactor till the end of the 'ON' timing. At the end of the 'ON' timing the 'OFF' timing shall start and keep the contactor open till the end of the 'OFF' timing. At the end of the 'OFF' timing the 'ON' timing shall start again and close the output contactor. This process of 'ON' and 'OFF' timing shall continue.
- 6.5.4 The 'ON' and 'OFF' timings of the timer shall be settable by separate 2 digit thumbwheel switches, each settable from 1 to 99 seconds. The timing error of the timer shall be less than 5 parts per million. In case of microprocessor based system keypad with display may be provided in place of thumbwheel switches.
- 6.5.5 Whenever the timer is switched on it shall always start with ON 'timing'. A timer-reset push button shall be provided. On pressing this pushbutton during operation of the timer, the timer shall get reset and upon release of the button the timer shall restart with 'ON' timing.
- 6.5.6 The power required for operation of the timer and contactor shall be derived from the main power supply to the CPTR unit.
- 6.5.7 The following controls and indications shall be provided for current interrupter. The controls shall be housed in a lockable cover, so that normally they are not accessible. The indications shall be mounted on the door.
- a) Controls
- Timer power 'ON' / 'OFF'
 - Timer reset
 - Thumb wheel switch for 'ON' timing
 - Thumb wheel switch for 'OFF' timing
- In case of microprocessor based system keypad with display may be provided in place of thumbwheel switches.
- b) Indications(LED)
- Timer power 'ON'
 - 'ON' timing
 - 'OFF' timing
- 6.5.8 The output contact of the current interrupter contactor shall be wired in the positive DC output of the CPTR unit. A link shall be provided for shorting these terminals whenever the current interrupter is not in use.
- 6.5.9 The current interrupter shall be an independent unit of portable type. The interrupter unit shall have terminals for input power supply and terminals of the output contactor. The input power supply and the rating of the output contactor shall be as required. Terminals shall be provided in the CPTR unit for taking power supply to the current interrupter.
- 6.5.10 Where the current interrupter is not specified with CPTR unit or is specified as portable type external to the CPTR unit, then the CPTR unit shall have provision/ terminals for connection of input power supply and output contacts of external current interrupter, for current interruption test. A link shall be provided for shorting the output terminals provided in CPTR unit whenever the current interrupter is not connected.

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- 6.5.11 For CPTR units with multiple output circuits, each output circuit shall have independent current interrupter.
- 6.6 Controls, Indication and Metering
- 6.6.1 Following controls shall be provided on CPTR unit front door.
- a) ON/OFF control for input through MCCB/MCB.
 - b) ON /OFF control for output through MCCB/MCB.
 - c) Auto/CVCC mode selector switch.
 - d) Potentiometers for Vos, Vps and los settings.
 - e) Selector switch for selecting indication of PSP set and PSP actual for all the reference cells.
- 6.6.2 Following controls shall be provided inside the module at user accessible common location:
- a) Potentiometer for Vrs, Vpm, Vpn and Vas/las settings.
 - b) Controls for current interrupter:
 - Timer power 'ON' / 'OFF'
 - Timer reset
 - Thumb wheel switch for 'ON' timing
 - Thumb wheel switch for 'OFF' timing
- 6.6.3 TR unit shall have following indicating lights (lamps or minimum 5 mm dia LEDs):
- a) CPTR unit ON/OFF
 - b) Unit in auto/CVCC (2 lamps)
 - c) Reference cell controlling the closed loop control of the CPTR unit (number of lamps same as number of reference cells).
 - d) Reference cell faulty (number of lamps same as number of reference cells).
 - e) Pipeline over protected.
 - f) Pipeline under protected
 - g) Indications for current interrupter:
 - Timer power 'ON'
 - 'ON' timing
 - 'OFF' timing

It shall be possible to switch-off all the indication lamps by a single switch. In case of LED indication lights this facility may not be provided.

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- 6.6.4 Following meters having min cl.1.5 accuracy shall be provided on the CPTR unit:
- a) Digital meter for output voltage
 - b) Digital meter for output current
 - c) Digital voltmeter to measure PSP set (Vps) and PSP actual for all the reference cells. The meter shall have range from -4 V to 0 V and shall have cl.0.5 accuracy.
 - d) Digital meters for measuring Vrs, Vpm, Vpn and Vas/las settings.
 - e) Meters for input voltage and current

It shall be possible to switch-off all the digital meters preferably by a single switch.

- 6.6.5 CPTR unit shall incorporate provision for remote monitoring of the unit through SCADA system as below:

- a) Potential free contacts for the following:
 - All the reference cells failed. (Contact open on alarm condition)
 - Pipeline overprotected. (Contact open on alarm condition)
 - Pipeline under protected. (Contact open on alarm condition)
 - System in auto-mode. (Contact close in auto condition)
 - System in CVCC mode. (Contact close in CVCC mode)
- b) 4 to 20 mA electrically isolated signal for the following:
 - PSP (-4V to 0V)
 - CPTR unit output voltage
 - CPTR unit output current



The transducers shall have electrical isolation between input and output. The isolation insulation shall withstand 2kV, 50Hz for minimum 1 minute. The accuracy class of the transducer shall be 0.5. The transducers shall be protected against input and output voltage surges. The transducer shall be suitable for driving up to 600 ohms load impedance located up to 500 m away and wired with 0.5 mm² copper conductor cable.

- 6.6.6 For units having multiple outputs, each output circuit shall have independent controls, indication and metering.

7.0 TESTS AND ACCEPTANCE

- 7.1 During manufacture, the equipment shall be subjected to inspection by owner or his authorised representative to assess the progress of the work as well as to ascertain that only quality raw materials are used for the same. He shall be given all assistance to carry out the inspection.

- 7.2 Final acceptance test shall be carried out at manufacturer's works under his care and expense. Instruments and equipments required for testing shall be arranged by manufacturer. Owner's representative shall be given minimum 2 weeks prior notice for

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witnessing the tests. Test certificates indicating test results shall be furnished by the manufacturer. Acceptance tests shall include but not be limited to the tests listed below.

7.2.1 Visual Inspection

This shall include-

- Completeness of the equipment in line with specification.
- Checking of all settings.
- All labels provided.
- Dimensional checking.
- Proper mounting of components and neatness of wiring etc.
- Model number.

7.2.2 Insulation tests

The voltage specified in the table below shall be applied for one minute to the circuits indicated:

Withstand voltage	Control electronics <60V	Power electronics U_{n1}	Auxiliary circuits U_{n2}
To earth	700VD.C.	$2xU_{n1} + 1000V$	$2xU_{n2} + 1000V$
To control electronics	-	$2xU_{n1} + 1000V$	$2xU_{n2} + 1000V$
To power electronics	$2xU_{n2} + 1000V$	-	$2xU_{n2} + 1000V$
To auxiliary circuits	$2xU_{n2} + 1000V$	$2xU_{n1} + 1000V$	-

(U_{n1} and U_{n2} are nominal voltage rating of power electronics and auxiliary circuits respectively).



D.C. test voltages may be applied instead of A.C. The magnitude of D.C. test voltages to be applied shall be 2 times the above-mentioned A.C. (r.m.s) Values.

Insulation resistance test shall be conducted before and after heat run test.

7.2.3 Heat run test

All CPTR units shall be subjected to a heat run test performed at rated voltage for period not less than 16 hours prior to execution of functional tests.

At least one CPTR unit of each rating shall be loaded to its rated output through out 16 hour test period. All other CPTR units shall be energized under partial load or zero load current condition throughout the test period.

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7.2.4 Functional tests

Functional tests as below shall be performed on each CPTR unit. If during execution of functional tests, any electronic component of the unit is required to be replaced e.g. due to malfunction or failure of the unit to fulfil the performance requirements of the specification, then the load test shall be repeated at rated current following which functional tests shall be carried out.

7.2.4.1 CVCC mode operation testing

a. Constant voltage operation

During the test, current limit shall be set to rated output current. Performance testing shall be carried out for various output voltage settings and load varying from zero to maximum. The verification of operation of the control functions, measurement of output voltage, current, input AC voltage, current, power factor, ripple in the output, evaluation of output voltage regulation and efficiency of the unit shall be carried out during the testing.

b. Constant current operation

During the test, voltage limit shall be set to rated output voltage. Performance testing shall be carried out for various output current limit settings and load resistance varied to achieve output voltage from minimum to maximum. The verification of operation of the control functions, measurement of output voltage, current, input AC voltage, current, power factor, ripple in the output, evaluation of output current regulation of the unit shall be carried out during the testing.

7.2.4.2 Auto PSP mode operation



Suitable set up shall be arranged for output loading and reference cell feedback. The closed loop performance and regulation shall be checked with the PSP set voltage varied from 0.85V to 1.2V.

Disconnecting the reference cell feedback connection in the above set up shall simulate the reference cell failed condition. The output voltage/current of the unit shall go to the value set on the potentiometer V_{as}/I_{as} provided inside the CPTR UNIT. The settings on V_{as}/I_{as} shall be varied and the output voltage/current shall be observed.

7.2.4.3 Operation of sensors for pipeline over protection, under protection, reference cell failure and reference cell selection logic in auto PSP mode shall be verified by connecting variable external voltage sources to reference cell inputs of the CPTR unit. The number of external voltage sources shall be same as number of reference cell inputs specified for the CPTR unit.

7.2.4.4 The unit shall be checked for operation of the current limit by over loading the unit in both CVCC and auto PSP modes of operation. For Units where semiconductor fuses are not provided for protection of the thyristors/triacs, the protection of same shall be tested as below:

A switch rated for making and carrying CPTR unit output short circuit current shall be connected to the output terminals of the unit. The output voltage and the output current limit settings of the unit shall be set to the maximum rated values. The switch connected in the output shall be shorted quickly.

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The unit shall go to current limit mode and shall not damage any active component of the unit.

7.2.4.5 The current interrupter shall be tested for time interval settings and specified operation.

8.0 PACKING AND DESPATCH



The equipment shall be properly packed for selected mode of transportation i.e. by ship/rail or trailer. The panels shall be wrapped in polythene sheets before being placed in crates to prevent damage to finish. Crates shall have skid bottom for handling. Special notations such as 'Fragile', 'This side up', 'Center of gravity', 'Weight' etc., shall be clearly marked on the package together with Tag nos., P.O. Nos. etc.

The equipment may be stored outdoors for long periods before erection. The packing shall be completely suitable for outdoor storage in areas with heavy rains/high ambient temperature.

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TECHNICAL SPECIFICATION

FIRE DETECTION AND ALARM SYSTEM

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Abbreviations:

BIS	Bureau of Indian Standards
BASEEFA	British Approvals Service for Electrical Equipment in Flammable Atmosphere
CCE	Chief Controller of Explosives
CFAP	Central Fire Alarm Panel
CMRI	Central Mining Research Institute
CPU	Central Processing Unit
DGFAP	Data Gathering cum Fire Alarm Panel
ERTL	Electronic Regional Test Laboratory
FAT	Factory Acceptance Tests
FDD	Floppy Disk Drive
FM	Factory Mutual
FRP	Fibre Reinforced Plastic
FO	Fibre Optic
GUI	Graphic User Interface
HAB	Hooter acknowledgement box (to mute hooters)
HDD	Hard Disk Drive
ISDN	Integrated Service Digital Network
ITU-T	International Telecommunication Union- (Telecom)
LED	Light Emitting Diode
LPC	Loss Prevention Council
LIFO	Last In First Out
MCP	Manual call point (break glass unit; BGU)
MMI	Man Machine Interface
MR	Material Requisition
Ni-Cd	Nickel Cadmium (battery)
PO	Purchase Order
RF	Radio Frequency
SAT	Site Acceptance Tests
SOE	Sequence Of Event
TAC	Tariff Advisory Committee
UWL	Under Writers Laboratory
UPS	Uninterrupted Power Supply
VRLA	Valve Regulated Lead Acid (battery)
WP	Weather Proof
ZFAP	Zonal Fire Alarm Panel

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1.0 SCOPE

The intent of this specification is to define the functional and design requirements for an Integrated Fire Alarm System for industrial plants and buildings. This specification covers the requirements for selection, design, and engineering, manufacture, testing at vendor's works, supply, installation, testing at site and commissioning of the system.

The Integrated Fire Alarm System shall be microprocessor based analog addressable system comprising of MCP, detectors, microprocessor based Fire Alarm panels, panels, hooters, exit signs, Loop / network / power cables, earthing, Junction box & associated equipments detailed hereunder and as per codes standards mentioned below and in Project data sheets / drawings.

2.0 CODES AND STANDARDS

The system and equipment shall comply with relevant BIS (Bureau of Indian Standards) and other Indian/International standards, as applicable. In case Indian standards are not available for any equipment, standards issued by IEC / BS / VDE / IEEE / NEMA / NFPA or equivalent agency shall be applicable. In case of imported equipment, the standards of the country of origin shall be applicable if these standards are equivalent or more stringent than the applicable Indian standards.

The equipment shall also conform to the special requirement/provisions of applicable statutory regulations currently in force in the country.

In case of any contradiction between various referred standards/specifications and statutory regulations, the following order of decreasing priority shall govern:



Statutory regulations

This specification

Codes and standards

The fire alarm system and the components used shall conform to the latest edition of the following and also the other Indian and International Standards as applicable.

IS-5	Colours for ready Mixed Paint & Enamels.
IS - 513	Specification for cold rolled low carbon steel sheets and strips
IS/IEC: 60079	Flameproof enclosures for electrical apparatus
IS - 1646	Code of practice for fire safety of buildings (general): Electrical Installations
IS - 2175	Specification for heat sensitive fire detectors for use in automatic fire alarm system
IS - 2189	Code of practice for selection; installation and maintenance of automatic fire detection and alarm system.
IS - 3034	Code of practice for fire safety of Industrial buildings: Electrical generating and distributing stations

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IS - 3700	Essential ratings and characteristics of semi conducting devices (Applicable parts)
IS - 3826	Connectors for frequencies below 3 kHz General requirements Part-I and tests
IS/IEC: 60079	Code of practice for the use of semi-conductor junction devices (Applicable parts)
IS - 5780	Specification for Intrinsically safe electrical apparatus and circuits
IS - 11360	Specification for smoke detectors for use in automatic electrical fire alarm system.
IS - 12459	Code of practice for fire safety in cable runs
IS - 13346	General requirements for electrical apparatus for explosive gas atmosphere
IS-14154 Part 2	Electrical apparatus with protection of enclosure for use in the presence of combustible dust
NFPA 72 Vol 4	National Fire Alarm code
LPC	Loss prevention council recommendations.
BS - 5839	Specifications for manual call points.
BS-EN 50081-1	EMC (Electromagnetic compatibility test)
BS-EN 50082-1	EMC (Electromagnetic compatibility test)

3.0 GENERAL REQUIREMENTS

The offered equipment shall be brand new with state of the art technology and a proven field track record. No prototype equipment shall be offered.

Bidder shall consider adequate nos. of Fire Alarm panels which shall be located at plant and control room of building/substation.



Bidder shall also consider repeater panels which shall be installed in fire station/control room. All the fire alarm and repeater panels shall be connected in ring network.

Repeater panel shall be replica of main fire alarm panel.

New Fire Alarm System shall be hooked up with the existing Fire Alarm System.

In case of a Fire alarm initiation by alarm initiating device, the audio-visual fire alarm shall be generated at Fire Alarm Control Panels (FACP) located at each substation & building and repeater panels for each Fire Alarm panel at Fire safety station as well as in CCR which also initiate signal to operate hooters/siren located in various locations in building and plant area.

The Fire Alarm System envisaged for Building shall be “2-Wire Analog Addressable” type.

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The communication between detectors and the FACP is by means of digital communication over 2-wire, which further provides power to the detectors, devices & Sounders. There shall be A/D and D/A conversion happening inside the detectors and FACP.

All the detectors shall be incorporated with microprocessors and shall be provided with Analog to Digital Converter (ADC), which enables the detector to provide linear output corresponding to the quantity of smoke or fire, the detector encounter.

All types of detectors offered will be of restorable type i.e. suitable for operating a fresh after each actuation on alarm without replace mentor adjustment.

Detector shall be provided with in-built isolator.

Redundancy shall be provided at input power supply, processor / controller etc. Loop card shall be hot swappable type.

The sensitivity of each sensor shall be individually adjusted from the FACP to suit the conditions of each location. Each detector shall have self-test facility, which is monitored in the FACP. Each detector shall have drift compensation.

The response sensitivity shall also be field adjustable and not only from fire panel over a wide range to suit site shall conditions. It shall be possible to test the sensitivity of a detector in the field. The sensitivity / threshold value of detectors which are cross zoned must be compatible.

The FACP shall also check each sensor for contamination of dust/dirt and give signal for "Service" in case of accumulation of dust / dirt reaches a preset limit.

The fire alarm system shall work without any problem both in networked mode and in standalone mode.

The electronic circuit shall be of solid state and of failsafe design and virtually hermetically sealed to have resistance to humidity and corrosion and to prevent its operation from being impaired by dust and dirt.

The circuit shall be protected against usual electrical transients, electromagnetic and electrostatic interference (EMI & RFI) present in the Building.

Reverse polarity or fault in the field wiring shall not damage the detector.

No moving parts subject to wear & tear shall be provided.



The system shall have following self diagnostic features:

Detector cabling shall be completely supervised for open circuit and short circuit and exact location of fault shall be displayed in the panel under Trouble / Faults.

Un-authorized removal of a detector head from its base shall be supervised to give an alarm on the connected control panel.

Annunciation shall be provided for DC fuse blown and loss of main AC supply etc.

Alarm verification features.

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If the Equipments to be located in hazardous areas, then same shall have test certificates issued by recognized independent test house such as CIMFR, ERTL, BASEEFA, VDS. All indigenous equipment shall conform to Indian standards and shall be certified by Indian testing agencies. All equipment (indigenous & imported) shall also have valid statutory approvals e.g. PESO, DGMS as applicable for the specified location. All indigenous flameproof equipment shall have valid BIS license and marking as required by statutory authority.

Fire alarm system shall be interfaced with the owner's system.

Siren/s shall be actuated manually and automatically as selected by operator from Fire Alarm panel located at fire station / other buildings.

Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment for at least 15 years from the date of supply. The spares shall be available ex-stock with the vendor.

Vendor shall give a notice of at least one year to the end user of equipment and PMC before phasing out the product / spares to enable the end user to place order for spares and services.

The vendor shall be responsible for design, engineering and manufacturing of the complete system and equipment to fully meet the intent and requirements of this specification.

All equipment and accessories required for completeness of the system, whether specifically mentioned or not but considered essential for satisfactory performance, shall be included as a part of the offered system.

The system integrator shall coordinate with the manufacturers of various bought-out items associated with the system, as required, and shall freely and readily supply all technical information as and when called for.

4.0 DEFINITIONS

Hazardous Area

An area in which an explosive gas/ dust atmosphere is present or likely to be present in quantities such as to require special protection for the construction, installation and use of electrical apparatus.



5.0 SYSTEM AND SITE CONDITIONS

All equipment shall be designed to operate with power supply and site conditions as specified below:

Input Power Supply

Power supply for fire alarm panels shall have battery backup as per IS-2189. Battery AH rating shall be determined on the basis of maintaining the system in normal operation for a period of not less than 48 hours (quiescent condition) and successive full load alarm condition of period not less than 30 min after the failure of normal mains supply.

The switch over from mains to back up, in the event of mains failure, shall be automatic.

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Batteries shall be Ni-Cd type. Suitable and adequately rated battery charger shall be supplied as a part of back up battery system.

The secondary power supply capacity required shall include all power supply loads that are not automatically disconnected upon the transfer to secondary power supply.

Battery sizing shall consider the maximum quantity of detector/equipment that can be connected in the loops, as well as 5 hooters and 5 exit signs per loop in Fire Alarm panels. Battery sizing calculations shall be reviewed during detailed engineering and there shall be no cost/time implication for providing adequately sized batteries and chargers of approved rating during the order execution. Separate battery charger shall be provided in case battery charger part of the Fire Alarm panel cannot cater to the boost charging requirement of battery.

An overall ageing factor of 0.8 and a temperature correction factor corresponding to minimum temperature of 5°C shall be considered for battery sizing. The battery calculations shall include a 10 percent safety margin to the calculated amp-hour rating.

Operation on secondary power shall not affect the required performance of a fire alarm system or supervising station facility. The system shall produce the same alarm, supervisory and trouble signals and indications.

Operation on secondary power shall not affect the required performance of a fire alarm system or supervising station facility. The system shall produce the same alarm, supervisory and trouble signals and indications.

The switch-over from primary source to secondary source, in the event of mains failure, shall be automatic. Battery shall be Ni-Cd type.

Site Conditions

The offered equipment shall be capable of operating continuously and maintaining its guaranteed performance at the site ambient conditions indicated in data sheet.

Unless specified otherwise, fire alarm panels along with associated hardware shall be suitable for installation and operation in a closed building / room with restricted ventilation. Any specific requirements for air conditioned / dust free environment, etc. for the panels, if absolutely necessary, shall be clearly highlighted by the vendor in the offer.



6.0 FIRE ALARM SYSTEM DESCRIPTION

General

Fire alarm system under this specification is envisaged to provide fire monitoring in industrial plants/ chemical plants / plant and non- plant buildings. The system shall be designed to detect incipient fires and generate audio/ visual alarm in case of fire.

The system shall consist of automatic fire detectors and manual call point or break glass unit. Automatic fire detectors shall work on the principle of sensing of smoke, heat or infrared rays. Depending on type of smoke, optical or ionization type detectors shall be used. Detectors shall generally be provided in plant / non-plant buildings. Manual Call Point shall be provided at exit doors of the buildings and at exit route of industrial plants. Number of detectors and break glass unit shall be decided as per guidelines given in applicable codes and standards.

Alarms, if specified, shall be relayed to repeater panel provided in buildings like control rooms / administrative buildings to provide zone wise annunciation. In addition facility shall be provided to actuate siren / hooter.

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For integrated fire alarm system where plant-wide large numbers of fire alarm panels are envisaged, these panels shall be integrated to CFAP, which shall be located in fire station or in administrative control room of the building as per the job requirements. The connectivity shall be achieved using data high way or dedicated cable connection from each fire alarm panel to CFAP. Mimic at CFAP shall be provided for fire / fault annunciation on geographical location in addition to the text / LED. If defined, CFAP shall have provision for automatic and manual actuation of plant-wide siren as per operator's choice. Interface with other systems such as telephone exchange / plant's public address system / Pager system shall be provided for communication required for disaster management.

Siren/s shall be actuated manually and automatically.

7.0 ENGINEERING REQUIREMENTS

Vendor shall design entire fire alarm system including design of system architecture with details of integration, cabling requirement and protocol selection etc. Vendor's scope shall also include basic design and preparation of layouts for fire alarm system for plant/ buildings as specified in the data sheet/ purchase documents.

8.0 ADDRESSABLE FIRE ALARM SYSTEM

ANALOGUE ADDRESSABLE FIRE ALARM CONTROL PANEL (FACP)

The FACP used in the Building shall confine to the EN54 standards having the following features.

FACP provided shall have the capacity to expand from at least loop for Future expansion.

Each loop shall accommodate maximum 250 detectors and devices in any combination with a loop length capable up to 2kms with 2Cx1.5 sq. mm cable. However bidder shall consider maximum number of detectors / MCP / addressable devices in a signal loop shall be 60.

It shall have facility to discriminate between a real fire alarm and false alarms.

FACP will function as fully stand-alone panel& also networked to other FACPs & repeater with peer to peer communication.



Each FACP shall have redundant controller to takeover in case of a Failure in the Primary Controller and also redundant loop card for each loop to takeover in case of a Failure in the Primary Loop Card.

Each FACP shall have inbuilt LCD colour touch screen (320*240 pixels) to clearly indicate the location of fire, type of device activated other indications like service requirement of a component etc.

In case of a Loop Card Failure, the FACP shall allow to replace the Loop card without switching off the panel and reprogramming.

The FACP shall be capable of Public Address system integration with the use of RS485 module or with the use of relays.

FACPs shall have inbuilt buzzer to alert the personnel in case of maintenance requirement.

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FACP shall have facilities for sequence of events to happen in case of fire like closing of fire dampers, shutting down supply fans for HVAC, Deactivating the access control system and activating the hooters with the help of a control relay module provided near the system to be activated.

The fire alarm control panel shall be suitable for Class-A type of wiring as per NFPA-72.

The fire alarm control panel shall work on positive sequence as per NFPA-72.

The fire alarm control panel shall be capable of disabling an individual detector, a group and or zone off or building maintenance purposes. Facility shall be provided on the FACP for simulating the fire condition to enable testing of the various alarm circuits.

All the fire alarm modules (loop cards, networking cards, and communication card etc.) should be hot pluggable and hot swappable to facilitate easy replacement of faulty modules. All the electronic components shall be compatible to non-air-conditioned environment for working satisfactorily.

The fire alarm control panel normal power supply failure shall be annunciated audio-visually.

In case of multiple alarms the multiple alarm indication shall be ON. The multiple alarm indication shall be displayed in chronological order.

FACP shall have the facility such that each detector can be identified as a separate zone.

The FACP shall be reset only by authorized users after the clearance of a fault.

Whenever there is a third party actuation to happen, like closing of fire dampers, switching off supply / exhaust units etc, the actuation shall happen only when the fire signal is received from two different initiating devices located in a zone connected to different fire alarm panels. The communication between the FACPs shall happen with two pair cables and the fire alarm status of one panel shall be communicated to the second panel in which the control relay module of the third party device is connected to. Inter panel communication is a must and needs to be provided for controlled actuations. All the necessary systems to ensure reliable communications between panels are to be built into the FACPs.

FACP shall have the facility to silence / acknowledge / reset the alarm. Apart from the FACP.

The FACP shall have FALSE ALARM REDUCTION algorithms like.

Alarm Verification, Dual Detector / Group Dependency, and Intermediate Alarm Storage to eliminate False alarms due to Dirt / Dust / Disturbance values.

EMC/EMI Monitoring - Signal-to noise ratio shall be high. To inform the possibility of a false alarm caused due to interferences from sources such as Motors, power cables, Wi-Fi routers, fluorescent lamps, network switches, mobile signals etc. The panel shall display the EMI / EMC Current and Average Values reported by the detector. The User / Installer shall have access to this reading during Maintenance (with password protection).

When fire condition is confirmed, the following sequence of annunciation will take place on the FACP:

Alarm Condition	Audible Alarm	Visual Alarm
First Fire Condition	ON	ON FLASHING / Description of area of fire origin with detector type
Acknowledge (first Alarm)	OFF	ON STEADY
New Fire Alarm Condition (after acknowledge of First alarm)	ON	ON FLASHING
Acknowledge (New fire alarm)	OFF	ON STEADY
Back to normal	OFF	ON STEADY
Reset	OFF	OFF
Reset Before Normal	OFF	ON STEADY

System shall provide adequate EEPROM size to store minimum of 200 events fire / fault. The event shall be stored in LIFO structure. All events shall be time stamped. FACP shall have real time clock for event time stamping.

Software access for either Zone programming or access to plant / building graphic on monitor shall be password protected. For viewing status of various field devices e.g. fire and fault status password protection shall not be given.

Fire Alarm & repeater panels shall be certified/ approved by an international approving agency / approving agency of country of origin as applicable.

The FACP shall have a process or which shall be of at-least 32 bit, which shall be designed to accept all the input and process the outputs within the time stipulated by the standards.

The CPU shall have the facility to communicate with other FACPs and process the fire signals received from other FACPs to actuate a third party device.

The processor shall be designed in such a way that the parameters in the repeater panel shall be refreshed in 1sec.

The capacity of the processor shall be adequately designed include all input / output signals and various functional requirements.



It shall have its own, built in advanced microprocessor, sophisticated software and extensive memory for storing the logs of alarms, times and action taken report.

Loop module shall have a line length up to 1600m or 3000m depending upon the configuration & cable type. It shall have an LED test button.

The loop module shall be encapsulated & shall be hot pluggable.

The front fascia of the loop cards shall be visible for easy identification of faults.

In case of the failure of loop card, it should be replaced without the need of any additional programming.

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Repeater Panels

These panels shall be required for repeat of alarm in buildings / plant control rooms / Fire station.

It shall be a LCD touch screen same as main panel. The MMI shall be the same as the main Controller.

Repeater panels shall be suitable for Wall mounting which will be displayed from all the major entrances and staircases which will enable the staff and fire fighting personnel to exactly locate the fire.

It shall be compatible to received at a FACPs.

Audio visual Alarms during fire shall be generated in case of fire.

All fire alarm panels including repeater panel shall be networked through copper / FO communication cable.

The Power supply to the Repeater Panel shall be drawn from the Fire Panel

The Repeater Panel shall display Messages like Alarm & Fault similar to the Main Panel and shall be accessed only by Authorized Users through a passcode.

The Repeater Panel shall be connected to the Main Panel and other repeater panels in such a way-1 pt Failure in the cable shall not affect the performance and shall intimate the exact location of failure in all Panels.

The Repeater Panel shall be equipped with a Key switch that allows Authorized users to Acknowledge / Reset Alarms.

The Repeater Panel shall be equipped with 2 different power inputs. On failure of primary power, the secondary shall take over.

The Repeater panel shall allow the users to login locally or login to the remote FACP.

The repeater panels shall integrate with the main panels without any additional interface or the bidder shall consider necessary accessories required to complete the system and quote as part of this model.

9.0 INTEGRATION WITH VARIOUS PLANT SYSTEMS

Fire Alarm System shall have required hardware to have interface with following plant systems as specified in data sheet.

Public Alarm Announcement system



Paging and plant intercom systems.

Plant data network

ISDN telephone exchange and pager system

Fire suppression system

PLC Data Communication through serial common modbus

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Shutdown signals to various air-handling units relative to the zone of fire.

Siren

10.0 PANEL CONSTRUCTION

Equipment Mounting

All apparatus, display screen, instruments and indicating lamps mounted on the panel front shall be flush mounting type. The external cabling shall not be terminated directly on the base connector of PCBs but shall be terminated on separate terminal block. Further connection to PCBs shall be as per manufacturer's standard. Routine calibration, adjustments, programming and operation shall be accessible from the front of the panel without opening the door. External cabling shall preferably be done from the rear.

Power supply system including battery bank shall be mounted inside the panel.

Doors shall be provided with pistol grip handle with lock. Lamps shall be provided inside the panel to provide adequate light for maintenance of equipments.

Cable entry shall be from bottom unless otherwise specified in the data sheet. Terminal strip shall be provided for incoming / outgoing cables.

Wiring and Terminals

Wiring within the panel shall be laid in slotted plastic raceways enclosed with cover. Control connections shall be done with 660V grade XLPE insulated wires having stranded copper conductors. 1.5mm² size of wire shall normally be used for circuits with control fuse rating of IOA or less. Control wiring for electronic circuits shall be through ribbon cable or through copper wire minimum of 0.5mm dia. Panels shall be supplied completely pre-wired, such that only field termination shall be required at site before it is energized.



PCBs for identical functions shall be interchangeable. PCBs shall be plug in type having pin/edge connectors. PCBs shall be suitable for use in tropical, humid and dusty environment. These shall be protected with anti fungus treatment.

Cables shall be terminated on terminal blocks. Clamp type terminals shall be of spring-loaded, stacking type, mounted on rails. Terminals shall be sized to accept, as a minimum 2.5mm² cross section conductors. Not more than one conductor shall be terminated on the outgoing side of each terminal. At least 20 % spare terminals shall be provided in each panel for termination of spare cores of cables.

Earthing

A common earth bar of minimum 25 x 3 mm. copper or equivalent aluminium shall be provided throughout the length of the panel. All non-current carrying metallic parts of the panel mounted equipment shall be earthed. Flexible jumpers shall connect all doors and movable parts to the earth bus. Two numbers earth lugs shall be provided outside the panel.

The FACP's shall be provided with triplicated earthing terminals on the either side. The grounding terminal G1 shall be for safety grounding, G2 shall be for shield grounding and G3 shall be for signal grounding.

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Name Plates / Warning plates

All nameplates for panel shall be engraved out of 3 ply (black-white- black) lamicoïd sheets or anodized aluminium. Back-engraved Perspex sheet nameplates will also be acceptable. Engraving shall be done with square groove cutters. Hard paper or self-adhesive plastic tape nameplates shall not be acceptable.

Labels shall be provided for every component on the cards, connecting wires as well as for the terminals in the terminal strip inside the panel. Wiring diagram shall be pasted inside the panel door as required for termination and maintenance.

Special warning plates shall be provided on all removable covers or doors giving access to energized metallic parts above 24 volts.

Painting

All metal surfaces shall be thoroughly cleaned and degreased to remove mill scale, rust, grease and dirt. Fabricated structures shall be pickled and then rinsed to remove any trace of acid. The under surface shall be made free from all imperfections before undertaking the finishing coat.

After preparation of the under surface, the panel shall be powder coated. The colour shade of final paint shall be as approved by the purchaser. The finished panels shall be dried in dust free atmosphere. Panel finish shall be free from imperfections like pinholes, orange peels, fun-off paint etc.

All unpainted steel parts shall be cadmium plated or suitably treated to prevent rust-corrosion. Moving elements shall be greased.

11.0 AUTOMATIC FIRE DETECTORS AND ACCESSORIES

Detectors for microprocessor shall be addressable type. Detectors shall be plug-in type and shall have twist lock action fitting. Multicolour LEDs provided on the detectors shall indicate Normal and Alarm state. Essential features of detectors are indicated as below.



Detectors shall be supplied with mounting bases. Mounting base shall be identical for all type of detectors. Detector housing (body and cover) shall be made up of damage resistant, fire resistant polycarbonate and shall be suitable for either surface or recess mounting. Detector base shall be mounted on Junction boxes having terminals for cable termination. Installation equipment such as GI conduits, GI junction box / conduit box etc. shall also be included in vendor's scope.

Detectors shall be suitable for storage at ambient condition specified in data sheet.

All detectors shall be on the approved list of LPC, VDS approving agency as applicable.

Intelligent Addressable Dual Optical Smoke / Heat (Multi-sensor) Detector



- i) The Intelligent Addressable Multi sensor Detector with 2 LED's-Infrared & Blue used and shall confine to the relevant standard shaving the following features.
- ii) It shall be combination of Smoke detection and heat detection. The smoke detection system shall work on Light scattering type principle using Infrared & Blue LED's, and the Heat detection system shall be of Rate of rise of temperature and Fixed Temperature.
- iii) The Intelligent Addressable Multi sensor Detector shall be of Spot type and Addressable type.

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- iv) The Intelligent Addressable Multi-sensor Detector shall be addressed either by DIP switches or through Programming from the Panel.
- v) The Detector shall monitor EMC / EMI values in the surroundings on a continuous basis and report the current & average values to the panel. The detector and the panel shall together avoid the possibility of false alarm caused due to interferences from sources such as Motors, power cables, Wi-Fi routers, fluorescent lamps, network switches, mobile signals etc.
- vi) All the detectors shall have a visible multi-color LED to indicate the healthiness / trouble / alarm condition of the detector. The LED shall be located in such a way that it shall be visible from all the 360 degree from below. In some cases where the visibility of the detector is obstructed by cable trays, false ceiling etc. Facility for connecting the detector to a response indicator has to be present. The response indicator derives the power to glow from the loop.
- vii) It shall possess False alarm immunity and a superior signal to noise ratio.
- viii) It shall have drift compensation facility built-in.
- ix) The detectors shall communicate the ambient reading to the FACP on time to time basis, and the FACP shall make the decision about the current status of the detector, whether it is in fire / pre-alarm / maintenance requirement etc.
- x) The detector shall have different levels of sensitivity settings based on the application and room where it is installed.
- xi) The detector shall provide a chamber maid plug to blow out the dust / dirt using a blower.
- xii) In case of a failure, panel shall allow to replace the detector with the same type without the need of additional programming
- xiii) The detector shall be programmed to work as Optical only or Thermal only detectors. It shall a provision to switch off any component (optical or thermal) of the detector.
- xiv) The detector shall work with 2 different sensitivity settings at any point of time and the User shall have access to choose the desired settings without programming or Laptop / PC for configuration.
- xv) The detector shall change sensitivity settings based on day / night mode or with schedules based on the programming.
- xvi) The detector shall have Intermediate Alarm Storage, Dual Detector Dependency, Dual group Dependency features that shall be programmed based on site application.
- xvii) The detector shall be capable of detecting both smoldering fires and open fires and shall be EN54 / VdS approved

Heat Sensing Cables

Heat sensing cable shall be analogue type. It shall consist of four copper conductors each covered with a colour coded, negative temperature co-efficient material. The cores shall be twisted together and protected by an outer sheath of high temperature, flame retardant XLPE insulation. External mechanical protection shall be provided over the

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sensor cables. Vendor shall provide control unit for each 100 m length of the sensor cable.

Manual Call Point (MCP) / Break Glass Unit (BGU)

Manual break glass unit shall be fabricated out of 14-gauge cold rolled sheet steel. Alternately the break glass unit may be made of die cast aluminium alloy such as LM6.

It shall have IP-65 enclosure and weatherproof construction suitable for outdoor installation. The break glass unit shall have a minimum dimension of 100x100x80mm.

The box shall be fabricated in such a way it can be mounted flush to the wall or on the surface without any modification. Two nos. 19 mm knockouts shall be provided at the bottom of the box to facilitate cable / conduit entry. The glass shall cover at least 30cm² area and shall have a thickness not exceeding 2mm.

The box shall have a push button element kept in pressed condition by a glass sheet fitted in the front of the box.

The enclosure shall be painted with fire red colour (shade 536 of IS-5) epoxy painting and an inscription "Break Glass in case of Fire", shall be painted in white letters or riveted on the enclosure by a steel nameplate. A suitable nickel-plated brass hammer, duly chained to the box with stainless steel chain shall be provided with each box for breaking the glass. Each box shall have a distinct identification number boldly painted on it.

One no. blanking plug shall be provided for 5% of the total quantity of MCPs.

Hazardous area Break Glass Units shall meet the requirement of clause 13 of this specification.

Response Indicator



Response indicators shall be provided suitable for wall / ceiling mounting as required. Response indicator shall be provided where the detector is located either above false ceiling or below false floor or where detectors are not directly visible. The response indicators shall be connected to the detectors directly and shall be complete with terminal blocks suitable to accept cables with up to 1.5mm² copper conductor. In the normal state of detector, the LEO shall flicker, but in the event the detector goes into alarm condition, the LEO shall glow steadily. LEOs shall be red in colour with 5mm dia. as a minimum.

Exit signs

Exit signs shall be fabricated out of 1.6mm thick cold rolled sheet steel. This shall be suitable for wall mounting or suspension from ceiling. Exit signs suspended from the ceiling shall have text / direction printed on both the side of exit sign.

Fire exit shall be displayed by means of 5mm dia. LEDs or backlit text. It shall be powered from the fire alarm panel. Exit sign shall operate on DC power supply.

The exit sign shall be either in red letter on white background or white letter on green background.

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Where specified in data sheet, self-luminous exit sign shall be provided.

Hooters

The unit shall consist of solid-state circuitry on a printed circuit board, a loudspeaker and a flashing lamp housed in a weatherproof dust tight, wall mounting type enclosure. The hooter shall, at least, have 102 db (A) output measured at 1-meter distance. The unit shall be powered from the fire alarm panel and operate on DC power. In the event of fire, the hooter shall raise pulsating audio alarm and the lamp shall start flashing.

HAB shall be provided at exit doors of buildings to mute the hooters after evacuation.

Flashing Lights (Beacon)

The unit shall consist of solid-state circuitry on a printed circuit board and a red-capped incandescent lamp and audio unit housed in a dust tight, wall / ceiling mounting type enclosure. It shall derive power from the Fire Alarm Panel and shall operate on DC supply.

Flashing lights shall be installed in the enclosed areas where clean agent / CO₂ to be released. In the event a signal for clean agent / CO₂, release is given, the lamp shall start blinking with a warning sound enabling operating personnel to evacuate the area. The audio unit (hooter) shall have 102 db (A) output measured at 1-meter distance.

Fault Isolator

Fault isolator shall be designed to provide short circuit protection to an addressable detector loop. It shall be possible to wire the fault isolator at any point in the detector loop.

On occurrence of a fault (short circuit), the isolator shall cut power to all devices installed between the two isolators minimizing the outage of all the detectors in a loop.

The fault isolator shall have the capability to continuously check the faulted side of the loop to determine if the fault still exists. On rectification of the fault, the isolator shall automatically reset itself.

Fault isolator modules shall be housed in an enclosure having IP-65 degree of protection as a minimum. If located in hazardous area, it shall also be tested and approved for use in area classification defined in the data sheet.



Clean Agent / CO₂ Release and Inhibit Switches

This unit is required to be provided at the exit of the protected buildings / rooms. If specified, this unit is integrated with DGFAP / ZFAP. This shall consist of pull type release and inhibit switches clean agent / CO₂. The unit shall be fabricated out of 2mm thick cold rolled sheet steel suitable for wall mounting. Switches shall be pulled to release or inhibit clean agent / CO₂. Release switches shall have inscription:

"PULL TO RELEASE CLEAN AGENT / CO₂"

And inhibit switches shall have inscription:

"PULL TO INHIBIT CLEAN AGENT / CO₂"

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Zener Barrier

Preferably flameproof (Ex'd') equipment that does not require the use of Zener barrier shall be used. When necessary, intrinsically safe (Ex 'i') detectors and MCPs, Zener barriers shall be provided. These shall be located in unclassified / non-hazardous areas.

Normally not more than 10 detectors shall be connected to one zener barrier. However vendor shall indicate maximum number of detectors MCPs that can be connected to one Zener barrier without compromising on working of loop zone. Vendor shall also indicate the maximum loop length from zener barrier considering 1.5 mm² copper conductor, screened cable.

In case loop length permits, zener barrier shall be located at DGFAP itself else it shall be located in safe area nearest to the *detector* / MCP.

Wherever zener barriers are provided in safe area outside the Zonal panel or DGFAP, these shall be housed in their own enclosure with IP-65 degree of protection as a minimum.

Fault Isolator

Fault isolator shall be installed, if specified in the data sheet.

Fault isolator shall be designed to provide short circuit protection to an addressable detector loop. It shall be possible to wire the fault isolator at any point in the detector loop.

On occurrence of a fault (short circuit), the isolator shall cut power to all devices installed between the two isolators minimizing the outage of all the detectors in a loop.

The fault isolator shall have the capability to continuously check the faulted side of the loop to determine if the fault still exists. On rectification of the fault, the isolator shall automatically reset itself.

Fault isolator modules shall be housed in an enclosure having IP-65 degree of protection as a minimum. If located in hazardous area, it shall also be tested and approved for use in area classification defined in the data sheet.



12.0 FIELD DEVICES FOR HAZARDOUS AREA

Hazardous area is classified as Zone 1 / Zone 2, gas group IIA / IIB or IIC, temperature class T3 (200 DC) as specified in data sheet. The field devices shall be suitable for installation in hazardous area as per specified area classification.

Field devices such as detectors, MCPs, fault isolators, Beacons, hooters etc for use in hazardous area, if specified in the data sheet shall have flame proof enclosure conforming to IS 2148. All equipment for hazardous area installation shall be complete with flame proof, weather proof cable glands as specified in clause 11.5.

Equipment, which cannot have flameproof construction, shall be intrinsically safe in design and shall be used with Zener barriers located in safe area.

Equipment that are tested / certified by a recognized test laboratory of country of origin shall only be offered. The vendor shall possess valid test certificate issued by a recognized independent test house such as CMRI / BASEEFA/ VDS for the offered equipment.

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All equipment (indigenous or imported) shall have valid statutory approval as applicable for the specified hazardous location from CCE or any other applicable statutory authority. All indigenous flameproof equipment shall also have valid BIS license and corresponding marking as required by statutory authority.

A separate name plate shall also be provided on each equipment to indicate details of testing agency, test certificate number with date, statutory approval number with date, approval agency, BIS license number with date, applicable gas group, temperature class etc. The nameplate shall be riveted / fixed with screws and not pasted. In case above information are embossed on the enclosure, the same need not be repeated.

13.0 CABLE AND CABLE ACCESSORIES

Supply and laying of FA cables shall be as per the requirement. Vendor shall provide JBs for detectors, BGUs, exit signs, hooters etc. as required.

Supply and installation and terminations of all cables at both ends shall be in bidder's scope.

Bidder, as a part of integration and selection of fire alarm equipment, shall furnish detailed specifications for loop / zone cables, data highway cables, cables for hooter / exit signs etc giving details such as type of cables, number of pairs, size of cable, inductance and capacitance data, number of fibres / connectors etc.

Data Cables

Unless specified otherwise, vendor shall supply Copper cable / FO type data communication cable to suit system design and equipment specification. Copper cables, if supplied, shall be of adequate size, twisted pair, XLPE insulated, overall screened, PVC inner sheathed, armoured, FRLS type PVC outer sheathed as the minimum requirement. Fibre Optic cables, if supplied, shall be armoured, overall FRLS PVC outer sheathed and shall be as per ITU-T recommendation as a minimum.

Vendor shall supply and install all hardware and cabling accessories as per data high way design including modems, repeaters etc as part of the FA system. Modems / repeaters shall be powered by the supply provided for Fire Alarm panel.

Cable Glands / Accessories



All cable glands / lugs / connectors as required for the equipment shall be included in bidder's scope and shall be supplied along with the system.

All the cable glands for outdoor application shall be weatherproof, nickel-plated brass and double compression type, whereas those for indoor application shall be single compression type.

Cable glands for hazardous area equipments shall be flameproof, weatherproof and nickel plated brass double compression type.

14.0 INSPECTION, TESTING AND ACCEPTANCE

All the equipment shall be tested to the defined specifications as per mutually agreed test plan / FAT procedure, which shall be submitted and got approved from Purchaser at least one month before inspection. PMC / Purchaser's inspectors shall witness all the tests.

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During manufacture, the equipment shall be subject to inspection as per attached inspection plan to assess the progress of work and to ascertain that the quality controls are being maintained. Vendor shall provide all necessary assistance and information concerning the supply to PDIL / Purchaser's inspectors.

Tests shall be carried out at the vendor's works under his care and expense and Purchaser shall be informed at least 4 weeks in advance regarding this.

FAT shall include simulation of operational field conditions and test for functional adequacy. Besides all routine, and acceptance tests specified by applicable codes and standards, shall be performed on the complete system.

For bought out items, the routine and acceptance tests shall be conducted at the respective equipment manufacturer's works.

At the time of inspection, vendor shall produce original of all the type test certificates, test and approval certificates for hazardous area equipment from testing and approving authority and any other certificates as required from statutory authority for the review of inspectors.

Vendor shall submit a SAT procedure for PMC / Purchaser's approval. All equipment and systems shall be tested at site as per the approved SAT procedure.



SAT shall be conducted by vendor after the entire fire alarm system is installed and inter connected by cables. These tests shall establish the operational correctness of the system. Vendor shall rectify deficiencies noticed during SAT with no commercial implication to Purchaser including replacement of system components and supply of new component for making system successfully operational.

15.0 PACKING AND DESPATCH

All the equipment shall be divided into several sections for protection and ease of handling during transportation. The equipment shall be properly packed for selected mode of transportation i.e. by ship / rail or trailer. The panels shall be wrapped in polythene sheets before being placed in crates to prevent damage to finish. Crates shall have skid bottom for handling. Special notations such as 'Fragile', 'This side up', 'Center of gravity', 'Weight' etc., shall be clearly marked on the package together with Tag nos., Purchase order Nos. etc. The equipment may be stored outdoors for long periods before erection. The packing shall be completely suitable for outdoor storage in areas with heavy rains / high ambient temperature.



16.0 INSTALLATION AND COMMISSIONING

As installation of the system is included in the scope of the vendor, vendor shall arrange all necessary manpower and equipment required for the same. Commissioning of the complete system is to be carried out by vendor in all cases irrespective of whether the installation was performed by vendor or not. All tools, test equipment etc. for the successful commissioning of the system shall be arranged by the vendor. Only the cabling specifically excluded from vendor's scope shall be installed by others. However, termination at panels for purchaser's cables shall be done by the vendor.



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17.0 TRAINING

The vendor shall provide, free of cost, comprehensive training to Purchaser's personnel on various operation and maintenance aspects of the Fire Alarm system as agreed during ordering.



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TECHNICAL SPECIFICATION COMMUNICATION AND FIRE ALARM CABLES

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1.0 SCOPE

The intent of this specification is to define the requirements for design, manufacture and supply of Flame Retardant type PVC sheathed cables for use in plant communication and fire alarm systems and Jelly filled telecommunication cables.

2.0 CODES AND STANDARDS

2.1 The equipment shall comply with the requirements of the latest revision of the following standards issued by BIS and DOT, unless otherwise specified:

2.1.1 BIS standards:

IS-7098 (Part-I)	XLPE insulated (heavy duty) electric cables-(Part-I for working voltages up to and including 1100V).
IS-8130	Conductors for insulated cables and flexible cords.
IS-10418	Drums for electric cables.
IS-10462 (Part-1)	Fictitious calculation method for determination of dimensions of protective coverings of cables:(Part-I Elastomeric and thermoplastic insulated cables).
IS-10810 (Part-58)	Methods of test for cables (Part 58. Oxygen Index test).
IS-10810 (Part- 61)	Methods of test for cables (Part 61. Flame retardant test)
IS-10810 (Part-62)	Methods of test for cables (Part 62. Fire resistance test for bunched cables).
IS-12444	Continuously cast and rolled electrolytic copper wire rods for electrical conductors.

2.2 DOT Standards:

GRJWIR-06/03	Specification for cable - switchboard (Screened and Unscreened) Generic Requirements.
G/CUG-O1/02	Specification for solid polythene insulated fully filled, Polythene sheathed underground telecom cables.



2.3 In case of imported cables, standards of the country of origin shall be applicable, if these standards are equivalent to or stringent than the applicable Indian standards.

2.4 The cables shall also conform to the provisions of the Indian Electricity rules and other statutory regulations currently in force in the country.

2.5 In case Indian standards are not available for any material, standards issued by IEC / BS / VDE / IEEE / NEMA or equivalent agency shall be applicable.

2.6 In case of any contradiction between various referred standards/ specifications/ datasheets and statutory regulations the following order of priority shall govern:

- Statutory regulations.
- This specification.

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- Codes and standards.

3.0 SITE CONDITIONS

Cables shall be suitable for installation in following conditions:

- i. Above ground in open-air locations (trays / ducts) in tropical, humid and corrosive atmosphere prevalent in refineries/petrochemical plants with severe weathering and exposure to solar radiation.
- ii. Directly buried in underground trenches, conduits with uncontrolled back-fill and possibility of flooding by water and chemicals.
- iii. Unless otherwise specified, the design ambient air temperature of 45° C / ground temperature of 30° C.
- iv. Cables shall be operating near electromagnetic radiations due to high voltage installation and other wireless equipments. Adequate screening shall be provided to make build the electromagnetic immunity.

4.0 TECHNICAL REQUIREMENTS -NON JELLY FILLED CABLES

4.1 Conductors

4.1.1 The size of conductor shall be as per job requirement.

4.1.2 The conductors shall consist of annealed, high conductivity solid copper wire, smoothly drawn, circular in cross-section, uniform in quality, free from defects and uniformly coated with pure tin and shall conform to Cl. 3.0 of DOT specification GR/WIR-06/03. For telecommunication cables conductor shall be 0.5 mm and for PA system conductor dia. shall be 0.6 mm as minimum. For fire alarm cables size of conductor shall be chosen based on sum of the current drain of all field points in that circuit.

4.2 Insulation

4.2.1 The core insulation shall be with XLPE.



4.2.2 The colours used for insulation shall conform as nearly as practicable to the standard colours as per 18-9938. The wire insulation shall have colours in accordance with Table-2 of DOT specification GR/WIR-06/03. The applied colour shall neither have deleterious effect on the electrical, mechanical or ageing properties of basic insulation nor shall get damaged by any friction etc.

4.2.3 For single pair cables, the colour shall be incorporated in the insulation.

4.2.4 For multi pair cables, cores shall have uniform pattern of continuous spiral (Pitch not exceeding 25mm) to facilitate easy identification. This may be done by the application of one or more coloured strips on a base colour or by direct extrusion.

4.2.5 Alternately, colouring may consist of concentric coloured rings or dots or dashes on the base colour. The coloured rings, dots or dashes shall have a width of not less than 1.0mm and shall be repeated along the length of the insulation at an interval not less than 15mm and not more than 25mm.

4.2.6 The dots or dashes shall be applied on diametrically opposite sides of the insulation, so that all colours are visible when the insulation is viewed from any side.

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4.3 **Twisting**

The two insulated conductors of a pair shall be uniformly twisted with a suitable right hand lay, which shall not exceed 80mm.

4.4 **Core Formation**

The core formation shall conform to C1.6.0 of DOT specification no. GR/WIR-06/03.

4.5 **Screen**

4.5.1 Unless otherwise specified the cables used for fire alarm and detection shall be provided with overall screen. The screen shall be of aluminium tape with minimum thickness of 0.04mm. The overlap shall be minimum 3mm for cables up to 50 pair & minimum 6mm for cables above 50 Pair. The screen shall be backed by an outer protective layer of 0.13mm PVC tape or other non hygroscopic material lapped applied longitudinally or helically with overlap.

4.5.2 The cables shall be provided with a drain wire. Drain wire shall have a minimum cross-section of 0.5mm², shall be composed of multistrand bare tinned annealed copper conductor. The drain wire shall be in continuous contact with the aluminium side of the overall screen. The drain wire resistance including screen shall not exceed 30 ohm/km.

4.6 **Ripcord**

A non-metallic ripcord of suitable quality shall be laid longitudinally under the inner sheath & screen. The ripcord when pulled shall cut through the sheath and strip the core.

4.7 **Inner Sheath**

4.7.1 An extruded inner sheath of type ST1 PVC, as per IS-5831, with minimum thickness as per Table-4 of IS-1554 (Part-1) shall be applied over the laid up core, by extrusion to fit closely on it.

4.7.2 The inner sheath shall be as circular as possible. It shall be possible to remove the inner sheath without damage to the insulation.

4.7.3 When one or more layers of non-hygroscopic tape is helically applied over the laid up cores, as a binder, the thickness of such tape(s) shall not be construed as a part of the inner sheath.

4.8 **Armour**



4.8.1 The cables shall be provided with armouring, made of hot dip galvanised steel wire /strip over the inner sheath.

4.8.2 The armour shall be by means of 104mm thick round wires for cables with under armour diameter upto 13mm. For cables with an under armour diameter above 13mm, the armour shall either be of steel strip or round wire with thickness as per IS-1554 (Part-1).

4.9 **Outer Sheath**

4.9.1 The cables shall be provided with an extruded PVC FRLS sheath for external protection. The PVC shall be type ST1 PVC, as per IS-5831.

4.9.2 The other sheath shall be with oxygen index 29 at 27±2°C and possess flame retardant properties meeting the requirements of IS 10810 Part-62 category - AF. In addition,

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suitable chemicals shall be added to the PVC compound of the outer sheath to protect the cable against rodent and termite attack.

- 4.9.3 The thickness of outer sheath shall be as per IS-7098 (Part 1).
- 4.9.4 The outer sheath shall fit tightly on the armour and shall be applied in such a manner that no undue residual strain is left in the material.
- 4.9.5 The outer sheath shall be grey in colour except for cables to be used for fire alarm system where it shall be red.
- 4.9.6 Sequential marking of the length of the cable, in meters, shall be provided on the outer sheath at every one meter. The marking shall be legible and indelible by suitable method.
- 4.9.7 The overall diameter of the cables shall be strictly as per the values declared in the technical information furnished along with the bids, subject to a maximum tolerance of ± 2 mm.
- 4.10 Cable Capacitance
- 4.10.1 The core to core capacitance of the cables shall not exceed $100nF/Km$ at 1KHz.
- 4.10.2 The core to screen capacitance for the screened cables shall not exceed $250nF/Km$ at 1KHz.

5.0 TECHNICAL REQUIREMENTS FOR JELLY FILLED CABLES

5.1 Jelly filled telecom cables shall in general conform to the requirements of DOT specification G/CUG-01/02, unless otherwise specified in this specification.

5.2 Conductors

5.2.1 The conductors shall consist of annealed, high conductivity solid copper wire, smoothly drawn, circular in cross-section, uniform in quality, free from defects and uniformly coated with pure tin and shall conform to cl. 3.0 of DOT specification G/CUG-01/02.

5.3 Insulation

5.3.1 Each conductor shall be insulated with insulating grade PE conforming to C1.4.0 of DOT specification G/CUG-01/02.

5.4 Twisting

The two insulated conductors of a pair shall be uniformly twisted with a suitable right hand lay, which shall not exceed 150mm.



5.5 Core Formation

The core formation shall conform to C1.6.0 of DOT specification G/CUG-01/02.

5.6 Filling Compound

5.6.1 The cable shall be filled with a suitable stable water resistant compound, which shall be compatible with the insulation, binders and tapes used in the cable.

5.6.2 It shall be homogeneous and uniformly mixed material containing an anti-oxidant.

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- 5.6.3 The compound shall not obscure the identification of the colour of the insulation of the conductors.
- 5.6.4 It shall not contain dirt, metallic particles or other foreign matter.
- 5.6.5 The compound shall be readily removable from the insulated conductors by wiping.
- 5.6.6 It shall be free from any unpleasant odour and shall have no toxic or dermatic hazards.
- 5.6.7 The flash point of the compound shall not be less than 200°C.
- 5.6.8 The volume Resistivity measured at 100°C shall not be less than 1010 ohm-ern.
- 5.6.9 The permittivity at 1 MHz tested as per ASTM 0-924 shall not be greater than 2.3 at 20°C.

5.7 **Core Wrapping**

At least one closed helical or longitudinal application of a non-hygroscopic and non-wicking polyester tape or tape of any other suitable material shall be provided over the cable core.

5.8 **Screen**

- 5.8.1 The cables shall be provided with overall screen. The screen shall be of aluminium tape with minimum thickness of 0.2mm. The overlap shall be minimum 3mm for cables having maximum diameter over inner sheath < 30mm & minimum 6mm for cables having maximum diameter over inner sheath ~ 30mm. The screen shall be coated with 0.05 mm nominal thickness polythene/copolymer on both sides. The thickness of the composite tape shall be 0.3mm±15%.
- 5.8.2 The aluminium tape shall be electrically continuous throughout the length of the cable.

5.9 **Inner Sheath**

- 5.9.1 The inner sheath shall be as circular as possible and free from pinholes and other defects. It shall be possible to remove the inner sheath without damage to the insulation.
- 5.9.2 The inner sheath shall be of polythene conforming to type 03C or H03C of BS 6234 and shall contain a suitable antioxidant system. The material shall be virgin as per ASTM 0-883 and meet the following requirements.



Density 0.910 to 0.940 glee for 03C and > 0.940 glee for H03C

Melt Flow index Maximum 1.0 g/10 minutes (190 °e, 2160 g load)

- 5.9.3 The thickness of inner sheath shall conform to Table - 6 of DOT specification no. G/CUG01/02.
- 5.9.4 The maximum diameter over inner sheath shall conform to Table - 7 of DOT specification no. G/CUG-O 1/02.

5.10 **Armour**

- 5.10.1 The cables shall be provided with bedding and armour over the inner sheath.
- 5.10.2 The bedding shall consist of two close helical lappings of polythene or polypropylene tape. Each tape shall be applied with a minimum of 5% overlap.

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5.10.3 The armour shall be made of hot dip galvanised steel tape of thickness as per Table - 8 of DOT specification G/CUG-01/02.

5.11 **Outer Sheath**

5.11.1 The external protection shall consist of a polythene sheath conforming to the material specification defined in Clause 5.9 above.

5.11.2 The thickness of outer sheath shall conform to Table - 9 of DOT specification G/CUG-01/02.

5.11.3 The outer sheath shall be as circular as possible and free from pinholes and other defects. It shall be possible to remove the inner sheath without damage to the insulation.

5.11.4 The outer sheath shall be grey in colour except for cables to be used for fire alarm system where it shall be red.

5.11.5 The maximum diameter over outer sheath shall conform to Table - 7 of DOT specification G/CUG-01/02.

5.12 Cable Capacitance

The average mutual capacitance of the pairs measured at 800 to 1000Hz shall be 52 ± 3 nF/km.

However, the mutual capacitance of individual pairs shall be within the limits of 52 ± 4.5 nF/km.

6.0 **INSPECTION, TESTING AND ACCEPTANCE**

6.1 The cables shall be tested and examined at the manufacturer's works. All the materials employed in the manufacture of the cable shall be subjected to examination, testing and approval by PDIL/Owner. Manufacturer shall furnish all necessary information concerning the supply to PDIL/Owner's inspectors. The inspector shall have free access to the manufacturer's works for the purpose of inspecting the process of manufacture in all its stages and he will have the power to reject any material, which appears to be of unsuitable description or of unsatisfactory quality.

6.2 The following acceptance tests shall be conducted on the completed jelly filled cables as per the test procedures given in DOT specification G/CUG-01/02 and this specification:

i. Measurement of diameter of conductor, over inner sheath & over outer sheath.

ii. Measurement of Thickness of insulation, inner sheath, screen, armour & outer sheath.

iii. Measurement of Resistance of conductor.

iv. Measurement of Resistance unbalance.



v. Continuity Check & Measurement of Resistance of Poly-al tape.

vi. Colour coding.

vii. Conductor continuity test.

viii. Mutual Capacitance test.

ix. Capacitance Unbalance test.

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- x. Cross talk test.
- xi. Attenuation test.
- xii. Insulation resistance test.
- xiii. Dielectric strength test.
- xiv. Drip test.
- xv. Armour Galvanisation Test.
- xvi. Conductor Annealing Test.
- xvii. Measurement of drum length.

6.3 The following tests shall be conducted on the completed non jelly filled cables as per the test procedures given in DOT specification GR/WIR-06/03 and this specification:

6.3.1 **Acceptance tests:**



- i. Measurement of diameter of conductor, over inner sheath & over outer sheath.
- ii. Measurement of Thickness of insulation, inner sheath, screen, armour & outer sheath.
- iii. Measurement of Resistance of conductor.
- iv. Colour coding.
- v. Conductor continuity test.
- vi. Mutual Capacitance test.
- vii. Capacitance Unbalance test.
- viii. Insulation resistance test.
- ix. High Voltage test.
- x. Armour Galvanisation Test.
- xi. Conductor Annealing Test.
- xii. Measurement of drum length.

6.3.2 **Special Tests**

The non jelly filled cables shall also be subjected to following special tests.



- i. Oxygen Index test as per IS-I 0810 (Part 58).
- ii. Flammability test on finished cable as per IS-I0810 (part 61 & 62).

The special test shall be conducted on one sample from each lot. The sample will be selected by the inspector.



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7.0 PACKING AND DESPATCH

- 7.1 Cables shall be despatched in non-returnable wooden drums of suitable barrel diameter, securely battened, with the take-off end fully protected against mechanical damage. The wood used for construction of the drum shall be properly seasoned, sound and free from defects. Wood preservatives shall be applied to the entire drum. Ferrous parts used shall be treated with a suitable rust preventive finish or coating to avoid rusting during transit and storage.
- 7.2 On the flange of the drum, necessary information such as project title, manufacturer's name, type, size, length of cable in meters, drum no., cable code, BIS certification mark, gross weight, 'Owner's particulars', 'P.O. numbers' etc., shall be printed. An arrow shall be printed on the drum with suitable instructions to show the direction of rotation of the drum.
- 7.3 Cables shall be supplied in drum lengths of 1000 meters, if not specified otherwise.
- 7.4 For non jelly filled cable, PVC / rubber end caps shall be supplied free of cost for each drum with a minimum of eight per thousand meter length. In addition, ends of the cables shall be properly sealed, with caps, to avoid ingress of moisture/water during transit and storage.
- 7.5 For jelly filled telephone cables, the ends of the cable shall be sealed by thermo shrinkable end caps of adequate wall thickness. Alternately ends may be sealed by enclosing them in rubber or PVC caps of wall thickness not less than 1.8mm. The caps shall be secured to the outer sheath with hose clips or ties or black adhesive tape or heat shrinkable sleeves.
- 7.6 The cables may be stored outdoors for long periods before installation. The packing shall be suitable for outdoor storage in areas with heavy rains / high ambient temperature, unless otherwise agreed.



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**TECHNICAL SPECIFICATION
HIGH MAST LIGHTING**

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1.0 SCOPE

- 1.1 The scope covers technical requirements of design, engineering, manufacture, testing before despatch at works and delivery in well packed condition of high mast lighting structure, LED light fittings including lamps, earthing of units, aviation lights for towers, supply of spares for 2 years operation and maintenance etc. for NFL, Nangal. The scope shall also include the erection including civil foundation & piling design, as required (except casting of piling at site), testing, commissioning of the system by High Mast Lighting manufacturer.
- 1.2 The scope shall broadly include all the equipment and accessories described under clause no. 7.0. All other items not specified, but required for satisfactory and trouble free operation of the system, shall also be included.



2.0 APPLICABLE STANDARDS

- 2.1 The following shall be the reference standards for the loading of the high mast:

Sr. No.	Code No.	Title
a)	BS Code of Practice CP-3 Chap V Part-II	Gradient of wind speeds related to height above ground
b)	BS 4360	Grades of MS Plates
c)	BS 5135	Welding
d)	BS 729	Galvanising
e)	Technical report (TR) No. 7	High Mast Lighting specification for design, manufacture assembly, erection, testing and maintenance–2000,published by the Institution of Lighting Engineers, United Kingdom
f)	IS 875 (Part III), 1987	Structural stability to sustain maximum reaction arising from wind
g)	BS EN 10025/10027	Yield strength of steel structure.
h)	BS EN ISO 1461	Environmental protection of the fabrication by hot dip galvanization
i)	BS 5135/AWS	Welding
j)	IS 325	Three Phase Induction motor
k)	IS 3043	Code of Practice for Earthing
l)	IS 2309	Protection of building & Allied structure against Lightning
m)	UL 1029	Standard for high intensity discharge lamp ballast
n)	EN 61347	Lamp Control gear
o)	UL 1059	Standard for Terminal Block
p)	EN 60947	Low Voltage Switchgear & control gear
q)	EN 60598	Luminaries general requirements & test
r)	IE rule	
s)	Any other regulations laid by statutory authorities	

3.0 INSTRUCTIONS TO BIDDER

- 3.1 As it is not possible to cover all aspects of design, the basic requirements only have been covered in this specification. Bidder shall ensure that design and installation is carried out as per the latest engineering practices, satisfying the requirements of safety, reliability, ease of maintenance and operation, aesthetics and maximum interchangeability.
- 3.2 Piling Design for high mast shall be furnished by bidder including its details drawings, documents etc. However erection/installation of Pilings shall be done by Owner.

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3.3 Compliance with this standard and / or approval of any of the bidder's documents shall not relieve the bidder of his responsibility towards his contractual obligation with regard to the completeness and satisfactory operation of the equipment.

3.4 Power Supply (Feeder Pillar)

The owner shall provide 415V, 3 phase & neutral power supply at the bottom of each mast through suitable XLPE-A-PVC (FRLS) (AI) cable. Suitable FLP/weatherproof arrangement for receiving & distribution of this power including suitable TPN MCCB/MCB incomer, outgoing MCB for switching on/off luminaries, contactors with suitable MCB/MCCB for motor, push button for raising & lowering of lantern carriage through motor operation etc. shall be provided by the bidder.

Above mentioned arrangement shall be weatherproof for the high mast to be installed in non-hazardous area.

3.5 2 nos. earth Pit shall be provided by bidder within 10 m of each mast for body earthing. Further 2 nos. earthing connections from high mast to earth pit (one earthing connection to one pit) shall also be provided by the bidder with GI strip of size not less than 50X6 mm².

4.0 SERVICE CONDITIONS

4.1 Ambient Conditions

These shall be as indicated in Design Philosophy-Electrical.

4.2 System Details

These shall be as indicated in Design Philosophy-Electrical.

5.0 OPERATIONAL REQUIREMENTS

5.1 The equipment shall be suitable for operating at rated capacity continuously under the ambient conditions and with voltage and frequency variations indicated above without exceeding the permissible temperature limits as per relevant standards and without any detrimental effect on any part.



6.0 GENERAL DESIGN REQUIREMENTS

6.1 The electrical system and installation shall be designed as per latest practice to provide maximum reliability, flexibility, safety to personnel and equipment and ease of operation and maintenance.

6.2 All equipment shall have adequate and standardised ratings.

6.3 Masts shall be of 30m height and unipolar (single pole) structure. Special consideration shall be taken in respect of lamp replacement, operation and maintenance.

6.4 Manufacture of masts and components, light fittings, lamps, control gears for fittings, control gears for lantern carriage movement (i.e. raise/lower) with self sustaining winch/stainless steel wire/rope, flameproof/weatherproof motors, control push button stations and flexible cables shall be as per relevant Indian / International Standards.

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7.0 EQUIPMENT DETAILS

7.1 High Masts

7.1.1 Structure

The High mast shall be of continuously tapered, polygonal cross section, at least 16 sided, presenting a good and pleasing appearance and shall be based on proven In-tension design conforming to the standards referred to above, to give an assured performance, and reliable service. The structure shall be suitable for wind loading as per IS 875 Part III 1987 as well as for prevailing wind condition at NFL, Nangal.

The mast height shall be 30m, with minimum diameter of 150mm at the top and 610mm at the bottom. Minimum plate thickness of bottom section shall be 5mm and other sections 4mm. The structure shall be suitable for wind loading as per IS 875 Part III, 1987 & for 24 nos. 350W LED light fitting complete with lamp. The PCD of the mast flange shall be minimum 740mm.

7.1.2 Construction

The mast shall be capable of safely withstanding the strong winds prevailing at site. The deflection at the top during heavy monsoon periods shall therefore be considered in the design and the mast designed in such way that the above deflection during worst periods is kept to a minimum value.

The High mast shall be fabricated from special steel plates, conforming to BS-EN10025, cut and folded to form a polygonal section and shall be telescopically jointed and fillet welded. The welding shall be in accordance with BS: 5135. The procedural weld geometry and the workmanship shall be exhaustively tested on the completed welds. Mast shall be delivered in multiple sections of length approx. 10 metres. Thus a 30 meter mast shall be delivered in three sections.



Each mast section, delivered to site, shall include one no. circumferential welded diaphragm stiffener to reduce the deflection of the mast in heavy winds. At site, the sections shall be joined together by slip-stressed-fit method. No site welding or bolted joint shall be done on the mast. The minimum overlap distance shall be 1.5 times the diameter at penetration.

The mast shall be provided with full penetrated flange which shall be free from any lamination or incursion. The welded connection of the base flange shall be fully developed to the strength of the entire section. The base flange shall be provided with supplementary gussets between the bolt holes to ensure elimination of helical stress concentration. For the environmental protection of the mast, the entire fabricated system shall be hot dip galvanised, internally and externally, having a uniform thickness of 65 microns for the bottom and top sections.

7.1.3 Door Opening

An adequate door opening of size 1000mm x 300mm shall be provided at the base of the mast and the opening shall be such that it permits clear access to equipment like winches, cables, plug and socket, etc. and also facilitate easy removal of the winch. The door opening shall be complete with a close fitting, vandal resistant, weather proof door, provided with a heavy duty double internal lock with special paddle key.

The door opening shall be carefully designed and reinforced with welded steel section, so that mast section at the base shall be unaffected and undue buckling of the cut portion is prevented.

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7.1.4 Dynamic Loading for the Mast

The mast structure shall be suitable to sustain an assumed reaction arising from a wind speed as per IS 875 (three second gust), and shall be measured at height of 10m above ground level. The design life of the mast shall be a minimum of 25 years. Wind excited oscillations shall be dampened by the method of construction and adequate allowance shall be made for the related stresses.

7.1.5 Earthing Terminals

2 Nos. earthing terminals for earthing of the mast, using 12mm dia. stainless steel bolts shall be provided at convenient location on the base of the mast.

7.2 Lantern Carriage

7.2.1 Fabrication

A fabricated Lantern Carriage shall be provided for fixing and holding the LED flood light fittings and control gear boxes. The Lantern Carriage shall be of special design and shall be of steel tube construction, the tubes acting as conduits for wires, with holes fully protected by grommets. The Lantern Carriage shall be so designed and fabricated to hold the required number of flood light fittings and the control gear boxes, and also have a perfect self balance.

The Lantern Carriage shall be fabricated in two halves and joined by bolted flanges with stainless steel bolts and plastic lock type stainless steel nuts to enable easy installation or removal from the erected mast. The inner lining of the carriage shall be provided with protective PVC arrangement, so that no damage is caused to the surface of the mast during raising and lowering operation of the carriage. The entire Lantern Carriage shall be hot dip galvanised after fabrication.

7.2.2 Junction Box



Weather proof junction box with IP55 enclosure, made of cast Aluminium shall be provided on the Carriage assembly as required, from which the inter-connections to the designed number of the flood light LED luminaries and associated control gears fixed on the carriage, shall be made.

7.3 Raising and lowering mechanism

For the installation and maintenance of the luminaries and lamps, it will be necessary to lower and raise the Lantern Carriage assembly. To enable this, a suitable winch arrangement shall be provided, with the winch fixed at the base of the mast and the specially designed head frame assembly at the top.

7.3.1 Winch

The winch shall be of completely self sustaining type, without the need for brake shoe, springs or clutches. Each driving spindle of the winch shall be positively locked when not in use, gravity activated PAWLS. Individual drum also should be operated for fine adjustment of lantern carriage. The capacity, operating speed, safe working load of the winch and the recommended lubrication and serial number of the winch shall be clearly marked on each winch.

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The gear ratio may be according to manufacturer's standard. However, the minimum working load shall not be less than 750Kg. The winch shall be self lubricating type by means of an oil bath and the oil shall be readily available grades of reputed producers.

The winch drums shall be grooved to ensure perfect seat for stable and tidy rope lay, with no chances of rope slippage. The rope termination in the winch shall be such that distortion or twisting is eliminated and at least 5 to 6 turns of rope remains on the drum even when the lantern is fully lowered and rested on the rest pads.

It should be possible to operate the winch manually by a suitable handle and / or by integral power tool. It shall be possible to remove the double drum after dismantling, through the door opening provided at the base of the mast. Also, a winch gear box for simultaneous and reversible operation of the double drum winch shall be provided as part of the contract. A test certificate shall be furnished by the Bidder from the original equipment manufacturer, for each winch in support of the maximum load operated by the winch.

7.3.2 Head Frame

The head frame, which is to be designed as a capping unit of the mast, shall be of welded steel construction, galvanised both internally and externally after assembly. The top pulley shall be of appropriate diameter, large enough to accommodate the stainless steel wire ropes and the multicore electric cable. The pulley block shall be made of non-corrodible material, and shall be of die cast Aluminium alloy (LM-6). Pulley made of synthetic materials such as plastic or PVC is not acceptable. Self lubricating bearings and stainless steel shaft shall be provided to facilitate smooth and maintenance free operation for a long period. The pulley assembly shall be fully protected by a canopy galvanised internally and externally. Close fitting guides and sleeves shall be provided to ensure that the ropes and cables do not get dislodged from their respective positions in the grooves. The head frame shall be provided with guides and stops with PVC buffer for docking the lantern carriage.



7.3.3 Stainless Steel Wire Ropes

The suspension system shall essentially be without any intermediate joint and shall consist of only non-corrodible stainless steel of AISI 316 or better grade. The stainless steel wire ropes shall be of 7/19 construction, the central core being of the same material. The overall diameter of the rope shall not be less than 6mm. The breaking load of each rope shall not be less than 2350Kg individually, giving a factor of safety of over 5 for the system at full load as per the TR-7 referred to in the beginning of this specification. The end constructions of ropes to the winch drum shall be fitted with telluric.

The thimbles shall be secured on ropes by compression splices. Two continuous lengths of stainless steel wire ropes shall be used in the system and no intermediate joints are acceptable in view of the required safety. No intermediate joint either bolted or else is provided on the wire ropes between winch and lantern carriage.

7.4 Electrical System, cable and Cable Connections

The electrical connection from bottom to top shall be made with at least 5 core 2.5 sq.mm flexible round sheath power cables using copper conductors of appropriate rating. A suitable flameproof/weatherproof socket arrangement shall be provided at the bottom of the mast. The trailing cable shall also have an FLP/weatherproof plug connected at the bottom end. Also, suitable provision shall be made at the base compartment of the mast to facilitate the operation of electrically operated integral FLP/weatherproof power tool for raising and lowering

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of the lantern carriage assembly. The trailing cables at the top shall be terminated in the weather proof junction box.

7.5 **Power Tool for the Winch**

A suitable, high powered, electrically driven, flameproof/weatherproof, integral power tool to be provided in the base compartment coupled with winch and suitable for manual & motorised operation shall be supplied for the raising and lowering of the lantern carriage for maintenance purposes. The speed of the power tool may, preferably, be slow of 1.5 to 1.8 metre/minute, so that vibrations associated with high speed operation are avoided. The power tool shall be single speed, provided with a flameproof/weatherproof motor of required rating. The power tool shall be supplied with suitable reversible starter in flameproof/weatherproof enclosure. The capacity and speed of the electric motor used in the power tool shall be suitable for the lifting of the design load installed on the lantern carriage.

Also, a handle for the manual operation of the winch in case of problems with electrically operated tool, shall be provided and shall incorporate a torque limiter.

7.6 **Luminaries: 350W LED Flood Lighting Fixture complete with lamp**

7.6.1 The LED Flood Lighting Fixture complete with lamp suitable for High Mast.

7.6.2 The fixture shall have efficiency long life LED with high efficacy and minimum of 100 lm/w with high brightness LED for glare free homogenous illumination.

7.6.3 Fixture housing shall be made of Epoxy powder coated die-cast aluminium housing (LM-24).

7.6.4 Fixture cover shall be made of high quality toughened glass fixed to housing with screws.

7.6.5 The fixture shall have in-built electronic driver with THD \leq 10%.

7.6.6 Twin dome LED type (2x40W) Aviation Obstruction Lights of reliable design and reputed manufacturer shall be provided on top of each mast. It shall have cast aluminium housing finished in aviation yellow colour, suitable rated step-up transformer, thick glass dome mounted on cast aluminium ring and spring loaded high tension porcelain socket fitted with neon cold cathode helix light source. The light source shall be designed to give Omni-directional red colour light distribution to have maximum light output in the zone between 10°C to 90°C above horizontal plane.



8.0 **TESTS AND INSPECTION**

Routine testing shall be carried out on the supplied items at manufacturer's works as per relevant standards. For imported items of masts, relevant test certificates need to be produced for the purpose. However, testing shall not absolve the supplier from his responsibility for making good any defect which may be noticed subsequently. Site testing to demonstrate working and performance of the system shall also be carried out.

9.0 **DRAWINGS AND DOCUMENT**

9.1 At the time of handing over of the installation, the bidder shall supply as built drawings taking into consideration the actual execution carried out at site.

9.2 Drawings and documents shall be submitted as per Annexure-A in number of copies as indicated therein.

	HORTON SPHERE ALONG WITH ITS REFRIGERATION SYSTEM AT NFL, NANGAL TECHNICAL SPECIFICATION – HIGH MAST LIGHTING (TS-8308)	PC281-NFL-N/E-1/P-II/7.0	0	
		DOCUMENT NO.	REV.	
		SHEET 9 OF 10		

10.0 SPARES



- 10.1 Spares for operation and maintenance:
Item wise unit prices of spare parts with recommended quantity shall be quoted along with the High Masts.
- 10.2 Commissioning spares as required shall be supplied with the main equipment without any price implication to owner. Item wise list of recommended commissioning spares shall be furnished for information.
- 10.3 All spare parts shall be identical to the parts used in the High Masts.

11.0 MAKE OF COMPONENTS

- 11.1 Make of all electrical items/components shall be as specified elsewhere in the NIT.

12.0 DEVIATIONS

Deviations, if any, must be highlighted by the bidder clause wise in the offer. In absence of any such deviation, it will be presumed that all the clauses of specification are fully complied in the bidder's offer.

	HORTON SPHERE ALONG WITH ITS REFRIGERATION SYSTEM AT NFL, NANGAL TECHNICAL SPECIFICATION – HIGH MAST LIGHTING (TS-8308)	PC281-NFL-N/E-1/P-II/7.0	0	
		DOCUMENT NO.	REV.	
		SHEET 10 OF 10		



**Annexure-A
Drawing and Documents Schedule**

Sr. No.	Description	With Bid	Documents Required (Y / N)		
			For Approval	For Information	Final
1.	Technical Particulars Completely filled in	N	Y	--	Y
2.	Typical Wiring Diagram/Arrangement	Y	Y	--	Y
3.	Technical data of light fittings	Y	Y	--	Y
4.	Technical literature / Catalogues	Y	--	Y	Y
5.	Civil foundation data / details including piling design	N	Y	--	Y
6.	Test Certificates	Y	--	--	Y
7.	Guarantee Certificates	N	--	--	Y
8.	List of spares	Y	Y	--	Y
9.	Installation & maintenance manual	N	--	Y	Y

Note:

- 4 hard copies & 1 soft copy shall be supplied with bid.
- 6 hard copies & 1 soft copy shall be supplied for approval / information after order within 4 weeks from the date of LOI.
- 8 hard copies & 2 soft copies of pen drive in editable form shall be submitted as final documents prior to despatch of the equipment. These shall be made in sets and supplied in fine plastic coated folder.

Y – Yes, N – No

	HORTON SPHERE ALONG WITH ITS REFRIGERATION SYSTEM AT NFL, NANGAL SCHEMATIC DIAGRAMS FOR LV SWITCH BOARD	PC281-NFL-N/E-1/P-II/7.0	0	
		DOCUMENT NO.	REV.	
		SHEET 1 OF 16		

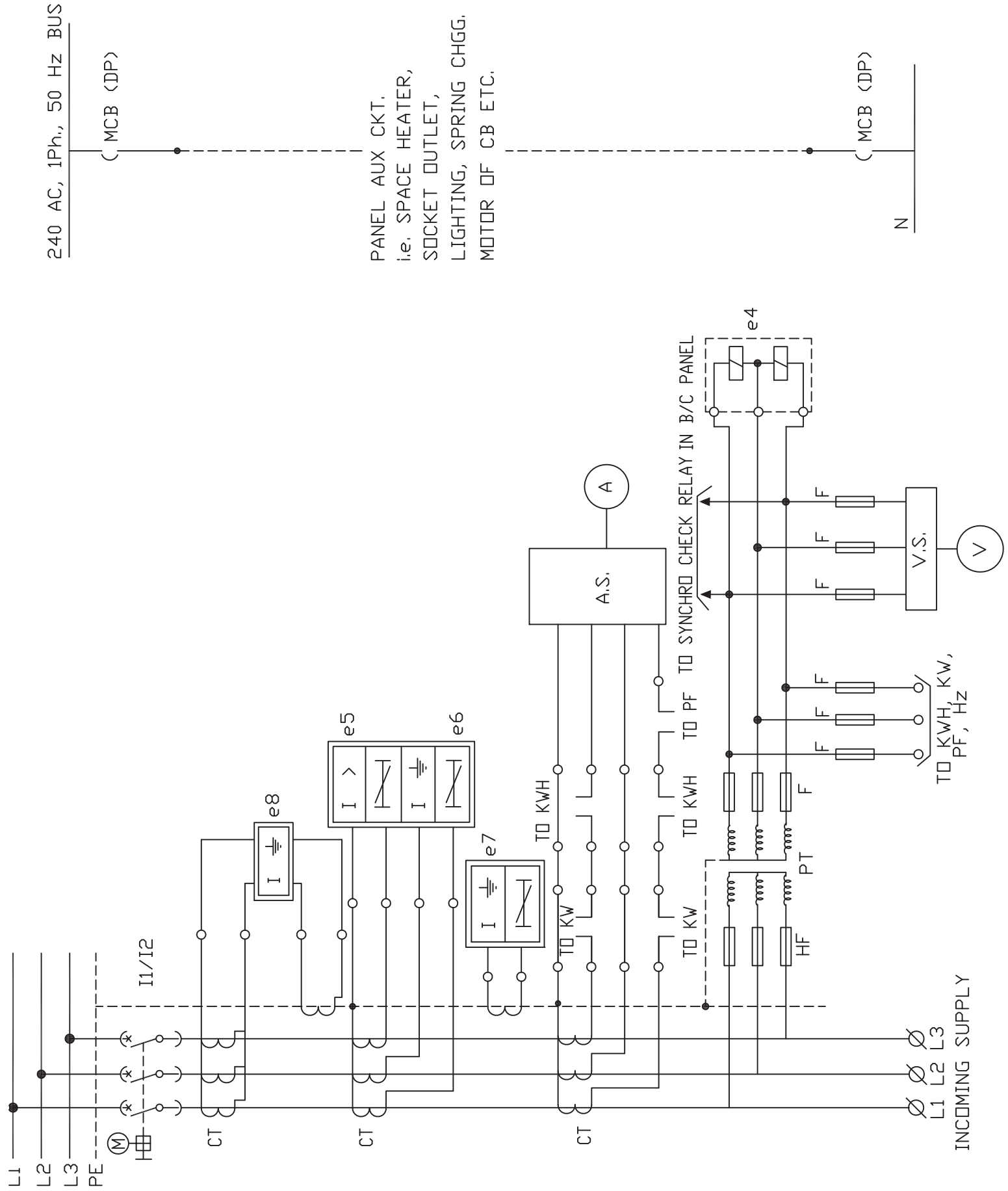
PART-II, TECHNICAL
SECTION – 7.0
SCHEMATIC DIAGRAMS WITH LEGEND
FOR
LV SWITCH BOARD

(Drg. No. PDS-1201)

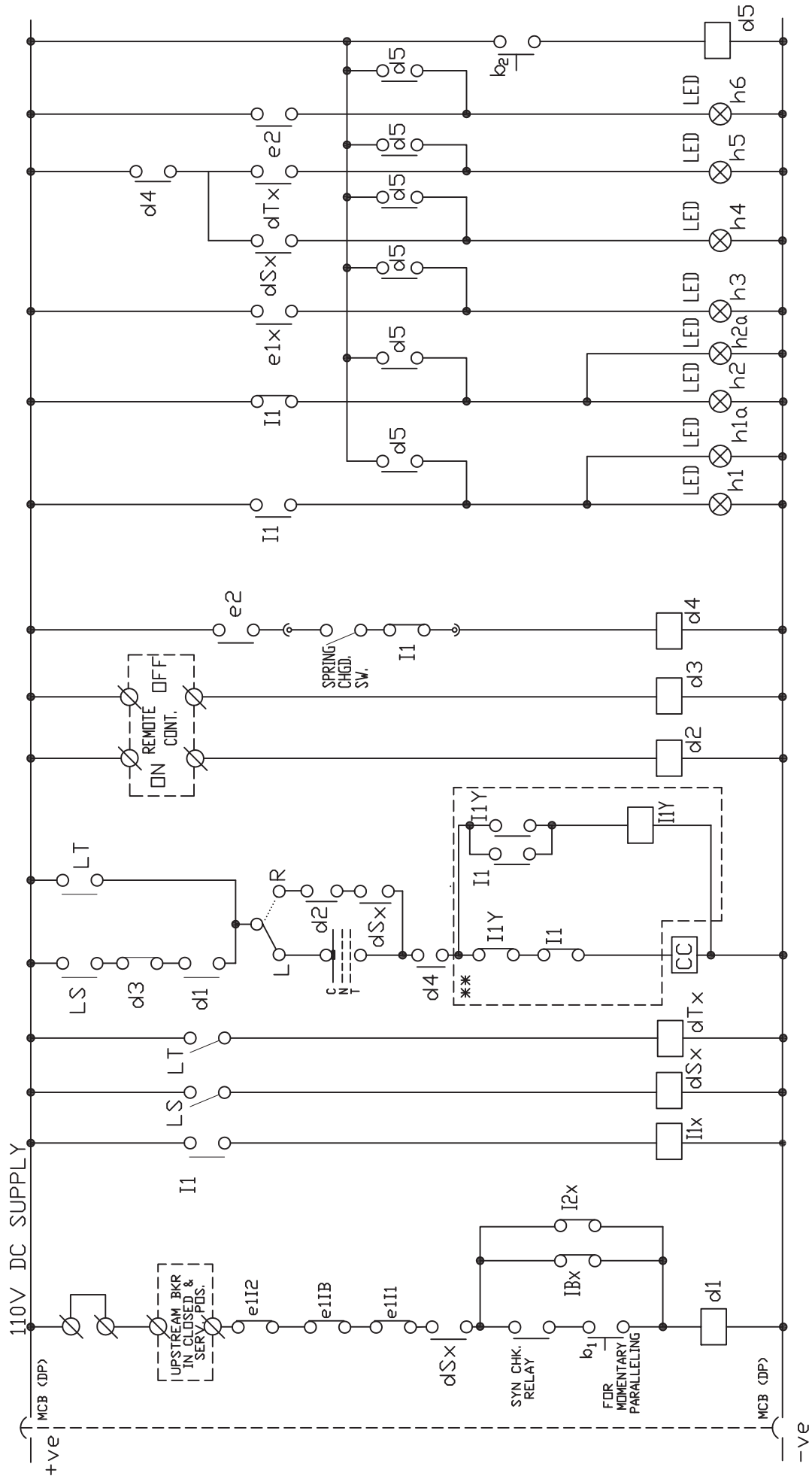
SL.NO.	SYM.	DESCRIPTION	SL.NO.	SYM.	DESCRIPTION
1	d	CONTACTOR	27	e4	U/V RELAY
2	e	RELAY	28	e5	O/C RELAY
3	b	PUSH BUTTON	29	e6	E/F RELAY
4	H	HOOTER	30	e7	SBF RELAY
5	BZ	BUZZER	31	e8	REF RELAY
6	T	TIMER	32	e9	DIFFERENTIAL RELAY
7	h	INDICATION LAMP	33	e10	HIGH SET INSTANTANEOUS RELAY
8	S	SELECTOR SWITCH	34	e11	AUX. RELAY FOR TRANSFORMER FAULT TRIP
9	L/R/A	LOCAL/REMOTE/AUTO	35	e12	AUX. RELAY FOR TRANSFORMER FAULT ALARM
10	x	AUX. RELAY & CONTACTOR FOR	36	e13	AUX. RELAY FOR LOW OIL LEVEL ALARM
		MULTIPLICATION OF CONTACTS	37	e14	AUX. RELAY FOR AUTO TRIP ALARM
11	LS	C.B. LIMIT SWITCH (SERVICE)	38	e15	AUX. RELAY FOR NON-TRIP ALARM
12	LT	C.B. LIMIT SWITCH (TEST)	39	e16	SYNCHRO CHECK RELAY
13	IM	MOTOR FEEDER C.B.	40	h1	'C.B. ON'
14	IT	TRANSFORMER FEEDER C.B.	41	h1a	'C.B. ON' (REAR SIDE)
15	I1/I2	INCOMER C.B. FROM O/G FEEDER OF UP-STREAM SW.BD.	42	h2	'C.B. OFF'
16	IB	BUS-COUPLER C.B.	43	ha2	'C.B. OFF' (REAR SIDE)
17	CC	CLOSING COIL OF C.B.	44	h3	'C.B. TRIPPED'
18	TC	TRIP COIL OF C.B.	45	h4	'C.B. READY FOR SERVICE'
19	RS	RESISTOR	46	h5	'C.B. READY FOR TEST'
20	HF	HT FUSE	47	h6	'TRIP CIRCUIT HEALTHY'
21	F	CONTROL FUSE	48	h7	'MOTOR SPACE HEATER ON'
22	TNC	TRIP-NEUTRAL-CLOSE CONT. SW.	49	∅	EXTERNAL TERMINALS
23	e1	LOCKOUT RELAY (ELECT. FAULT)	50	⊙	INTER PANEL TERMINALS
24	e'1	LOCKOUT RELAY (PROCESS)	51	LCS	LOCAL CONTROL STATION NEAR MOTOR
25	e2	TRIP CIRCUIT SUPERVISION RELAY	52	HM	HOURLY METER
26	e3	MOTOR PROTECTION RELAY			

NOTE: INSIDE DRAWINGS THERE SHALL BE CHANGE AS PER POINTS GIVEN BELOW

1. NO COMMON ALARM CIRCUIT (EXCEPT HOOTER/BELL) IN BUSCOUPLER FEEDERS AS EACH FEEDER WILL HAVE ITS OWN MICROPROCESSOR BASED ANNUNCIATOR.
2. EXCLUSIVE LV PT FUSE FOR e4.
3. BLOCKING DIODE FOR LAMP TEST INSTEAD OF d5.
4. SPACE HEATER LAMP IN LCS FOR MV MOTORS ARE NOT REQUIRED (O/L TRIP LAMP MAY BE USED)
5. LCS MAY HAVE 'READY FOR START' LAMP FOR AUTO STARTING MOTORS.
6. VIB./OIL LEVEL TRIP LAMP WITH RESET PB FOR CT FAN MOTORS.

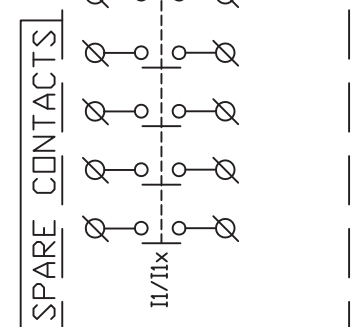
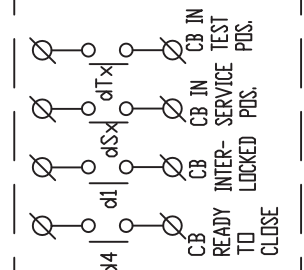
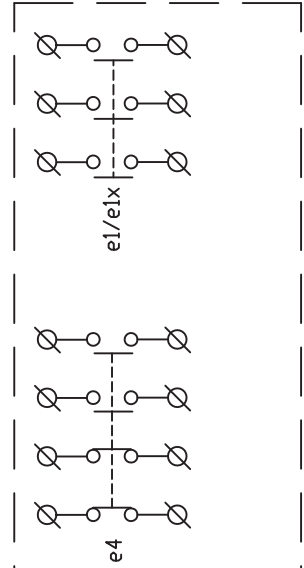
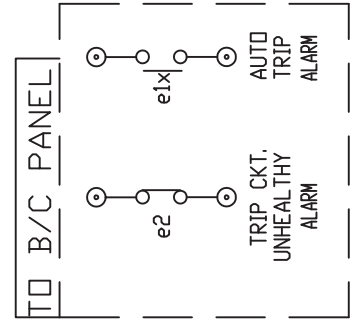
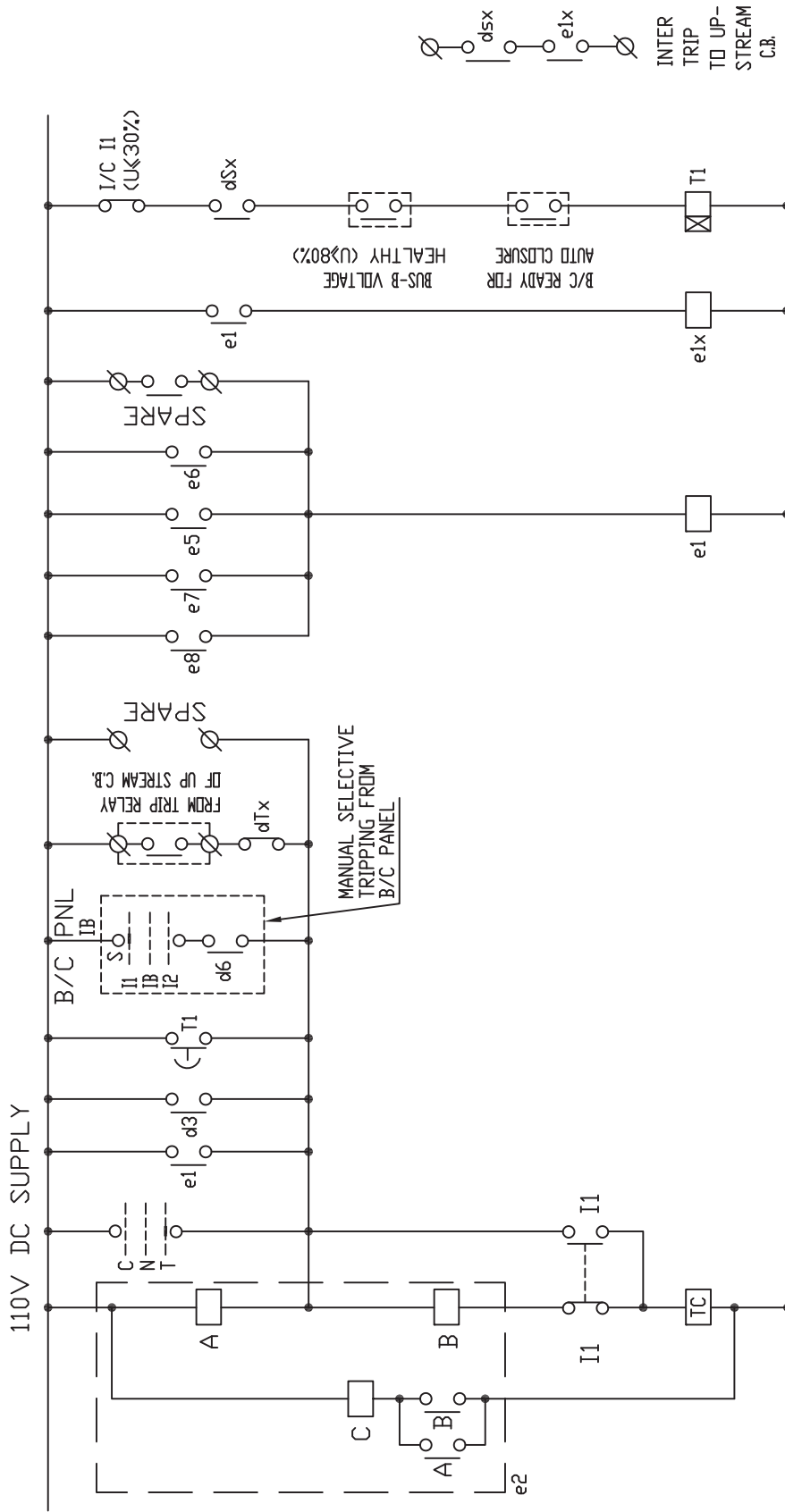


CLOSING & INDICATION SCHEME

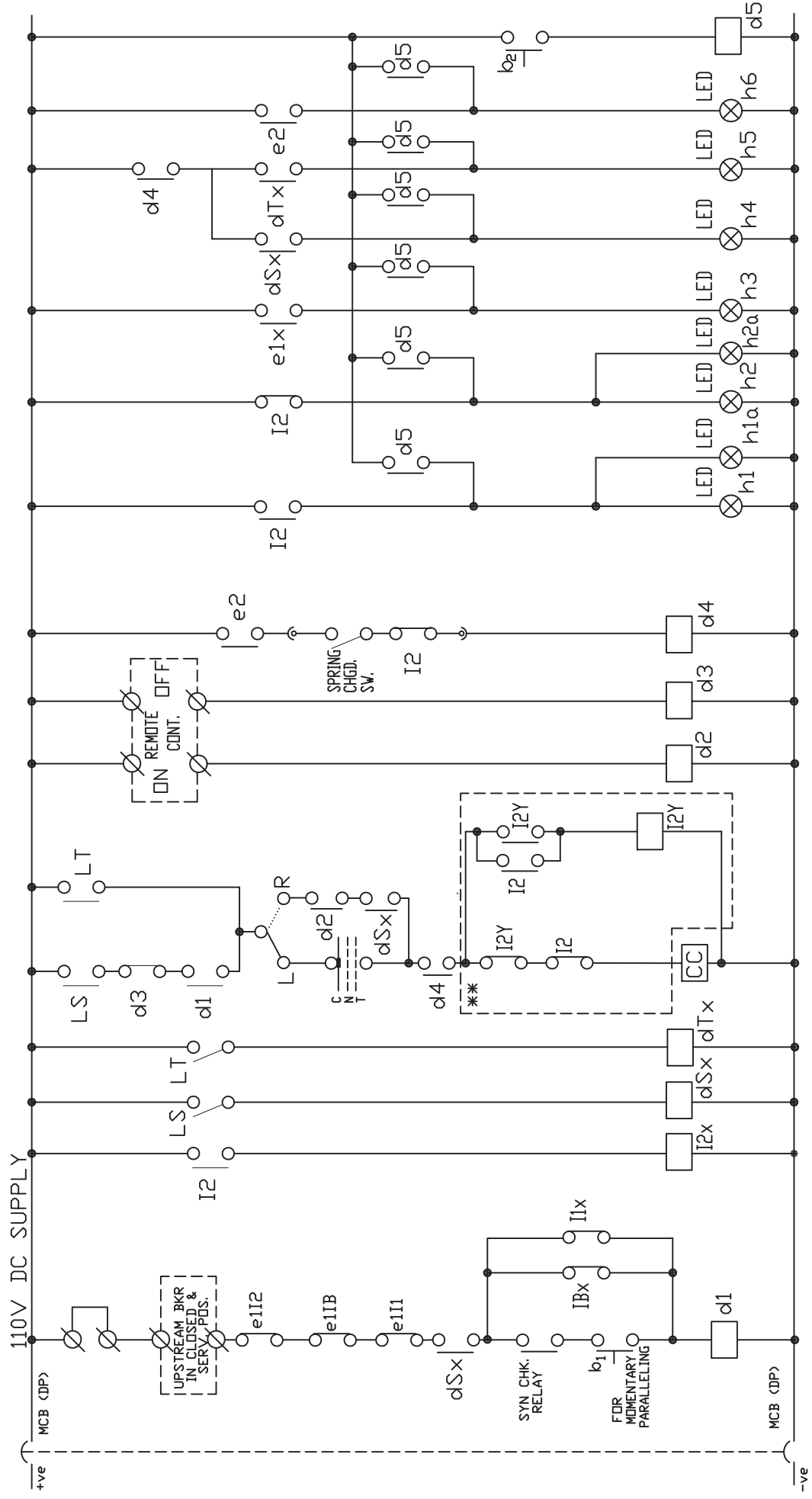


** TYPICAL SCHEME FOR ANTIPUMPING

TRIPPING SCHEME

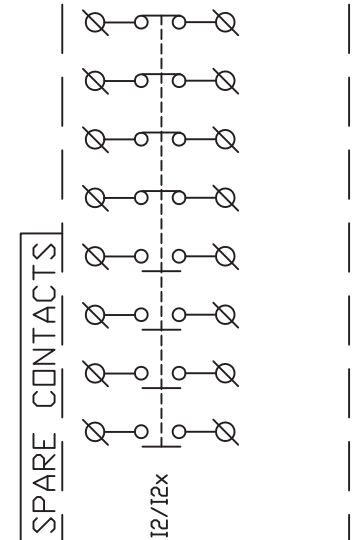
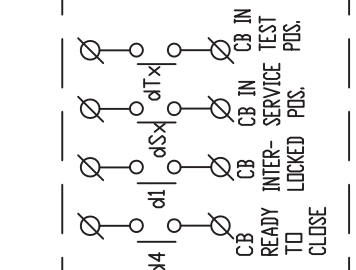
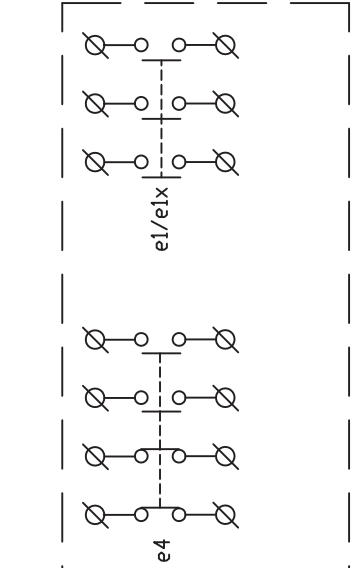
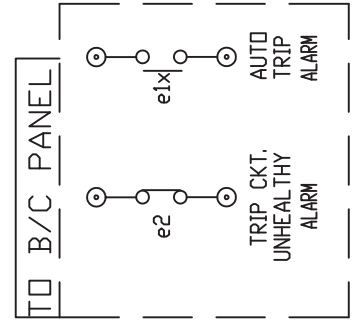
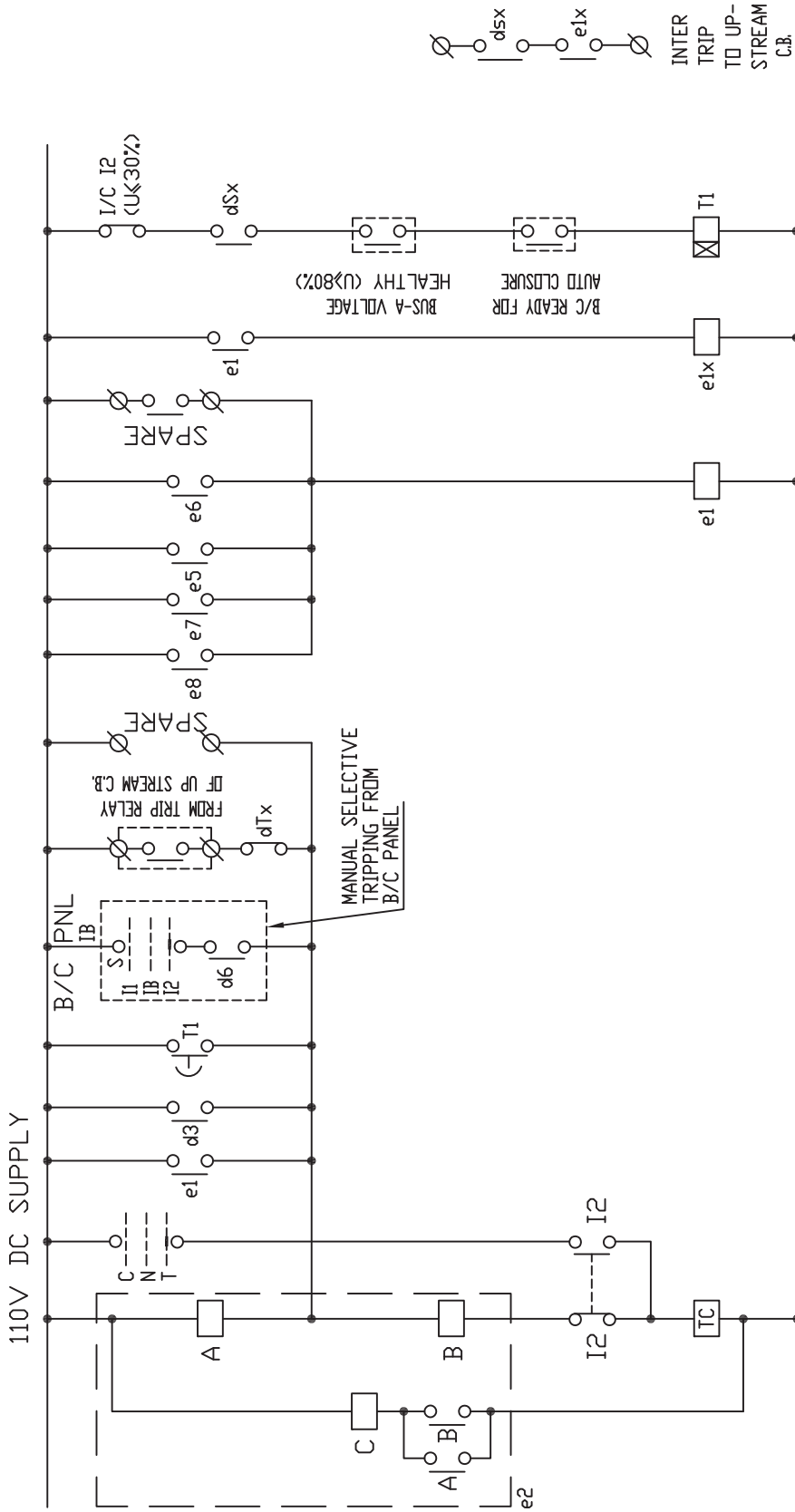


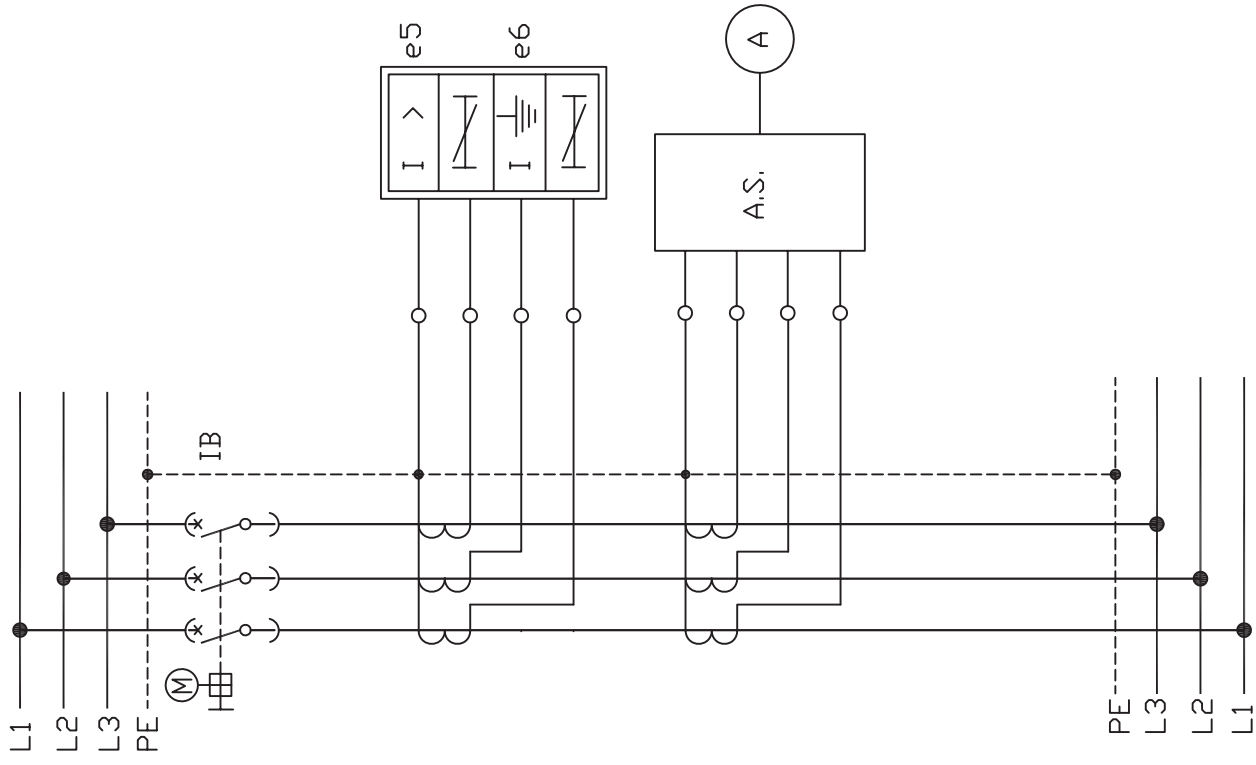
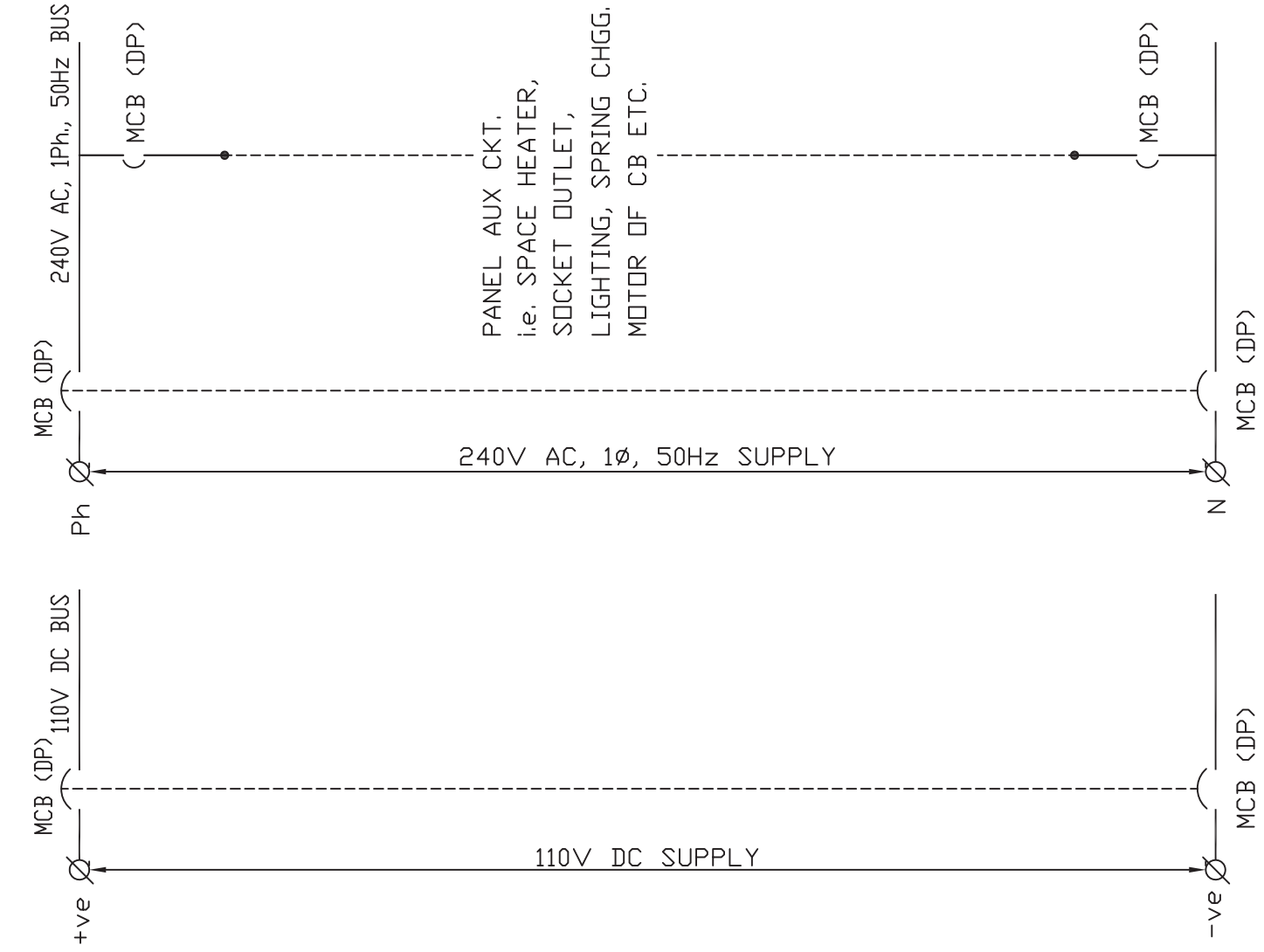
CLOSING & INDICATION SCHEME



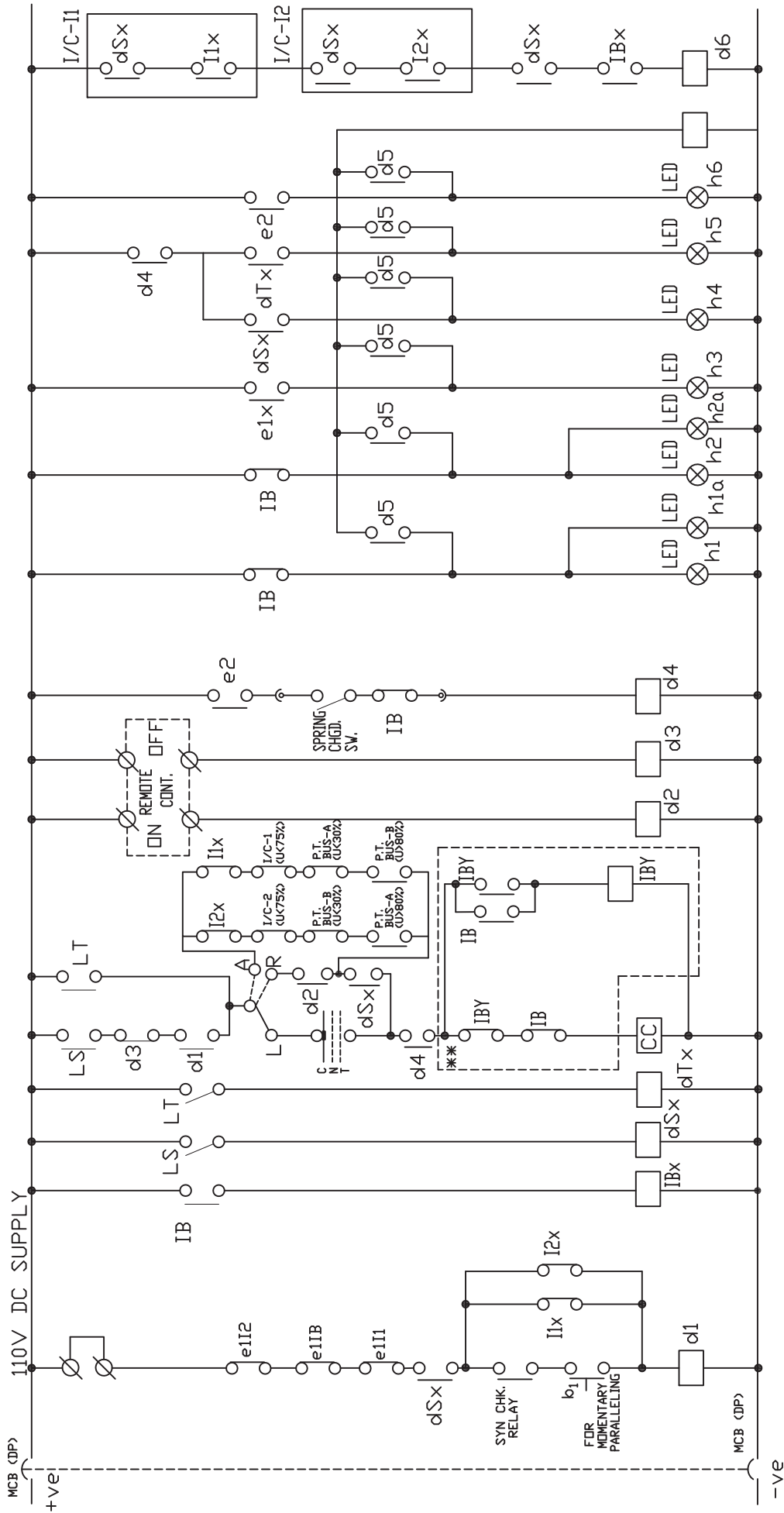
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TRIPPING SCHEME



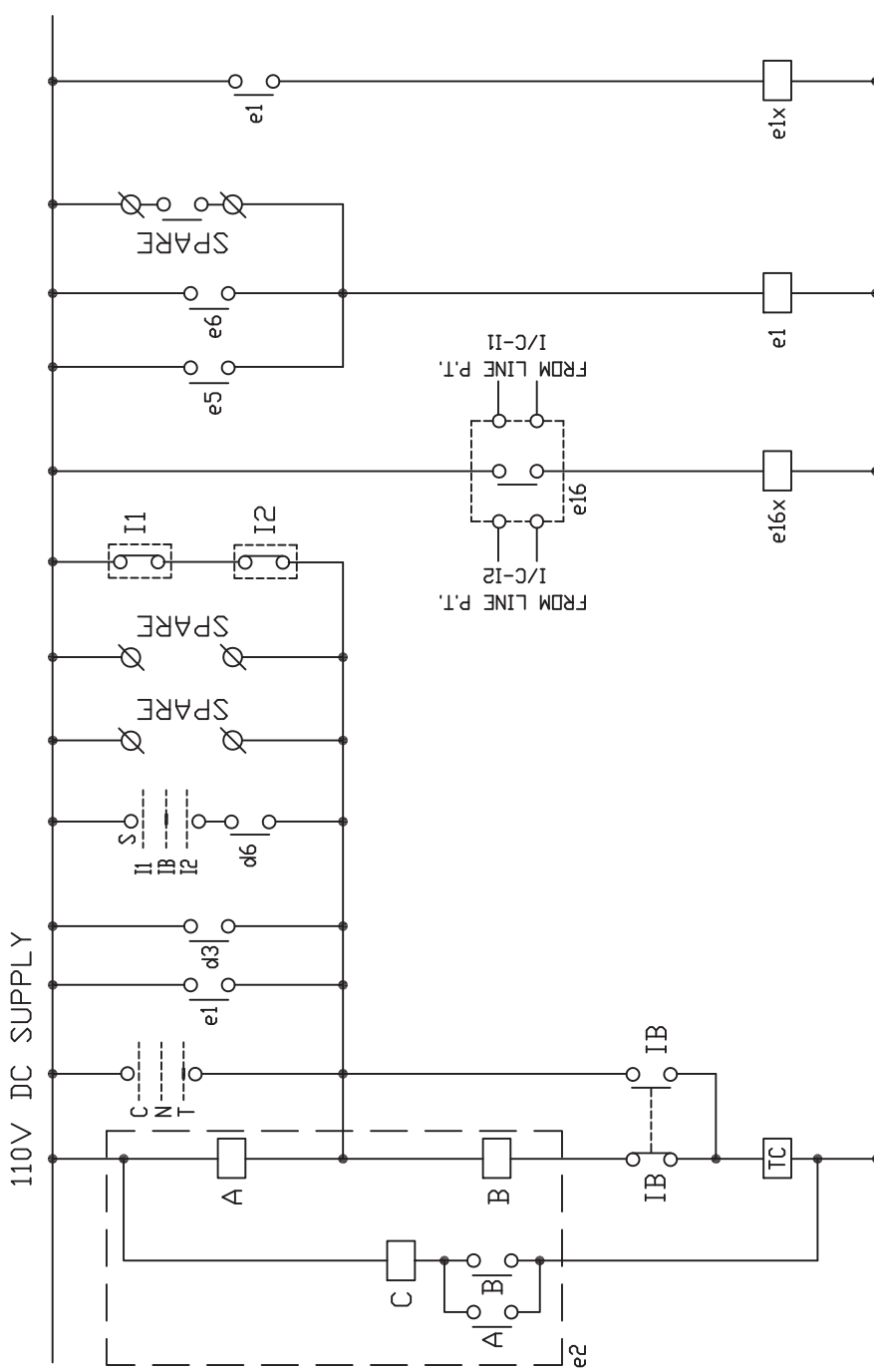


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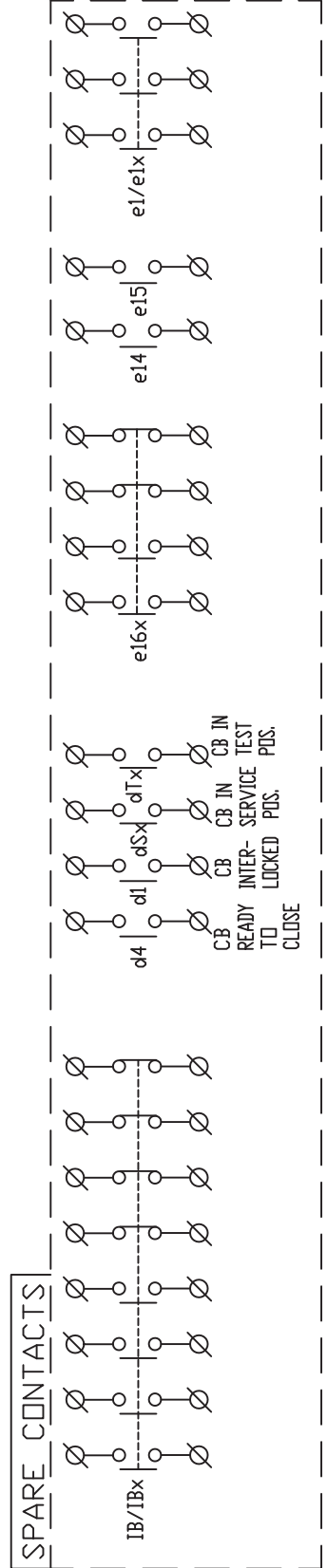
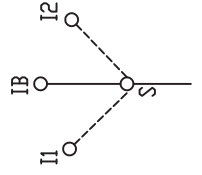


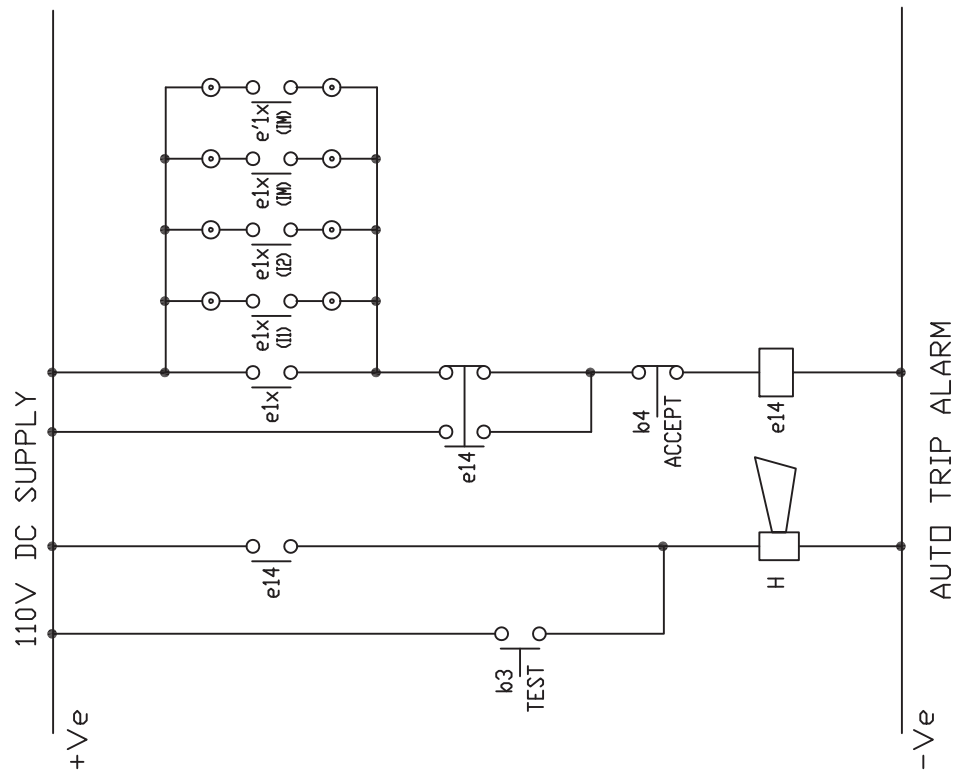
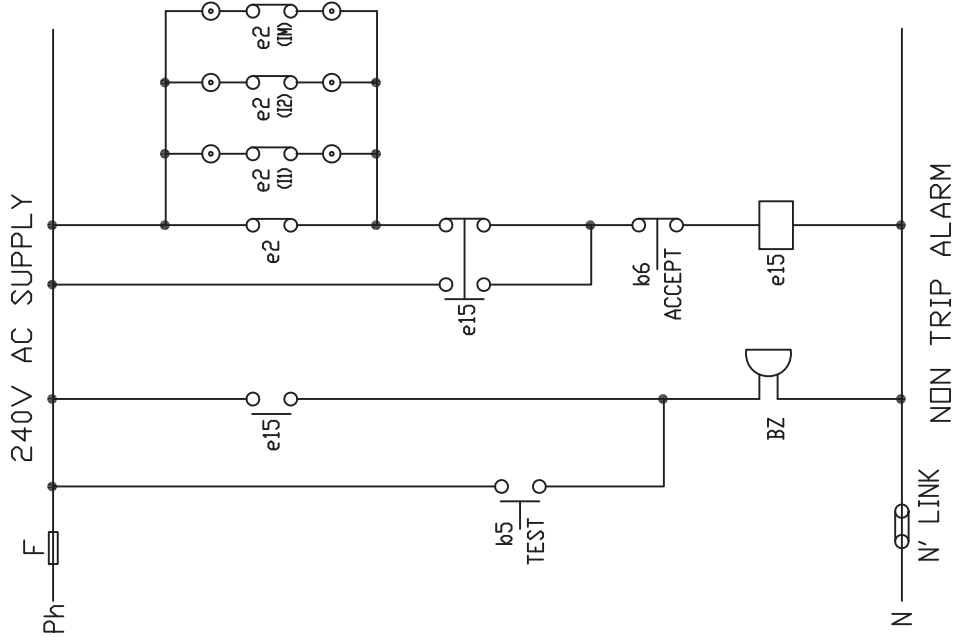
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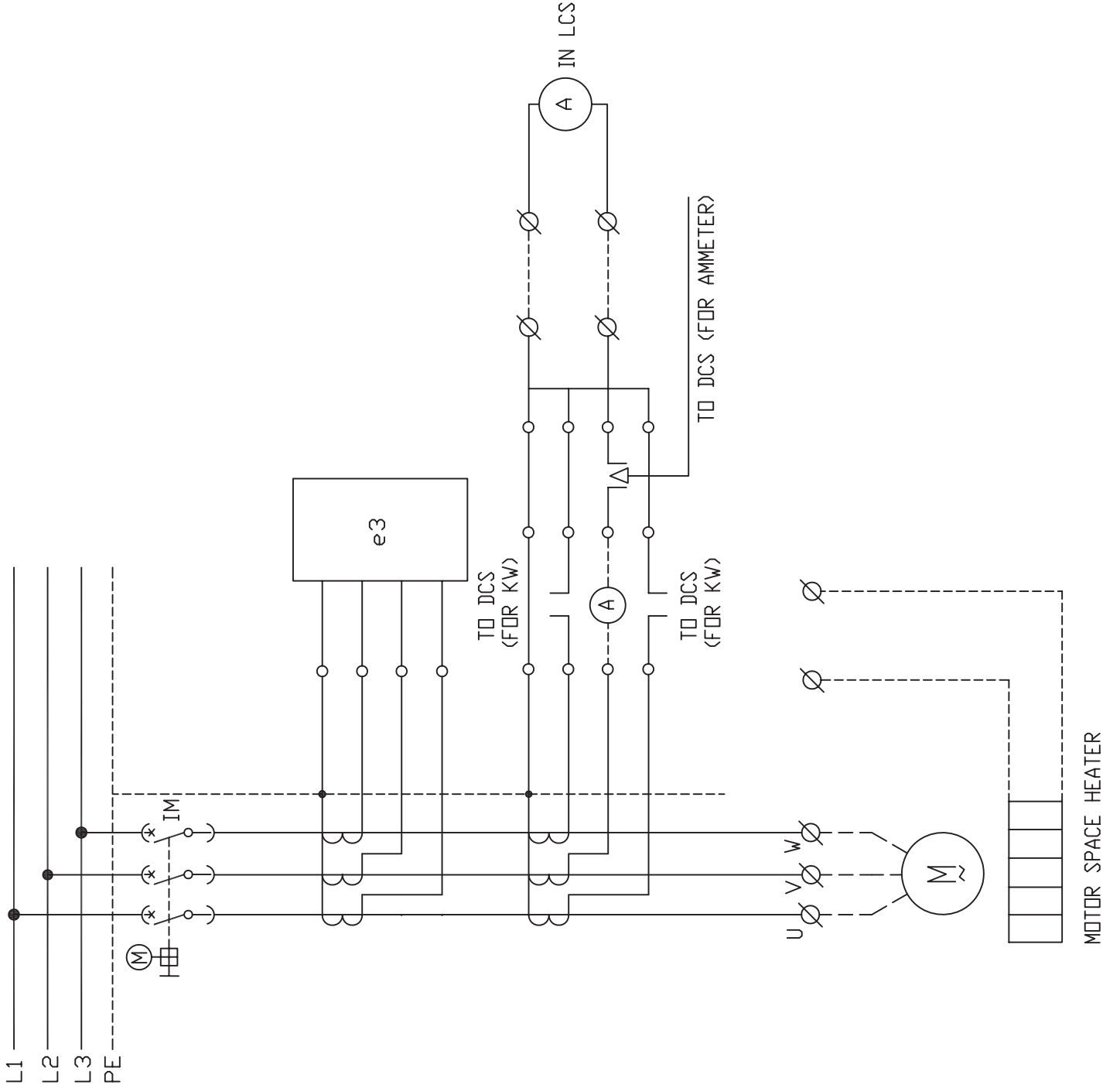
TRIPPING SCHEME



TRIP SELECTOR SWITCH

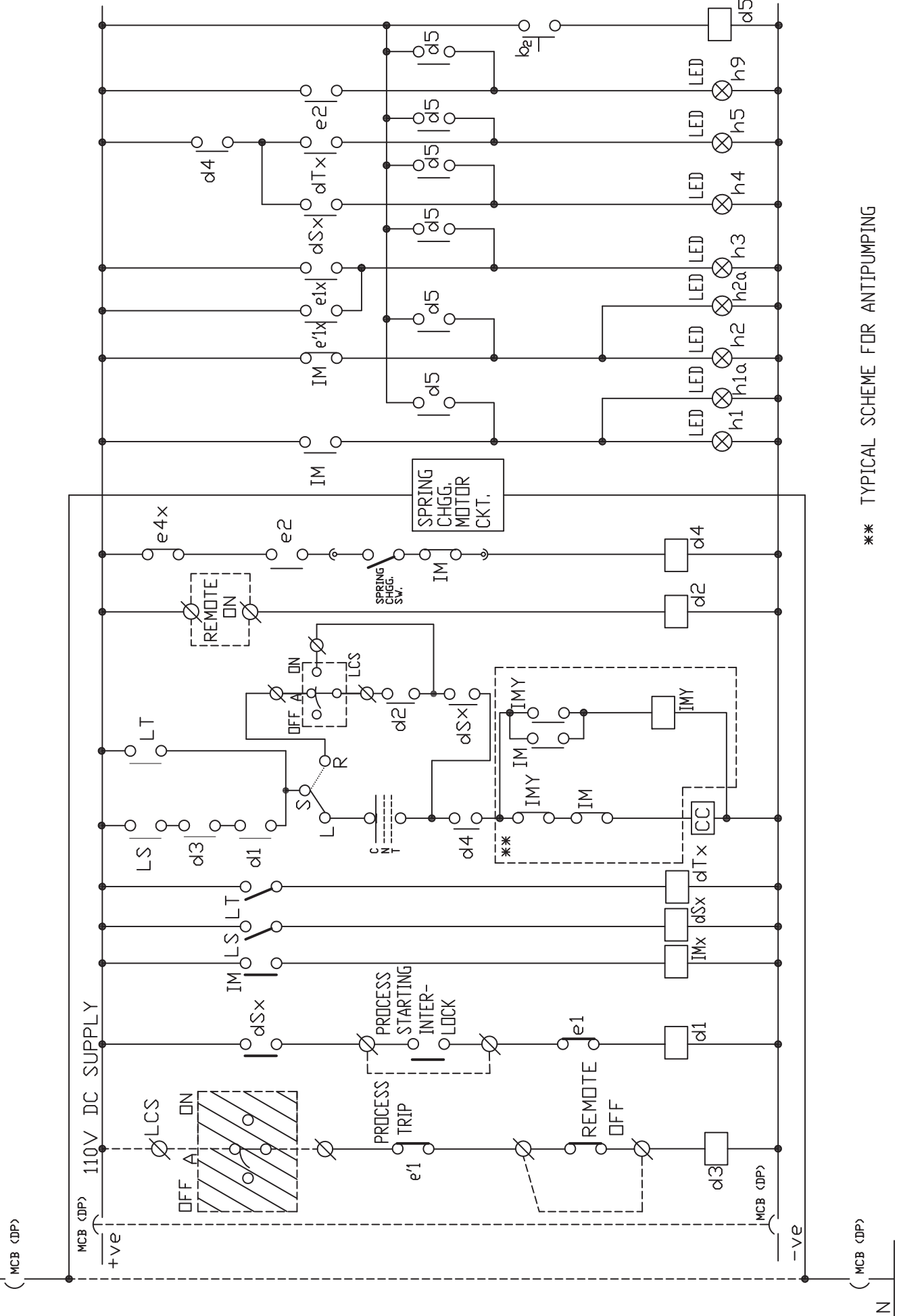






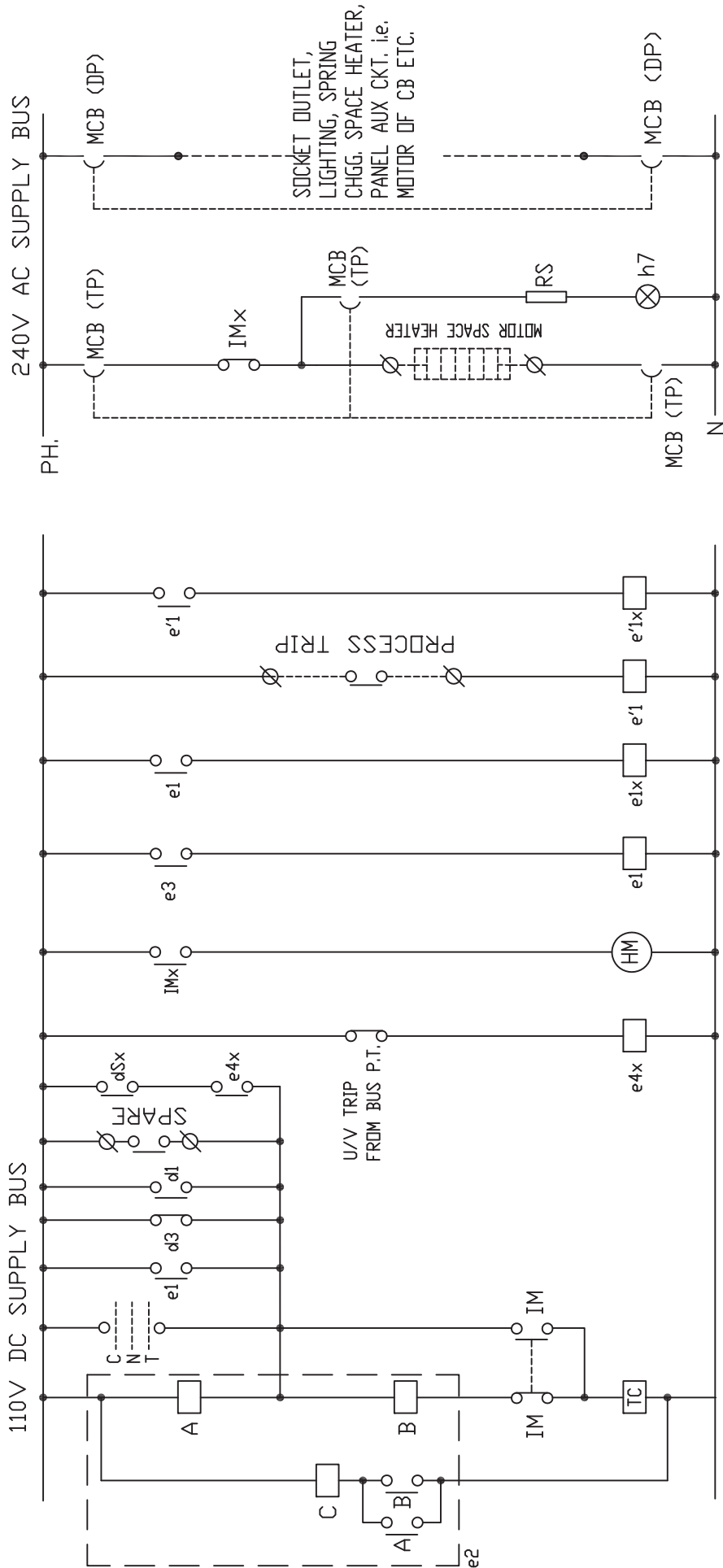
CLOSING & INDICATION SCHEME

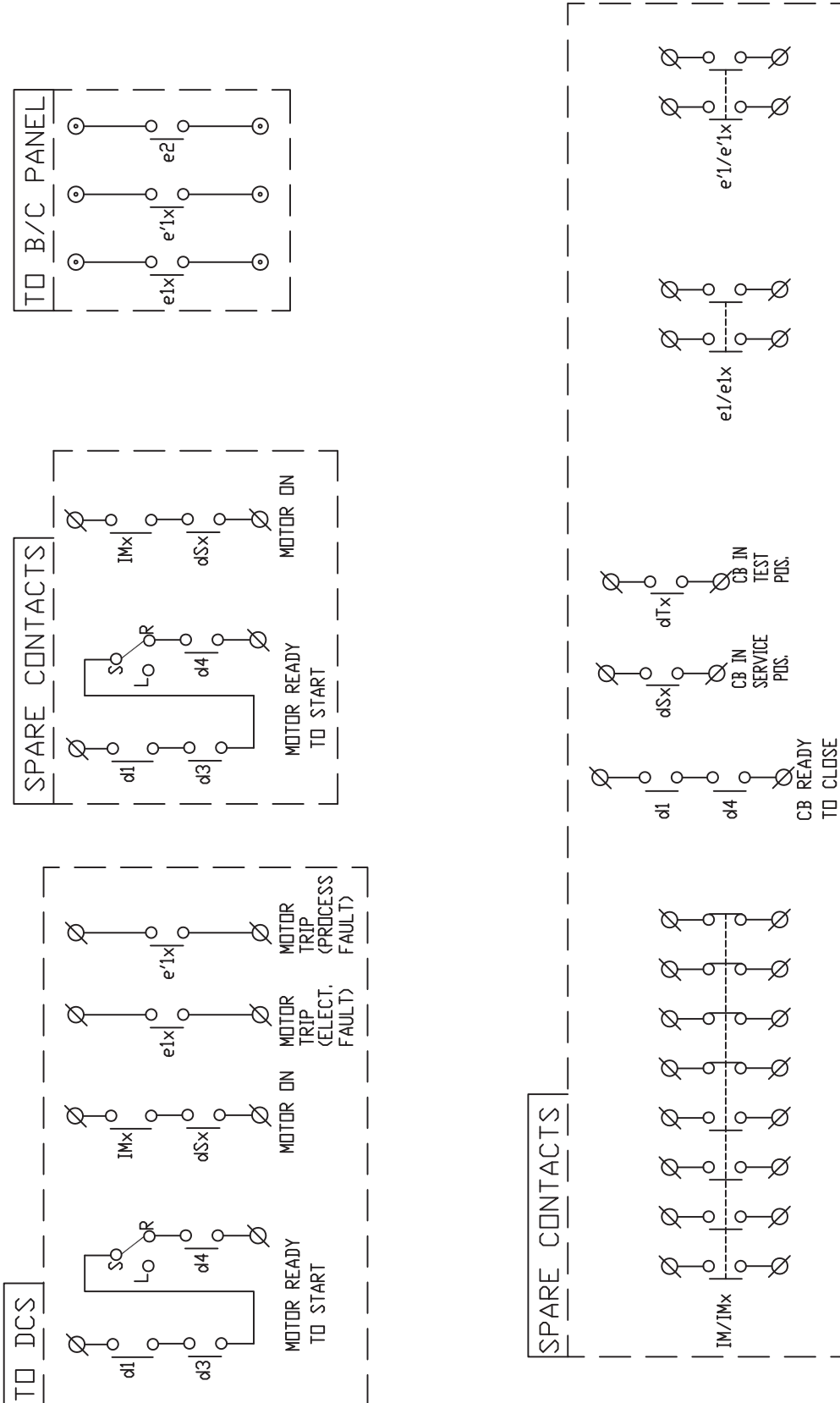
240V AC, 1 Ph., 50Hz BUS

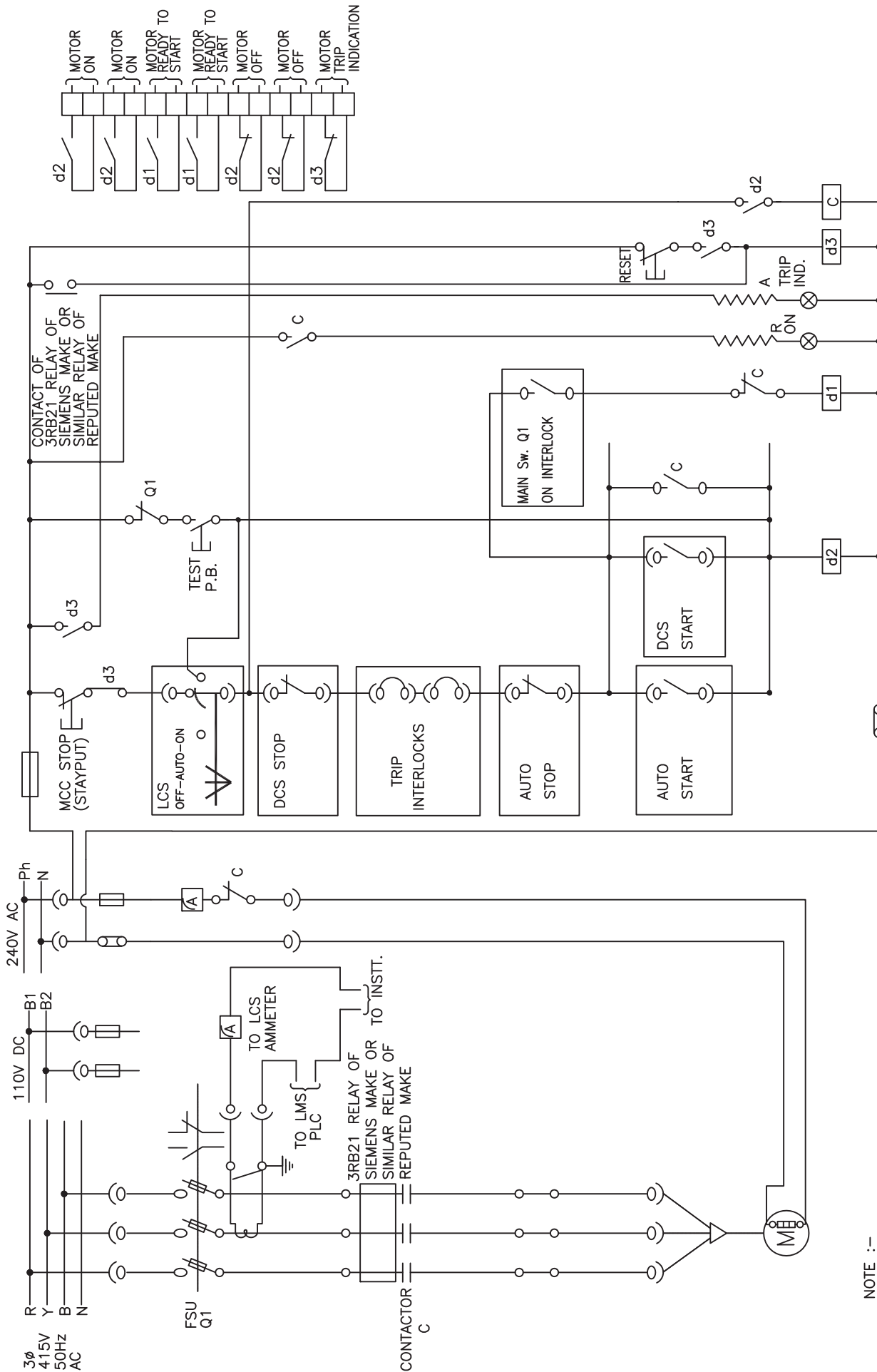


** TYPICAL SCHEME FOR ANTIPUMPING

TRIPPING SCHEME

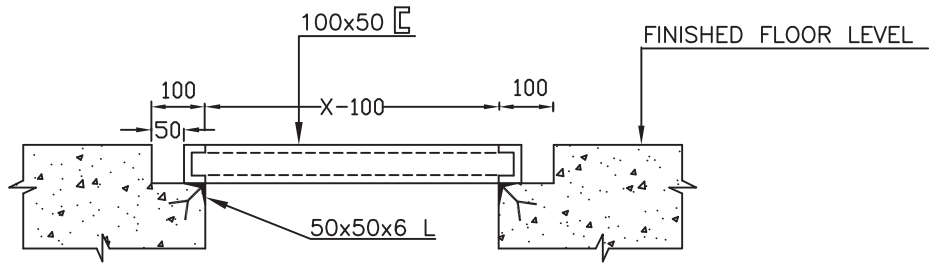




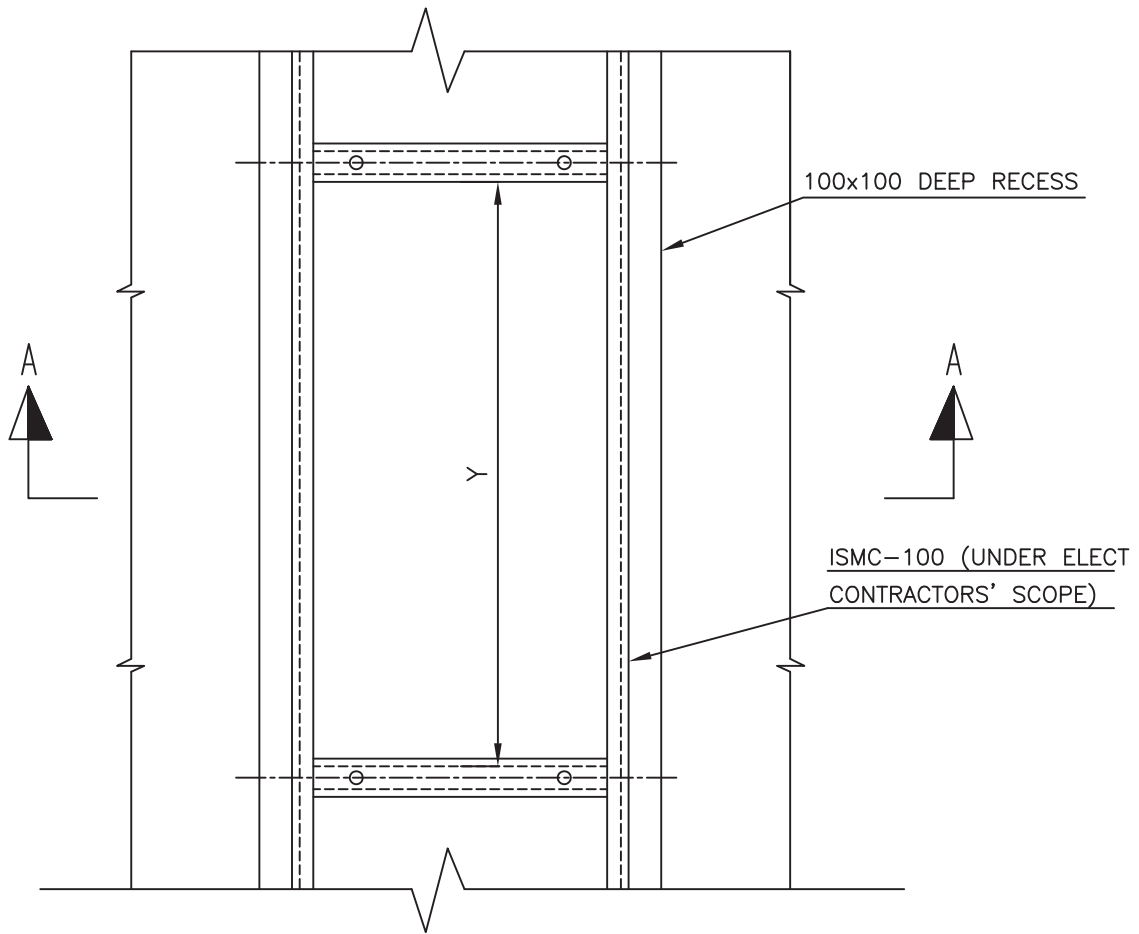


NOTE :-

1. Space heater shall be provided for motor rated 30KW and above.
2. CT provision for ammeter shall be done for 15KW & above rating motor feeders.
3. Shorting link shall be provided between interlock terminals.
4. All indicating lamp shall be LED type.



SECTION-A A



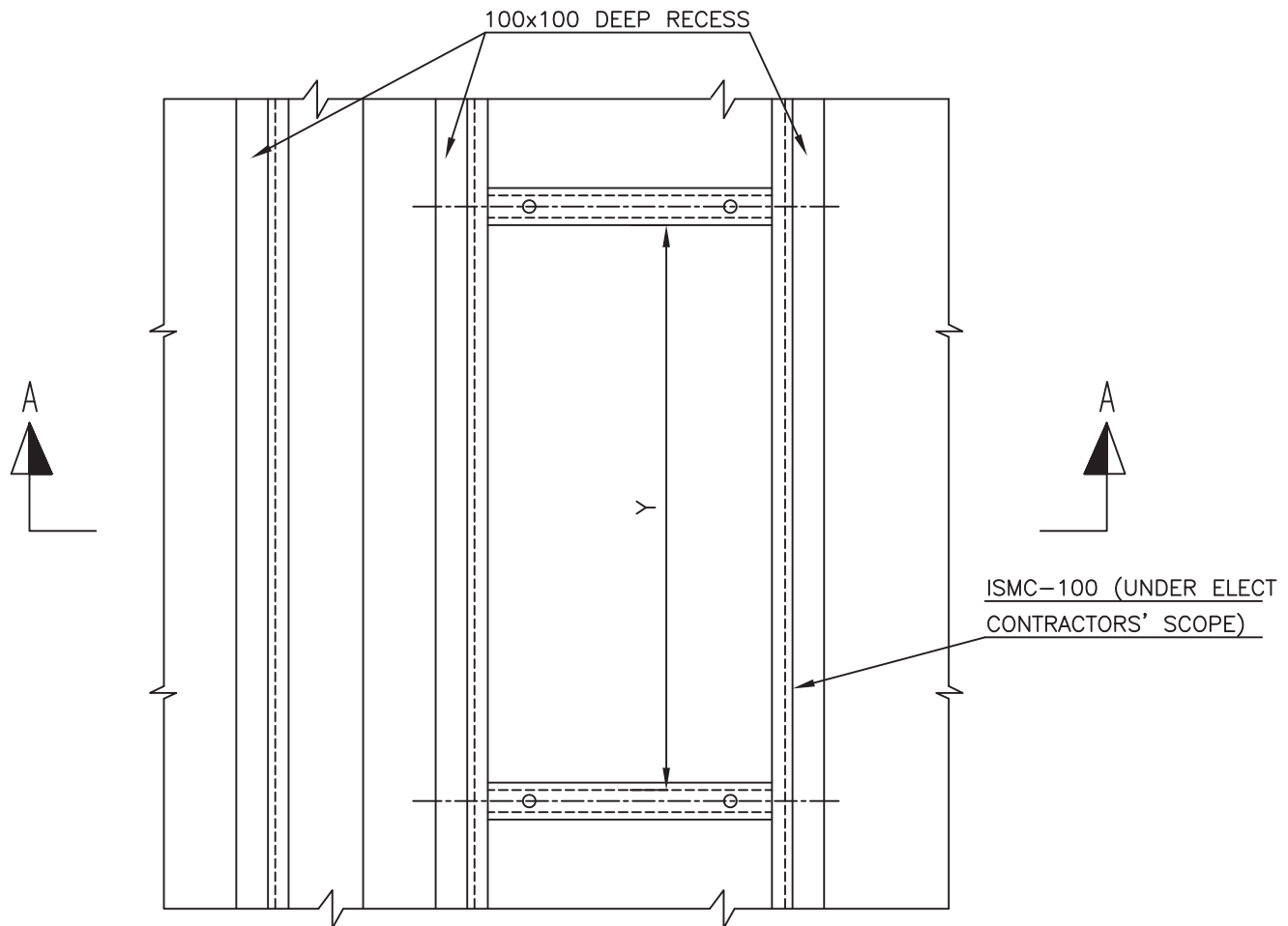
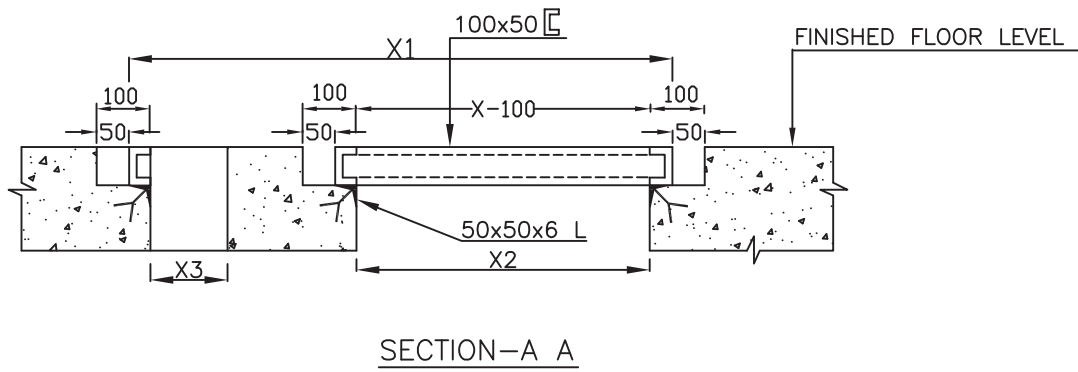
PLAN

X- DEPTH OF PANEL

Y- LENGTH OF TWO PANELS

NOTES:-

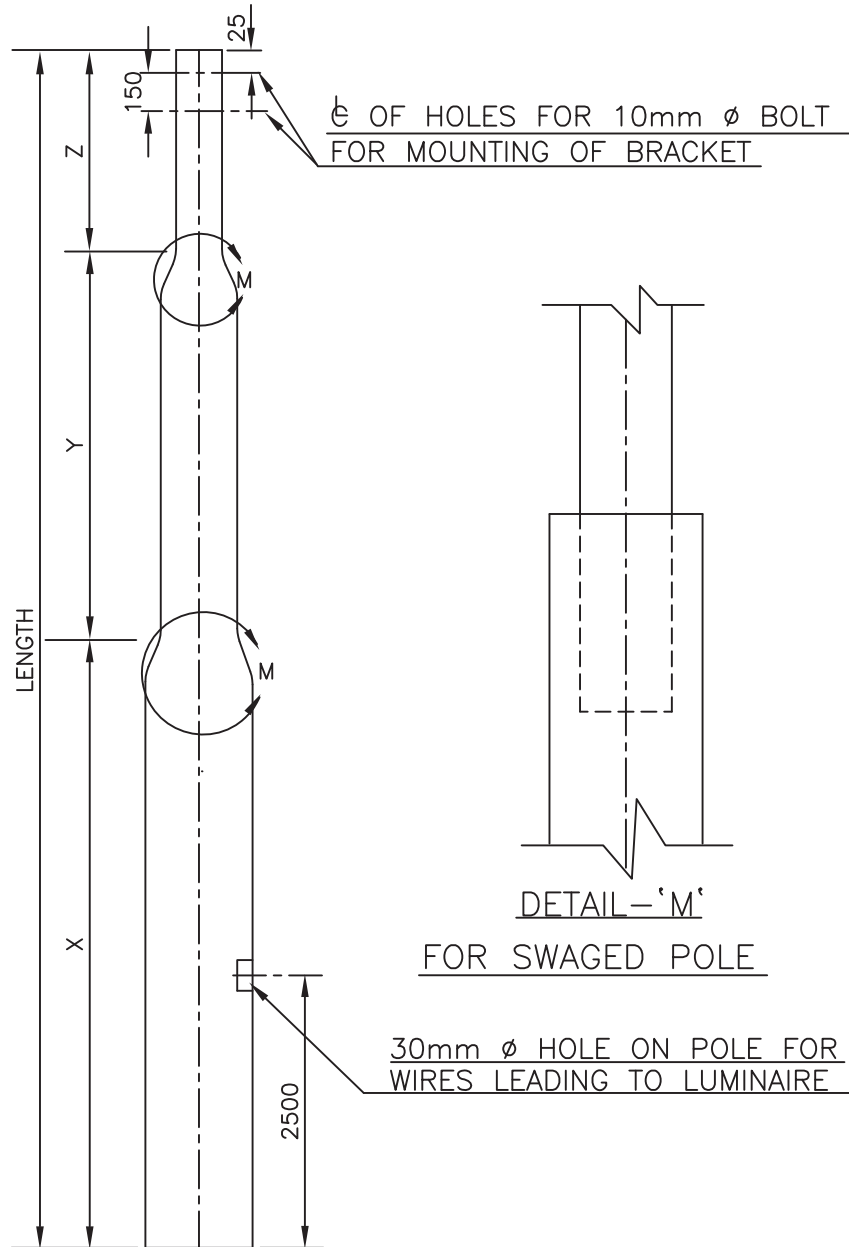
1. THIS ARRANGEMENT SHALL BE APPLICABLE FOR M.C.C., DISTRIBUTION BOARDS, CONTROL PANELS ETC.
2. PANELS AFTER ERECTION SHALL BE TAG WELDED TO FOUNDATION CHANNELS



X1 = DEPTH OF PANEL
X2 = FOOR OPENING
X3 = FOOR OPENING
Y = LENGTH OF PANEL

NOTES:-

1. PANELS AFTER ERECTION SHALL BE BOLTED TO FOUNDATION CHANNELS
2. POWER & CONTROL CABLES SHALL ENTER THROUGH OPENING X2
3. DEPENDING UPON THE FINAL DATA FROM THE VENDOR, ONLY TWO CHANNELS MAY BE NECESSARY IN WHICH CASE THE 3RD. RECESS SHALL BE FILLED AT SITE.

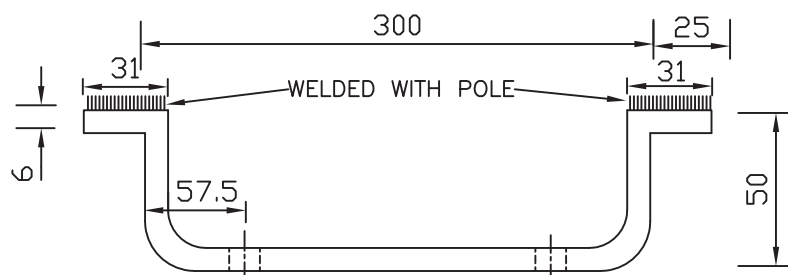
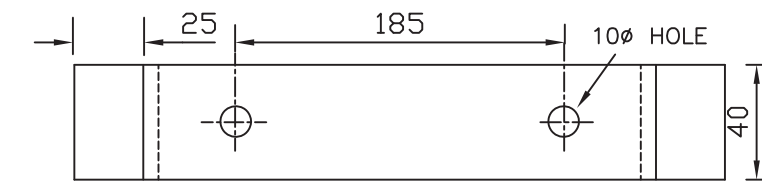
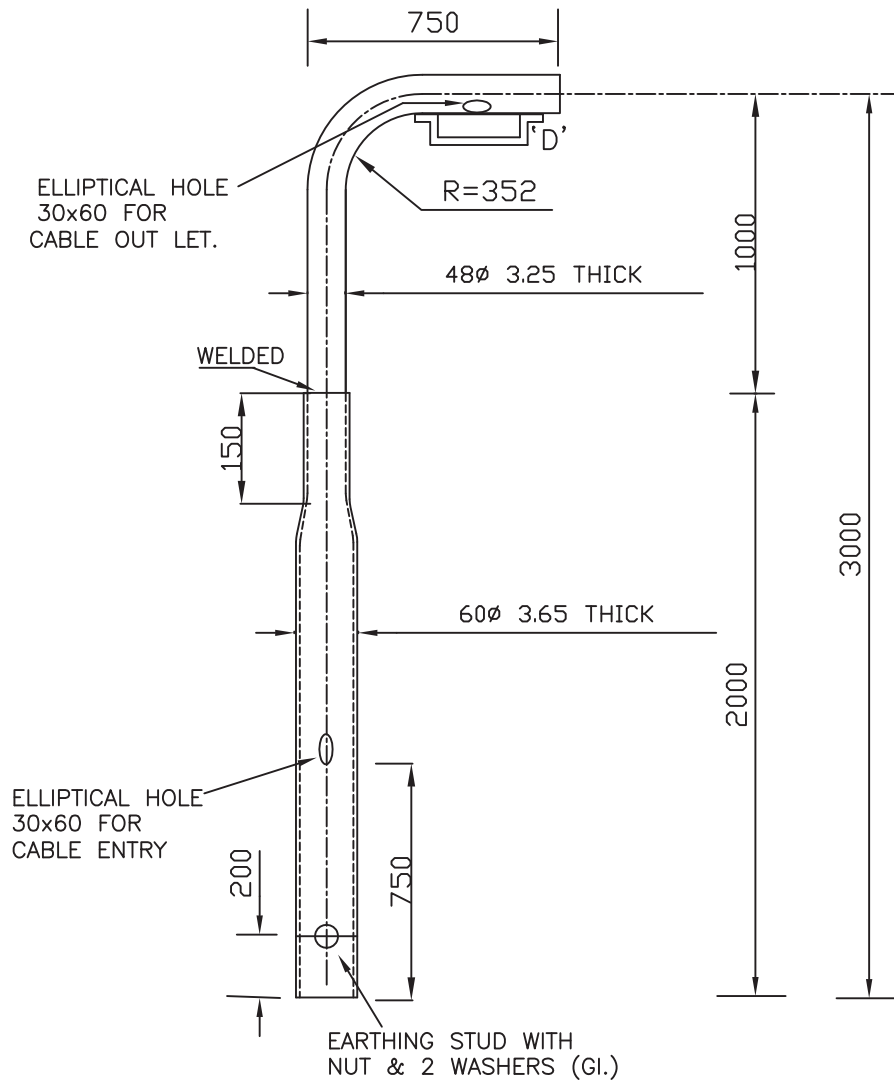


POLE DESIGNATION	LENGTH(M) $X+Y+Z=L$	PLANTING DEPTH(M)	DIAxTHICKNESS BOTTOM(mm)	DIA MIDDLE(mm)	DIA TOP(mm)	WEIGHT OF POLE (Kg)
410 TP3/SP3	$X+Y+Z=7$	1.25	114.3x4		78.1	87/85
410 TP12/SP12	$X+Y+Z=8$	1.5	114.3x4		78.1	101/97
410 TP13/SP13	$X+Y+Z=8$	1.5	139.7x4		88.9	125/119
410 TP27/SP27	$X+Y+Z=9$	1.5	114.3x4		76.1	113/108
410 TP30/SP30	$X+Y+Z=9$	1.5	139.7x4		88.9	140/133
410 TP33/SP33	$X+Y+Z=9$	1.5	165.1x4		114.3	170/184

NOTE:-

1. TP REFER TO STEPPED POLE.
2. SP REFER TO SWAGED POLE.
3. POLE DESIGNATION IS AS PER IS: 1239

SWAGED POLE TYPE 'B'

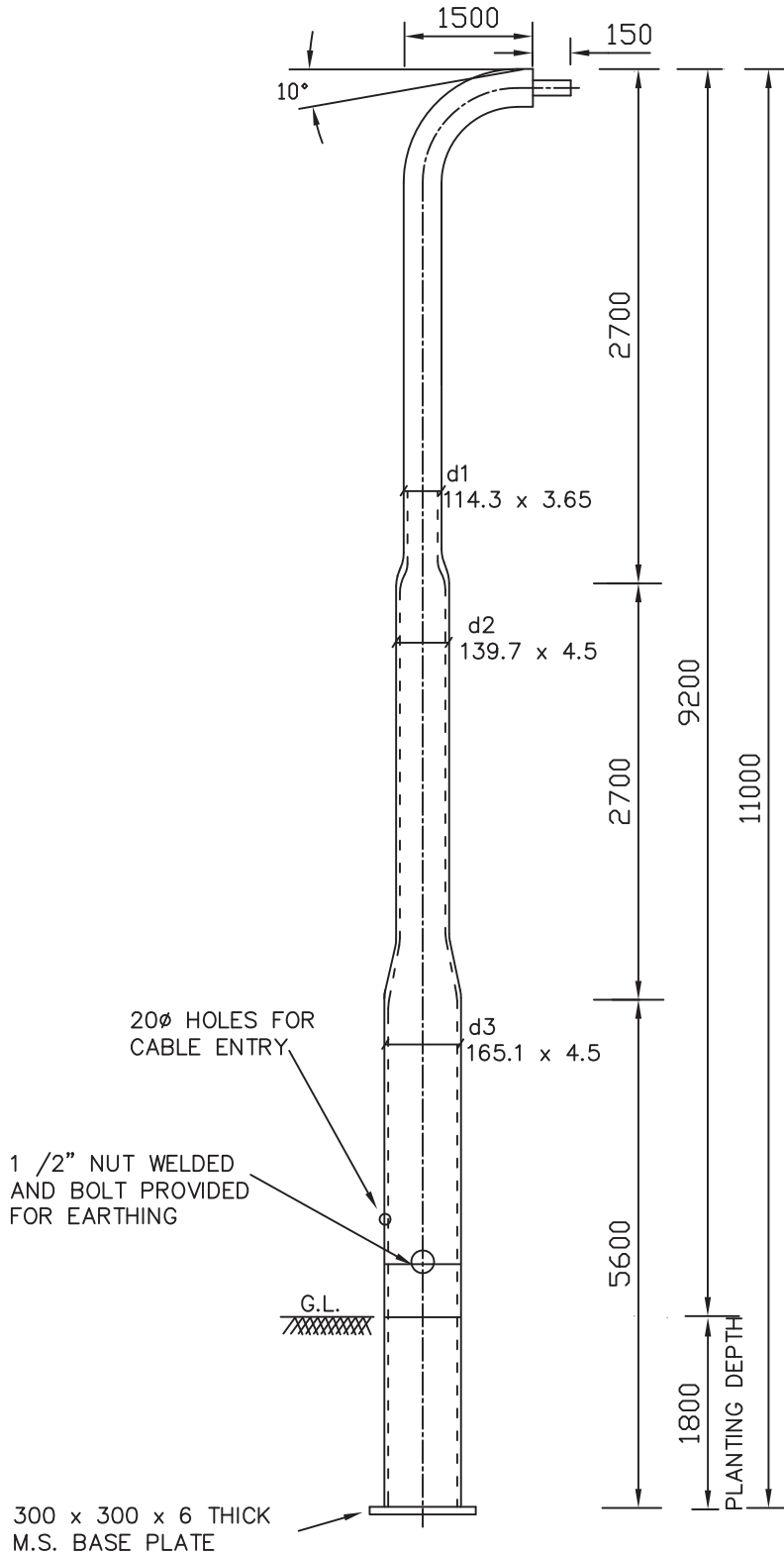


DETAIL-D

NOTE:-

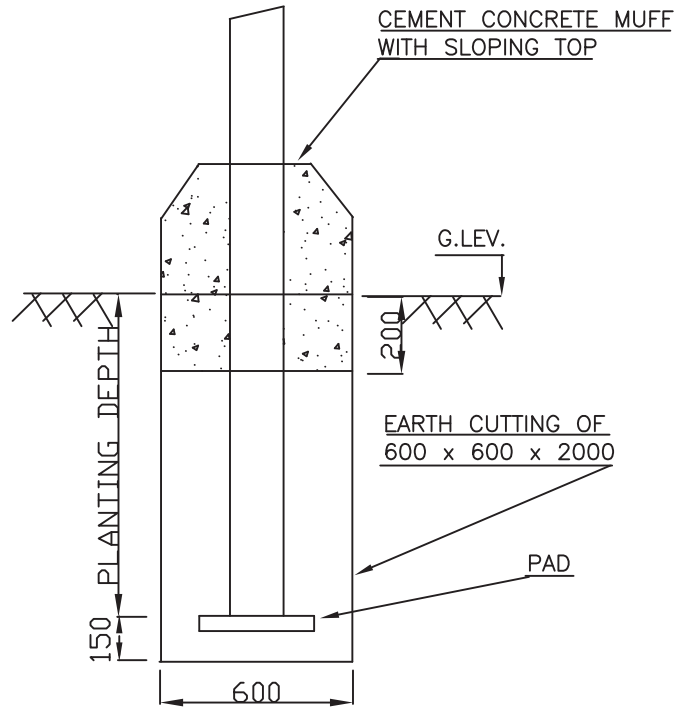
1. ALL DIMENSIONS ARE IN mm

SWAGED POLE TYPE 'C'
(FOR PLANT GROUND MOUNTING)



NOTES: -

1. NIPPLE OF DIA. 45 (NIPPLE TO BE PREPd. BY DIRECT REDUCTION OF DIA OF TOP PIPE WITHOUT USE OF ANY WASHER)
2. POLE MATERIAL MS AS PER IS 1239 ABOVE GROUND PORTION TO BE PAINTE 2 COATS OF RED OXIDE PRIMER, UNDER GROUND PORTION PAINTED BITUMINUS PAINT.
3. FOR FLOOD LIGHTING POLE THE TOP PORTION NOT TO BE TILTED BUT A 300 x 300 x 6mm THICK M.S. PLATE WELDED AT THE TOP SHALL BE PROVIDED TO MOUNT FLOOD LIGHT.
4. ALL DIMENSIONS ARE IN mm



1. FOR PAD USE:-

- a) 400x400x70 CONCRETE BLOCK FOR POLES.
- b) BASE PLATE AS SHOWN IN PDS:E 205 FOR STEEL TUBULAR POLES SHALL BE USED AS PAD
- c) RCC / WOOD POLES DO NOT NEED ANY PAD.

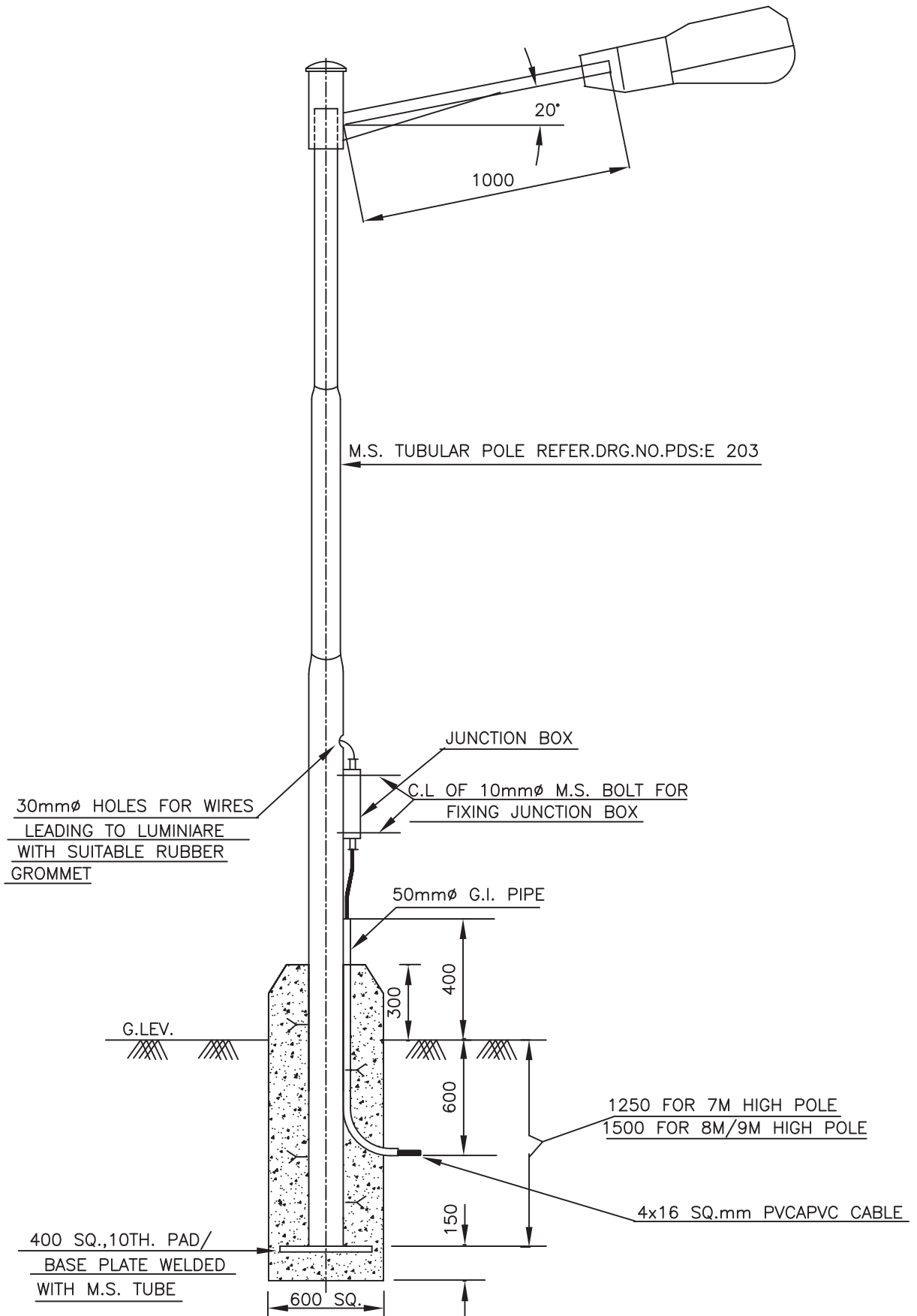
2. MUFF IS MUST FOR STEEL TUBULAR POLES AND OPTIONAL FOR OTHERS POLES, MUFF SHALL BE PROVIDED AFTER UNDER GROUND CABLING FOR STREET LIGHTING IS COMPLETED.

3. MUFF HEIGHT FROM GROUND LEVEL SHALL BE 300mm FOR ORDINARY POLES AND 457mm FOR STREET LIGHTING POLES HAVING J.B.LOCATED ON THE MUFF

4. FOR MOUNTING OF JBS' ON THE MUFF REFER PDS:E 209

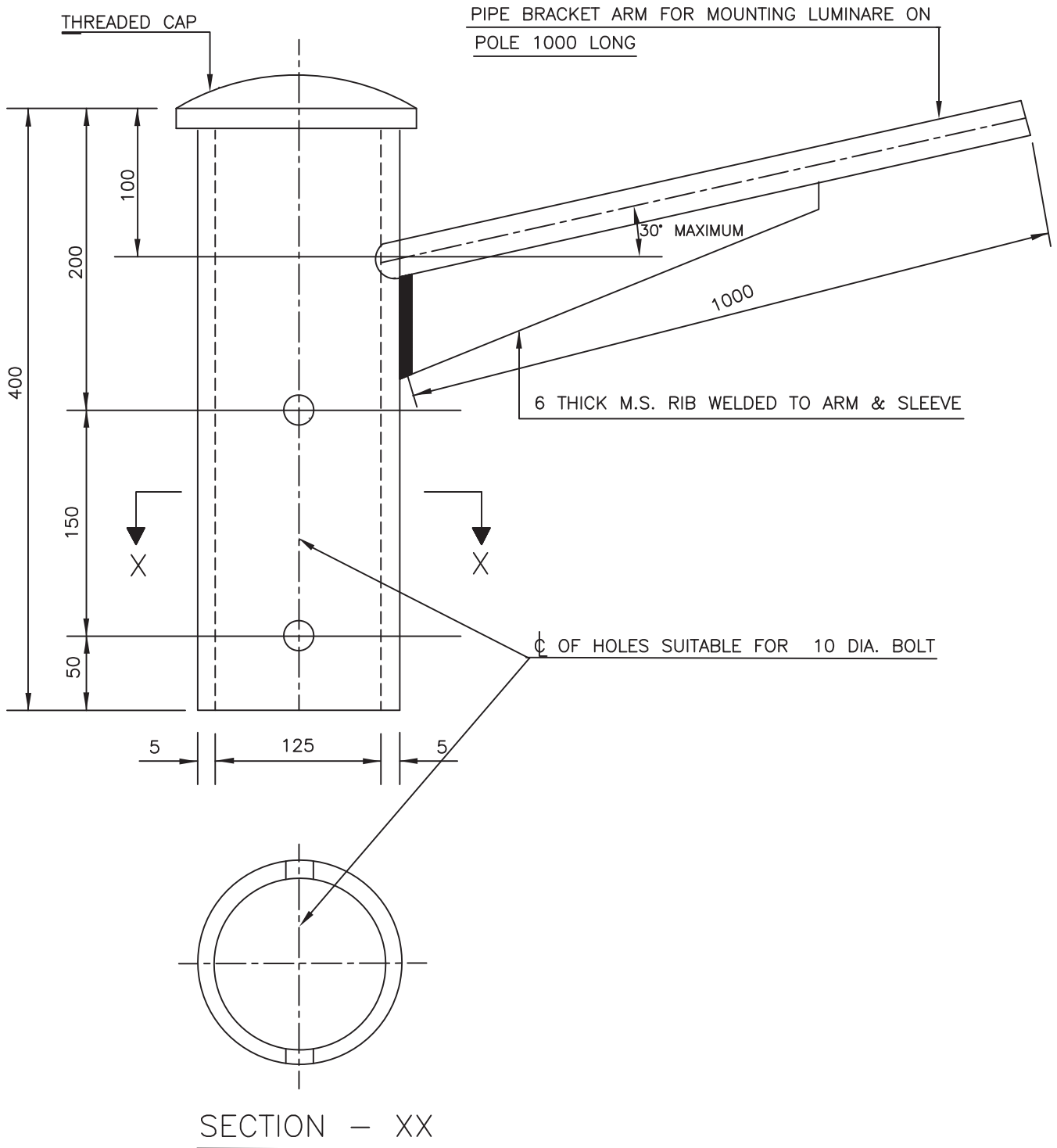
5. FOR PLANTING DEPTH REFER RELEVANT ISS.

6. ALL DIMENSIONS ARE IN mm



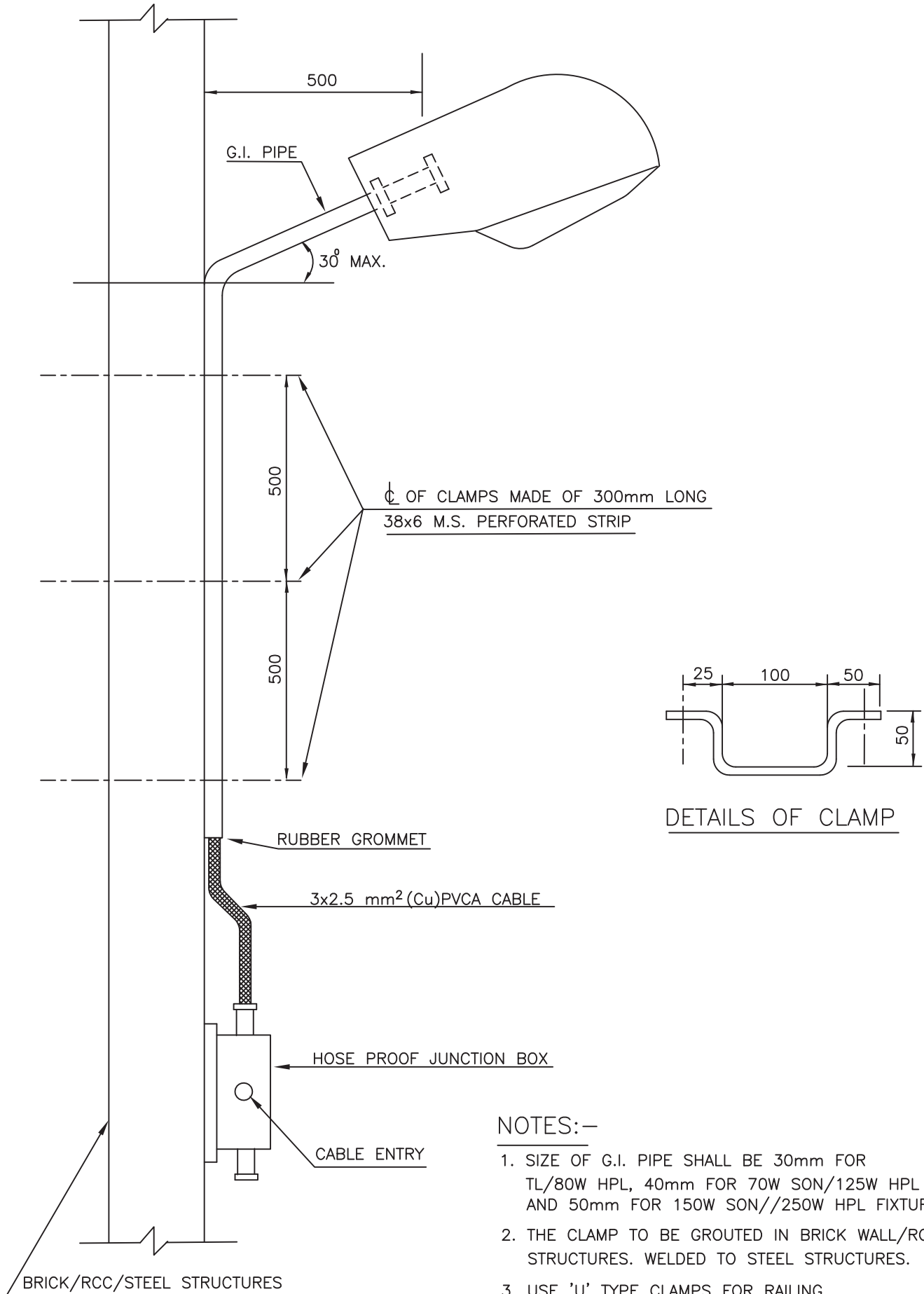
NOTE :-

ALL DIMENSIONS ARE IN mm.



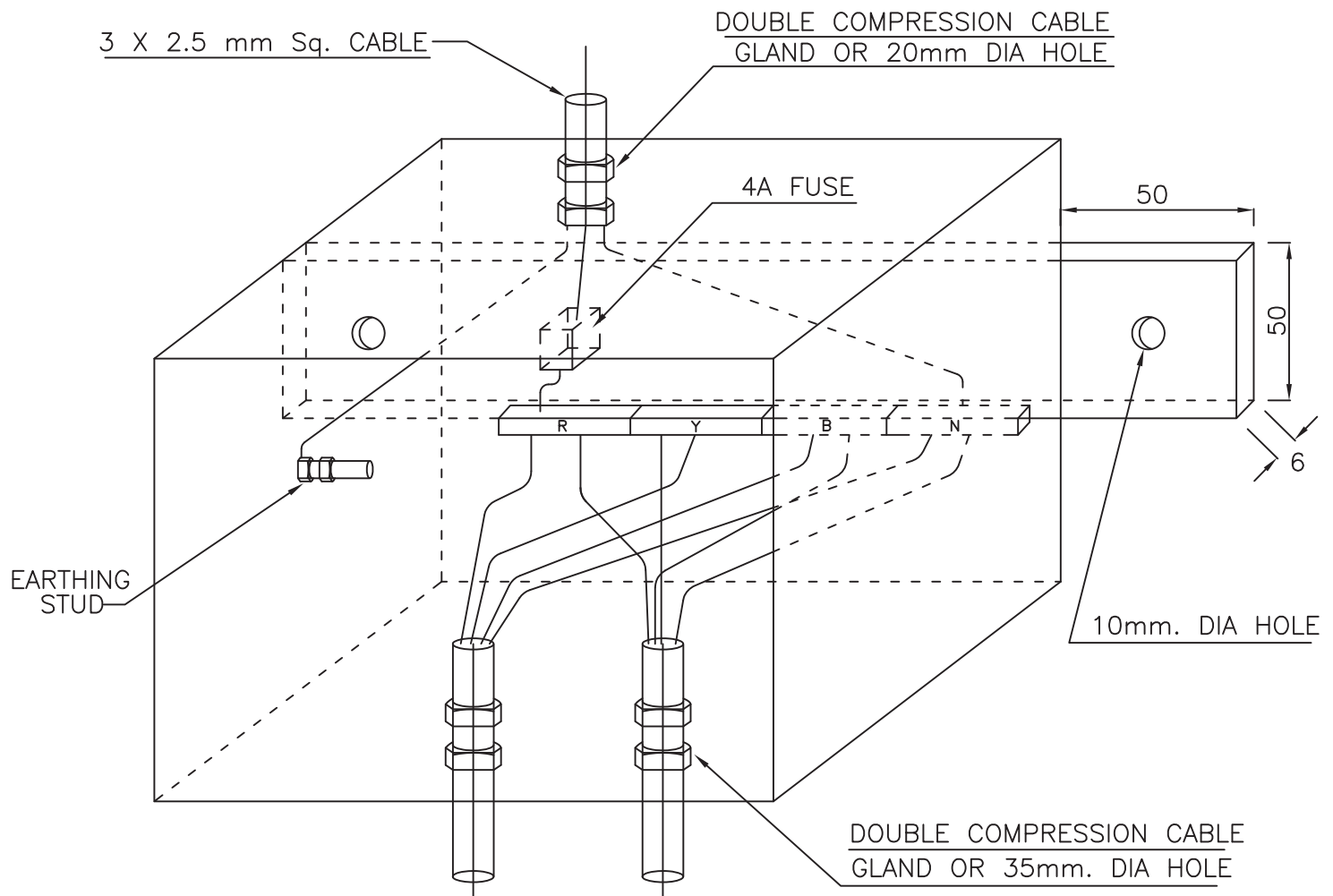
NOTES:-

1. SIZE OF PIPE SHALL BE 30mm FOR TL/80W HPL FIXTURES,
40mm FOR 70W SON/125W HPL FIXTURES AND 50mm FOR
150W SON/250W HPL FIXTURES.
2. ALL DIMENSIONS ARE IN mm.



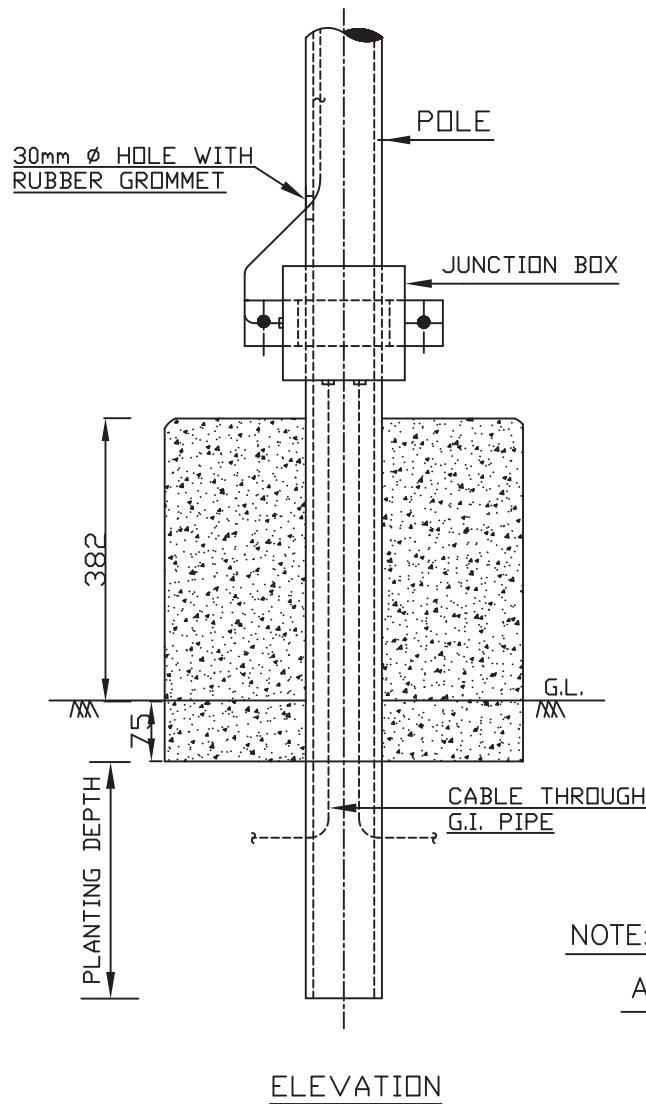
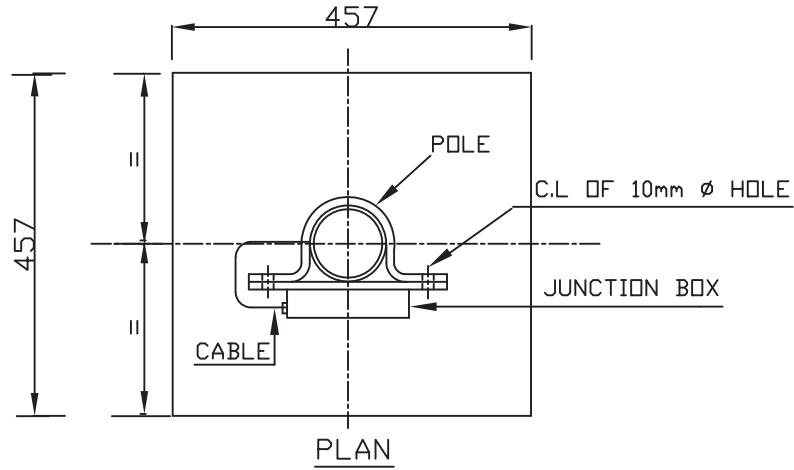
NOTES:-

1. SIZE OF G.I. PIPE SHALL BE 30mm FOR TL/80W HPL, 40mm FOR 70W SON/125W HPL AND 50mm FOR 150W SON//250W HPL FIXTURES.
2. THE CLAMP TO BE GROUTED IN BRICK WALL/RCC STRUCTURES. WELDED TO STEEL STRUCTURES.
3. USE 'U' TYPE CLAMPS FOR RAILING.
4. ALL DIMENSIONS ARE IN mm.



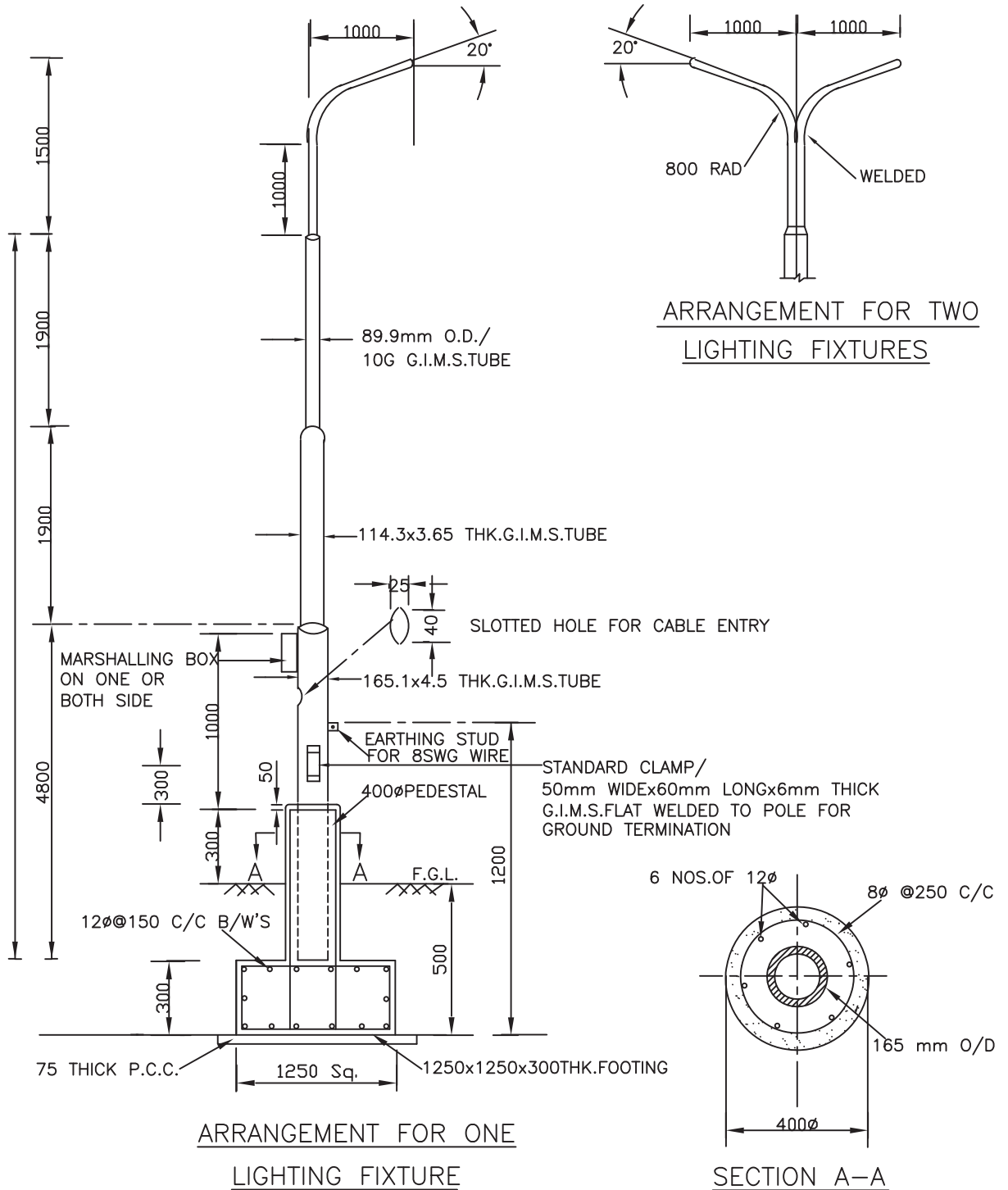
NOTE:—

1. THE MINIMUM INTERNAL DIMENSION OF THE J.B. SHALL BE 152 X 152 X 152.
2. THE FRONT DOOR SHALL BE HINGED & LOCKABLE TYPE.
3. THE CONNECTION OF FUSE TO THE PHASE 'R' IS TYPICAL ONE THE EXACT PHASE TO WHICH CONNECTION SHALL BE MADE SHALL BE DECIDED AT SITE.
4. FOR HAZARDOUS AREA'S THESE JUNCTION BOXES SHALL BE INCREASED SAFETY TYPE AND THE FUSE NEED NOT BE PROVIDED.
5. FOR POLE MOUNTED JUNCTION BOXES THE CABLE GLAND SHALL BE SIDE MOUNTED.
6. ALL DIMENSIONS ARE IN mm.



NOTE:—

ALL DIMENSIONS ARE IN mm



NOTE :-

1. CONCRETING AND APPROVED MOUNTING HARDWARE FOR LIGHTING FIXTURES ARE INCLUDING IN SCOPE OF SUPPLY.
2. CONCRETE FOUNDATION OF GRADE M15 SHALL BE PROVIDED.

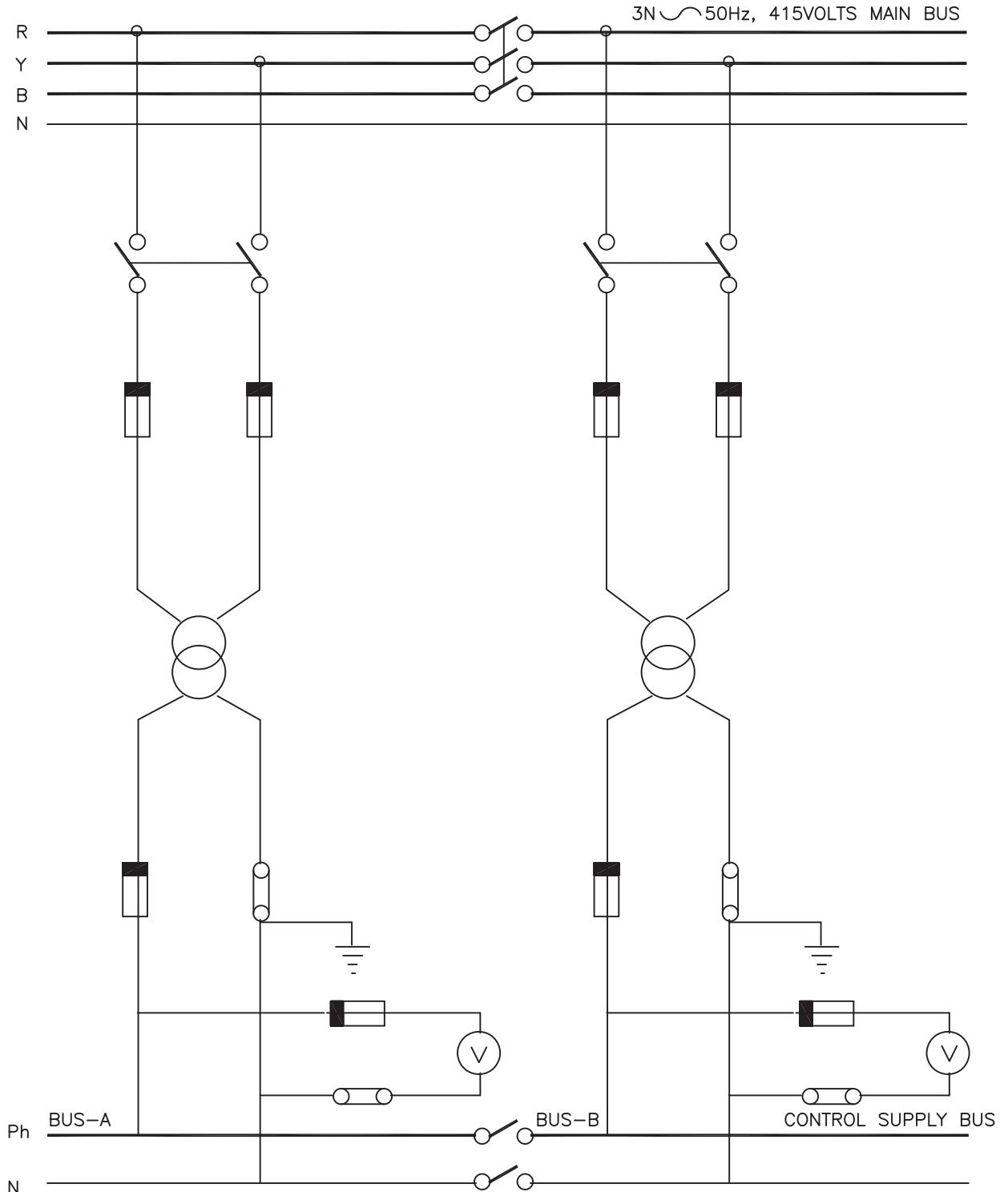
ALL DIMENSIONS ARE IN mm.

SL. NO.	MOTOR RATING IN KW	FULL LOAD CURRENT IN AMPS.	STARTING CURRENT IN AMPS.	MOTOR DUTY SWITCH RATING IN AMPS.	FUSE RATING IN AMPS.	CONTACTOR RATING IN AMPS.	THERMAL O/L RANGE IN AMPS.		C.T. RATIO	POWER CABLE SIZE sq. mm (PVC/APVC)
							L&T	SIEMENS		
1.	0.18	0.59	4.2	16	2	16	0.4-0.65	0.5-0.8	2/1	3x2.5(CU)
2.	0.25	0.88	6.3	16	4	16	0.6-1.0	0.8-1.2	2/1	3x2.5(CU)
3.	0.37	1.05	7.56	16	4	16	0.9-1.5	0.8-1.25	2/1	3x2.5(CU)
4.	0.55	1.50	10.8	16	6	16	1.4-2.3	1.0-1.6	2/1	3x2.5(CU)
5.	0.75	1.80	12.96	16	6	16	1.4-2.3	1.25-2.0	2/1	3x2.5(CU)
6.	1.10	2.50	18.0	16	10	16	2.3-3.0	2.0-3.2	5/1	3x2.5(CU)
7.	1.50	3.4	24.4	16	16	16	3.0-5.0	2.5-4.0	5/1	3x2.5(CU)
8.	2.20	4.60	33.1	16	16	16	4.5-7.5	3.2-5.0	5/1	3x2.5(CU)
9.	3.00	7.0	50.4	32	20	16	4.5-7.5	5.0-8.0	10/1	3x2.5(CU)
10.	3.70	7.3	52.5	32	20	16	6.0-10.0	5.0-8.0	10/1	3x2.5(CU)
11.	5.50	10.5	75.6	32	32	16	9.0-15.0	8.0-12.5	15/1	3x4(CU)
12.	7.50	14.0	100.8	63	32	16	9.0-15.0	10.0-16.0	20/1	3x6(CU)
13.	9.30	17.5	126.0	63	32	32	14.0-23.0	12.5-20.0	20/1	3x10(AL)
14.	11.0	20.6	148.3	63	63	32	14.0-23.0	16.0-25.0	25/1	3x10(AL)
15.	15.0	28.0	201.6	63	63	32	20.0-33.0	20.0-32.0	35/1	3x16(AL)
16.	18.5	33.0	237.6	100	80	40	30.0-50.0	25.0-36.0	40/1	3x25(AL)
17.	22.0	40.0	288.0	125	80	45	30.0-50.0	32.0-50.0	50/1	3x25(AL)
18.	30.0	52.0	374.4	125	100	70	45.0-75.0	40.0-57.0	60/1	3x35(AL)
19.	37.0	63.5	457.2	125	125	70	45.0-75.0	57.0-70.0	75/1	3x50(AL)
20.	45.0	76.0	557.2	200	160	110	66.0-110.0	70.0-95.0	100/1	3x70(AL)
21.	55.0	96.0	691.7	250	200	110	66.0-110.0	85.0-105.0	125/1	3x95(AL)
22.	67.5	119.0	858.0	250	200	200	90.0-150.0	85.0-135.0	125/1	3x150(AL)
23.	75.0	140.0	1008.0	A.C.B.	A.C.B.	A.C.B.	MICROPROCESSOR RELAY	150/1	3x185(AL)	
24.	90.0	156.0	1123.2	A.C.B.	A.C.B.	A.C.B.	MICROPROCESSOR RELAY	175/1	3x240(AL)	
25.	110.0	192.0	1382.4	A.C.B.	A.C.B.	A.C.B.	MICROPROCESSOR RELAY	225/1	3x300(AL)	
26.	125.0	217.0	1627.5	A.C.B.	A.C.B.	A.C.B.	MICROPROCESSOR RELAY	250/1	3x400(AL)	
27.	132.0	234.0	1684.8	A.C.B.	A.C.B.	A.C.B.	MICROPROCESSOR RELAY	250/1	3x400(AL)	
28.	160.0	279.0	2008.8	A.C.B.	A.C.B.	A.C.B.	MICROPROCESSOR RELAY	300/1	2-3x185(AL)	
29.	180.0	304.0	2188.8	A.C.B.	A.C.B.	A.C.B.	MICROPROCESSOR RELAY	350/1	2-3x240(AL)	

NOTE:-

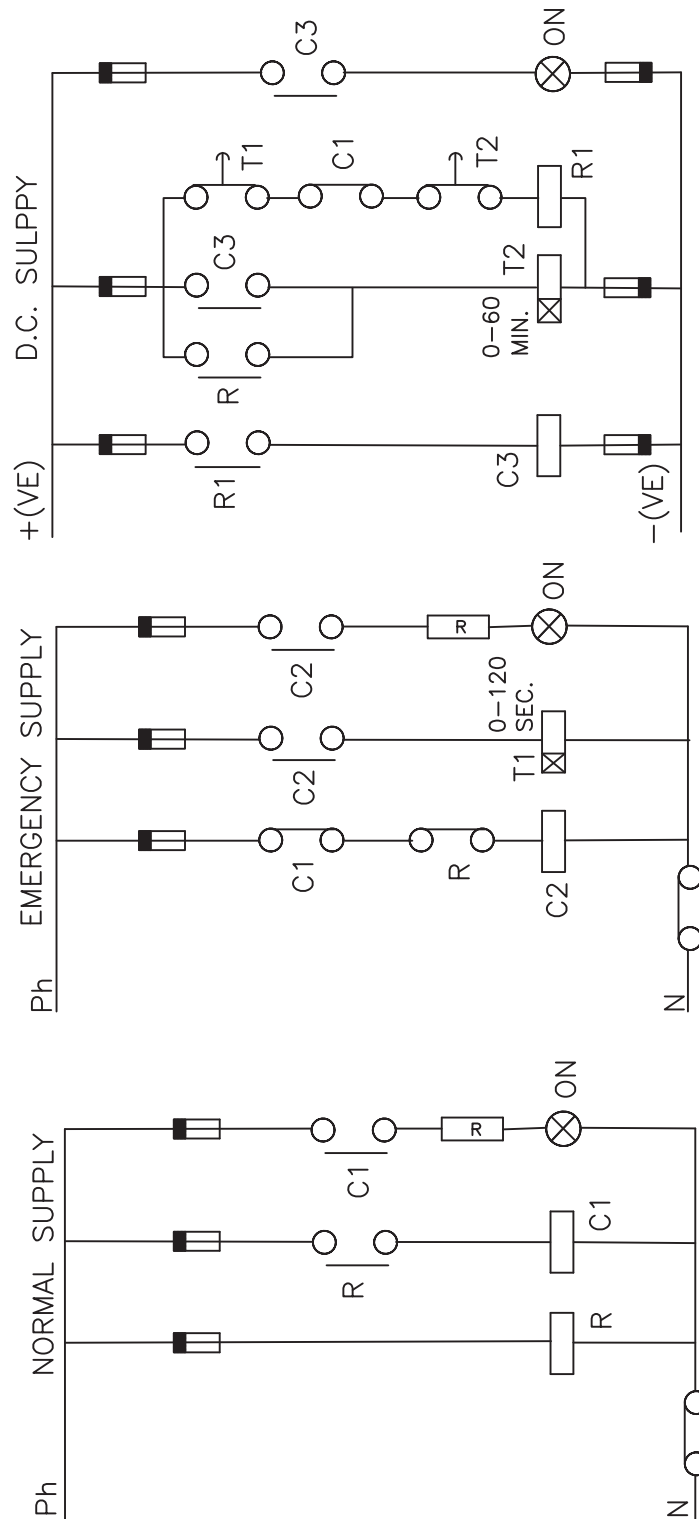
1. THE ABOVE DATA IS APPLICABLE FOR 415V, 4 POLE MOTORS.
2. AMMETERS SHALL HAVE UNIFORM SCALE UPTO C.T. PRIMARY CURRENT AND COMPRESSED END SCALE UPTO SIX TIMES THE C.T. PRIMERY CURRENT.
3. POWER CABLE SIZE SHALL BE SUBJECT TO VOLTAGE DROP CHECK.

SL. NO.	FEEDER RATING		SWITCH RATING AC-23	FUSE RATING (AMP)	C.T. RATIO	AMMETER SCALE RANGE	* POWER CABLE SIZE sq. mm (PVCAPVC)	REMARKS
	KVA	AMP						
1.	10	16	32	25	20/5	0-20	3/4x6(CU)	
2.	25	40	63	63	50/5	0-50	3/4x25(AL)	
3.	35	50	100	80	60/5	0-60	3/4x35(AL)	
4.	45	60	100	100	75/5	0-75	3/4x50(AL)	
5.	50	70	100	100	75/5	0-75	3/3.5x70(AL)	
6.	60	80	125	125	100/5	0-100	3/3.5x70(AL)	
7.	65	90	200	160	100/5	0-100	3/3.5x95(AL)	
8.	70	100	200	160	125/5	0-125	3/3.5x120(AL)	
9.	80	125	200	200	150/5	0-150	3/3.5x150(AL)	
10.	100	150	250	250	200/5	0-200	3/3.5x185(AL)	
11.	125	175	315	300	200/5	0-200	3/3.5x240(AL)	
12.	140	200	315	300	250/5	0-250	3/3.5x300(AL)	
13.	170	250	400	400	300/5	0-300	2-3/3.5x150(AL)	
14.	200	300	400	-	400/5	0-400	2-3/3.5x185(AL)	
15.	275	400	630	-	630/5	0-630	2-3/3.5x300(AL)	
16.	350	500	630	-	630/5	0-630	3-3/3.5x240(AL)	
17.	425	600	800	-	800/5	0-800	3-3/3.5x300(AL)	
18.	500	700	800	-	800/5	0-800	3-3/3.5x400(AL)	



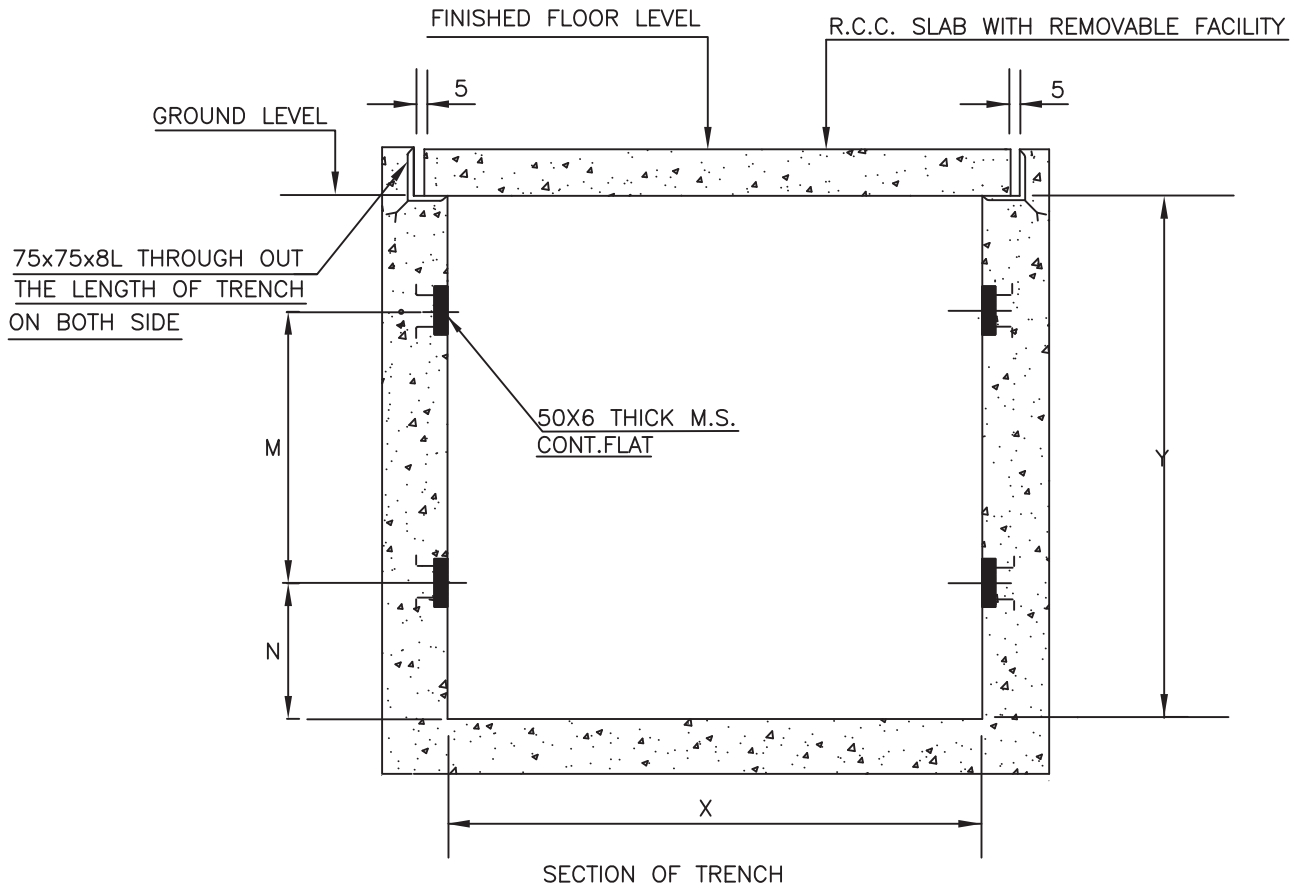
NOTES:-

1. EACH TRANSFORMER SHALL BE RATED FOR 2.5 TIMES THE TOTAL CONTROL SUPPLY LOAD.
2. THE CONTROL BUS INTERCONNECTING SWITCH SHALL BE LOCKABLE IN OFF POSITION AND LOCATED IN BUS COUPLER PANEL.



NOTE:-

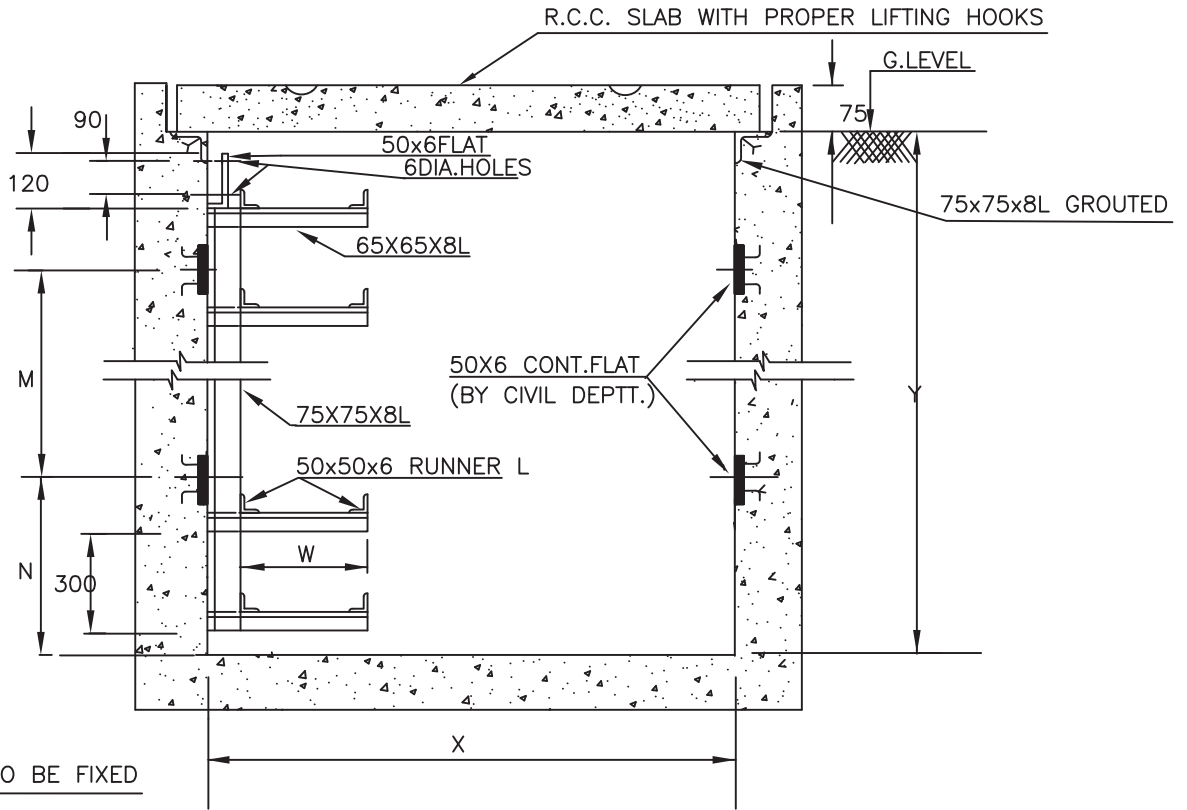
CONTACTORS C1,C2 AND C3 CONTROLS THE LIGHTING FEEDERS FOR NORMAL,EMERGENCY AND D.C. SUPPLY RESPECTIVELY.



DESIGN TYPE	X	Y	N	M
5T 350DS.	1400	1500	400	650
4T 350DS.	1400	1200	250	650
3T 350DS.	1400	900	250	300
5T 350SS.	1000	1500	400	650
4T 350SS.	1000	1200	250	650
3T 350SS.	1000	900	250	300
5T 250DS.	1200	1500	400	650
4T 250DS.	1200	1200	250	650
3T 250DS.	1200	900	250	300
5T 250SS.	900	1500	400	650
4T 250SS.	900	1200	250	650
3T 250SS.	900	900	250	300

NOTES:—

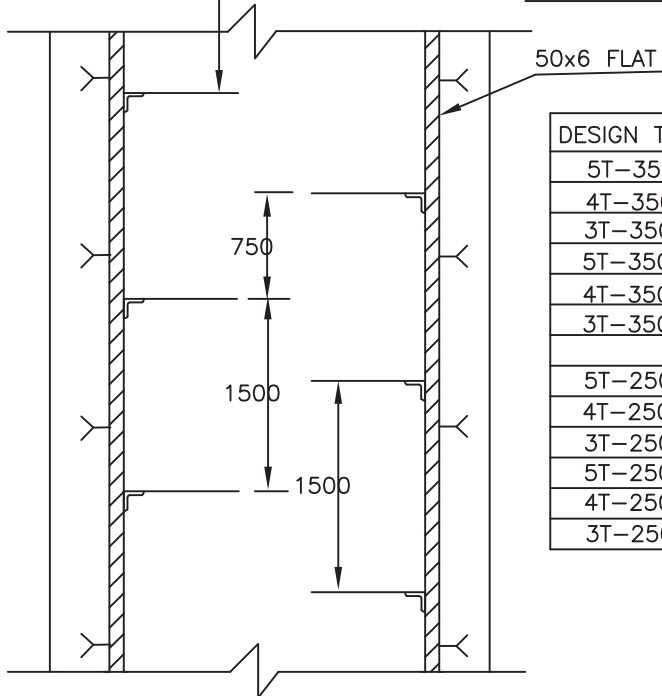
1. THE TOP OF TRENCH SHALL MATCH THE FLOOR LEVEL IN PLANT AREA.
2. IN INDOORS INSTEAD OF RCC SLAB, 20mm. THICK AL. EXTRUDED PLANK OR 10mm. THICK M.S. CHEQUERED PLATE SHALL BE USED AS PER PDS: E 507.
3. PROPER SLOPE TO BE GIVEN IN THE TRENCH FOR NATURAL DRAINAGE.
4. SS—SINGLE SIDE CABLE SUPPORTS.
5. DS—DOUBLE SIDE CABLE SUPPORTS.
6. ALL DIMENSIONS ARE IN mm.



CABLE SUPPORTS TO BE FIXED

@ 1500 INTERVAL

SECTION OF TRENCH



TYPICAL PLAN OF TRENCH

DESIGN TYPE	X	Y	N	M	W
5T-350-DS.	1400	1500	400	650	350
4T-350-DS.	1400	1200	250	650	350
3T-350-DS.	1400	900	250	300	350
5T-350-SS.	1000	1500	400	650	350
4T-350-SS.	1000	1200	250	650	350
3T-350-SS.	1000	900	250	300	350
5T-250-DS.	1200	1500	400	650	250
4T-250-DS.	1200	1200	250	650	250
3T-250-DS.	1200	900	250	300	250
5T-250-SS.	900	1500	400	650	250
4T-250-SS.	900	1200	250	650	250
3T-250-SS.	900	900	250	300	250

- NOTES: -1. SS-SINGLE SIDE CABLE SUPPORT.
 2. DS-DOUBLE SIDE CABLE SUPPORT.
 3. ALL DIMENSIONS ARE IN mm.

FABRICATION DETAILS OF CABLE RACK
IN TRENCH AND DUCT

PDS: E 512

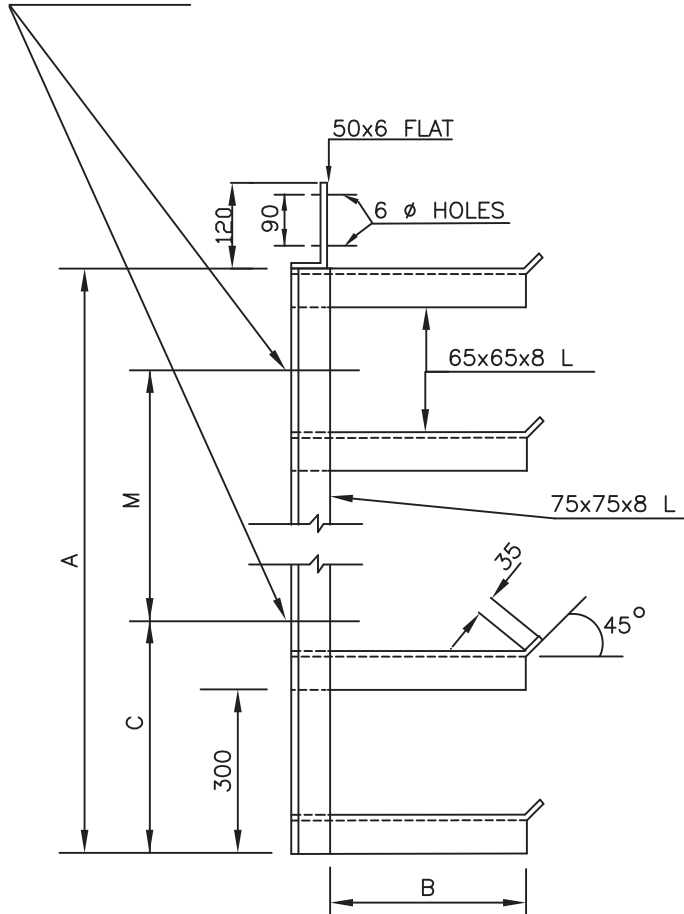
1

DOCUMENT NO.

REV

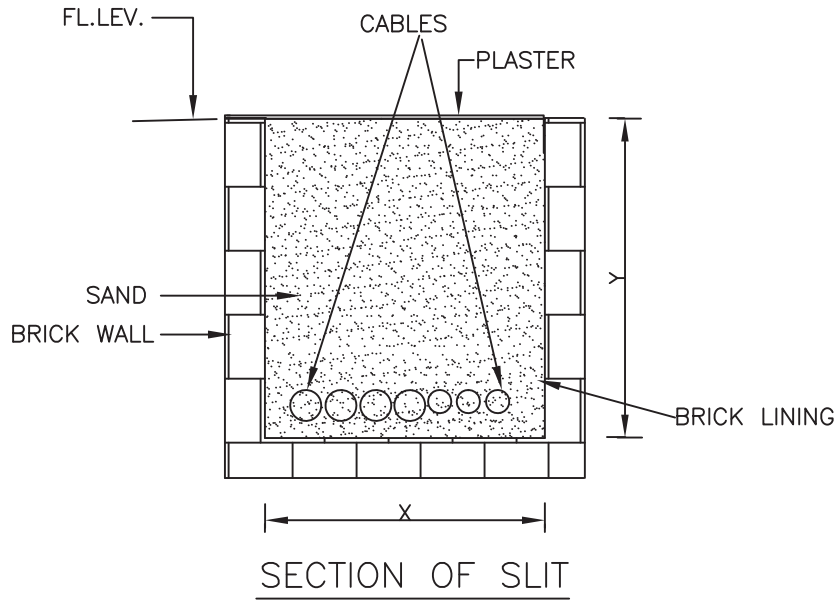
SHEET 1 OF 1

BACK FACE OF L TO BE WELDED AT THESE POINTS
WITH 50x6 M.S. CONTINUOUS FLAT PROVIDED IN
CABLE TRENCH



DESIGN TYPE	A	B	C	M	WT.OF STEEL PER UNIT(kg)
5T 350	1265	350	365	650	35
4T 350	965	350	215	650	28
3T 350	665	350	215	300	21
5T 250	1265	250	215	650	30
4T 250	965	250	215	650	25
3T 250	665	250	215	300	20

ALL DIMENSIONS ARE IN mm.

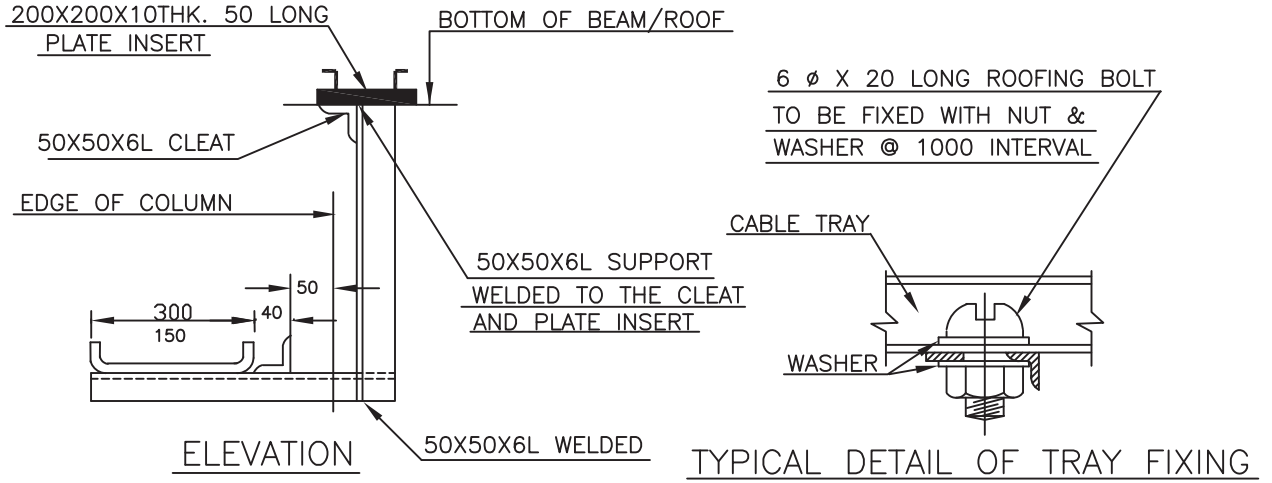


DESIGN TYPE	X	Y
S 300	300	300
S 200	200	200

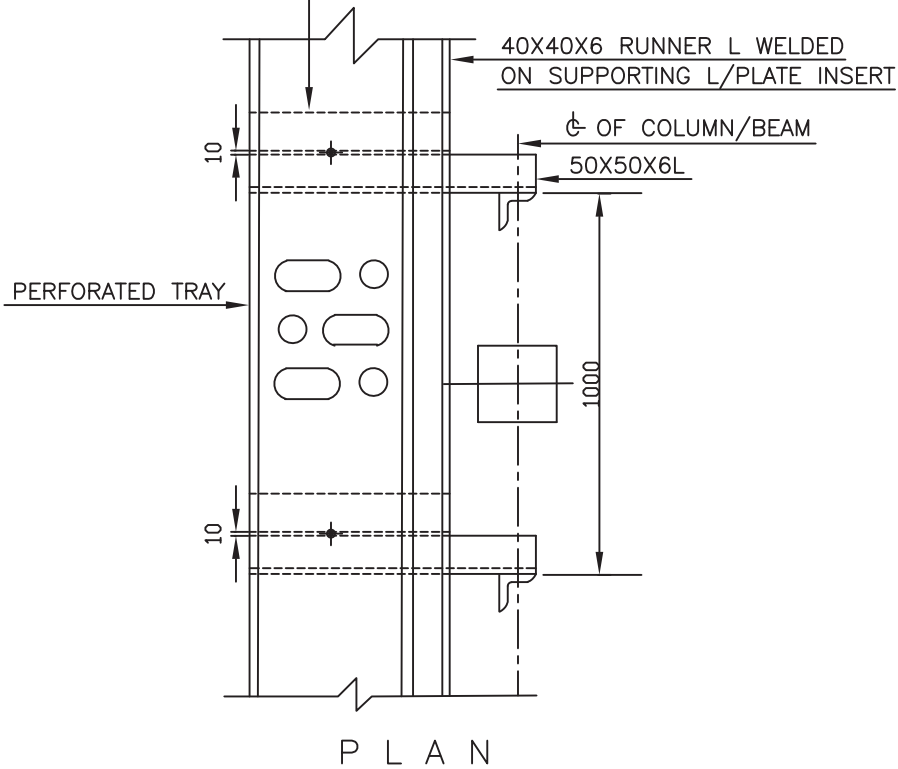
NOTE:—

1. CABLE SLITS SHALL BE FILLED WITH SAND AND PROPERLY PLASTERED WITH LEAN CONCRETE AFTER LAYING OF CABLES.
2. WHEREVER CABLES ARE COMING OUT OF THE SLIT, SUITABLE MECH.PROTECTION TO BE PROVIDED.

CEILING SUPPORTED RACK



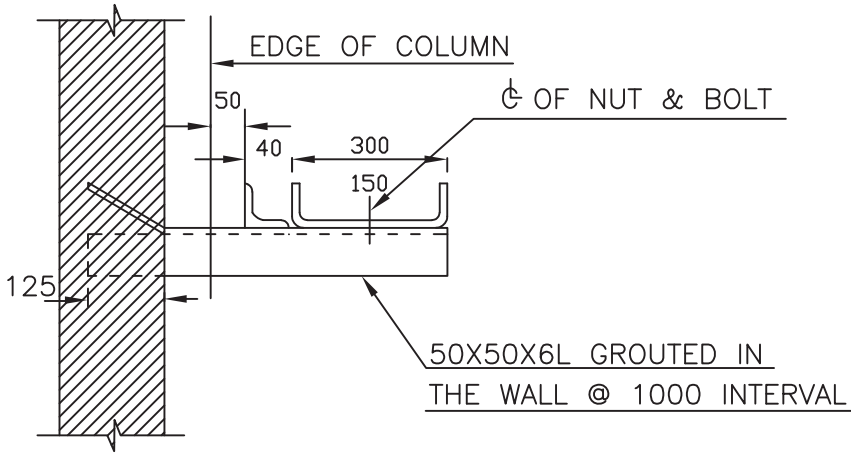
50X6 FLAT WELDED TO
RUNNER L @ 1000 INTERVAL
FOR FIXING CABLE TRAY



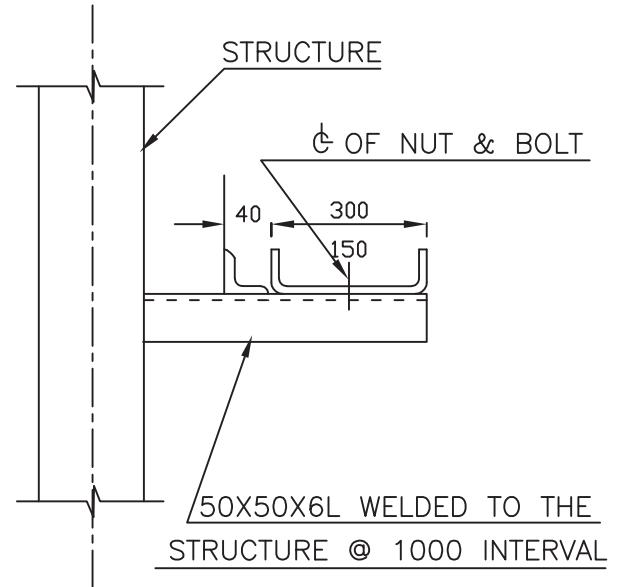
NOTE:—

1. THE TRAY SHALL BE FIXED AT 1000 INTEREVAL BY 6 ϕ X 20 LONG ROOFING BOLT AND SHALL BE USED ONE NO. FOR 150 WIDE TRAYS & TWO NOS. FOR 300 WIDE TRAYS.
2. FOR MULTI TIERS RACK MINIMUM CLEARANCE BETWEEN THE TIER TO BE KEPT 300.
3. ALL DIMENSIONS ARE IN mm.

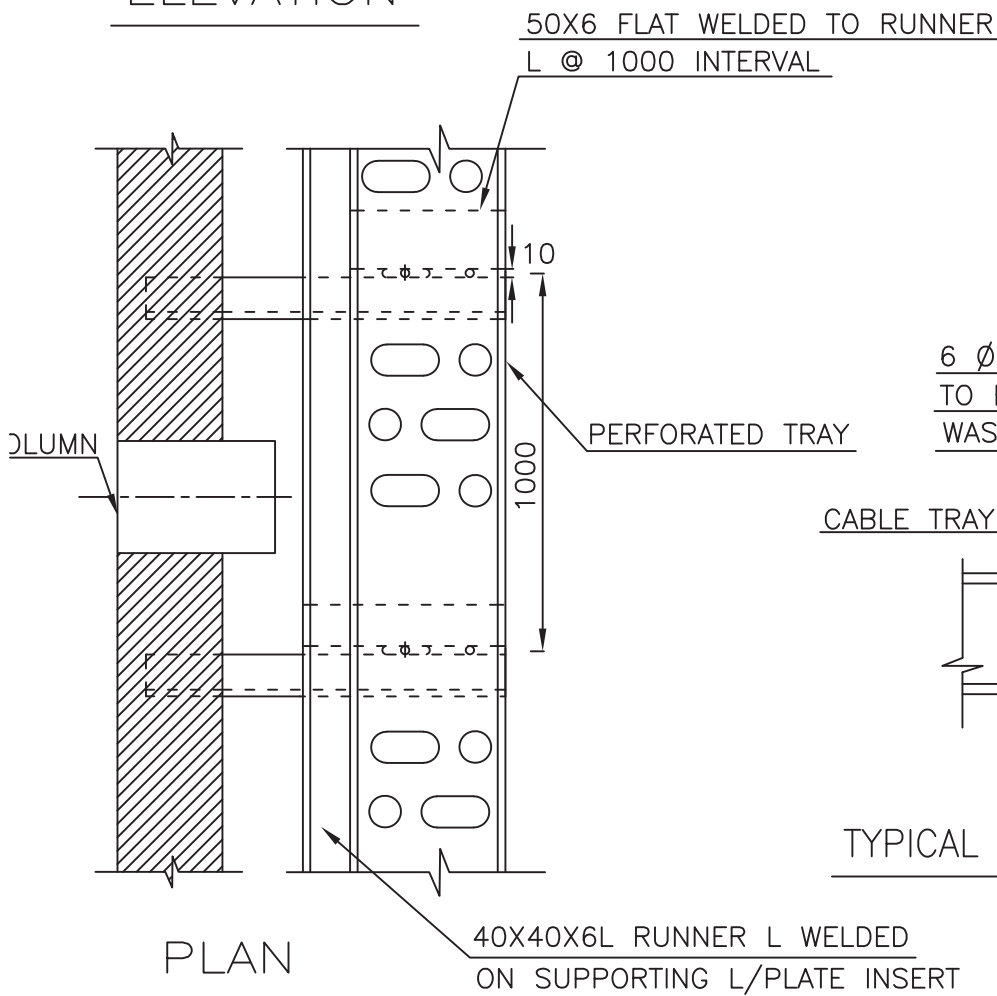
WALL / STRUCTURE SUPPORTED RACK



ELEVATION

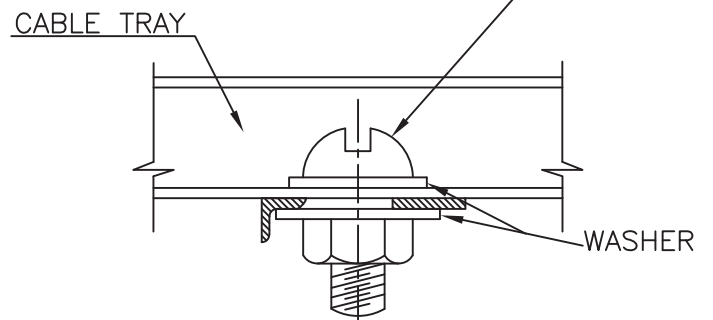


ELEVATION



PLAN

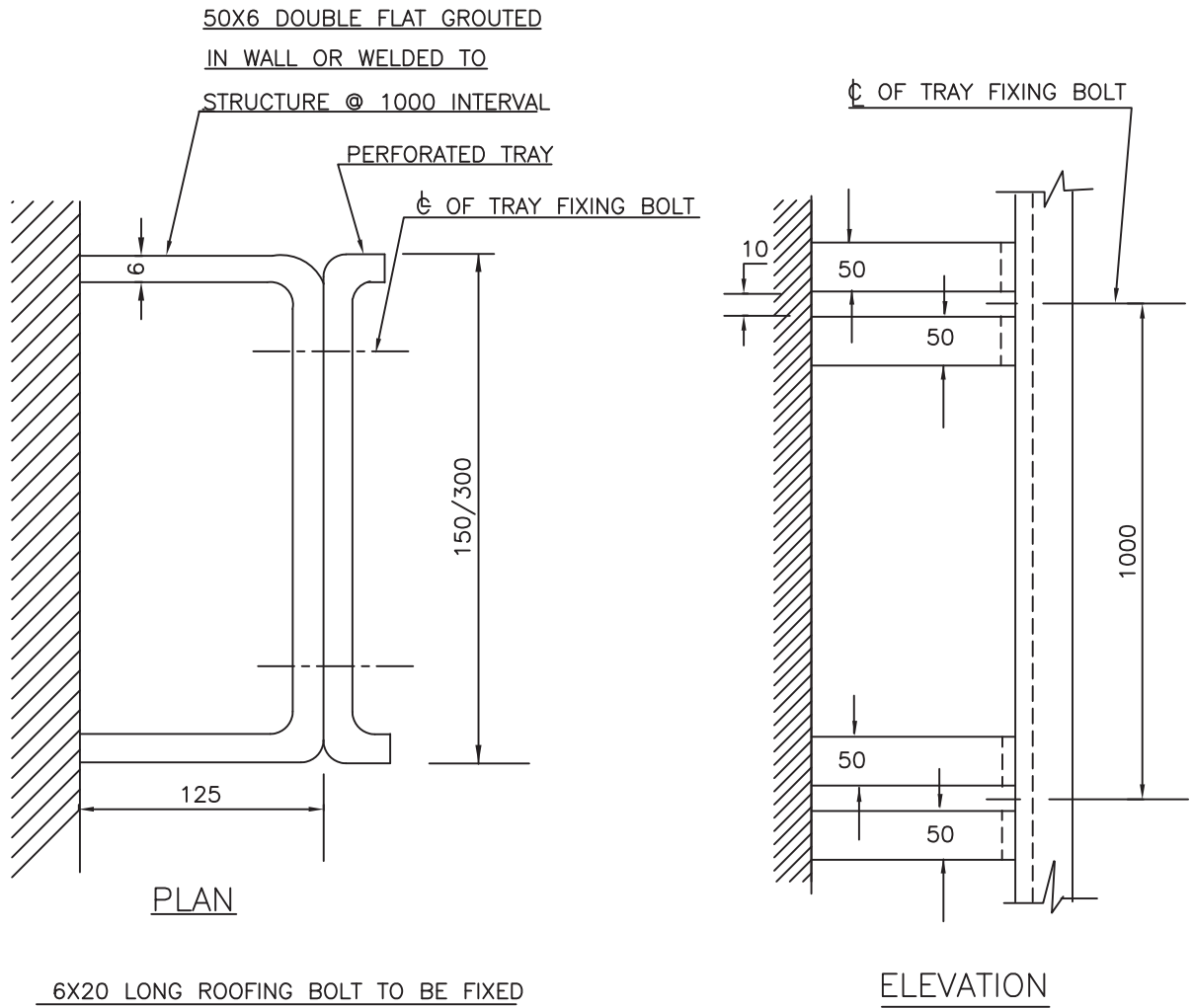
6 Ø X 20 LONG ROOFING BOLT
TO BE FIXED WITH NUT &
WASHER @ 1000 INTERVAL



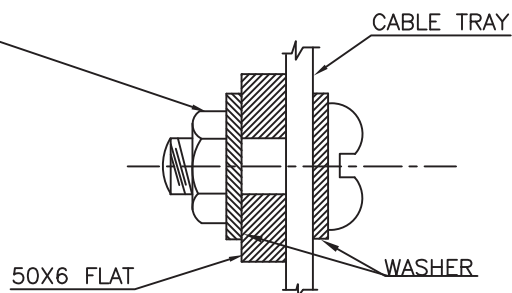
TYPICAL DETAIL OF TRAY FIXING

NOTES:-

1. THE TRAY SHALL BE FIXED AT 1000 INTERVAL BY 6 Ø X 20 LONG ROOFING BOLT. (ONE NO. FOR 150 & TWO NOS. FOR 300 WIDE TRAYS.)
2. FOR MULTI TIERS RACK MINIMUM CLEARANCE BETWEEN THE TIER TO BE KEPT 300.
3. ALL DIMENSION ARE IN mm.

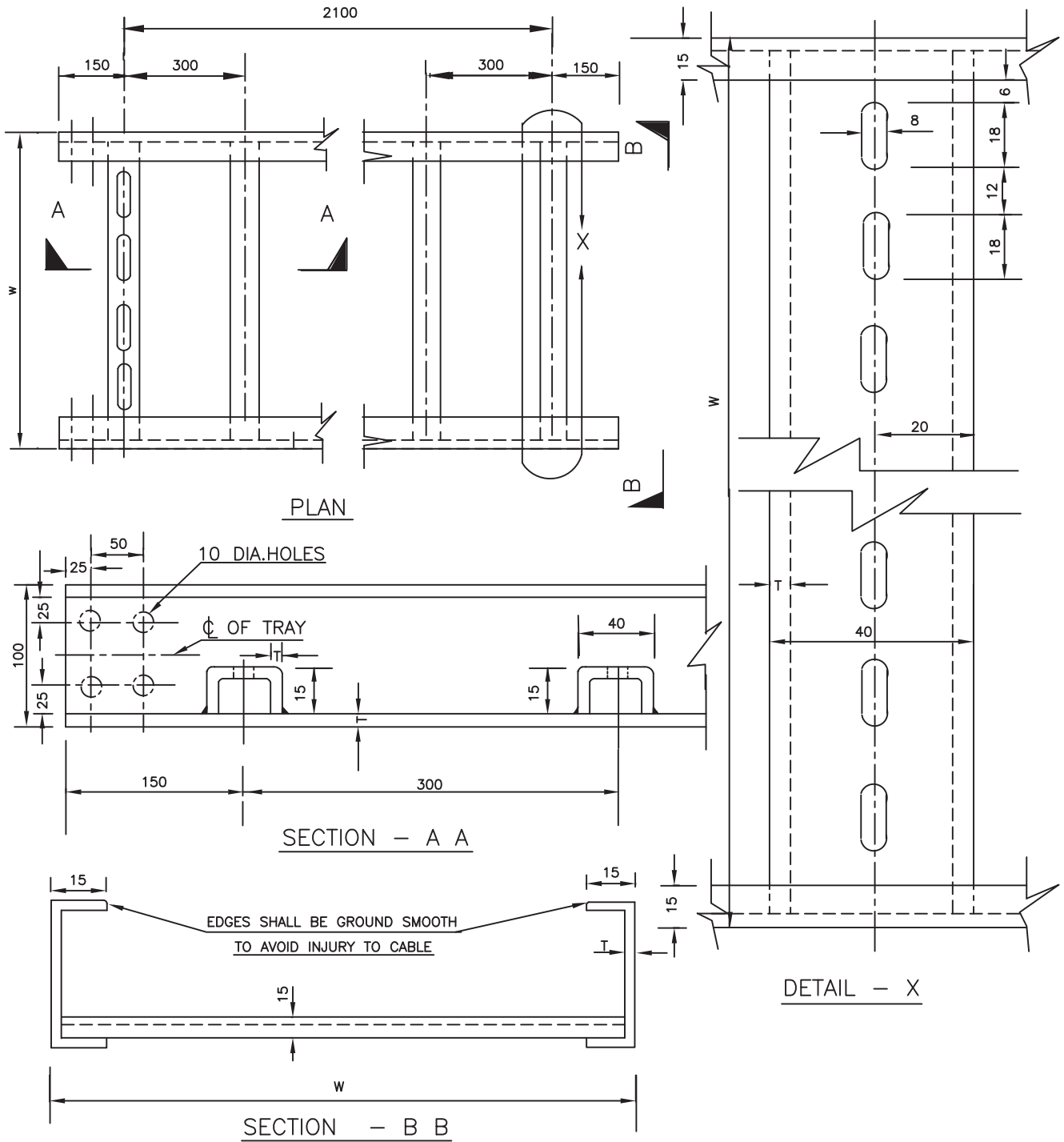


6X20 LONG ROOFING BOLT TO BE FIXED
WITH NUT AND WASHER @ 1000 INTERVAL.



TYPICAL DETAIL OF
TRAY FIXING

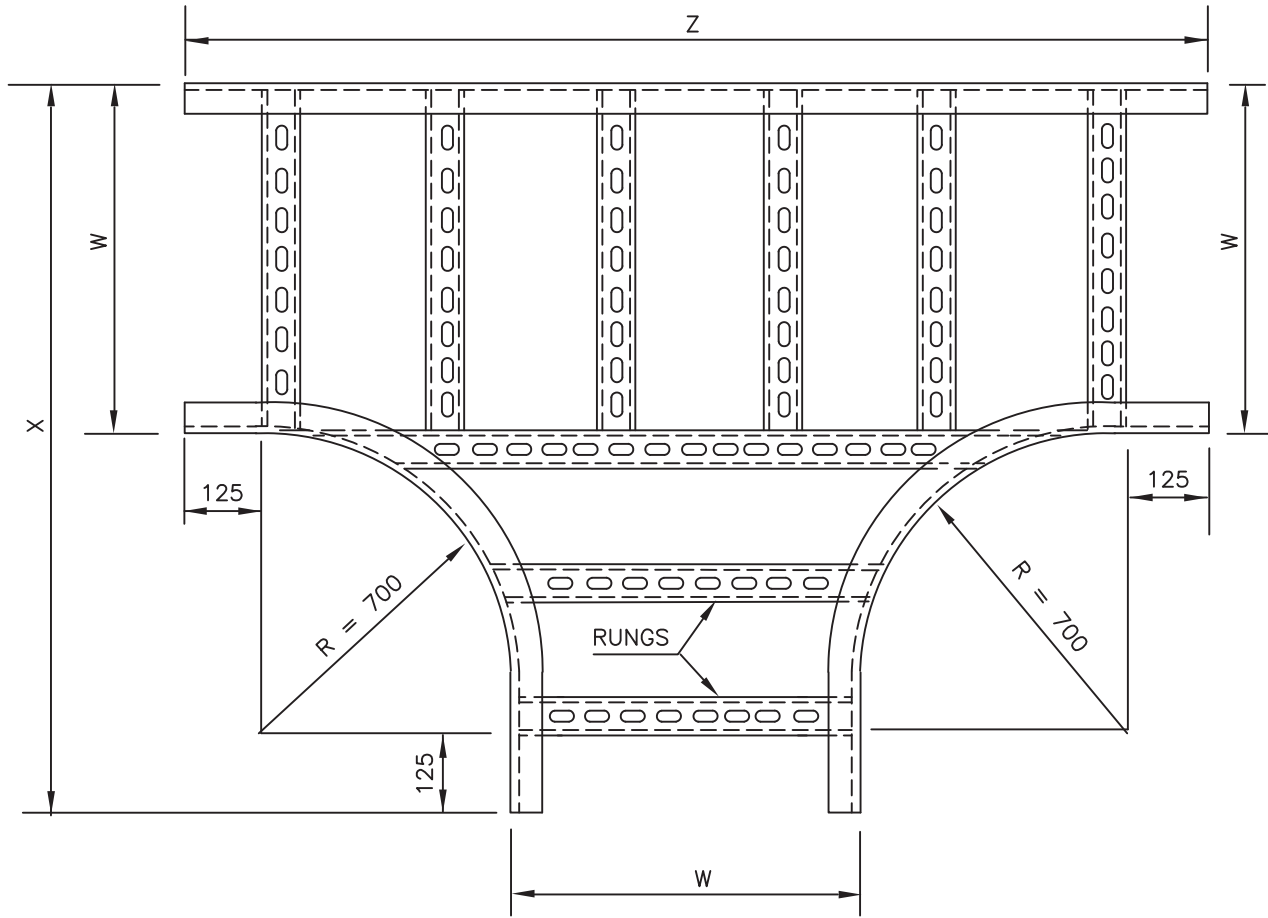
ALL DIMENSIONS ARE IN mm.



DESIGN TYPE (WIDTH)	MAX.SUPPORTING SPAN		WEIGHT/METER APPROX. IN Kg.	
	G. I.	A. L.	G. I.	A. L.
SR 900	2000	2000	10.5	3.6
SR 600	2000	2000	8.9	3.05
SR 450	2000	2000	8.0	2.75
SR 300	2000	2000	7.6	2.6
SR 150	2000	2000	6.8	2.33

NOTE:-

THICKNESS " T " SHALL BE 3mm FOR G.I AND 4mm.FOR AL.

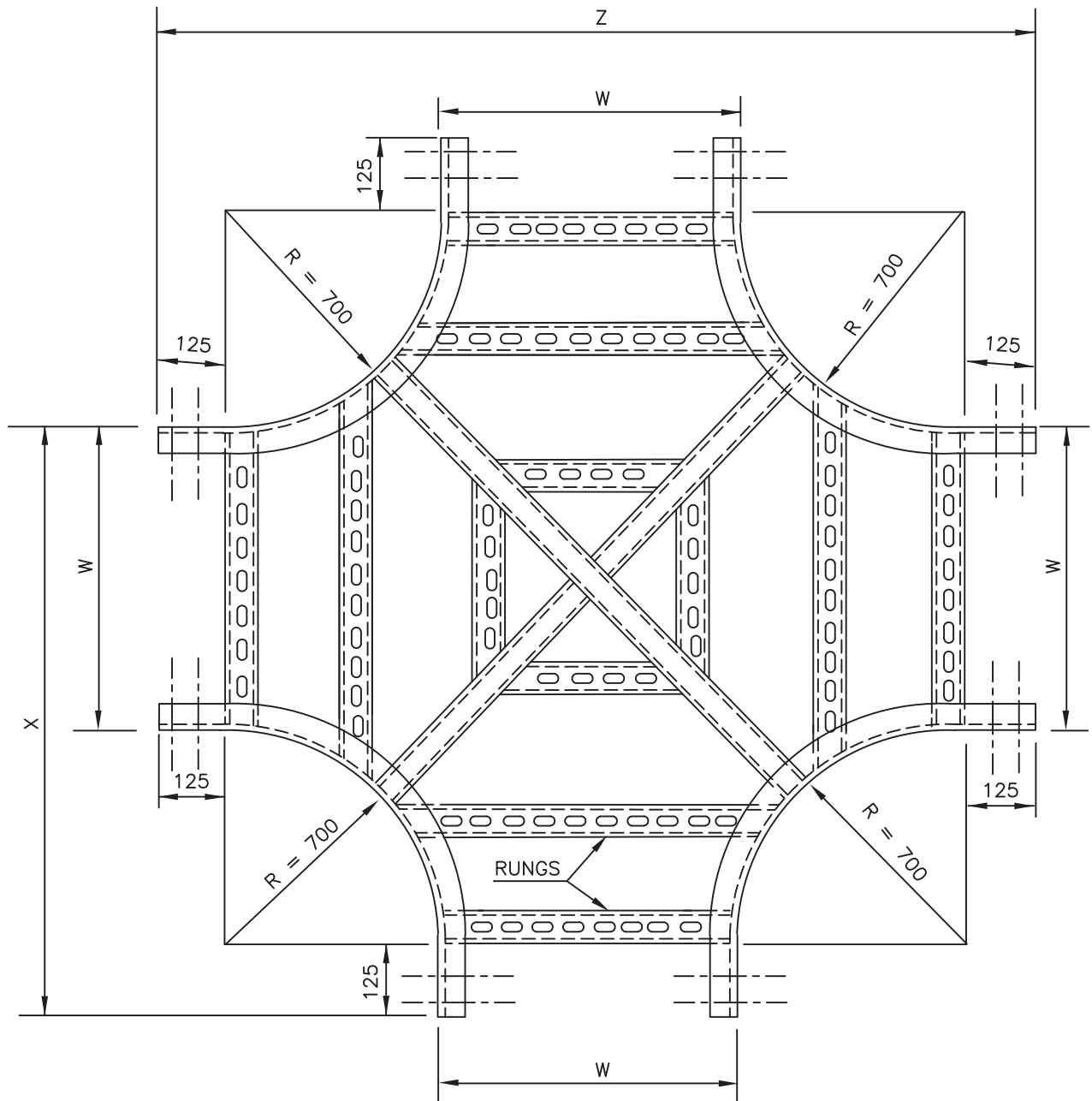


PLAN

DESIGN TYPE	W	$X=R+W+125$	$Z=2R+W+250$
HT 900	900	1725	2550
HT 600	600	1425	2250
HT 450	450	1275	2100
HT 300	300	1125	1950

NOTES :-

1. DISTANCE BETWEEN TWO RUNGS SHOULD BE APPROX. 300mm.
2. ALL DIMENSIONS ARE IN mm.

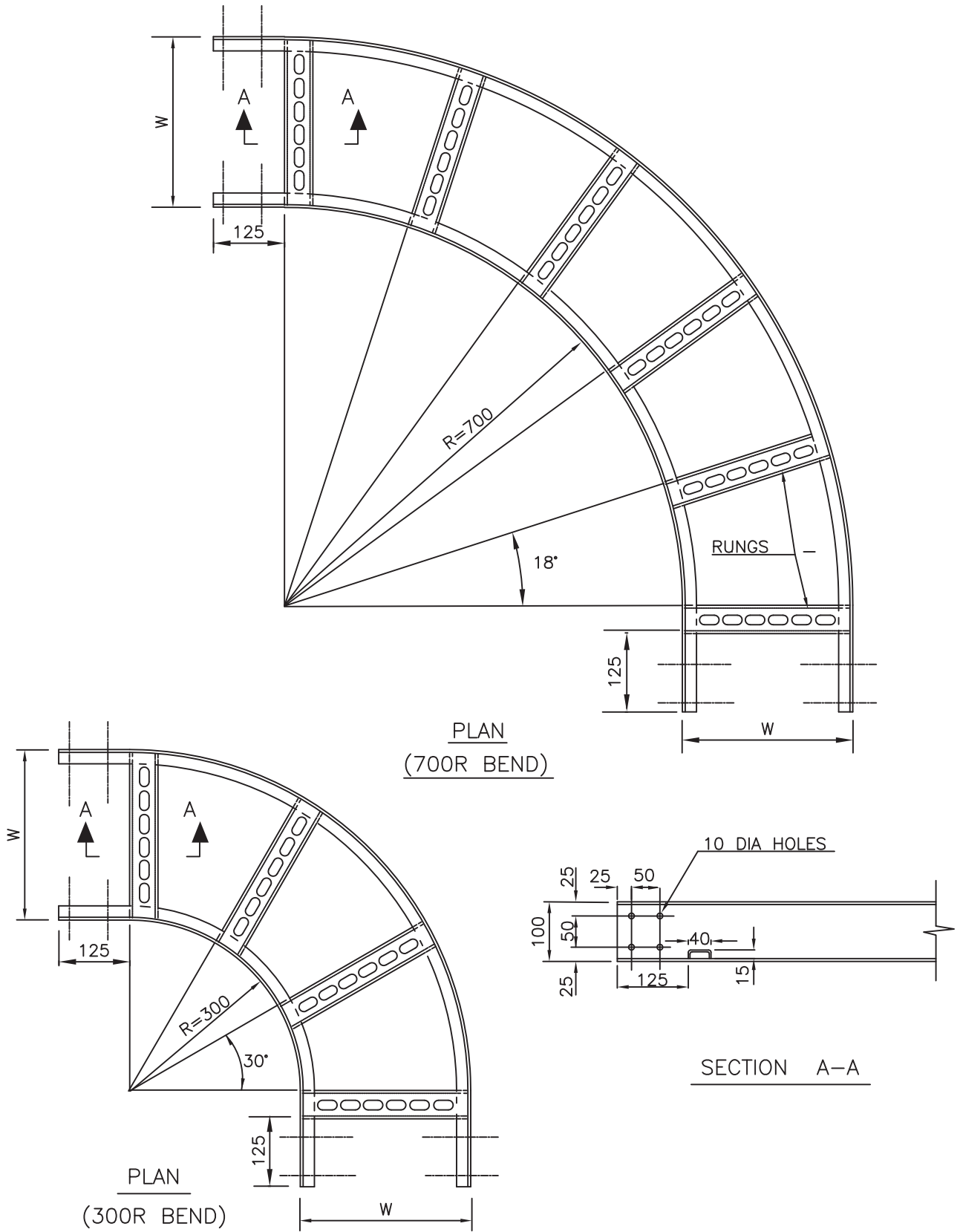


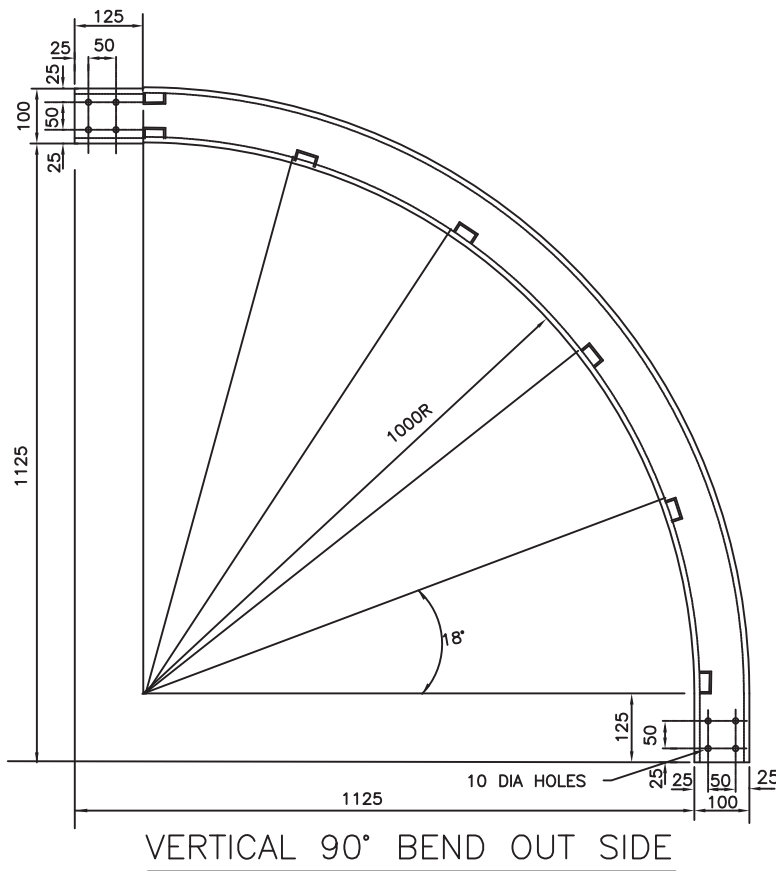
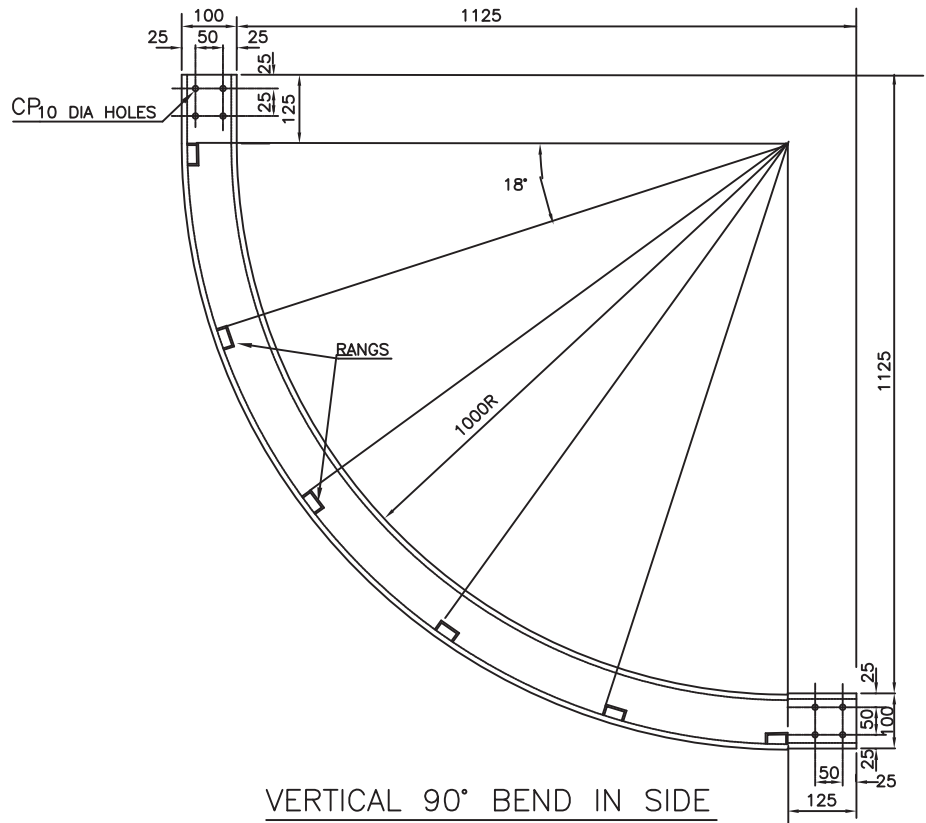
PLAN

DESIGN TYPE	W	$X=R+W+125$	$Z=2R+W+250$
HC 900	900	1725	2550
HC 600	600	1425	2250
HC 450	450	1275	2100
HC 300	300	1125	1950

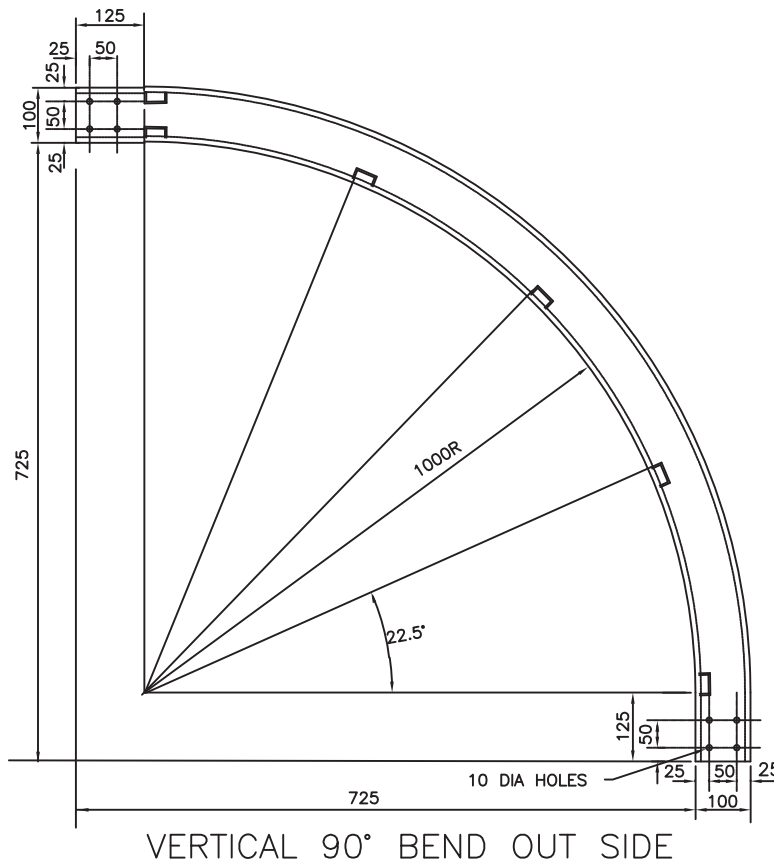
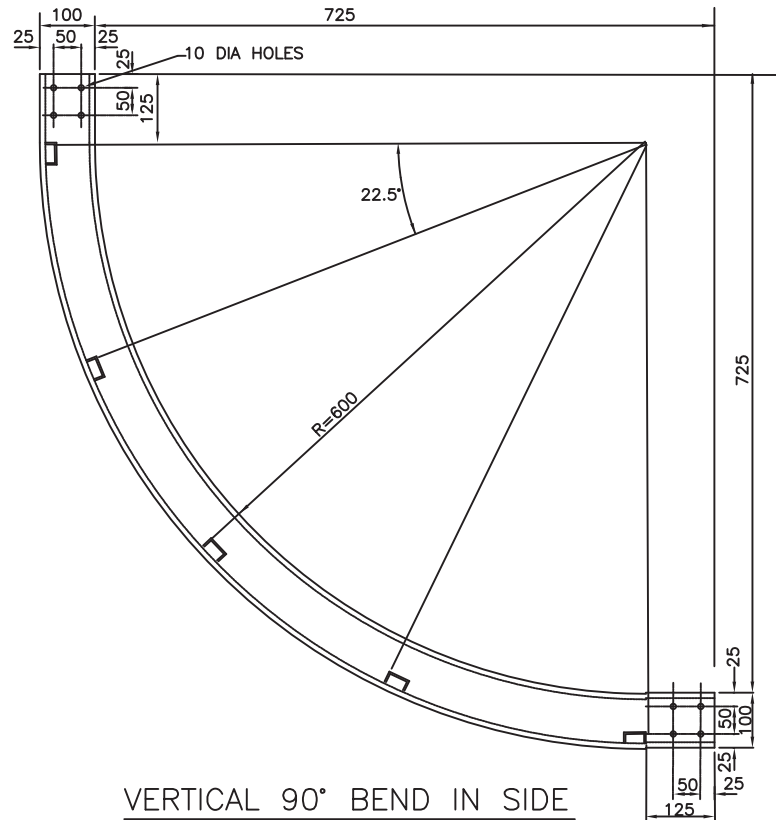
NOTES :-

1. DISTANCE BETWEEN TWO RUNGS SHOULD BE APPROX. 300mm.
2. ALL DIMENSIONS ARE IN mm.

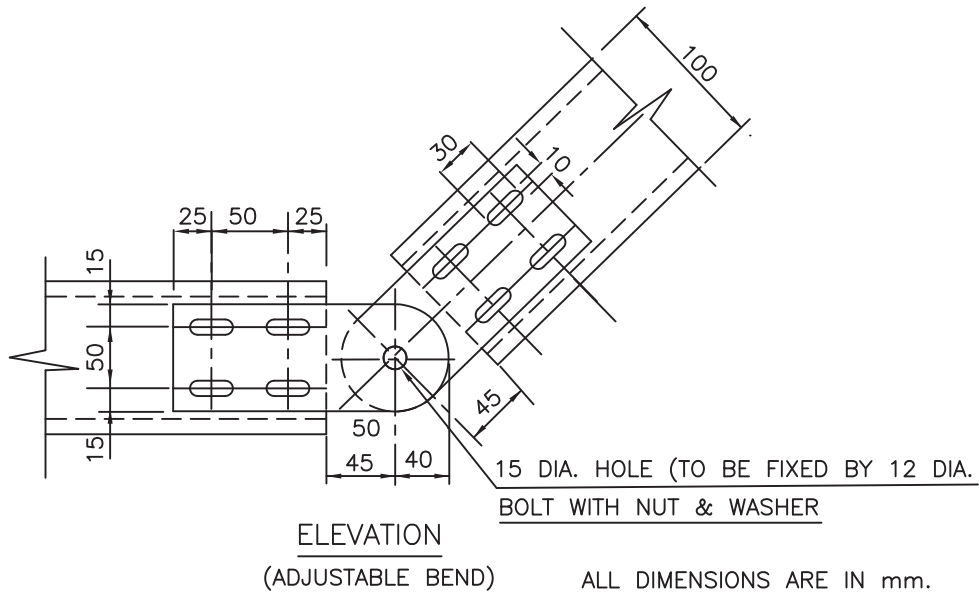
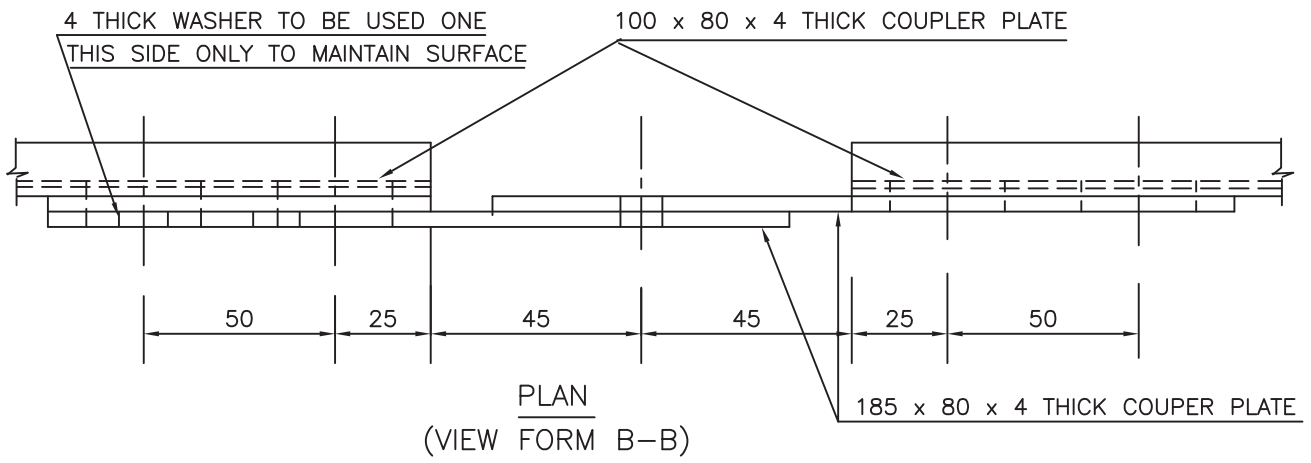
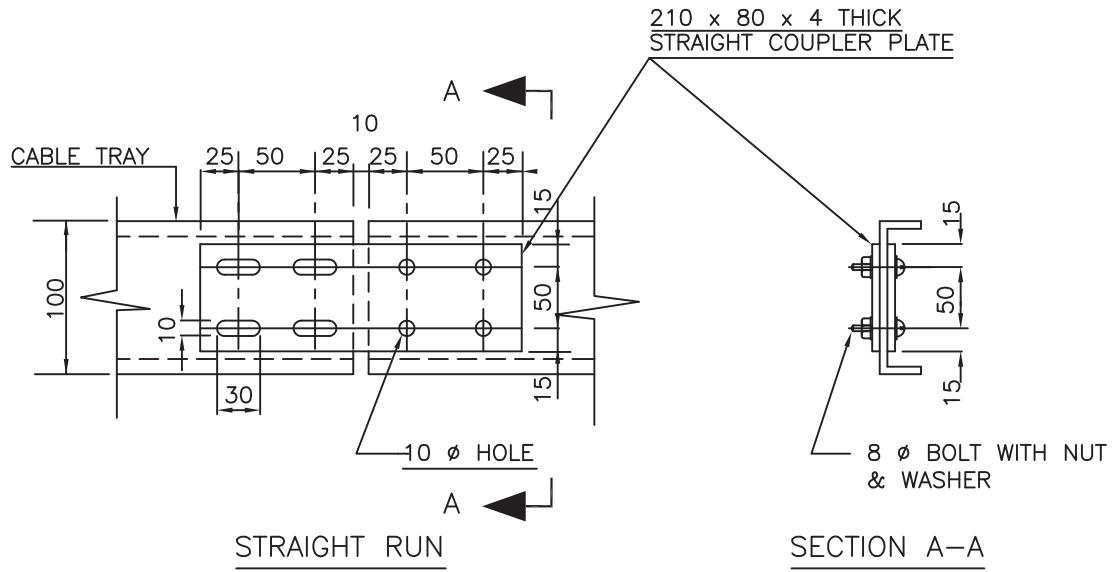


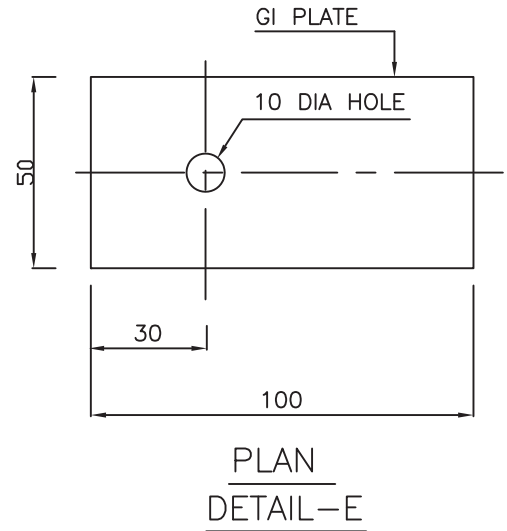
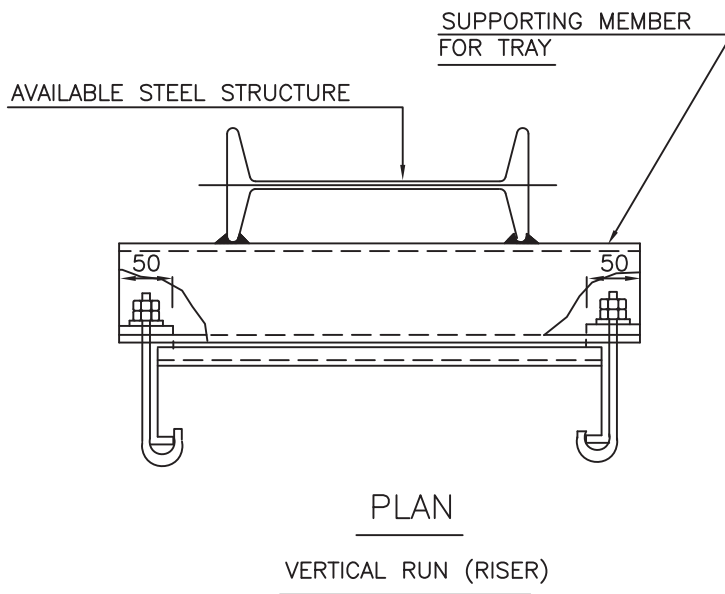
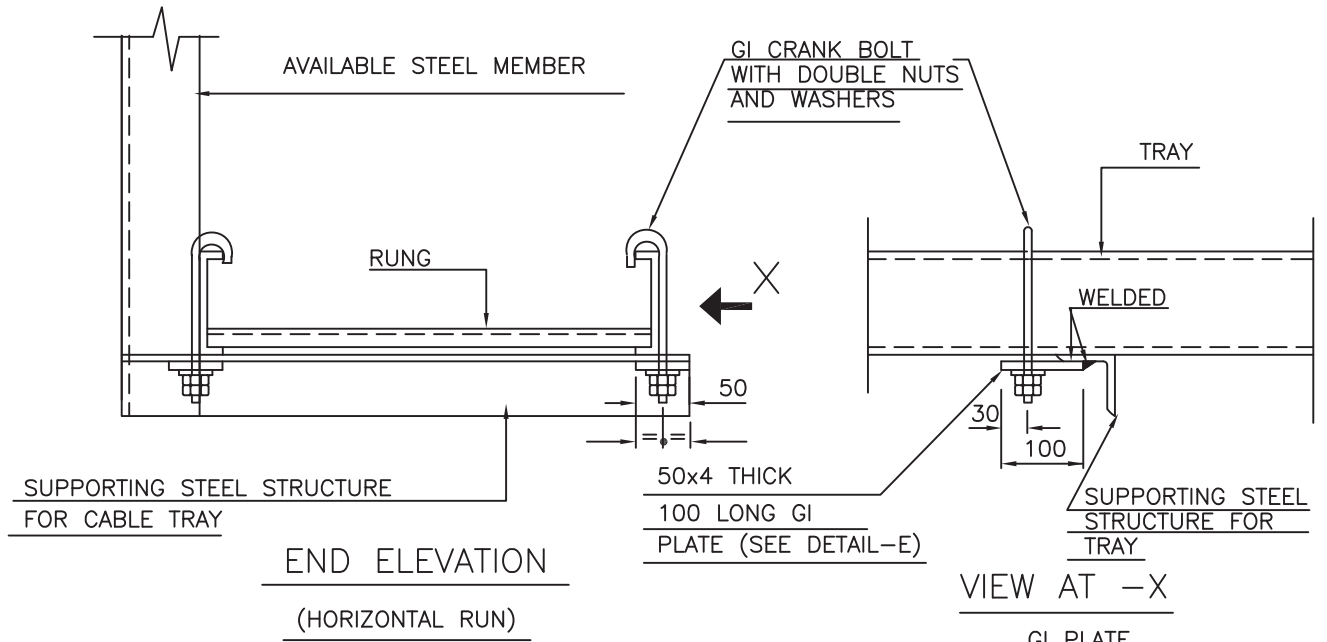


DIMENSIONS ARE IN mm.

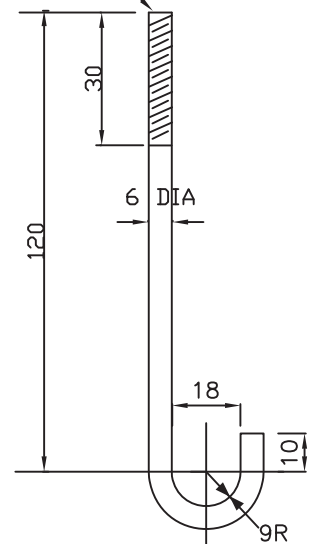


ALL DIMENSIONS ARE IN mm.



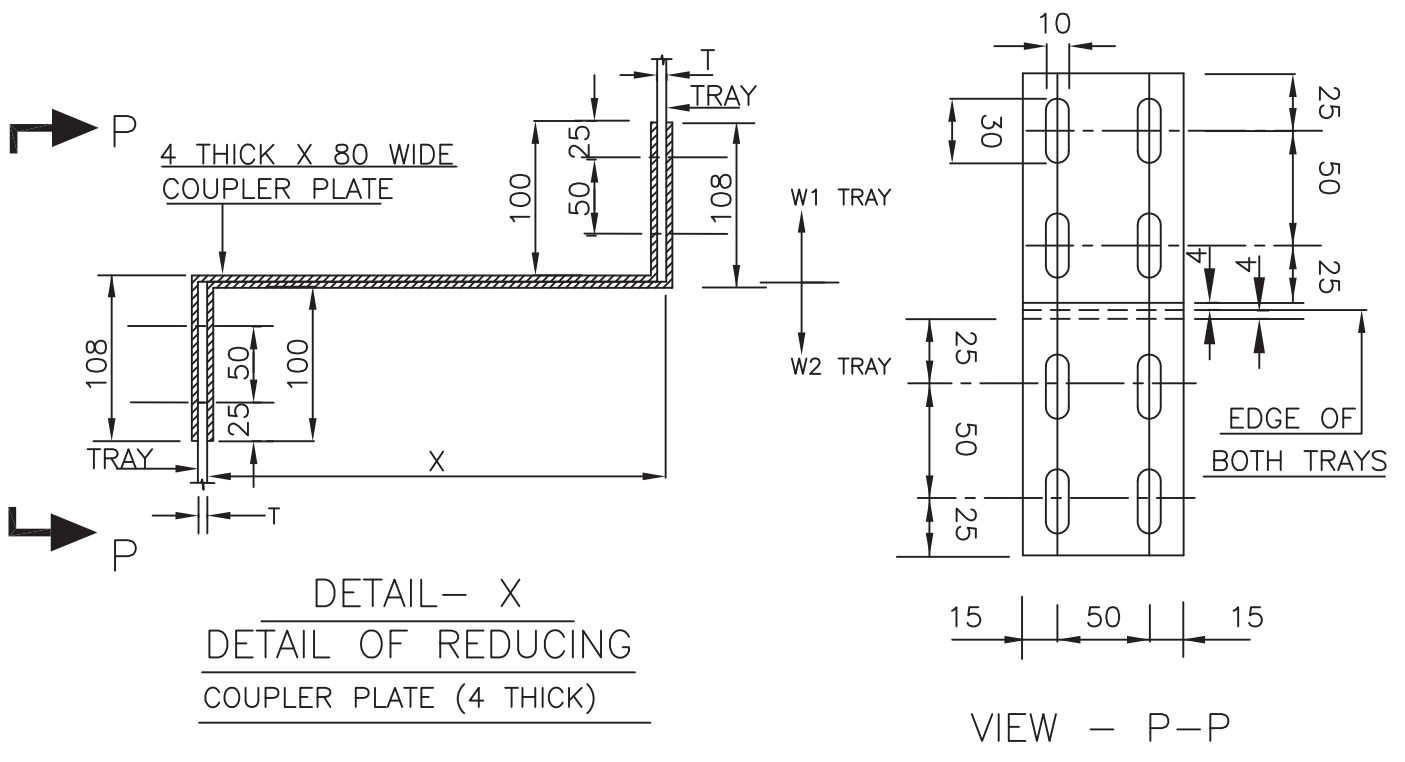
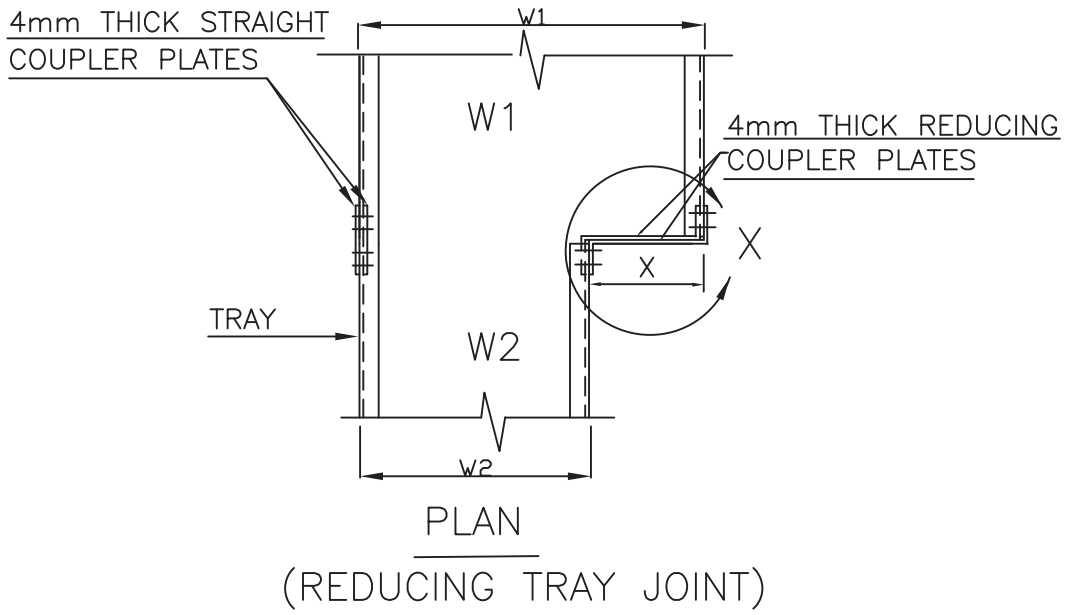


GI CRANK BOLT WITH DOUBLE NUTS & WASHERS.



NOTES:-

1. HORIZONTAL RUN TO BE CLAMPED WITH EVERY SUPPORT AS PER LAYOUT
2. VERTICAL RUN/ RISER TO BE CLAMPED WITH EVERY SUPPORT AS PER LAYOUT
3. EACH CRANK HOOK SHALL BE SUPPLIED WITH ONE PLAIN WASHER, ONE SPRING WASHER AND TWO DOUBLE CHAMFERED HEX NUTS. THESE SHALL BE GALVANISED ITEMS.
4. ALL DIMENSIONS ARE IN mm.



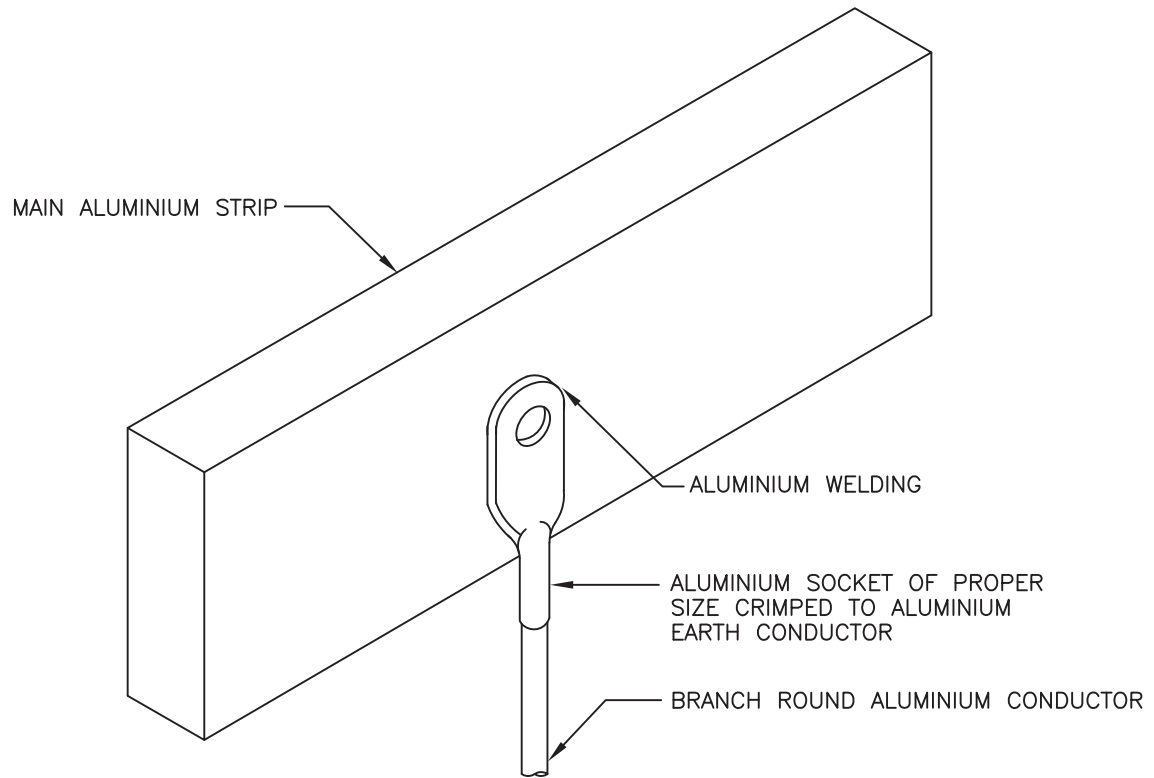
ALL DIMENSIONS ARE IN mm.

SL. NO.	W1	W2	X
1	900	600	300
		450	450
		300	600
2	600	450	150
		300	300
3	450	300	150
		150	300

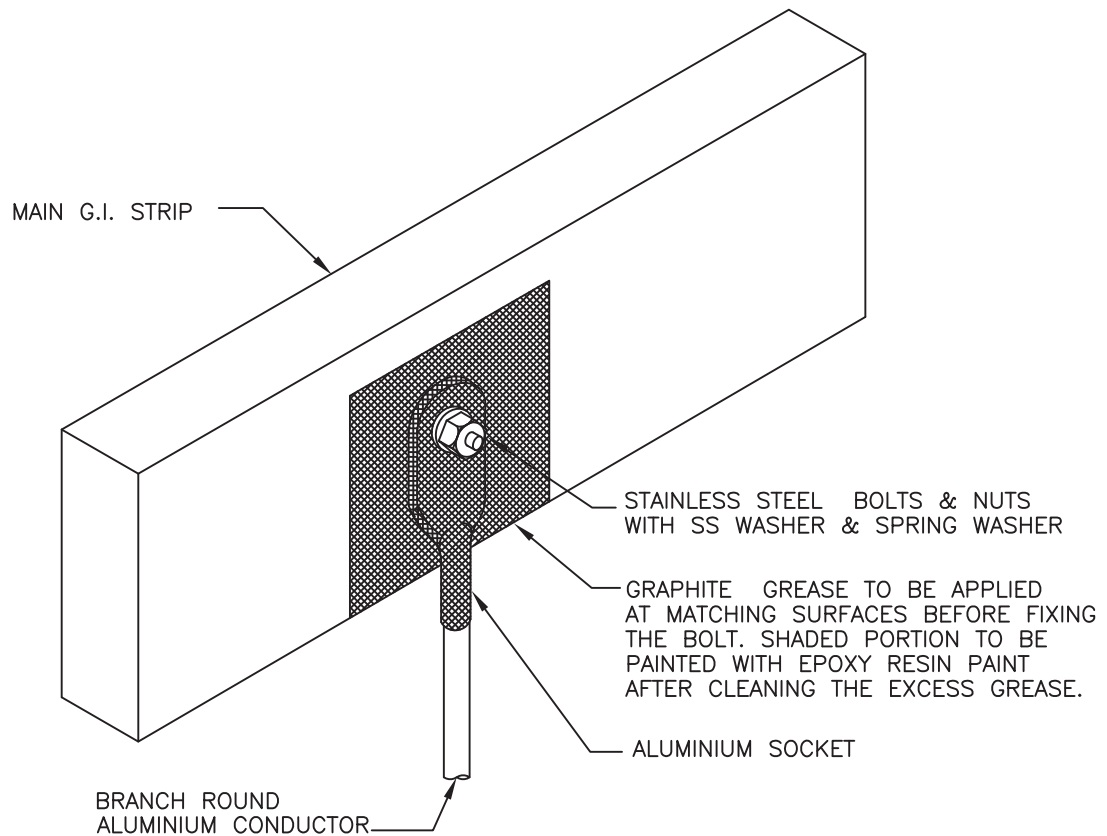
SL. No.	EQUIPMENT TO BE EARTHED	FAULT LEVEL (MVA)	G.I. STRIPS/WIRES		ALUMINIUM			REMARKS			
			MIN. SIZE (mm ²)	SIZE TO BE USED (mm ²)	SYMBOL	STRIPS/WIRES					
						MIN. SIZE (mm ²)	SIZE TO BE USED (mm ²)		SYMBOL	1.1kv PVC SINGLE CORE CABLE SIZE (mm ²)	
1A.	FOR PLANTS HAVING SWITCHYARDS/ GENERATING STATION										
I.	SWITCH YARD EQUIPMENT, GENERATORS, H.T. SWITCH BOARDS, TRANSFORMERS, MAIN EARTHING GRID, CONNECTION FROM EARTH BUS TO EARTHING GRID.	750 AT 11KV	706	2-50x8		491	2-38.1x6.35=484		500		AS PER CLAUSE 17.3.2 OF IS:3043
II.	SWITCH YARD EQUIPMENT, GENERATORS, H.T. SWITCH BOARDS, TRANSFORMERS, MAIN EARTHING GRID, CONNECTION FROM EARTH BUS TO EARTHING GRID.	500 AT 11KV 300 AT 6.6KV 150 AT 3.3KV	471	60x8		328	50.8x6.35=323		400		-00-
III.	SWITCH YARD EQUIPMENT, GENERATORS, H.T. SWITCH BOARDS, TRANSFORMERS, MAIN EARTHING GRID, CONNECTION FROM EARTH BUS TO EARTHING GRID.	250 AT 6.6KV 125 AT 3.3KV	392	50x8		272	50.8x6.35=323		300		-00-
IV.	SWITCH YARD EQUIPMENT, GENERATORS, H.T. SWITCH BOARDS, TRANSFORMERS, MAIN EARTHING GRID, CONNECTION FROM EARTH BUS TO EARTHING GRID.	350 AT 11KV 200 AT 6.6KV 100 AT 3.3KV	330 314 314	50x8		229 218 218	38.1x6.35=242		240		-00-
V.	SWITCH YARD EQUIPMENT, GENERATORS, H.T. SWITCH BOARDS, TRANSFORMERS, MAIN EARTHING GRID, CONNECTION FROM EARTH BUS TO EARTHING GRID.	250 AT 11KV 150 AT 6.6KV 75 AT 3.3KV	235	50x6		163	31.75x4.78=152		185		-00-
1B	FOR PLANTS WITHOUT SW. YARD/GENERATING STN. H.T. SWITCH BOARDS, TRANSFORMERS, MAIN EARTHING GRID, CONNECTION FROM EARTH BUS TO EARTHING GRID.	ANY FAULT LEVEL AT ANY VOLTAGE	210	50x6		120	38.1x3.18=121		120		AS PER CLAUSE 12.3.2 OF IS:3043
1C	ALL M.V. SWITCH BOARDS		210	50x6		120	38.1x3.18=121		120		AS PER CLAUSE 12.3.2 OF IS:3043
2	H.V. MOTORS		210	50x6		120	38.1x3.18=121		120		-00-
3	TRANSFORMER NEUTRALS		-	-	-	120	-	-	150		-
4	M.V. MOTORS RATED 75KW & ABOVE		210	50x6		120	38.1x3.18=121		120		AS PER CLAUSE 12.3.2 OF IS:3043
5	M.V. MOTORS ABOVE 30KW & LESS THAN 75KW		175	35x6		93	31.75x3.18=101		95		-00-

SL. No.	EQUIPMENT TO BE EARTHED	FAULT LEVEL (MVA)	G.I. STRIPS/WIRES		ALUMINIUM STRIPS/WIRES			1.1kv PVC SINGLE CORE CABLE		REMARKS	
			MIN. SIZE (mm ²)	SIZE TO BE USED (mm ²)	SYMBOL	MIN. SIZE (mm ²)	SIZE TO BE USED (mm ²)	SYMBOL	SIZE (mm ²)		SYMBOL
6	M.V.MOTORS ABOVE 5.5KW & LESS THAN 30KW 63A SW.SOCKETS,BATTERY CHARGERS,LIGHTING SUB-DIST.BDS.,D.C.BDS.		44	25x6	△5	25	2 SWG=38.6	△17	25	△29	AS PER CLAUSE 12.3.2 OF IS:3043
7	M.V.MOTORS RATED 5.5KW & BELOW		7	8 SWG=13	△6	5	10 SWG=8.3	△18	6	△30	-DO-
8	ALL MINOR EQUIPMENT RATED FOR 250V & BELOW		-	10 SWG=8.3	△7	-	10 SWG=8.3	△18	6	△30	
9	NON ELECTRICAL EQUIPMENT,SUCH AS VESSELS STRUCTURES IN HAZARDOUS AREA & LIGHTNING PROTECTION CONDUCTORS		32x6	35x6	△4	-	25.4x3.18=81	△16	-	-	AS PER IS:2309

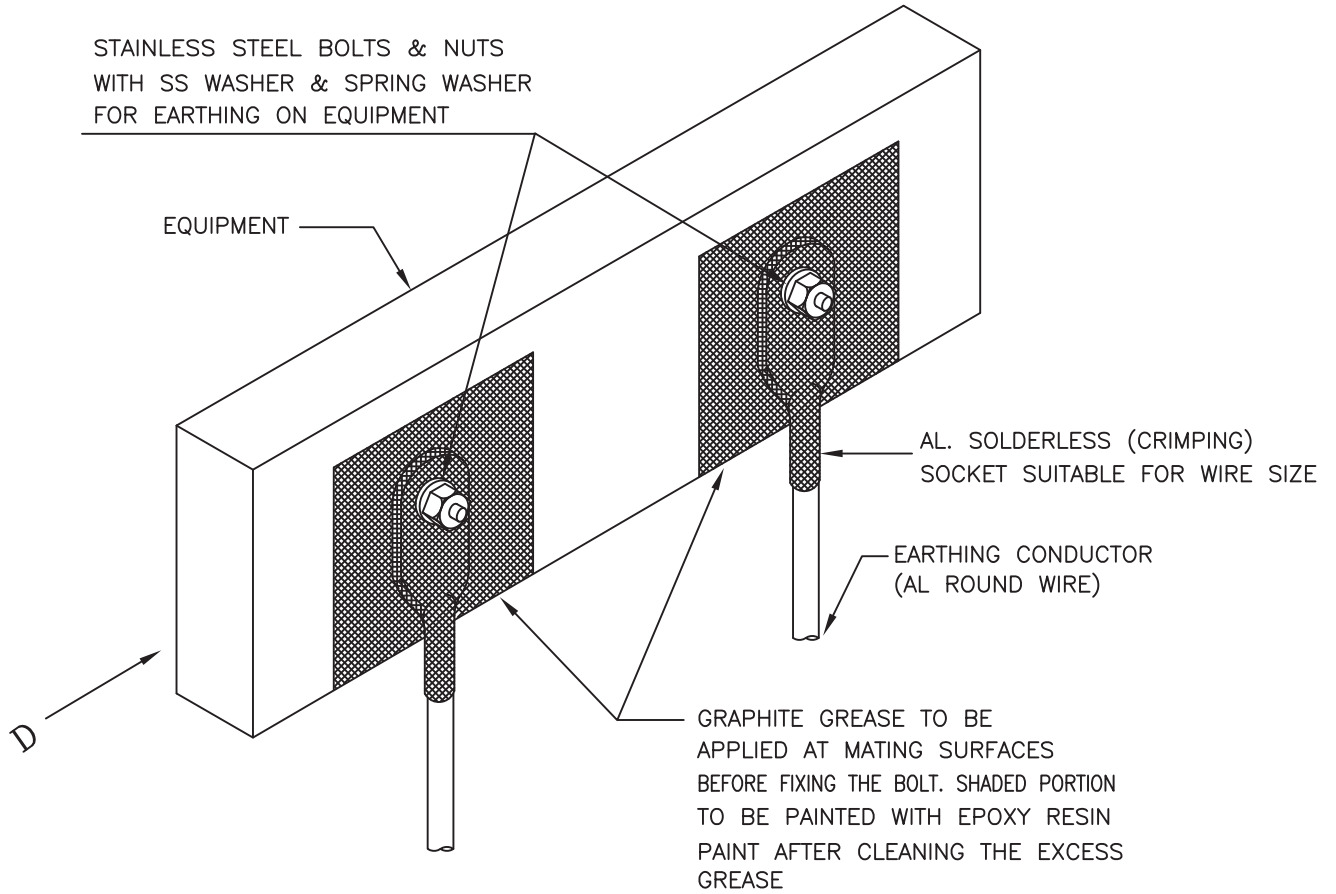
NOTE :-EARTHING CODUCTOR SIZES FOR ITEMS AT SL.No.4,5,6 & 7 SHOULD BE CHOSEN AS HALF THE POWER CABLE SIZES ACTUALLY USED.



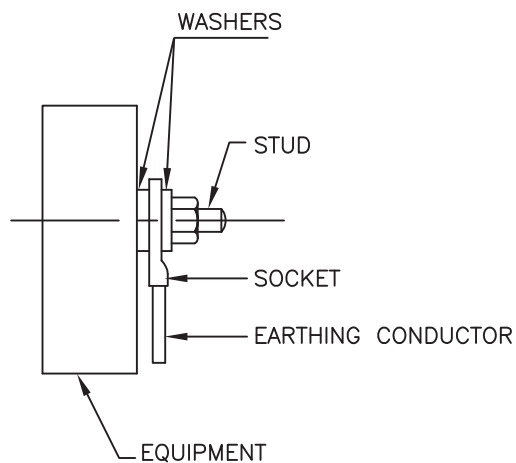
' T ' JOINT ALUMINIUM STRIP TO ROUND ALUMINIUM CONDUCTOR



' T ' JOINT G.I. STRIP TO ROUND ALUMINIUM CONDUCTOR

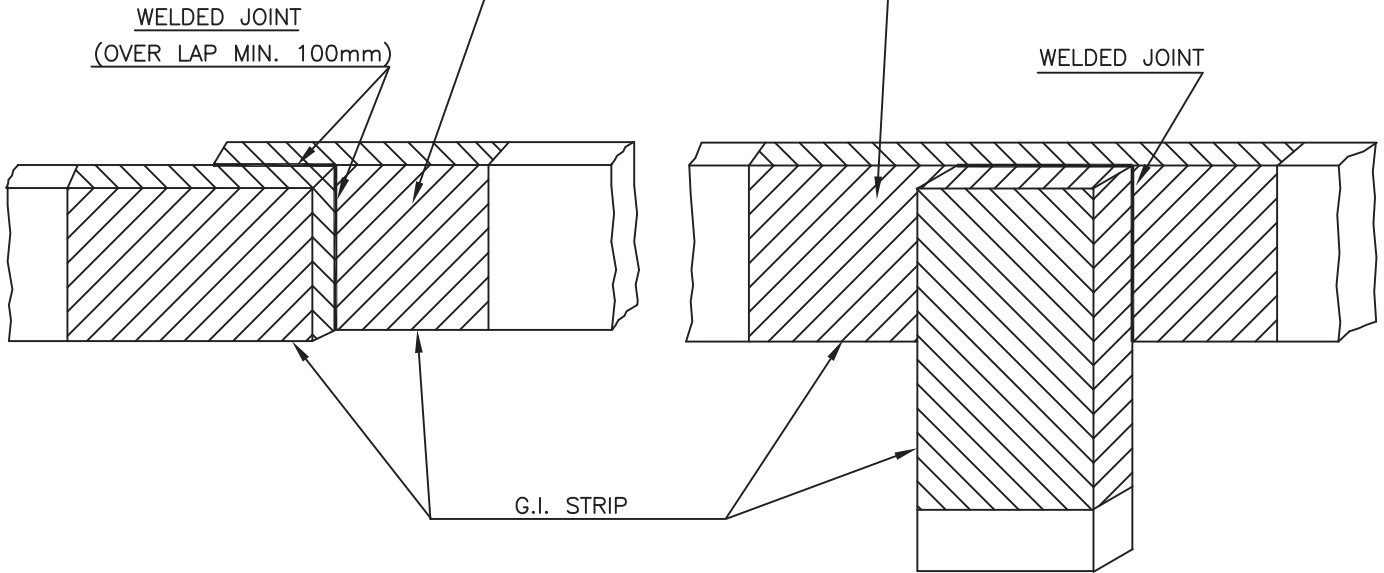


ARRANGEMENT OF DOUBLE EARTH CONNECTIONS TO EQUIPMENT



V I E W F R O M - D

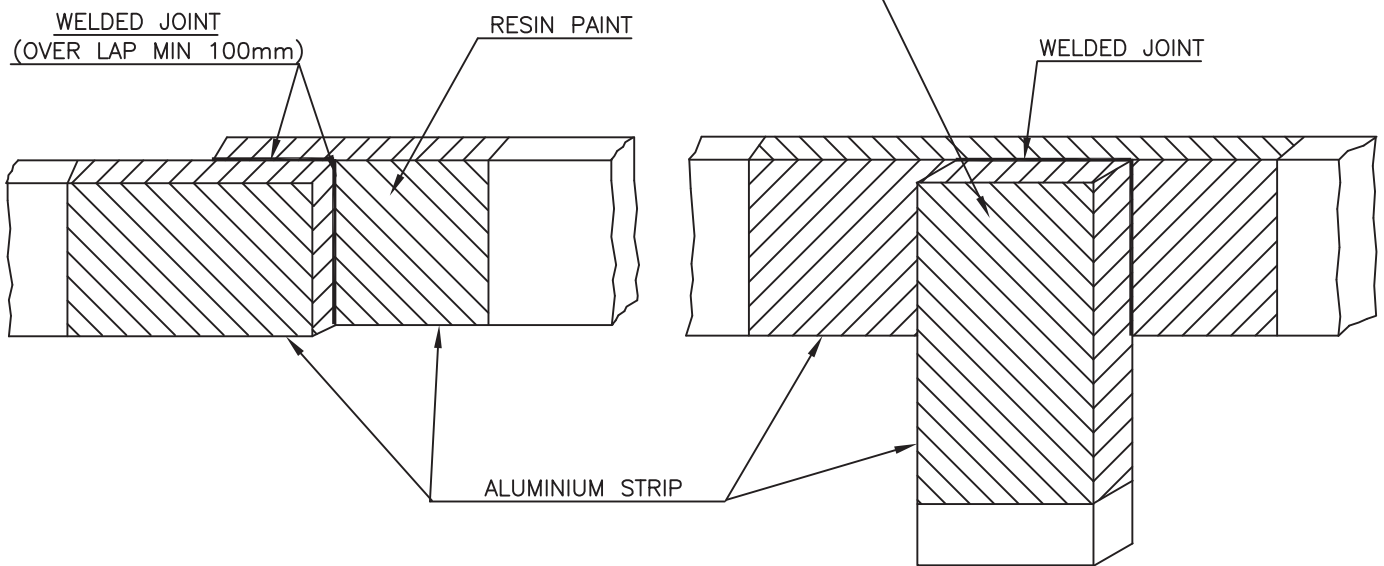
HATCHED PORTION TO BE PAINTED
WITH BITUMINOUS PAINT AND TAPPED
WITH BITUMINOUS HESIAN TAPE AFTER
WELDING TO PREVENT CORROSION



STRAIGHT JOINT G.I. TO G.I. STRIP

" T " JOINT G.I. TO G.I. STRIP

ALUMINIUM STRIP SHOULD BE CLEANED
BEFORE WELDING THE COMPLETED JOINT
SHOULD BE PAINTED WITH EPOXY



STRAIGHT JOINT AL. TO AL. STRIP

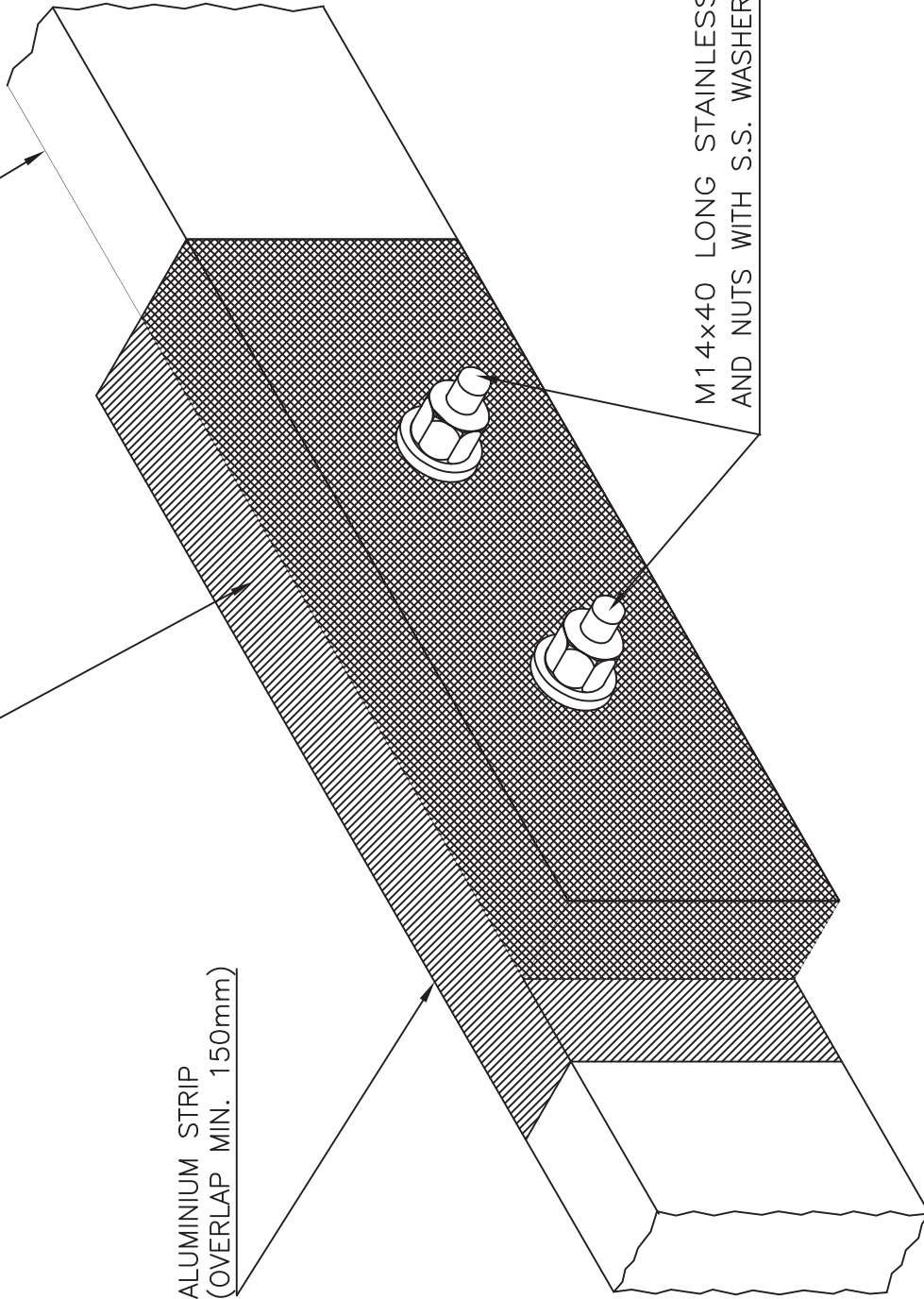
" T " JOINT AL TO AL STRIP

GRAFITE GREASE TO BE APPLIED AT MATCHING SURFACES BEFORE FIXING THE BOLT. SHADED PORTION TO BE PAINTED WITH EPOXY RESIN PAINT AFTER CLEANING THE EXCESS GREASE.

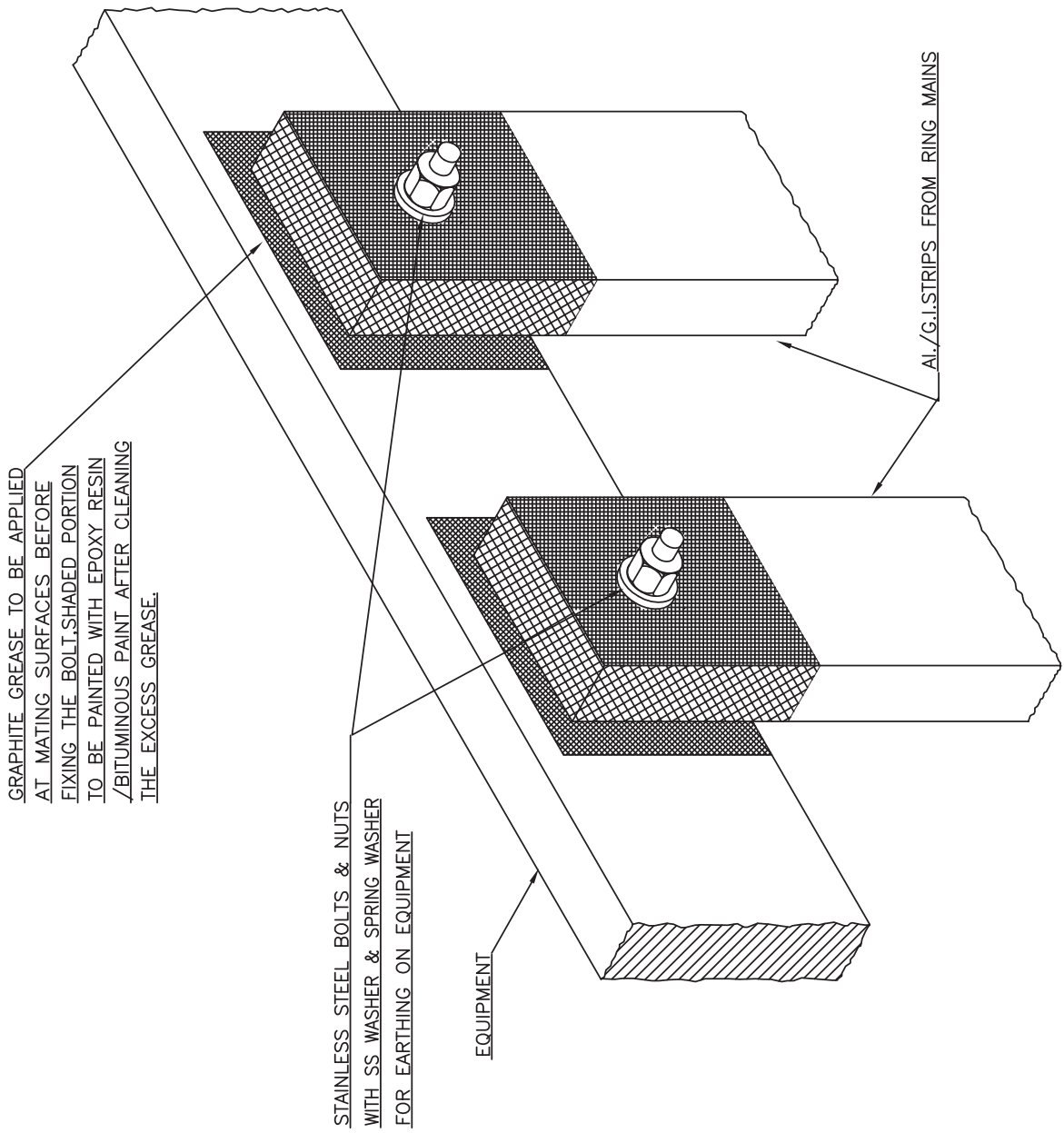
G.I. STRIP

ALUMINIUM STRIP
 (OVERLAP MIN. 150mm)

M14x40 LONG STAINLESS STEEL BOLTS AND NUTS WITH S.S. WASHER & SPRING WASHER

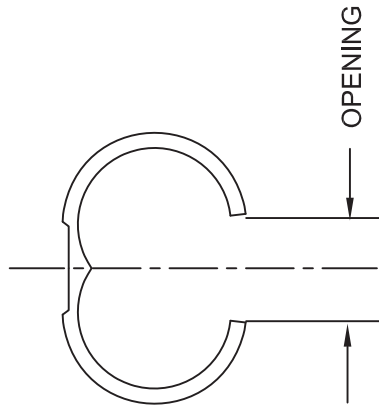


ARRANGEMENT OF LAP JOINT BETWEEN
 AL. EARTH STRIP TO G.I. EARTH STRIP

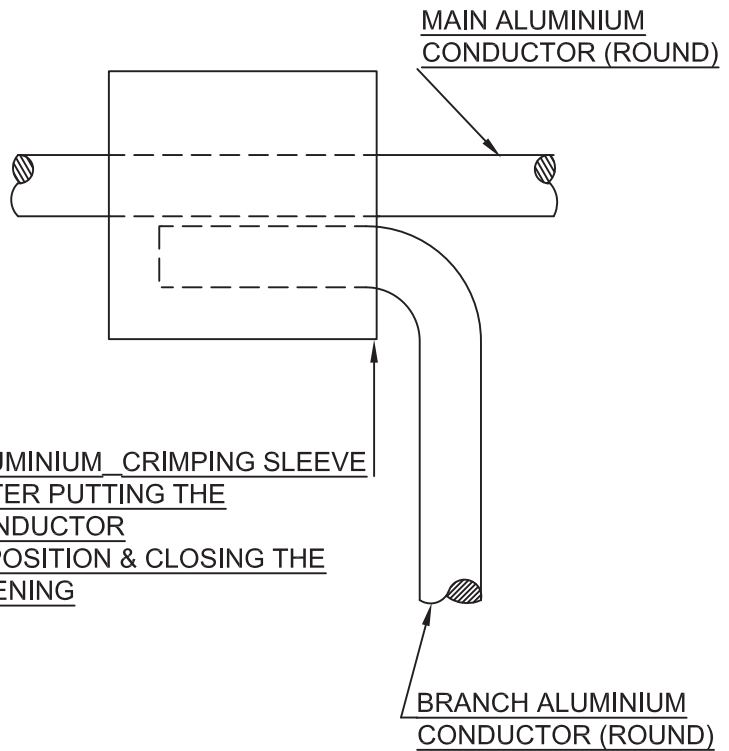


ARRANGEMENT OF DOUBLE EARTH CONNECTION ON EQUIPMENT

NOTE:-
EPOXY RESIN PAINT SHALL BE USED FOR AL STRIP AND BITUMINOUS PAINT FOR G.I.STRIP.



END VIEW OF THE ALUMINIUM CRIMPING SLEEVE BEFORE CRIMPING

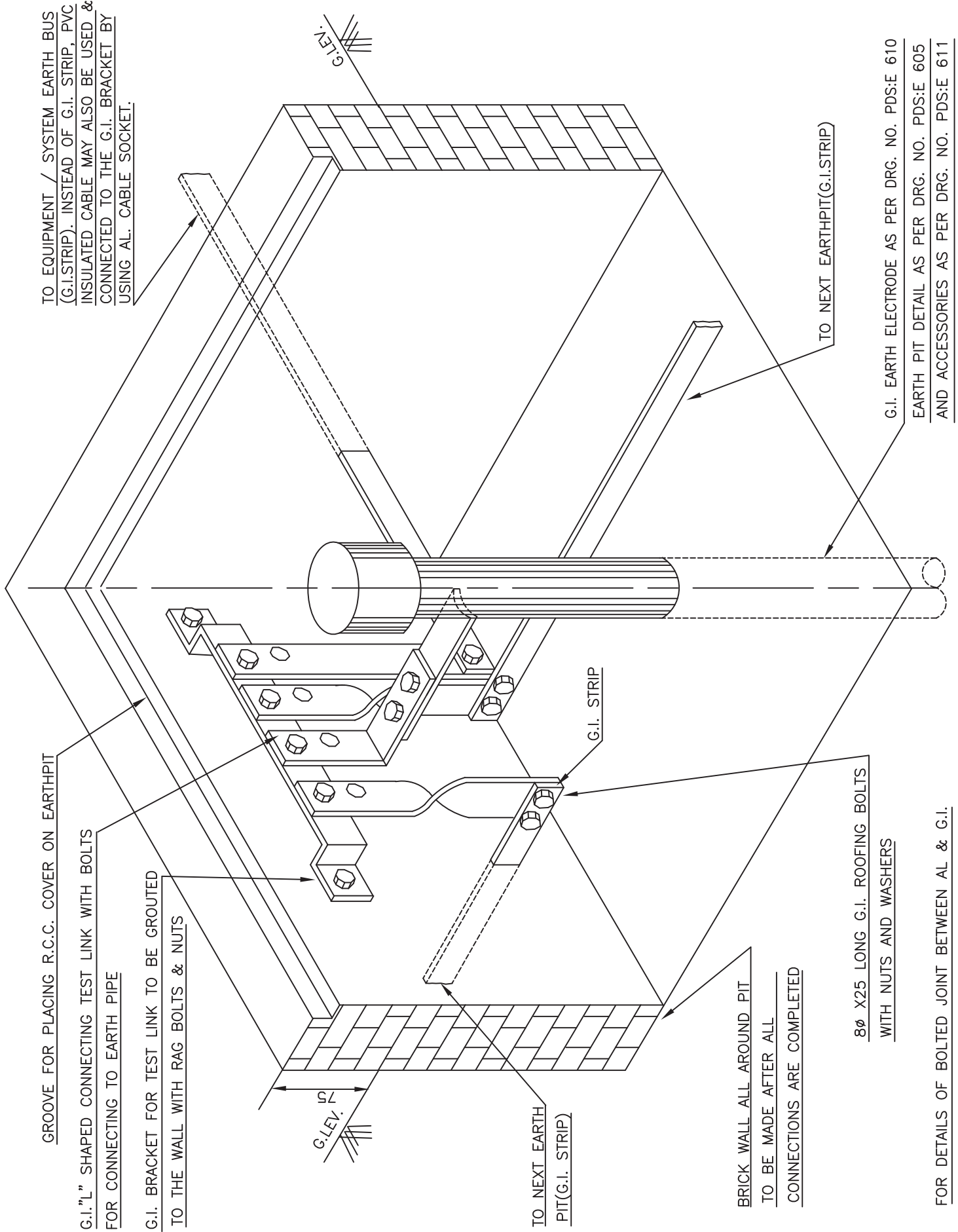


ALUMINIUM CRIMPING SLEEVE AFTER PUTTING THE CONDUCTOR IN POSITION & CLOSING THE OPENING

"T" JOINT ROUND ALUMINIUM CONDUCTOR TO ROUND ALUMINIUM CONDUCTOR (CRIMPING TYPE)

NOTE :-

USE CORRECT SIZE OF COMPRESSION DIES.



GROOVE FOR PLACING R.C.C. COVER ON EARTH PIT

G.I. "L" SHAPED CONNECTING TEST LINK WITH BOLTS FOR CONNECTING TO EARTH PIPE

G.I. BRACKET FOR TEST LINK TO BE GROUTED TO THE WALL WITH RAG BOLTS & NUTS

TO NEXT EARTH PIT (G.I. STRIP)

BRICK WALL ALL AROUND PIT TO BE MADE AFTER ALL CONNECTIONS ARE COMPLETED

8 ϕ X25 LONG G.I. ROOFING BOLTS WITH NUTS AND WASHERS

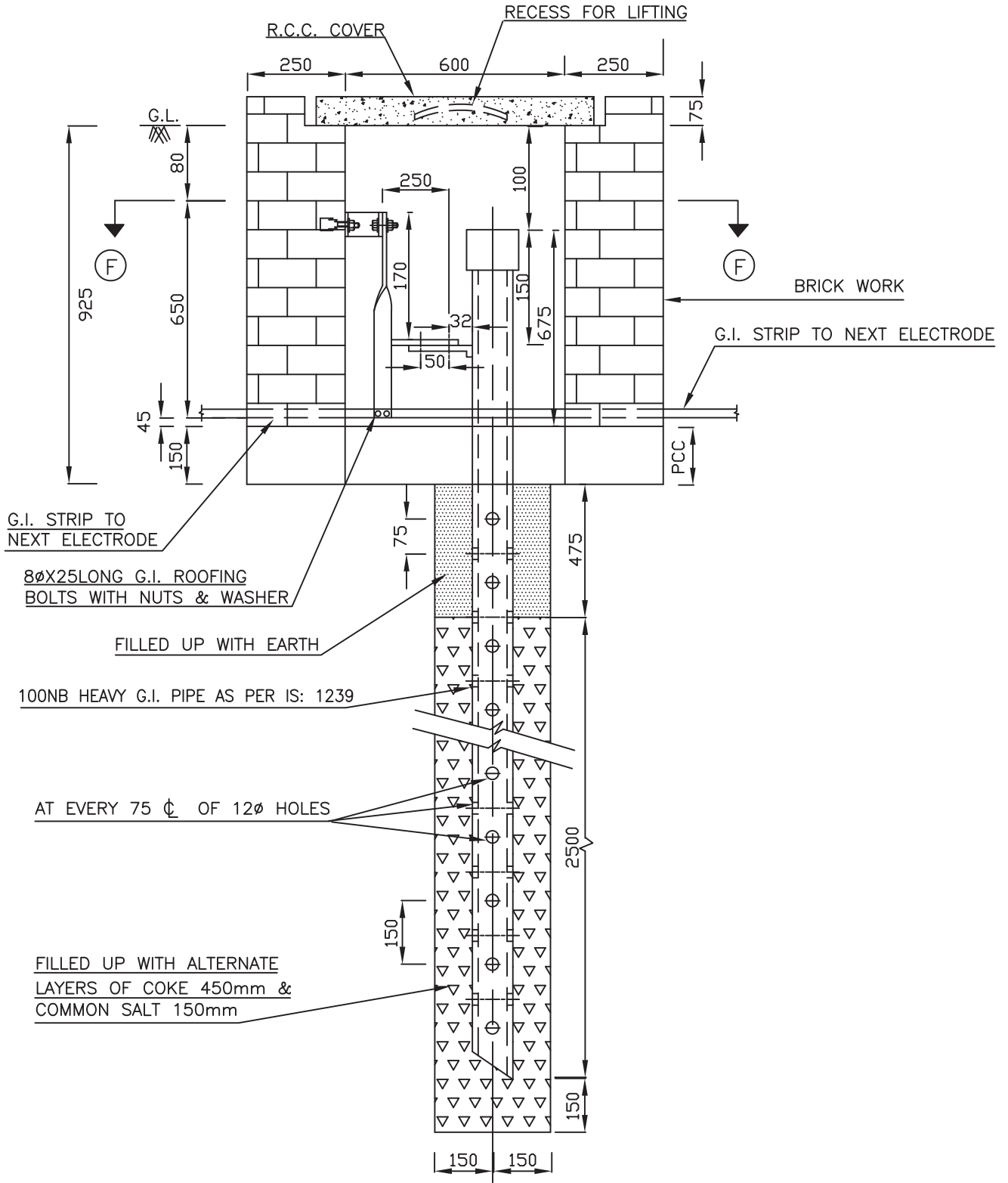
FOR DETAILS OF BOLTED JOINT BETWEEN AL & G.I.

REFER PDS:E 603 (SHEET 4 OF 6)

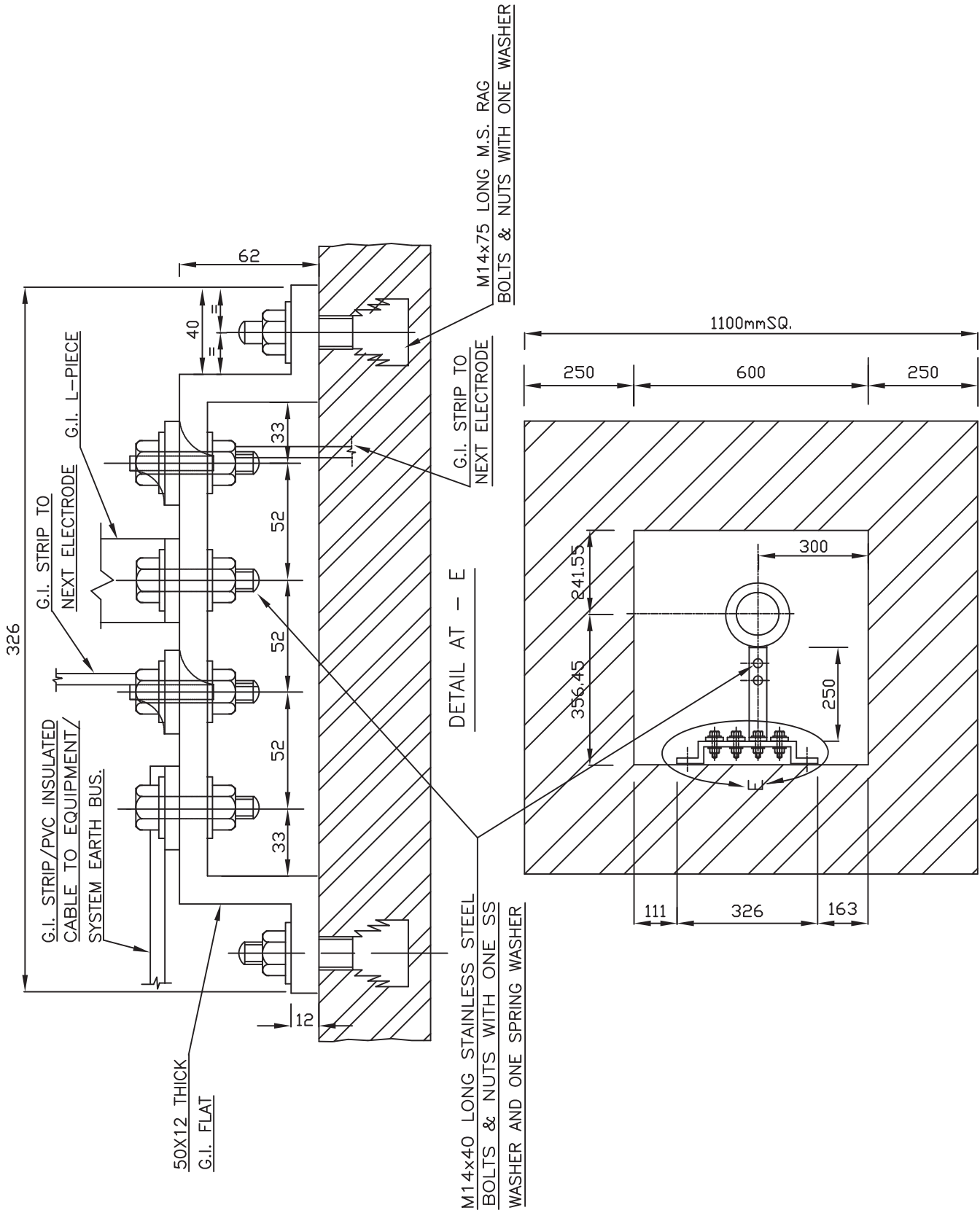
TO EQUIPMENT / SYSTEM EARTH BUS (G.I. STRIP). INSTEAD OF G.I. STRIP, PVC INSULATED CABLE MAY ALSO BE USED & CONNECTED TO THE G.I. BRACKET BY USING AL. CABLE SOCKET.

TO NEXT EARTH PIT (G.I. STRIP)

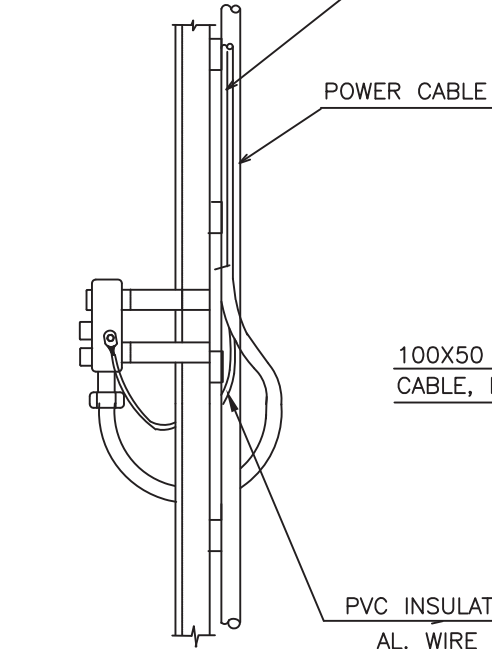
G.I. EARTH ELECTRODE AS PER DRG. NO. PDS:E 610
EARTH PIT DETAIL AS PER DRG. NO. PDS:E 605
AND ACCESSORIES AS PER DRG. NO. PDS:E 611



SECTIONAL ELEVATION OF EARTH PIT

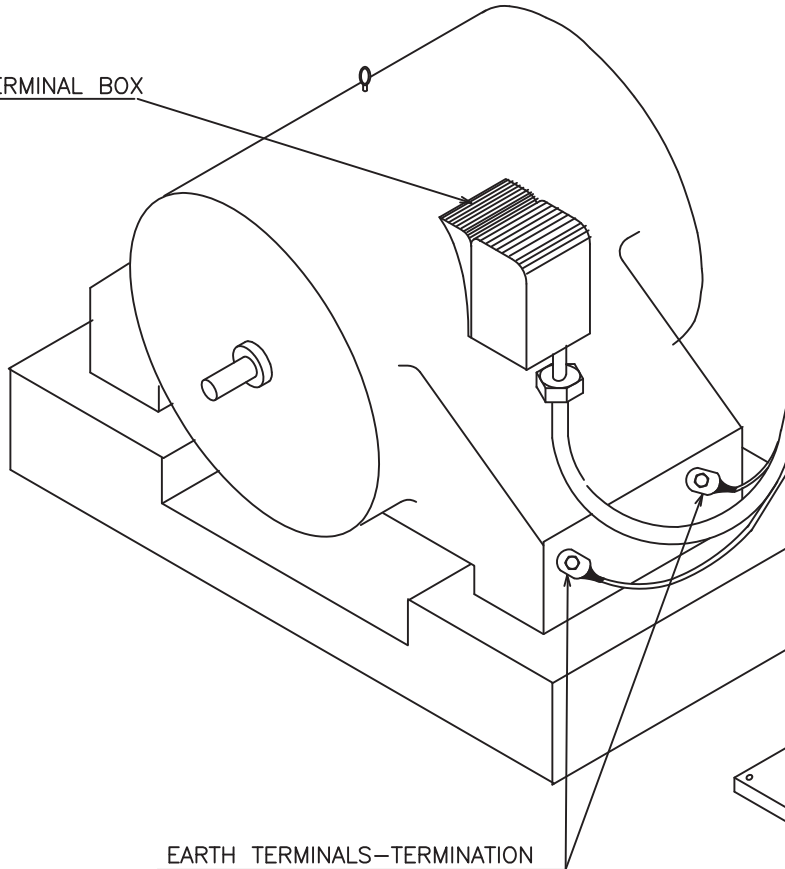


PVC INSULATED CONDUCTOR/ G.I.WIRE/
AL. WIRE FOR EARTHING OF MOTOR



VIEW AT-A

MOTOR TERMINAL BOX

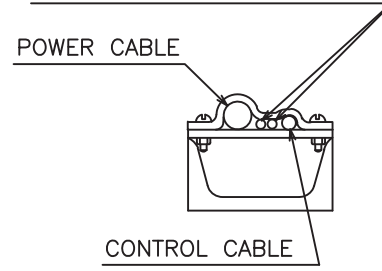


EARTH TERMINALS-TERMINATION
OF AL. CONDUCTOR THROUGH
AL. CABLE SOCKET
(FOR DETAILS REFER PDS:E 603 SH.2)

2NOS. EARTHING CONDUCTORS

POWER CABLE

CONTROL CABLE



CABLE CLAMPING
ARRANGEMENT

100X50 M.S CHANNEL FOR SUPPORTING
CABLE, LOCAL CONTROL STN.

HOSE PROOF/DUST PROOF
LOCAL CONTROL STN.

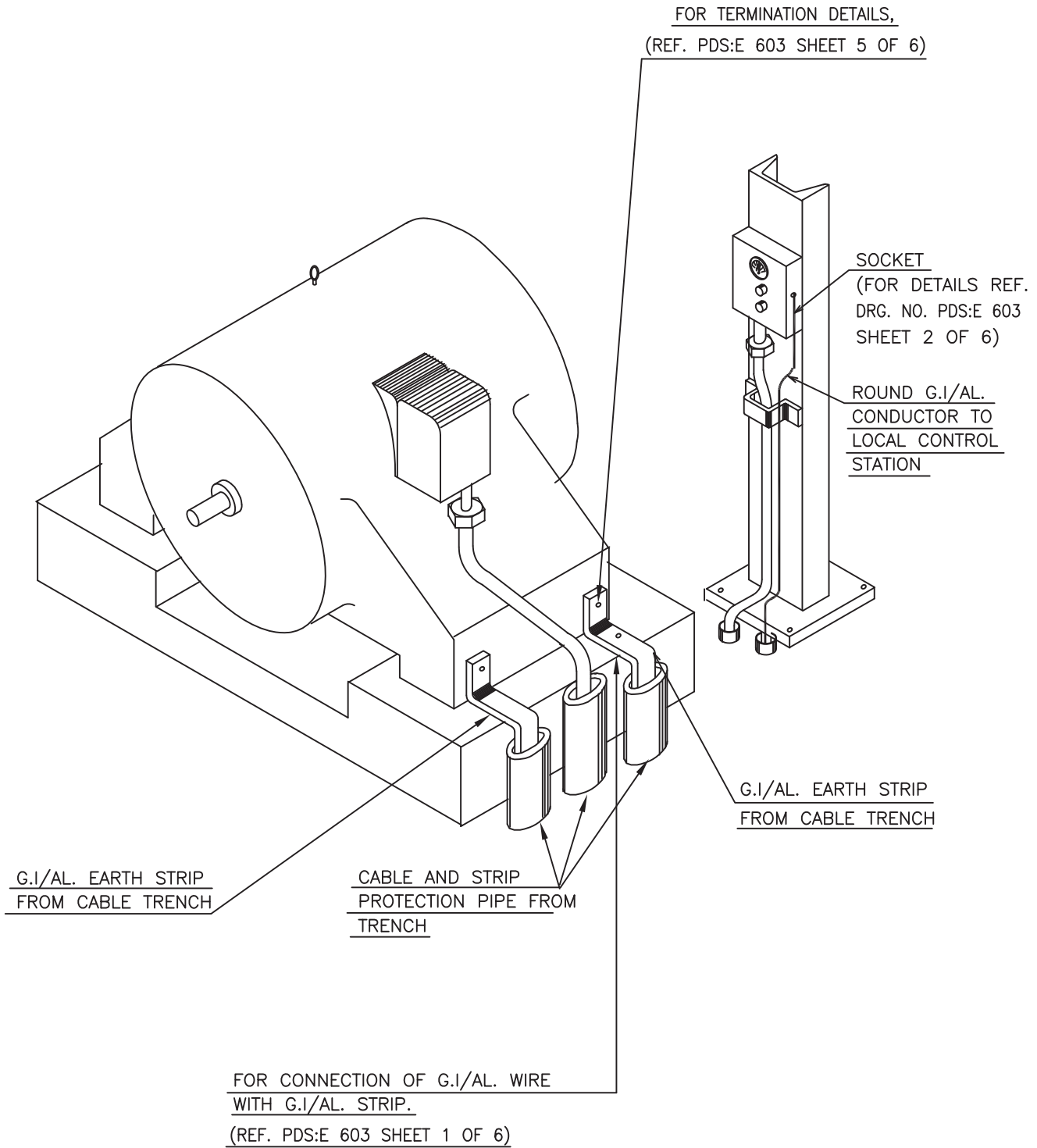
PVC INSULATED CONDUCTOR/G.I. WIRE/
AL. WIRE FOR EARTHING OF L.C.S.

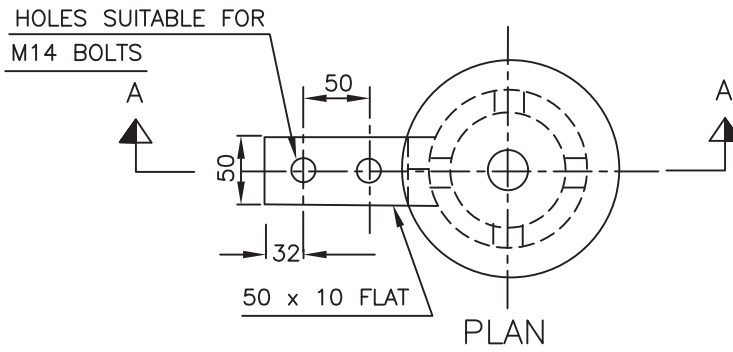
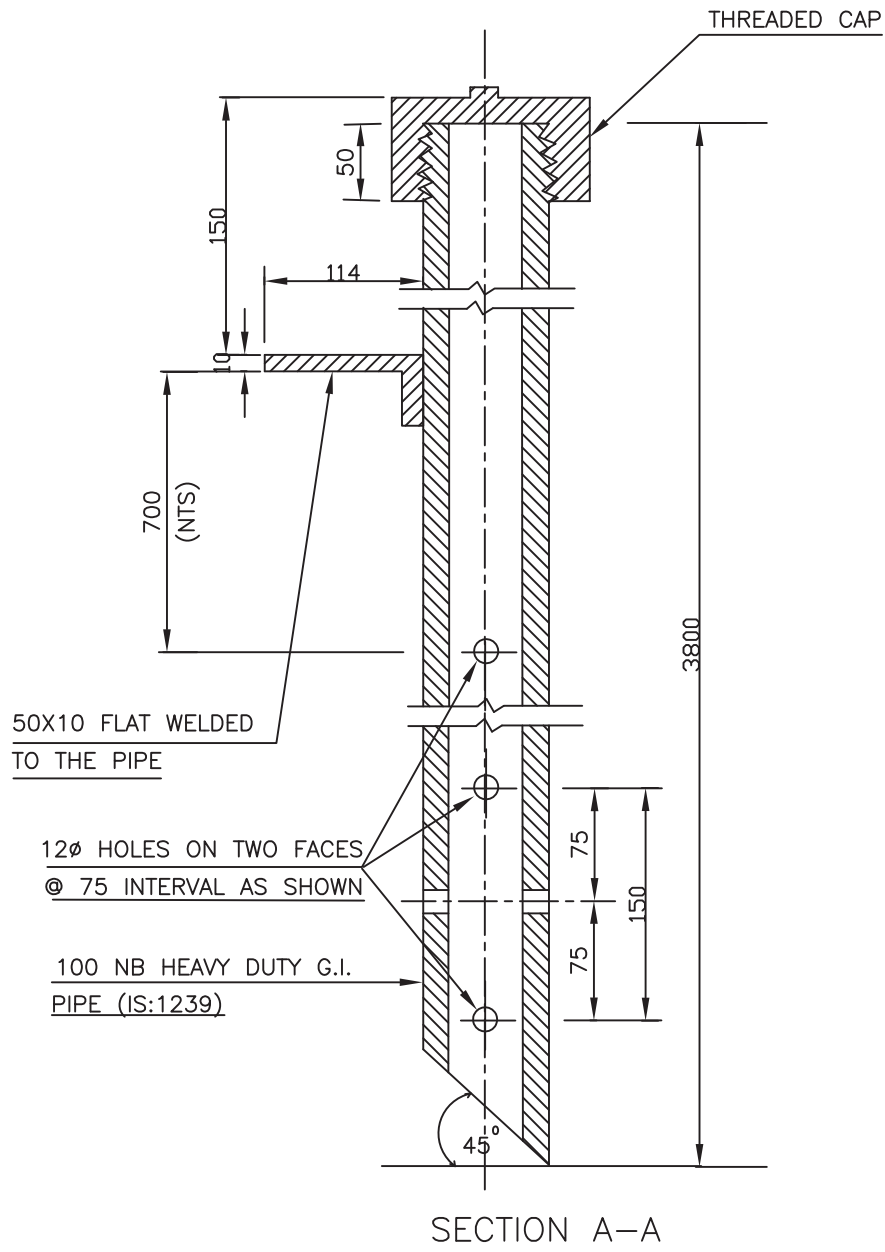
A

RUBBER BUSHING

50X6 FLATS WELDED TO
THE CHANNEL @ 300
INTERVAL

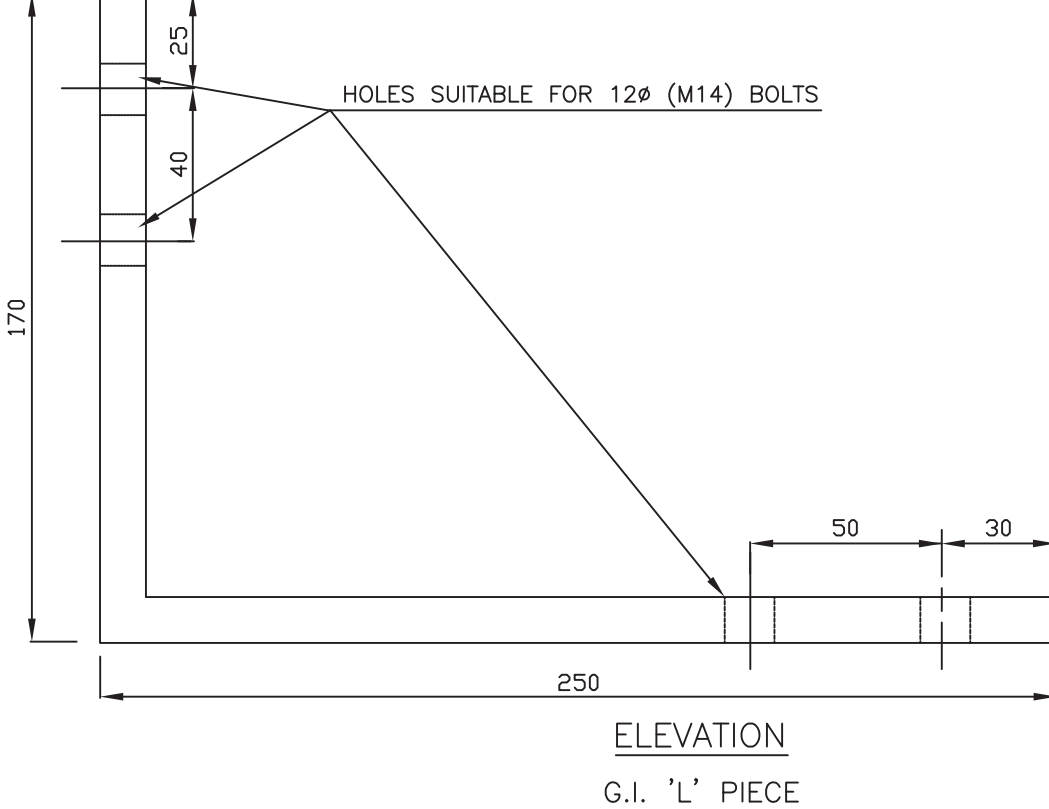
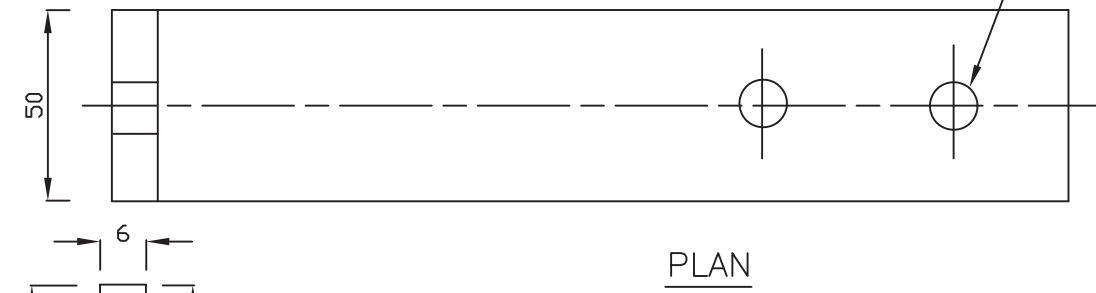
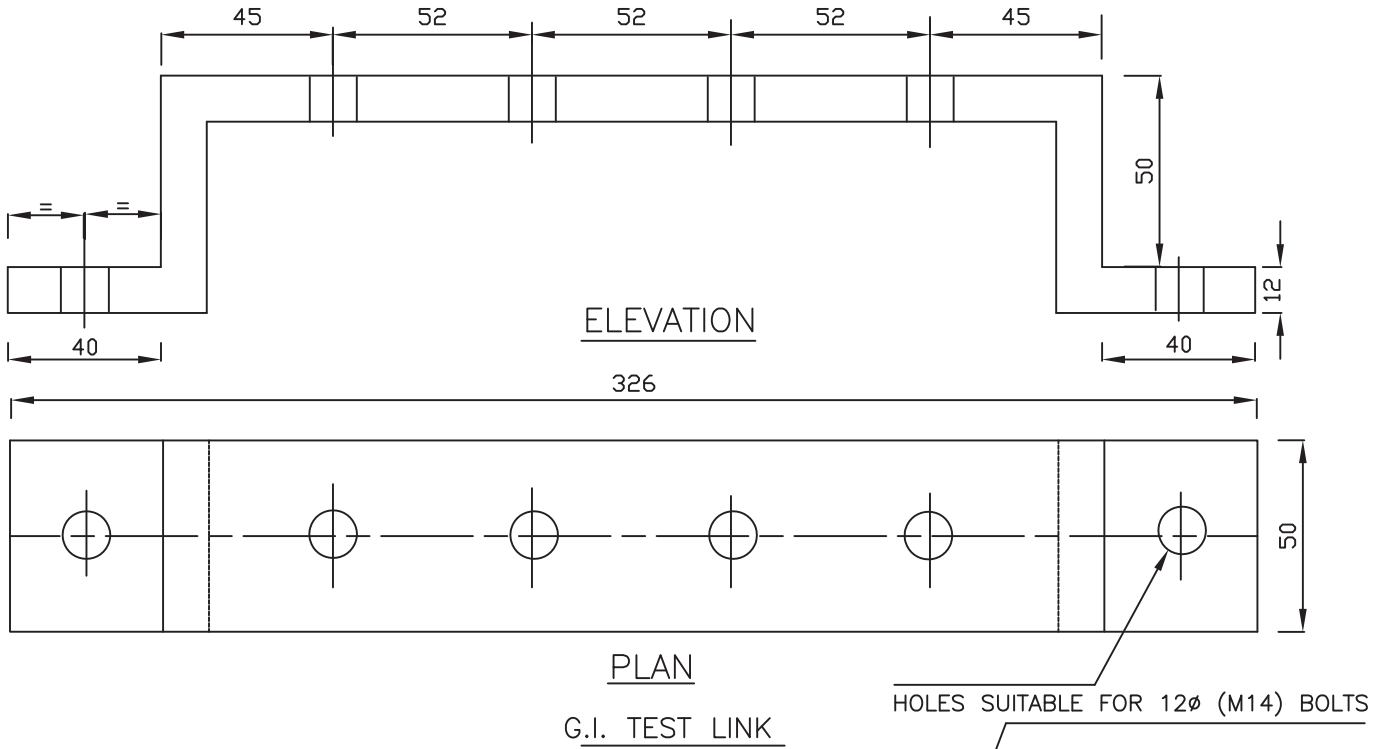
200x200x10 THCK PLATE
GROUTED FLUSHING WITH
FINISH FLOOR LEVEL

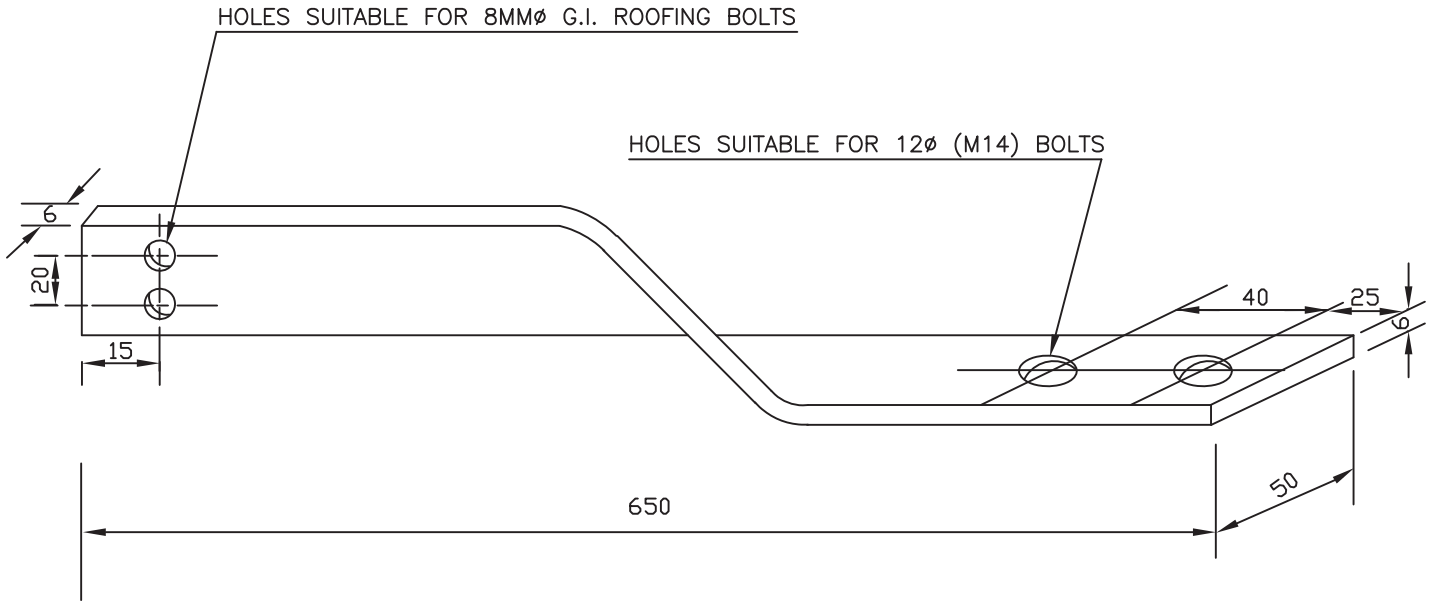




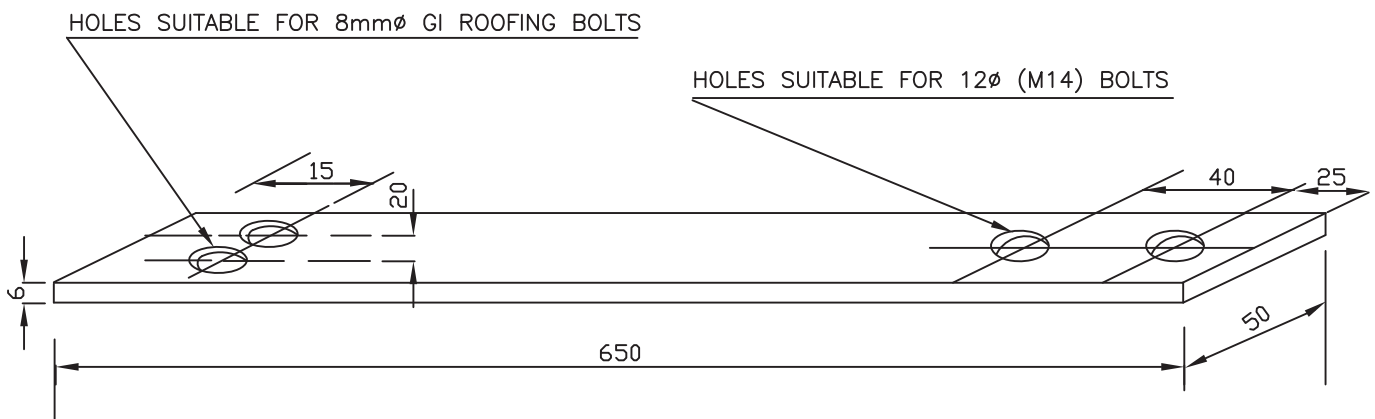
NOTE:-

1. 12 ϕ HOLES WILL BE PROVIDED AT 75mm INTERVAL ON TWO FACES THROUGHOUT THE LENGTH OF PIPE. THE FIRST ONE SHALL START 700mm BELOW THE WELDED FLAT.
2. ALL DIMENSIONS ARE IN mm.

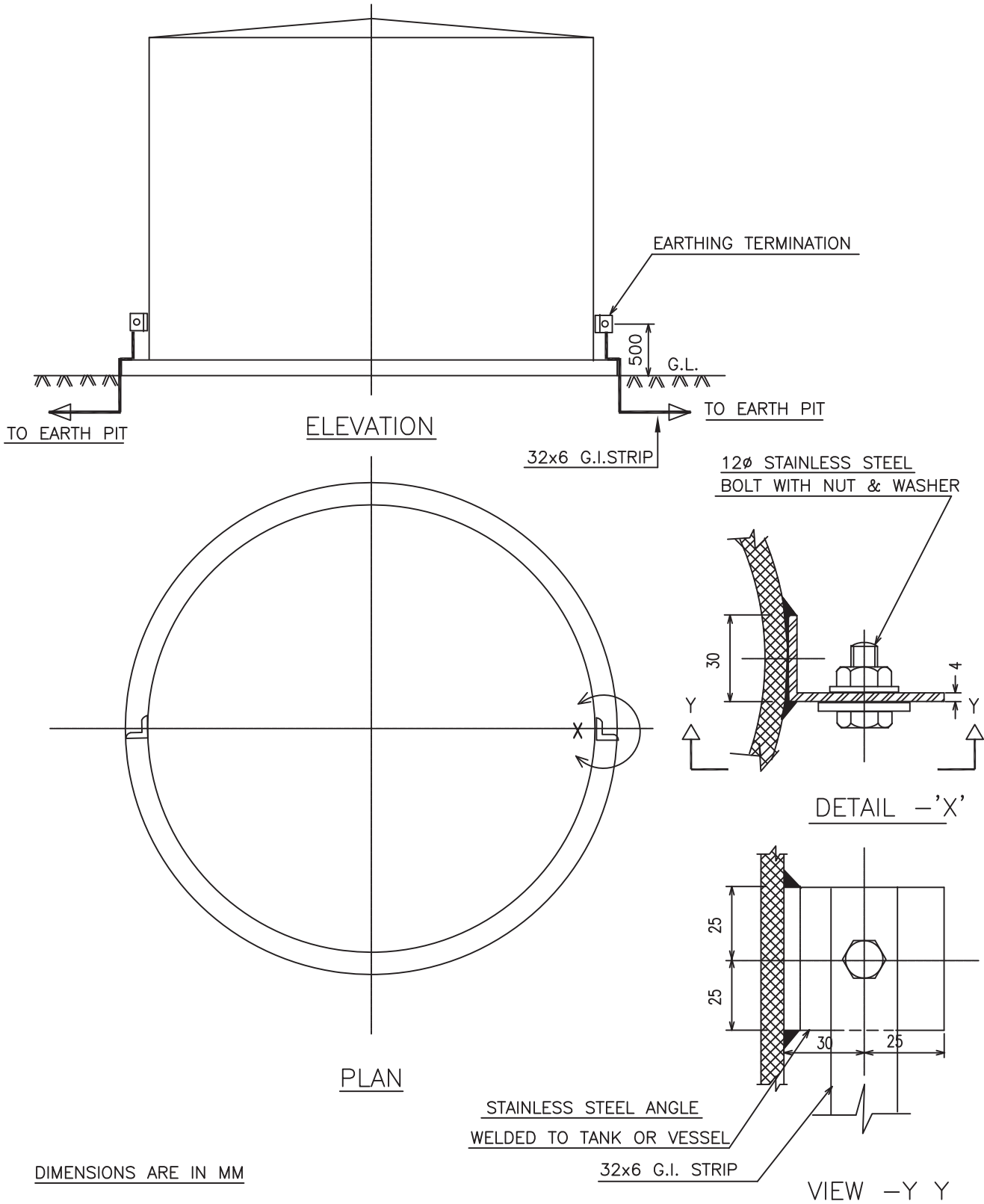




CONNECTING TWISTED ALUMINIUM FLAT PIECE



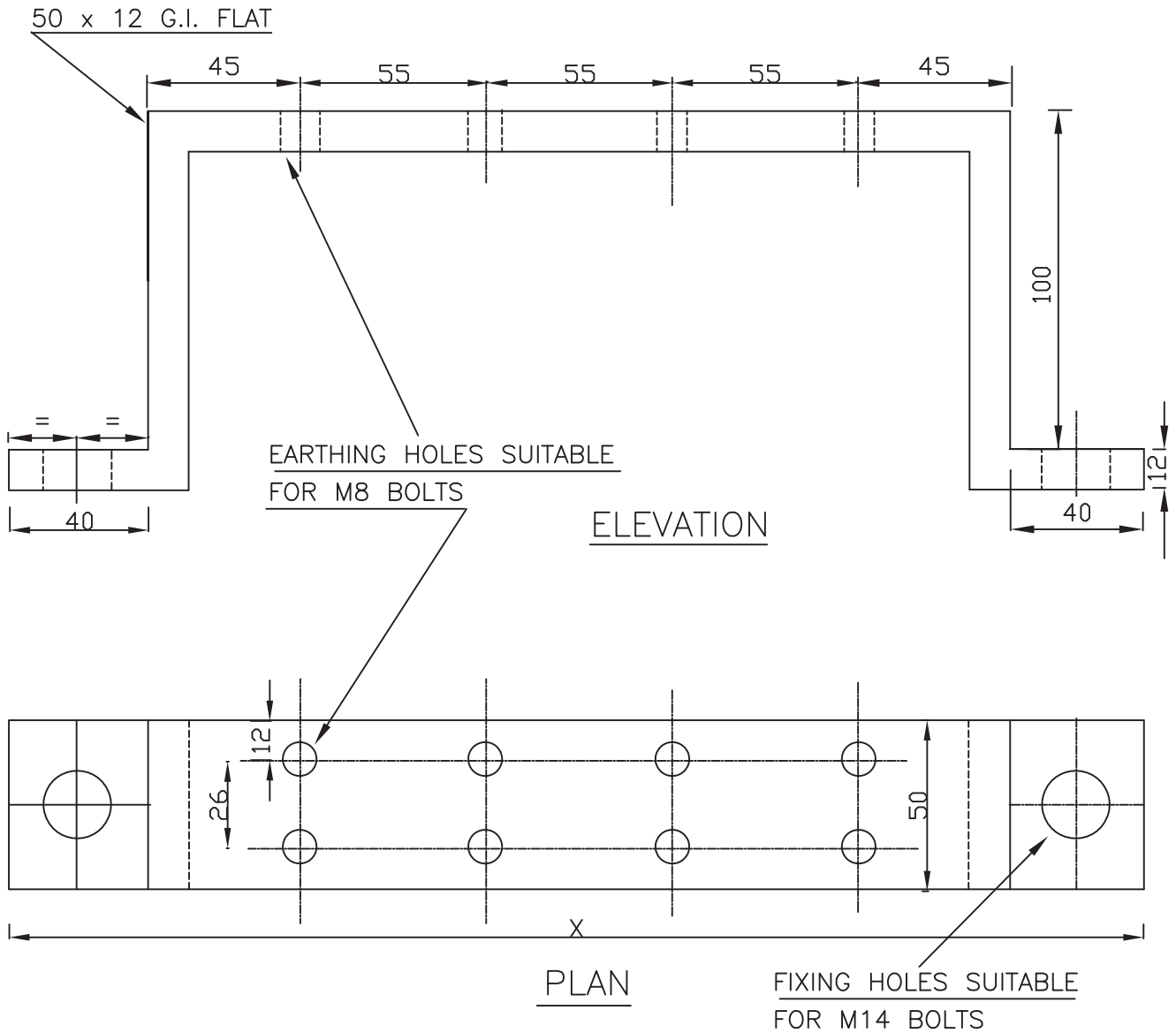
CONNECTING ALUMINIUM / G.I. FLAT PIECE



DIMENSIONS ARE IN MM

THE NO. OF EARTH CONDUCTOR SHALL BE AS FOLLOWS

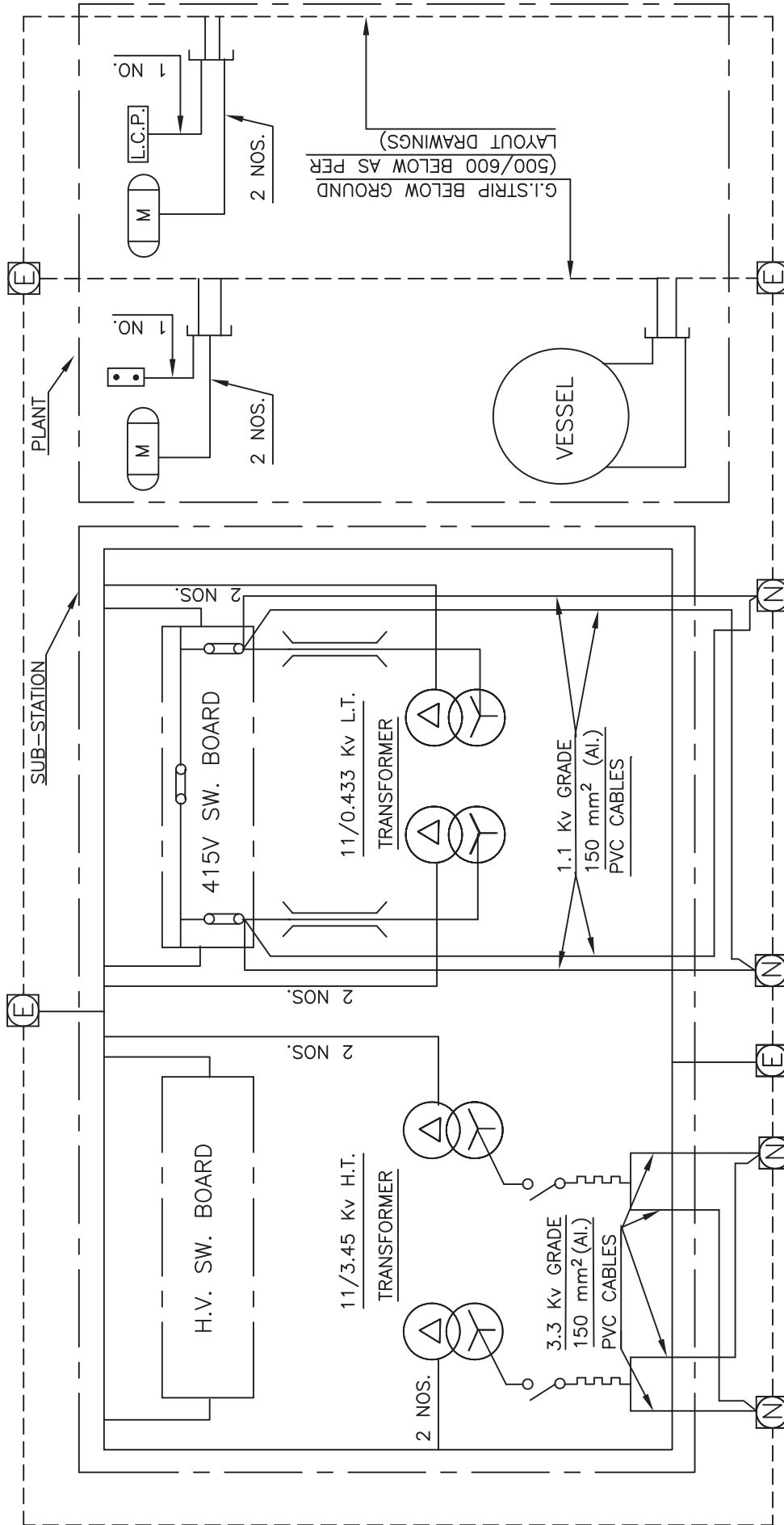
EQUIPMENT WITH ANY DIMENSION	HAZARDOUS AREA	NON-HAZARDOUS AREA
≤ 3 Mts.	1	1
> 3 Mts. ≤ 30 Mts.	2	1
> 30 Mts.	3	2



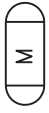









TYPE OF EARTH BUS	NO.OF EARTHING HOLES	OVERALL LENGTH x (mm)
1	8	335
2	10	390

NOTES:—

1. LOCATION OF EARTH BUS TO BE DECIDED AS PER EQUIPMENT POSITION AT SITE.
2. EARTH BUSES SHALL BE LOCATED ON STRUCTURES/COLUMNS WALLS/EQUIPMENT FOUNDATION ETC.
3. MOUNTING HEIGHT OF EARTH BUS SHALL NOT BE LESS THAN 500mm FROM FINISHED FLOOR LEVEL
4. ALL DIMENSIONS ARE IN mm



L E G E N D

-  MOTOR
-  LOCAL CONTROL PANEL
-  LOCAL CONTROL STATION
-  NEUTRAL EARTH PIT
-  EARTH PIT FOR SYSTEM
-  NEUTRAL LINK
-  TPN BUS DUCT
-  NEUTRAL EARTHING RESISTOR
-  SWITCH
-  EARTH BUS

REF. DRGS.

1. EARTH PIT DETAILS - PDS:E 605
2. EARTH CONDUCTOR SIZES - PDS:E 602 (2 SHEETS)

NOTE :-

EARTH BUS SHALL BE 500 ABOVE FROM FLOOR LEVEL

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		DOCUMENT NO		
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PART II: TECHNICAL



SECTION – 8.0

DESIGN PHILOSOPHY – INSTRUMENTATION

**PLANT: NATIONAL FERTILIZERS LIMITED, NFL, NANGAL,
PUNJAB**

**PROJECTS: INSTALLATION OF NEW 2500 CUBIC METER
CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA
ALONG WITH ITS REFRIGERATION SYSTEM
AT NFL, NANGAL**


REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD
0	15/02/23	15/02/23	Comments Incorporated	HK	HK	RKR
P	06.12.2022	06.12.2022	Issued For Draft Tender	HK	HK	RKR

	DESIGN PHILOSOPHY-INSTRUMENTATION INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/8.0		
		DOCUMENT NO		
		REV. 0	SHEET 2 OF 66	

CONTENT

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2.	SCOPE	4
3.	BASIS OF DESIGN	5
4.	INSTRUMENTATION CODE AND PRACTICES	6
5.	HAZARDOUOUS AREA CLASSIFICATION & ELECTRICAL EXECUTION	10
6.	ELECTRICAL SUPPLY	11
7.	GAS DERTECTOR	11
8.	FLOW INSTRUMENTS	11
9.	LIQUID LEVEL INSTRUMENTS	15
10.	RADAR LEVEL INSTRUMENT	19
11.	SOLID LEVEL MEASUREMENT	20
12.	PRESSURE INSTRUMENTS	25
13.	TEMPERATURE INSTRUMENTS	29
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15.	CONTROL, SHUTDOWN SYSTEM (DCS/ESD) AND CONTROL ROOM	35
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LIST OF ATTACHMENTS

A. List of Annexure:

ATTACHMENT NUMBER	DESCRIPTION	NUMBER OF SHEETS
ANNEXURE-1	ACCURACY OF INSTRUMENTS	2
ANNEXURE-2	INSTRUMENT NOZZLES	3
ANNEXURE-3	UNITS OF MEASUREMENT	1
ANNEXURE-4	SYSTEM CONFIGURATION	3

	DESIGN PHILOSOPHY-INSTRUMENTATION INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/8.0		
		DOCUMENT NO		
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1.0 INTRODUCTION

M/s National Fertilizers Limited (NFL) proposes to install new Ammonia Horton Sphere (Capacity 2500 cubic meter) along with its refrigeration system and interconnection with existing Horton Sphere(F2401) system, including complete Mechanical, Civil, Electrical, Instrumentation work at NFL, Nangal.

1.1 PURPOSE

The purpose of this document is to establish the design basis for Instrumentation and Control system for new Ammonia Horton Sphere at NFL, Nangal.


2.0 SCOPE

2.1 This section outlines the general requirements and specifications for Instrumentation and Control System for the PROJECT. The Instrumentation and Control System shall consist of but not limited to the following:

- a. Supply, erection and commissioning of new Ammonia Horton Sphere (Capacity 2500 cubic meter) along with its refrigeration system and interconnection with existing Horton Sphere(F2401) system complete with instrumentation, interlock and control from existing DCS and ESD system, Online Gas detection system etc.
- b. Existing DCS and ESD shall be used for Control and Operation for new Ammonia Horton Sphere. Bidder to consider IO cards, power supplies, cables etc for hookup with the existing system. Bidder to ensure presence of Honeywell DCS/ESD vendor at the time of erection and commissioning of new Ammonia Horton Sphere.
- c. Erection of new Refrigeration Compressor Control Room.
- d. Laying of multipair cables from its battery limit to Main Ammonia/Urea Control room. Approximate distance is 800m. Cable tray/trench lay out has not yet been finalized, successful LSTK contractor may visit the site and the route and layout can be mutually finalized depending upon the site conditions.
- e. The bidder shall also include in his proposal and shall furnish all equipment, devices and services which may not be specifically stated in the specification but are needed for completeness of the equipment/systems furnished by the bidder and for meeting the intent and requirements of the specification.

2.2 The Bidder's scope of supply for Instrumentation, Control and DCS/ESD (Emergency Shut Down system) shall comprise of design, engineering, manufacturing, testing, supply, erection and commissioning of complete Field Instrumentation and Control system required for fail safe startup, operation, control and shutdown shall therefore be the responsibility of the bidder. Bidder's scope of supply shall consist of the following as minimum:

- a) Preparation of general specification for Instruments.
- b) Sizing of flow instruments, control valves, etc., and preparation of Technical data sheets for all Instruments.
- c) Preparation of engineering and construction documents like functional schematics, I/O list, configuration diagram, electrical load list, cable schedule, cable tray/trench layout,

	DESIGN PHILOSOPHY-INSTRUMENTATION INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/8.0		
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- instrument air requirement, nameplate schedule, JB schedule, instrument location layout, electrical instrument signal interface, instrument index, layout drawings, loop diagrams, interlock diagram, primary and secondary sketches and bill of materials.
- d) Preparation of all engineering documents like graphic schemes, instrument loop data base, log formats and any other documents necessary to carry out the system engineering,
 - e) Preparation of specification for erection materials like cables, cable trays, pipe & pipe fittings, air tubing, junction boxes, air distribution pots etc.
 - f) Execution & Site supervision of construction, erection, testing and commissioning activities of field instrumentation and control room instrumentation activities.
 - g) Supply of all instruments, cable, Junction box, cable glands, branch cable trays etc. Also, cable laying, wiring, tubing, piping, installation of cabinets, cable termination, ferruling etc. shall be in the scope of bidder.
 - h) The equipment shall employ latest state of the art technology to guard against obsolescence. In any case, bidder shall be required to ensure supply of spare parts for 15 years of the plant. In case, it is felt by the Bidder that certain equipment/component is likely to become obsolete, the Bidder shall clearly bring out the same in his bid and indicate steps proposed to deal with such obsolescence.
 - i) All control and shutdown application shall be done on existing DCS and ESD system. Existing DCS and ESD system is of Honeywell make.
 - j) 2 out of 3 voting logic system upto field sensor levels shall be considered for all trip parameters. In short, 2 out of 3 trip sensor/transmitters philosophy shall be employed for all the trip input parameters, which may cause complete plant disruption, directly or indirectly. All these three diff transmitters shall be wired to three diff. cards of existing ESD to distribute/ minimize the risk of card failure. This necessitates installing and connecting three transmitters for interlock purpose with ESD on the same parameter.
 - k) Existing cable tray shall be used for laying cables from new Ammonia Horton Sphere to Existing control room. Wherever cable tray not available, bidder to consider the same in their scope.
 - l) For signals having interlock and control both, the execution shall be 2003 voting only through use of three transmitters upto ESD system. The control shall be median control through hardwired repeat outputs from ESD marshalling cabinets.
 - m) For measurements having control only, at least two transmitters shall be wired up to DCS. One shall be in control and second shall be used for alarm with provision to shift the control on it.

In case of contradiction / conflict among documents, Bidder shall refer to Owner for clarification. However, most stringent specification shall be followed with Owner's approval. Owner decision shall be considered as final.

3.0 BASIS OF DESIGN

General

Instrumentation for the proposed New Ammonia Horton Sphere Project is to provide a highly reliable and comprehensive control and monitoring system. To facilitate these, well proven techniques shall be adopted for measurement and control.

	DESIGN PHILOSOPHY-INSTRUMENTATION INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/8.0		
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The following philosophy is to be adopted:

- a). No Direct Process Switches (Pressure / Level/ Flow / Temp.) shall be used. However, if it's not possible to install transmitter for particular application online pressure/level switches (float type) may be used with specific approval of owner (NFL/PMC).
- b). Execution type for all field transmitters in hazardous area shall be intrinsic safe. Flame/ ex. proof enclosures shall be provided where intrinsic certifications are not available.
- c). All field transmitters for pressure, d/p, level and flow shall be microprocessor based (dual compartment) SMART transmitters with "UNIVERSAL HART" protocol with latest revision. The transmitter selection shall be such that the operating maximum upper limit shall be around 70% of the total measurement range of the transmitter.
- d). 2oo3 SOV to be considered for all Trip solenoids, and configured and hooked up properly in such a way that failure of one solenoid doesn't initiate a false trip. Trip solenoids shall be normally in energised condition and shall be de-energised to initiate trip.
- e). Air fail to open, Close or Hold of any control valve shall be as per Licensors document, to take care of process, plant and human safety. For Piston actuators necessary air volume chambers and lock up relay shall be provided to achieve the fail safe condition.
- f). Inputs from thermocouples shall be provided with cold junction compensation and downscale burns out feature for high temperature shut downs and vice versa for low. A passive alarm shall warn about the burn-out.
- g). Copper and copper alloy shall not be used for wet part of field instruments.

4.0 INSTRUMENTATION CODE AND PRACTICES

Design and terminology shall comply, as a minimum, with the latest edition prior to the date of purchaser's enquiry with following codes, standard practices and publications:-

AGA	<u>American Gas Association</u>
Report No.3 -	Orifice Metering of Natural Gas & other related hydrocarbon fluids
Report No.7 -	Measurement of Gas by Turbine Meters.
Report No.9 -	Measurement of Gas by Ultrasonic Meter
<u>ANSI/ASME</u>	<u>American National Standards Institute/American Society of Mechanical Engineers.</u>
B 1.20.1	Pipe Threads General Purpose (Inch)
B 16.5	Pipe Flanges and Flanged Fittings
B 16.20	Metallic Gaskets for pipe Flanges, Ring Joint, Spiral wound and Jacketed.
ANSI /ISA - S 7.3	Quality standard for instrument air
ANSI MC 96.1	Temperature measurement thermocouples
NSI/ISA - S 5.115.3	Instrumentation symbols and identification
ANSI/ISA S 75.01	Flow equations for sizing control valves

	DESIGN PHILOSOPHY-INSTRUMENTATION INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/8.0		
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ANSI/ISA S 75.02	Control Valve procedure capacity test
ANSI/ISA S 75.03	Uniform Face to Face dimensions for flanged globe valve bodies
ANSI B40.1/ASME	Gauges and Pressure Indicating Dial Type Elastic Element
ANSI/ASME B16.36	Orifice Flanges
ANSI B 133.4, 1978 (R 1990)	Gas Turbine Control & Protection System

ANSI/FCI

ANSI B16.104/FCI 70.2 Control valve seat leakage classification

API

American Petroleum Institute

API MPMS	Manual of Petroleum measurement standards.
API RP 551	Process Measurement Instrumentation Part I - Process Control and Instrumentation
API S 1101	Measurement of Petroleum Liquid Hydrocarbon by Positive Displacement meter.
API S 2534	Measurement of liquid hydrocarbons by turbine meter systems
API 614	Control system for Gas Turbines
API S	670 Vibrations, Axial-Position and Bearing-Temperature Monitoring Systems
API RP 550	Manual on installation of refinery instruments and control system
API RP 551	Process Measurement Instrumentation
API RP 552	Transmission Systems
API RP 553	Refinery Control Valves
API RP 555	Process Analysers
API RP 557	Guide to Advance Control Systems
API RP 554	Process Instrumentation & Control

ASME

American Society of Mechanical Engineers

ASME B16.5	Pipe Flanges and Flange Fittings
ASME B16.10	Face-to-Face and End-to-End Dimensions of Valves
ASME B16.11	Forged steel fittings, socket welding and threaded But welding ends
ASME B 16.25	Valves- Flanged threaded and welding end and annexure for radiography and magnetic particle procedure and acceptance standards.
ASME B 16.34	
ASME B16.47	Large Diameter Steel Flanges (NPS 26 thru NPE 60)

ASTM


ASTM American Society for Testing and Materials.

ASTM E 230	EMF tables for standardized thermocouples
ASTM E 608	Standard specification for metal-sheathed base-metal thermocouples
ASME B16.10	Face-to-Face and End-to-End Dimensions of Valves

BS

British Standards

BS-5308 Part-II	Specification for PVC insulated cables.
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	DESIGN PHILOSOPHY-INSTRUMENTATION INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/8.0		
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- BS 3463 Observation and Gauge Glasses for Pressure Vessels
BS 1042 Section 1.2 Specs for square edged orifice plates and nozzles and venture tubes and inserted in circular cross section conduits.
BS 1042 Section 1.1 Specs for square edged orifice plates and nozzles and their orifice plate and board inlets

DIN

German Standards

- DIN-43760 Temperature Vs Resistance curves for RTDs.
DIN-19234 Electrical Distance Sensors; DC interface for Distance Sensor and Signal Converter.
DIN 51116/
VGB 117C Protection systems

EN-10204

Inspection Documents for Metallic Products

IBR

Indian Boiler Regulations

IEC

International Electro technical Commission

- IEC 60085 Thermal Evaluation and Classification of Electrical Insulation.
IEC 60332 Test on bunched wires or cables. Part III Cat. A
IEC 60529 Degree of protection provided by enclosures.(IP code)
IEC 60534-2 Industrial Process Control Valves-Flow capacity.
IEC 60584-2 Thermocouple Tolerances
IEC 60751 Industrial Platinum Resistance Thermometer Sensors
IEC 61000-4 Electromagnetic compatibility for Industrial Process measurement and control equipment.
IEC 60079 Code of Practice for the Selection, Installation and Maintenance of Electrical Apparatus for use in Potentially Explosive Atmospheres
IEC 60534.1 Control valve terminology and general considerations
IEC 60534.2.1 Flow capacity - Sizing equations for fluid flow under installed conditions
IEC 60534.2.3 Flow capacity - Test procedures
IEC 60534.2.4 Flow Capacity - Inherent flow characteristics and rangeability
IEC 60534, 2.5 Flow capacity - Sizing equations for fluid flow through multistage control valves with inter stage recovery
IEC 60534.3.1 Face-to-face dimensions for flanged, two- way, globe-type, straight pattern and centre- to-face dimensions for flanged, two-way, globe-type, angle pattern control valves
IEC 60534.3.2 Face-to-face dimensions for rotary control valves except butterfly valves
IEC 60534.8.3 Industrial Process Control Valves- Aerodynamic Noise Prediction
IEC 60534.8.4 Industrial Process Control Valves – Prediction of Noise Generated by Hydrodynamic Flow
IEC 60584-1 Thermocouples-Part 1: reference table
IEC 60751 Industrial Platinum Resistance Thermometer Sensors
IEC 61000.4.1 Testing and Measurement techniques- Overview
IEC 61000.4.3 Testing and Measurement techniques- Radiated, Radio Frequency, Electromagnetic Field Tests

	DESIGN PHILOSOPHY-INSTRUMENTATION INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/8.0		
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IEC 61000.4.4	Testing and Measurement techniques- Electrical Fast Transient/burst Immunity Tests
IEC 61000.4.5	Testing and Measurement techniques – Surge Immunity
IEC 61508	Functional Safety of Electrical, Electronic, Programmable Electronic Safety Related Systems
IEC 61511	Functional Safety of Safety Instrumented Systems for the Process Sector
IEC 751	Industrial PI. RTD
IEC 529	Degree of Protection by Enclosure

IEEE

C37.90.1 - 2002	Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems
IEEE 422	Guide for the design and installation of cable system in power generating station (cable trays, support system, conduits, test standards etc.)

IS


Indian Standard

IS-5	Colours for ready mixed paints and enamels
IS-319	Specification for free cutting Brass bars, rods and sections
IS-1239	Mild steel tubes, tubulars and other wrought steel fittings.
IS-1271	Specification of Thermal Evaluation and Classification of Electrical Insulation
IS-1554	PVC insulated (heavy duty) electric cables working Part I -voltage up to and including 1100V
IS-2074	Ready mixed paints, air drying, red oxide - zinc chrome
IS-13947	Degree of Protection provided by Enclosures for Low Voltage Switchgears and Control gears. Part 1 General Rules.
IS-2148	Flame proof enclosures for electrical apparatus for Explosive Gas Atmospheres – Flameproof Enclosures 'd'.
IS-3624	Specification for pressure and vacuum gauges
IS-5831	PVC insulation and sheath of electric cables.
IS-7358	Specifications for Thermocouples
IS:13947	Degree of Protection by Enclosure

ISA

Instrumentation, Systems and Automation Society

S-5.2	Binary logic diagrams for process operations.
S-7.3	Quality standard for instrument air
S-75.01	Flow equations for sizing control valves
ISA 18.1	Annunciator sequences and Specifications
ISA S84-01-1996	Application of Safety Instrumented Systems in the Process Industries
ISA S 5.1/KKS	Instrumentation Symbols and indent
ISA5.2	Binary Logic Diagrams for Process Operations
ISA5.3	Graphic symbols for distributed control/shared display instrumentation, logic and computer system
ISA S 12.4	Air Purge System
ISA S 71.04	Environmental Conditions
ISA S 75.01	Control Valve Sizing
ISA S 75.02	Control Valve Procedure Capacity Test

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ISO

- ISO 5167 Measurement of fluid flow by means of orifice plates, nozzles and venture tubes inserted in circular cross-section conduits.
- ISO 5208 Pressure Testing of Valves

CENELEC

- CENELEC EN 50014 Electrical Apparatus for potentially explosive atmosphere- General Requirements
- CENELEC EN 50016 Electrical Apparatus for potentially explosive atmosphere- Pressurized Apparatus "P"
- CENELEC EN 50018 Electrical Apparatus for potentially explosive atmosphere- Flame proof enclosure "d"
- CENELEC EN 50019 Electrical Apparatus for potentially explosive atmosphere- Increased safety "e"
- CENELEC EN 50020 Electrical Apparatus for potentially explosive atmosphere- Intrinsic Safety "I"

NEC

National Electrical Code

- NEC/USA Art 5001978 Classification of hazardous area

NEMA

National Electrical Manufacturers Association

- NEMA VE-1 Guide for the design and installation of cable system in power generating station (cable trays, support system, conduits, test standards etc.)

NFPA

National Fire Protection Association

- NFPA-496 Purged and pressurized enclosures for electrical equipment.
- NFPA 852007 Ed. Firing system
- NFPA 70-1984 Art 500 Vol.6 Classification of hazardous area.

OSHA



Occupational Safety and Health Authority.

SAMA

Scientific Apparatus Maker's Association

5.0 HAZARDEOUS AREA CLASSIFICATION & ELECTRICAL EXECUTION

- 5.1 The Hazardous Areas are Zone 2, and all Instruments shall conform to Exd or Exia, Gr. IIC Temp class T6 to CENELEC EN 50018, & 50020. The certification shall be as per ATEX/NEC or IEC directives.

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Electrical / Electronic instruments	IP 67
Sensors; RTD, T/C, etc.	IP 65
Local Gauges; PG, etc.	IP 65
Pneumatic instruments	IP 54
Solenoid valves	IP 67
Local Panel / Skid Mounted Panels	IP 55
EMC compatibility and electrical safety as per latest IEC standard.	

5.2 Electrical instrument equipment shall be designed for and supplied as intrinsic safe certified. Analysers, solenoid valves and other equipment that cannot be classified intrinsic safe shall be ex-proof in accordance with the above mentioned electrical specification.

Certification for installation in hazardous areas in accordance with IEC 60079 series is shown below:

Switches:	Ex de IIC T6
Analysers and Panels:	Ex p IIC T6
Solenoid Valves:	Ex d IIC T6 (Ex md not allowed)
Junction Boxes and Cable Glands:	Ex d IIC T6
Junction Boxes and Cable Glands (hazardous area):	Ex d IIC T6

6.0 ELECTRICAL SUPPLY



The electrical supply will be as follows:

Distributed Control System, trip system, and Control Room Instruments	: 115V AC+/-10%
Solenoid Valves	: 110VDC (Deviation if any shall be with specific approval of NFL/PMC)
Local Panels	: 115V AC/24 V D.C
Local Illumination, equipment for air conditioning, space heaters, ventilation of local panels and similar purposes	: 240V AC
Field-mounted Transmitters and switches	: 24V D.C. intrinsic safe
Safety Circuits	: 115 V AC

The 115V AC supply will be an uninterrupted power supply (UPS) of 115V +/- 10%, 50Hz +/- 3% from two sources. Both shall be used for redundancy.

Where 24V DC is needed, it will be generated by local rectifier units, which are part of the instrumentation supply. The power supply to these units shall be taken from the UPS.

Where 24V DC are used for Safety Circuits, the rectifier units shall be duplicated and with high reliability and form a part of ESD vendor. Redundant 24V D.C. power supply shall be powered from two different sources of UPS.

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A separate instrument earthing system apart from the power supply protective earthing system is foreseen.

7.0 GAS DETECTORS

Gas Detector of Hydrocarbon / IR type, Ammonia will be required. For all the Gas detectors cable size shall be of 2.5 sq mm only. Bidders to consider 2 wire gas detectors to the extent possible. Gas detector will be provided as per layout attached elsewhere.

Separate junction box shall be used for Gas detector.

8.0 FLOW INSTRUMENTS

The choice of primary differential producing devices will depend on service conditions and on the permanent pressure loss, which can be tolerated. A square edged concentric orifice plate is the usual selection if conditions permit. Quadrant edge or quarter circle orifice plates shall be used for viscous liquids and for pipe Reynolds number below 10,000 Conical entrance type of orifice plates shall preferably be used for very highly viscous liquids up to throat Reynolds number of 250. These shall be fabricated as per ISO 5167. Vent and drain holes shall be provided wherever necessary.

The primary element shall generally be thin plate, square-edge concentric orifices plate mounted between a pair of weld-neck type orifice flanges with flange taps. The minimum pressure rating of flanges shall be 300 lb ANSI. Eccentric and Segmental type of orifice plates shall be used for specific application like highly viscous fluid etc.

Quadrant edge or conical entrance orifice plates shall be used for services with low Reynolds number

Venturis and flow nozzles may be selected where system requires low pressure drops.

Rotameters shall be used in exceptional cases in consultation with NFL/PMC


If used Variable area flow meter shall have 4-20 mA output signal for indication in DCS.

Vent and Drain holes shall be provided wherever necessary.

For steam service above 16", flow nozzle can be provided.

For combustion air flow measurement in heaters, venturi to be used instead of annubar.

In case of multi-transmitter installation from a single orifice, separate identical pair of tapping with isolation valves to be provided for the separate transmitters i.e. no branching from a single tapping.

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8.1 In no case Turbine type or PD flow meter shall be used. Where Mass flow meter is not applicable, Ultra sonic flow meter/Magnetic flow meter can be used. For the measurement of cooling water flow magnetic flow meter shall be used in general. However, for the pipes below the ground level, Pitot tube should be an averaging pressure type, and may be selected for clean fluids, low-pressure loss and large quantity measurement.

Vortex meter may be considered for clean liquids, gases and steam measuring application with higher turndown ratio. Vortex flow meters shall be taken for high rangeability applications.

Ultrasonic flow meter may be considered for the flow meter on large bore piping such as flare gas measurement.

Flow nozzles, Venturi tubes, Target meters, Magnetic flow meters, Ultrasonic flow meters, self averaging Pitot tube etc may be used wherever specified in the data sheet or as required

DP type flow transmitter shall normally be electronic SMART type with integral LCD indicator for output indication.

No flow switches shall be used. The same shall be achieved through flow transmitters, which shall be directly connected as analog input to DCS/PLC.

No PD / Turbine meters shall be considered unless otherwise specified by Licensor. Only Mass flow meters shall be used instead of PD / Turbine meters.

8.2 Thin Plate Orifices:



Orifice plate shall be thin plate with square-edge concentric orifice. The plate shall be mounted between a pair of weld-neck flanges with flange taps to form orifice plate assembly.

Design calculation of standard type orifice plates shall be as per ISO 5167.

The flow range shall be selected such that normal flow rates are between 50% and 70% of the flow upper range value.

Beta ratio limits for orifice plates shall generally between 0.5 to 0.7.

Material of construction of orifice plate shall be 316 SS except where this material is unsuitable for the service because of corrosion or erosion considerations, in which case an alloy shall be chosen whose corrosion allowance is equal to or better than line material. Orifice plates dimensions, finishing, flatness, tolerances for dimensions and identification information shall be in accordance with ISO standard. Orifice plate shall be provided with tab handle, which is welded on the orifice plate and engraved with following information on the upstream of the tab handle.

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- UPSTREAM or UP
- Instrument tag number
- Orifice diameter
- NPS (Nominal Pipe Size) and ANSI flange class
- Material of the orifice plate
- DP range & Meter (Flow) range

The tab shall also be in line with the Drain or Vent hole and shall indicate the direction of flow.

BIDDER shall submit the sizing calculations for orifice plates for review.

Pressure drop for orifice sizing shall generally be selected among the following values: 125, 250, 500, 625, 1250, 2500, 5000 and 10000 mm H₂O with standard selection at 2500 mmH₂O

Upstream and downstream straight length shall be provided based on maximum d/D ratio of 0.75, in general. Where it is difficult to meet this requirement, the actual d/D can be considered for reducing the straight length as permitted by ' recommended practice shall be as per API-MPMS Recommended Practices and AGA Report No.3. The piping layout, where possible, shall be arranged such that straightening vanes are not required.

Orifice plates shall be installed on horizontal lines when practical. Vertical meter runs may be used for down flow of vapour and up flow of liquids.

The Meter Range flow shall be equal to the 1.5 times of normal flow or 1.3 times of the maximum flow.


Differential ranges for all liquid flow meters shall not exceed 5000 mm water. Typical ranges for gas, steam or vapor meters are as follows:

Static Pressure (in Kg/Cm ² g)	Diff. Range (in mmwc)
0.35 to 2.5	500-1200
2.6 to 6	1250-2500
Above 6	2500-5000

Orifice bore with diameter less than 0.125" shall be avoided.

- 8.2.1 Flange taps orifice shall generally be used for line sizes 2" to and including 18". Above 18" line size, D and D/2 taps shall be used. Integral Orifice assembly with transmitter shall be used for line size 1 1/2 "or below (as per standard BS-1042)

Orifice assembly shall be provided with two sets of "Flange Taps" located in accordance with latest AGA standards. The orifice assembly shall be provided with jack screw for removal of

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orifice plate. In case of 2 out of 3 logic requirement, three transmitters shall be used. In such case six set of taps shall be provided in orifice assembly.

Instrument tapping connections shall be 1/2"NPT (F).

8.2.2 Orifice flanges

Orifice flanges shall be in accordance with the ANSI B16.36, ANSI B16.36a and applicable piping specification. The minimum pressure rating of flanges shall be ANSI 300 lbs.

Flanges larger than 3" shall have a pair of jack-screws. The mating flanged shall be aligned in such a way that jack-screws will be diametrically opposite.

8.3 D/P Flow Transmitters

Flow transmitters for use with differential producing devices shall be Smart Transmitter with Universal HART protocol with Latest Revision with integral LCD indicator and be furnished with test terminals and bypass diode to facilitate field testing without disconnection of integral indicator. The transmitters shall have over-range protection.

Body pressure rating shall be 160 Kg/cm² minimum and measuring capsules shall be able to withstand pressure up to the body rating in either direction without damaging the instrument. The body and other wetted parts material shall be SS 316L minimum. Other materials such as hastelloy, Monel or tantalum may be used as per process requirement.

Process connections shall be 1/2" National Pipe Thread (NPTF) and from the side/horizontal to the transmitter. Cable entry shall be 1/2" (NPTF).

For general services, five valve manifold (for the service above 90 deg C for drain/vent of fluids) and oval flange adaptor shall be provided in place of isolation & equalizing valves in the impulse piping of flow transmitters. No piping manifold shall be acceptable. No needle Valve shall be used as First or Second Isolation Valve for Transmitters.

8.4 Rotameters

Rotameters may be required as indicators or transmitters. Magnetic filters shall be provided up stream of Rotameters.



Accuracy of measurement shall be within 2% full scale.

Rotameters shall be mounted in-line for pipe sizes less than 2 inches.

Metal tube meters shall be used on hydrocarbon (liquid or gas) service, steam or other hazardous application.

Rotameter Rangeability shall be more than 10:1.

Flow damper shall be provided for pulsating flow. Cooling fins shall be provided for high temperature service (150 deg C & above) & extension well shall be provided for low

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temperature service (0 deg C and below). Jacket shall be provided for crystallizing fluid at ambient temperature.

Only metal tube Rotameter shall be considered. Glass tube Rotameter shall not be used.

8.5 Purgemeters

Purgemeter units shall consist of a glass / metal tube rotameter with needle valve at the inlet and a built-in check valve at the outlet. A differential pressure regulator shall also be supplied in applications where either the purge supply or process pressures are likely to vary significantly.

The design requirements for Purgemeters include: rangeability of 10:1, accuracy of +/-2% of maximum flow, "O" ring construction, and end connections of 1/4" N.P.T (F).

9.0 LEVEL INSTRUMENTS

9.1 Selection

For greater spans remote diaphragm seal, D/P type level instruments with integral indication shall be used. For slurries or other difficult services Wafer / flush diaphragm seal type with extended capillary D/P cells shall be considered. Extended diaphragm seal type shall not be used unless otherwise specified.

In general Seal Diaphragm type DPT with 5 meters armoured capillary shall be used for all level measurement up to 3000 mm. Displacer type level transmitter/ Guided radar type level transmitter shall be used where seal diaphragm type level transmitter is not suitable.

Separate and independent tapping shall be provided for level gauges and level transmitters on the vessels.



9.2 Guided wave radar Level Instruments

For interface level measurements, guided wave type Radar instrument shall be considered. The sealing material for GWR shall be Calrez or as per fluid service corrosion index and temperature rating.

Radar type Level transmitter to be used wherever service is of varying density. Ultrasonic or radar type level instruments are to be used for all acid and alkali tanks

Non-contact type level transmitters may be used on corrosive, congealing, slurry services where diaphragm seal type transmitter cannot be used

Water cut measurement with radar is to be provided for tanks. For sumps and tanks, Radar type level instruments shall be used.

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For underground tank applications non-contact type top mounted level measuring instruments like radar type shall be used.

The flushing connections shall be at process side with drip ring arrangement. Steam tracing, if required shall be provided with owner's review. Internal displacer type of level transmitters shall be not be used

The level tapping from the vessels & columns are not to be taken from bottom. The lower tapping is to be from side of the column / vessel. And accordingly minimum measurement level will be considered from the minimum possible level nozzle location.

Level measurement for product tanks, two level instruments shall be provided for each tank. Both level instruments shall be different type. In general one shall be radar type & other shall be servo type. As far as possible level measurement of process equipments guided wave process radar instrument shall be used in place of Displacer type of instrument.

The transmitter top unit should be rotatable type so that it can be positioned as required.

Cable entry for transmitter shall be ½" NPT (F).

9.3 D/P Level Transmitters

Transmitters shall be SMART Type with HART protocol, integral LCD indicator and be furnished with test terminals and bypass diode to facilitate field-testing without disconnection of integral indicator. Transmitter accuracy shall be $\pm 0.1\%$ FS or better.

The stability of the transmitters shall be valid for 5 years.

Remote Seal type Differential pressure transmitter is to be considered for level measurement, the element shall be with drip ring provision & with welded joint for vent & drain.


Remote seal diaphragm type transmitter shall be used for all clean service except in hydrogen service. Diaphragm seal D/P Level transmitters used shall have 3" ANSI RF process connection. Process tapping shall also be 3" flange

The body and wetted parts material shall normally be SS 316L. Other materials such as Hastelloy, Monel or Tantalum may be used based on process requirement

Dip tube type may be used on corrosive, slurry applications where diaphragm material as wetted part is not suitable for direct contact of process fluid or is not easy to install.

9.4 Level Gauge Glasses

In general, Magnetic level gauge shall be used where ever possible.

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Liquid level gauges shall be used for local indication. Gauge glasses shall be made of borosilicate armored /toughened glass. Gauge glass shall be a single piece forged construction.

The use of reflex/transparent gauge glass shall be minimised and are to be used if magnetic level gauge could not be used.

The transparent gauge glass shall be provided with protective shield.

In case of service of crystallizing and viscous fluids, need steam tracing at ambient temperature, level gauge shall be provided with facility of tracing.

Tubular type gauge glass shall not be used.

Magnetic level indicators shall be used in the place of gauge glasses for corrosive, dangerous or other difficult services.

Magnetic Level gauges shall be used for high pressure H₂ services.

For high pressure services no threaded joints shall be used.

Gauge cocks shall be provided for all gauges preferably quick operating lever operated forged offset ball type. All level gauges shall be supplied with ½” Drain valve with plug & ½” vent plug. All the fittings shall be welded or screwed & seal weld. All welding shall be TIG welding.

Transparent type glasses shall have integral illuminators operating at 230VAC and suitable for the specified electrical area classification. Owner shall provide 230 VAC 50 Hz supply for this.



Transparent type with mica or Kel-F shield shall be used for treated water, boiler and condensate services and corrosive liquids which will attack glass.

The visible range of level gauge shall be selected to cover the operating level or the operating range of level instruments provided for the vessel.

The maximum visibility length of a single gauge shall not exceed 1500 mm. Glass of 300 mm (approx) section length shall be used.

On low temperature services with liquids having very high vapor pressure at ambient temperatures safety valves shall be provided on the vent connection of the gauge glass.

Frost protection shall be considered for minus temperature fluid application.

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Bi-color level gauges may also be provided if indicated by Licensor.

In case of dosing vessel level measurement, tubular gauges can be used but acrylic transparent tubes to be used not glass tube

9.5 Tank Level Instruments

Servo controlled gauges shall be used for level measurement of pressurized tanks/vessels/spheres requiring remote signal transmission and +/- 1 mm level measurement accuracy. Level data transmission signal shall be digital only. Servo type instruments shall have SS well. The servo gauge shall be with 4-20 mA Hart output.

The tank side indicator for all types of gauges shall have hoisting facility. All tank level gauges shall have side-mounted indicator and solid state digital indication for servo controlled level gauge.

The wetted materials like displacer, wire, calibration chamber etc. shall generally be 316 SS.

The accessories for servo-controlled level gauge shall include calibration chamber and isolation ball valves for pressurized tanks.

For the level measurements of product tanks, Radar type instruments shall be provided. In addition to it for local indication servo type level instrument shall be considered.

9.6 Steam Drum Level Measurement

For drum level, following measurements are envisaged:



- (a) Bi colour/Magnetic Drum level gauge on both sides of drum.
- (b) 3 Nos. differential pressure type drum level transmitters from 3 separate nozzles for (2oo3) trip signals.
- (c) Hydra-step type (electric resistivity type) level instruments with both local indication and remote indication at CCR/DCS shall be provided for drum level of steam drum. These shall be in addition to conventional level measuring instruments in compliance to IBR requirement.

Radar type level Instrument shall not be used.

All Instruments shall be spaced equidistance on the drum and shall cover maximum operating range of drum.

All level instrument shall be provided with same centre to centre distances.

For boiler drum applications special approval of IBR has to be taken for level instruments

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10.0 RADAR LEVEL INSTRUMENT



10.1 General

- 10.1.1 The level transmitters shall be designed, selected and constructed according to data sheets listed in the requisition. Deviations/additions, if any, shall need approval from bidder/client.
- 10.1.2 Measurement should not be affected by changing specific gravity of process fluid and should be insensitive to gas-phase pressure. The selection of the GWR shall be based on service, interface level measurement and dielectric constant of the fluid.
- 10.1.3 The Guided Radar should have facility to suppress interference echoes on-site or via remote operation.
- 10.1.4 For level range calculations, the density of the upper medium shall be considered for Interface Level measurement. Electronics shall be capable of measuring upper liquid and interface level simultaneously.
- 10.1.5 Guided Wave Radar Level transmitter shall be applicable for liquids or slurries, hydrocarbons to water- based media.
- 10.1.6 In absence of dielectric constant for the process fluid, Bidder shall confirm the suitability of Guided Wave radar Level Transmitter for such applications and bidder shall suggest the suitable model for the same.
- 10.1.7 Bidder shall suggest the suitable model for Interface applications like oil on water, Hydrocarbon on water, etc.
- 10.1.8 All RADAR type instruments shall have Flanged process connections and min. nozzle height for process connection shall be 150mm.
- 10.1.9 Minimum pressure rating for RADAR shall be 300#.
- 10.1.10 Flange and wetted part MOC for RADAR shall be min. SS316.

11.0 PRESSURE INSTRUMENTS

11.1 General

Gauge Pressure / DP transmitters shall be used for measurement & control of process pressure from DCS. Local indication shall be by means of pressure gauges (bourdon tube, diaphragm or other element) to suit the application.

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All instruments shall have SS Tag plate with following information engraved on it:

Tag name

Range

Make

Max working pressure

11.2 Pressure Transmitters

All transmitters shall be Smart type with latest HART protocol and with integral LCD indicator. Also transmitter shall have test terminals and bypass diode to facilitate field-testing without disconnection of integral indicator.

No pressure switches shall be used. Instead pressure transmitters shall be considered which shall be directly connected as analog input to DCS/PLC. In case of DP applications in vessels & reactors, if the DP range is more than 1 KG/cm², two individual PT to be used in lower & upper level and DP to be calculated in DCS. This is to achieve better reliability and to avoid effect of accumulation of condensate in upper leg of DP transmitter.

Pressure transmitters shall have suitable pressure sensing element with capacitance principle and normally be with digital integral indicator.

The pressure transmitters shall have zero and range adjustable, and it shall be specified so that the normal operating pressure is within 40% to 70% of the calibrated range.

Over range protection to 1.3 times the maximum range of the instrument shall be provided.

Transmitters in vacuum service shall be capable of withstanding full vacuum regardless of range, without damage or calibration shift.

Pressure transmitter process connections shall be 1/2" NPT (F).



The cable entry for transmitter shall be 1/2" NPT (F).

The body and wetted parts, Body flange studs & nut, Process flange bolts, drain and vent plug's material shall normally be SS 316. Other element materials shall be based on process requirement.

Transmitter output, as specified, shall be linear, directly proportional to the applied pressure.

The stability shall be better than +/- 0.5% of upper range limit for 1 year.

Flush type diaphragm seal element with capillary shall be used for congealing, corrosive and highly viscous services. The extended capillary shall be minimum 5 meter long with steel armored and PVC coated. The process connection shall be flanged 3" ANSI RF. The material

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for the diaphragm shall be as per process requirement, but minimum 316L SS. The flange material and rating shall be as per piping specification / SS-316 minimum.

All pressure transmitters shall be with 2 way valve manifold of SS316. All DPT's shall be with 5 valve manifold.

11.3 Pressure Gauges

Local indication shall be by means of pressure gauges utilizing a seamless bourdon tube, diaphragm or other element to suit the application.

Local pressure gauges shall have 150 mm dials and shall be quality gauges designed for the process industry. Ranges of gauges shall be selected such that the normal operating pressure indication is approximately at mid-scale. Accuracy of local pressure gauges shall be +/-1.0% of full scale.

All pressure gauges in toxic service or with ranges 0 to 60 kg/cm² g and above shall have safety type, solid front case.

In general for all transmitters like (Pressure, Flow) shall have an integral output meter with configurable LCD display of Process value with engineering unit, will be considered. It may be that in instruments, where configurable engineering unit display not available as standard, then the same to be considered as per standard available. Remote mounted meters may be provided for specific applications. However, same should not be put in series in the main loop. A separate AO to be generated through DCS for connecting loop powered indicators.

Diaphragm seal element with capillary shall be used for congealing, corrosive and highly viscous services. Capillary shall be of minimum SS316 and shall have SS304 armoring with PVC covering.



Pressure gauges in pump discharge services are to be either with capillary diaphragm seal type or located in a remote location.

All pressure gauges shall have SS casing.

Pressure gauges shall be capable of withstanding intermittent overpressures of 1.3 times the maximum scale reading without damage or calibration shift of more than 1% of the scale reading. Blow out disc shall be provided for all ranges & solid front shall be provided for ranges above 60 Kg/cm²g.

Cases for gauges having ranges between 0-2 and 0-20 Kg/cm²g shall have blowout discs in the back of the case.

Cases for gauges having ranges above 0-100 Kg/cm²g shall be of the solid front type having blowout backs.

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Gauges connections size shall be 1/2" NPT (M). Connection location shall be bottom for local mounting with wrench flats or back for local panel board with mounting flange.

All the gauges shall be equipped with 2 way valve manifold of SS 316 or shall be with block and bleed valves securely fastened with identification tags.

The standard measuring element shall be a seamless bourdon tube of AISI 316 stainless steel, except where the process fluid requires the use of special material. Bourdon tubes shall be welded to socket and tip and stress relieved as required.

Diaphragm seals shall be of welded diaphragm type close coupled to the instrument, or connected to it with capillary tubing.

The connection size for diaphragm type gauge shall be 1 1/2" flanged. The diaphragm material shall be minimum 316 SS & flange material and rating shall be as per piping specification / minimum SS 316.

In case, the diaphragm seal type instrument with extended capillary is used extended capillary tube shall be armoured with stainless steel, and length shall be as determined individually but minimum 5 meter.

Diaphragm seals shall have flush connection 1/4" NPT with plug and filling connection.

For viscous fluids, the diaphragm seal shall be clean-out type with removable bottom case.

Sockets and tips shall be of the same material as the measuring element and shall be welded to the element using the same filler material. Movements shall be SS 304.

Dial face shall be white with black graduations marked. Also, the operating range shall be marked with 'Green' band and above range shall be marked with 'Red' band.



The gauge pointer shall be adjustable without removing it from its shaft.

Pressure gauges in pump discharge services are to be either with capillary diaphragm seal type or located in a remote location.

Case shall be of stainless steel, solid front type and weatherproof to IP-55 minimum.

11.4 Auxiliary Components for Pressure Gauge

Over-range protector (gauge saver) shall be provided where a pressure gauge cannot withstand a protuberant pressure due to unavoidable operation. Over-range protector whenever used shall be of SS316, as a minimum.

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Pulsation dampener shall be provided for all pulsating services e.g. Reciprocating pump discharge piping etc. Pulsation dampeners shall be of minimum SS 316 and have connection 1/2" NPT (F) on both ends. Dampener shall be provided with integral screw head needle valve to adjust aperture externally.

Pigtail type siphon shall be provided for steam service. Siphons shall be made of minimum SS 316 having connections 1/2" NPT (M) on both ends.

11.5 Draft Gauges

In general, the draft gauges shall be provided for each process heater to measure draft at burners, and in the stack, if required by process.

Direct connected gauges for indication of very low pressures and vacuum in the range of 0-0.5 m bar to 0-150m bar shall be vertical scale gauges utilizing a slack diaphragm (rubberized nylon or equivalent) as the sensing element.

Draft gauges shall be designed for 2-inch pipe mounting. Where draft gauges are for used in the field, a suitable housing shall be provided.

The design of the draft gauge shall incorporate linearizing linkages where necessary to ensure a linear response of the indicating pointer.

Draft gauges shall be required to have an accuracy of +/-3% FS or better and shall be capable of withstanding pressures or vacuum equivalent to 100% over range. Process connection shall be 1/4" NPT (F).


11.6 Calibrators:

11.6.1 Bidder shall provide multi-purpose calibrators (Qty: 2 Nos.) for all pressure transmitters, differential pressure transmitters, pressure gauges, level transmitters, Flow transmitters, pressure switches etc.

11.6.2 Calibrators shall also be able to calibrate low range draft pressure transmitters / gauges / switches. Process connection shall be 1/4" NPT (F). Calibrators shall be highly accurate. Accuracy is mentioned in the annexure-1.

11.6.3 Bidder shall provide 2 nos. of loop calibrators. Loop calibrators shall have current measure, source and sink functions. It shall also be able to provide 24 VDC power supply.

11.6.4 Calibrators shall be rugged, portable and easily field operable by single technician. It shall have backlit display. Calibrators shall be provided with protective carrying case, test leads, alligators clips etc.

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11.6.5 Calibrators shall be provided with traceable NIST/Other acceptable test and Calibration certificates.

11.6.6 One number of 0-600 deg. C Temperature calibrator shall be provided.

11.6.7 One number of Temperature simulator for calibrating temperature suitable for sourcing and measuring RTD/Thermocouple with range 0-600 deg. C]

11.6.8 Bidder shall supply 1 no Universal Hand Held HART Communicator.

11.7 Precision Digital Multimeters:

11.7.1 Bidder shall provide 3 nos. of microprocessor based 5½digit digital multimeters. Multimeters shall be able to measure/display Current (AC/DC), Voltage (AC/DC), Resistance, Temperature, Diode, Capacitance etc. Accuracy is mentioned in the annexure-1.

11.7.2 Multimeters shall have backlit display.

11.7.3 Multimeters shall be provided with traceable NIST / Other acceptable test and Calibration certificates.

11.8 Digital Pressure Gauges:

11.8.1 Bidder shall provide 2 nos. of microprocessor based digital pressure gauges. Digital Pressure Gauges shall be able to measure/display pressure in various ranges from 0 – 7 kg/cm² and 0 – 20 kg/cm², 0 – 60 kg/cm², 0 – 160 kg/cm². Various pressure units shall be selectable through keypad. Accuracy is mentioned in the annexure-1.

11.8.2 Digital Pressure Gauges shall have backlit display. Process connection shall be 1/4" NPT (F). Dial Size shall be minimum 4".

11.8.3 Digital Pressure Gauges shall be provided with traceable NIST / Other acceptable test and calibration certificates.


Above mentioned loop calibrators, Multimeters, digital pressure gauges shall be powered by Rechargeable batteries. 2 nos. of battery chargers shall be provided for the same.

11.9 Digital Sound Level Meter

Condenser type microphone, frequency and time weighting functions, AC and DC outputs supplied with 9V battery and calibration screw driver. Quantity 2 Nos.

12.0 TEMPERATURE INSTRUMENTS

12.1 General

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For transmission of individual temperature signals, thermocouples shall be used in conjunction with field mounted temperature transmitters.

Temperature transmitters are provided for all temperature measurement (closed/open/interlock) loops. All process temperature measurements shall be done through Temp. Transmitters. No temp. Input shall be connected directly to DCS

Resistance Temperature element (RTD) may be used as temperature primary elements where greater accuracy and better reproducibility are required than is afforded by thermocouples. RTD shall conform to standard IEC-751.

All temperature elements shall generally be protected by thermo-wells.

Class 'A' /Class '1' tolerance as per IEC 751/584-2 shall be specified for RTD/thermocouple for temperature measurement used in closed loops, interlocks and monitoring of critical parameters.

12.2 Thermocouples:


Electrical properties and tolerances shall be as per IEC-584-2.

Thermocouples shall be spring loaded, duplex-type and magnesium oxide mineral-insulated metal sheathed with ungrounded tip. Other specification shall be as below:

- Wire size shall be 18 AWG for single and 20 AWG for Duplex type.
- Sheath material shall be minimum stainless steel 316.
- Outer diameter of sheath shall normally be 6 mm.
- "K" type thermocouple shall be used.
- Thermocouple extension wire and calibration shall conform to ANSI MC 96.1
- Skin thermocouples shall generally be RETRACTO type of Geyesco design with material as per API unless specified otherwise in the licensor specification/Job specification.
- Heater skin thermocouple standard should be very carefully followed based on heater piping orientation
- For Furnaces or heater thermocouples, mineral insulated Inconel-600 sheath shall be considered for Non-sulphurous atmosphere. SS-446 sheath shall be used for sulphurous services. Kanthal sheath material shall be used above 870 deg. C temperature.

12.3 Resistance temperature elements

- RTD shall conform to be PT-100, 3-wire type Duplex element. Din 43760 standards.
- RTD shall be spring-loaded, mineral insulated and SS 316 metal sheath type.

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- The sheath diameter shall be 6.4 mm as a standard unless otherwise specified.

12.4 RTD/Thermocouple heads shall be as follows:

- The thermocouple head shall be connected with thermowell with 3-piece union to ensure proper contact of TC junction to thermowell.
- Head cover shall be screwed type, with SS retaining Chain fixed to body.
- Head cover shall be weather proof and ex proof suitable to specified hazardous area classification.
- Cable entry shall be 2 nos. 1/2" NPT (F) with one entry plugged with SS 304 plug.
- Terminals shall have separate screws for connecting element and extension cable.
- All RTDs including for Bearing & Winding temperature shall be 3 wire, Duplex element, Pt 100 to DIN 43760 standard.

12.5 Temperature Transmitters

Temperature transmitters shall be Remote mounted type (on 2" Pipe), Smart with latest HART protocol and integral digital output meter.

In general Temperature transmitter shall have dual thermocouple /RTD input connection.. Transmitters should be configurable for dual mode. If one sensor fails, switchover to second one should occur and alarm to be generated for sensor failure. Temperature transmitter shall be Dual compartment type.

Head mounted transmitters shall not be used.

Conventional transmitter shall have universal input for thermocouple/RTD and output 4-20mA DC for 2 wire system.

Transmitter output signal shall be linear and directly proportional to the measured temperature with overall accuracy of +/- 0.1% FS.


Transmitter shall have automatic cold junction compensation for thermocouples.

Burnout protection (selectable Up Scale/Down Scale) must be provided for temperature transmitters.

Temperature transmitters shall be provided for all temperature elements in closed loops and loops connected to PLC/Interlocks.

No temperature switches are to be used. The same is to be achieved through transmitters which shall be directly connected as analog input to DCS / PLC.

12.6 Filled System / Bimetallic Element Local Gauges

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Only Bi-metallic elements shall be used. Where bimetallic gauges cannot be used, only gas filled gauges shall be considered. No liquid filled system to be used.

Filled system elements shall be as per gas-filled (as per SAMA) as required by temperature limit and span consideration.

(Explosive, flammable or toxic liquid/gas should not be used as the filling medium)

The thermal filled system shall be equipped with ambient temperature compensation, over range and/or under range protection. Accuracy shall be + / - 1% of span.

Element bulb extension shall be with armored capillary in 316 SS having capillary length of 3.5 meter minimum. Thermal element bulb shall be protected in thermowell.

½” NPTM adjustable bush & gland of SS shall be provided on element bulb stem to maintain the firm insertion of the bulb in thermowell.

Filled system instruments shall not be used if process contamination due to system failure is not acceptable.

Bimetallic thermometers shall be bimetallic actuated rigid element and dial every-angle type. Dial size of the gauge shall be 150 mm diameter. The stem and case material of the gauges shall be 316 SS.

Range shall be selected from manufacturer’s standards such that normal operating temperature indication is approximately at midscale. Indicating dial shall be with linear graduation.

In vibrating services bimetallic thermometers shall not be used and only filled capillary type be used.



12.7 Special Thermometers

Infrared radiation thermometer, thermistor sensor etc. shall be used based on the process requirement.

12.8 Thermowells

Thermowells shall generally be provided for protection of the primary measuring element.

Thermowells for all services shall be in SS 316 minimum, and drilled in a single piece from solid bar stock and tapered. Built-up thermowells may be considered in low pressure and low velocity services like in fired heaters and also where longer thermowell immersion length is required (for greater than or equal to 700 mm).

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Thermowells process connections shall be flanged 11/2" ANSI, 300# rating minimum. Well and flange material shall be SS 316 minimum. Thermowells with rating 900# and above shall be RTJ type only. For sour services, thermowell material shall be as per Piping Material Specification.

Immersion length of thermowells for different line sizes shall be as follows:-

<u>Line Size</u>	<u>Immersion length (U)</u>
4" to 6"	280 mm
8" and above	320 mm
Vessels	400 mm
Flue Gas Duct	Minimum 120mm projection inside the duct after the duct insulation,
Heater Box	Minimum 120mm projection inside the duct after the duct insulation,

Immersion length is based on 200 mm length between flange face and inner well of pipe and approx. 60% insertion in the pipeline. In vessels, where fouling with vessel internals is expected, the immersion length shall be suitably modified. However licensors standards/recommendation shall be followed as governing case.

Other sizes and immersion lengths may be considered based on special condition/actual requirements.

Generally thermowell shall be drilled bar stock. Built-up thermowells may be considered in low pressure and low velocity services like in fired heaters and also where longer thermowell immersion length are required (for greater than or equal to 700 mm). In case of, built up thermowells of larger length, radiographic examination for bore concentricity shall be done.

For Alloy steel piping classes, the thermowell and flange material shall be of SS321 /SS347 (no dissimilar welding).

The design of the wells shall be verified by means of stress analysis, resulting from stream velocity condition. The wake frequency shall not exceed 66% of the thermowell natural frequency.



Pipe line below 4" nominal bore shall be blown to 4" NB size to install thermowell.

Only thermowell (test well) when specified, it shall be provided the element entry plugged with SS plug and SS chain.

All the thermowells shall be offered for hydro testing at site before installation.

When specified, Material testing, Radiography shall be carried out at govt. approved laboratory and corresponding test certificates shall be provided.



Wake frequency calculation per ASME PTC 19.3 required for all thermo wells

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13.0 CONTROL VALVES

General

- a) Control valves shall normally be Globe type unbalance type and single seated. For clean services, guiding shall be top and bottom/cage type. For highly viscous services, cage guiding shall be avoided.
- b) All shutdown valves tubing for faster actions shall be of 12mm, SS 316 size in general. Trip valves and control valves shall be different.
- c) Ball valves shall be considered for services where solids in suspension, high rangeability, low pressure drops, and tight shut-off are required. Ball valves may be provided for On-Off service.
- d) Butterfly valves /Rotary eccentric type valves shall be considered for control and on-off applications for services where solids in suspension, low pressure drops and high capacities are required.
- e) Angle valves shall be considered for services where flashing, chocking, solids in suspension or very large pressure drops are encountered. Angle valves should be in general multistage plug type and not cage/channel stream type.
- f) For steam/BFW application, body metallurgy of control valves shall be WCC or equivalent in place of WCB and trim to be stellited. In cases where process pipes are of alloy steel, control valves body & trim material shall be considered accordingly.
- g) Other valve types like diaphragm valves (Saunders valve), rotary plug, angle or 3 way etc. shall be selected as per service / Licensor's requirements.
- h) I/P convertors are not required. All controls valves shall be equipped with SMART Electro-pneumatic positioner with latest HART protocol, accepting 2 wire, 4-20 ma input signals from central DCS system. These shall be provided with metallic casing / cover along with software for valve signature collection, wherever applicable. The software shall be provided for remote configuration and diagnostic analysis too. Also the non contact feedback with analog output for continuous position shall be available, which can be used for interlock/control purpose.
- i) Smart positioners are to be provided with ½" NPT (F) signal cable entry and integral terminal connections. DIN type connections, PG 11 type cable glands shall not be used. SS nameplate tagging should be provided for all I/P convertors. Wherever applicable SS cable glands with Exd approval shall be used.
- j) Control valve Positioners with Linkage-less, Non-contact feedback mechanism shall be preferred.

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- k) Leakage class for all control valves shall be Minimum Class V in accordance with ANSI B-16.104-1976 / FCI 70.2.
- l) Class VI leakage class with soft seat shall be considered for fuel gas services to flare below 200 deg C and/or 20 Kg/Cm² pressure drop. Above this pressure & temperature, leakage class V with metal-to-metal contact is to be considered.

13.1 Control Valve body shall be flange joint type. Valve body material, flange type, rating and finish shall conform to the piping specification, however, the body & flange rating shall be minimum 300# for globe valves.

Valves with body sizes 1 1/4", 2 1/2", and 5" shall not be used.. Less than 1" valve will not be accepted. For higher size lines, valves shall not be less than half of the line size.

13.2 Anti-cavitation trim shall be selected wherever cavitation is expected in the valve.

13.3 Valve Sizing shall be used on a maximum flow rate of approx. 1.5 time normal flow or 1.3 times the max. Flow, whichever is greater, and the process conditions that exist at the increased flow (Pressure and differential pressure). Valve lift shall be approximately 70 % for equal percentage and 60 % for linear characteristic plug design at normal flow. It shall be checked that the calculated and the selected valve also covers start-up and stop conditions. In cases where over sizing shall not apply, it will be specifically mentioned in the Instrument Data Sheets.

Minimum body size of the control valve shall be 1" for all the line size. Reduced trim shall be considered for smaller line size / small flow.

The fluid velocity at outlet flange shall not exceed 6 m/sec for liquids whereas the velocity of gas or vapor shall not normally exceed 0.3 Mach under operating conditions. To meet this, valves shall be selected having reduced trim, labyrinth plug or cage trim as manufacturer standards.


Bidder shall submit the sizing calculations for all control valves.

13.4 Valve Trim Characteristics

13.4.1 Selection of Characteristics shall be done on the basis of application and type of control.

Quick opening trim shall be used for ON-OFF and Emergency Shutdown Valves.

Material used for Trim shall be minimum 316 SS, with guide bushing of hardened stainless steel like 440 C, 17-4 PH all up to a pressure drop of 10 kg/cm². For higher pressure drops (more than 10 bar), for higher temperature than 230 deg C and for erosive and slurry services and in general for all steam services, hard surfacing of plug, seat rings and sealing area of inner valve with full stylizing shall be used. Trim for fuel gas valve shall be minimum 17-4 PH to take care of abrasive damage due to presence of metal dust in natural gas.



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Special cases may require 17-4 PH seat ring and 440 C solid plugs or other materials like Hastelloy, Monel etc.

Licenser requirements shall take precedence.

- 13.2 Face to face dimensions of the control valves shall be as per ANSI/ISA-S75.03.
- 13.3 Noise level measured at 1 meter downstream and 1 m upstream of pipe wall shall not exceed 85 dB. Source treatment of noise shall be preferred by using special trims like anti-noise trims.
- 13.4 Copper or copper alloys and cast iron parts in valves and accessories shall not be used.
- 13.5 Bonnet shall be provided with cooling fins or extension when the fluid temperature is 230 deg C and more and shall be of extension type for low temperature -18 deg C and below.
- 13.6 Valve packing shall be Glass filled Teflon for temperature below 180 deg C and graphite for steam services and temperatures above 180 deg C. Double packing set shall be used for toxic services.
- 13.07 E/P Positioners, solenoid valves, booster relay, air lock relay, limit switches etc shall be supplied wherever required. Separate air filter regulator shall be used for each E/P Positioners. Linkage-less feedback positioners shall be preferred.
- 13.08 In general all tubing and fittings for control valve pneumatic signal shall be 12mm SS 316 for fast stroking valve and for other application valves shall be SS 316, 6 mm OD minimum unless specified elsewhere.
- 13.09 All control valves shall be provided with side mounted hand-wheels. In general no by-pass or hand wheel shall be used for shutdown valves unless otherwise specified by licenser.
- 13.10 Valves with less than 6" size shall be with bypass and isolating valve where as valves with higher than 6" size having critical service as per process shall be provided with bypass plus isolating valve as per licenser recommendations.
- 13.11 The guideline to identify the tight shutoff control valves is as follows:
- Compressor spillbacks
 - High pressure shutoff valves (Depressurizing valves)
 - Isolation valves
 - Emergency Shutdown valves
 - Vent valve

Valves in above services shall have minimum Class V leakage or Class VI as per licenser's recommendation or as specified in individual data sheet.

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13.12 Seat leakage class for single ported or cage guided valves shall be minimum class V type for vent, drain and isolating service. All tight shut-off valves specified by Licensor shall meet class V seat leakage class requirements for metal seated valves and class VI requirements for soft seated valves as per FCI 70-2.

Class-VI leakage class with soft seat shall be considered for fuel gas service to flare below 50 deg.C and / or below 10 kg/cm² pressure drop, other than this metal to metal contact with leakage class-V to be used.

13.13 The other auxiliary devices such as lock up relay, pilot relay, booster relay volume tank etc. shall be provided as parts of the actuating system in order to achieve the required stroke-speed, fail safe action etc.

Stroke time of the antisurge valves shall be 2-3 seconds and for critical services shall be as defined by process licensor or as mentioned in individual data sheet.

13.14 All control valves in service for temperature less than -20 deg. C, shall undergo cryogenic testing in line with BS-6364.

13.15 All control valve castings in H₂ service for ANSI 600 # and above rating shall undergo Helium leak test.

Note: Electric motor operated valves are not part of this specification and specified by the Electrical and the Piping discipline.



13.16 Direction of flow indication shall be engraved or embossed on the body.

13.17 Valve stem position indicators shall be fitted as standard, showing incremental stroke positions.

13.18 Control Valve Test and Inspections

Valves shall be tested in accordance to individual specification which shall cover but not limited to:

- Visual Inspection and dimensional check
- Liquid Penetrants examination on stellite coating as per ASME B16.34 ann D.
- Radiographic, ultrasonic, magnetic particle as per ASME B16.34
- Hydrostatic Body Test - Duration 3 min. (including all parts in assembled condition like body, gland, all joints)
- Impact test
- Seat leakage test as per ANSI B16.104/FCI 70.2
- Performance tests and Functional tests
- Leakage test from actuators and seals and packings
- Diaphragm head test
- Complete actuator leak test

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- Helium leak test for control valve with bellow seals
- Stroke calibration
- Stroke speed test

13.20 Limit switches / Position Switches:

- 13.23.1 All type of limit switches shall be 2 wire, proximity type, intrinsically safe certified. Limit switches shall be provided both for close and open positions for all shutdown valves.
- 13.20.2 The sensor shall be generally cylindrical NAMUR sensor type proximity switch. The diameter and sensing range shall be selected based on application.
- 13.20.3 The MOC of sensor shall be SS316. Krastin type probes shall not be used, unless surrounding atmosphere heat permits the use of the same under worst condition.
- 13.20.4 All limit switches sensor shall be adjustable with the threaded length and check & nut arrangement.
- 13.20.5 Flying lead type loose connections for NAMUR sensors are not acceptable. All these NAMUR sensors installed on any instruments to sense the position shall be housed in a closed box certified for weatherproof to IP65. The gland size shall be ½" NPT(F).
- 13.20.6 All ON-OFF type application valves taking in part in interlock/shutdown shall be provided with Open and Close type NAMUR sensor as limit switches. The sensors along with enclosure shall be installed in control valve in such a way that it can be removed with ease for maintenance.
- 13.20.7 Limit switches shall not be used for Control Valves. All controls valves shall be equipped with SMART positioner, from where the analog output for continuous position is available, which shall be used for interlock/control purpose.

13.21 Solenoid valves

- 13.21.1 Solenoid valves (Direct acting type) shall be used as the pilot valve to trip a shutdown valve, On/Off valve. Solenoid valves, wherever used, shall be universal type and shall be continuous rated type with class H coil insulation as per IEC 85/IS 1271.
- 13.21.2 Solenoid valve shall be minimum SIL 3 certified. Field manual reset for trip solenoid valves is to be considered for main Fuel valve. Positioners with inbuilt SOV are not acceptable.
- 13.21.3 All trip solenoid valves shall be 2oo3 with diagnostics.

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- 13.21.4 All Solenoid Valves used in the whole plant shall be of HERION make only.
- 13.21.5 The solenoid valve operating voltage shall be 24V DC suitable for specified hazardous area classification. It shall have integral terminal box. Flying leads are not acceptable. Solenoids shall be de-energized to trip.
- 13.21.6 Direct line mounted SOV shall not be considered.
- 13.21.7 All solenoid valves shall be 3/2 way, 1/2" NPT(F) or 1/4" NPT(F) process connections based on Kv/Flow requirement of control valve actuator and stroke speed requirement, SS 316 MOC body with SS316 trim, as a minimum, double compression cable glands SS316, 1/2" NPT(F) cable entry.

13.22 Actuators

- 13.22.1 Generally, control valve actuator shall be of the spring and diaphragm, pneumatically actuated type. Standard air control signal to positioner shall be 0.2 to 1.0 kg/cm²g. For larger dP shut offs, higher spring range/higher areas shall be considered.
- 13.22.2 Piston type actuators (spring return type) with or without fail-safe capacity tanks (minimum of 2 strokes to be possible in case of air failure) shall be considered for high-pressure drop services or if actuator force requirements fall beyond the normal range of diaphragm actuators. All actuators shall be adequate to fully stroke the valve under the maximum differential pressure specified by the process requirements.
- 13.22.3 Air filter Regulator filter to be 5 micron. Miniature type, plastic body & drain assembly etc as parts of air filter regulator are not acceptable. Air filter Regulator with bleed port on top are not acceptable.
- 13.22.4 Actuators are to be designed considering Instrument air pressure of 4.00 kg/cm² minimum.

14.0 PRESSURE REDUCING AND DESUPERHEATER STATION

- 14.1 Desuperheater design shall ensure that temperature at the outlet shall be maintained within + /- 5 deg. C of desired outlet temperature, unless otherwise specified by the Licensor.
- 14.2 Separate liquid injection valve and steam valve, if provided must be installed along with block and bypass valves.
- 14.3 The body and trim material of construction shall be suitable for the service. In general trim including spray nozzle shall be fully stellited.

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- 14.4 The PRDS/ DS in steam application shall be IBR certified including valve in boiler feed water line.
- 14.5 The CV shall be calculated in accordance with manufacturer's calculation procedure and selected based on following points:
- Valve sizing shall be based on the maximum capacity of 1.25 times the normal flow or 1.1 times the max. Flow, whichever is greater.
 - The minimum flow capacity shall be suitable for rangeability of 30:1. The valve stroke shall not be less than 20% opening at the minimum flow capacity.
 - Fluid velocity at the outlet shall be selected suitably in consideration of the property of fluid, the differential pressure of the valve and the line size etc.
 - Noise level at 1 meter downstream of DS and at distance of 1 meter from the pipe surface at normal flow shall not exceed 85 DBA.
- 14.6 A manual operator, limit switch, solenoid valve or any other auxiliary devices shall be provided.
- 14.7 Mfr. Standard manual operator / Hand wheel shall be provided.
- 14.8 Direction of flow shall be permanently affixed on DS body.

15.0 CONTROL, SHUTDOWN SYSTEM (DCS/ESD) AND CONTROL ROOM

CONTROL AND SHUTDOWN SYSTEM

ABBREVIATIONS Used in this document

AIMS	=	Alarm Information Management System
AMS	=	Asset Management System
APC	=	Advanced Process Control
CPU	=	Central Processing Unit
DCS	=	Distributed Control System
ESD	=	Emergency Shutdown System
FAR	=	Field Auxiliary Room
GDS	=	Gas Detection System
HMI	=	Human Machine Interface
HVAC	=	Heating, Ventilation and Air Conditioning
IMCS	=	Intelligent Motor Control System
LEL	=	Lower Emission Level
MCC	=	Motor Control Centre
CR	=	Control Room
MOS	=	Maintenance Override Switch

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MS	=	Microsoft	
OPC OLE	=	(Object Linking and Embedding) for Process Control	
PLC	=	Programmable Logic Controller	
SER	=	Sequence of Events Recorder	
TÜV	=	Technische Überwachungs Verein	
VDU	=	Video Display Unit (Always 21" TFT /LCD type color	monitor)
VESDA	=	Very Early Smoke Detection Apparatus	

15.1 Control And Safeguarding Design Criteria

There is no separate system has been envisaged for new Horton Sphere. Existing DCS of Honeywell shall be used for control & operation of the system. All the necessary accessories like IO cards, power supply, controller cards, relays, cables etc. shall be supplied by bidder for the smooth operation for new Horton Sphere.

There is sufficient space in DCS Marshalling panel to accommodate extra IO cards for new Horton Sphere Project. However, bidder to ensure availability of DCS/ESD vendor (Honeywell) while erection and commissioning of new Horton Sphere.

Preparation of graphics, cause & effect diagram, logic diagram shall also be in scope of bidder for this new Horton Sphere.

15.2 DCS/ESD requirements

15.2.1 All DCS/ESD systems' all cards shall be supplied with ISA G3 level or equivalent coating for environmental protections.

15.2.2 All digital output from DCS and ESD shall drive interposing relays of OMRON make, 4 Change over (4 NO/NC) with socket mounted relays with LED indicators and built in surge suppressor. The contact rating shall be minimum 230 V AC/10 amps. Any DO Channel from DCS/ESD shall not be directly connected to any devices without interposing relays.



15.2.3 DCS shall be a large and expandable type system available with the vendor.

15.2.4 DCS and ESD I/O cards channel density shall be as per following:

I/O cards' Channel density shall be as follows:

Analog Input	16 Channels
Analog Output	8 Channels
Digital Input	16 Channels
Digital Output	16 Channels

Channel loading: a maximum of can only be 80 % shall be used, ie; AO – 6 out of 8 can be used and for AI/DI/DO 13 out of 16 can only be used as maximum

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15.2.5 All I/O cards in individual category shall be of same type/model/revision only. No different bulk I/O cards or I/O cards with degraded features shall be accepted in any of the category in a mix mode supply.

15.3 Isolations

Analog I/Os to Field: Galvanic Isolation through safety barriers

Analog I/Os Module: Channel to Channel Galvanic Isolation

If individual channel to channel isolation is not available with DCS / ESD vendor, then only Isolation shall be provided in a group of 4 channels as per DCS / ESD vendor design.

Digital Input/ Output to Field: all potential free contacts shall be through relay and potential contacts shall be through barriers.

15.4 Panels:

Sufficient space is available in panels to accommodate extra cards/racks for additional IOs. PLC (ESD) and DCS marshalling and system panels are separate. Accordingly IO cards, power supply, relay shall also be separate as per control & trip philosophy for new Ammonia Horton Sphere.

However, if extra marshalling panels is required during detail engineering, the same shall be provided by the bidder without extra cost.



15.5 DCS System Redundancy

Following system redundancy shall be available as a minimum:

- | | | |
|----|---|---------------------------|
| a. | Input / output cards | redundant
Closed loops |
| b. | Communication Bus | 1:1 |
| c. | System Device | 1:1 |
| d. | Power supply
(Power supply for all CPUs, I/O power supply modules) | 1:1 |
| e. | Serial (RS-485) Modbus (For Interlock PLC) | 1:1 |

I/O bus and I/O interface card at controller rack shall be redundant.

Connectivity from Upstream redundant device to downstream redundant device shall be through redundant device or cable.

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15.6 Scanning Time

- ≤50 msec. for anti surge control loops
- 200 msec. for flow and pressure control loops.
- 500 msec. for all other control loops
- 1 sec. for temperature acquisition loops
- 1 sec. for all other acquisition loops

15.7 EMERGENCY SHUTDOWN SYSTEM (ESD)

General

There is no separate system has been envisaged for new Horton Sphere. Existing ESD of Honeywell shall be used for trip of the system. All the necessary accessories like IO cards, power supply, controller cards, relays, cables etc. shall be supplied by bidder for the smooth operation for new Horton Sphere.

The emergency Shutdown System shall perform any of the following functions for safety of new Horton Sphere from Main Ammonia/Urea Control room.

- Total Shut Down
- Unit Shut Down
- System Draining and Depressurisation

15.7.1 System Redundancy

Following system redundancy shall be available as a minimum.



- | | |
|---|-----|
| 1. IO Cards | 1:1 |
| 2. System Device | 1:1 |
| 3. Power supply | 1:1 |
| (Power supply for all CPUs, I/O power supply modules) | |

Active isolator / barriers (P&F make only) shall be rail powered with option of individual powering also and should be certified for fail safe operation/ SIL-3 Certified.

15.7.2 System Cabinets

Sufficient space is available in panels to accommodate extra cards/racks for additional IOs. PLC (ESD) and DCS marshalling and system panels are separate. Accordingly IO cards, power supply, relay shall also be separate as per control & trip philosophy for new Ammonia Horton Sphere. Followings points to be noted by bidder while installing additional cards in Marshalling panels:

The terminals shall be screw less type. Cage clamp type single tier design (double tier design shall be avoided). Terminal stack for each unit shall be supplied with approx. 20% extra

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terminal points as spare/future provision in addition to the existing inputs and outputs.

Physical separation between the terminal stacks/points shall be maintained for the intrinsically safe and normal termination. Also the termination area shall be physically separated from the electronics area there by sealing the latter from dust ingress.

Interlock System Cabinet

Cards of identical/similar functions shall be grouped together in the racks.

The system design including layout shall take into account the following factors.

- Ease of testing and simulation
- Ease of maintenance and operability
- Ease of modification and expansion

Interconnection Cables

All interconnection cables beyond termination strips in the Interlock marshalling cabinet shall be part of interlock system and would include cables between:

- Interlock marshalling cabinet and interlock system cabinet.
- Interlock system cabinet and panel mounted display/operator stations.
- Interlock system cabinet and event recording system
- Event recording system printer and video display
- Any other cables required within the IMC and ISC not covered above.

The Interlock system shall also include following test diagnostic tools:

- Logic tester
- Test adapter
- Test signal generator

15.7.3 Precision & Accuracy



The isolator, repeater modules/trip amplifiers for analog inputs shall have a total accuracy of less than 0.2% of full span for the measurement circuit.

The accuracy and stability for thermocouple trip amplifiers shall be +/- 0.5%.

15.7.4 DCS & PLC Spare Philosophy:

Installed Spares	I/O Level Marshalling	20%
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16.0 SAFETY RELIEF VALVES / VACUUM RELIEF VALVES

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- 16.1 Sizing of safety relief valves shall be in accordance with API RP-520 (latest edition), Indian Boiler Regulations, ASME Section I (Power Boilers) and ASME code for Pressure Vessels Section- VIII'. The code stamps shall be provided for safety valves in case ASME and Indian Boiler Regulations design.

Safety relief valves shall normally be direct spring loaded types and provided with full nozzle type. Balanced bellows type safety valves shall be provided when variable backpressure exceeds 10% of the set pressure or fluid is corrosive. Pilot operated pressure relief valves shall be used for special services and where set pressure is closer than 10% of the operating pressure, in general. Thermal relief type valves shall be used for thermal expansion of liquid or gas. Vacuum relief type valves shall be used for Storage tank. Steam jacket type safety valves shall be used for crystallizing fluid at ambient temperature.

- 16.2 $\frac{3}{4}$ "x 1" threaded (NPT) modified nozzle type valves with typically 0.38 cm² orifice size shall be specified for thermal relief.

- 16.3 The body material shall, as a minimum, be as per piping specifications. Nozzle and disc material shall be SS316 as a minimum with machined stainless steel guide, and spindle. Whenever semi nozzle designs are unavoidable, body material shall be atleast same as nozzle material.

- 16.4 The spring material of pressure relief valves shall be as follows unless otherwise necessary because of process conditions.

-29°C to 250°C	:	Cadmium/nickel plated carbon steel or phosphatised carbon steel
Above 250°C	:	Tungsten alloy steel
Below – 29°C	:	Stainless steel 316

- 16.5 Flanged connection shall normally be specified for standard sizes 1 " or larger with facing and rating in accordance with the piping specification.

- 16.6 Where permissible, screwed connections shall be used on sizes $\frac{3}{4}$ " and below and for thermal expansion relief valve.


- 16.7 Conventional type safety valves shall have vented bonnets with screwed caps; balanced bellows type safety valves shall be of the yoke type with screw setted caps.

- 16.8 Plain lifting levers shall be provided for steam and air services. Packed lifting levers shall be used when protection against leakage is required.

- 16.9 Bidder shall submit sizing calculations for all safety relief valves.

- 16.10 If, safety relief valves relieving to flare header shall be balanced bellows type only with trims and bellows in SS 316 L.

- 16.11 Pressure relief valves required for liquid service shall have liquid trim with discharge coefficient certified by ASME.

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- 16.12 Pressure relief valve body casting and nozzle casting with inlet rating of 600 # and above in Hydrogen service shall undergo Helium leak test.
- 16.13 Bidder shall supply operational spares for all the installed safety valves. Minimum spares like seat, plug, bellow, spindle. etc. to be considered by the bidder as per spares philosophy.
- 16.14 Minimum 1 nos safety valve, each having full relieving capacity, to be installed on all the equipments. These safety valves to be provided with isolation valve so as the same can be removed for maintenance during normal running of the plant.

17.0 RUPTURE DISC

- 17.1 Bidder shall provide rupture disc assembly wherever shown in P&ID. The assembly shall consist of
- a) The rupture disc fitted in a pre torque holder assembly.
 - b) J bolt for proper installation
 - c) The Rupture disc in vacuum shall be provided with vacuum support as recommended by manufacturers.



Disc material shall be compatible with the vessel contents and shall be consistent with the bursting requirements. Inconel discs shall be used above 100°C if compatible with the process fluid.

- 17.2 When rupture disc is used upstream of a pressure relief valve, a pressure gauge, pressure switch and excess flow check valve / safety relief valve as recommended by manufacturers. (Tell-tale assembly) shall be provided on the downstream of the disc to indicate any rupture of the disc. In addition derating capacity factor for the safety valve – rupture disc assembly as recommended by ASME section VIII shall apply. Tell –tale assembly as above must be provided irrespective of P&ID representation. For plugging toxic service pressure gauges shall be diaphragm seal type.
- 17.3 Each rupture disc must be supplied with minimum 3 number of additional discs. This is in addition to discs required for carrying out burst testing at factory.
- 17.4 The indication of leaky rupture disc (i.e. the disc with a pen hole) or burst rupture disc shall be provided in the main control room.
- 17.5 The bursting tolerance of the rupture disc shall be $\pm 5\%$ of the specified bursting pressure or less. Unless otherwise specified.



18.0 INSTALLATION MATERIALS

18.1 Cables

- 18.1.1 All cables shall have PVC insulated primary insulation of 85°C PVC as per IS-5831 type C and inner and outer jacket shall be 90°C PVC to IS-5831 type ST-2. Oxygen index of PVC shall be over 30% and temperature index shall be over 250°C.

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- 18.1.2 Cables shall be fire retardant (FRLS) as per standard IEC 332 Part III Cat. A.
- 18.1.3 The insulation grade shall be 1100 V as a minimum and shall meet insulation resistance, voltage and spark test requirements as per BS-5308 Part-II.
- 18.1.4 All cables shall be twisted (no of twist xx per meter) & armored with galvanized steel wire as per IS-1554 part-I.
- 18.1.5 Color coding of thermocouple extension cables shall be Yellow as per ANSI standard. Outer color shall be light blue for intrinsically safe cables and Yellow for thermocouple extension cables.
- 18.1.6 Conductors shall be stranded electrolytic annealed copper except for T/C extension cables. Maximum DC resistance of the conductor of the cable shall be as per IS 8130.
- 18.1.7 The drain wire resistance including shield shall not exceed 30 ohms / km.
- 18.1.8 A pair of communication wire shall be provided for multi pair cables. Each wire shall be 0.5 mm² of plain annealed single or multi-stand copper conductor with 0.4 mm thick 850C PVC insulation. Insulation shall be green and red color coded.
- 18.1.9 BIDDER shall supply spare cables as per 'Spare parts list Philosophy'. In each multi pair cable 20% pairs shall be kept as spare.
- 18.1.10 Run length of the cable shall be printed at least at every 5-metre interval.
- 18.1.11 All cable entries in the control/cabinet room will be through MCT block only
- 18.1.12 All multistrand multicore signal cables shall be of 0.75 mm² size. 2/3 core signal cables shall be of 1.5mm² size. Solenoid cables/ power cable shall be of 2.5 mm² size
- 18.1.13 Signal / Alarm cables**
- a) Single pair shielded signal cables shall be used between field instruments and junction boxes/local control panels.
- b) Multi pair individually and overall shielded signal shall be used between junction boxes to local control panels and main control room, in general.
- c) Shield shall be aluminum backed mylar polyester tape bonded with the metallic side down helically applied with either side having 25% overlap and 100% coverage. The minimum shield thickness shall be 0.05 mm in case of single pair/triad and 0.075 mm incase of multipair/triad cable. Wire armour shall be round type, flat type is not acceptable.

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- d) Drain wire shall be provided for individual pair and overall shield, which shall be 0.5-mm² multi, stranded bare tinned annealed copper conductor. The drain wire shall be in continuous contact with aluminum side of the shield.
- e) All multi pair cables shall have 12 pairs only while multi triad cable shall have 8 triads only.
- f) The signal cables shall have mutual capacitance <60 pf/m, L/R ratio of < 25 microhenry /ohm for 0.75 mm² cable and < 40 microhenry /ohm for 1.5 mm² cables (shall meet the loop entity values for intrinsic safety class)

18.1.14 Solenoid valve cables/Alarm cables

- a) 2 core cables shall be used between field mounted solenoid valves and junction boxes/local control panels.
- b) Multi core control cables shall be used between junction boxes local control panel and main control room mounted devices in general. These cables shall have only overall shielding.

18.1.15 Thermocouple extension cables

- a) Single pair shielded thermocouple extension cables shall be used between thermocouple head and junction boxes transmitters/ local control panel mounted instruments.
- b) Multipair individually and overall shielded thermocouple extension cables shall be used between junction boxes and main control room mounted devices.
- c) The type of thermocouple extension cables shall be compatible with thermocouple used. In addition the colour coding of the primary insulation shall be as per ANSI.
- d) The cable shall have 16 AWG and 18 AWG solid conductors for single and multi pairs respectively.
- e) All thermocouple extension cable shall be matched and calibrated in accordance with MC-96.1.
- f) Shield shall be aluminum backed by mylar/polyester tape bonded together helically applied with the metallic side down with either side having 25% overlap and 100 % surface. Minimum shield thickness shall be 0.05 mm for single pair and 0.075 mm for multi pair cable. Drain wire shall be 0.5-mm² multi-strand bare tinned annealed copper conductor. The drain wire shall be in continuous contact with the aluminum side of the shield.

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- g) Inductance shall not exceed 4mH/Km.
- h) All multi-pair cables shall have 12 pairs only.

18.1.16 Power supply cables


- a) All power supply cables shall be as per IS-7098 Part I and shall have XLPE insulated multi- stranded copper conductors. Minimum conductor size shall be 2.5 mm². The cables shall be PVC insulated and armoured. The higher size conductors shall be used incase of long distance power cable where voltage drops more than 3 volts than required supply.
- b) Any other special cable required for instruments that should also be supplied as per requirements. BIDDER shall ensure that these cables are armored type and shall meet all other requirements.
- c) All cables shall be fire retardant (FRLS) type as per IEC- 332.

18.1.17 All the cables (Multipair signal cables, RTD triads, Multipair Thermocouple extension Cables, Power cables etc) originating from field junction boxes shall be terminated in the destination marshalling cabinet of DCS/PLC/ESD/Governing Console/Annunciator Panel.

The following table shall be followed for selecting cables for specific application:

TABLE FOR INSTRUMENT CABLE

USE	CONDUCTOR			Overall Jacket
	Sec area (mm2)	Type	Insulation	
Electronic inst. signal (X) 4-20MA DC (X) Pulse (X)ON-OFF CONTACTS (X) RTD (X) Alarms & Interlocking Signal(x)	(X) 0.75	Multi stranded Copper Wire, Twisted pair, Triad, Direct Cable	(X) PVC	(X) PVC Sheathed () Cu Taps Shield (X) Al Mylar Tape Shield With drain Wire (X) Steel/Wire Armour (X) Each air/Triad & Overall Shield
	() 1.5			
	()			
	() 0.5	Multi-conductor cable (multi-pair, multi-triad etc) - DO		
(X) 0.75				
() 1				
Solenoid valve	() 1.5	Multi-strand Copper wire. core, cable.	(X) PVC	(X) PVC Sheathed (X) Steel Tape/wire armour (X) Alarms and interlock signals Pair & overall Shield (x) Solenoid valve overall
	() 2.0			
	(X) 2.5			

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	() 1.0 () 1.5 (X) 2.5	Multi-conductor Cable -DO		shield core cable
Thermocouple extension lead wire (X) RX (X) KX () EX (X) TX JX type not to be used	() 0.5 (X) 16 AWG ()	Single-strand wire, pair cable	(X) PVC ()	(X) PVC sheathed () Cu tape shield (X) Al mylar tape shield with drain wire
	() 0.5 (X) AWG 18 () AWG 16	Multi-pair cable -DO-		(X) Steel tape/wire armour (X) pair & overall shield
Power Supply	(X) 2.5 (X) 4.0 (X) 6.0 (X)10.0	XLPE insulated multi-stranded copper conductors (size as per requirement)	(X) PVC ()	(X) PVC sheathed (X) Steel tape/wire armour ()

18.2 Cable glands

BIDDER shall supply all cable glands required for glanding the above-mentioned cables both at field instrument and local control panel, junction boxes and at main control room.

All cables glands shall be of Ex-proof type, 304 SS double compression type suitable for armored cables and have PVC shrouds.


Ex-proof glands wherever required shall be supplied with Ex (d) certification.

The BIDDER as per spare parts list philosophy shall supply spares against all these items.

18.3 Junction boxes

Separate junction boxes shall be used for IS and Non IS signals. Further it shall be segregated based on signal types given below:

- a) Analog input
- b) Analog output
- c) Thermocouple
- d) Digital input
- e) Digital output
- f) SOV
- g) Power cable
- h) RTD
- i) Vibration signals
- j) Gas detectors

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NOTE: Direct cable shall be considered for pulse signals.

BIDDER shall supply junction boxes of die cast aluminum alloy (LM-6) body, flameproof with Ex (d) certification and weather proof as a minimum. Junction Box shall be CCOE/CMRS approved, for specified hazardous area class based on gas group service.

Junction boxes shall have terminals suitable for the cable sizes to be terminated but shall be minimum suitable for 2.5 mm² cable.

All the terminals (phoenix make) shall be stud and nut type (CBT) mounted on rails in the junction box.

20% spare terminals shall be supplied in each junction box.

Cross ferruling philosophy to be followed for wiring.

Telephone sockets and plugs shall be provided in junction boxes. One earth plates shall be provided for shield connections.

Each junction box shall have minimum of 10% or 2 Nos. minimum spare entries. All spare entries shall be provided with SS plugs. All the cable entries shall be from bottom only.

JB shall have 12 no. (6 nos. on each side) 1/2" NPT cable entries and 2 nos. 1.5" bottom entry.

TBs shall be Wago/Phoenix screwless only.

JBs for outdoor installation shall have a degree of protection of IP-66.



18.4 Instrument valves and manifolds

BIDDER shall supply instrument valves and valve manifolds wherever required. All isolation and drain valves shall be gate valves (Needle valve is not acceptable). Equalizing valves shall be globe valves.

Body rating and material shall be as per piping class or better and trim material shall be SS 316. All valves and manifolds shall be forged type only and of minimum 2500 LBS rating.

Superior body and trim material shall be selected if required by process conditions. Packing material in general shall be of PTFE.

Double isolation valves for take off tapping and drain/vent shall be provided in high pressure services having more than 90 Kg/cm².

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The BIDDER as per spare parts list philosophy shall supply spares against all these items.

18.5 Impulse piping/tubing

Closed coupled piping standard shall be used for all the services including high viscous services. The pump discharge pressure instruments in all services must be remote mounted with complete piping standard.

All Impulse connection shall be PIPE only.

For instruments installation, no unions shall be used in the impulse piping. Instead flange joints (maximum 1 No. near Transmitter) shall be used. However unions can be used in branching of SS304 Air line only.

Steam tracing shall be 6mm OD SS tubes.

Proper accessibility to be provided to installed field devices by providing ladder or platforms, for maintenance.

The BIDDER shall supply spares against all these items as per attached spare part list.

For instrument impulse at high temperature services, support to be taken from same piping/vessel/ columns etc to avoid differential expansion resulting damage of impulse.

All impulse piping except for steam shall be close-coupled type except in pump discharge & the areas it cannot be used due to high process temperature. The remote type if used in Hydrocarbon application for high process temperature or vibration shall be total piping installation only. For lube oil and Skid mounted instruments where piping installation cannot be used due to space constraints, tubing installation is allowed with all tube fittings shall be of Swagelok or Parker make only.



18.6 General Installation

No instrument should be located in hot area.

All Instruments & field mounted emergency push buttons shall be provided with canopy. Only SS sheet canopies shall be used along with all field instruments (including transmitters and other field sensors) in general.

The JB's in the open areas/offsite are also to be provided with canopies supplied by bidder. All field JBS need to be earthed.

All cable entries to junction boxes shall be from bottom. PVC shroud to be provided to all cable glands for JB's, Transmitters, Positioners, I/P converters and other field instruments.

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Instruments of gas service are to be installed only above or at least parallel to the tapping with a slope in the impulse piping towards the tapping to achieve self draining condition.

No seal pot, but the diaphragm seal instruments are to be used for congealing services.

CS Impulse piping to be suitably painted.

No elbow to be used before first isolation valves.

All impulse lines for congealing services to be steam traced and insulated with ceramic ropes.

For diaphragm seal instruments (Level, Differential Pressure) the spacer ring shall not be used. The spacer ring design shall be modified to a flanged spool piece of size equal to tapping point/ nozzle subject to minimum of ½” size with flanges at both ends and drain/vent connection. Wafer along with the blind flanges shall be bolted to the other end of spool piece.

Impulse piping for air/water service shall be schedule 80 A106 pipe. GI or IS-1239 shall not be used.

18.7 Steam tracing:

- a) Two layer of SS 316 tube for each impulse line with separate take off & isolation valve shall be provided.
- b) Separate steam trap shall be provided for each steam take-off points.
- c) After tracing of the SS 316 tube, two tubes should not be connected to single stem trap. Individual trap must be used for each stream traced SS 316 tube.



18.8 Pipes and tube fittings

BIDDER shall supply SS 316L flare less compression tube fitting of three-piece construction of Swagelok / Parker/ Hoke only. The tube fittings shall be of minimum 3000 LBS rating NPT.

The fitting/ferrule hardness shall be in the range of RB 85-90 so as to ensure a minimum hardness difference of 5 to 10 between tube and fittings. The ferrule shall be of stainless steel material, in general.

Socket-weld type forged pipe fittings of suitable material and rating shall be supplied for pipe fittings. The minimum rating shall be 800 lbs. Weld neck fittings shall be used where socket weld types are not allowed by piping class.

All threaded fittings shall have NPT threads as per ANSI/ASME B16.11 only.

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The BIDDER as per spare parts list philosophy shall supply spares against all these items.

18.9 Pneumatic signal tubes

BIDDER shall supply 6mm/12 mm” OD x 0.065” SS 316L tubes as per ASTM A 269 seamless type.

BIDDER shall avoid use of intermediate connectors and shall estimate single run length for each instrument location.

The BIDDER shall supply spares against all these items as per attached spare part list.

Air supply to individual instruments shall be provided with SS 304 full bore ball valves.

18.10 Instrument air manifolds, fittings and valves

Instrument air manifolds made out of 1 inch Seamless SS316L pipe.

Number of tapping shall be provided on one instrument air manifold as per API standard.

Double compression type Stainless steel fittings made out of solid bar stock of 3000 lbs rating shall be used.

Isolation valves on instrument air service shall be packless gland type full-bore ball valves and body material shall be SS 304.

The BIDDER shall supply spares against all these items as per attached spare part list.

Main instrument air header shall be SS pipe only, further distribution to control valves shall be by SS tubes as specified.

Main instrument air header shall be SS 304 minimum.



18.11 Air filter regulators

Instrument air filter regulator of suitable size, range and capacity with SS316 internals shall be supplied for each pneumatic instrument.

AFR with vent port on top without protection shall not be acceptable This is to avoid rain water ingress.

Material for all mounting accessories including pressure gauge shall be minimum SS316.

The body of the filter shall be anodised aluminium.

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The filter shall have 5 micron sintered SS filter element and shall be provided with manual drain and 2" nominal size pressure gauge.

The BIDDER as per spare parts list philosophy shall supply spares against all these items.

Instrument Air will be supplied at one single point rest all distributions will be in the bidder's scope.

18.12 Cable trays and cable ducts

New cable trays shall be laid upto the control room. All cables on the main pipe rack shall be laid in cable duct. Cable ducts shall be made of M.S. sheets & frames fabricated as per 'Duct Fabrication Details. Cable duct shall be painted with corrosive resistant paints.

All cables shall run on cable trays supported on structural angle.

These cable trays shall be of perforated anodized aluminum as per IS 737. Thickness shall be 2.0 mm for 50 mm wide tray, 3.0 mm for 100 to 400 mm wide and 4.0 mm for 500 mm wide tray. The width shall be so selected that 50% of tray space is available for future use.

Suitable cable clamps shall be supplied for binding the cables/tubes at every 500 mm. Mounting clamps, nuts shall be SS for instruments and cable trays.

Cable duct route should be away from hot pumps.

Optical fiber cables and other communication cables pertaining to Machine monitoring system / analyser systems etc. shall be armoured.


Cable duct shall be with partition for power signal and communication cable with screwed clamped cover, maximum loading of duct should not exceed 50%.

The entire cable duct shall be covered. MOC of GI is not acceptable.

18.13 Instrument support / structural steel

BIDDER shall supply instrument stands, stanchions and other structural steel material required for supporting the cable trays, impulse lines and instruments. Structural angles used for cable dropping to Junction Box or to field device shall be preferably galvanized. Stanchions shall be made out of A106 Gr. B 2" size pipe as a minimum. In case application calls for higher grade material, the same shall be supplied by bidder. All the structural steel & stanchion shall be epoxy painted.

All field Instruments shall be adequately supported.

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18.14 Earth Pits

Separate earth pits shall be provided for system earth, IS (Intrinsic Safe) earth, power earth, and general body earth for instruments, equipments, junction box body etc These earth pits shall be separate and isolated from electrical earth pits.

18.14.1 General Earthing System

All metal enclosures housing instrument and/or instrument systems and all armoring of field cables shall be connected to the general earthing system.

18.14.2 Instrument Earthing System

- The instrument earthing system consists of one or more earthing electrodes close to the control satellite building at a safe distance from any plant-earthing electrode.
- The resistance to earth is to be less than 1 ohms. To achieve this an array of parallel electrodes may be used.
- The instrument earthing shall terminate in a copper bus, mounted centrally to all instrument equipment, but electrically isolated from any other equipment or structure.
- The cable connections shall be easily accessible for testing facilities.
- All connections between the copper bus bars and to the central earth bar shall be individually connected via a separate, insulated, stranded wire conductor of at least 4 mm².
- To avoid undesired ground loops due to differences in earth potential or influence of surface currents, the shield of signal wires shall be connected to the instrument earth system only at one side (in the control room/satellite building). The shielding shall be kept isolated from cable armoring and instrument enclosures.


18.15 Painting Specification

- a) All the outdoor items shall be tropicalised and epoxy painted. All carbon steel bolting shall be hot dip galvanized or Cadmium plated and bi-chromated.
- b) Screws, rivets, brackets and stiffeners shall be stainless steel.
- c) Color of the top coat of panels shall be manufacturer standard / to be confirmed.

18.16 Identification and marking

Each device shall be identified with the following information.

Manufacturer's name or identity
 Manufacturer's model and /or serial number
 Input range



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Tag no.
Power Supply
Area Class & IP Class
IS / Non IS
ID no. for field devices.

The above information shall be in a permanent form on a metal nameplate, permanently attached to the device/equipment.

19.0 VIBRATION MONITORING SYSTEM

- Vibration monitoring system wherever provided shall be Microprocessor based. The number of bearing locations to be monitored on each fan/pump shall be as per requirements finalized during detailed engineering but not less than 2 bearing locations for each fan/pump.
- The vibration monitoring system shall be furnished on a system basis including vibration transducers with low noise flexible cables in flexible conduit, terminated in local terminal boxes, necessary pre-amplifier/electronics mounted in local weather proof boxes, vibration monitors, mounting racks and cabinets. The vibration monitoring system shall include all power supplies, interconnecting cabling, calibration equipment, indicators, integrating units, signal conditioning devices and all other accessories required for monitoring of vibration at each point.
- Bidder shall offer 2 channel vibration monitors for each measurement location catering for horizontal and vertical measurements. Offered vibration monitors shall be modular in construction, plug in type and suitable for 19" rack mounting.
- Eddy current type proximity transducers shall be used. However, the finally selected sensor type shall also depend on recommendation of the equipment manufacturer & suitable for application requirement. Transducers shall be furnished in weatherproof housing suitable for field conditions.
- In case bidder opt for velometer type transducer as per their philosophy, then eddy current type shaft monitoring system (vibration, axial and speed) to be included in the scope over and above.
- Vibration monitoring system shall give output of 4-20 mA DC for each point monitored. The signal shall be suitable for use as an input to DCS as well as for analog recording & analysis, linear in proportion to vibration velocity as well as displacement.
- VMS monitor should be able to generate potential free contact for alarm and trip.
- Vibration monitoring system shall be Bently Nevada make 3500 series only.
- The type/model of probes/proximometers and all primary hardware, which is installed in the field, shall be as per applicable hazardous classification and suitable for the application.


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- The vibration monitoring central rack shall be accommodated in a central cabinet room in the close vicinity of control room in RITTAL panel as specified in DCS/ESD specifications. The probes and proximeters shall be installed in the field.
- BIDDER to supply the interconnecting cables between central rack monitoring cards and proximeters installed in the field. These cables shall be multi strand, armoured, FRLS insulated as per detail specifications mentioned in the cable specifications of this document.
- The system shall be equipped with various key-phasor and speed probes with the latest System-I software modules for Orbit analysis and polar plots and other various diagnostics for machine health. The central rack shall be supplied with required hardware and a lap top PC for this purpose. This programming station PC shall be accommodated in central engineering room in the close vicinity of central cabinet room.
- All communication cables between central rack hardware installed in central cabinet room to engineering station PC installed in central engineering room shall be laid below false floor in rigid PVC conduit in perforated aluminium cable trays, away from other diff. voltage level cables.
- The trip from vibration monitoring system shall be via TMR Relay module of Series 3500 system with 2 out of 3 configuration and hardwired relay outputs connected to central ESD system.
- All the 4-20 ma outputs from individual channel of each module shall be connected with DCS for continuous monitoring/trending purpose.
- Apart from these hardwired input/outputs from 3500 series system, it shall be equipped with 2 wire RS485/Ethernet serial link and MODBUS protocol to communicate all the real time data to central DCS.
- The power supply to central rack hardware shall be 115 V AC UPS. The power supply module in the central rack shall be 100% redundant. Power to redundant modules shall be fed from two diff. 115 V AC UPS feeders.

20.0 CCTV

4 Nos of PTZ camera shall be provided new Horton sphere area surveillance. These cameras shall be connected to existing CCTV network. Existing network shall be used for carrying the data from new Horton sphere area to Main Ammonia Control Building. No extra OFC cable is required for the same. Following shall also be provided with Cameras:



- i) 1 no 16 channel NVR to be installed in ammonia control building.
- ii) 1no 8 channel POE switch.
- iii) 1 no wall mount rack.
- iv) 43" LED TV to be installed in Main Ammonia Control Building.
- v) Any other accessories required for successfully integrating the cameras to existing CCTV network shall also be consider by the bidder

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21.0 DOCUMENTATION

List of Deliverables of the Bidder shall comprise of but not limited to the following :

SI. No.	Description	For Review/ Approval	For Information	Remarks
1	Drawing & document schedule	✓		
2	Instrument Index		✓	
3	Instrument sizing calculations	✓		
4	Utility requirements		✓	
5	Level sketches		✓	
6	Material Requisition	✓		
7	Purchase Requisition		✓	
8	Vendor Drawings		✓	
9	Functional Schematic (A3 Spiral Binded)	✓		
10	Logic Diagrams as per ISA 75.2 (A3 Spiral Binded)	✓		
11	Instrument loop drawings		✓	
12	Control room layout	✓		
13	Panel front arrangement	✓		
14	Power supply distribution	✓		
15	Wiring diagram for panels		✓	
16	System Configuration diagram	✓		
17	I/O assignment	✓		
18	Control Schematics	✓		
19	Panel GA / IA Drawing	✓		
20	DCS graphics, report/log formats & other DCS docs.	✓		
21	LCP GI/ IA Drawing	✓		
22	Analyser including SHS	✓		
23	Analyser Shelter Layout	✓		
24	Instrument duct / tray layout	✓		
25	Instrument cable schedule	✓		
26	FF Signal Junction Box Assignment	✓		
27	Instrument location plans	✓		
28	Instrument installation drawings	✓		

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29	Bill of material for installation items		✓	
30	Spare part list for :			
	a. Mandatory Spares (if applicable)	✓		
	b. Start up & commissioning (if applicable)		✓	
31	Inspection & test procedures	✓		
32	Complete catalogues with part list for all vendor supplied instruments, control etc.		✓	
33	Installation, operation & maintenance manuals		✓	
34	As Built Drawings		✓	
35	Wake frequency calculation shall be carried out for thermo wells comes under two phase flow	✓		

NOTES :

- (1) This list indicates the minimum drawings and documents requirements. However bidder shall submit complete list of document & drawing schedule listing all drawings and documents to be submitted by them during the course of execution of the job. The schedule shall list all drawings and documents along with their number and expected date of submission.
- (2) As spelt out elsewhere in the Bid, Review / Approval / Information requirements of PMC, & Owner shall be intimated separately for the above documents, later.
- (3) Bidder to refer Section 8.0 document & schedule for number of hard/soft copies, schedule, etc.
- (4) PTR for field instruments shall be considered min for ONE Year and PTR System oriented items like Bently Nevada, DCS, PLC, SER, MMS, CDSU and analyser shall be one year.

22.0 AMCs:


General

22.1 Scope and Schedule Of Services For AMC

System details covered under Comprehensive Annual Maintenance Contract is:

- Refrigeration Compressor PLC system in new Ammonia Horton Sphere in NFL unit.
- All the hardware and software supplied by Vendor shall be covered under AMC excluding printers, batteries and consumables.

SHUTDOWN MAINTENANCE	-	6 man days per year
PERIODIC MAINTENANCE	-	4 man days per year
BREAKDOWN MAINTENANCE	-	4 emergency calls per year

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22.2 Hardware Maintenance Service

Replacement of hardware

- Faulty Hardware including modules, I/O racks, system cables, FTA cards, Ethernet Switches, controller, power supplies, etc shall be replaced free of cost.
- Diagnosed defective part shall be delivered within 24 hrs on normal working day and Within 72 hrs on weekend and holidays.



22.3 Scope Of Work For Periodic Maintenance Service

The PERIODIC MAINTENANCE is an on-line maintenance which will be carried out 04 (four) times during each year of the contract period. Each routine maintenance visit will be for 1 Day. Schedule can be drawn on mutual agreement. The details of services under Periodic Maintenance are as follows :-

- **Checking Of Operating Conditions**
Party's engineer will discuss with our staff and ascertain the operating conditions of the system. If required , the images of operator stations and control stations will be saved on CD's.
- **Checking Of General Healthiness Of The System**
Test programs will be run on operator stations to detect any functional problems. Battery voltages will be checked.
- **Investigations Of Problems**
If any problems are identified by party's engineer during testing or problems highlighted by our staff ,party's engineer will investigate such problems and take necessary steps to resolve such problems.
- **Replacements Of Parts / Spares**
If batteries are required to be replaced and if the concerned system is released, party's engineer will replace the same if such parts are made available by NFL to him.
- **Report**
A detailed report on the jobs carried out and the observations will be submitted by the party after each visit.

22.4 Scope Of Work For Breakdown Maintenance Service

Breakdown visits will be provided on demand during the contract period. In the event of breakdown of the system , upon call from our side , the party will give remedial advise to our maintenance staff over telephone / fax / telex. If still party's engineer's visit is required ,party's engineer will reach our site at the earliest but not later than 24 hours from the time of first intimation to attend the problem and restore the system back to normalcy within 24 hours.

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Emergency situation is defined as:

- Failure of the system or part of system which results in plant shutdown or tripping.
- Failure in which the operator is not able to control the plant through DCS , such as CRT blanking , freezing , keyboard freezing etc.
- Failure of systems internal power source.
- Failures such as Hard disk crash etc.

22.5 Notes:



- All required special tools and tackles required for performing the job shall be carried by the vendor engineer. However man power for hard work if required, shall be supplied by NFL.
- If any component needed to be carried to party's works for special maintenance, NFL will arrange for the gate pass. Transportation shall be in party's scope.
- Other charges viz Over- time, transportation, travelling, lodging and boarding etc. will not be paid by NFL and shall be borne by the party.
- A man day considered is for 8 hrs of work in plant.
- This is visit base contract and payment shall be done for no. of days visited only. Invoice shall be raised after completion of each visit and submission of visit report.

23.0 TRAINING

Supplier shall train Clients' maintenance engineers as well as operations staff in his works at Vendors Center of Excellence. The training imparted shall be by qualified and experienced staff available. It shall be exhaustive and aimed at making clients' maintenance & operations staff self reliant for most of the day to day applications. For training, supplier shall make available as close a model of the system with all the representative nodes, as the actual system to be installed. It is envisaged that following be covered in the training:

23.1 Maintenance Staff Training

- a. System architecture.
- b. Functions of each node.
- c. Hardware in each node.
- d. Complete application software. This shall cover everything from basics like generation of various system nodes to advance language programming, configuration and debugging etc.
- e. Commonly occurring hardware problems and the maintenance procedures to be followed.
- f. Various diagnostic programmes available and their use and interpretation.
- g. Routine preventive maintenance procedures.
- h. Maintenance of various peripheral devices like printers, copiers etc.

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23.2 Operations Staff Training

- a. System architecture.
- b. Functions of each node
- c. Functions of various keys in the keyboard.
- d. Generation of displays like graphics, group, trend groups, etc.
- e. Display hierarchy, access methods for various displays, switching between different types of displays etc.
- f. Control of plant from various displays.
- g. Alarm handling.

For purposes of training, detailed literature, instruction & maintenance manuals in English shall be arranged by the BIDDER.

24.0 INSPECTION

1. The system and all its 100 % associated components shall be inspected and tested at the BIDDER's works by OWNER & third party (if required).
2. OWNERS reserve the right to inspect any bought out items by the BIDDER at the sub-BIDDER's works.
3. Cost of inspecting/testing shall be borne by the BIDDER. FAT/SAT procedures to be submitted with offer.
4. For final integrated inspection of the system, the BIDDER shall give a minimum notice of 3 weeks to OWNER. Throughout the Factory acceptance test, BIDDER shall provide all necessary test equipments and consumables and shall make all necessary connection as many times required. OWNER shall carry out 100% functional checking of all hardware and software modules.
5. For Acceptance testing BIDDER shall prepare test procedures for Owners approval.

24.1 Level of testing:



Beyond the mandatory test and inspections according to BIDDER's quality assurance program during fabrication there shall be two testing described as follows:

1. Factory acceptance test (FAT) to be performed at the BIDDER's factory.
2. Site acceptance test (SAT) to be performed on plant site.

24.2 Factory acceptance test (FAT)

The FAT shall be performed when the complete system, including all hardware and software components, to be supplied by the BIDDER, has been assembled and prepared for operation in the factory.

The testing procedures shall be performed with the aid of adequate simulation hardware, software and/or test programs. The objective of the testing procedures is to ensure that all hardware components and the related software modules (standard function blocks) are free

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from errors/defects when being tested individually and in the system configuration. The tests shall be performed with the aid of test programs permitting easy location of defective components and/or software modules.

During the factory acceptance test, the complete system must remain 100 % operational for at least 100 consecutive hours with no hardware and/or software failures.

The BIDDER shall provide test and simulation equipment, appropriate testing staff and any service utilities to perform the test in an efficient and timely acceptable manner. The course and duration of the test procedure shall be specified by the BIDDER. Simulation equipment for simultaneous testing of 100 % of I/O-signals shall be kept available by the BIDDER/manufacturer (with multiple plug-in connectors).

The Owner and the BIDDER shall agree upon the start of the test. If any failures occur within said 100 hours the test shall be restarted when the failure has been corrected and the system shall be re-tested for another 100 consecutive hours.

During FAT BIDDER shall prepare a report signed by the Owner and the BIDDER.

After the factory acceptance test has been successfully completed the system shall be ready for transportation to plant site.

Additionally the communication between various Systems like supplied DCS and Plant DCS shall also be tested. The procedure, e.g. simulation or test program has to be clarified between Owner and BIDDER.

24.3 Site acceptance test (SAT)

After transportation to plant site the BIDDER has to investigate and prove all system components and devices against transportation and erection damages.

This level of testing will take place on site after the system has been installed and certified as operational by the BIDDER.

The BIDDER shall have the responsibility to ensure that the installed hardware including the software supplied is fully operational.

The testing procedure shall include mechanical checks of the system including all system links connected according to the BIDDER's specification.



After this the software will be loaded and self-test routines of the EDS-system shall ensure that all system components are in acceptable condition as well as the communication links are working properly.

The application software will be loaded. If the system shows no deviation to the normal operation, the system will be ready for loop checks.

When the system operates normally for continuously 30 days, after completion of the loop checks and all simulation test, the ESD-system shall be considered as accepted by the Owner.

All guarantee performance data which are specified (CPU spare capacity, spare capacity of hardware, scanning time of process variables etc.) will be proven by BIDDER.

A certificate of acceptance shall be signed by the representatives of the Owner and BIDDER.



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Annexure - 1

ACCURACY OF INSTRUMENTS

Accuracy of the Instruments shall be minimum as follows:



Type of Instrument	Accuracy
- Differential pressure & Pressure transmitter–SMART with latest HART protocol	± 0.075% of span within span ratio of 1:10
- Variable area type flow meter with transmitter	± 2.0% FS Note (1)
- Vortex flow meter –Smart with latest HART protocol	± 1.0% FS
- Positive displacement flow meter	
- Raw material and Product	± 0.2% FS
- Others	± 0.5% FS
- Turbine meter or Mass flow meter -Smart with latest HART protocol	
- Raw material and Product	± 0.2% FS
- Others	± 0.5% FS
- Magnetic type flow meter-Smart with latest HART protocol	± 0.5% FS
- Ultrasonic type flow meter(4 - path)- Smart with latest HART protocol	± 0.25% FS
- Displacement type level indicator	± 1.0% FS
- Displacement type level transmitter-Smart with latest HART protocol	± 0.2% FS (Smart)
- Radar type tank gauge Smart with latest HART protocol	± 1 mm or better for custody transfer ± 5 mm or better for normal application
- Draft range Pressure transmitter - Smart with latest HART protocol	± 0.15% of span within span ratio of 1:10
- Diaphragm seal transmitter - Smart with latest HART protocol	± 0.2% of span within TD ratio of 1: 10
- Pressure gauge	± 1.0% FS
- Temperature Transmitter	± 0.2% of calibrated span for RTD ± 0.5% of calibrated span for Thermocouples
- Filled system/Bimetallic	± 1.0% FS
- Small size pressure gauge	± 3.0% FS
- Draft gauge	± 3.0% FS
- Receiver gauge	± 1.5% FS

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- Thermocouple & Resistance Bulb	Applicable Codes/Standards
- Digital Multimeter	i. Voltage DC $\pm 0.1\%$ ii. Voltage AC $\pm 1.0\%$ iii. Ampere DC $\pm 1.0\%$ iv. Ampere AC $\pm 1.5\%$ v. Resistance $\pm 0.9\%$ vi. Temperature $\pm 1.0\%$
- Loop Calibrator (Source & Measurement)	$\pm 0.015\%$ of reading
- Pressure Calibrator	$\pm 0.05\%$ FS
- Digital Pressure Gauge	$\pm 0.05\%$ FS

Note: 1. Vendor's standard accuracy is applied to local indicator type

- Remarks:**
- Accuracy of instrument and special articles except for the above mentioned instrument shall be in accordance with the applicable codes/standards, or as specified in individual data/specification sheet or Vendor's standards as approved by Purchaser.
 - FS: Full scale.
 - Overall rangeability of transmitter except for draft range shall be 1: 100. Draft range transmitter rangeability shall be 1: 30 for the accuracy indicated above.

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Annexure - 2



Size of Instrument Nozzles

- a) Min 2" Nozzle on vessels except for Temperature Instruments. (1 ½")
- b) 3" for cladded equipments
- c) Instrument connections:

In general, process connections of various types of Instruments mentioned below shall be as a standard unless there is a special case where the size shall be decided on case to case basis. However if there is a change different from the table, prior approval shall be taken from owner/consultant.

A. Connections on vessels:

<u>Sr</u>	<u>TYPE OF INSTRUMENTS</u>	<u>VESSEL/STAND-PIPE /COLUMN NOZZLE CONNECTION</u>	<u>FIRST BLOCK VALVE</u>	<u>INSTRUMENT CONNECTION</u>
1	External Displacer Level Instrument on vessel	2" flanged	2" flanged	2" flanged
4	External Ball Float Level Instrument on Vessel	2" flanged	2" flanged	1" S.W.
7	Level Gauge on Vessel	2" flanged	2" flanged	¾ " flanged
9	D/P instrument on Vessel	2 " flanged	2 " flanged	½ " screwed
10	RADAR/ULTRASONIC	3" flanged	3" flanged	3" flanged
11	Diaphragm Seal D/P Instrument on Vessel	3" flanged	3" flanged	3" flanged
12	Extended D/P Instrument on Vessel	4" flanged	-	4" flanged or as per requirement
13	Dip Tube Level Instrument	2" flanged	½ " S.W. (by inst.)	½ " screwed
14	Tank Level Instrument (Mech.) ATM. / Pressurized	1 ½ " flanged	1 ½ " flanged (by inst.)	½ " screwed
15	Pressure Instrument on Vessel	2 " flanged	2 " flanged	½ " screwed
16	Diaphragm Seal Pressure Instrument on Vessel (screwed)	2 " flanged	2 " flanged	2 " screwed
17	Diaphragm Seal Pressure Instrument on Vessel (flanged)	2 " flanged	2 " flanged	2 " flanged
18	Thermo well	1 ½ " flanged in general but some application , it may be done as MFR std	-	1 ½ " flanged in general but some application , it may be done as MFR std

	DESIGN PHILOSOPHY-INSTRUMENTATION INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/8.0		
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B. Connection on piping:



Sr.	TYPE OF INSTRUMENT	WHERE PIPING CLASS PRESCRIBES SCREWED CONNECTIONS			WHERE PIPING CLASS PRESCRIBES SW CONNECTIONS			WHERE PIPING CLASS PRESCRIBES FLANGED CONNECTIONS		
		Process Conn.	1 st Block Valve	Inst. Conn.	Process Conn.	1 st Block Valve	Inst. Conn.	Process Conn.	1 st Block Valve	Inst. Conn.
1	Orifice /venturi Flow meter	3/4"/1/2" /screwed *	3/4"/ 1/2 " /screwed *	3/4"/ 1/2 " /screwed *	3/4"/ 1/2 " /screwed *	3/4"/ 1/2 " * S.W.	3/4"/1/2" /screwed *	3/4" screwed*	3/4" flanged	1/2 " screwed
2	Averaging Pitot Tube	1 1/2 " flanged	1 1/2 " flanged (by inst.)	1 1/2 " flanged **	1 1/2 " flanged	1 1/2 " flanged (by inst.)	1 1/2 " flanged **	1 1/2 " flanged	1 1/2 " flanged (by inst.)	1 1/2 " flanged **
3	Pressure Instrument	3/4 " screwed	3/4 " screwed	1/2 " screwed	3/4 " S.W.	3/4 " S.W.	1/2 " screwed	3/4 " flanged	3/4" flanged	1/2 " screwed
4	Diaphragm Seal Pressure Instrument (flanged)	2 " flanged	2 " flanged	2 " flanged	2 " flanged	2 " flanged	2 " flanged	2 " flanged	2 " flanged	2 " flanged
5	Thermowell	1 1/2 " flanged	-	1 1/2 " flanged	1 1/2 " flanged	-	1 1/2 " flanged	1 1/2 " flanged	-	1 1/2 " flanged

* - Depending on service

** - Rating & metallurgy shall be as per piping specification

Notes:

- For any other instrument not referred above, the connection details shall be as per individual requirement.
- All flange/SW ratings shall be as per piping specification.
- In case of direct mounted flanged instruments and where flanged first isolation valves are provided, bolting and gasket shall be in piping scope.
- Installation of all inline instruments shall be in piping scope.
- For multipoint thermocouple in reactor/regenerator, thermo well size shall be dependent on Licensor's /equipment manufacturer's recommendation.
- Flanged or Threaded connections shall be as per ANSI standard.



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Annexure - 3

Units of Measurement

The units of measurement, graduation of scales and charts shall be in accordance with the following table:

Measured variable	Unit of measurement	Scale
Temperature	deg Celsius	Direct reading
Pressure & Diff. Pressure	mm of WC, kg/cm ² g,	Direct reading
Draft pressure	mm of H ₂ O	
Vacuum pressure	mm of Hg, mm of WC, kg/cm ² a	-do-
Liquid flow Volume Mass	M ³ /h Kg/hr, T/ D	0-10 sq. root (DP cells) 0-100 linear
Gas flow Volume Mass	NM ³ /hr, M ³ /hr Kg/hr. T/ D	- do -
Steam flow	Kg/hr, T/hr, T/ D	- do -
Level	% level, mm	0-100 linear / Direct
Vibration/Axial	mils	Direct
Analysers	%by volume or as specified	Direct
Density	Kg/m ³ ,g/cm ³	Direct
Conductivity	S/cm, uS/cm	Direct
pH measurement	pH	Direct

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Annexure - 4
SYSTEM CONFIGURATION

The system configuration is defined as a minimum here. The Bidder has also to consider any other item defined in the Section 5.7. Any other system required to successfully commissioning the plant shall also be provided by LSTK bidder.

Refrigeration Compressor

1 No Engineering station in engineering room with SER, 24" TFT, COLOR, LED type, RAID-5 Configuration Processor: Intel Xeon Dual / Quad (Min 3GHz), RAM: 8GB Min, Hard disk: 500GB min, Network Port: Min. 3 No's, of speed 10 / 100 / 1000 MBPS, OS: Genuine Windows

1 No. OS for Remote viewing with Raid-1 configuration, Processor: Intel Xeon Dual / Quad (Min 3GHz), RAM: 8GB Min, Hard disk: 500GB min, Network Port: Min. 3 No's, of speed 10 / 100 / 1000 MBPS, OS: Genuine Windows

Compressor Control Room : 1 No.

Necessary hardware like Optical fibre cable/Media converters/switches etc shall be in Bidder's scope, client will provide only power supply in Compressor control room)

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PART II: TECHNICAL

SECTION – 9.0



DESIGN PHILOSOPHY FOR CIVIL & STRUCTURAL WORKS

**PLANT: NATIONAL FERTILIZERS LIMITED, NFL, NANGAL,
PUNJAB**

**PROJECTS: INSTALLATION OF NEW 2500 CUBIC METER
CAPACITY HORTON SPHERE FOR STORAGE OF
AMMONIA ALONG WITH ITS REFRIGERATION SYSTEM
AT NFL, NANGAL**

0	16.12.2022	16.12.2022	ISSUED FOR NIT	AK	RNS	RNS
REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD

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	DESIGN PHILOSOPHY – CIVIL & STRUCTURAL WORKS INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/9.0	0	
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1.0 INTRODUCTION

M/s National Fertilizers Limited (NFL) proposes to install new Ammonia Horton Sphere (Capacity 2500 cubic meter) along with it's refrigeration system and interconnection with existing Horton Sphere(F2401) system, including complete Mechanical, Civil, Electrical, Instrumentation work at NFL, Nangal.

1.1 GENERAL

This document intend to provide the requirements for design and construction of civil & structural work, for the new Ammonia Horton Sphere located in NFL, Nangal (Punjab, India) as described under this section. The design shall be complied with the requirements of necessary codes & standards mentioned in subsequent clause of this document.

1.2 PURPOSE

The scope of design basis is to establish preliminary data required for the design and analysis of structures and foundation in this project. This document covers applicable codes, standards, material. This also covers design basis for design loads, foundation design, Tank foundation design, pipe rack design and general civil design.

1.3 GEOTECHNICAL INVESTIGATION



Bidder to conduct their own geotechnical investigation (at their own cost) and design accordingly

1.4 DRAWINGS & DOCUMENTS

Bidder shall submit all foundation drawings along with design calculation and structural drawings along with design calculation for review and approval.

2.0 CODES AND STANDARDS

Code no	Title
IS-456(2000)	Code of practice for plain & reinforced concrete



	DESIGN PHILOSOPHY – CIVIL & STRUCTURAL WORKS INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/9.0	0	
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IS 1893 (Part 1) : 2016	Criteria for earthquake resistant design of structures : Part 1, General Provisions & Buildings
IS 1893 (Part 4) : 2015	Criteria for earthquake resistant design of structures - Industrial structures including Stack- Like Structures
IS 875 (Part 1, 2, 4 & 5) : 1987 & (Part 3) : 2015	Code of practice for design loads (Other Than Earthquake) for buildings and structures.
IS 2974 (Part 1) – 1982	Code of practice for design and construction of machine foundations : Part I Foundation for reciprocating type machines.
IS 2974 (Part 3) - 1980	Code of practice for design and construction of machine foundations: Part II Foundation for impact type machines (Hammer Foundations).
IS 2974 (Part 3) : 1992	Code of practice for design and construction of machine foundations: Part 3 Foundation for rotary type machines (medium and high frequency).
IS 2974 (Part 4) : 1979	Code of practice for design and construction of machine foundations: Part 4 Foundation for rotary type machine of low frequency.
IS 2974 (Part 5) - 1987	Code of practice for design and construction of machine foundations; Part 5 Foundation for impact machines other than hammers (forging and stamping press, pig breakers, drop crusher and jolter).
IS 269 - 2015	Ordinary Portland Cement
IS12330 - 1988	Specification for Sulphate Resisting Portland cement
IRC:6 – 2017	Standard Specifications and Code of practice for road bridges, Section : II Loads and Load Combinations
IRC:37 - 2012	Tentative Guidelines for the Design of Flexible Pavements.

IRC:58 -2015	Guidelines for the Design of Plain Jointed Rigid Pavements for Highways
IS 800 : 2007	General Construction in Steel - Code Of Practice
IS 808 : 1989	Dimensions for hot rolled steel beam, column, channel and angle sections.
IS 806 : 1968	Code of Practice for Use of Steel Tubes in General Building construction.

IS 816 : 1969	Code of Practice for Use of Metal arc welding for general condition in mild steel
IS 813 : 1986	Scheme of symbols for welding
IS 2062 : 2011	Hot rolled medium and high tensile structural steel – specification-Steel for general structural purpose.
IS 3502 : 2009	Steel chequered plates.
IS 1363 : 2002	Hexagon head bolts, screws, nuts of product grade C
IS 1364: 2002	Hexagon head bolts, screws, nuts of product grades A and B
IS 1161 :2014	Steel tubes for structural purpose
IS 801 : 1975	Code of practice for use of cold form light gauge steel structural member in general building construction.
IS 2629 : 1985	Recommended practice for hot dip galvanizing on iron & steel.
IS 2633 : 1986	Methods of testing uniformity of coating of zinc coated articles.
IS 6745 : 1972	Method of determination of mass of zinc coating on zinc coated iron and steel articles.
IS 1786 : 2008	High strength deformed steel bars & wires for concrete reinforcement.
IS 432 (Part-I & II) : 1982	Mild steel & medium tensile bars & wires for concrete reinforcement.
SP 34 : 1987	Handbook on concrete reinforcement detailing.
SP 6 (5) : 1980	Handbook on cold formed light gauge steel sections.
IS:3488(1980)	Brass bars, rods and sections suitable for forging
IS 458 : 2003	Specification for Precast Concrete Pipes (With and Without Reinforcement
IS 13592 : 2013	Pipes for soil and waste discharge system for inside and outside buildings including ventilation and rain water system
IS 8009 (Part I)	Code of practice for calculation of settlement of Foundations – Deep Foundations
IS 6403 : 1981	Code of Practice for determination of bearing capacities of shallow foundation

Note : Latest IS Codes ,Latest Design Codes and Standard Engineering Practices shall be adopted for design & execution.

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Units

SI units shall be applied as the measurement system to the Drawings and Documents.

2.1 Material

Unless otherwise specified in the Drawings, material specifications shall conform to the following.

2.1.1 Cement

Cement used for concrete works for superstructure shall be Ordinary Portland cement Grade 43 and for piling work shall be Ordinary Portland cement Grade 53.

2.1.2 Aggregates

Aggregates used in the concrete works shall be locally available gravel or crushed stone conforming to IS: 383 and / or IS: 515. Before using the aggregate shall be tested as per IS 2386.

For large foundations: 40mm graded down aggregate shall be used (provided the pitch of the reinforcement is more than 100).

For mass or Plum concrete: Rubble stone of size not more than 150mm to 200mm shall be used.

For lean Concrete of mix 1:3:6 (M10), 40 mm and down size grade crushed stone aggregate shall be used.

For all others, 20mm and down size grade crushed stone aggregate shall be used.



2.1.3 Fine Aggregates :

Fine aggregates are the aggregates which shall pass through 4.75mm sieve but not more than 10 % shall pass through 150 micron IS sieve. These shall comply with the requirements of grading zones I, II and III of IS:383. Fine aggregate confining to grading zone IV shall not be used for reinforced concrete works.

2.1.4 Reinforcement

Reinforcement shall be High Strength Deformed (TMT) bars of grade Fe500D conforming to IS: 1786- 2008

2.1.5 Structural Steel

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Structural Steel shall be grade E250A conforming to IS 2062-2011.

2.1.6 Anchor Bolts

Anchor Bolts shall be of mild steel bars conforming to IS: 2062-2011. (GRADE 4.6)

2.1.7 Insert Plates

Insert plates shall be of structural steel of grade E250A, quality conforming to IS: 2062 and shall be provided with mild steel lugs as per drawings/ standards.

2.1.8 Mild steel bars shall conform to IS: 432.

2.1.9 Hexagonal head bolts, screws & nuts shall be grade C conforming to grade IS1363 and for M42 to M150 shall be conforming to IS3138.

2.1.10 Grating

Grating shall be 25mm thick welded / galvanized.

Galvanization shall be in accordance with IS 2629. Minimum weight of zinc shall be 900 gms per square meter of surface area with minimum uniform thickness of 0.12 mm.

2.2 Design Strength of Concrete

Unless otherwise specified, the minimum design compressive strength of cast-in-situ/ Precast concrete at 28 days (conforming to IS: 456) shall be as follows:



Foundation Concrete (M30).....	30 N / mm ²
Structural Concrete (M30).....	30 N / mm ²
Trench/ Drainage (M30).....	30 N / mm ²
Light Duty Paving (M25).....	25 N / mm ²
Grade Slab (M25)	25 N / mm ²
PCC Mudmat / Leveling Concrete	PCC 1:4:8

2.3 Admixtures

All concrete admixtures shall comply with the following IS codes

Specification for integral cement water proofing compounds :IS:2645

Specification for other admixtures for concrete : IS: 9103

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- No admixture shall impair the durability of the concrete nor combine with the ingredients to neither form harmful compounds nor increase the risk of corrosion of reinforcement. Use of admixtures shall not reduce the dry density of concrete. Once the proportion of admixtures has been established, strict check shall be maintained not to alter the proportions of ingredients and water-cement ratio of the Design Mix during execution.
- The chloride contents in admixtures shall be minimum.
- Admixtures which do not meet above requirements shall not be used.

2.4 Minimum pedestals height above finished grade level

The minimum height of outdoor and indoor pedestals (supporting equipment / structures) shall be 300 mm and 150 mm respectively above the highest paving level/ finished floor level whichever is higher. The height of pedestals for staircase/ ladder shall be 200 mm above HPP.

2.5 Minimum width of steel staircase

Main entrance staircase width 1200mm

3.0 Design Basis for Loads

This section covers the Loads and Load Combinations that shall be considered in the Design and Engineering for Concrete, Structural Steel and General Civil facilities. Detailed Engineering Design shall be carried out in accordance with Design Specification covered separately under respective heads in this document. Design shall be done with due consideration to the functional requirements, the conditions at Site, so that the requirement of this Specification shall be met and economical, effective methods and materials shall be used.

3.1 Dead Loads (DL)

Dead loads shall be considered as total weight of materials forming a permanent part of structure. Dead load shall include the total weight of structure viz. beam, column, slab, wall and foundation, floor finish, roof finish, false ceilings, water proofing, electrical cables. Unless noted otherwise following unit weights shall be adopted.

Table-1 Unit weight for materials

Material	Unit weight
Reinforced concrete	25.0 kN/m ³
Plain Concrete/lean concrete	24.0 kN/m ³
Brick Wall	20.00kN/m ³
Structural steel	78.5 kN/m ³
Dry Soil	18.0 kN/m ³
Saturated soil	19.0 kN/m ³
Staircase (Steel)	1.4 kN/m ²
Ladder	0.4 kN/m ²
6 mm Thk. chequered plate	0.55 kN/m ²
25 x 6 mm Thk. grating	0.44 kN/m ²
Operating floor with grating	3 kN/m ²
Hand railing	0.15 kN/m

Cable tray load:

The estimated actual load from electrical/ instrumentation trays shall be considered at the specified locations given by the respective department. Before proceeding with the design, the loadings for electrical and instrumentation cable trays shall be obtained/ got confirmed from the respective discipline.

3.2 Live Loads (LL)

Live load shall mean, the loads resting on the structure, loads that are not permanently fixed such as personnel, furniture and tools.

However weight for small equipment's and miscellaneous facilities like following, which may be permanently fixed there to, shall be included in live loads.

- Local lighting facilities
- Local instrumentation and electrical facilities and cables
- Local small piping

3.2.1 Live Loads on locations other than roofs

The Design Live Loads shall be in general as per IS: 875, Part -2 but shall not be less than the following values:

Table-2 Design Live Loads

LOCATION	DESIGN LIVE LOADS
<u>Process Building / Technological Structure</u>	
(Open / Enclosed Type)	
Operating Area	5.0 KN/m ²
Maintenance Area	7.5 KN/m ²
<u>Compressor House</u>	
Ground floor	10.0 KN/m ² .
Operating Area	0.75 KN/m ²
<u>Service Platform</u>	
Vessel / Tower	3.0 KN/m ²
Isolated Platform	2.5 KN/m ²
(For valve operation)	
<u>Stairs</u>	
Process Building	5.0 KN/m ²
Emergency staircase	2.5 KN/m ²
Service Platform	2.5 KN/m ²
Walkway of Gantry Girder	3.0 KN/m ²
Handrails	1.0 KN point load in any direction
<u>Live Loads on roof</u>	
(i) Flat Roof, sloping roof with slope $\leq 10^\circ$	
With Access	1.5 KN/m ²
Without Access except for maintenance	0.75 KN/m ²
ii) Sloping roof with slope $> 10^\circ$	
a) For roof membrane sheet or purlins	0.75 kN/m ² less 0.02 kN/m ² for every degree increase in slope over 10 degrees subject to minimum of 0.4 KN/m ²
iii) For member supporting purlins such as trusses, girders etc.	2/3 of the load calculated in (ii)(a)

3.3 Wind Load (WL)

Basic wind speed for this site is 47 m/sec as per code IS:875.

Wind Loads on buildings / structures shall be calculated in accordance with IS: 875 Part 3. The design wind pressure shall be calculated as below: - $p_z = 0.6 \times V^2$ (IS: 875. Clause no 5.4)

Design wind pressure p_z in N/m^2 at height "z" shall be calculated from following condition: V_z = Design wind velocity in m/s at height "z"

$$V_z = V_b \times k_1 \times k_2 \times k_3 \times k_4 \text{ (IS: 875)}$$

Clause no. 6.3) $V_b = 47$ m/sec, Basic wind speed....

$$\text{Design wind pressure } p_d = K_d K_a K_c p_z$$

Wind Load on Pipe rack

Wind Load shall be calculated based on the requirements of IS-875, Part 3. Transverse wind loading on the structure shall be calculated corresponding to the width of the pipe rack as per the following table. This force shall be considered irrespective of the height between two tiers.

Table-3

Width of the pipe rack	Wind force at each tier level
Upto 4 m	$1.25 \times p_z \times s$
Above 4.0m but up to 6.0m	$1.50 \times p_z \times s$
Above 6.0m but up to 8.0m	$2.00 \times p_z \times s$
Above 8.0m but up to 10.0m	$2.50 \times p_z \times s$

Where "pz" is design wind pressure and "s" is spacing between the portals. Above mentioned wind load formula includes the wind force of structure & pipe.

Wind load on cable tray duct shall be worked out separately. For flare header or any other line supported on extended leg of pipe rack the wind force shall be calculated separately.

3.4 Seismic Load (SL)

Structures shall be designed for the earthquake load calculated as per the provisions in IS 1893 (Part-1) : 2016 and (Part 4) : 2015 using Response Spectrum method. This plant is located at Nagal, Punjab.

As per code, the area comes under zone IV.

The Design horizontal seismic coefficient 'A_h' for a structure shall be determined by the following formula.

$$A_h = \frac{Z I S_a}{2 R g}$$

Where,

Z = 0.24, for zone IV, Zone factor obtained from table 14 of IS 893(Part4):2015

I - Importance factor obtained from table 3 of IS 1893 (Part-4) : 2015

R- Response reduction Factor obtained from table 4 of IS 1893 (Part-4) : 2015

Sa/g- Average response acceleration coefficient obtained using standard specific design spectra Annexure B of IS 1893 (Part-4) : 2015

3.4.1 Damping

The following values of damping are recommended for design of DBE and MCE condition. Refer Table 5, IS: 1893 Part 4 & as produced below.

Table- 4: Structure wise damping percentage as Follows:

SR.NO	STRUCTURE	DBE	MCE
1.	Steel structures	2	4
2.	Reinforced concrete	5	7

3.5 Equipment Loads (Ee, Eo, Et)



Equipment Loads shall be defined as per the following 3 cases, according to the governing conditions of erection, operation and testing.

Equipment Loads for Erection (Ee):

This shall mean the weight of equipment during erection and exclude; the weight of internals, fluids and solids within the equipment, platforms, insulation and piping attached to the equipment.

Equipment Loads for Operation (Eo):

This shall mean, the load of equipment during normal operating conditions, including the weight of internals, fluids and solids within the equipment and all materials permanently attached to the equipment, such as platforms, insulation and piping.

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Vibration caused by operation of equipment shall be considered separately as Vibration Loads (VL).

Equipment Loads for Testing (Et):

This shall mean, the load of equipment during hydrostatic testing after erection / installation, including the weight of water within the equipment, piping and all materials permanently attached to the equipment, such as platforms, insulation and piping.

3.6 Piping Loads (P)

3.6.1 Piping Load for Erection (Pe):

Actual pipes coming at each tier shall be considered. Pipe empty weight shall comprise only empty weight of pipes excluding the contents but includes the insulation weight wherever applicable. These loading shall be as per piping loading data.

3.6.2 Piping Load for Operation (Po) :



This load, as given by piping department after stress analysis, comprises of actual weight of pipes taking care of the class of pipe, material content and insulation, if any apart from thermal loads e.g. anchor loads and guide loads.

Piping loads shall be calculated considering the pipe diameters and piping arrangement subject to minimum 125kg/m^2 over entire span. In case the calculated loading is higher than 125 kg/m^2 , this shall be rounded off to the nearest multiple of 25 (i.e. 150,175, 200 kg/m^2). The loading as given after stress analysis shall be applied on the pipe rack structure, as per the civil information.

Longitudinal beams of pipe rack connecting portal columns shall be designed to sustain 25% of the design load on the main portal beams. This total load shall be applied as two equal concentrated loads acting at 1/3 rd span. Friction and Anchor forces, if specifically given by piping dept. shall also be taken care in the design of longitudinal beams. Loads from monorails, intermediate beams, if supported from these beams shall also be considered simultaneously with all other loads. Occasional loads: The Surge loads shall be given separately by piping department, as applicable.

3.6.3 Piping Load for Testing (Pt) :

Test loads shall comprise of the maximum design loads (inclusive of empty Weights) sustained by the pipes during hydro testing. This loading shall be as per piping civil information.

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3.7 Friction Loads (FL)

3.7.1 Piping friction force on Pipe rack

Friction force on pipe rack, at each tier on every portal in longitudinal directions shall be 30% of design vertical load for single pipe or up to 3 pipes and 10% of design vertical load for more than 3 pipes. Longitudinal friction force shall be applied as concentrated load at appropriate locations of concentrated load at each tier level. Intermediate beams shall be designed for 25% of design u.d.l. on the main portal beams.

3.7.2 Piping friction force on Equipment supporting structure.

Friction force of piping on structure shall be applied as 30% of operating load along the length of pipe & 10% of operating load across the pipe.

3.8 Equipment thermal / friction force

Horizontal forces due to thermal expansion of horizontal vessels/ Exchangers shall be relieved by using slotted holes and slide plates and remaining force derived from product of the sliding saddle gravity load and co-efficient of friction (0.3 to steel or 0.1 PTFE), which shall be applied to each support

These friction forces shall not be transferred to the foundation. All individual beams shall be designed for local effects of friction.

3.9 Anchor and Guide Force “AL”

Longitudinal and transverse anchor and guide forces shall be taken from piping stress analysis. These loads shall be considered for local / global design of members / structure as appropriate. In absence of information of anchor force it shall be considered as 10 % of Operating weight of pipe per pipe layer.



3.10 Bundle Removal Loads (B)

Bundle Removal loads shall mean the force needed to remove the tube bundle of heat exchanger.

3.11 Maintenance load / Crane Loads (ML or CRL)

Handling device loads shall mean the loads of Cranes, hoists and lifts including the lifted weight in the normal operation.

Handling device loads shall be increased as per IS:875 part II.

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3.12 Vibration Loads (VL)

Vibration loads shall mean the vibration forces caused by heavy vibrating equipment or machinery and dynamic forces caused by fluids in the normal operation.

Frames, structures and foundations for machinery or equipment causing vibration shall be designed to limit vibrations to an acceptable level.

It shall be designed such that whether they are independent or part of the building, it shall not only safely carry the loads for such items but also prevent resonance. Natural frequencies of frames, structures and foundations must differ by more than 20% from that of the machinery under operating conditions.

Amplitude of vibration shall be less than values specified by Machine Manufacturer (Vendor). If not specified, provisions of IS: 2974 shall be followed. While carrying out dynamic analysis of foundations / structures supporting dynamically loaded equipment, the loads indicated by vendor in his documents shall be used.

3.13 Earth Pressure (Ep)

Earth Pressure shall mean pressure of the soil acting on the underground structures and / or foundations of retaining walls, dikes etc.

3.14 Liquid Pressure (Lp)

Liquid Pressure shall mean the pressure of liquid acting on the Pit/Basin structures.



3.15 Traffic loads (TL)

Traffic Loads for plant engineering and construction shall be defined as the following loads according to the governing condition at construction, operation and maintenance.

Unless otherwise specified, appropriate IRC Loading shall be applied to the design of road crossing constructions such as drainage pipes and cable trench.

3.16 Safety Factors for Stability

All buildings, structures and foundations shall be designed, such that the safety factor shall not be less than the values mentioned below, in any condition.

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Overtuning: 1.5 with wind & seismic
: 2.0 without wind & seismic

Sliding : 1.5

Buoyancy : 1.2

4.0 Design Loads and load Combinations

- a. Design loading shall be as per the design specification for loads and shall be applied to the following.
 - Design loads
 - Loading combinations
 - Safety factors for stability
 - Load factors for required strength
- b. The calculation of stability and soil contact pressure of foundation shall be carried out on the basis of working load and allowable soil bearing capacity.
- c. The resisting lateral force against the sliding of foundation shall generally be based on the friction force between the foundation and its supporting subsoil with friction factor of 0.4

Load combinations to be adopted for serviceability, stability and bearing capacity check and superstructure and foundation design are as per IS: 456-2000 for concrete design.

4.1 Types of Loads

Unless otherwise specified, all loads listed herein, shall be considered in the design: DL= Dead Loads.

LL= Live Loads.

WL = Wind Loads.

SL= Seismic Loads.

EL = Equipment Loads (Ee, Eo, Et)

PL= Piping Loads (Pe, Po, Pt)

TL/FL = Thermal Loads due to piping.

BP= Bundle Pull.

HL = Handling Device Loads.



VL= Vibration Loads.

Ep = Earth Pressure.

Lp = Liquid Pressure.

Tr = Traffic Loads.

CRL /ML = Crane load.\

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4.2 Load Combinations

Buildings, structures, foundations, and all structural components shall generally be designed for the following load combinations,

Loading Combination for Pipe rack / Stair Tower / Equipment Foundations:

Following major load combinations shall be considered for stability & serviceability.

LOAD CONDITION	LOAD COMBINATION	REMARK
ERECTION	DL+ Ee / Pe+ WL 0.9[DL + Ee / Pe] + WL	
OPERATION	DL+ Eo / Po + LL DL+ Eo / Po + WL DL+ Eo / Po + SL DL + LL + Eo / Po + WL DL + LL + Eo / Po + SL	
TESTING	DL+ Et / Pt + 25% WL DL + Et / Pt	

Partial Safety Factor for Strength design:



LOAD CONDITION	LOAD COMBINATION	REMARK
ERECTION	1.5[DL + Ee / Pe + WL] 0.9[DL + Ee / Pe] + 1.5 WL	
OPERATION	1.5[DL+ Eo / Po + LL] 1.2[DL + Eo / Po + WL] 0.9[DL + Eo / Po] + 1.5 WL 1.2[DL + Eo / Po + SL] 0.9[DL + Eo / Po] + 1.5 SL	
TESTING	1.5[DL+ Et / Pt + 25%WL] 1.5 DL + 1.5 Et / Pt	

NOTES:

- 1) Reduce Live load as per IS1893 for seismic load combination.
- 2) Traffic loads shall be considered, where required.
- 3) All building/structures shall be designed to resist worst combination of above loads

5.0 Design Basis:

- a. Framing Systems shall be arranged so that the stiffness of structure can be well balanced and the structural stability can be secured.

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- b. Expansion joints for the structure shall be provided every 40m to 45m in the longitudinal direction.
- c. Structural analysis and section design shall be made in accordance with the applicable codes, standards and specifications and by using the authorized and approved methods.
- d. Minimum Dimensions of members
Member sizes shall be as per Design Requirements. However, minimum dimensions of structural members shall be as given below:

Levelling concrete : 75mm thick

Footings: 300mm thick



Grade slabs : 150mm thick

- e. Minimum Cover to Reinforcement
Reinforcement shall have concrete cover not less than twice the diameter of bar at end. Minimum clear cover to main bar shall be:

Table- 5: Minimum cover to reinforcement

Sr.no	Item	Clear cover to main reinf.		
		TOP	BOTTOM	SIDE
1	Foundation	50	50	50
2	Pile cap	50	100	50
3	Column & pedestal			
	Below ground	-	-	50
	Super structure	-	-	40
4	Plinth beam & grade beam	40	40	40
5	Floor beam	30*	30*	30*
6	Floor slab	30	30	-
	Top deck slab	50	50	50
7	Trench, local foundation, minor platform foundations, sump pit / manhole			
	Face in contact with earth	-	-	25
	Free face	-	-	30*
	Raft	25	25	25
8	Trench cover (precast)	30	30	30
9	Grade slab	50	50	-
10	Paving	50	50	-

* or Dia of bar whichever is greater

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f. Minimum Bar diameter



Major Foundation	: 12mm
Minor Foundation (Local foundation etc.)	: 8mm
Column, Pedestal - Main Bars	: 12mm
Column, Pedestal - Ties	: 8mm
Beam - Main Bars	: 12mm
Beam - Anchor Bars	: 10mm
Beam - Stirrups	: 8mm
Slab - Main Bars	: 10mm
Slab - Distribution Bars	: 8mm
Wall - Main Bars	: 10mm
Wall -Distribution Bars	: 8mm
Minor Elements such as Chajjas, Lintel Beams, etc.	: 8mm

6.0 Allowable Deflection

Maximum deflection in case of RCC Structure for unfactored loads shall be as follows:

Table-6

Load combination	Member	Criteria
All combinations except those including blast load and Seismic Load	Beams & Slab (vertical deflection)	For span to depth ratio refer (IS:456 cl. 23.2.1). L/350 or 20 mm whichever is less.
	Column (Lateral deflection) in case of combination with wind	H/500

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The permissible vertical & lateral deflection for structural steel members shall be as specified below

Table - 7

Sr. No	Description	Limiting deflection
1	Grating / Chequered plate	L / 200 or 6mm whichever is less
2	Beams	L / 300
3	Cantilever Beam	L / 150
4	Lateral deflection of structure under wind loading	H / 200

7.0 Method of Design



Concrete: Limit State Method as per IS 456 : 2000 for general structures. Steel : Limit State method in accordance with IS: 800, 2007

The steel and concrete member design shall be carried out using STAADPro software.

8.0 Design Details

Anchor Bolts

- In case of, no tension loads in the anchor bolts of equipment such as small towers, tanks, heat exchangers, pumps, blowers, compressors, etc. Anchor bolts shall generally be set in anchor boxes unless embedment is required.
- Minimum distance between the inside surfaces of the anchor boxes and the outside surface of the foundation shall be 100mm.
- Clear distance between the edge of the base plate or base frame to the outer edge of the pedestal shall be minimum 50mm.
- In general, anchor bolts for structural steel columns are embedded into the pedestal. Clear distance from the edge of the sleeve or anchor plate to the edge of the pedestal shall be minimum 100mm.
- All anchor bolts shall also be provided with additional lock nut.

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Grouting

- a. Unless otherwise specified by equipment manufacturers, top of foundations except for local foundations shall be provided with an allowance for grouting as specified below:
 - a. Foundation for large heavy duty compressors, generator, etc. : 50mm
 - b. Foundation for big towers (>20m) : 50mm
 - c. Other foundation bases for columns, trusses, etc. : 25mm
- b. Grouting for Anchor bolt pockets & below major equipment base plates shall be done with fosroc conbextra GP2 non-shrink grout having compressive strength (28 days) not less than 400 kg/ cm².
- c. Grouting works below base plates of structural steel column bases & below base plates of roof trusses shall be with fosroc conbextra GP2 non-shrink grout.

9.0 Design Basis for General Civil:

9.1 Scope

This document covers the design philosophy to be adopted for General Civil.



This Design philosophy covers design basis for following types of systems to be provided for this project.

- Roads & Paving
- Fence & Gate
- Storm Water Drains

9.2 Paving

Concrete Paving shall be classified as follows: -

- **Heavy Duty Concrete Paving**
Heavy Duty Concrete Paving shall be provided in areas where movement of heavy maintenance vehicles is expected.
- **Light Duty Concrete Paving**
Light Duty Concrete Paving shall be provided in areas where the access of light vehicles such as cars, pickup trucks and forklifts is expected. 100mm thk paving shall be provided above 200 mm thick compacted sand filling. Subgrade below sand filling shall be well compacted.

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9.3 Gravel Paving

Gravel paving shall consist of 50 mm thick gravel or crushed stone.

9.4 Drainage System

Drainage Classification

The plant drainage system shall consist of the following classification.

Surface Drainage System

Surface drainage system for the proposed plant area/facility shall be designed and constructed to be suitable to completely collect, convey and dispose of the storm water as well as the uncontaminated waste water from the proposed facility with storm water drain trench.

Rectangular drains, pipe culverts, embedded Hume pipes, etc. as required shall be hooked up to existing storm water drain network without any treatment.

9.5 Design Details and Materials

Surface Drains



For storm water drains, the following specification shall be adopted.

- Material of construction– Rectangular drains of R.C.C. (M30) Concrete (for plant area)
- 75 mm thick leveling concrete (1:4:8) to be provided, as base layer.
- Adequate slope to be provided, such that no silting / scouring occur.
- All drains are open type.
- Design minimum freeboard of 100 mm or 15% of water depth of open channel stream, whichever is larger shall generally be kept between the design water surface and top of the channel.

Underground Pipes

Underground pipes shall have a minimum diameter of 150 mm NP2 - Class. Minimum cover over sewer line shall be 600 mm. Under Road Sewer shall be protected by Concrete Encasement and minimum cushion shall be 1200 mm.

- In case if minimum coverage is not kept at road crossing, alternative method like encasing by reinforced concrete around pipe shall be provided with the condition of the strength confirmation by structural calculation.

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9.6 Fence & Gate

Entrance Gate

M.S. Gate of 2250 mm high shall be provided.

Fencing

Galvanised Chain link and barbed wire fencing of 2000 mm high shall be provided around the battery limit.

9.7 Painting : Structural steel



Surface preparation:

The surfaces to be painted shall be sand blasted to Sa - 2.5 as per Swedish Standard SIS 05-59-

00. Air used for sand blasting must be dry and oil free. Sand used for sand blasting shall be good quality river sand suitable for achieving the required surface finish. For optimum results pressure of sand blasting gun should be maintained at around 7 kg/cm² and maximum height of profile should be kept around 50 microns. Sand blasted surfaces must be coated with primer within 4 hrs in dry climate. Moreover it is not advisable to carry out sand blasting when humidity exceeds 85% (RH).

Painting system to be used are indicated below :

Epoxy painting - Primer P 1-2 coats + Finish paint (2 coats) where P1 is epoxy polyamide cured zinc chromate primer having DFT (Dry Film Thickness) of 35 micron and FP1 is epoxy polyamide cured finish paint having DFT of 35 micron per coat.

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PART II: TECHNICAL



SECTION – 10.0

**CONSTRUCTION/ERECTION, PRE-COMMISSIONING,
COMMISSIONING AND START-UP**

**PLANT: NATIONAL FERTILIZERS LIMITED, NFL, NANGAL,
PUNJAB**

**PROJECTS: INSTALLATION OF NEW 2500 CUBIC METER
CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA
ALONG WITH ITS REFRIGERATION SYSTEM
AT NFL, NANGAL**

0	28.12.23	ISSUED FOR NIT	JKY	JKY	RRK
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LIST OF ANNEXURES



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1 General scope of Work and services - Construction/Erection

LSTK CONTRACTOR shall be responsible for construction and erection of the Plant/ Unit including but not limited to the following:



- 1.1 Construction and erection of Plant/Unit and perform all other activities required to be performed for implementation of the WORK.
- 1.2 Provide and supply in due course all construction Equipment and Materials, tools, and temporary facilities necessary for implementation of the WORK.
- 1.3 Establish and operate adequate material control system in site for receipt, unloading, inspection, maintenance, handling, storage and utilization to ensure all Equipment and Materials are preserved and available as necessary for completion of the Plant/Unit.
- 1.4 Provide and supply all staff, tradesmen and labours for implementation of the WORK.
- 1.5 Establishment of overall construction policy and procedures for the Plant/Unit.
- 1.6 Provision of overall management and control of construction phase of the Plant/Unit.
- 1.7 Ensuring that all parts of the Plant/Unit are constructed and tested strictly in accordance with the specifications and applicable codes and standards set forth in the contract.
- 1.8 Ensuring that construction is accomplished in accordance with the schedules.
- 1.9 Provide transportation of all Equipment and Materials to be provided and supplied by LSTK CONTRACTOR under the CONTRACT either from inside or outside to Site.
- 1.10 Construct, operate and maintain all temporary facilities required for its personnel involved in the WORK.
- 1.11 Provide transportation in the area of the Site and between Site and temporary facilities for all its personnel involved in the implementation of the WORK, including field labour, administrative staff, etc.
- 1.12 LSTK CONTRACTOR manages and supervises its Sub Contractors and field labour for the WORK.
- 1.13 Provide liaison with OWNER/PMC, Sub Contractors, Licensors and Vendors to ensure that the Plant/Unit is constructed in accordance with the respective standard and specifications, set forth in the CONTRACT.
- 1.14 Establish with OWNER/PMC adequate procedures, control and reporting systems to provide close control of the progress of the WORK.

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- 1.15 Provision of labour and facilities for loading, unloading and transportation of the Equipment within the site area.
- 1.16 Performance and/or provision of all other works and/or services required for performance of the WORK.
- 1.17 Execution of the whole civil, structural and building works of the Plant/Unit and/or utilities and off-site facilities.
- 1.18 Prefabrication of piping spools in a shop on the Site.
- 1.19 Erection and installation of EQUIPMENT and auxiliary facilities associated with the Plant/Unit.
- 1.20 Erection and field fabrication of structural steelwork, cladding ladders, handrails, stairs and platform of the Plant/Unit and/or utilities and off-site facilities.
- 1.21 Installation of pipe work including field fabrication at site.
- 1.22 Installation and testing of all instrumentation network and equipment of the Plant/Unit.
- 1.23 Installation and testing of electrical system and equipment of the Plant/Unit.
- 1.24 Installation of rubber lining, refractory brick lining & C-Brick lining, FRP/PVC/HDPE lining, as required for the Plant/Unit.
- 1.25 Painting of steelworks, piping, Equipment and building of the Plant/Unit.
- 1.26 Maintenance of construction equipment, vehicles and tackles of the Plant/Unit, during construction and erection period.
- 1.27 Pre-commissioning, Commissioning and Start-up of the Plant/Unit.
- 1.28 Carrying out Mechanical Completion.
- 1.29 Perform all material identification as per application codes and standards.
- 1.30 Provide winterization during construction.
- 1.31 Provide drawings and documents as required.
- 1.32 Supply to OWNER complete test records within three (3) days after completion of actual testing.
- 1.33 Installation and testing of all underground piping, if any.

2.0 General scope of WORK and Services- Pre-commissioning

LSTK CONTRACTOR shall be responsible for the pre-commissioning phase of the Plant.

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LSTK CONTRACTOR shall provide at SITE an adequate number of qualified pre-commissioning engineers to direct and control pre-commissioning activities.

LSTK CONTRACTOR shall also ensure that all special tools and test equipment required for pre-commissioning are to be arranged at its own cost.

LSTK CONTRACTOR shall provide adequate construction labour, construction tools and equipment for pre-commissioning.

Pre-commissioning which shall be performed by LSTK CONTRACTOR shall include, but not limited to the following:

- 2.1 Cleaning, flushing, draining blowing out, steaming out, drying and purging of Equipment and their linings and piping systems, including the installation and removal of temporary blinds, strainers, screens etc., and the replacement of all permanent items removed while the WORK is in progress.
- 2.2 Chemical cleaning wherever required, including but not limited to compressor suction piping and lube and seal oil piping, heaters, supply of chemical and disposal of wastes.
- 2.3. Chemical cleaning of feed water systems, and steam systems. Supply of chemical and disposal of wastes.
- 2.4 Chemical cleaning of any other parts, which have corroded to an extent, which, will detrimentally affect Plant/Unit performance or run length for such reasons as increased fouling due to rust. Supply of chemical and disposal of wastes.
- 2.5 Checking, Testing, calibration simulation test and adjustment of instruments, equipment and systems including control valves and safety devices, installation and checking of orifices plates and other sensor devices in so far as this can be done before actual operation of the item concerns of complete system and loops.
- 2.6 Function test and checking out of electrical systems including substations, transformers, cables and switchgear, checking of all interlocks and setting of all relays. This shall include drying out operations, filtering of oil if required.
- 2.7 For motor driven equipment, amperage checking of motors and removal of temporary safety screens.
- 2.8 Cleaning of screens and filters replacement and adjustment of packing and seals and tightening of flanges.
- 2.9 Introduction of fuels.
- 2.10 Introduction of lubricants and oil flushing for machinery.

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- 2.11 Introduction of chemical into and initial operation of treatment plant.
- 2.12 Boiling out, bringing up to pressure and performing all required code tests on steam generation facilities and associated instrumentation.
- 2.13 Drying out of stacks and all refractory lined equipment.
- 2.14 For all piping systems, installation and removal of temporary blinds as required, circulation and commissioning of systems including process systems, services, effluent and drainage, utilities distribution, relief and blow down and interconnecting lines.
- 2.15 Test running of all other rotating equipment for 24 hours wherever possible.
- 2.16 Adjustment of all piping expansion and support devices.
- 2.17 Air-drying of Plant/Unit, which is required to be water-free.
- 2.18 Testing (including running, tightness and vacuum) of systems, as necessary to ensure that the sections and components of Plant/Unit are ready for operation.
- 2.19 All such further works which LSTK CONTRACTOR judges to be necessary or in the reasonable opinion of OWNER is necessary to bring the Plant/Unit to a state of readiness for the introduction of feedstock into Process Plant/Unit for processing requirements and for safe commencement of operation.

3.0 Basic Plan for Temporary Services

Temporary Construction Facilities

The LSTK CONTRACTOR shall arrange following facilities at his own cost for Construction/Erection purpose. Demolition and cleaning of temporary facilities developed for construction purpose shall also be under LSTK Contractor's scope.

1. 1 No. 11 kV or 3.3 KV or 415 V Feeder depending upon temporary load requirement at Existing Substation shall be made available. Tapping of Construction Power (Free of Cost) from this feeder (including supply & erection of all required materials like structural supports for cable tray, cable trays, power cables, control cables, protection & metering, cable termination etc. as well as underground cabling work) and further distribution shall be in LSTK Contractor's scope. LSTK Contractor shall arrange emergency power (suitably rated DG set) at his own cost during construction to ensure safety of personnel at site during power failure.
2. Construction Water shall be made available at single point without any cost.
3. Construction sheds

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4. Construction offices
5. Temporary Communication facilities
6. Office furniture
7. Labour colony during construction outside OWNER premise.

3.1 Sewage & Refuse Disposal

All temporary building like site office, canteen etc. shall be provided with individual septic tanks and soak pits for treatment and disposal of sanitary sewers. Construction site shall be provided with a network of temporary drain for disposal of rain water.

4.0 Mechanical Completion

Mechanical Completion means the time when all construction, erection & installation work per finally approved P&ID after HAZOP study and pre-commissioning related to the Plant is completed in accordance with the Project drawings and specifications, and all mechanical and pressure tests, including but not limited to hydro-testing, non-operating adjustments, cold alignment checks, final cleanup, hot bolting, refractory drying, field calibration of safety valves, calibration of all instruments, instrument loop checking and testing, monitoring / control / safety systems checking and testing, and all pre-commissioning activities have been completed, all incoming & outgoing services and utilities have been connected to each unit of the PLANT, interconnections of process lines and interconnection are completed and the Plant/Unit is ready in every respect for commissioning and for the first introduction of feed materials.

When OWNER is satisfied that Mechanical Completion of the plant has been achieved, OWNER shall issue certificate of Mechanical Completion to LSTK CONTRACTOR in accordance with the CONTRACT for Owner's Approval.

In order to meet this, LSTK CONTRACTOR shall perform all necessary mechanical works, tests and checks.

5.0 COMMISSIONING



5.1 Schedule for Commissioning

LSTK CONTRACTOR shall prepare a schedule for commissioning, start-up, and performance testing and initial operation in conjunction with OWNER. This shall be issued at least three months before pre commissioning of the first facility.

This schedule shall include all activities as detailed herein and any other special activities, which require to be performed during commissioning.

5.2 Commissioning

LSTK CONTRACTOR shall be responsible to perform commissioning of the Plants and to provide necessary facilities during commissioning of the Plant including the Performance Tests. LSTK CONTRACTOR shall provide commissioning engineers

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and supporting staff and adequate commissioning labour. LSTK Contractor shall associate OWNER's engineers and operating staff with the commissioning work.

6.0 START UP

LSTK CONTRACTOR shall be responsible to perform start-up of the Plant/Unit. LSTK CONTRACTOR shall provide necessary facilities and for Start Up of the PLANT.

NOTE:

Detail CONTRACTOR'S scope of work in relation with the construction / erection, and pre-commissioning, commissioning and start-up from the point of scope of execution as well as performing way are described in detail in the following Sub-Annexes of Section-7.0.

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Sub-Annexure:



Annex 7 - 1 : LSTK Contractor's Work Definition

Annex 7 - 2 : Detail Technical Scope

Annex 7 - 3 : Quality Control Procedures and Inspection Requirement

Annex 7 - 4 : Schedule Progress Evaluation and Progress Reporting

Annex 7 - 5 : General Notes

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ANNEXURE-7-1



LSTK CONTRACTOR'S WORK DEFINITION

LSTK CONTRACTOR shall perform/provide the following activities but not limited to:

1. LSTK CONTRACTOR scope of work shall broadly consist of construction / erection, refurbishing, pre-commissioning, commissioning and Start Up of the Plant under the management of commissioning team it includes but not limited to civil works, fabrication & erection of structural steelwork, field assembly, mechanical erection and / or assembly and installation of all equipment and machinery, piping, electrical systems and network, instrumentation, insulation, painting, etc., except in so far as "Contract" otherwise provides, the provision of all temporary facilities, staff, tradesmen, labour, tools, tackle, construction equipment and materials, insurance, consumables and everything whether of temporary or permanent nature necessary and required in and for the work, so far as the necessity for providing the same is specified or reasonably inferred in or from the contract.
2. Perform all civil and building works as per Annex7 - 2A, titled civil and building works.
3. Perform all structural steel works as per Annex 7 - 2B, titled structural steelwork.
4. Perform all piping fabrication and erection works as per Annex7 - 2C, titled piping fabrication and erection work.
5. Perform all equipment erection works as per Annex 7 - 2D, titled equipment erection work.
6. Perform all electrical works as per Annex7 - 2E, titled electrical work.
7. Perform all instrumentation works as per Annex 7 - 2F, titled instrumentation works.
8. Perform all insulation works as per Annex 7 - 2G, titled insulation works.
9. Perform all painting works as per Annex 7 - 2H, titled painting Specification/work.



Supply the materials in order to execute WORK as per CONTRACT.
10. LSTK CONTRACTOR shall be responsible for providing services and materials for construction of all temporary facilities, which are essential for successful completion of construction and erection.

The LSTK CONTRACTOR shall establish, operate and maintain all temporary facilities, such



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as, but not limits to:

- a) Labour camp/officers camps
 - b) Fabrication shops/yard
 - c) Workshop for maintenance of construction/testing equipment.
 - d) Field drawing office
 - e) Temporary warehouses, including open storage yards.
 - f) Construction offices (including facilities for photocopying, drawing reproduction, etc.)
 - g) First aid.
 - h) Lab facilities, including NDT, for testing calibration, etc.
 - i) All temporary or approach roads for carrying out the WORK including temporary approach roads for access to LSTK CONTRACTOR'S site office/workshop/camp, etc. ground preparation for heavy lifts including approaches to cranes for heavy lifts. OWNER does not take any responsibility for making temporary roads.
 - j) Canteen & catering facilities for all LSTK CONTRACTOR'S work force.
 - k) All drainage around the facilities created for his WORK, and sewage disposal arrangements for labour camps/officers camps, site offices, etc.
 - l) Necessary transport for movement of its personnel, construction Equipment and Materials, consumables, etc.
 - n) Watering of roads through water tankers for dust suppression.
 - o) All temporary lighting for working during night.
 - p) All temporary hutments, sanitary & potable water and domestic sewerage requirements of LSTK Contractor's work force.
11. Supply to OWNER complete survey report within three (3) working days after completion of any survey.
 12. All excess soil shall be disposed of by LSTK CONTRACTOR outside the premises in a location designated by OWNER representative.
 13. Perform all nondestructive, hydrostatic and pre commissioning testing required.

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14. Supply to OWNER complete test records within three (3) days after completion of actual testing.
15. Perform all welding including radiography required.
16. Provide drawings and documents as required.
17. Provide mobilization and demobilization, temporary material and temporary facilities and utilities required for executing work.
18. Provide winterization during construction, if required.
19. Provide scheduling, planning and reporting as per CONTRACT.
20. Keep complete administration and control of work, specified in CONTRACT.
21. Provide maintenance on all construction and permanent plant material as required during the CONTRACT period.
22. Perform all material identifications as per CONTRACT.
23. Perform all transportations as required.
24. Perform quality assurance, control and supply quality control documentation.
25. Perform all pre-commissioning activities as defined in the CONTRACT.
26. Provide and supply all procedures for execution of the work in accordance with drawings specifications, and applicable codes and standards.
27. Perform all other works and activities and supply all other materials which are required for completeness of the Work either mentioned in the CONTRACT or they are necessary for completeness of the Work, in compliance with highest available standards and good quality.



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ANNEXURE- 7 - 2

DETAIL TECHNICAL SCOPE

See accompanying by discipline

Annexure-7 - 2A	Civil and Building work
Annexure-7 - 2B	Structural steel work
Annexure-7 - 2C	Pipe prefabrication and Erection
Annexure-7 - 2D	Equipment erection
Annexure-7 - 2E	Electrical work
Annexure-7 - 2F	Instrumentation work
Annexure-7 - 2G	Insulation work
Annexure-7- 2H	Painting work (For detail refer TS-2001)

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ANNEXURE- 7 - 2A

CIVIL AND BUILDING WORK

1.0 SURVEYING

1.1 Base line and base elevation will be furnished to LSTK CONTRACTOR. LSTK CONTRACTOR will furnish all surveys from this base line and elevation.

1.2 OWNER shall have the authority at anytime to determine, in accordance with the drawings or written directives, the correctness on completeness of the lines in use by LSTK CONTRACTOR.

1.3 Any erroneous WORK shall be corrected to OWNER'S satisfaction at LSTK CONTRACTOR'S expense.

2.0 SITE

Finish grading elevation to be as shown on drawing.

LSTK CONTRACTOR'S access to the WORK areas shall be via existing roads.

Any other roads required by LSTK CONTRACTOR are to be developed by LSTK CONTRACTOR.

3.0 EXCAVATION AND BACKFILL

3.1 Excavation

- Provide all excavation by machine or by hand according to the specifications.
- Excavation is to be executed by LSTK CONTRACTOR in a manner that will provide adequate space for performance, inspection and timely completion of the WORK. Supply dewatering as required. The method of dewatering shall be subject to Approval by OWNER.
- Temporary water drainage routing requires prior Approval by OWNER.



3.2 Backfill

All backfills shall be according to the specifications.

All excavations shall be kept dry and workable prior to and during backfiring and compacting.

Material that LSTK CONTRACTOR excavates in the course of WORK and which can be used for backfill, must be approved by OWNER prior to use. All other backfill material as required in this scope of work, drawings and specifications, shall be supplied by LSTK CONTRACTOR.

Back filling shall be to ground level as shown on drawing. The placing of backfill may only

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start after approval by OWNER.

LSTK CONTRACTOR will inform OWNER to arrange for the required proctor tests. Tests shall be done by OWNER on his account.

4.0 **PILES AND CONCRETE FOUNDATIONS**

4.1 Install Piles and major and minor concrete foundations in accordance with the specification and drawings.

4.2 **Blinding to Underside Foundation Work**

Prior to placing a blinding layer of concrete, LSTK CONTRACTOR shall supply, place, compact and prepare the surface of excavated area. After this LSTK CONTRACTOR shall supply a blinding layer of concrete. Blinding layer to be in accordance with specifications and / or drawings.

4.3 **Reinforcement of Concrete**

Cut and bend to bar bending schedules, all type of reinforcing bars.

Store and protect all reinforcing bars against corrosion and any other deleterious effects prior to placing.

Installation of reinforcement including installation of spacers, supports, tying, wire in accordance with the specifications and drawings.

4.4 **Anchor Bolts**

Install all anchor bolts, in accordance with the specifications and drawings.



The following WORK is included but not limited to LSTK CONTRACTOR'S scope for installation of anchor bolts:

- Deliver of all templates.
- Store and protect against corrosion and any other deleterious effects.
- Place anchor bolts accurately in formwork or by templates, if required, or in pockets.
- Clean and grease anchor bolts threads after Concrete pour and protect bolts after greasing with plastic covers.

4.5 **Inserted and Embedded Item**

Install all concrete inserts and embedded items, including but not limited to the following items in accordance with the specifications and to the detail drawings to be furnished by LSTK CONTRACTOR.

- Cement - In sockets.
- Cinch anchors.

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- Steel sleeves, various size angle.
- Channel shapes with anchors. Curb angles and steel plates.
- Anchor rails.
- Pipe sleeves of heavy duty PVC pipe.



The WORK shall include but not limited to:

Store and protect against corrosion and damage place accurately in Formwork or by templates, if required, or by temporary bars for proper positioning.

4.6 The following WORK is included but not limited to LSTK CONTRACTOR'S scope for installation of major and minor foundations:

- All excavation, including sheet piling, if required, backfill, compacting and the transportation of surplus material, neatly stockpiled at a location, chosen by LSTK CONTRACTOR and approved by OWNER. The supply, installation and maintenance of a complete concrete batch plant, including concrete testing laboratory. Installation of selected backfill material, if required. Supply and delivery and installation of all formwork, assembly and disassembly of all reusable formwork, inclusive if any and all required supporting, bracing, pockets, cutouts, recesses, etc.
- Bending and installation of concrete reinforcement bars to the requirements and supply of items as defined in 4.3 above.
- Installation of all anchor bolts (including fabrication of templates), to the requirements and supply of items as defined in 4.4 above.
- Installation of embedded and inserted items, to the requirements and supply of items as defined in 4.5 above.
- Installation of construction and expansion joints where required.
- Mixing, delivery and pouring of concrete in accordance with specifications. Stripping of formwork and removal of all surplus material to LSTK CONTRACTOR'S yard or locations designated by OWNER.
- All temporary storage of formwork at SITE shall be of an orderly nature. In case storage does not comply with the above-mentioned rule, OWNER shall have the right to remove formwork from SITE within forty eight (48) hours after first warning and back charge LSTK CONTRACTOR for all related costs. OWNER shall not be held responsible for any of LSTK CONTRACTOR'S losses.
- The finishing of concrete, where required to a finish in compliance with the specifications.

A copy of all-concrete mix truck delivery slips if applicable.

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Concrete composition analysis of the concrete batch plant.

All scaffolding required.

All required dewatering to keep the excavations / backfill dry for the WORK.

5.0 **CONCRETE STRUCTURES AND ELEVATED SLABS**

Install concrete structures, in accordance with the specifications and drawings.

6.0 The following work is included but not limited to LSTK CONTRACTOR'S scope for installation of concrete elevated slabs:

See 4.6; however with -following exceptions: No-excavation, no backfill and- no dewater

7.0 **YARD PAVING AND FINAL SURFACING**



7.1 **Excavation**

Setting out and grading by machine and/or by hand for yard paving to the shape and depth in accordance with the specifications and drawings.

Disposal of all excavated material and neatly stock piling to a location chosen by LSTK CONTRACTOR and approved by OWNER.

7.2 **Concrete Yard Paving**

- Mix and install concrete for heavy duty paving areas, in accordance with the specifications and drawings.
- Mix and install concrete for light and medium duty paving areas in accordance with the specifications and drawings.
- The following work is included but not limited to LSTK CONTRACTORS scope for installation of concrete yard paving: See 4.6 above
- Surface preparation, including the supply and placing of waterproof building paper or similar waterproof material, well lapped at joints, laid on top of the well compacted sand layer and before pouring concrete.
- Reinforcement for heavy duty paving at top and bottom face and for light duty paving at top face only, with square mesh fabric reinforcement including protection against corrosion, the cutting, the bending and placement.
- Mixing and pouring of concrete in accordance with specifications, sufficient vibrating. Stopping clear from bases, plinths and piers and forming around surface and lay to give levels and falls.
- Installation of construction / expansion joints.

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7.3 Unpaved Areas

Install gravel, tiles or crushed stone on leveled unpaved areas, all in accordance with the specifications and drawings.

7.4 Concrete Tiles for Walkways

Install well compacted sub-base layer and install the tiles on the sub-base all in accordance with specifications and drawings.

8.0 CONCRETE PIPE SLEEPERS

Fabricate and install reinforced concrete sleepers for pipe, complete with foundations in accordance with the specifications and drawings.

9.0 MANHOLES AND CATCH BASINS, TRENCHES

9.1 Fabricate and install pre-cast or formed and poured in situ concrete manholes and catch basins and trenches in accordance with the specifications and drawings.

9.2 The following work is included but not limited to LSTK CONTRACTOR'S scope for installation of manholes and catch basins. All excavation including sheet piling of required, backfill, compacting and the transportation of surplus material, neatly stockpiled at a location, designated by LSTK CONTRACTOR and approved by OWNER.



For Poured in Site

- Delivery and installation of all formwork, inclusive if any and all required supporting, bracings, pockets, cutouts recesses etc.
- Bending and installation of concrete reinforcement bars to the requirements and supply of items as defined in 4.3 above.
- Fabrication and installation of embedded and inserted items, if any, to the requirements and supply of items as defined in 4.5 above.
- Mixing and pouring of concrete in accordance with specifications.
- Stripping of formwork and removal of all surplus material to LSTK CONTRACTOR'S yard or locations designated by OWNER.
- All required dewatering to keep the excavations / backfill dry for installation work.
- Install cast - iron manhole frames and solid cover and fabricate and install steelwork catch basin grating and frames in accordance with specifications.

10.0 COLLECTION BASINS, PITS, SUMPS, RETAINING WALLS AND CULVERTS

10.1 Fabricate and install concrete collecting basins in accordance with the specifications and drawings.

10.2 Fabricate and install concrete sumps and pits in accordance with the specifications and drawings.

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10.3 Fabricate and install concrete walls around tanks and other retaining walls in accordance with the specifications and drawings.

10.4 Fabricate and install concrete pipe and bridge culverts including head walls in accordance with the specifications and drawings.

11.0 **DITCHES AND TRENCHES**

11.1 Fabricate and install earthen and concrete ditches and trenches including connection pipes and boxes in accordance with the specifications and drawings.

12.0 **STEEL SLIDING PLATES AND PTFE SLIDING PLATES**

12.1 **Steel Sliding Plates**

- Fabricate and install steel sliding plates in accordance with specifications and drawings.
- The following work is included, but not limited to LSTK CONTRACTOR'S scope for fabrication and installation of steel sliding plates
- Pick up materials, storage and protection against corrosion and any other deleterious effects.
- Fabricate, place in pockets, level and grout, protect against possible damage and corrosion.

12.2 **PTFE Sliding Plates**

- Install sliding plates, in accordance with the specification and drawings.

The following work is included but not limited to LSTK CONTRACTOR'S scope for installation of sliding plates pick up materials, transport, store and protect

- Place in pockets, level and grout, protect against possible damage.



13.0 **GROUTING**

13.1 Mix and install grouting in accordance with the specifications and drawings.

13.2 LSTK CONTRACTOR shall grout under all structural steel columns and under all equipments, as specified.

13.3 The following work is included but not limited to LSTK CONTRACTOR'S scope for installation of grouting:

- Prepare top surface of base and /or plinth, pockets, sleeves etc., prior to placing grout.
- Mix and install grout mortar in accordance with specifications.

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- Grout mortar shall be used between steel base plate and concrete foundations.
- Mix and install non-shrink grout between reciprocating rotary equipment base frame including the filling of the equipment steel frame, if required, and concrete foundation in accordance with manufacturer specifications and project specifications.

13.4 Grouting of equipment shall proceed only when equipment setting has been accepted by OWNER.

14.0 **ASPHALT PAVING**

14.1 Mix and install asphalt paving over base courses installed by LSTK CONTRACTOR, in accordance with the specifications and drawings.

- Roads/ Driveways/ Parking areas/ Sidewalks/ Tank pads



14.2 The following work is included but not limited CONTRACOR'S scope for installation of asphalt paving to.

- Installation of all materials necessary to make a complete installation.
- Installation of sub-grade, sub-base and base courses all properly compacted.
- Delivery and installation of all formwork, inclusive if any and all required supporting, bracing, pockets, cutouts, recesses, etc.
- Installation of expansion joints where required and/or construction joints
- Stripping of formwork and removal of all surplus material to LSTK CONTRACTOR'S yard or locations designated by OWNER.
- Mixing, delivery, installation, spreading and compaction of asphalt paving mixture in accordance with specifications.
- Any and all measures for proper asphalt paving installation and curing.

15.0 **ROAD REPAIR AND MAINTENANCE**

15.1 Supply and deliver necessary materials, equipments and labour to repair and maintain all plant roads, as necessary.

- Repair work shall be in accordance with the specifications.
- LSTK CONTRACTOR shall be responsible for repair of roads, all on the indication of OWNER due to the damage to the roads, caused by LSTK CONTRACTOR'S activities and construction operations, or due to faulty construction by LSTK CONTRACTOR. LSTK

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CONTRACTOR is not entitled for compensation for such repair work.

16.0 REPAIR OF DYKES, SLOPES AND DITCHES

16.1 Supply and deliver necessary materials, equipment and labour to effect repairs on dykes, slopes and ditches as necessary.



- Repair WORK shall be in accordance with the specifications.
- LSTK CONTRACTOR shall be responsible for repair of dykes, slopes and ditches all on the indication of OWNER'S representative, due to damage to the dykes, slopes and ditches caused by LSTK CONTRACTOR'S activities and construction operations, or due to faulty construction by LSTK CONTRACTOR.
- LSTK CONTRACTOR is not entitled for compensation for such repair work.

17.0 UNDERGROUND SEWERS AND PIPING SYSTEMS

17.1 Install the underground piping systems, in accordance with the specifications and drawings.

17.2 The following work is included but not limited to LSTK CONTRACTOR'S scope for installation of underground piping systems.

- Excavation including sheet piling, if required, backfill, compacting and the transportation of surplus material, neatly stockpiled at a location designated by LSTK CONTRACTOR and approved by OWNER.
- Installation of sand backfill if required
- Receiving unload, inspect and transport LSTK CONTRACTOR'S supplied materials and store and protect.
- Installation of piping materials necessary for a complete installation.
- The installation of above ground fire hydrants, fire monitors and standpipe as well as the underground firewater system.
- The fabrication and installation of supports and thrust blocks for the piping as required.
- Surface preparations and installation of coating and wrapping of the underground piping, if required as per Technical specification Mentioned in **Annexure- 7 - 2C**
- Installation of glass fiber reinforced epoxy piping in accordance with manufacturer's instructions as well as the specifications.
- Hydrostatic pressure testing of the underground piping systems including test apparatus,

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test piping, test blinds, bolts and gaskets in accordance with the specifications.



17.3 **Hydro Testing of Sewers and Underground Lines**

- Tests all sewers and underground piping systems as per test instructions. Testing is to be witnessed and approved by OWNER. A test schedule by test system shall be prepared by LSTK CONTRACTOR. Testing and completion shall be in accordance with project system priorities.
- Piping systems shall be tested with suitable water.
- Develop test system procedures and follow priorities established by OWNER. LSTK CONTRACTOR shall prepare detailed schedules based on this data for submittal to OWNER for his approval.
- The water for testing purposes is to be provided by LSTK CONTRACTOR.
- Inexpensive temporary gaskets shall be used in place of permanent gaskets where test blinds are located for hydrostatic testing. On successful completion of a test, the permanent gasket shall be installed when the blinds are removed.
- After hydro testing, LSTK CONTRACTOR shall perform the following activities:
 - Flushing
 - Remove temporary blinds
 - Install permanent gaskets.
 - Flange connection bolts tightened.
 - Coat and wrap welds.
 - Holiday testing and coating repairs.
 - Backfill and compaction.



18.0 **CIVIL PART FOR UNDERGROUND ELECTRICAL GROUNDING SYSTEM**

- 18.1 Excavation of the routing for the direct buried cables, for the road crossing and for the branch conduit and sleeves in accordance with layout and detail drawings.
- 18.2 Transport of the excavated soil, neatly stockpiled to location chosen by LSTK CONTRACTOR and approved by OWNER.
- 18.3 Installation of all protection conduits and installation materials in accordance with the specification, and design and detail drawings.
- 18.4 Transport of excavated soil and backfill including compacting of the round up to finished plant level.

19.0 **CIVIL PART FOR UNDERGROUND CABLE TRENCHES (AND CABLE) CIVIL PART**

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- 19.1 Excavation of the routing for the concrete cable trenches for the direct buried cables, for the crossings and for the branch conduit and pipe sleeves by machine or by hand as dictated by local conditions.
- 19.2 Transport the excavated soil, properly stockpiled to a location off chosen by LSTK CONTRACTOR and approved by OWNER.
- 19.3 Installation of the concrete cable trenches in accordance with the specification and the design and detail drawings.
- 19.4 For scope of installation of concrete cable trenches see item 11.
- 19.5 Installation of the road culverts, protection sleeves and cable ducts at road crossing in accordance with layout and detail drawings. For scope of installation see item 10
- 19.6 Transport of the excavated soil and backfill of the surrounding area of the concrete trenches up to finished plant level.
- 19.7 Transport of the excavated soil and backfill of road crossing up to road including the supply and installation of the repair of the paving and / or asphalt road covering.
- 19.8 Transport and backfill of the trenches with a layer of clean sand, free from stones equalized up to the bottom level of the first (bottom) cable layer.
- 19.9 Transport and backfill of the layer of clean sand between cable. Layers and above top cable layer.
- 19.10 Transport of excavated soil and backfill including compacting of the ground up to the layer of concrete tiles or trench covers.
- 19.11 Installation of the cable protection covers and/or trench covers and /or cable routing colored marking tape.
- 19.12 Transport of the excavated soil and backfill including compacting of the ground above the layer of concrete tiles up to finished plant level.
- 19.13 Installation of the cable route designated, trench markers.
- 20.0 **STORAGE TANK PADS AND DYKES**
- 20.1 Install tank pads as specified and as quantified on the specifications and drawings.
- 20.2 Install tank dykes and ramps as specified and as quantified on the specifications and drawings.

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20.3 Install impervious clay layer inside the dyked tankage areas in accordance with specifications and drawings.

21.0 **PERMANENT PLANT FENCING**

21.1 Install permanent plant fencing, including personnel gates and truck gates as located, specified and quantified in the specifications and drawings.

22.0 **SCAFFOLDING**

22.1 Supply and erect all scaffolding for WORK.

22.2 Scaffolding shall be supplied, erected and maintained in strict accordance with local and governmental regulations as well as OWNER'S safety requirements. If there are conflicts, the more stringent shall prevail.

LSTK CONTRACTOR shall dismantle all its scaffolding at the completion of its WORK.

23.0 **TESTING**

23.1 All necessary tests in order to control the quality of the field works shall be done and all such test certificates should be kept in record, such as but not limited to

- Soil compaction tests.
- Concrete testing
- Asphalt testing
- Reinforcing bars testing

23.2 If any test fails LSTK CONTRACTOR shall replace those items, which do not meet the requirements.

All costs for replacements shall be borne by LSTK CONTRACTOR.



24.0 **WELDING PROCEDURES SPECIFICATIONS AND WELDING PROCEDURE QUALIFICATION RECORDS**

24.1 Provide within two months before starting the construction execution, its welding procedures (for A.G, U.G piping and any structural steel) for comment and approval. Approval of welding procedures by OWNER is required before the start of welding.

24.2 Prior to start of filed welding LSTK CONTRACTOR shall submit one (1) copy of all welders' qualification paper and applicable welding procedures approved and stamped by regulating authorities to OWNER.

25.0 **DRAWINGS AND DOCUMENTS**

25.1 LSTK CONTRACTOR will carry out all construction activities directly from the AFC construction drawings and specifications.

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25.2 LSTK CONTRACTOR shall submit reports of each test or inspection within three (3) days after actual test or inspection. Failure to comply with the above rule may result in OWNER arranging for additional tests or inspections. Costs of which will be back charged to LSTK CONTRACTOR.

25.3 LSTK CONTRACTOR shall submit material certificates and quality records of the materials, as specified in previous sections and the applicable engineering specifications and standards.

25.4 LSTK CONTRACTOR shall also furnish a concrete installation record within two (2) weeks after completion of the WORK indicating, date of installation and quantity of concrete of each foundations, floor slab, elevated slab, frames, columns, etc.

This concrete installation record shall also show a reference with the concrete compression test certificates of the respective concrete pours and the concrete delivery slip numbers.

Failure to comply with the above time may result in the preparation of the documents by OWNER in which case all related costs will be back charged to LSTK CONTRACTOR.

26.0 **MISCELLANEOUS**

26.1 LSTK CONTRACTOR shall be fully responsible for the correct and accurate setting out of all elevations, positions, dimensions, alignments, profiles. etc, of all parts of the WORK and for the provision of all necessary instruments, appliances and labour in connection therewith The checking of any such matter by OWNER shall not relieve LSTK CONTRACTOR of its responsibility for the correctness thereof.

26.2 If during the construction or maintenance of WORK, any error is discovered in WORK, LSTK CONTRACTOR shall at its own cost rectify such error to the satisfaction of OWNER. LSTK CONTRACTOR shall in such case take all necessary actions such as overtime, etc. in order not to endanger the agreed upon time schedule.



26.3 All dimensions shown on the plans and drawings are given in the SI system, unless otherwise stated.

26.4 All costs for setting out the earthwork and for assisting OWNER in checking the various points, lines, levels, profiles, etc. shall be deemed to be included in the price.

26.5 LSTK CONTRACTOR shall under no circumstances extend its operations outside the limits of the area appropriated for WORK. LSTK CONTRACTOR will ensure that its operations shall not interfere in any way with properties of others.



26.6 No excavation work shall be started before the exact positions of the WORK have been marked by means of stakes controlled and approved by OWNER.

26.7 OWNER shall notify LSTK CONTRACTOR of all known existing underground pipes, cables,

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drains, manholes, etc, in current use, together with the approximate locations and hazards involved and LSTK CONTRACTOR shall ensure that they will not be broken or damaged in any way by the execution of WORK. Hand labour shall be used for excavation within a horizontal distance of 1.5 meters from existing utilities.

- 26.8 Any damage as referred to above at 26.7 shall be reported by LSTK CONTRACTOR. LSTK CONTRACTOR shall repair the damage.
- 26.9 The discovery of any unregistered pipes, drains, cables, etc., shall be promptly reported to and dealt with as directed by OWNER. Excavation, as required to determine the exact location of existing underground pipes, drains, cables etc. shall be considered as a part of WORK.
- 26.10 LSTK CONTRACTOR shall take precautions i.e. mats, lining with timber, etc. not to cause damage to permanent plant roads curbing and sidewalks with its construction equipment.
- 26.11 LSTK CONTRACTOR shall provide and be responsible for the construction of all temporary dewatering. Drainage, sheet piling, timbering etc. to ensure the stability of slopes, trenches, embankments, etc. during excavation work and that all areas are adequately drained to the satisfaction of OWNER.
- 26.12 LSTK CONTRACTOR is responsible for all soil slides that may occur during the execution of the WORK and for any detrimental effect of the same. LSTK CONTRACTOR shall as directed by OWNER either correct or repair the damage to the satisfaction of OWNER at its own expense or pay for the cost of repair by others of all damage caused to the WORK or adjacent property. No additional payments shall be made to LSTK CONTRACTOR to compensate the financial consequences of soil slides.
- 26.13 Collapse, cave-in, or movement of excavations, trenches, or the like shall be the responsibility of LSTK CONTRACTOR. LSTK CONTRACTOR acknowledges this responsibility and instructions of the OWNER.
- 26.14 Trenches, excavations, and the like shall be maintained in strict accordance with the requirements of the applicable national and local regulations.
- 26.15 LSTK CONTRACTOR shall be held entirely responsible for any effect or damage, which the execution of any of the earthwork may have upon, or which may be caused to any portion of WORK or any of the surrounding property.
- 26.16 Excavation will proceed until all unsuitable material is removed.
- 26.17 LSTK CONTRACTOR is responsible for the excavation required to installing bottom of footings at elevations as shown on drawings. The removal of a poor soil below the intended bottom of excavation is included in the CONTRACT. Any unnecessary over excavation will be in LSTK CONTRACTOR'S account.
- 26.18 Backfill shall be to the elevation shown on the approved drawings or as directed in writing

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by OWNER.

- 26.19 Special care must be taken in compaction operations over underground pipelines.
- 26.20 LSTK CONTRACTOR shall furnish all field engineering, surveying, layout, and checking to properly install all foundations to meet all requirements of the drawings and specifications, on completion of each foundation LSTK CONTRACTOR shall mark all foundations with a clear center line, locating both North, South, East and West and a bench elevation mark. LSTK CONTRACTOR shall stencil or by other means, paint equipment and column designation and coordinates, to all foundations installed by LSTK CONTRACTOR. All markings shall be located above high point of paving. These markings shall be preserved for use by others.
- 26.21 LSTK CONTRACTOR shall design concrete mix specification and furnish by means of reports from OWNER'S laboratory, proof that the materials and mixes for concrete conform to the specifications and codes prior to pouring the first concrete on SITE. LSTK CONTRACTOR shall furnish all field labour to make concrete tests and fill cubes quality of concrete aggregates and mix design will be checked by OWNER'S laboratory regularly.
- 26.22 All aboveground concrete for supports for steel structures must be smooth finished, and exposed edges of concrete to have a chamfer.
- The top of the foundations shall be poured so as to ensure true surfaces and designated slopes in all cases. LSTK CONTRACTOR is to avoid damage or movement of already installed reinforcement and/or other structures, formwork, etc., when pouring concrete.
- 26.23 All concrete pours for a given element must be monolithic, except where noted on the drawing or approved by OWNER.
- 25.24 If pouring cannot be finished within normal working hours, necessary actions shall be taken, sufficiently in advance for requesting permits for overtime. All pouring must be continued until the element is complete. OWNER shall be informed at least twenty-four (24) hours in advance.
- 26.25 Damaged formwork must be repaired in such a way as not to mark the concrete finish. All formwork must be braced adequately and be of a rigid construction. Gravel nests, surfaces crack, honeycombs, etc., and shall be repaired to the satisfaction of OWNER.
- 26.26 LSTK CONTRACTOR shall use immersion-vibrating equipment but it needs to be of a type approved by OWNER prior and also during use. Vibration of formwork and fresh concrete WORK is not allowed. OWNER will have the right to require replacement of inadequate during all phases of the WORK. A must condition shall be maintained after pouring as set forth in specifications. The WORK involved in this is to be included in the pricing.
- 26.27 OWNER reserve the rights to reject any WORK already poured which is not in accordance with drawing and specifications and of adequate quality.

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Serious inclusions appearing in concrete shall be reason for the rejection of WORK and LSTK CONTRACTOR requested to repair or replace at his own expense.

- 26.28 All costs involved in demolition, removal and replacement of rejected WORKS shall be the responsibility of LSTK CONTRACTOR all materials, equipment or auxiliaries not accepted by OWNER shall be removed immediately from the OWNER'S property.
- 26.29 Ready - mixed concrete shall be delivered without segregation. The concrete batch plant has to be approved by OWNER. Small quantities of concrete may be made at SITE after approval of OWNER.
- 26.30 The pouring of any reinforced concrete may only start after having obtained Approval of OWNER.
- 26.31 LSTK CONTRACTOR shall provide, during the period of this CONTRACT, temporary drainage ditches in WORK so that water will not be pended and so that all areas are adequately drained to the satisfaction of OWNER.
- 26.32 LSTK CONTRACTOR shall provide, during the period of this WORK, systems for the dewatering of all its WORK areas as required to properly execute the WORK. All dewatering methods shall be subject to the approval of OWNER.
- 26.33 All excavated boulders will be removed from SITE by LSTK CONTRACTOR.
- 26.34 Manholes are to be marked with M.H. Number.
- 26.35 Underground service lines have to be marked at their installation limits to aboveground piping, indicating line size, and service and line number.
- 26.36 Prefabricated concrete -items are to - be marked with date of fabrication, size, Length, identification code and installation north arrow.
- 27.0 **BUILDINGS**
- 27.1 LSTK CONTRACTOR shall do the construction of the buildings, including all activities and installations as specified, in drawing and specifications including the fabrication of all items that are not standard hardware components.
- 28.0 Quality of all civil and building materials shall be approved by OWNER before usage in the PLANT.

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ANNEXURE- 7-2B

STRUCTURAL STEELWORK



1. Delivery of all materials and fabricated structural steel to SITE, including all required transport, storage, intermediate storage, etc., including loading and unloading of materials.
2. LSTK CONTRACTOR will carry out all construction from the AFC construction / erection drawings and specifications.
3. LSTK CONTRACTOR shall be held entirely responsible for any effect or damage, which the erection of the structural steel may have upon, or which may be caused to any portion of WORK or any of the surrounding property.

4. **Erect Structural Steel-Structure Frames**

This item covers all activities required to erect prefabricated structural steel framing for single and multilevel structures.

It includes, but is not limited to, the following:

- ◆ Provision of all tools, equipment and consumables used in the course of the work.
- ◆ Shimming of foundations and joints.
- ◆ Erecting.
- ◆ Cutting, drilling, welding and bolting to achieve fitment.
- ◆ Rectification required, if any.
- ◆ Final levelling, aligning and bolting (including torquing).
- ◆ Grouting of components and areas supplied unpainted or requiring finish coats, as per specifications.
- ◆ Touch up painting of damaged areas.
- ◆ Also included in this item are all clips plates, stiffeners, gussets, and connection material supplied loose for field installation.

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5. **Fabricate and Erect Structural Steel-Structure**

This item covers all activities required to fabricate and erect structural steel framing for single and multilevel structures, from raw steel, if any, sections, plates, rounds, etc. It including, but is not limited to the following:

- ◆ Provision of all tools, equipment and consumables used in the course of the work.
- ◆ Preparation of detailed fabrication drawings and getting them approved from Owner.
- ◆ Shimming of foundations and joints.
- ◆ Measuring, cutting, bending, bolting and / or welding.
- ◆ Erecting.
- ◆ Cutting, drilling, welding and bolting to achieve fitment.
- ◆ Final levelling, aligning, bolting and /or welding (including torquing)
- ◆ Grouting of support piers.
- ◆ Painting as per specifications.

6. **Fabricate and Erect Ladder and Safety Cages**

This item covers all activities required to fabricate, assemble and erect ladders and safety cages in steel structures, from raw steel (unpainted) sections, plates rounds, etc.

It includes, but is not limited to, the following:



- ◆ Provision of all tools, equipment and consumables used in the course of the work.
- ◆ Preparation of detailed fabrication drawings and getting them approved from Owner.
- ◆ Measuring, cutting, bending, bolting and / or welding.
- ◆ Assembly and erecting including cutting, drilling, bolting, welding to achieve fitment.
- ◆ Cutting, drilling, welding and bolting to achieve fitment.
- ◆ Final Bolting and / or welding in position.
- ◆ Fabrication and installation of safety barrier rail and gate.
- ◆ Installation of raw bolts and forming of concrete pads, or connecting to a lower platform.
- ◆ Painting as per specifications.

7. **Fabricate and Erect Platform and Walkways**

This item covers all operations required to fabricate erect platforms and walkways on vessels, towers, structures, etc or on the ground from raw steel (unpainted) sections, plates, rounds, etc.

It includes, but is not limited to, the following :

- ◆ Provision of all tools, equipment and consumables used in the course of the work.
- ◆ Preparation of detailed fabrication drawings and getting them approved from Owner.
- ◆ Measuring, cutting, bending, bolting and / or welding.
- ◆ Erecting including any, cutting, drilling, welding for fitment.

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- ◆ Final levelling, bolting and / or welding.
- ◆ Installing anchor bolts and grouting.
- ◆ Painting as per specifications.

Not including is the installation of flooring or the erection of handrail.

8. **Fabricate and Erect Welded Handrail**

This item covers all operations required to fabricate and erect double rail handrail and tope plate of all welded construction, from raw steel (unpainted) sections, plates rounds, etc.

It includes, but is not limited to, the following:

- ◆ Provision of all tools, equipment and consumables used in the course of the work.
- ◆ Preparation of detailed fabrication drawings and getting them approved from Owner.
- ◆ Fabrication including cutting, bending, welding, etc.
- ◆ Erecting of posts, top and middle rails toe plate including any cutting, trimming for figment and welding.
- ◆ Grinding smooth of all cut edges and welds.
- ◆ Painting as per specifications.



9. **Fabricate and Erect Galvanized Tubular Handrails**

This item covers all operations required to fabricate and erect double rail tubular galvanized hand railing including all standards, fittings, bends, etc., from raw steel (unpainted) sections, plates, tubes, etc.

It includes, but is not limited to, the following:

- ◆ Provision of all tools, equipment and consumables used in the course of the work.
- ◆ Fabrication including cutting, trimming edge stripping to required size & shape.
- ◆ Erecting into position.
- ◆ Bolting and/or welding.
- ◆ Trimming to suit platform structure and providing openings for pipe or cable, etc.
- ◆ Making good edges, and touch up painting including cold galvanizing of cut or welded parts.
- ◆ Painting of unpainted steel sections

10. **Fabricate and Install Floor Grating**

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This item covers all activities required to fabricate and install galvanized floor grating from large sheets ready for cutting, trimming, etc., to platform shapes.

It includes, but is not limited to, the following:

- ◆ Provision of all tools, equipment and consumables used in the course of the work.
- ◆ Fabrication including cutting, trimming, edge stripping to required size & shape.
- ◆ Erecting into position.
- ◆ Bolting and/or welding.
- ◆ Trimming to suit platform structure and providing openings for pipe or cable, etc.
- ◆ Making good edges, and touch up painting including cold galvanizing of cut or welded parts.

11. **Fabricate and Install Chequer Plate Flooring**

This item covers all activities required to fabricate and erect chequer plate flooring, from sheets.

It includes, but is not limited to, the following:

- ◆ Provision of all tools, equipment and consumables used in the course of the work.
- ◆ Fabrication including cutting, trimming edge stripping to required size & shape.
- ◆ Erecting into position.
- ◆ Bolting and/or welding.
- ◆ Cutting to suit platform structure and providing opening for pipe or cable, <etc.

12. **Erect Davits**

This item covers all activities required to erect fabricated davits on exchangers, vessels or in structures.

It includes, but is not limited to, the following :



- ◆ Delivery of davits and all other materials.
- ◆ Provision of all tools, equipment and consumables used in the course of the work.
- ◆ Erecting up painting of damaged areas.

13. **Roof and Wall Sheeting**

This item covers all activities required to erect by bolting of roof and wall sheeting.

It includes, but is not limited to, the following :

- ◆ Provision of all tools, equipment and consumables used in the course of the work.
- ◆ Cutting and fitting of sheeting including all shrilling, trimming and notching to facilitate openings.
- ◆ All flashing of ridges, corners gables, door jambs, etc.

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14. Down pipes and Gutters

This item covers all activities required to install metal downpipes and gutters.

It includes, but is not limited to, the following:

- ◆ Provision of all tools, equipment and consumables used in the course of the work.
- ◆ Erecting including fitting, trimming supporting and jointing.

15. Roof or Ridge Ventilator

This items covers all activities required for the erection of roof or ridge ventilators on a steel clouded building.

It includes, but is not limited to, the following:

- ◆ Provision of all tools, equipment and consumables used in the course of the work.
- ◆ Erecting on roof including any trimming or figment.

16. Install Gantry Crane Rails

This item covers all activities required to install rails.

It includes, but is not limited to, the following :

- ◆ Provision of all tools, equipment and consumables used in the course of the work.
- ◆ Erecting jointing levelling, aligning, and bolting or welding in passion.

17. Install Gantry/Overhead Travelling Crane

This item covers all activities required to erect and complete the installation of overhead cranes.



It includes, but is not limited to, the following :

- ◆ Provision of all tools, equipment and consumables used in the course of the work.
- ◆ Erecting into rails.
- ◆ Installing all controls, both mechanical and electrical.
- ◆ Testing and running of crane.

18. Install Travelling Trolleys

This item covers all activities required for the installation of beam mounted travelling trolley.



It includes, but is not limited to, the following :

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- ◆ provision of all tools, equipment and consumables used in the course of the work.
- ◆ Erecting into position.
- ◆ All levelling and shimming of trolley beam as required.
- ◆ Marking of all beams and trolley with safe Working Load.
- ◆ All testing and running as required.

19. **Inspection and Testing**

- ◆ Inspection of steel structure shall be in accordance with the codes and standards.
- ◆ LSTK CONTRACTOR shall provide NDE services acceptable to OWNER. NDE inspection shall be carried out in accordance with standards, codes and specifications .
- ◆ LSTK CONTRACTOR shall be responsible for the repair of faulty welds and for all required extra radiography and inspection of the faulty welding work. In case of a faulty weld, 100% radiography on LSTK CONTRACTOR'S account can be done as per code.

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ANNEXURE- 7 – 2C

PIPE PREFABRICATION AND ERECTION

1.0 PIPING

1.1 Magnitude of Piping

LSTK CONTRACTOR shall prefabricate, install and test all piping as shown on the plan drawings and isometrics.

2.0 PIPING FABRICATION AND ERECTION

2.1 Piping systems and pipe supports shall be designed, fabricated, inspected, and tested in accordance with rules, codes, specifications and drawings.

2.2 Miscellaneous piping materials for vents, drains, instrument connections, etc. on equipment shall be installed using P & ID'S and equipment drawings.

2.3 The fabrication and erection of piping includes field welds. It is LSTK CONTRACTOR'S responsibility to choose the number and location of field welds to ensure efficient transportation and handling during erection. Furthermore LSTK CONTRACTOR shall locate the field welds in such a way that final adjustment for fit-up purposes will be possible.



For alloy piping that has to be stress relieved after welding the number of filed welds shall be kept to a bare minimum. LSTK CONTRACTOR shall thoroughly evaluate the need for each field weld in alloy piping he deems necessary.

2.4 LSTK CONTRACTOR will furnish OWNER with a marked up set of isometrics identifying all spool pieces, and weld numbers. All piping spools shall be clearly identified, per isometric by means of stainless steel tags affixed with wire.

2.5 LSTK CONTRACTOR shall erect all prefabricated and straight run piping as required by the drawings and specifications.

The erection and installation of the piping shall include but not be limited to the following

- Control valves.
- Safety valves
- Rapture disks.
- Level instrument and gauges.
- External level displacers.
- Special fittings.
- Breaching of vents, drains, instrument connections, etc.
- Rota meters.

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- Orifice flanges.
- Orifice plates.
- In - line instruments.
- Steam tracing.
- Steam traps.
- Extension stems. Valve operators.
- Bellows, expansion joints and similar specialty items.
- Thermo wells (flanged, screwed and weld Ins.).
- Sample coolers.
- Instrument connections (up to and including the first block valve).
- Spring hangers and spring supports.
- Installation of miscellaneous piping and instrumentation supplied by equipment vendor.
- Temporary piping for drying, flushing and hydrostatic testing if necessary.
- Connection of piping to equipment.
- Connection of aboveground piping to underground piping.
- Pipe supports.

This shall include any necessary work to the piping to correct equipment misalignment.

2.6 Fastening of floor supports on concrete will be done with expansion type foundation bolts, if no anchor bolts are provided.



2.7 LSTK CONTRACTOR is responsible for the installation of steam tracing of piping, valves fittings and instruments where required, in accordance with the specifications and drawings. In general steam and condensate headers will be indicated on the piping plans. Lines to the traced will be indicated on P& ID'S and lines lists. Details of steam and condensate headers will be shown on separate drawings. Identification of steam tracers shall be by aluminum tag noting circuit number. Each end of system should be tagged.

A method of identification and tagging of the other various systems shall be established, subject to approval by OWNER and is for account of LSTK CONTRACTOR.

2.8 LSTK CONTRACTOR is responsible for the fabrication and erection of pipe supports, hangers, anchors and guides, as required by the drawings and specifications.

Spring pots and spring hangers, which shall be provided by LSTK CONTRACTOR as will be assembled, installed, adjusted and unlocked by LSTK CONTRACTOR after hydrostatic testing of the line. The required angle iron, will be decided in the field and supplied by LSTK CONTRACTOR.

2.9 LSTK CONTRACTOR shall install and remove all temporary strainers required for WORK defined herein. The removal of these items will be directed by OWNER. OWNER may decide to leave temporary strainers in during commissioning.

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2.10 LSTK CONTRACTOR shall be responsible for the fabrication, installation and dismantling of temporary spool pieces and blinds required for control valves, safety valves and in - line instruments during testing and cleaning. Requirements for these shall be minimized. Requirements for these will be prescribed by OWNER.

In general, in-line instruments, safety valves and control valves may be installed for fit-up purposes if available to avoid the use of temporary spool pieces. They shall be removed for flushing and testing and reinstalled as directed by OWNER. In the case of safety valves these must be installed for fit - up, taken down for calibration by LSTK CONTRACTOR, and reinstalled before mechanical completion. All open flanges and valves shall be blinded or plugged off.

2.11 LSTK CONTRACTOR is responsible for the installation and testing of all piping and steam, electrical tracing and all materials including all items necessary to completely close the systems in strict accordance with the established test system procedures and priorities as directed by OWNER.

2.12 **Wrapping & Coating:-** Surface preparations and installation of Wrapping & Coating of the underground piping with Cold tape (Materials for line coating and wrapping shall be of Tape coating system (Polyethylene backed tape with butyl rubber based adhesive system), if required

2.12.1 Protective coating shall consist of a coating system employing Primer, Inner Wrap and Outer Wrap.

2.12.2 The coating system shall be mechanically applied by an approved type of wrapping machine utilizing constant tension brakes except at tie-in welds, repair patches and at other locations where mechanical application is not practicable..

2.12.3 Coating and wrapping materials shall be handled, transported, stored and applied strictly in accordance with the manufacturer's instruction.

2.12.4 Wrapping Coating material is Cold tape type from **Polyken/Denso/Atla** shall be used.

2.13 **Flushing and Cleaning Of Piping Systems**



i) Sections fabricated in LSTK CONTRACTOR'S workshop shall be fitted with plastic end caps to seal pipe ends, and jointing surfaces shall be suitably protected.

These caps shall not be removed until sections are in the course of erection after delivery at SITE and then shall be removed for refuse.

ii) During fabrication and erection the sections shall be inspected or internal cleanliness.

iii) The water which will be used for testing and flushing of the piping system shall be recollected per instruction given by OWNER.

v) Piping systems shall be flushed with suitable water as supplied by LSTK Contractor

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unless designated for nitrogen or air testing or otherwise specified by licensor. OWNER'S approval is required before start of flushing.

- v) LSTK CONTRACTOR shall supply all equipment, pumps, gauges, etc. required for flushing and testing of the piping systems.
- vi) For hydro testing and flushing the piping LSTK CONTRACTOR shall weld and caps and install drain plugs, remove end caps after successful hydro test.

3.0 HYDRO TESTING

3.1 Inspection and hydro testing of the piping systems shall be in accordance with the drawings and specifications and in strict witness by OWNER representatives.

3.2 Atmospheric pressure systems shall be:

- Visually inspected that all joints are properly made.
- Filled with water for a 24 hours leakage test under atmospheric conditions.

If any leakage occurs in the system during testing, repairs must be made without extra costs to OWNER.

3.3 LSTK CONTRACTOR shall test all piping systems as per the project test diagrams. Testing is to be witnessed and approved by OWNER and where applicable by the appointed (independent inspection authority) filed inspector. A test schedule by test system shall be prepared by LSTK CONTRACTOR and shall be submitted to OWNER for Approval.

3.4 Testing and completion shall be in accordance with project system priorities.

3.5 All equipment, pumps, gauges, pressure recorders temporary piping and fittings, test gaskets and bolting, required for testing of the piping systems and part of LSTK CONTRACTOR'S supply. Before testing LSTK CONTRACTOR shall calibrate its testing equipment.



3.6 LSTK CONTRACTOR shall supply and install blind flanges when required to enable testing of the lines.

3.7 Inexpensive temporary gaskets supplied by LSTK CONTRACTOR, shall be used instead of permanent gaskets where test blinds are located for hydrostatic testing. On successful completion of a test the permanent gasket shall be installed when the blinds are removed.

3.8 Piping systems shall be tested with suitable water. Extreme care shall be taken that suitable water is used for stainless steel systems. For stainless steel the water must be approved by OWNER and shall have a content of chlorides ≤ 50 mg/L

3.9 The water for testing purposes will be furnished by LSTK CONTRACTOR.

3.10 LSTK CONTRACTOR is to perform the testing in a sequence so as to allow sufficient time for



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insulation and/or painting to complete within the time frame of the project schedule.

- 3.11 A formal system of documentation will be developed by LSTK CONTRACTOR and approved by OWNER for use by LSTK CONTRACTOR to certify this testing phase of the piping erection. This system will also include a section for supplying OWNER'S "But list" comments.
- 3.12 Erected piping shall be hydrostatically tested in test systems, but not through equipment, control valves etc. except where piping is welded to equipment.
- 3.13 LSTK CONTRACTOR remains responsible for ensuring that no item of equipment, or instrument, is damaged by the test pressure or the test fluid. Suitability of test fluid to be Approved prior to testing by the OWNER.
- 3.14 It is emphasized that the installation of temporary strainers prior to testing shall be part of WORK. OWNER shall be contacted concerning installation of temporary strainers.
- 3.15 When lines are pressure tested, valves at the end of the lines must be covered with a test blank for safety reasons. A record, preferably on the test diagrams, shall be kept by LSTK CONTRACTOR indicating which sections have been completed.

Note : Testing against closed valves in not allowed (spades to be used)

- 3.16 All material damaged during tests shall be replaced on LSTK CONTRACTOR'S account. All joints broken after testing for installation of strainers, orifice flanges, safety valves, etc. must be remade tightly; labour is for LSTK CONTRACTOR'S account.
- 3.17 After testing the piping systems, they shall be completely flushed and drained. OWNER will approve when a line is considered flushed and drained by LSTK CONTRACTOR.
- 3.18 When each section or circuit has been pressure tested and passed, a certificate prepared by LSTK CONTRACTOR on LSTK CONTRACTOR'S furnished forms showing details must be signed by LSTK CONTRACTOR and OWNER, when the test has been completed and the system drained, test blanks must be removed by LSTK CONTRACTOR.
- 3.19 The following activities by LSTK CONTRACTOR are included for the reinstatement of piping after hydro testing:
- LSTK CONTRACTOR installed temporary testing blinds to be pulled.
 - Temporary spool pieces taken out.
 - Gaskets renewed, temporary replaced with permanent.
 - Flange connection bolts tightened.
 - Post hydro punch list items corrected.

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- Temporary strainers installed.
- Chemical cleaning performed.
- Supports and hangers checked if in final position.
- Rotating equipment cold alignment checked.
- Reinstallation of control and safety valves and in - line instruments which LSTK CONTRACTOR has removed for hydro-testing.

3.20 Nondestructive testing of welds and systems is to be performed in accordance with standards, codes and specifications prior to perform any hydro-test.

4.0 **PIPING MATERIAL IDENTIFICATION AND PAINTING**

4.1 All piping materials are supplied by LSTK CONTRACTOR and shall be properly stamped and color-coded to ensure that the correct materials are used as required by the drawings, specifications, codes and regulations.

4.2 All materials will be adequately marked as to its specifications. Should LSTK CONTRACTOR be required to cut same or otherwise render piece(s) to have no marking, LSTK CONTRACTOR'S transfer or replacement of proper identification marking to the pieces involved, must be done according to approved stamping method and to be counter stamped by LSTK CONTRACTOR. Paint alone is unacceptable.



4.3 The governing principle shall be that in the installed piping systems, all components can be identified and their origin and complete specifications can be determined. The method for identification and stamping or tagging of the various components of the system shall be worked out in coordination with OWNER and only be implemented after approval.

LSTK CONTRACTOR shall be held responsible for this requirement as a minimum, and any other requirements of local codes and regulations as to identification and documentation of materials.

4.4 Surface preparation and paint application of piping system by LSTK CONTRACTOR, shall be per paint specification.

4.5 LSTK CONTRACTOR shall assure that no welds are covered by prime coats prior to acceptance of hydro test.

4.6 LSTK CONTRACTOR must ensure that all stamping such as code stamps, registration spool identification, charge numbers etc. shall be visible after paintwork.

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5.0 WELDING

5.1 All welding shall be carried out according to codes and specifications.

5.2 Welder's qualification

5.2.1 All welders including those with valid qualifications will be required to submit a test conducted by OWNER prior to start of welding.

Welders that have a certificate which is still valid for the type of material and in accordance with ASME IX will not be tested by OWNER.

5.2.2 A current list of qualified welders must be maintained by LSTK CONTRACTOR and a copy furnished to OWNER each time a revision is made.

5.3 Welders' identification stamps shall be provided by LSTK CONTRACTOR. Each weld shall be clearly stamped with welders identification. All welding including tack welding shall be carried out by qualified welders. Unstamped welds shall be removed and replaced at LSTK CONTRACTOR'S expense.

5.4 Job SITE fabrication shall be carried out under cover where possible.

5.5 Weld spatter shall be knocked off around all welds leaving a smooth clean surface.

5.6 Where openings for branches are cut in run of pipe, all material, which may drop inside the pipe, shall be completely removed before the branch line is welded in place.

6.7 The interior welds of orifice flanges shall be ground smooth.

5.8 Electrodes, Rods, Wires and Fluxes



Electrodes shall be stored in the makers' airtight containers until required for use. Electrode heaters shall be used on Job SITE, for low hydrogen types of electrodes.

Electrodes and filler wires to be used at site in this job shall be procured from the approved vendors only. Electrodes and filler wires shall be **D&H, Advani Orlikon or ESAB, Mailam and Bohler group make only**

5.9 Open Air Welding

Where welding in the open air is unavoidable, WORK must be discontinued where the quality of the weld may be impaired by weather conditions. Including but not limited to airborne moisture, sand or high winds. After rain the metal surfaces shall be dried. For metal temperature below 5 °C joints to be preheated.

5.10 Welding Procedure Qualification

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LSTK CONTRACTOR shall supply welding procedure specifications and qualification in accordance with the rules as set by OWNER.

5.11 Fees for inspection required for welding procedure and welders qualifications, supply of equipment required for the qualification test of welders and welding procedures are for account of LSTK CONTRACTOR.

5.12 **Inspection and Testing**

5.12.1 Inspection of welds shall be in accordance with the instructions of OWNER and/or the requirements of codes and standards.

5.12.2 LSTK CONTRACTOR shall be responsible for the repair of faulty welds and for all the required extra radiography and inspection of the faulty welding work. In case of a faulty weld, 100% radiography, on LSTK CONTRACTOR'S account, shall be done on the weld performed as per code.

OWNER shall have absolute discretion in the selection of the welds, which are to be radiographed.

5.12.3 LSTK CONTRACTOR shall provide NDE service, acceptable to OWNER.

NDT inspection shall be carried out in accordance with codes for all lines as indicated in the piping specification.

6.0 **STRESS RELIEVING**



6.1 LSTK CONTRACTOR shall provide stress-relieving service acceptable to OWNER. Spool pieces shall be stress relieved in an approved furnace equipped with thermostatic control and temperature recorder. Field welds to be stress relieved with electric resistance heaters. Temperature cycles to be monitored with portable temperature recorder.

6.2 Stress relieved welds shall be hardness tested by approved procedure and must meet criteria spelled out in specifications.

7.0 **TRANSPORTATION**

The following various categories of transportation of pipe, pipe fittings and prefabricated pipe spools will be performed by LSTK CONTRACTOR. All categories include loading and unloading materials. Categories will consist of but not limited to:

- From LSTK CONTRACTOR'S warehouse to LSTK CONTRACTOR'S pipe prefab shop.
- From LSTK CONTRACTOR'S pipe prefab shop to LSTK CONTRACTOR'S painting shop.
- From LSTK CONTRACTOR'S pipe prefab or painting shop to LSTK CONTRACTOR'S

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storage area or working area located on site or any other location on SITE.

- All transportation required performing nondestructive testing of prefabricated pipe spools.

8.0 **LIFTING, LIFTING EQUIPMENT AND GEAR**

8.1 Rigging and hoisting shall be executed as per construction specification and local requirements and safety rules, as manufacturer's instructions. If there are stringent one shall prevail.

8.2 **Testing And Certification**

All LSTK CONTRACTOR furnished cranes, lifting appliances and lifting gear must be properly tested, examined and/or inspected before being used on SITE, and at the intervals specified in the applicable regulations. Copies of the relevant certificates must always be available on SITE for inspection on request by OWNER or other authorities.

8.3 **Operation**

8.3.1 LSTK CONTRACTOR shall not permit a lifting appliance to be operated otherwise than by a person trained and competent to do so.

8.3.2 LSTK CONTRACTOR shall take express steps to ensure that all personnel employed by LSTK CONTRACTOR are competent and experienced for their assigned tasks.

9.0 **DRAWINGS AND DOCUMENTS**

LSTK CONTRACTOR shall fill in checklists as required by OWNER.



10.0 **MISCELLANEOUS**

10.1 LSTK CONTRACTOR shall furnish all field engineering surveying layout, and checking to properly install all above ground piping to meet all requirements of the drawings and specification. OWNER is authorized to reject any WORK already installed, which is not in accordance with drawing and specifications and of adequate quality.



10.2 All costs involved in demolition, removal and replacement of rejected works shall be the responsibility of LSTK CONTRACTOR. All materials equipment or auxiliaries not accepted by OWNER shall be removed immediately from SITE.

10.3 Underground service lines are marked at their installation limits to above ground piping, indicating line size, service and line number.

10.4 During storage, fabrication and erection, care must be taken to ensure that sand, scrap materials, welding rods, items of clothing and other foreign bodies are not allowed to enter piping.

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- 10.5 All connections which are left open by LSTK CONTRACTOR shall be well protected, so that no sand, dirt or any foreign object come into the system.
- 10.6 In certain instances special bolting torques might be required on critical connections. LSTK CONTRACTOR will arrange WORK in accordance with these requirements.
- 10.7 Flanged piping connections to vessels or equipment shall be aligned and shall be properly fitted before bolting up. Piping may be heated to bring it into alignment only when approved by OWNER. Extreme care should be exercised to avoid damage. Heating, welding and flame cutting on equipment will not be permitted.
- 10.8 No cold springing or pre- stressing of piping will be allowed other than indicated on piping drawings, isometrics and manufacturer's instructions (e.g. for expansion joints).
- 10.9 Flange faces shall be clean and free from foreign matter before assembly. Damaged flange faces may be dressed with a medium cut file only if the damage does not require new facing. This shall be decided by OWNER.
- 10.10 During erection care shall be taken to remove all dirt, seals, sand and foreign matters from inside the pipe.
- 10.11 Since LSTK CONTRACTOR is responsible for both the prefabrication and the erection of all the piping, it is LSTK CONTRACTOR'S sole responsibility to ensure that all piping to be installed fits properly prior to lifting. LSTK CONTRACTOR is to check all equipment and underground piping to be piped to, for proper location and orientation. OWNER will not entertain any claims for extra work for :
- i. Taking piping down for rework after it is lifted
 - ii. Re-lifting piping after it is reworked.
- 10.12 Final hookup of piping to equipment such as pumps and compressors shall be done together with the final alignment of this equipment and shall include checking of dimensions. Piping must fill these flanges without inducing any strain on equipment.
- 10.13 In all cases, all designated support and hangers should be in unlocked / cold position before final alignment. LSTK CONTRACTOR will be expected to expedite this critical phase of construction.
- 10.14 Certain small vessels will be considered to be piping items and shall be fabricated as such by LSTK CONTRACTOR.

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EQUIPMENT ERECTION

1.0 SURVEYING

- 1.1 Baseline and base elevation will be furnished to the LSTK CONTRACTOR. LSTK CONTRACTOR will furnish all surveying from this baseline and elevation.
- 1.2 OWNER shall have the authority at any time to determine in accordance with the drawings or written directives, the correctness or completeness of the lines in use by LSTK CONTRACTOR.
- 1.3 Any erroneous WORK shall be corrected to OWNER'S satisfaction at LSTK CONTRACTOR'S expense.

2.0 RIGGING STUDIES AND PLANS

- 2.1 LSTK CONTRACTOR shall supply rigging studies and plans as specified.

3.0 EQUIPMENT HANDLING

- 3.1 The handling of all equipment shall include, but not limited to the following activities by LSTK CONTRACTOR:
- 3.1.1 Submittal to OWNER of detailed rigging studies and plans for lifting, transporting and setting of equipment 4 weeks in advance of work for OWNER to review and approval. Complicated lifts shall be started in the morning and completed the same day.

The transportation plans are to include as a minimum:



Type of equipment to be used to transport each piece.

The planned route of the movement.

The estimated duration of the movement.

The obstructions to the route to be temporarily removed.

- 3.1.2 Receive, inspect, store, protect and perform preventative maintenance on all equipment in accordance with the specifications and drawings and/or equipment manufacturer's instructions.
- 3.1.3 Prepare foundations, pipe sleeves, paving, concrete structures and steel structures for setting equipment.

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3.1.4 Transport from warehouse or point of unloading and install equipment on foundations, paving or structures.

3.1.5 Plumb level and align equipment with coordinates in accordance with the specifications and drawings.



3.1.5.1 **GENERAL**

All of the equipment must be plumbed, leveled and aligned with the coordinates specified on the drawings both in plan and elevation and to the tolerances called out in the specifications, specific manufacturer's instructions or recommended manufacture's practices.

- LSTK CONTRACTOR will be required to verify field conditions and will be responsible for final alignment of mechanical items for this project. LSTK CONTRACTOR will check the anchor bolt locations against the equipment. Any deviation must be reported to OWNER in writing.
- LSTK CONTRACTOR will be required to supply and install shims required for all equipment erection. All cinch anchors required for equipment and supports will be supplied and erected by LSTK CONTRACTOR.

Prior to the placement of the equipment on a foundation, the surfaces of the foundation shall be cleaned of oil, grease, excess concrete and foreign matters by LSTK CONTRACTOR.



- Prior to setting the equipment on the foundations, the underside of the equipment base plate or supports will be cleaned free of oil, grease and other loose materials by LSTK CONTRACTOR.
- Anchor bolts shall be checked for damage to the thread and the threaded part shall be properly greased.
- Damaged anchor bolts must be replaced by LSTK CONTRACTOR and brought to the attention of OWNER.
- The openings between the anchor bolts and sleeves have to be cleaned of foreign materials to full depth of the opening by LSTK CONTRACTOR.
- All steel wear plates and guide keys shall be coated by CONTRACT with proper lubrication, prior to setting the equipment.
- Equipment shall be set true to line. at correct elevation and in proper orientation as shown and noted on the drawings.

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- Maximum allowable setting tolerances shall be in accordance with manufacturer's requirements or with the specifications, whichever is more stringent.
- All equipment, unless otherwise specified, shall be leveled with shims at each anchor bolt (shim on both sides of each anchor bolt) and at intermediate points as required to prevent distortion of the equipment. Shims shall have square cut edges (not trimmed or sheared) and shall be of various thicknesses to minimize the number of shims required. Shims shall be supplied by LSTK CONTRACTOR.
- The equipment shall be set, leveled, aligned and inspected with precision tools (steel straight edge, graduated machinist levels, dial indicators, theodolites, water level instruments, turbine levels, etc.). Setting, leveling and alignment shall be according to manufacturer's recommended tolerances and specifications.
- There may be a number of items not installed by the manufacturer, i.e. seals, packing, lubricators, gauges, miscellaneous piping and tubing, thermometers, etc. that will come separately packed from the equipment itself that must be identified, stored, preferably inside in accordance with project criteria, and finally installed. LSTK CONTRACTOR is responsible for these activities.
- LSTK CONTRACTOR shall remove all temporary shipping supports or erection materials.
- LSTK CONTRACTOR shall do surface preparation for, and apply coating and wrapping on buried vessels before installation.

Equipment supported on legs or on saddles shall be set to the tolerances specified in specifications of the required elevation measured on the flange of the largest diameter pipe-connecting nozzle.

- For equipment with sliding type supports, LSTK CONTRACTOR will remove dirt, grease or other foreign matter and will coat with graphite grease supplied by LSTK CONTRACTOR on the support.
- The anchor bolt nuts will be placed so as not to restrict the longitudinal movement of the sliding end.
- Vessels, drums, etc. shall be aligned, where applicable and leveled per shown or drawing.
- Shims shall be placed approximately evenly spaced under the support ring of vessels, drums, tanks.
- Towers with two or more pieces shall be assembled and welded at site by LSTK CONTRACTOR.

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- LSTK CONTRACTOR is responsible to check and inspect at these equipments in the vendor's shop.
- All costs are included in the lump sum price.

3.1.5.2 Rotating Equipment

- Rotating equipment will be installed in accordance with manufacturer's instructions.

Align drivers with all rotating equipment.

- LSTK CONTRACTOR shall install all ancillary equipment such as, but not limited to, drivers, guards, harness piping and all other interconnecting piping, casing drains, base plate drains and all necessary supports.
- The measurements for the positioning and leveling of mechanical equipment will be made on the suction flange.
- LSTK CONTRACTOR to install permanent packing, seals lubricating oils, greases and circulated oil systems.
- Services of manufacturer's technical representative by LSTK CONTRACTOR shall be used to the fullest extent.
- Rotating equipment base plates will be supported for positioning and leveling on shims located as follows.
- For bases with four (4) anchor bolts. one set of shims will be placed adjacent to each anchor bolt.
- For bases with six (6) or more anchor bolts, two (2) sets of shims will be placed adjacent to each anchor bolt, one on each side of the anchor bolt.
- In addition shims shall also be placed directly under those parts of the base plate carrying the greatest weight and shall be placed closely enough to give uniform support.
- When the base plate is level in all directions as indicated by an accurate instrument on the machined pads, the anchor bolt nuts shall be brought down evenly, but not too firmly. The unit is now ready for grouting. After the grout has adequately set, pull the anchor bolt nuts down tight and recheck the base for levelness.
- Release for grouting of base plates must be approved by OWNER.
- After completion of the electric installation to the motor, the direction of rotation of the motor will be determined. Prior to checking the direction of rotation, the coupling between

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the motor and the equipment will be disconnected for the test run of motor by LSTK CONTRACTOR.

- Rough aligning of the centrifugal units and their respective drivers shall take place after the equipment has been put on the foundation.
- Coupling alignment
- Dial indicators shall be used and where possible optical alignment equipment.

Peripheral alignment shall be checked by using one dial reading peripheral differences between coupling halves as they are rotated together.

Face alignment shall be checked using two dials reading face-to-face differences between coupling halves.

- Tolerances shall be in accordance with manufacturer's instructions with and without pipe work connected.
- Manufacturer's representative shall check that the final alignment of equipment is satisfactory before any running takes place. For small equipment. Where it is agreed by OWNER that the services of a manufacturer's representative are not required, manufacturer's written instructions shall be followed.
- The final checks will be supervised by LSTK CONTRACTOR and the results recorded by LSTK CONTRACTOR and signed by OWNER and LSTK CONTRACTOR.

Final alignment shall be carried out in two stages.



- After piping is complete with all bolts removed from the flange connections.
- Final alignment with piping assemblies 100% complete and all flanges bolted up to ensure that no unforeseen vertical or horizontal pipe loading is imposed on the unit.
- The final aligning supervised by OWNER to make sure that the detailed instructions furnished by the equipment suppliers are carried out to the full satisfaction.

LSTK CONTRACTOR to supply qualified personnel in the final alignment activities.

- Prior to putting pumps, etc. into operation, loose equipment such as guards and gauges shall be installed by LSTK CONTRACTOR.

3.1.6 Mount the drivers to the rotating equipment in case of turbines and any large motors that are shipped separately.

3.1.6.1 In case electric motors have to be installed in the field, this shall be done after leveling of



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base plate, but prior to grouting.

Chrome / nickel shim material, supplied by LSTK CONTRACTOR shall be used for alignment of drivers and pumps and shall be installed under the entire footing of the driver.

- 3.1.6.2 Equipment and drivers shall be doweled to bed plate if required by manufacturer's instructions.
- 3.1.7 Assembly whenever required for the items / package unit like Auxiliary Boilers, Waste Heat Boilers, Air - cooled exchangers, furnaces , compressors ,Turbo generators etc. units as part of the scope of WORK of installation by LSTK CONTRACTOR.
- 3.1.7.1 Compressor seal oil and lube oil systems and control panels are included in LSTK CONTRACTOR'S installation of compressors.
- 3.1.7.2 When equipment is delivered in two or more sections for site welding the weld preparation must match accurately on mating sections before assembling.
- 3.1.7.3 LSTK CONTRACTOR shall assemble and erect items, whether skid mounted or supplied in individual components as specified in the requisition or indicated on drawings in order to make a completed unit.
- 3.1.7.4 Installation, assembly and alignment of the various components shall be done by LSTK CONTRACTOR.
- 3.1.7.5 Installation of air - cooled exchangers includes the erection of structural steel on the pipe rack, which will support the tube bundles must be done by LSTK CONTRACTOR.
- 3.1.7.6 Walkways, platforms, stairs, ladders shall be installed for the items / package unit like Auxiliary Boilers, Waste Heat Boilers, Air - cooled exchangers, furnaces, compressors, Turbo generators etc. by LSTK CONTRACTOR.
- 3.1.7.7 Drying out systems, refractory and linings is included in LSTK CONTRACTOR scope of work.
- 3.1.8 Install ladders, platforms, davits, pipe supports and pipe guides in accordance with drawings and specifications.
- 3.1.9 Open man ways. Inspect. clean and close man ways of all tanks, towers. vessels and other equipment as directed by specification or manufacturer.
- 3.1.10 Install all trays and vessel internals and support for same shipped loose. in accordance with drawings, specifications and manufacturer's recommended installation instruction.
- 3.1.11 Under the supervision of OWNER and respective manufacturer's representative LSTK CONTRACTOR shall load the first loading of chemicals.

- a) There will be certain items of equipment such as filters and package equipment

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that come with cartridges filled with desiccants, resins, etc. Their items will be installed by LSTK CONTRACTOR if they are shipped separately from the equipment.

- b) Installations include the pick-up of these chemicals from the place of storage and transportation to point of installation.

3.1.12 Under the supervision of OWNER, LSTK CONTRACTOR install the first loading of catalysts. Installations include the pick-up of these catalysts from the place of storage and transportation to point of installation.

3.1.13 Touch - up of painting on new equipment after erection.

3.2 LSTK CONTRACTOR shall install grout under all equipment as required.

3.3 Grouting will be as per the specification per the equipment manufacturer's recommendation, whichever is more stringent.

3.4 The following work is included but not limited to LSTK CONTRACTOR'S scope for installation of grouting:

3.4.1 Prepare top surface of base and/or plinth, pockets, sleeves etc., prior to placing grout.



3.4.2 Install grout mortar consisting of one part Portland cement and one part of clean sand and sufficient clean water for workability.

This grout mortar shall be used between steel base plate and concrete foundations.

3.4.3 Wherever non-shrinkage grout is specified on the drawings, the same shall be supplied by LSTK CONTRACTOR and installed in accordance with manufacturer's instructing.

3.5 Install non-shrink grout between reciprocating / rotary equipment base frame including the filling of the equipment steel frame if required, and concrete foundation in accordance with manufacturer specifications and project specifications. Type of non-shrink grout to be approved by OWNER. After grouting, shims used in leveling equipment will not be removed except where removal is specifically required by manufacturer's instructions.

3.6 Unless indicated otherwise on drawings vessels supported on skirts and support rings will be grouted using a stiff mix under the support ring so as to obtain full bearing, Grout will be placed within the area of the skirt the high point of ground at the vertical axis of the tower (or vessel), sloping downward to the support ring with four (4) weep holes under the support ring sufficiently large to ensure drainage.

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4.0 MATERIAL HANDLING SYSTEM

4.1 ERECTION & COMMISSIONING

- 4.1.1 The complete material handling system including its all equipment shall erected at site and commissioned in accordance with the best engineering practice.
- 4.1.2 Packing, forwarding, transportation, unloading and storage at site, safety and protection of various components at site, insurance etc. shall be the responsibility of the LSTK Contractor / supplier.
- 4.1.3 All men, material and tools required shall be arranged by the LSTK Contractor at his own cost. The LSTK Contractor shall also arrange for the safe handling, storage, protection and security of his good at site.
- 4.1.4 The purchaser shall be responsible for supplying his part of material only as covered by the clause pertaining to the work to be excluded from LSTK Contractor's scope of supply.
- 4.1.5 After erection at site, the belt conveyors and related equipment shall be tested for satisfactory operation for mechanical completion and full-load performance run. The LSTK Contractor shall carry out performance test as per mutually agreed procedure. The details of the procedure shall be submitted by the LSTK Contractor for purchaser's approval.

4.2 MECHANICAL COMPLETION

- 4.2.1 Mechanical completion shall be considered as achieved when the system is mechanically complete along with the pre-commissioning activities and is ready for feeding. This shall include but not limited to the following :
1. The installation as per FINAL PROPOSAL is complete in all respects in accordance with the drawings, specifications including any approved changes thereto and in accordance with all applicable codes and laws.
 2. The machinery, conveyors and all drives are aligned and run or cycled under no-load conditions.
 3. The electrical system is installed and tested in accordance with applicable codes and specifications. All wiring is checked for correct hook-up. Motor rotation is checked and power system protective devices are set.
 4. Painting is completed to the extent that the incomplete work does not prevent plant start-up and commissioning.
 5. Successful completion of no-load test of all the equipment and the complete system.
 6. Temporary construction facilities are removed to the extent necessary to permit the plant start-up and commissioning.

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4.2.2 The OWNER shall inspect and certify that the LSTK Contractor executed the job in accordance with drawings and specifications.

4.2.3 When the complete belt conveyors and related equipment have been fully erected at site, LSTK CONTRACTOR shall request OWNER for his agreement to start the No-load Test Run. Owner shall, within 72 hours of receipt of such request, issue his agreement or advise LSTK Contractor in writing of any deficiencies noticed in the equipment.

4.2.4 Omissions / rectifications of minor items, if any, not affecting commissioning shall not withhold MECHANICAL COMPLETION as long as the LSTK Contractor agrees to supply / rectify the same within the specified period. The decision of the OWNER is final in this regard.

4.3 COMMISSIONING AND GUARANTEE TEST

4.3.1 After issue of Mechanical completion certificates by Owner, LSTK CONTRACTOR & OWNER shall mutually decide the date of commissioning of the equipment. From the date of commissioning, the equipment shall be gradually brought up to full load or any other load at the discretion of OWNER, and thereafter the equipment shall be run for a minimum period of 5 days. OWNER shall have the right to reduce this period where deemed necessary because of OWNER's difficulties. During this period of 5 days of operation or the reduced period, the system shall run at an average of 90% of rated capacity. If the LSTK CONTRACTOR is not able to bring the load to 90% of the rated capacity as mentioned above within 2 (two) months, OWNER shall, without prejudice to any of his rights under the contract, has the right to take over the equipment and to proceed with modifications / rectifications / additions as he considers necessary at LSTK CONTRACTOR's cost and risk to achieve this sustained load run.

5.0 PREPARE EQUIPMENT FOR OPERATION

5.1 Immediately prior to turnover, LSTK CONTRACTOR will make all the equipment ready for operation. This includes, but is not limited to such activities as:



5.1.1 Removal of preservatives and rust preventatives.

5.1.2 Installation of seals or removal of steel covers.

5.1.3 Removal of moisture absorbing materials.

5.1.4 Draining of oil reservoirs and the flushing and filling of the initial charge.

5.1.5 If required by OWNER for the final inspection the opening and closing of man ways of vessels and tanks.

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- 5.1.6 Assisting equipment manufacturer's representatives by final checkout of equipment.
- 5.1.7 Remove all temporary supports, bracing, or other foreign objects that were installed in vessels rotating equipment or other equipment to prevent damage during shipping, storage, transport and erection.
- 5.1.8 Conduct all flushing, blowing and chemical cleaning required by the specifications.
- 5.1.9 Check and run in all rotating equipment, i.e. compressors, pumps.
- 6.0 Scaffolding Sufficient amount of scaffolding required for good performance of the WORK shall be supplied by LSTK CONTRACTOR.

7.0 DRAWINGS AND DOCUMENTS

7.1 LSTK CONTRACTOR will carry out all construction and any required procurement activities directly from the AFC construction drawings and specifications and forming part of the CONTRACT. No additional design work or development e.g. completion of drawings will be required from LSTK CONTRACTOR.

However, the plan type drawings called out to be supplied by LSTK CONTRACTOR in previous subsections of this section are included in LSTK CONTRACTOR'S scope of WORK.

- 7.2 All of LSTK CONTRACTOR'S drawings, calculations, documents, test reports, and test certificates are to be submitted to OWNER for approval in 6-fold. After receiving approval LSTK CONTRACTOR to submit for final approval all of the above and one (1) soft copy in CF format. LSTK CONTRACTOR drawings receiving "Approved as Noted" stamp may be worked on provided all notes are incorporated. It is understood that OWNER'S approval shall not receive in no way LSTK CONTRACTOR from any of his obligations and further more shall not relieve LSTK CONTRACTOR from his obligations to timely complete the WORK according to approved project schedule by OWNER.
- 7.3 LSTK CONTRACTOR'S drawings shall be clearly marked with titles, equipment numbers or other item identification.
- 7.4 Approval of drawings and calculations by OWNER in no way absolves LSTK CONTRACTOR from its responsibility for the accuracy or for the design, construction and timely performance of the WORK.
- 7.5 LSTK CONTRACTOR shall promptly submit reports of each and every test or inspection.
- 7.6 LSTK CONTRACTOR shall submit quality records of the materials, as specified in previous sections and the applicable engineering specifications.
- 7.7 LSTK CONTRACTOR shall furnish an equipment installation record indicating date of installation and tag number of each piece of equipment.
- 7.8 LSTK CONTRACTOR shall furnish an equipment maintenance record indicating date and type or maintenance of each piece of equipment during the LSTK CONTRACTOR period.

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7.9 LSTK CONTRACTOR shall fill out checklists as required by OWNER.

8.0 **LIFTING, LIFTING EQUIPMENT AND GEAR**

8.1 Rigging and hoisting shall be executed in accordance with construction specification local and governmental requirements and safety manuals, as well as specific equipment manufacturer's instructions. If there are conflicts, the more stringent shall prevail.

8.2 LSTK CONTRACTOR shall only perform the lifts and movements in accordance with approved LSTK CONTRACTOR submitted rigging studies and plans.

8.3 Preferably, equipment will be lifted in accordance with manufacturer's instructions, if include, using lifting trunnions, lifting lugs if provided, or by slings attached to or around the equipment, with adequate protective measures to prevent damage to equipment. No temporary lifting lugs shall be used without the written approval of OWNER.

8.4 No nozzles or other appurtenances not intended for lifting shall be used for attachment of slings.

8.5 Equipment shall be handled with sufficient care to prevent damage. Slings shall have adequate protection to prevent marring the surface of equipment. Where necessary, sling spreaders shall be used to prevent crushing or other damage to the equipment.

8.6 **Testing And Certification**

All LSTK CONTRACTOR furnished cranes, lifting appliances and lifting gear must be properly tested, examined and /or inspected before being used on site and at the intervals specified in the applicable regulations. Copies of the relevant certificates must always be available on site for inspection on request by OWNER or proper authorities.

8.7 **Operation**

8.7.1 LSTK CONTRACTOR shall not permit a lifting appliance to be operated otherwise than by a person trained and competent to do so.



8.7.2 LSTK CONTRACTOR shall take express steps to ensure that all personnel employed by LSTK CONTRACTOR are competent and experienced for their assigned tasks.

9.0 **WELDING**

Welding of or on equipment shall only be permitted with the approval of OWNER.

10.0 **EQUIPMENT PAINTING & INSULATION TOUCH**

Rotating and special equipment to be erected by LSTK CONTRACTOR will be delivered to SITE finished painted. LSTK CONTRACTOR is responsible to apply remedial / touch up painting for any damages to paint, or protective coatings on equipment handled by it in connection. With any aspect of this operations such as unloading, transport, handling and erection as per Annexure mention in ITB Section.

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ANNEXURE- 7 - 2E

ELECTRICAL WORK

1.0 **SCOPE: ELECTRICAL WORK COVERS**

- 1.1 Installation and erection of the following equipment (items) consists of the preparation for installation, connection, testing and pre-commissioning etc. as per specifications and as per drawings.
- 1.2 Provision of all tools, equipment and consumables used in the course of the work.
- 1.3 The installation of the following systems (items) shall consist of the connection, testing and pre-commissioning etc., so that the systems are ready for use as per specifications and as per drawings.
- 1.4 Transport, store and protect supplied materials to the construction location.

2.0 **ELECTRICAL ITEMS**

- 2.1 Generators / Motors
- 2.2 Control panels
- 2.3 Transformer

Note : Installation of all accessories, tanks, levelling and fixing in place are also considered.

2.4 **Switch Gears**

Note : Bolting together sections where supplied separately and installation of panels, levelling and fixing in place are also considered.

2.5 **Bus Ducts**



Note : Jointing and securing the associated switch boards / transformers are also considered.

- 2.6 Battery charger, battery sets and UPS unit.

- 2.7 Cables in trench / conduit / tray / Rack.

Note : Following items are also necessary .

- a) Measuring and cutting of cable and protection of cut ends.



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- b) Identification of cables
- c) Fixing of cable to tray / rack

- 2.8 Cable Glands
- 2.9 Cable terminations
- 2.10 Earthing cable in trench / conduit / tape on tray / Rack
- 2.11 Earth cable tape terminations
- 2.12 Lightening protection
- 2.13 Lighting/ fittings / supports
- 2.14 Earth Rod PRT and cover
- 2.15 Cable tiles
- 2.16 Trench marker posts
- 2.17 Air craft warning
- 2.18 Underground electrical grounding system

Note : All bellow items are also considered :

- a) Pulling of grounding cable in trenches, through culverts, protection sleeves and cable ducts as per grounding cable supplier installation instruction, project specifications and layout and detail drawings.
- b) Coil up and clearly designate the final destination of the cable ends, especially if cables have to be continued their routing underground or overhead via cable tray or otherwise to their final destination at a later date.
- c) Install, including the provision of the required tools, the required through branch and end connections.
- d) Installation of all grounding electrodes including inspection pits as per specification and the layout and detail drawings.
- e) Return of the cable drums to the storage area including a clear make up of cable lengthleft on the reels of drums that are not empty.
- f) Measure cable resistance for grounding continuity and grounding resistance of ground rods, record data and submit the rest result reports to OWNER prior to commissioning of the installation.

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- g) Check cables are in proper trenches and ground rods at their location.
- h) Perform all test; witnessed by OWNER'S REPRESENTATIVES of the founding installation including the provision of all OWNER approved testing equipment and measuring devices.

2.19 Miscellaneous Electrical equipment

2.20 Earth resistance testing including earth resistance rods for grounding, continuity of grounding, installation resistance testing for electrical cables and HL-POT testing for electrical cables.

2.21 Elevator

2.22 LSTK CONTRACTOR shall install the fire alarm including sensors, cabling, local panels, mimic panels and host system. In accordance with:

- Project engineering specification and codes and standards.
- Cabling between panel and detectors, alarms, switches etc. as described above.
- Installation of all junction / terminal boxes, cable terminations and connections, supporting brackets for cabling as described above.

3.0 TESTING AND COMMISSIONING



Testing and commissioning consist of the complete testing prior to commissioning, including provision of required testing apparatus and testing documents as requested and as specified in the testing specifications.

- All test results shall be recorded on the test form and submitted to OWNER. Each test record shall include. date of test, ambient temperature, climatic conditions, instruments used with serial numbers, names of test personnel and witnesses, identifications of equipment, ground electrode or circuit tested.
- Testing shall be scheduled at least 24 hours in advance and OWNER is to be notified by LSTK CONTRACTOR. LSTK CONTRACTOR will notify all necessary interested parties including manufacturer's representatives.



High potential tests shall not be repeated without authorization by OWNER.

4.0 DRAWINGS AND DOCUMENTS

4.1 LSTK CONTRACTOR will carry out all construction and any required erection activities directly from the AFC construction drawings and specifications.

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- 4.2 LSTK CONTRACTOR shall promptly submit reports of each and every test or inspection.
- 4.3 For more details LSTK CONTRACTOR shall follow **Electrical design philosophy elsewhere mentioned in ITB.**

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ANNEXURE- 7 – 2F

INSTRUMENTATION WORK



1.0 GENERAL

- 1.1 Instrumentation symbols and identification of functions shall be based on the current edition of ISA S5.1.
- 1.2 Specifications for instruments and items of control equipment are shown on data sheets to be issued as they become available.
- 1.3 All materials and connections for control valves, relief valves, level controllers and similar equipment shall comply with applicable requirements for valves and fittings as noted in the piping specification.
- 1.4 LSTK CONTRACTOR shall install all shim plates, fixing material such as but not limited to anchors, red heads, etc.
- 1.5 LSTK CONTRACTOR shall install all instrument equipment tag plates.

2.0 FIELD INSTRUMENT INSPECTION AND CALIBRATION AND INSTALLATION

- 2.1.1 This item covers all activities and supply of all materials to import calibration of instruments. It includes, but is not limited to, the following:
- 2.1.1 Provision of all tools, equipment and consumables used in the course of the work.
- Calibration of instruments and provision of all necessary test equipment gauges, materials and ancillary items. All necessary testing instruments to be used must be certified by Govt. recognized testing laboratories.
 - Check orifice plates and control valves.
 - Protection of instruments to maintain cleanliness at all times.
 - Mark instrument to indicate status of calibration.
 - Return instruments, after calibration and checking to lay-down areas and / or stores including all packaging.
 - Pressure and leak test including the provision of all necessary test equipment gauges materials and ancillary items.

Note : The calibration of all instruments within the packages is also the responsibility of LSTK

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Contractor.

2.1.2 LSTK CONTRACTOR shall install all instruments as listed in the instrument index and further per the relevant installation specifications, documents and drawings.

2.1.3 Field instrument installation includes, but is not limited to:



Mounting of instruments and related equipment, supports protection boxes, manifolds, junction boxes, nameplates, etc.

Installation of measuring elements (probes, sensors, detectors, etc) including their auxiliaries as required (thermo wells, supports, valves, etc.) unless done by others

Installation of on-line instruments (by piping)

The following is a typical list of on-line instruments:

- Safety blow down valves.
- Control valves (all types)
- Motor - operated valves.
- Safety shut - down valves (including solenoid valves).
- Safety / relief valves.
- Pressure / vacuum relief valves.
- Self - regulating valves.
- Level gauges.
- Level displacer chambers.
- Orifice assemblies.
- Orifice plates.
- Venturies.
- Turbine meters, annubars, magnetic flow meter.
- Positive displacement meters.
- Variable area meters (rotameters)

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- Stilling Wells.
- Thermo wells and etc.

- Installation of process connections, impulse lines and capillaries.
- Installation of purge and flushing supply tubing, filter blocks and rotameters.
- Installation of air supply lines.
- Supply and installation of instrument nameplates for field instruments.



2.2 Cable, Supports and Fixing Wire pins, Conduit

LSTK CONTRACTOR shall use for cable installation for indoor and outdoor use the materials such as tubing, cable trays, etc. as called in the specifications.

- 2.2.1 Cable tray ladder rack and tubing systems shall be installed to ensure electrical continuity throughout the run and such that water cannot collect or remain in any part of the system. Cable tray shall be laid as per cable tray lay out drawing and as required to install cables. Required supporting shall be in LSTK CONTRACTOR. No cable or cable portion shall be laid without cable tray.
- 2.2.2 Pulling of the cables into the trenches, through culverts, protection sleeves and cable ducts as per cable supplier installation instructions and layout drawings, cable lists, trench sections and reel schedules.
- 2.2.3 Installation of the cable separation tiles, if specified.
- 2.2.4 Coil up and clearly designate the final destination of the cable ends, especially if cables have to be continued their routing underground or overhead via cable tray or otherwise to their final destination at a later date.
- 2.2.5 Installation of the sealing shrouds to avoid water ingress after cable cutting.
- 2.2.6 Installation of the cable markers stamped with cable number by LSTK CONTRACTOR as per cable list.
- 2.2.7 Installation of cable splicing if required.
- 2.2.8 Return of the cable drums to the storage area including clear markup of the cable length left on the reels of cable drums that are not empty.
- 2.2.9 Check if cables are spaced as specified.
- 2.2.10 Measure cable resistance and cable insulation, record data and submit the test result reports prior to commissioning of installation.

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- 2.2.11 Check whether all cables are installed in the proper trenches/ cable trays.
- 2.2.12 Perform all tests, witnessed by OWNER of the underground cable installation including the provision of the OWNER'S approved testing equipment and measuring devices. However, it is recommended to use only overhead cable tray for instrumentation cable installation.
- 2.2.13 Record of actual installed cable lengths and location of cable splices.
- 2.2.14 where cables required to be installed through or across the edges of tray or other metal work the edge of the lips shall be smoothed painted and lined with a protective sleeving to avoid cable damage.
- 2.2.15 Supporting steelwork shall be fabricated and installed by LSTK CONTRACTOR. The material shall be primed in accordance with the painting specification by LSTK CONTRACTOR.
- 2.2.16 Storage and handling of cable before and during installation shall be carried out with due regard to manufacturer's recommendations. Cable drums shall be rotated only in the direction indicated by drum markings, and open ends of cables are to be effectively sealed immediately after cutting to prevent the ingress of moisture.
- 2.2.17 At all times, the utmost care shall be exercised to avoid damaging the protective sheathing to cable or of causing excessive bending or twisting which may result in damage to core insulation, sheaths armor and so on.
- 2.2.18 The bending radius of a cable either during or after installation shall not be less than manufacturer's recommended minimum.
- 2.2.19 Cables shall be run in continuous unbroken lengths and joints shall not be permitted.
- 2.2.20 Cables installed above ground shall be routed to avoid high-risk areas, e.g. high fire risk areas, and those areas where accidental leakage or spillage may occur and cause damage to cables and supports.
- 2.2.21 During installation, the ends of cables shall temporarily be protected using compound, tape, heat shrink seals or similar approved methods to avoid damage or entry or moisture until they are permanently terminated.
- 2.2.22 Pre-cast concrete members should not be drilled for any reason. Fixing shall always be by means of clamping brackets in the most efficient way and in consultation with OWNER.
- 2.2.23 Under no circumstances shall welding be carried out to any process plant equipment, vessels, pipelines, or structures or to any protected surface unless specifically indicated on the drawings and documentation and then in strict accordance with a procedure subject to Approval of OWNER.

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2.2.24 Fixings to the above shall normally be made where brackets and so on, have already been provided or when agreed by the use of purpose built clamps.

2.2.25 On trays horizontal cable runs shall be fastened with aluminum strip at every 1200 mm, vertical cable runs every 600 mm.

2.2.26 Grouping

The cables employed to convey electricity shall be grouped according to the signal kinds. The main group kinds are but not limited to the followings

- a) Intrinsically safe signals.
- b) Signal cables not intrinsically safe.
- c) Instruments power supply cables.
- d) Coaxial cables or telephone cables used as serial data buses.
- e) Analog input/output signals, Digital input signals
- f) Digital output signals
- g) Inter-Panel cable between electrical MCC room and instrumentation system

2.2.27 All cable trays, ladders, tubing and supports and fixing material for indoor and outdoor use shall be installed by LSTK CONTRACTOR.

2.2.28 All cables shall always be installed and connected in such a way that no forces can act on terminals. Further, all instrument and power supply cables inside and outside buildings shall be installed in accordance with both cable lists and drawings by LSTK CONTRACTOR.



Carbon steel coated cable stub ups shall be installed by LSTK CONTRACTOR for all cables from sand trenches to 500 mm above ground, in accordance with electrical connection detail drawings.

2.2.29 Conduit system

Single pair cables shall be used to connect field mounted instruments to local junction boxes. Single cables shall be armoured type laid open cable trays, However any unarmoured type cable shall be laid in galvanized carbon steel / aluminium pipes with open ends or on closed cable trays. In order not to damage the cable, a plastic annular cap shall cover the pipe end. Multipair cables shall be used to connect above said local junction boxes to the control room. Multipair cables shall be armoured type and shall run over head in closed cable trays / ladders supported on the pipe racks.

2.2.30 Wire Pins

All stranded cable conductors shall be fitted with crimped taper pins (bootless type), amp (or equivalent) and all screens with lugs. Installation of all amp wire pins and screen lugs by LSTK CONTRACTOR.

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Further, in general, all standby conductors shall be wired to terminals.

2.2.31 **Cable Marking**

All instrument cables, conductors and the instrument screen/earth wires shall be tagged on both sides in accordance with the instrument connection list for local and central control room signals by LSTK CONTRACTOR.

2.2.31a Cross ferruling shall be used for wire termination at each end.

2.2.32 **Cable Entry Sealing**

- **General**

After installation of all cables and on direction of OWNER, LSTK CONTRACTOR shall seal off all cable entries and passages.

- **Outside walls**

All cable entries in outside walls and below grade level shall be watertight sealed. Method of sealing shall be supplied by LSTK CONTRACTOR.

- **Separation walls**

All cable entries in separation walls of buildings shall be sealed with a fire resistant sealing as described hereafter.

- **Control Room Floors**

All cable and cabinet entries in floors shall be sealed with polyurethane foam.

- **Fire - resistant sealing**

All fire resistant sealing shall be class H-30.

Small openings in walls shall be sealed with CSD –F (or equal) in luminescent foam.



Large openings in walls and between computer floor and cable basement shall be sealed by inserting CSD-F (or equal) in luminescent plates under between and above the cables. The remaining openings shall be sealed with CSD-F (or equal) in luminescent foam.

2.3 **Alarm Systems**

DELETED

2.4 **Analyzers Installation**

LSTK CONTRACTOR shall install all analyzers and sampling conditioning systems in the

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analyzer house (analyzer house shall be air conditioner and shall be design and constructed by LSTK Contractor) as well as in the field consisting of, but not limited to:

- Installation of all vents and drains from analyzers.
- Installation of calibration gas bottles as well as regulators and connecting tubing, as required.
- Installation of required tubing and cabling in cable tray from analyzer house to tapping point.
- Cable installation between Analyzer panel to DCS/ESD/other control system panel for hardwire signal communication.

3.0 LOCAL PANELS

LSTK CONTRACTOR shall install local panels, consisting of, but not limited to:

- a) Mounting, aligning and fixing to the foundation or steelwork. Uncoil, install and terminate underground cable ends. Install and terminate all aboveground cable to / from panels.
- b) Install and connect air supply and air signal piping and tubing to 'from panels.
- c) Install cabling and connect alarm horns.
- d) Identification / tagging of all equipment, terminals, cables and tubing which is not installed by panel vendor. Tag plates to be installed by LSTK CONTRACTOR.
- e) Installation of brackets / supports for cable, etc. and installation material as required to complete the installation.
- f) Cable installation between Local panel to DCS/ESD/other control system panel for hardwire signal communication.



4.0 TERMINATION OF CONTROL CABLES FROM THE LV SWITCH ROOM

The control cables running from the switch room shall be installed and connected in the marshaling cabinet by LSTK CONTRACTOR.

5.0 CONTROL BUILDING INSTRUMENT INSTALLATION

5.1 LSTK CONTRACTOR shall install all control building instrumentation in accordance with the relevant installation specifications and drawings.

6.0 CABINETS AND CONSOLES

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6.1.1 LSTK CONTRACTOR shall install align and anchor all equipment cabinets and consoles in accordance with design drawings and seller's installation instructions.

6.1.2 The false floor shall be completely installed by LSTK CONTRACTOR.

All panels, cabinets, tables, boxes, computers etc. located on the instrument equipment layout shall be place and installed by LSTK CONTRACTOR.

6.1.3 Where cable passage is required according to installation drawings, LSTK CONTRACTOR to indicate locations of holes and passages.

6.1.4 FCS/ESD/PLC cabinets and data base unit:

These groups / cabinets shall be installed in place and bolted together by LSTK CONTRACTOR.

Internal wiring / cabling and / or connections between these groups of cabinets shall be done by LSTK CONTRACTOR in accordance with the instructions of the system vendor's representative.

6.1.5 **FCS Consoles**

The consoles shall be installed in place and bolted together by LSTK CONTRACTOR, including installation of special table with peripherals.

Internal wiring and cabling and/or connections between consoles shall be done by LSTK CONTRACTOR in accordance with the instructions of the system vendor's representative who will be present during these operations.

6.1.6 Communication racks with the same work description as specified elsewhere in Tender documents.

6.1.7 Main processor cabinets (data base units) with the same work description as as specified elsewhere in Tender documents.



6.1.8 **Marshaling Cabinets**

Cabinets shall be installed in place and bolted together by LSTK CONTRACTOR.

Cross wiring between these assembled sections shall be done by LSTK CONTRACTOR.

6.1.9 DELETED

6.2 **Handling and installation. Termination and Connection of Cabling**

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Cables entering instrument room are installed under false floor and laid in cable tray. These cable shall be handled, cut to length, stripped and after installation of the cabinets be terminated and connected by LSTK CONTRACTOR.

LSTK CONTRACTOR shall leave slack in the cables and provide markings.

6.3 Installation of System Cables

LSTK CONTRACTOR shall install, plug in and support all system cables. Cable supporting rail in cabinets is installed by cabinet / console vendors, but in any case LSTK CONTRACTOR is responsible.

- System cable shall be installed by LSTK CONTRACTOR under false floor in auxiliary room. System cables are covered by instrument cable list.

6.4 Conduits Cable Tray / Trucking. Support Frames and Brackets

All cable trays, cable trucking, supports / brackets, etc. if required , shall be installed by LSTK CONTRACTOR. For cable tray installation see respective part.

6.5 Auxiliary Cable Installation and Termination.

LSTK CONTRACTOR shall install, terminate, support and connect all auxiliary cables.

Auxiliary cables are all cables covered by instrument cable list and instrument cable layout for control room.



LSTK CONTRACTOR shall open / remove and close parts of the false floor as required for cable installation.

6.6 Communication Cables

LSTK CONTRACTOR shall install and support communication cables. The connection of the cables in the consoles and cabinets shall be done by LSTK CONTRACTOR, under direct supervision of system vendor. LSTK CONTRACTOR shall open / remove and close parts of the false floor as required for cable installation. Communication cables are listed on instrument cable layout for control room and the system cable list.

6.7 Power Supply Cabling

LSTK CONTRACTOR shall install. terminate and connect all power supply cables between power distribution boards and cabinets, consoles, printers and other instrument equipment when listed on the power supply list

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6.8 Earthing System

LSTK CONTRACTOR shall install and connect the insulated earthing cabling / wiring from the earth buses to the cabinets, consoles and all other instrument equipment.

All cabinets and consoles shall be fitted with earthing bus bars and earthing connection bolts by the vendors and under supervision of LSTK CONTRACTOR.

LSTK CONTRACTOR shall install utility, shield and dedicated earth (clean earth) cabling and connections including tags at both ends.

LSTK CONTRACTOR shall check and test earthing system in accordance with relevant documents.

LSTK CONTRACTOR shall be provide required nos. of earth pit. Earth pit shall be separate for electrical and instrument requirement.

7.0 LIFTING

7.1 Major instrument equipment shall be rigged from points designated or suitable to accept rigging. When available, LSTK CONTRACTOR shall utilize lugs on equipment.

7.2 When establishing hoisting loads, riggings plans and crane capacities, LSTK CONTRACTOR shall adhere to the requirements and instructions as defined in the specifications and as instructed by OWNER. Any equipment handling machine i.e Hydra, cranes etc. required at that time, same shall be provided by LSTK contractor.

8.0 TESTING AND PRECOMMISSIONING (FUNCTION TEST)

8.1 Testing and pre-commissioning consist of the complete testing and pre-commissioning prior to commissioning, including provision of required testing apparatus and testing documents, comprising, but not limited to:



8.1.1 Check for completion and conformance to specifications.

8.1.2 Check the accessibility of all instruments and components for field adjustments, routine maintenance and removal for overhaul, and relocate as necessary.

8.1.3 Perform pressure test on all air sub headers as required by the line specifications.



8.1.4 Clean all instrument air sub headers, transmission tubing and control tubing by blowing with dry, filtered air prior to connection of instrument components

8.1.5 Leak test pneumatic transmission and control tubing, using an approved method acceptable to OWNER

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- 8.1.6 Perform hydrostatic or, where appropriate, pneumatic pressure tests on all instrument process piping, as required by the respective line specifications. Drain and below free of water, as necessary after test.
- 8.1.7 Check continuity and identification of transmission and control systems for each instrument to ensure proper hookup. Perform megger and continuity tests for instrument electrical wiring. Check correct source of power, polarity and earthing (take into account intrinsically safe technology of this procedure).
- 8.1.8 Check the bore of the orifice plates and flow direction during and after installation.
- 8.1.9 Check (on/off valve and) control valves for direction of flow and proper operation, e.g. travel, action with air failure, etc.
- 8.1.10 Calibrate all instruments (including the instruments in the fire and gas system) and synchronize transmitter and receiver readings for each instrument loop. Check the orifice plates and flow nozzles. Set air pressure regulators.
- 8.1.11 Install pressure and temperature gauges after line flushing.
- 8.2 Check fuses, perform voltage checks and energize all electrically powered instruments, alarm and shutdown system, etc. Maintain power supply.
- 8.3 Set pneumatic and electronic type switches and local control by simulation of input signals.
- 8.4 Check thermocouples and resistance thermometer circuits from element to measuring instrument by simulation.
- 8.5 Check and adjust calibration of all other field and panel mounted instruments.
- 8.6 Complete loop functional test of all instruments, including the instruments in all package units and in the fire and gas system. Functionally test complete control loops alarm and shutdown systems and partial process sequence, etc., to verify capability to measure, operate and stroke final control elements in the direction and manner required by the process application. All test results shall be recorded and submitted to OWNER. Each test record shall include date of test, ambient temperature, climatic conditions, instruments used with serial numbers, names of test personnel and witnesses, identification of equipment, ground electrode or circuit tested.
- Testing shall be scheduled at least 24 hours in advance and OWNER is to be notified by LSTK CONTRACTOR. LSTK CONTRACTOR shall advise OWNER prior to testing, of make, type and accuracy of test equipment used for above-mentioned items. All required test certificates should be of a recent date not exceeding 6 months.
- 9.0 **PAINTING**
Surface preparation and application of all required paint layers shall be executed in accordance with paint specifications and related standards.

10.0 **WELDING**

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LSTK CONTRACTOR shall perform welding in accordance with the normal accepted industrial standards.

11.0 **MECHANICAL COMPLETION**

LSTK CONTRACTOR shall advise OWNER in writing when erection is completed.

Mechanical completion date shall be the date when the activities have been accomplished by LSTK CONTRACTOR as dictated by the construction schedule, which shall be submitted by LSTK CONTRACTOR and approved by OWNER on due time.

12.0 **QUALITY ASSURANCE, QUALITY CONTROL, INSPECTION, CALIBRATION TEST AND MATERIAL CERTIFICATES**

12.1 LSTK CONTRACTOR shall perform quality control, inspect, calibrate required testing, pre-commissioning and supply certificates.

12.2 LSTK CONTRACTOR shall submit reports of each and every test or inspection within three (3) days after actual test or inspection is made.

12.3 Calibration and Testing.

12.3.1 Calibration and testing to be executed by LSTK CONTRACTOR in accordance with respective specifications.

Local instruments such as transmitters, converters, receivers and so on, will be preset by bench testing by LSTK CONTRACTOR in accordance with the specifications before installation on the process, so that no new settings will be necessary for loop acceptance tests.



12.3.2 LSTK CONTRACTOR shall inspect all materials up on receipt for damage and completeness. In case of damage incomplete material, LSTK CONTRACTOR shall modify/replace with new one and immediately inform OWNER.

12.3.3 LSTK CONTRACTOR shall carry out all tests included in this paragraph shall fill out the installation checklists and shall submit all required test certificates and documentation as required.

12.3.4 All tools and test gear necessary to carry out described tests shall be provided by LSTK CONTRACTOR.

12.3.5 Inspection and testing shall be phased with construction and installation in such a manner as to involve the minimum necessary concentration of effort and manpower and the minimum loss of time in reaching the pre-commissioning stage.

12.3.6 All inspection and testing shall be witnessed and approved by OWNER / authorized representative.

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- 12.3.7 LSTK CONTRACTOR shall be responsible for the complete loop continuity check of the field and control room installation, including the parts of the package units, which have been connected by others.
- 12.3.8 OWNER reserves the rights whenever distinguished package Plant(s)/Unit(s) vendor's representative to be present at site LSTK CONTRACTOR shall be responsible to arrange this WORK.
- 12.3.9 LSTK CONTRACTOR shall be responsible for the loop continuity checks from the marshaling cabinets or direct connected cabinet cables in the control room (termination point of underground multi core cable). The loop continuity checks shall be performed on a complete loop, including all parts of the loop as indicated on the instrument loop diagrams (ILD'S).
- 12.3.10 The communication equipment between field and control room building and/ or other buildings shall be the responsibility of LSTK CONTRACTOR.
- 12.3.11 Only complete loops shall be accepted, signed by OWNER after all calibration / function checks have been demonstrated successfully completed and recorded.
- 12.3.12 For all package units and systems supplied by LSTK CONTRACTOR, installed or partly installed and connected by LSTK CONTRACTOR.

LSTK CONTRACTOR shall perform a normal wiring and loop check of signals and supplies to and from these systems.



The following systems apply:

- Analyzer system
- Bentley Nevada system
- Flow metering system
- Fire, smoke and gas detection system
- Tank gauging
- FCS / ESD / PIC system, etc.
- Machine monitoring system
- Public address system (PA system)

For more details LSTK CONTRACTOR shall follow **Instrument design philosophy elsewhere mentioned in ITB.**

13.0 **Miscellaneous**

LSTK CONTRACTOR shall remove all waste and debris from the SITE.

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ANNEXURE- 7 - 2G
INSULATION WORK

1.0 GENERAL



1.1 SCOPE

This standard covers the requirement for supply and application of materials for thermal insulation of equipment, piping and other items.



1.2 REFERENCE STANDARDS

The design shall be in accordance with established codes, sound engineering practices and shall conform to the statutory regulations applicable to the country. The main codes, standards and statutory regulations considered as minimum requirements are as follows: (Latest revision of these shall be followed)

- IS 14164 Code of Practice for Industrial Application and finishing of thermal insulation material at temperature -800C and up to 7500C.
- IS 737 Wrought aluminum and aluminum alloys, sheet, strip
- IS 1254 Specification for corrugated aluminum sheet
- IS 1322 Bitumen felts for waterproofing and damp proofing
- IS 3069 Glossary of terms, symbols and units relating to thermal insulation materials.
- IS 8183 Specifications for bonded mineral wool.
- IS 9743 Thermal insulation finishing cements
- IS 12436 Specification for Preformed Rigid Poly-urethane (PUF) and Poly-isocyanurate (PIR) Foams for Thermal Insulation
- IS 13205 Code of practice for the application of polyurethane insulation by the in-situ pouring method.
- ASTMC921 Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- ASTM C1029 Specification for Spray-Applied Rigid Cellular Polyurethane Thermal Insulation
- ASTM C1696-16 Standard Guide for Industrial Thermal Insulation Systems
- ASTM C411 Standard Test Method for Hot-Surface Performance of High -Temperature Thermal Insulation
- ASTM C450 Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging
- ASTM C871 Test Methods for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate, and Sodium Ions
- ASTM C1338 Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
- ASTM C1055 Guide for Heated System Surface Conditions that Produce Contact Burn Injuries
- ASTM C1139 Specification for Fibrous Glass Thermal Insulation and Sound Absorbing Blanket and Board.
- ASTM D1622 Test Method for Apparent Density of Rigid Cellular Plastics

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ASTM C680	Standard Practice for Heat Loss or Gain and Surface Temp.
ASTM C1728	Standard Specification for Flexible Aerogel Insulation
ASTM C303	Standard Test Method for Dimensions and Density of Preformed Block and Board-Type Thermal Insulation
ASTM C177	Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot-Plate Apparatus
ASTM C411	Standard Test Method for Hot-Surface Performance of High Temperature Thermal Insulation
ASTM C1104	Standard Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation
ASTM C1101	Standard Test Methods for Classifying the Flexibility or Rigidity of Mineral Fiber Blanket and Board Insulation
ASTM E84	Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM C356	Standard Test Method for Linear Shrinkage of Preformed High-Temperature Thermal Insulation Subjected to Soaking Heat
ASTM C1763	Standard Test Method for Water Absorption by Immersion of Thermal Insulation Materials
ASTM C165	Standard Test Method for Measuring Compressive Properties of Thermal Insulations
ASTM C795	Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel
ASTM C692	Standard Test Method for Evaluating the Influence of Thermal Insulations on External Stress Corrosion Cracking Tendency of Austenitic Stainless Steel
ASTM 1617	Standard Practice for Quantitative Accelerated Laboratory Evaluation of Extraction Solutions Containing Ions

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Leached from Thermal Insulation on Aqueous Corrosion of Metals

ASTM C1338 Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings

1.3 Deviations:

Should unforeseen difficulties arise to comply with requirements of this standard. Alternative material and application techniques superior to the requirements of this standard be submitted with complete details for approval of owner. In case of any conflict / deviations amongst various documents, the order of precedence shall be as follows:

1. Statutory regulations.
2. Job specifications.
3. Engineering design basis.
4. Standard specification.

1.4 LIMITATIONS

Temperature Limits.

This standard deals with insulation applied externally on piping equipments etc. as per the table below:-

Maximum Operating Temperature	Type of Insulation
600C to 7500C for C.S., A.S. & S.S.	HOT

- 1800C to 200C COLD

1.5 THICKNESS DESIGN BASIS



Thickness calculation method as per procedure given in ASTM C-680

1. Hot Insulation

Design Ambient Temperature	: 35°C
Design Surface Temperature	: 450C
Permissible Heat Loss	: 100 kcal./m ² hr.
Permissible Wind Velocity Outside	: 1 m/sec
Permissible Wind Velocity Inside	: 0.25 m/sec

2. Cold Insulation

Design Ambient Temperature	: 35°C
Design Surface Temperature	: 2 °C below ambient/ 0.5 Deg C above the Dew Point
Permissible Heat Gain	: 10-12 kcal/m ² hr
Relative Humidity	: 85%
Permissible Wind Velocity Outside	: 1 m/sec.
Permissible Wind Velocity Inside	: 0.25 m/sec.

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1.6 GENERAL REQUIREMENTS

1.6.1 Information to be supplied

- Material of construction / dimension of equipments / pipes required to be insulated.
- Temperature
- Location of equipment (Indoor/Outdoor/Elevn.)
- Requirement of removable box type insulation if any
- Special requirements if any regarding type of insulation material and other properties.
- These information shall be supplied in form of insulation schedule.
- Design calculations, drawings and insulation material schedule.
- Material Test certificate's.
- Insulation works execution schedule.
- Detailed procedure for all types of execution works.
- Bill of Quantities, Initial material take-off, final material take off and material requisition.
- QA/QC plan.

1.6.2 STORAGE OF MATERIAL

Insulation material shall at no time be stacked directly on the ground; instead it will be stored at a level higher than ground level. It should not only be covered by tarpaulin but other effective protections against weather are also to be provided. The contractor shall provide a properly covered storage to the satisfaction of engineer-in-charge (Refer IS: 10556).

1.6.3 HYDROSTATIC TEST FOR PIPES

Before taking up insulation job on piping or vessels it shall be ensured that hydrostatic test of the concerned equipment / piping is completed. Where it is felt necessary to take up the insulation job before such testing are performed all welded and mechanical joints shall be left un-insulated for a length of at least 150mm on either side of the joint.

1.6.4 PROTECTION OF INCOMPLETE JOBS



Any part of insulation job which is not provided with final weather proofing will be adequately protected by means of tarpaulins and other aids. After the day's work similar protection should be provided for the partially completed jobs to be continued the next day to avoid any absorption of rain / moisture during the night.

2.0 INSULATION SUPPORTS (CLEATS) TO BE PROVIDED BY EQUIPMENT SUPPLIER

Suitable supports (cleats) in the form of rings, lugs, studs or pins shall be provided on equipment by equipment supplier, however should any additional supports or anchorage be felt necessary for insulation works, the same shall be also considered in LTK's scope, including all allied work necessary for the same. These will be installed by the contractor free of any extra cost. Owner shall be informed about the same in advance, so also design/drawings shall be updated accordingly.

3.0 MATERIAL REQUIREMENTS

3.1 INSULATION MATERIALS

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3.1.1 General

Whenever reference to any Standard is made it is presumed that the latest revision as on date should be considered unless otherwise specified.

3.1.2 Specification and other requirements:



Specification and other requirements will be as per below mentioned table:-

Hot Insulation:

For operating temperature Upto 400 deg.C,	Rockwool Mattress of density 120 kg/m ³ conforming to IS:8183.
For operating temperature 401-450 deg.C,	Rockwool Mattress of density 150 kg/m ³ conforming to IS:8183.
For operating temperature 451-500 deg.C,	1st layer insulation shall be 25mm Ceramic Fibre Blanket of density 128 kg/m ³ conforming to IS :15402 and balance layers with Rockwool Mattress of density 150 kg/m ³ conforming to IS:8183.
For operating temperature 501-550 deg.C	1st layer insulation shall be 50mm Ceramic Fibre Blanket of density 128 kg/m ³ conforming to IS :15402 and balance layers with Rockwool Mattress of density 150 kg/m ³ conforming to IS:8183.
For operating temperature 551-600 deg.C,	1st layer insulation shall be 75mm Ceramic Fibre Blanket of density 128 kg/m ³ conforming to IS :15402 and balance layers with Rockwool Mattress of density 150 kg/m ³ conforming to IS:8183.
For Hot Pipe Bends/Elbows	For Hot Pipe Bends/Elbows ceramic fibre rigid preformed pipe bend section density 220 -250 Kg/m ³ as per IS15402.

OR

For operating temperature Upto 400 deg.C,	hybrid insulation system (1st layer of 10 mm Aerogel 1 Insulation + 2nd layer of Mineral 2 wool) Flexible aerogel insulation shall be in accordance with ASTM C1728, Type III, Grade 1, Category A. Rockwool Mattress of density 120 kg/m ³ conforming to IS:8183.
For operating temperature 401-650 deg.C,	hybrid insulation system (1st layer of Mineral 1 wool + 2nd layer of 10 mm Aerogel 2 Insulation) Rockwool Mattress of density 150 kg/m ³ conforming to IS:8183. Flexible aerogel insulation shall be in accordance with ASTM C1728, Type III, Grade 1, Category A.

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Technical specification of Flexible Aerogel Insulation Blanket:

Flexible aerogel insulation blanket is made of non-woven fibre blanket infused with amorphous silica aerogel.



Flexible aerogel insulation shall be in accordance with ASTM C1728, Type III, Grade 1, Cat. A.

This material is suitable to be used for designated pipe work/equipment with a service temperature up to 650°C.

Flexible aerogel insulation properties shall comply with the requirements provided in table below in accordance with ASTM C1728, Type III, Grade 1, Category A.

Technical Specification for Flexible Aerogel Insulation:

Material Properties	Value	Test Standard
Blanket Thickness	5, 10, 15, 20 mm	ASTM C303
Density	160 – 240 kg/m ³	ASTM C303
Thermal Conductivity	0.021 W/(m.K) @ 24°C 0.022 W/(m.K) @ 38°C 0.023 W/(m.K) @ 93°C 0.025 W/(m.K) @ 149°C 0.029 W/(m.K) @ 204°C 0.032 W/(m.K) @ 260°C 0.036 W/(m.K) @ 316°C 0.043 W/(m.K) @ 371°C	ASTM C177
Maximum Service Temperature	650 °C	ASTM C477
Hot Surface Performance	Pass	ASTM C411
Water Vapour Sorption	≤ 5% by weight	ASTM C1104
Flexibility	Flexible	ASTM C1101
Surface Burning Characteristic	Flame Spread Index ≤5, Smoke Developed Index ≤10	ASTM E84
Linear Shrinkage	< 2% in width & length	ASTM C356
Water absorption	Max. 8% (before conditioning) Max. 16% (after conditioning)	ASTM C1763
Compressive strength	≥ 3 psi (20.7 kPa) @ 10% compression	ASTM C165
Sag resistance	≤ 5% thickness change	ASTM C411
Stress Corrosion Performance for Use on Austenitic Stainless Steel	Pass	ASTM C795
Corrosiveness to steel	MLCR < that of 5-ppm chloride solution	ASTM C1617
Fungal resistance	No growth	ASTM C1338
Hydrophobic	Yes	

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Bands/Wires for securing insulation shall be of ASTM 8209 Alloy 3003 H16 or 18-737 designation 31000 (old NS3) condition H3 or 18/8 Stainless steel.

For securing cladding on insulation on piping, aluminium band 12mm (min) X 24 SWG thick shall be used. For securing cladding on insulation on equipment, aluminium band 20mm wide X 24 SWG shall be used.

Other insulating materials may be used provided they have the same or better properties and durability aspects.

Insulation thickness of insulating materials shall be based on design calculation of thermal conductivity, insulation class, etc. Same shall be submitted to the Owner with necessary design calculations, drawings, test certificates and durability parameters.

For Valves, Turbines & Compressors Insulation

Prefabricated factory made Ceramic Fibre or Flexible Aerogel Insulation pad to be used made out of Ceramic Fibre Blanket of density 128 kg/m³ or Flexible Aerogel Insulations encased in high temperature resistant cloth. The minimum thickness of the pad shall be –

Option 1 (Ceramic Fibre):

0 Deg.C	to	300 Deg.C	= 25mm
301 Deg.C	to	400 Deg.C	= 50mm
401 Deg.C	to	500 Deg.C	= 75mm



Option 2 (Flexible Aerogel Insulation):

0 Deg.C	to	300 Deg.C	= 15 mm
301 Deg.C	to	400 Deg.C	= 30 mm
401 Deg.C	to	500 Deg.C	= 40 mm

Removable insulation for flanges and valves, like tailor made jackets or pre formed insulation boxes, shall be suitable for quick removal and reinstallation. All tailor made jackets shall fit the actual valve/flange/equipment and secure adequate overlap to incoming insulated pipes.

Technical data sheet of the Ceramic Fiber Pad is as below:

A.	Purpose/Application This Engineering specification is for Fabric jacketed supercera ceramic Fibre insulated flexible reusable covers/pad for application on pipes: pipe fittings, valves, flanges etc vessels & equipments, tubes etc in hot services.	
01	Dimension (mm)	As per drawing/sketch provided by OEM.
02	Thickness (mm)	25-100
Specification of Protective jacketed material		
I	Vest Cover	Liner Fibre Glass Fabric

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ii	External Top Cover Fabric (for cold face)	Polymer Coated Fibre Glass fabric Temp. resistance 300 Deg. C, oil & water resistant			
iii	External Bottom Cover fabric (for hot face)	High silica cloth for Temp Resistance up to 900 Deg C			
2.	Specification of insulation Material	Ceramic Fibre Blanket (As per IS 15402)			
i	Classification Temperature	1260 degree Celsius			
ii	Thickness	25 – 100mm			
iii	Bulk Density	128kg/m ³			
iv	Shot content on 70 mesh (%)	<30			
v	Tensile strength (KPa)	>40			
vi	Mean Fibre Dia (Micron)	2-4			
vii	Linear Shrinkage (%) At 1200 Deg. C for 24 Hrs	3.5			
viii	Thermal Conductivity (W/mK) Max.	1000C	2000C	3000C	5000C
		0.046	0.072	0.078	0.150
ix	Chemical composition	SiO ₂ %		49-58	
		Al ₂ O ₃ %		41-48	
		ZrO ₂ %		0-7	
		FeO ₃ %		<0.1	
3	Hardware & Non Metal fastening				
i)	Buckle/Draw Stings	Stainless steel (min SS 316), High Temp Braided Chord of fibre glass			
ii)	Stic Pins	Stainless Steel (min SS 316), Pins to prevent the insulation from movement inside the cover			
iii)	Stitching	Double sewn with Teflon coated Fibre glass wrapped stainless thread. The sewing thread shall not resolve or decompose in typical chemical plant environment.			
iv)	Belting	High Temp Fabric same as used in hot face cover			
4	Other Properties				
i	Fire Resistance (As per BS 476 Part-4)	Non-Combustible			
ii	Chemical Stability/Resistance of Corrosion/water	Good			
iv	Shock Resistance	Excellent			

Rockwool Insulation shall be of water Repellent Grade and tested as per BS: 2972 for Water Absorption. Maximum water absorption is 0.5 kg/m² in 48 hours duration.

Precautions must be implemented in the design and fabrication of the insulation jackets to avoid the insulation material from sagging causing reduction of the insulation properties of the jackets.

Cold Insulation:

Insulation material and specifications for cold insulation for operating temperatures up to (-) 180°C and dual temperature (cold/hot) service where, upper temperature limit is 125°C shall be as given below for all sizes of piping/equipment:

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Polyurethane Foam:

Preformed pipe section's and radial lags (for higher diameter pipe) of polyurethane foam of self-extinguishing type shall be in accordance with ASTM C591 TYPE-II Grade 2. The physical requirement of bulk density, chloride content, thermal conductivity and PH value of the material shall be as follows:

Temp. Limit Bulk density:	Upto (-)180°C & 120°C (max) 35.0 to 39.9kg/m ³
Chloride content :	20 ppm (max)
Thermal conductivity :	0.221 mw/cm°C at mean temp. 10 deg C
PH Value :	Neutral.
Closed cell content :	95% (min)

High density polyurethane foam block of bulk density more than 300 Kg/m³ shall be used for supports.

Cast-in-Situ Polyurethane Foam of density 42+2 kg/m³ conforming to IS: 13205 shall be used. High density polyurethane foam block of bulk density more than 300 Kg/m³ shall be used for supports.

Temp. Limit : Up to (-) 45 DEGC and 120 DEG C (max.)

Polyisocyanurate

Temp. Limit : Up to (-) 180°C and 125°C (max.)

For Cold pipe Bends/Elbows: PUF/PIR Pre-formed Pipe bend section in two halves having 40-45 kg/m³ as per IS12436.

Flexible Elastomeric Foam (FEF), NBR Based



Flexible elastomeric foam pipes and sheets shall be made of synthetic NBR rubber and conform to EN 14304 - Factory made flexible elastomeric foam (FEF).

This material is suitable to be used for designated pipework with a design line temperature of -50°C to +110°C.

FEF material properties shall comply with the requirements provided in table below.

Table: Technical Specification for Industrial Grade FEF (LTI)

Properties	Requirements	Standard
Density	65 to 80 kg/m ³	ISO 845, ASTM D1622
Service temperature	-50°C to 110°C	EN 14706

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	(+85°C if sheet or tube is glued to the object with its whole surface)	
Thermal Conductivity @ mean temperature	0.032 W/(m-K) at -50°C 0.036 W/(m-K) at 0°C 0.040 W/(m-K) at +50°C 0.044 W/(m-K) at +100°C	EN 12667 (Eq. to ASTM C177)
Water vapour permeability	Max. 2.79 x 10 ⁻¹¹ g/(m.s.Pa) (0.019 Perm-inch)	EN 12086, EN 13469 (Eq. to ASTM E96)
Leachable chloride ions	Max. 90 mg/kg	ASTM C871
Fire performance & approvals	IMO Part 2 & Part 5 Class A, < 25 Flame Spread Index Class 1 DNV Approved	IMO 2010 FTP Code ASTM E84 BS 476 part 7
pH Value	6 to 8	ISO 10523

Flexible Aerogel Insulation Blanket



Flexible aerogel insulation blanket is made of non-woven fibre blanket infused with amorphous silica aerogel. The aerogel insulation blanket shall come with factory applied vapour barrier consisting of PET-Aluminium layers.

This material is suitable to be used for designated pipe work/equipment with cryogenic and dual-temperature temperatures from -196 to 250 °C.

Flexible aerogel insulation properties shall comply with the requirements provided in table below in accordance with ASTM C1728, Type IV, Grade 1A.

Table: Technical Specification for Flexible Aerogel Insulation

Material Properties	Value	Test Standard
Blanket Thickness	5, 10, 15, 20 mm	ASTM C303
Density	160 – 240 kg/m ³	ASTM C303
Thermal Conductivity	0.015 W/(m.K) @ -129°C 0.018 W/(m.K) @ -73°C 0.020 W/(m.K) @ -18°C 0.021 W/(m.K) @ 24°C 0.022 W/(m.K) @ 38°C 0.023 W/(m.K) @ 93°C	ASTM C177
Maximum Service Temperature	250 °C	ASTM C477
Hot Surface Performance	Pass	ASTM C411
Water Vapour Sorption	≤ 5% by weight	ASTM C1104
Flexibility	Flexible	ASTM C1101
Surface Burning Characteristic	Flame Spread Index ≤25,	ASTM E84

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	Smoke Developed Index ≤50	
Linear Shrinkage	< 2% in width & length	ASTM C356
Water absorption	Max. 8% (before conditioning)	ASTM C1763
Compressive strength	≥ 5 psi (20.7 kPa) @ 10% compression	ASTM C165
Sag resistance	≤ 5% thickness change	ASTM C411
Stress Corrosion Performance for Use on Austenitic Stainless Steel	Pass	ASTM C795
Corrosiveness to steel	MLCR < that of 5-ppm chloride solution	ASTM C1617
Fungal resistance	No growth	ASTM C1338
Hydrophobic	Yes	

Other insulating materials may be used provided they have the same or better properties and durability aspects.

Insulation material specification/ thickness/application mentioned in this document are the minimum requirements. Insulation specification/ thickness/ application shall be based on design calculation of thermal conductivity, insulation class, relevant IS/ ASTM codes etc. Same shall be submitted to the Owner with necessary design calculations, drawings, test certificates and durability parameters. CONTRACTOR shall submit detailed material specifications, durability parameters assured, test certificates and application procedure to OWNER/ PMC approval.



3.2 AUXILIARY MATERIALS FOR CLADDING

a) Aluminium Cladding -Horizontal Vessels

Aluminium sheet as per IS-737 (designation 31000, condition H3 for flat sheet & 31500/51300, H4 for corrugated sheets)) shall be used for cladding. Insulation on overall piping, vessel and equipment, cladding will be coated on the side in contact with insulation with 3 mil thick polysurlyn film.

Specifications for aluminium Cladding material shall be as follows:

Material	Reference Code / Standard	Thickness	Application
Aluminium sheet with applied moisture barrier of 3 mil thick Polysurlyn coating	IS : 737 / ASTM C-653	22 SWG (0.71mm)	For all piping, tanks, vessels, heat exchanger, flanges, valves, equipments etc. upto 24" outside dia
		20 SWG (0.91mm)	For piping, tanks, vessels, heat exchanger, flanges, valves etc. above 24"

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			outside dia
Removable cover for flanges, valves etc. shall be made out of minimum 18 SWG thickness Aluminium Sheets.			

-Vertical Vessels

Cladding material for vessels with insulation O.D. 900 mm and less shall be same as for pipes. For vessels above 900 mm insulation O.D. 22 SWG corrugated aluminium sheet as per IS-1254 or ribbed aluminium sheet 32 mm x 5 mm deep corrugations may be used.

Aluminium Foil to protect stainless surfaces in Temperature below 0 deg c shall be 0.1 mm (42 SWG) thick per ASTM 8209 alloy 3003 H16 or IS-737 designation 31000 (0ldNS3) condition H3. For securing aluminium foil on stainless steel surface 24 SWG thick x 20mm wide aluminium bands shall be used.

b) Screws

Screws used with aluminium sheeting shall be of self tapping type, A No.8x12mm long cadmium plated / SS of high quality at intervals of 150mm.

c) S-Clips.

Aluminium, 20x1.5mm or 25mm wide stainless steel banding bent to form a shape of "S" provide a minimum lap of 50mm.

d) Bands for securing cladding.

Aluminium of dimensions 12mm width x 0.56 mm thick (24 SWG) for pipes. Stainless Steel bands Type 304, 0.4mm thick x 13mm wide for large dia pipes (above 24") and cylindrical equipment up to outside dia 900mm, 0.5mm thick x 19mm wide for cylindrical equipment above 900mm outside dia meter.

e) Quick release clips for removable covers.

Suitable quick release clips will be made as shown in fig. 7 from 20Cm width x 20 SWG aluminium sheet and some fig.7 from 20mm width x 20 SWG aluminium sheet and some suitable rectangular ring.

f) Sealant for cladding joints with Foster 95-44 /TIKI F9544/ LOID SEAL 94.

g) The vapour barrier mastic shall be Foster 60-38/39 /TIKI M6038/39/ LB 135



h) Adhesive for cold insulation shall be Foster 81-33 /TIKI P8133/ LB 83

Vapour Stops at pipe support location shall be Foster 90-66 /TIKI F9066/ LOID SEAL 96

j) Rivets: Aluminium 'POP' blind eye type / Stainless Steel 9.5mm long x 5mm dia meter.

k) Filler material shall be PUF dust or mineral wool mixed with specified adhesive shall be placed lightly so as to fill irregular voids and sealant shall be Foster

Foam Seal Sealer 30-45. Glass cloth to be used for vapour barrier reinforcement shall be open weave 10 mesh having glass fibre thickness of 5 mils.

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Galvanized steel sheets/ Annealed galvanised steel sheets/ Galvanised colour coated sheet are strictly PROHIBITED for use in cladding works. Other cladding materials (except G.I.) may be used provided they have the same or better properties and durability aspects, after prior approval from Owner/PMC.

Cladding material / auxiliary material specification/ thickness/ application mentioned in this document are the minimum requirements. Cladding material/ auxiliary material specification/ thickness/ application shall be based on design calculation of thermal conductivity, insulation class, corrosion aspects, durability, relevant IS/ ASTM codes, etc. Same shall be submitted to the Owner with necessary design calculations, drawings, test certificates and durability parameters.

CONTRACTOR shall submit material specifications, durability parameters assured, test certificates and application procedure to OWNER/PMC approval.

4.0 INSPECTION.

4.1 General

All insulation material shall be subject to inspection by owner before application. In case of doubt, Owner's representative will have the liberty to get the material tested by the contractor at any approved test laboratory. Any material not meeting specified requirement will be rejected and the rejected material shall have to be replaced by the contractor with material of specified type and quality. Insulation found to be improperly installed shall be removed and reinstalled properly by the contractor.

Contractor shall maintain detailed log of various insulation works and same shall be updated on daily basis. QA/QC checks of work done and materials shall be also registered in the daily logs. Owner will have the liberty to check the logs.

4.2 Inspection



Inspection of materials and / or installation by owner shall not relieve the contractor of his responsibility to ensure that finished insulation conform to specified requirements and is free from defects, contractor shall correct any defects due to poor workmanship. Contractor shall maintain test certificates and other relevant data from manufacturer.

4.3 Test for thickness

Test for thickness shall be carried out after application. Thickness at any point shall not be less than 2mm than the indicated designed thickness and excess thickness up to 115% of the designed thickness is permissible. .

4.4 Testing for bulk density

Testing of bulk density of the insulating materials shall be carried out before the application of insulation. This should be within $\pm 15\%$ of the specified value. Test location shall be selected

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by owner and its repair shall be done by contractor.

5.0 APPLICATION

5.1 General

Insulation thickness shall be as per design calculations as specified in the drawings/ insulation schedule/ specification/isometric drawings prepared for equipments/piping. Contractor shall submit detailed calculations and procedure for different insulation works based on relevant IS / ASTM codes.

5.2 No. of Layers

When insulation thickness exceeds 75 mm, the insulation shall be applied in multi-layers with all joints staggered. Each layer will be separately secured with metallic bands/wires.

No. of layers shall be as follows:

Insulation Thickness	No. of Layers (Min.)
Up to 75mm	1 Layer
76 to 150 mm	2 Layers
151 and above	3 Layers or more.

5.3 GENERAL REQUIREMENTS

5.3.1 Surface preparation

-Surface to be insulated shall be cleaned of all dirt. Oil loose scale etc. by wire brushing. Insulation works shall commence only after necessary clearance from QA/QC for painting works as per painting specification. All insulation shall be applied at ambient temperature and both the metal surface and insulation material shall be dry prior to application of insulation.

-The surface for cold insulation shall be then coated with a bitumen emulsion or a mastic coating.



-If the vessel is made of stainless steel, it shall be wire-brushed. with stainless steel wire brush.

5.3.2 Expansion / contraction joint

Depending on the type of insulation used the operating temperatures and nature of the material it may be necessary to provide expansion/contraction joints on vessels or pipes to prevent the insulation from rupturing/buckling when the surface expands/contracts. Joints are to be designed as per relevant IS / ASTM codes.

5.3.3 Filling of Voids

All voids, irregularities and joints shall be packed with loose insulation material/insulation cement trowelled smooth whichever is applicable.

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- 5.3.4 Special requirements for Aerogel hot insulation
(Special Guideline for line temperatures 400 °C and above)
For operating temperatures 400°C and above, Aluminium foil, of minimum 0.05 mm thick is to be applied on the penultimate (second last) layer of AeroGel.
Aluminium foil shall be overlapped by 100 mm (4 in.) on straight lengths and 50 mm (2 in.) at fittings and joints shall be sealed with 50mm self-adhesive Aluminium foil tape.

6.0 MEASUREMENT OF INSULATION WORK.



- 6.1 Measurement of insulation works shall be as per IS: 14164.

7.0 GUARANTEE

- There shall be a surface temperature recording as mentioned in the Design Parameter to be performed with the help of Thermography Camera, post the line/ equipment is charged in operating conditions. The same shall be in CONTRACTOR's scope and CONTRACTOR shall give a detailed report of the same.
- The guarantee test shall be carried out when plant is fully operative.
- The surface temperature, reading shall be taken at six points per pipe line and at each point it shall be taken on all four sides in top, bottom, left side and right side.
- The above reading shall be taken at 2 hours intervals and shall be taken for 18 hours starting from 11 a.m. in the morning.
- Simultaneously ambient temperature shall be taken as per IS: 14164
- A graph shall be plotted between ambient and surface temperature reading
- From this graph the surface temperature against ambient temperature shall be found out
- The ambient and surface temperature shall be measured by the instrument provided by the contractor. The instrument shall be calibrated to the satisfaction of owner/consultant.
- The contractor is required to guarantee the surface temperature of 60°C (max.) for equipments and piping in case of Hot Insulation. For cold insulation of equipments and piping, the difference between skin temperature and ambient temperature shall not exceed 2 °C.
- Ambient temperature and surface temperature shall be measured by duly calibrated instruments provided by CONTRACTOR.
- The CONTRACTOR shall undertake immediate replacement of insulation material damaged in transit, storage or application, at no additional cost to Owner.



CONTRACTOR shall produce required number of copies of test certificates as per relevant IS/ASTM Standard. CONTRACTOR shall certify/ensure that Test to be done are from NABL approved laboratory, approved by Owner.

- All materials are new and unused and are as per specifications called for in this standard.
- The operating thermal conductivity shall be as specified
- The workmanship shall be in accordance with good practice
- Other terms & conditions of the guarantee clause shall be as per NIT / purchase order / Commercial documents of ITB.

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VENDORS FOR SUPPLY & APPLICATION OF INSULATION WORK
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Lloyd Insulations (India) Limited, New Delhi
Murugappa Morgan Thermal Ceramics Ltd, Chennai
Poineer Insulation ,Ghaziabad
Minwool Rockfibers Ltd, Hyderabad
HIL, Hyderabad
Associate Insulation Co.

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ANNEXURE- 7 - 2H

PAINING SPECIFICATION (TS-2001)

1.0 GENERAL

1.1 Scope

This specification covers the technical requirements for shop and site application of paint and protective coatings and includes; the surface preparation, priming, application, testing and quality assurance for protective coatings of mechanical equipment, structural steelwork, plate work, tankage, guards, pipe work, handrails and associated metal surfaces, which will be exposed to atmospheric for the Project.

1.2 Definitions

C.S	-	Carbon steel and low chrome (1- ¹ / ₄ Cr through 9 Cr) alloys
S.S	-	Stainless steel, such as 304,316, 321, 347,
Non-ferrous	-	copper, aluminium and their alloys.
High Alloy	-	Monel, Inconel, Incoloy, Alloy 20, Hastelloy, etc.
DFT	-	Dry Film thickness, the thickness of the dried or cured paint or coating film.

1.3 Safety Regulations

Protective coatings and their application shall comply with all national, state, and local codes and regulations on surface preparation, coating application, storage, handling, safety, and environmental recommendations.

Sand or other materials producing silica dust shall NOT be used for any open-air blasting operations.

1.4 Material Safety Data Sheets



The latest issue of the coating manufacturer's product datasheet, application instructions, and Material safety data Sheets shall be available prior to starting the work and shall be complied with during all preparation and painting / coating operations.

1.5 Materials

All paints and paint materials shall be obtained from the company's approved manufacturer's list. All materials shall be supplied in the manufacturer's containers, durably and legibly marked as follows.

- Specification number
- Colour reference number
- Method of application
- Batch number
- Date of Manufacture
- Shelf life expiry date
- Manufacturer's name or recognised trade mark.

2.0 CODE AND STANDARDS:

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Without prejudice to the provision of Clause 1.1 above and the detailed specifications of the contract, the following codes & standards shall be followed. Wherever reference to any code is made, it shall correspond to the latest edition of the code.

2.1 Indian Standards:

IS-5: 1994	Colors for ready mixed paints and enamels.
IS-2379: 1990	Color codes for identification of pipe lines.
IS-2629: 1985	Recommended practice for hot-dip galvanizing on iron and steel.
IS-2633: 1986	Methods for testing uniformity of coating of zinc-coated articles.
IS-8629: 1977	Code of practice for protection of iron and steel structures from atmospheric corrosion.
IS:110	Specification for Ready Mixed Paint, Brushing, Grey Filler, for Enamels, for Over Primers
IS:101	Methods of test for ready mixed paints & enamels.

2.2 Other Standards:

2.2.1 Swedish Standard: SIS-05 5900-1967 / ISO-8501-1-1988

(Surface preparations standards for Painting Steel Surface).

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 Engineer-in-charge.

2.2.1 DIN: 53151 Standards for Adhesion test.

2.3 The paint manufacturer's, instructions shall be followed as far as practicable at all times. 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.
- c) Mixing and thinning.
- d) Application of paints and the recommended limit on time intervals between coats.

3.0 SURFACE PREPARATION

3.1 Metal Surface Preparation

3.1.1 Safety

All work in adjacent areas, which may negatively affect the quality of blast cleaning, and/or impose safety hazards, must be completed or stopped before the blasting operation starts.

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3.1.2 Pre-cleaning

Prior to surface preparation all weld spatter shall be removed from the surface, all sharp edges ground down and all surfaces cleaned free of contaminants including chalked paint, dust, grease, oil, chemicals and salt. All shop primed surfaces shall be water washed by means of suitable solvent, by steam cleaning, with an alkaline cleaning agent if necessary or by high-pressure water, to remove contaminants prior to top-coating

3.1.3 Surface Decontamination

Surface decontamination shall be performed prior to paint application when uncoated surface is exposed to a corrosive environment or existing paint work is to be repaired.

Existing coatings shall be removed by abrasive blast cleaning, and then high pressure potable water shall be used to clean steel surfaces.

Prior to application of coatings, the surface shall be chemically checked for the presence of contaminants. A surface contamination analysis test kit shall be used to measure the levels of chlorides, iron salts and pH in accordance with the kit manufacturer's recommendations.

Swabs taken from the steel surface, using cotton wool test swabs soaked in distilled water shall not be less than one swab for every 25m² of surface area to be painted.

Maximum allowable contaminant levels and pH range is as follows:

Sodium chloride, less than 50 microgram / cm²;

Soluble iron salts, less than 7 microgram / cm²; and



If the results of the contamination test fall outside the acceptable limits, then the wash water process shall be repeated over the entire surface to be painted, until the contaminant test is within the specified levels.

3.1.4 Abrasive Blasting

All C.S. materials shall be abrasive blast cleaned in accordance with Codes (Ref. Clause 2.0). To reduce the possibility of contaminating S.S., blasting is not usually specified. However, for coatings which require a blast-cleaned surface for proper adhesion, S.S. may be blast cleaned using clean aluminium oxide or garnet abrasives (Free from any chloride or Iron / Steel contamination). When hand or power tool cleaning is required on S.S., only S.S. wire-brushes (including 410 S.S.) which have not been previously used on C.S. surfaces may be used.

The surface profile of steel surfaces after blasting shall be of preparation grade Sa 2-1/2 of Swedish Standards SIS-05-5900 (Latest Revision) or better according to ISO 8501-1 and shall be measured using the replica tape method or the comparator method.

The roughness (profile) of blast-cleaned surfaces shall be Medium (G) according to ISO 8503-2: 1988 (appendix 1) unless otherwise specified. Medium defines a surface profile with a maximum peak-to-valley height of 60-100 microns, and G indicates that the surface profile is obtained by grit blasting. For the evaluation of surface roughness Comparator G shall be used.

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Abrasive blast cleaning shall NOT be performed when the ambient or the substrate temperatures are less than 3° C above the dew point temperature. The relative humidity should preferably be below 50% during cold weather and shall never be higher than 60% in any case.

Abrasive blast cleaning shall be performed with a clean, sharp grade of abrasive. Grain size shall be suitable for producing the specified roughness. Abrasives shall be free from oil, grease, moisture and salts, and shall contain no more than 50ppm chloride. The use of silica sand, copper slag and other potentially silica containing materials shall not be allowed

The blasting compressor shall be capable of maintaining a minimum air pressure of 7 kPa at the nozzle to obtain the acceptable surface cleanliness and profile.

The blast cleaning air compressor shall be equipped with adequately sized and properly maintained oil and water separators. The air supply shall be checked to ensure no oil and water contamination at the beginning of each work shift.

Blast cleaning abrasive shall be stored in a clean, dry environment at all times. Recycling of used abrasive is prohibited.

After blast cleaning, the surfaces shall be cleaned by washing with clean water (Pressure 7kg/Cm² using suitable nozzles. During washing broom corn brushes shall be used to remove foreign matter.

Assessment of the blast cleaned surfaces shall be carried out in accordance with reference code.

Blast cleaned surfaces which show evidence of rust bloom or that have been left uncoated overnight shall be re-cleaned to the specified degree of cleanliness prior to coating.

All grit and dust shall be removed after blasting and before coating application. Removal shall be by a combination of blowing clean with compressed air, followed by a thorough vacuum cleaning with an industrial grade, heavy duty vacuum cleaner.



All cleaned surfaces shall have protection from atmospheric corrosion as per IS8629:1977

3.1.5 Alternate Methods of Surface Preparation

When open air blasting is not permitted on site, or when space limitations or surface configurations preclude blasting, the alternate cleaning methods listed below may be used with prior approval. Alternate cleaning methods shall consider the degree of surface cleanliness and roughness profile required by the specified coating system.

- Vacuum or suction head abrasive blast-cleaning,
- Wet jet abrasive blast-cleaning,
- Compressed-air wet abrasive blast cleaning,
- Pressurized liquid blast-cleaning,
- Power tool cleaning,
- Hand or power tool cleaning,

Hand and/or power tool cleaning shall only be used for spot repair where abrasive blasting is not permitted or is impractical, and on items which could be damaged by abrasive blasting. Power tool cleaning shall not be carried out with tools which polish the surface, e.g. power wire brushes.

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The surfaces of equipments and prefabricated piping etc. which are received at site Primerised or with finish paints, depending upon their conditions, shall be touched up and painted at site. For these surfaces sand blasting is not envisaged and these surfaces shall be prepared using power brushes, buffing or scraping, so as to achieve a surface finish to St-3 as per SIS-05-5900 . After wash-up the area to be touched up shall be jointly marked, measured and recorded for payment purposes. The type of system & nos. of coat (primer and/or finish paint) to be applied after touch up, which shall be decided by OWNER/CONSULTANT in writing before taking up the job.

When paint is to be applied on damaged painted surfaces of equipments all loose and flaking paint work should be removed to a firm feathered edge. Rusted spots should be cleaned by one of the methods specified in the clauses 4.4.1 & 4.4.2 above. In case the previous paint work is not compatible to the specified one the entire coating must be removed.

It shall be ensured that sand blasted surface/machine cleaned surface is not contaminated with oil and grease. Water shall also not be allowed to come in contact with sand blasted surface.

4.0 APPLICATION

4.1 General

The final specification of paint systems to be used to suit the exposure conditions of equipment and steelwork, shall be as specified on the scope of work, equipment data sheets or the drawings.

All coatings shall be in accordance with Indian / International Standards, the coating manufacturer's product data sheets and application instructions and the requirements contained in this specification.

4.1.1 General Requirements for Shop Application

All work areas which facilitates shop paint application shall be surface prepared for painting and have the paint system applied before installation.

Equipments assembled at site shall only receive primer coat in the shop and finish coatings will be applied at site.

In all cases, where surfaces will be inaccessible after shop assembly, they shall be prepared and have the paint system applied before assembly is carried out. Drying times between successive coats shall be at least those recommended by the manufacturer.



All known field weld areas shall be given the specified abrasive blast surface preparation but left uncoated for a distance of 50mm from the weld line. Such areas shall be given the appropriate touch-up treatment after installation.

The manufacturer's directions for preparation and application of coatings shall be followed to ensure that the durability of the coating system is not impaired.

The Contractor shall submit the full details of the proposed surface preparation and paint systems prior to the commencement of any surface preparation.

4.1.2 General Requirements for Site Application

Paint shall be stored only in accordance with the manufacturer's instructions.

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All materials used for the specific system being applied shall be products supplied by one manufacturer and details of such product shall be submitted for approval before commencement of work.

The contents of cans shall be thoroughly stirred before being poured into paint pots and shall be thinned only in the specified proportions in accordance with the manufacturer's instructions.

Finish coats may be applied by spraying except where any over spray is likely to affect finished surfaces or where spraying constitutes a health hazard to workmen in the other areas. Brush and roller application will require multiple coats to achieve the specified dry film thickness.

Brush application may be used only with the approval of the company.

Roller application shall only be used on relatively large surface areas (i.e. > 50m²) and only if spraying is not an option.

The Contractor shall complete the application of any one type of paint or each coat thereof, before beginning the next coat on that section.

In cases nominated as critical, the application of each coat shall be approved before application of the next coat can proceed, in accordance with 'hold' points nominated in the Inspection and Test Plans (ITPs)

All fittings within any given area are to be painted with the same system as the area unless otherwise specified.

Where 2 coat of finish paint are indicated they shall be applied in two different shades to ensure that two coat are applied.

Paint shall not be applied in rain, snow, fog or mist or when the relative humidity is such as to cause condensation on metal surface.



The CONTRACTOR must ensure the availability of a specialist from the paint manufacturer, at SITE during pendency of CONTRACT within his quoted rates to ensure the quality of painting & procedure. Addition of drying agents, pigments or other substances is not allowed unless specifically prescribed or approved by paint manufacturer's specialist.

Name plates/tags attached to the equipments/machineries shall not be painted or removed during painting job. Failing to comply with above, the CONTRACTOR may be required to replace name plates/tags at his cost.

4.1.3 Qualifications and Materials

All surface preparation, coatings application and inspection, shall be carried out by personnel experienced in that particular field. Contractors shall submit the names of subcontractors to be employed for the specific work together with the brand names of coating materials for approval prior to commencement of application.

4.1.4 Handling and Transport

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All pipe work, steelwork and equipment that have been finish coated shall be handled with care to preserve the coating in the best practical condition.

Painted materials shall not be handled until the coating has completely cured and dried hard Supports in contact with coated steel during transport and storage shall be covered with a soft material to prevent damage to the coating. Appropriate materials shall be used during transportation between coated steelwork and holding down chains to prevent damage to the coating.

4.2 Application of Coatings

4.2.1 General

The application method and type of equipment to be used shall be suitable for the paint specified and the surface being painted.

Paints and thinners shall be brought to the point of usage in unopened original containers bearing the manufacturer's brand name and colour designation and ready-mixed unless otherwise specified. Two-pack systems shall be mixed at the site of application to the paint manufacturer's recommendations. The mixed amount prepared shall be no more than the amount that can be applied during the stated pot life.

Paint shall be applied so that an even film of uniform thickness, tint and consistency covers the entire surface and is free of pin holes, runs, sags or excessive brush marks. Film finish shall be equal to that of first class brushwork.

Unless it is practical to do so colour shades for primer, intermediate coat and finish coat must be different to identify each coat without any ambiguity

Paint ingredients shall be kept properly mixed during paint application.

Equipment shall be kept clean to ensure dirt, dried paint and other foreign materials are not deposited in the paint film. Any cleaning solvents left in the equipment shall be completely removed before painting.

To ensure the required film thickness is achieved on angles, welds, sharp external edges, nuts and bolts, a coat shall be applied to such items/locations immediately prior to the application of each coating to the whole area.

Care shall be taken to ensure paint application into all joints and crevices.



The contact surfaces between steelwork to be fastened by means of friction grip bolting shall be abrasive blast cleaned and prime coated only, prior to erection.

4.2.2 Atmospheric conditions

Surface preparation and coating shall not be carried out in inclement weather and shall be carried out such that the surface being coated is free of moisture, wind-borne or blast cleaning dust.

Coatings shall not be applied if:

- The relative humidity exceeds 85%.
- The ambient temperature is less than 5⁰C (depending on local condition)
- The metal temperature is less than 3⁰C above the dew point.

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- There is likely hood of an unfavourable change in weather conditions within two hours after painting.

As a general rule, sufficient ventilation, dehumidification and heating capacity to cope with local climatic conditions must be secured before any coating – related work is started.

In any case, humidity, ambient and surface temperature conditions at the time of paint application, and curing and drying time before application of the next coat, shall be in accordance with the paint manufacturer's recommendations. These conditions shall be recorded in the Inspection Test Record (ITR) by the Contractor and be available for review.

4.2.3 Conventional or Airless Spray

Spray equipment shall be equipped with accurate pressure regulators and gauges. Spray gun nozzles and needles shall be those recommended by the paint manufacturer.

Air from the spray gun shall be clean and dry with no traces of oil or moisture.

Coatings shall be wet on contacting the painted surface. Areas of dry spray shall be removed and the correct system re-applied.

4.2.4 Brush Application

The method of "laying-off" shall be suited to the paint specified and shall ensure minimum brush marking.

4.2.5 Roller Application

A uniform method of application shall be adopted when painting large areas. The rolling direction shall minimise paint joint build up. Edges and areas subject to possible roller damage shall be brush-painted prior to rolling.

4.2.6 Thickness of Coatings

The maximum thickness DFT in any one application shall not exceed that specified in Technical specifications/ recommended by the paint manufacturer.



Wet film thickness gauges shall be used to make frequent checks on the applied wet film. The Contractor shall maintain at the site of painting operations, a dry film thickness tester of an approved type with a valid current calibration.

Coating thickness checks in accordance with reference code shall be performed, and the Contractor shall undertake remedial action if the measured thickness is less than specified.

Build up of each material to required thickness shall be made prior to the application of the subsequent coat; final film build shall be the minimum specified.

4.2.7 Multiple Coat Applications (Except Wet-On-Wet)

Before successive paint coats are applied, intermediate coats shall be inspected for surface contamination. The presence of any grease or oil, shall be removed by a suitable solvent, and any salt and dirt adhering to the surface shall be removed by scrubbing with a solution of non-toxic detergent (except those prescribed by the manufacturer as "wet-on-wet"). Removal of contaminants shall only be performed after an intermediate coat has had sufficient time to cure.

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The surface shall then be pressure hosed or dusted down by brush to disturb and remove deposits not apparent on visual inspection.

Coatings shall be applied only under the following conditions:

- The surface has been cleaned and is dry;
- The manufacturer's stated minimum time for re-coat has elapsed;
- The manufacturer's stated maximum time for re-coat has not elapsed. If the maximum time has elapsed then pre-treatment shall be in accordance with the paint manufacturer's recommendations; and
 Damaged areas in preceding coat have been made good in accordance with this Specification.

When multiple coat of finish paint are indicated, they shall be applied in different shades to ensure that multiple coats have been applied.

4.2.8 Protective Coatings for Fasteners

Black and galvanised erection bolts/nuts and galvanised holding down bolts/nuts shall be prepared and painted in accordance with Section 4.4 of this Specification.

Black high tensile bolts/nuts shall be painted after erection to the same paint system specification as the surrounding structural steel.

4.3 Hot Dip Galvanising

All galvanising shall be carried out by the hot dipping process and conform to the requirements of IS-2629:1985 and uniformity of coating shall confirm to IS 2633:1986.

All welding slag shall be removed by chipping, wire brushing, flame cleaning or abrasive blast cleaning where necessary prior to galvanising

For temporary identification, either water-soluble marking paints or detachable metal labels shall be used. For permanent identification, figures/labels shall be heavily punched or embossed by the fabricator.



For galvanised items after pickling, the work shall be inspected and any defects that render the work unsuitable for galvanising shall be repaired. After such repairs, the work shall again be cleaned by pickling.

The coating mass of zinc shall be as specified on equipment data sheets and the Drawings. Galvanised coatings shall be tested by the methods described in referred code.

After galvanising all material shall be cooled to air temperature in such a manner that no embrittlement occurs.

Galvanised coatings shall be smooth, uniform, adherent and free from stains, surface imperfections and inclusions.

All gratings and fixtures including nuts, bolts and washers that are required to be galvanised, shall be hot dipped galvanised and all nut threads shall be re-tapped after galvanising and a lubricant applied on Cold working of galvanised steelwork shall be avoided.

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4.4 Damaged or Inaccessible Surfaces

4.4.1 Damaged Paint Surface

Repair of damaged painted surfaces, as well as painting of galvanised and black bolts, and galvanised holding down bolts after erection shall comply with this Clause. The treatment shall be:

- Pre-clean the damaged or unpainted areas in accordance with Section 4.2.1 of this Specification;
 - Disc or hand sand to clean bright metal;
- Inorganic zinc primers subject to mechanical damage or weld etc shall be power tool cleaned
- Feather backs by sandpapering or whip blasting the original coatings surrounding the damaged area over a 50mm distance. A rough surface shall be obtained on epoxy coatings;
 - Clean surface to remove all dust;
- Conduct surface contaminant test in accordance with Section 4.2.2 of this document; and
 - Build up a new paint system over the affected area with paints equal to those originally used and having the same dry film thickness for each coat. As an exception, damaged inorganic zinc primers shall be repaired with epoxy organic zinc rich paint and shall be applied within four hours of blast cleaning.

The new coatings shall overlap the original coating over the 50mm prepared distance and shall be colour matched to the specified colour of the original coating.

4.4.2 Damaged Galvanised Surfaces

Damaged areas caused by oxy-cutting, welding or physical impact shall be treated as follows:

- Prepare the surface by removing any weld slag followed by vigorous power wire brushing of the coating surrounding the damaged area over a 50mm distance;
 - Clean surface to remove all dust; and
- Apply two coats of organic zinc-rich primer to a minimum DFT of 100 microns.

The area to be reinstated shall be colour matched to the surrounding finish colour with 40 microns of aluminium paint to the manufacturer's **written instructions**.

4.4.3 Inaccessible Surfaces



Surfaces that will be inaccessible after erection of other elements of the structure, shall be fully painted prior to the installation of the obstructing item.

4.5 Surfaces Not To Be Coated

The following surfaces shall not be blasted or coated unless specifically directed:

Machined surfaces, bearings, seals, grease fittings, adjusting screws and name plates, and identification tags.

- Valve stems;
- Raised faces on pipe and equipment flanges;
- Electrical cabling;
- Instrumentation, gauges and sight glasses;

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- Titanium, stainless steel and non-metallic surfaces; and
Field weld margins, 50mm either side of weld, on tankage and piping, prior welding.

The rear face of piping flanges shall be shop prime coated only. Flange holes for fasteners shall be fully coated.

4.6 Wash-Up

All surface of equipments/prefabricated piping etc. Primerised / painted at Vendor shop and received at site if required shall be washed up as follow:

- a) Washing with clean water (Pressure 7 Kg/cm²) using suitable nozzles. During washing, broomcorn brushes shall be used to remove foreign matter.
- b) Solvent washing, if required, to remove traces of wash up as per above procedure of all surfaces of equipment, piping, structure etc. completely painted at contractor's shop shall be included in the quoted rates of oil, grease etc. Wash up as per above procedure of all surfaces of equipment, piping, structure etc. completely painted at contractor's shop shall be included in the quoted rates.

4.7 Touch-Up Painting

Prior to the application of any coat, all damage to the previous coat(s) shall be touched-up. Damage to finished work shall be thoroughly cleaned and re-coated.



Surface preparation shall be done as per clause no. 3.0.....

Items supplied with the manufacturer's standard coating system shall be touched-up with the same generic coating system or recoated.

4.8 Paint Storage

The following must be ensured:

- a) All paints and painting material shall be stored only in such rooms assigned for the purpose. All necessary precaution shall be taken to prevent fire. The Storage building shall preferably be separate from adjacent buildings. A sign-board bearing the Words "PAINT STORAGE- NO NAKED LIGHT" shall be clearly displayed outside. The building shall be properly ventilated and shall be adequately protected with fire fighting equipment.
- b) Storage shall be far away from heated surface open flames, sparks & well protected from sun rays.
- c) Ambient temperature at which paints are stored shall be intimated to paint manufacturer & their advice sought regarding precautions to be taken if any, regarding flammability, explosiveness & toxicity.
- d) Maximum allowed storage time for various paint materials shall be clearly indicated on individual containers. Materials which have passed expiry date shall not be used.
- e) Paints in non-original containers and/or in containers without seals, shall not be used.

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5.0 COATING SYSTEM SELECTION

Coating Systems for Structures Piping and Equipment

The following Table 1 shall be used as a general guide for the selection of a paint system suitable for a particular plant area application. Paint systems specified on equipment data sheets and the Drawings shall take precedence over the general paint system area applications listed in Table 1.

TABLE - 1

Ref No.	Application	Surface Preparation	Generic Coating System	Minimum DFT	Remarks	
01	Structural Steel work with operating temp. Up to 90 ^o C (Steel structures, Piping support, uninsulated CS piping, flanges, valves, stairways, walkways etc. except grating).	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	P2 : ONE coat of two pack zinc rich epoxy Primer meeting SSPC Paint 20 level 1 F1 : One coat of two packs. Polyamide Cured Epoxy. F5 : One coat of two pack aliphatic acrylic polyurethane	P2 : 60 microns F1 : 120 – 200 microns F5 : 60 microns	Total dry film thickness of paint system: 240 microns as per C4 – High durability	Total dry film thickness of paint system: 320 microns as per C5 – High durability
02	Uninsulated CS piping, flanges, valves with operating temp. From Above 90 ^o C to 200 ^o C.	Blast cleaning to near white metal grade Sa-2½, of Swedish Standards SIS-05-5900 (Latest)	P1 : One coat of Ethyl Silicate zinc rich with solvent Primer meeting SSPC Paint 20 level 1 F3 : Two coats of single pack special Oleo resinous based heat resistant ready mixed Aluminium Paint.	P1 : 75 microns F3 : 2 x 25 microns for each coat Total - 125 microns.	Total dry film thickness of paint system: 125 microns.	
03	Uninsulated CS piping, flanges, valves with operating temp. Over 200 ^o C.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	P1 : One coat of Ethyl Silicate zinc rich with solvent Primer meeting SSPC Paint 20 level 1 F4 : Two coats of Heat Resisting Silicon Aluminium Paint.	P1 : 75 microns F4 : 2 x 25 microns for each coat Total - 50 microns.	Total dry film thickness of paint system: 125 microns.	



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Ref No.	Application	Surface Preparation	Generic Coating System	Minimum DFT	Remarks	
04	Insulated CS piping flanges, valves with operating temp up to 90° C	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	F8 : One coat of high temperature epoxy phenolic	F8 : 2 x 125 microns	Total dry film thickness of paint system: 250 microns.	
05	Insulated CS piping, flanges, valves with operating temp. From 90° C to 200° C.	Blast cleaning to near white metal grade Sa-2½, of Swedish Standards SIS-05-5900	F8 : Two coats of high temperature epoxy phenolic (novolac)	F8 : 2 x 125 microns	Total dry film thickness of paint system: 250 microns	
06	Insulated CS piping, flanges, valves with operating temp. Over 200° C.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	F9 : Two coats of Inorganic Co-polymer based coating With an Inert Multipolymer Matrix.	F9 : 2 x 150 microns	Total dry film thickness of paint system: 300 microns.	
07	Uninsulated CS equipment with operating temp. Up to 90° C, to be treated at Manufacturer's shop.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	P2 : ONE coat of two pack zinc rich epoxy Primer meeting SSPC Paint 20 level 1 F1 : One coat of two packs. Polyamide Cured Epoxy. F5 : One coat of two pack aliphatic acrylic polyurethane	P2 : 60 microns F1 : 120 – 200 microns F5 : 60 microns	Total dry film thickness of paint system: 240 microns as per C4 – High Durability	Total dry film thickness of paint system: 320 microns as per C5 – High Durability
08	Uninsulated CS equipment with operating temp. From 91° C to 200° C, to be treated at Manufacturer's shop.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	P1 : One coat of Ethyl Silicate zinc rich with solvent Primer meeting SSPC Paint 20 level 1 F3 : Two coats of single pack special Oleouresinous based heat resistant ready mixed Aluminium Paint.	P1 : 75 microns F3 : 2 x 25 microns for each coat	Total dry film thickness of paint system: 125 microns.	
09	Uninsulated CS equipment with operating temp.	Blast cleaning to near white metal grade 2	P1 : One coat of Ethyl Silicate zinc rich with solvent Primer	P1 : 75 microns	Total dry film thickness of paint system: 125 microns.	



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	Over 200°C, to be treated at Manufacturer's shop.	½, of Swedish Standards SIS-05-5900 (Latest).	meeting SSPC Paint 20 level 1 F4 : Two coats of Heat Resisting Silicon Aluminium Paint.	F4 : 2 x 25 microns for each coat Total - 50 microns.	
10	Insulated CS equipment with operating temp. Up to 90°C, to be treated at Manufacturer's shop.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	F8 : Two coats of high temperature epoxy phenolic (novolac)	F8 : 2 x 125 microns	Total dry film thickness of paint system:250 microns
11	Insulated CS equipment with operating temp. From 91°C to 200°C, to be treated at Manufacturer's shop.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	F8 : Two coats of high temperature epoxy phenolic (novolac)	F8 : 2 x 125 microns	Total dry film thickness of paint system:250 microns
12	Insulated CS equipment with operating temp. Over 200°C, to be treated at Manufacturer's shop.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	F9 : Two coats of Inorganic Co-polymer based coating With an Inert Multipolymer Matrix.	F9 : 2 x 150 microns	Total dry film thickness of paint system: 300 microns.
13	Surface of structural steel for furnaces, external surface of furnaces, external surface of flue duct, metal stacks and similar with operating temp. Up to 200°C. (With exclusion of stair ways, walk ways etc.).	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	P1 : One coat of Ethyl Silicate zinc rich with solvent Primer meeting SSPC Paint 20 level 1 F3 : Two coats of single pack special Oleo resinous based heat resistant ready mixed Aluminium Paint.	P1 : 75 microns F3 : 2 x 25 microns for each coat	Total dry film thickness of paint system: 125 microns.
14	For external	Blast cleaning	P1 : One coat of Ethyl	P1 : 75	Total dry film



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	surfaces of flue ducts, metal stacks, and similar with operating temp. Above 200°C.	to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	Silicate zinc rich with solvent Primer meeting SSPC Paint 20 level 1 F4 : Two coats of Heat Resisting Silicon Aluminium Paint.	microns F4 : 2 x 25 microns for each coat Total - 50 microns.	thickness of paint system: 125 microns.	
15	For surfaces of air cooler heads not galvanized with operating temperature up to 90 ⁰ C, treated at manufacturer's shop.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	P2 : ONE coat of two pack zinc rich epoxy Primer meeting SSPC Paint 20 level 1 F1 : One coat of two packs. Polyamide Cured Epoxy. F5 : One coat of two pack aliphatic acrylic polyurethane	P2 : 60 microns F1 : 120 – 200 microns F5 : 60 microns	Total dry film thickness of paint system: 240 microns as per C4 – High Durability	Total dry film thickness of paint system: 320 microns as per C5 – High Durability
		NOTE: All surfaces shall be galvanized at manufacturer's shop with exception of the end header of air cooled heat exchangers that shall be treated as described above at Manufacturer's shop. In case the same surfaces shall not be treated at shop, they shall be treated at site according to environmental and operating conditions.				
16	For surfaces of air cooler heads not galvanized with operating temperature up to 91 ⁰ C TO 200 ⁰ C, treated at manufacturer's shop.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	P1 : One coat of Ethyl Silicate zinc rich with solvent Primer meeting SSPC Paint 20 level 1 F3 : Two coats of single pack special Oleouresinous based heat resistant ready mixed Aluminium Paint.	P1 : 75 microns F3 : 2 x 25 microns for each coat	Total dry film thickness of paint system: 125 microns.	
		NOTE: All surfaces shall be galvanized at manufacturer's shop with exception of the end header of air cooled heat exchangers that shall be treated as described above at Manufacturer's shop. In case the same surfaces shall not be treated at shop, they shall be treated at site according to environmental and operating conditions.				
18	STORAGE TANKS					
a)	Acid / Alkali CS Storage Tank (External	Blast cleaning to near white metal grade 2	P2 : ONE coat of two pack zinc rich epoxy Primer meeting SSPC	P2 : 60 microns	Total dry film thickness	Total dry film thickness



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	Surface including all stair ways)	½, of Swedish Standards SIS-05-5900 (Latest).	Paint 20 level 1 F1 : One coat of two packs. Polyamide Cured Epoxy. F5 : One coat of two pack aliphatic acrylic polyurethane	F1 : 120 – 200 microns F5 : 60 microns	of paint system: 240 microns as per C4 – High Durability	of paint system: 320 microns as per C5 – High Durability
b)	CS Storage Tanks, Excluding indicated in Sl. No. (a)	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	P1 : One coat of Ethyl Silicate zinc rich with solvent Primer meeting SSPC Paint 20 level 1 F1 : One coat of two pack Polyamide Cured Epoxy. F5 : Two-pack aliphatic Isocyanate cured acrylic finish paint	P1 : 60 microns F1 : 120 - 200 microns F5 : 60 microns	Total dry film thickness of paint system: 240 microns as per C4 – High Durability	Total dry film thickness of paint system: 320 microns as per C5 – High Durability
19	Cold Insulated Carbon Steel and low alloy Steel (1-¼ Cr through 9 Cr) Piping and Equipment. (Upto 60 Deg. C)	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	F7 : Two coats of Tar Free Epoxy paint suitably pigmented	F7 : 2 x 125 microns	Total dry film thickness of paint system: 250 microns.	
20	Cold Insulated high alloy Steel piping and Equipment (Upto 200 Deg. C)	Lightly Blast cleaned as per Sa 1.0 Swedish Standards SIS-05-5900 (Latest).	F8 : Two coats of high temperature epoxy phenolic (novolac)	F8 : 2 x 125 microns	Total dry film thickness of paint system: 250 microns	
21	DELETED					
22	Surface (CS) with Equipment with temp. Indicating paint from 220°C to 240°C treated at Manufacturer's shop	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	P1 : One coat of Ethyl Silicate zinc rich with solvent Primer meeting SSPC Paint 20 level 1 F6 : Temperature indicating paint	P1 : 75 microns F6 : 2 x 25 microns for each coat Total - 50 microns.	Total dry film thickness of paint system: 125 microns.	



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23	PACKAGE:					
a)	Surface(CS) with operating temperature upto 90°C treated at Manufacturer's shop	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	P2 : ONE coat of two pack zinc rich epoxy Primer meeting SSPC Paint 20 level 1 F1 : One coat of two packs. Polyamide Cured Epoxy. F5 : One coat of two pack aliphatic acrylic polyurethane	P2 : 60 microns F1 : 120 – 200 microns F5 : 60 microns	Total dry film thickness of paint system: 240 microns as per C4 – High Durability	Total dry film thickness of paint system: 320 microns as per C5 – High Durability
b)	Surfaces (CS) with operating temperature upto 91° C TO 200°C, treated at manufacturer's shop.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	P1 : One coat of Ethyl Silicate zinc rich with solvent Primer meeting SSPC Paint 20 level 1 F3 : Two coats of single pack special Oleouresinous based heat resistant ready mixed Aluminium Paint.	P1 : 75 microns F3 : 2 x 25 microns for each coat	Total dry film thickness of paint system: 125 microns.	
c)	Surface (CS) with operating temp. Over 200°C, treated at manufacturer's shop.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	P1 : One coat of Ethyl Silicate zinc rich with solvent Primer meeting SSPC Paint 20 level 1 F4 : Two coats of Heat Resisting Silicon Aluminium Paint.	P1 : 75 microns F4 : 2 x 25 microns for each coat Total - 50 microns.	Total dry film thickness of paint system: 125 microns.	
d)	Package in Carbon Steel and low Alloy Steel (1-¼ Cr through 9 Cr) with cold insulated surface treated at manufacturer's shop (Upto 60 Deg. C)	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	F7 : Two coats of Tar Free Epoxy paint suitably pigmented	F7 : 2 x 125 microns	Total dry film thickness of paint system: 250 microns.	
e)	Package in Cold Insulated high	Lightly Blast cleaned as per	F8 : Two coats of high temperature epoxy	F8 : 2 x 125	Total dry film thickness of paint	

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	alloy Steel. (Upto 200 Deg. C)	Sa 1.0 Swedish Standards SIS-05-5900 (Latest).	phenolic (novolac)	microns	system:250 microns
f)	DELETED				
24	For internal surface of shell, roof of CS tanks, with operating temp. Upto 110°C	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	F2 : Two coats of two pack amine adduct cured Phenolic (Novolac) epoxy (immersion grade)	F2 : 2 x 150 microns for each coat	Total dry film thickness of paint system: 300 microns.
25	For underside (soil side) of the tank bottom (CS) below only of the fixed tanks, bottom & shell shall be treated as follows:	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	F7 : Two coats of Tar Free Epoxy paint suitably pigmented OR F8 : Two coats of high temperature epoxy phenolic (novolac)	F7 : 2 x 200 microns OR F8 : 2 x 150 microns	Total dry film thickness of paint system: 400 microns. OR Total dry film thickness of paint system: 300 microns.
26	CS Equipment and associated piping subject to cyclic, intermittent or regeneration operating condition (e.g. Molecular Sieve Driers) subjected to very severe corrosion with wide operating temperature range.	Blast cleaning to near white metal grade 3, of Swedish Standards SIS-05-5900 (Latest).	Primer: One coat of Thermal spray Aluminium paint and sealed with a Silicon Aluminium seal Finish Coat: One coat of Thermal spray Aluminium paint and sealed with a Silicon Aluminium seal.	Primer: 125 microns Finish: 125 microns	Total dry film thickness of paint system 250 microns.

NOTES:

Primers

ZINC ETHYL SILICATE PRIMER – P1

The zinc ethyl silicate consists of two packs. One pack contains the ethyl silicate binder with suitable solvents. The other pack contains zinc dust (NOT Paste). Zinc dust shall be ASTM D

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520 Type II. They have to be mixed in suitable proportions before application as recommended by manufacturer.

Volume solids	:	Min.64% ±2
DFT Range	:	50 – 75 microns
Theoretical Spreading Rate	:	12.8 – 8.53 sqm/litre
Colour	:	Grey
Application	:	Spray (airless/air)
Drying time (dry to handle)	:	< 45 mins. @ 30 Deg. C and 65% RH
Curing	:	<16 hrs @ 30 Deg. C and 65% RH
% of total metallic zinc in dry film (As per the ASTM D520 – Spherical size)	:	(SSPC SP 20 Level 1) >85% by wt.
Specific Gravity	:	2.5 Kg/Litre min.
Storage life	:	6 months under sealed conditions

Zinc silicate Material curing shall be checked using ASTM D 4752, minimum Acceptable value is 4.

ZINC RICH EPOXY PRIMER – P2

The zinc rich epoxy consists of two packs. One pack contains the epoxy binder with suitable solvents. The other pack contains zinc dust as per ASTM D520 Type II. They have to be mixed in suitable proportions before application as recommended by manufacturer.



Volume solids	:	65% min. ±2
DFT	:	50 – 100 microns
Theoretical Spreading Rate	:	13 – 6.5 sqm/litre
Colour	:	Grey
Application	:	Airless spray/air spray/brush
Drying time (dry to handle)	:	<10 min. @ 30 Deg C
Hared Dry	:	< 1.5 hrs @ 30 Deg C
% of total metallic zinc in dry film (As per the ASTM D520 – Spherical size)	:	(SSPC SP 20 Level 2) 81% by wt. min.
Specific Gravity	:	2.3 Kg/Litre min.
Storage life	:	12 months under sealed conditions

Finish Paints

HIGH BUILD EPOXY FINISH – F1

This finish paint is fast drying, high build, Two-pack polyamide cured epoxy resin

Volume solids	:	85% min. ±2
DFT Range	:	100 – 200 microns
Theoretical Spreading Rate	:	7.6 – 3.8 sqm/litre
Colour	:	As per Manufacturer List
Binder	:	Polyamide cured epoxy resin, Lead & Chrome Free
Application	:	Brush or spray
Drying time	:	< 2 hrs @ 30 Deg C
Over coating time	:	< 2 hrs @ 30 Deg C
Storage life	:	24 months under sealed conditions

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HIGH BUILD EPOXY FINISH (Immersion Grade) – F2

This finish paint is high build, Two-pack phenolic (novolac) epoxy

Volume solids	:	68% min. ±2
DFT Range	:	100 – 150 microns
Theoretical Spreading Rate	:	6.8 – 4.5 sqm/litre
Colour	:	As per Manufacturer List
Binder	:	Amine adduct cured epoxy resin
Application	:	Brush or spray
Drying time	:	< 1.5 hrs @ 30 Deg C
Over coating time	:	< 6.5 hrs @ 30 Deg C
Storage life	:	24 months under sealed conditions



HEAT RESISTANT ALUMINIUM FINISH PAINT : F3

It is a single pack system based on oleo resinous general purpose aluminium paint with good heat resistance upto 250 Deg. C. and light reflection.

Volume solids	:	25% min. ±2
DFT Range	:	25 microns
Theoretical Spreading Rate	:	10 sqm/litre
Main pigment	:	Aluminium (ASTM 962), Lead & Chrome Free
Colour	:	Metallic Aluminium
Pigment Volume Concentration	:	15 – 20%
Application	:	Brush or spray
Drying time	:	Surface dry <1hr. @ 30 Deg. C Hard dry < 3 hrs. @ 30 Deg. C
Storage life	:	24 months under sealed conditions

HEAT RESISTANT SILICON ALUMINIUM FINISH PAINT : F4

It is a single pack system based on ambient curing silicone aluminium pigmented polysiloxane paint with maximum heat resistance of upto 600 Deg. C.



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Volume solids	:	25% min. ±2
DFT Range	:	25 microns
Theoretical Spreading Rate	:	10 sqm/litre
Main pigment	:	Aluminium (ASTM 962), Lead & Chrome Free
Colour	:	Metallic Aluminium
Pigment Volume Concentration	:	15 – 20%
Application	:	Brush or spray
Drying time	:	Surface dry < 1hr. at 30 Deg. C Hard dry < 3 hrs. at 30 Deg. C
Storage life	:	12 months under sealed conditions

TWO PACK ALIPHATIC ACRYLIC POLYURETHANE FINISH PAINT – F5

It Consists of Acrylic Resin in Part A. Part B consists of an aliphatic poly-isocyanate with appropriate solvents and additives.

Volume solids	:	51% min. ±2
DFT range	:	50 – 100 microns
Theoretical Spreading Rate	:	10.2 – 5.1 sqm/litre
Main pigment	:	Suitable pigments to get the desired colour, Lead & Chrome Free
Colour	:	Metallic Aluminium
Binder	:	Shall not contain any binder other than acrylic resin; should not contain any alkyd / acrylate alkyds / esters.
Application	:	Brush or spray
Drying time	:	Surface dry < 1hr. @ 30 Deg. C Hard dry < 8 hrs. @ 30 Deg. C
ISO 11507/ASTM G 154, QUV A -	:	Gloss retention: approx. 80 % and colour change approx. DE 1.2 after 3000 hours

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Accelerated weathering		exposure
Storage life	:	24 months under sealed conditions

TEMPERATURE INDICATING PAINT : F6

It is a single pack temperature indicating system based on silicone binder. Pigments change colour by heating. The colour change of the coating is permanent. At approximately 200°C, the colour changes from green to blue, above 310°C, the colour changes from blue to greyish white. Maximum service temperature is 400°C.

Volume solids	:	40% min.
DFT	:	25 microns
Theoretical Spreading Rate	:	16 sqm/litre
Main pigment	:	As per shade requirement, Lead & Chrome free
Colour	:	As per manufacturer
Binder	:	Based in silicone Resins
Application	:	Brush or spray
Drying time	:	Surface dry < 1hr. @ 30 Deg. C
		Hard dry < 4 hrs. @ 30 Deg. C
Storage life	:	12 months under sealed conditions



TAR FREE EPOXY – F7 (Coal Tar is Banned Globally being Carcenogenic)

A high build two component abrasion resistant, pure epoxy with anti-corrosive properties meant for excellent performance.

Volume solids	:	Minimum 72%
DFT Range	:	150 – 200
Theoretical Spreading Rate	:	4.8 – 3.6 sqm/litre
Application	:	By brush or airless spray
Drying time	:	Touch Dry within 4 hrs. @ 30 Deg C
		Hard dry < 9 hours @ 30 Deg. C
Storage life	:	12 months under sealed conditions

EPOXY PHENOLIC (NOVOLAC) – F8

Two Pack epoxy-phenolic (novolac) cured with amine adduct used as an External coating for the protection of insulated (CUI) equipment.

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Volume solids	:	68% min.
DFT Range	:	100 – 150 microns
Theoretical Spreading Rate	:	6.8 – 4.5 sqm/litre
Binder	:	Epoxy phenolic (novolac)
Dry Temp. Service	:	Min. -196 to max. 205 Deg. C.
Application	:	Airless Spray / Brush Touch up
Drying Time	:	Surface dry < 1.5hr. @ 30 Deg. C
		Hard dry < 6 hours @ 30 Deg. C
Storage life	:	12 months under sealed conditions

INORGANIC CO-POLYMER COATING – F9

MIO pigmented single component inorganic copolymer coating which cures to form an in polymer matrix able to resist temperatures up to 650°C/1202°F and thermal shock/cycling dry or dry/wet service.

Volume solids	:	74% min.
DFT Range	:	150 microns
Theoretical Spreading Rate	:	5 sqm/litre
Binder	:	Inorganic copolymer coating
Dry Temp. Service	:	Min. -196 to max. 650 Deg. C.
Application	:	Airless Spray / Brush Touch up
Drying Time	:	Surface dry < 0.5hr. @ 30 Deg. C
		Hard dry < 1.5 hours @ 30 Deg. C
Storage life	:	12 months under sealed conditions

6.0 MACHINERY, ELECTRICAL AND INSTRUMENT EQUIPMENT:

6.1 Machinery

Steel surfaces shall be treated with complete paint system at Manufacturer's shop. The paint system shall be according to Manufacturer's Std. However, suitable for operating condition and the environmental condition where the machinery will operate. Where necessary machinery shall be restored at site by Contractor with suitable finish.

6.2 Electrical and Instrument Equipment

Steel surfaces shall be treated with complete paint system at Manufacturer's shop. The paint system shall be according to Manufacturer's Std., however suitable for operating condition and the environmental condition where the electrical and instrument equipment will operate. Where necessary Electrical and Instrument Equipment shall be restored at site by Contractor with suitable finish.

7.0 COLOURS:

These shall be as required by specification and in particular for:

Description	Colour	Ra1	Correspond. Asian Paint colors to be defined – See Note-2



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Description	Colour	Ra1	Correspond. Asian Paint colors to be defined – See Note-2
- Piping with temperature less than 90°C	GREY	7035	
- Piping, hot surface, flue gas ducts and stacks with temperature above 90°C	SMOOTH	ALUMINIUM	“
- Cooling Water Piping	SEA GREEN		“
- Fire fighting Piping	Red	3002	“
- Structures	GREY	7010	“
- Stair cases – ladders	BLACK	9005	“
- Walkways	GREY	7010	“
- Handrails assemblies	YELLOW	1004	“
- Equipment	GREY	7035	“
- Hot equipment	SMOOTH	ALUMINIUM	“
- Fire fighting equipment	RED	3002	“
- Valves in general	GREY	7035	“
- Hot valves	SMOOTH	ALUMINIUM	“
- Safety and Fire fighting valves	RED	3002	“
- Valves handwheels	BLACK	9005	
- Electric Rotary Machines	SKY BLUE	5012	
- Electric Static Machines	GREY	7035	
- Machinery (compressors & pumps) with operating temperature less than 90°C	GREY	7035	“
- Machinery (compressors & pumps) with operating temperature above 90°C	SMOOTH	ALUMINIUM	“
FURNACES			
- Casing and connected steel works	SMOOTH	ALUMINIUM	“
- Steel work not connected to casing	SMOOTH	ALUMINIUM	“
AIR COOLER			
- High Temperature Surfaces (Temp. > 90°C)	SMOOTH	ALUMINIUM	
- Low Temperature surface (Temp. ≤ 90°C)	GREY	7035	“
- Flare ≤ 90°C	GREY	7035	“
- Flare ≥ 90°C)	SMOOTH	ALUMINIUM	“
TANKS			
- Shell of fixed roof	WHITE	9010	“

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Description	Colour	Ra1	Correspond. Asian Paint colors to be defined – See Note-2
- Roof of fixed roof tank	WHITE	9010	

NOTE-1: The colours shall be according to IS2379:1990/International STD. RAL or BS, proposed by Contractor or Manufacturer

8.0 PARTICULAR DESCRIPTION

The abrasive Grit Blasting shall be used for surface preparation. **Sand blasting is prohibited due to environmental regulations.**

Primerized surface shall be faultless and shall not have mud-cracking, dripping over thickness and dry sprays.

Blast cleaning and painting shall not be carried out on wet surfaces.

Blast cleaning shall not be done when surfaces temperatures are less than 3°C above dew point, or temperature is below 5°C.

No acid washes or other cleaning solutions or solvents shall be used on metal surfaces after they have been blasted.

The surface preparation of all steel surfaces to be coated shall be free of all mill scale, rust corrosion product, oxides, paint, oil or other foreign matter

Only dry abrasive blasting procedures will be allowed. The compressed air supply used for blasting shall be free of detrimental amounts of water and oil. Adequate separator and traps shall be provided and these shall be kept emptied of water and oil. Any blast cleaning set up without functioning moisture separators shall be removed from blast cleaning areas.

All welded areas and appurtenances shall be given special attention for removal of welding flux in crevices. Welding splatter, slivers, laminations and underlying mill scale exposed during sand blasting shall be removed or repaired.

The blast-cleaned or power brushing surfaces shall be coated with primer within four hours of surface preparation.

No primer or intermediate or finishing coating shall be applied without prior notification to the Company.



The application of the products shall be carried out in strict compliance with the paint manufacturer's recommendation.

The Contractor shall provide suitable protection for all adjacent plants or equipment from airborne during spraying and sand blasting.

9.0 INSPECTION AND TESTING

The inspection and testing requirements outlined in this section shall be performed for shop and site applied coating systems.

Preference shall be given to manufacturers and applicators that are quality certified to ISO 9001: 2000.

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Documentation of coating material manufacturers and applicators shall include daily inspection reports, equipment reports, and shall clearly identify and trace materials supply and testing performed on coated items and areas.

Inspection and Test Plans (ITPs), and quality control procedures used for application of coating systems shall form part of the Method Statement and shall be submitted for approval by the Principal prior to commencement of work.

The applicator shall appoint a certified inspector of coatings for inspection and testing of coating systems.

Tests of coated areas and items shall form part of the ITPs.

- Surface Preparation in accordance to Swedish Standard SIS-05-5900 (Latest).
- Blast cleaning profile shall be checked using a suitable profile meter – Acceptable profile shall be 40 - 60 microns.
- Check of time of top coating and drying in accordance with the direction of the paint manufacturer.
- Check of dry film thickness by suitable non-destructive Instrument such as “MIKROTEST”, “DIAMETER” or equivalent.
- Before any coating work is performed on the site, the contractor shall ensure that any works applied by others is acceptable.

Any defect that are discovered, are to be notified in writing to the owner before proceeding with the contract work. To ensure the good execution of painting work following test shall be performed:

- Surface Preparation
- Surface contaminant tests
- Surface profile tests
- Coating thickness tests
- Tests for cure of coatings
- Adhesion tests
- Continuity testing
- Iron contamination
- Chloride contamination
- Dust Contamination



All Inspection and Test Records (ITRs) shall be submitted with the Manufacturer’s Data Report (MDR) at the conclusion of the job.

Defective coated areas shall be suitably marked for rectification work to be performed in compliance with this specification.

Access shall be granted for inspection of all paint work, and witnessing of test work. This shall not however relieve the Contractor of their own QA/QC responsibilities.

10.0 ADHESION TEST RESULTS

For all type of primer the Contractor shall guarantee the Classification of Adhesion Test Results as per ASTM D3359. The acceptable Rate Adhesion Test Results shall be for sandblasted and primerized surfaces shall be minimum 3A (or Higher)

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For primer plus finishing coat(s) the Contractor shall guarantee the Classification of Adhesion Test Results as per ASTM D 3359. The acceptable Rate Adhesion Test Results shall be for blast cleaned and painted surfaces shall be minimum 3A (or higher).

After test, the surface must be repaired according to the system applied.

11.0 SUBMISSION OF DATA

Contractor shall submit in phase of bid the original technical data sheet and system for all material supplied by him to apply for the permanent works and test report for the paint in compliance to IS101. This material shall be subject to Owner's approval.

The test certificates of zinc silicate shall provide the specific gravity of mixed paint.

12.0 LETTER AND NUMBER INSCRIPTION

Inscriptions letters, as herebelow indicated, shall be made on equipments, piping, storage tanks, machinery etc.

12.1 Geometric forms and dimensions

Letters and numbers dimensions shall be orientatively fixed according to following:

(A – Dimension of side of unitary elements of grid)

- a) Storage Tanks A – 60 mm
- b) Equipments and piping with O.D. above 600 mm A– 40 mm and
- c) Equipments and pipings with O.D. from 300 to 600 mm and for machinery of great dimensions A – 20 mm
- d) Equipments and pipings with O.D. less than 300 mm and for machinery with small dimensions A – 10 mm

12.2 Inscription's Colours

Inscriptions shall be Black ENI 901 (RAL 9005) on light base

Inscriptions shall be White ENI 101 (RAL 9010) on dark base

12.3 Spaces and Interspaces



Spaces between words and assemblage of numbers shall have dimensions equal to 2A

Interspaces between letters or numbers shall have dimensions equal to A.

13.0 Colour Band for piping :-

As a rule minimum width of colour band shall confirm to the following Table:-

Nominal pipe Size	Width L (mm)
3" & below	25
4" NB-6" NB	50
8" NB-12"NB	75

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14" OD & above	100
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14.0 LIST OF MANUFACTURERS :

1. M/s Berger Paints
2. M/s Jensions & Nickolson
3. M/s Jotun Paints
4. M/s Asian Paints
5. M/s Grauer & Weil (India) Limited
6. M/s Shalimar paints
7. M/s Garware Paints
8. M/s Goodlass Nerolac Paints Ltd
9. M/s. HEMPEL Paints
10. M/s International Paints (Akzo Nobel Brand)
11. M/s Carboline (India) Pvt. Ltd.
12. M/s Mohan Paints

15.0 The contractor shall obtain prior approval from Engineer-In-Charge for the brands of paint material proposed to be used. The contractor shall submit the following details of paint material either at the time of bidding or soon after award of work for approval of paints.

- a. Technical data sheet
- b. Material safety data sheet
- c. Finger printing of paint products as per ISO 20340

16.0 Owner reserves the right to take random samples and get it tested through reputed labs. In case the supplied paint material do not meet the specified performance requirements then suitable action shall be taken against the paint supplier. The decision of Engineer-In Charge shall be final and binding on the Contractor in such cases

17.0 WARRANTY:

Contractor along with Paint Manufacturer jointly shall develop the paint schemes following the system specification.

They shall jointly provide a performance guarantee for a period 5 years as stipulated below,

After 1 years – Corrosion in 3% of total painted area accepted



After 2 years – Corrosion in 6% of total painted area accepted

After 3 years – Corrosion in 9% of total painted area accepted

After 4 years – Corrosion in 12% of total painted area accepted

After 5 years – Corrosion in 15% of total painted area accepted

where spontaneous visible corrosion has broken down the paint film to a degree exceeding “Ri 3” (as defined in ISO 4628/3-2003).



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ANNEXURE- 7 - 3

QUALITY CONTROL PROCEDURE AND INSPECTION REQUIREMENTS

1.0 LSTK CONTRACTOR'S QUALITY CONTROL

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1.1 LSTK CONTRACTOR shall provide a quality control program manual include specific WORK methods and inspections, which assure quality.

This quality control program manual must be submitted to OWNER for Approval before starting the construction activities.



All installation WORK must be in strict accordance with this approved manual.

1.2 The quality control program shall include as a minimum the following:

- Methods use to control drawings; specifications and CONTRACT correspondence to assure that only the latest revisions are being used in the field.
- Inspection personal name, organization.
- Inspection methods and documentation of inspection (or tests) for shop fabrication, if required, and installation.
- Material control procedures from SITE receiving point, through "over, short and damage inspection" through storage and through installation.
- Positive material identification Procedures for:
 - Electrical cable pulling and testing.
 - Asphalt placement inspection.
 - Handling and storage methods to prevent damage.
- Inspection and testing procedures and reports for civil, structural, piping, electrical, instrument, equipment and all installation WORK.
- Repair.
- Scrap and reject.
- Grouting.
- Welding.
- Welder qualification.
- Receiving all permanent plant material & equipment.
- Rigging.
- Welder's tests.
- Nondestructive examinations to be used.
- Positive material identification. etc.
- Identification of LSTK CONTRACTORS and ensuring their compliance with the manual and WORK required.
- Material certification verification methods.
- Calibration procedures for measurements and test equipment.
- Marking and identification of components in process and complete assemblies.

2.0 Shop fabrication and field installation inspection OWNER'S REPRESENTATIVE to ensure specifications. in the following areas will be performed by full adherence to Receiving and inspection.

- Calibration of test inspection equipment.
- Preventive maintenance and storage protection.

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- Internal cleanliness.
- Proper material use and control.
- Nondestructive testing and its results.
- Workmanship.

3.0 OWNER'S REPRESENTATIVE or others as authorized by OWNER are to be permitted access to LSTK CONTRACTOR'S work areas for the purpose of inspection of material, equipment, documentation and other areas as required in LSTK CONTRACTOR'S quality assurance / quality control program.

4.0 No concrete will be placed by LSTK CONTRACTOR without an OWNER "Pour Release Form".

5.0 OWNER'S construction inspections will not relieve. LSTK CONTRACTOR of inspection or other responsibilities.

6.0 For piping all welders test pieces shall be supplied by LSTK CONTRACTOR and fully prepared for welding by LSTK CONTRACTOR.

7.0 LSTK CONTRACTOR shall evidence its familiarity and experience with the execution of the installation of WORK to the requirements of the applicable codes and shall perform its WORK in accordance to these requirements and to instructions issued by OWNER'S REPRESENTATIVE in this regard.

8.0 **CHECK ON QUALITY OF WORK**

8.1 OWNER'S REPRESENTATIVE'S inspector shall have free access to the place where the WORK is performed at all times, in order to check the quality of WORK

8.2 If during inspection / check reveals unsatisfactory WORK, LSTK CONTRACTOR shall immediately at LSTK CONTRACTOR'S expense. take such corrective measures as deemed required.

9.0 **CONTROL SYSTEMS**

LSTK CONTRACTOR shall initiate and maintain the following control systems

9.1 **Backfilling**

- Compaction tests.

9.2 **Concrete**

- Design mix and approval record(s).
- Batch plant inspection record.
- Slump test record.
- Compressive test record.
- Pour release record.
- Grouting release record.
- Placement inspection records.
- Concrete curing records.

9.3 **Asphalt**

- Design mix and approval records.
- Batch plan inspection records. Placement inspection records.



9.4 **Piping**

- Weld x-ray file.
- Pipe and fitting certificate file.
- Isometric weld control sheet. Hydrostatic test records.

9.5 **Grounding**

Earth resistance test records.

9.6 **Electrical Cable and Instrument cable**

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- Insulation resistance test records.
- Continuity test records.

9.7 **Material certification files**

9.8 **Equipment**

- Weld x-ray file.
- Material certificate files.
- Equipment installation records.
- Equipment maintenance record.
- Hydrostatic test records.
- Grouting release records.
- Alignment records.
- Vibration records.

10. **Requirements for Certification of Materials**

10.1 Mill certification of materials will be required based on the material type, the use and the codes and requirements.

10.2 LSTK CONTRACTOR shall provide:

Type A certification of compliance, for all but not limited to the following materials which LSTK CONTRACTOR is responsible to supply:

- Imported backfill materials.
- Ready mix concrete.
- Asphalt paving materials
- Prefab concrete items, including pre-cast manholes, catch basins, pits, sumps and sleepers.
- Paving stones and tiles.
- Inserted and embedded items, other than rebar, wire mesh and anchor bolts.
- Masonry blocks.
- Steel sliding plates.
- Special grouting materials, i.e. non-shrink type.
- Grouting materials, including grounding loop and branch wire which they are LSTK CONTRACTOR'S supply.

Type "B "certificate, for all but not limited to the following materials, which LSTK CONTRACTOR is responsible to supply:

- Materials to be considered structural or structural grade.
- Reinforcing grade.
- Wires mesh reinforcement fabric.
- Anchor bolts.



10.3 **Definition of Type of Certificates**

Type A (certificate of Compliance):

This is a certificate of compliance, issued by the manufacturing or processing works and signed by the quality department or persons to carry the responsibility for quality and conformity, stating that the materials) supplied correspond (5) with what was agreed in the purchase order.

Type B (mill Certificate) :

This is a certificate on which the manufacturer's head of quality department confirms that the product supplied corresponds with what has been agreed in the purchase order. Certification

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shall be on the basis of tests carried out on the material of the product itself, as per purchase order specification. The testing and certification are to be carried out by a testing center which is independent of the production section of the manufacturing works and which has the code-approved facilities. Independence of such testing center should be warranted by LSTK CONTRACTOR.



- 10.4 LSTK CONTRACTOR will maintain a systematic filing system of all certificates and reports for all tests and inspections carried out by it under the applicable specifications, standards and codes of practice quoted therein.

LSTK CONTRACTOR may use its own format for records but this must be submitted to OWNER'S REPRESENTATIVE for his approval prior to use.

LSTK CONTRACTOR can expect to be audited on a continuous basis. Originals of all documents to be sent to OWNER'S REPRESENTATIVE.

ANNEXURE- 7 – 4

SCHEDULE, PROGRESS EVALUATION AND PROGRESS REPORTING

	CONSTRUCTION/ERECTION, PRE-COMMISSIONING, COMMISSIONING AND START-UP INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/10.0	0	
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1.0 GENERAL

1.1 WORK shall start and be completed in the field as indicated on the approved project construction schedule.

LSTK CONTRACTOR shall follow the sequence of construction in executing the WORK as shown in the schedule or as modified by OWNER.

The detailed scheduling of WORK will be supplied by the LSTK CONTRACTOR. WORK shall be conducted in such a manner that other construction activities are not affected.

Once detailed schedule, established and approved by OWNER, LSTK CONTRACTOR commits itself to follow the schedule in detail.

2.0 DETAILED & SCHEDULE

2.1 Detailed construction schedule must cover all construction work, from lowest level up to highest level.

2.2 Activities shown by means of a bar chart must include as a minimum the activities listed in 4.

3.0 PROGRESS REPORTING

LSTK CONTRACTOR shall issue a reporting procedure and a representative sample of all progress reports.

Following schedules and reports must be issued by LSTK CONTRACTOR to OWNER:

Construction schedule. (preliminary and detailed)
Monthly status report.
Weekly progress report.
Monthly construction guide schedule.
Daily manpower reports.



All except detailed construction schedule based on approved project construction schedule.

4.0 CONSTRUCTION SCHEDULE

Within **Two** months after Effective Date, LSTK CONTRACTOR will issue separate graphical "S" curves for the following work activities of total CONTRACT.

Installation of :

- Concrete foundations, pits. manholes. catch basins, trenches and concrete structures.
- Prefabricated concrete items
- Concrete paving and elevated slabs
- Other paving and final surfacing
- Grouting.

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- Final road paving.
- Underground piping.
- Underground cable trenches and cables.
- Building erection.
- Structural steel erection.
- Engineering and design of small bore carbon steel piping systems.
- Prefabrication of piping.
- Electrical installation.
- Instrument installation.
- Equipment assembly and elect
- Erection of piping.
- Flushing and cleaning
- Hydro-testing
- Painting
- Insulation.

5.0 INTRODUCTION

The introduction to the monthly status report shall include LSTK CONTRACTOR'S comments on the overall construction schedule with a status update line as attachment, and shall consist of the following items:

- Goals achieved last month.
- Goals for next month.
- Reason for delay, if any. Reason for deviation of original schedule.
- Average manpower by craft, including management and indirect staff.
- LSTK CONTRACTOR'S comments to general situation.

6.0 CONSTRUCTION ACTIVITIES STATUS

This section consists of scheduled versus actual progress curves.



The progress curves are to be commented upon by LSTK CONTRACTOR.

The basis for reporting shall be the construction schedule:

The monthly status shall be reported as a percentage of the total WORK per type of WORK.

7.0 MANPOWER AVAILABILITY / REQUIREMENTS FOR THE MONTH COMING

LSTK CONTRACTOR shall submit its manpower availability requirements for the next month. This section consists also of the scheduled versus the actual manpower curves.

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These manpower curves are accompanied by LSTK CONTRACTOR'S comments hereon.

8.0 MAIN CONSTRUCTION EQUIPMENT AVAILABILITY / REQUIREMENTS FOR THE MONTH COMING

LSTK CONTRACTOR shall submit its main construction equipment availability / requirements for the next month. This section consists also of the scheduled versus actual construction equipment requirement curves. These by LSTK CONTRACTOR'S comments hereon.

9.0 WEEKLY PROGRESS REPORT

Progress reporting will be done on a weekly basis by the actually completed work based on details of work such as quantities or piece of equipment as a percentage of the total anticipated work per work activities as defined in item 4.

9.1 Progress will only be reported on the basis of completed activities as per the percentage breakdown of the major steps as follows:

Progress Measurement Parameters

Actual physical progress in the field shall be measured based upon standard percentage of completion of progress stages, that, they are to be prepared by LSTK CONTRACTOR and Approved by OWNER to calculate actual physical progress of the WORK, the exact weight value of each activity from lowest level up to highest level in each category of the WORK shall be specified by LSTK CONTRACTOR and supplied to OWNER.

After OWNER'S Approval this weight value can be used for calculation of actual progress of the WORK

10.0 WEEKLY PROGRESS MEETING

10.1 Weekly Work List

In the weekly progress review meeting LSTK CONTRACTOR shall forecast the WORK it plans to perform during the week by means of a weekly WORK list including its manpower resource allocation as per the activities listed in 4 and 6.



This weekly program shall be in accordance with the construction guide schedules.

10.2 Work Front

LSTK CONTRACTOR shall submit monthly and weekly a total recapitulation Of the total work front available with estimated manpower requirements, materials and equipment which shall be supplied by LSTK CONTRACTOR.

11.0 MONTHLY CONSTRUCTION GUIDE SCHEDULE

Based on approved overall construction schedule, LSTK CONTRACTOR must issue a

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monthly construction guide schedule covering a two (2) months period, for each individual activity.

Progress updating of construction guide schedules must be weekly and presented in the weekly progress review meeting at site.

The updated issue will show for each individual activity:



- Percent complete.
- Weight factor complete.

12.0 DAILY MANPOWER REPORTS

LSTK CONTRACTOR shall be furnished daily manpower report as per agreed format.

ANNEXURE- 7 – 5

EXECUTION PLAN

	CONSTRUCTION/ERECTION, PRE-COMMISSIONING, COMMISSIONING AND START-UP INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/10.0	0	
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1.0 BIDDER ORGANISATION

1.1 Company Organisation

Bid shall include a description of the organization, its management structure and organization chart of Bidder's company with particular reference to the means whereby the execution of this project will be related to the overall company organization.

The Bidder shall also furnish the name(s) of their partners, associated/ subsidiary companies & their activities, and whether any such associated/ subsidiary company will be involved in the execution of WORK, and if so, their scope thereof.

1.2 Project Organization

Bidder shall give charts of organization, which he intends to use in the execution of the work. Such charts must show lines of authority and communication of senior personals who will be assigned to this work in Bidder's home - office and other offices where WORK shall be performed (if any) and the lines connecting such Project Organization to the Bidder's internal overall organization including partners (if any). The chart shall be supported by a narrative, which shall explain how the proposed organisation will operate and in particular will provide

The name of the location of the office(s) in which the Basic and Detail Engineering Design Packages of the plant shall be carried out.

If any parts of the Basic and Detail Engineering Design Packages are to be carried out in more than one office, then details of the distribution of the jobs between offices and coordination procedure shall also be presented.

A description of the facilities offered to the OWNER'S resident engineers.

2.0 Estimated project and Engineering man-hours

Bidder shall give an estimate of the engineering man-hours and its break down for all activities

3.0 Methods and procedures

Bidder shall summarise the methods and procedures that BIDDER intends to implement during the performance of the WORK. It shall include the proposed procedures such as Engineering, Procurement, construction strategy, WORK Progress Measurement, Pre-commissioning, Commissioning and Performance Test Run of the PLANT, and Training.

BIDDER shall also furnish proposed procedures for the Project management, communication and method and frequency of reporting the progress of the WORK.



The final form for reports, which will be subject to OWNER's Approval, shall include as a minimum the following :

- a) Planning and Scheduling
- b) Work Progress
- c) Safety and Security

NOTES:

- a) Sample reporting forms and other key standard forms shall be included.
- b) Bidder shall state the extent to which he will be using computerized drafting, etc.

4.0 Job descriptions and personnel resumes

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Bidder shall include job descriptions and personnel resumes of his staff nominated to the key positions, including (where applicable) at least the followings, or Bidder's equivalent:



Project director
 Process engineering co-ordinator
 Construction manager
 Process engineer
 Project engineering co-ordinator
 Senior pre-commissioning engineer
 Senior commissioning engineer
 Training co-ordinator and instructor.
 Construction Engineering Coordinator
 Construction Quality Control Engineer
 Construction Project Control Engineer
 Welding Specialists
 Heavy Lift Rigging Specialist
 Senior Specialist Engineers
 Senior Planning Engineers
 Materials Coordinators
 Senior Construction Engineers
 Senior Pre-commissioning Engineers
 Warehousing Officer
 Material Planning Engineers

Resumes shall give at least the name, age, nationality, education, professional exception/deviation and previous experience of each assigned personnel. Additionally, one alternative shall be offered for each position. **Bidder shall ensure that personnel to be deployed meet the minimum criteria specified in Annexure-7-6**

Bidder shall confirm that these key personnel will be made available to WORK on the Project as required by the schedule on full time basis.

Bidder shall furnish Summary of its Deployment Schedule Personnel as per **Annexure-7-7**.

Bidder understands that the said proposal represents the minimum deployment and the Bidder acknowledges that the said deployment may have to be augmented with additional number and/or categories, if required, if directed by Engineer-in-Charge in order to complete the work within the completion schedule and quoted lump sum price.

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5.0 Construction equipment and machinery

The BIDDER shall furnish details of construction equipment & machinery, testing equipment, tools/tackles, etc., which will be made available by the Bidder at the Site. Bidder shall furnish Summary of such details as per **Annexure-7-8, Annexure-7-9**.

Such list shall, in no way limit the CONTRACTOR's responsibility to arrange & provide any additional construction equipment, tools, tackle, etc., which might be required to execute and complete the WORK as per contractual schedule.

BIDDER shall furnish the procedures and his tools for erection of the Heavy Lift Equipments including tall columns):

6.0 Heavy lifts

BIDDER shall furnish his proposed, site transportation, lifting, along with preliminary rigging schemes and erection procedure for the heavy lifts. Such plans / schemes shall be furnished along with detailed write -up on heavy cranes proposed to be deployed by CONTRACTOR, duly supported by relevant technical literature.

7.0 BIDDER experience & exception/deviation to perform the work

The BIDDER should have experience in the construction of similar Plants. The BIDDER should have successfully executed and completed construction of at least one similar Plant with his own project management and with complete responsibility of construction / erection and pre-commissioning.

The BIDDER shall furnish, as a part of his Tender Documents establishing the BIDDER'S experience and exception/deviation to perform the CONTRACT. Such documentary evidence shall also establish to OWNER's satisfaction that the BIDDER has the necessary financial, technical, project management capabilities and the requisite resources to execute the Work.

Such documentary evidence shall also be furnished for BIDDER'S proposed Subcontractors, if any. The Bidder shall furnish, in a tabular form, a list of jobs of similar type and magnitude executed by them in the past. BIDDER shall also furnish details of their experience in erection of heavy lifts. The Bidder shall furnish documentary evidence, establishing to OWNER satisfaction, that such jobs have been timely and successfully executed by them. The BIDDER shall also furnish the details of their present major commitments.

8.0 QA/QC Program

Bidder shall furnish a summary description of their proposed QA/QC program.

Bidder shall furnish any other technical information / details as per the requirements of ITB.



9.0 Technical assistance

The extent of the Technical Services and Assistance to be rendered by CONTRACTOR for, commissioning and performance test run, etc., is to be proposed

10.0 Training

Bidder shall furnish the following details regarding the Training of OWNER'S personnel:

- a) Bidder's organisation set up for Training program.
- b) Training facilities available with the Bidder to train the OWNER'S personnel in

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- Theory of process, operation, maintenance and manufacturing of products
- Field (on the job) training in process, operation, maintenance and manufacturing of products, to train the personnel on the job.

- Test procedure and other matters.

c) The courses and their duration, number of attendees in each course and location where such courses will be held that the Bidder would recommend OWNER to consider.

d) Bidder's experience of training the personnel for units similar to the subject PLANT.

11.0 Estimate of the number of personnel required for the safe and satisfactory operation of the Plant.

For and on behalf of



Stamp & Signature :

Name :

Designation :



Date :

ANNEXURE-7-6

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Minimum Qualification & Exp. Of Key Supervisory Construction Personnel

<u>SL. NO.</u>	<u>CATEGORY</u>	<u>QUALIFICATION & EXPERIENCE</u>
1	RESIDENT CONSTRUCTION MANAGER / RESIDENT ENGINEER / SITE-IN-CHARGE	Degree in Engg. With minimum 20 years relevant experience in construction should successfully constructed & commissioned at least one process unit in hydrocarbon / fertilizer sector.
2	LEAD DISCIPLINE ENGINEER	Degree in relevant Engg. discipline with minimum 15 years experience in Construction or Diploma in relevant Engg. Discipline with minimum 20 years experience in Construction.
3	LEAD WELDING / NDT ENGINEER	Degree in Mechanical Engg./Metallurgy with minimum 15 years experience in Welding / NDT (Non-Destructive Testing) plus Level-II in RT (Radiographic Testing) or diploma in Mechanical Engg. / Metallurgy with minimum 20 years experience in Welding / NDT plus Level-II in RT.
4	LEAD QA/QC ENGINEER	Degree in Engg. With 15 years Construction Experience of which 5 years should be as QA Manager.
5	LEAD PLANNING ENGINEER	Degree in Engg. With 15 years experience in Planning & Scheduling.
6	LEAD SAFETY OFFICER	Degree / Diploma in Engg. And Diploma in Industrial Safety with min. 10 years relevant experience in Construction Safety.
7	WAREHOUSE-IN-CHARGE / MATERIALS MANAGER	Graduate in Science or Diploma in Engg. / Materials Management with 15 years experience in Warehousing / Stores Management of similar nature.
8	DISCIPLINE SURVEYORS	Degree in relevant Engineering Discipline with minimum 3 years experience in Construction or diploma in relevant Engineering Discipline with minimum 6 years experience in Construction.
9	QUANTITY SURVEYORS	Degree in relevant Engineering Discipline with minimum 3 years experience or diploma in relevant Engineering Discipline with minimum 6 years experience in quantity estimation, field measurement, rate analysis etc. in construction field.

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ANNEXURE-7-7
Deployment Schedule of Supervisory Personnel

SL. NO.	DESCRIPTION	DEPLOYMENT SCHEDULE																											TOTAL
		1	2	3	4	5	6	7	8	9	10	:	:	:	:	:	..	:	..	:	:	..	35	36	37		
1	PROJECT MANAGEMENT																												
1.1	PROJECT MANAGER																												
1.2	PLANNING MANAGER																												
1.3	PLANNING ENGINEERS																												
2	RESIDUAL DESIGN AND DETAILED ENGINEERING																												
2.1	PROJECT ENGINEERING MANAGER																												
2.2	ENGINEERING COORDINATOR																												
2.3	ENGG. PERSONNEL FOR VARIOUS DISCIPLINE																												
2.3.1	CIVIL STRUCTURAL																												
(i)	ENGINEERS																												
2.3.2	PRESSURE VESSELS																												
2.3.3	MECHANICAL EQPT/ ROTARY EQPT.																												
2.3.4	PIPING																												
(i)	ENGINEERS																												
2.3.5	ELECTRICAL																												
(i)	ENGINEERS																												



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INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL

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4.10	SITE ENGINEERING WORKS																			
4.10.1	ENGINEERS																			
4.10.2	SUPERVISORS																			
4.11	COMPUTER ENGINEER																			
4.12	ADMINISTRATION MANAGER																			
4.13	MISCELLANEOUS																			
4.14	WAREHOUSE PERSONNEL																			
4.15	MATERIAL MANAGER																			
4.16	COMMISSIONING																			
i)	COMMISSIONING COORDINATOR																			
ii)	COMM ENGINEER (SHIFT-IN-CHARGE)																			
iii)	CONTROL ROOM COORDINATOR																			
iv)	FIELD SUPERVISOR																			
v)	TECHNICIAN																			



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ANNEXURE-7-8
Deployment Schedule of Construction Equipment

SL. NO.	DESCRIPTION	CAPA-CITY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	..	33	34	35	36	37	TOTAL
			1	CRANES																				
1.1	1200 MT																							
1.2	700 MT																							
1.1	500 MT																							
1.2	300 MT																							
1.3	150 MT																							
1.4	75 MT																							
1.5	50 MT																							
1.6	20 MT																							
1.7	15 MT																							
1.8	10 MT																							
1.9	5 MT																							
2	DIESEL GENERATORS																							
2.1	500 KVA																							
2.2	300 KVA/250KV																							
2.3	150 KVA/125KV																							
3	COMPRESSORS																							
3.1	600 CFT																							
3.2	350 CFT																							
4	WELDING M/CS																							
4.1	DIESEL WELDING M/C																							
4.2	DIESEL GENERATOR																							



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4.3	WELDING TRANSFORMERS/RECTIFIERS																							
4.4	TIG WELDING M/CS																							
5	GRIT BLASTING M/CS																							
6	SPRAY PAINTING M/CS																							
7	STRESS RELIEVING M/CS																							
8	RADIO-GRAPHY M/CS																							
9	TEST PUMP																							
10	WATER PUMP																							
11	TRANSPORTATION EQPT																							
11.1	TRACTOR -TRAILOR																							
11.2	TRUCKS																							
11.3	BUS																							
12	JACKS																							
12.1	MECHANICAL																							
12.2	HYDRAULIC																							
13	CIVIL																							
13.1	EXCAVATORS																							
13.2	DUMPERS																							
13.3	BATCHING PLANT																							



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13.4	CONCRETE PUMP CAR																							
13.5	TRANSIT MIXER																							
13.6	MIXER																							
13.7	VIBRATORS																							
13.8	COMPACTORS																							
13.9	THEODOLITES																							
14.0	OTHERS																							
14.1	INSULATION TESTING EQUIPMENT																							
14.2	SECONDARY INJECTION TESTING KIT																							
14.3	METERS, TOOLS & TACKLES ETC.																							
14.4	CALIBRATION EQUIPMENT																							
14.5	OTHER TOOLS & TACKLES																							
14.6	MULTI METERS CALIBERATORS ETC.																							
14.7	INDUCTION PIPE BENDING PLANTS																							
14.8	METALOGRAPHY																							
14.9	SPECTRO-METERS																							

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ANNEXURE-7-9

Details Of Equipment Proposed to be used for Tendered Work

I / We, shall use the following MAJOR equipments owned by the tenderer for the work, if awarded to me /us :

Sl. No	Description	Quantity. (Numbers)	Make	Capacity	Owner	Approximate date when it will be deployed at site	Period of retention at site



For and on behalf of

Stamp & Signature :

Name :

Designation :

Date :

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PART II: TECHNICAL

SECTION – 11.0

SITE WORKING AND SAFETY CONDITIONS

**PLANT: NATIONAL FERTILIZERS LIMITED, NFL, NANGAL,
PUNJAB**

**PROJECTS: INSTALLATION OF NEW 2500 CUBIC METER
CAPACITY HORTON SPHERE FOR STORAGE OF
AMMONIA ALONG WITH ITS REFRIGERATION SYSTEM
AT NFL, NANGAL**

0	28.12.2023	ISSUED FOR NIT	JKY	JKY	RRK
REV	REV ATE	PURPOSE	PREPD	REVWD	APPD





	SITE WORKING AND SAFETY CONDITIONS INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/11.0	0	
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8.	ELECTRICAL SAFETY REGULATIONS	
9.	REPORTING	
10.	GENERAL SAFETY REQUIREMENTS TO BE OBSERVED DURING SITE FABRICATION AND ERECTION BY THE CONTRACTOR	

	SITE WORKING AND SAFETY CONDITIONS INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/11.0	0	
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1.0 SITE LOCATION

The proposed new Ammonia Horton Sphere with associated facilities shall be located inside the existing operating complex of NFL, Nangal unit.

2.0 SITE ESTABLISHMENT

2.1 The LSTK CONTRACTOR shall provide all huts, stores, tarpaulins and other covers for the accommodation of his staff, workmen and materials. All materials likely to deteriorate in the open shall be stored under suitable cover.

2.2 The LSTK contractor shall advise the owner within 15 days of the placement of LOI his space requirement which shall include for office, covered storage, open storage, fabrication space, etc. Depending on availability & requirement, space shall be allotted to the contractor for the duration of this contract. He will not be permitted to make use of any other space without the sanction of the Owner. The use of this space shall strictly be made for the execution of this contract only. The sanitary conditions of the ground in or around such structures shall, at all times, be maintained by the contractor in a manner satisfactory to the owner.

2.3 The security of the LSTK contractor's equipment and materials is his own responsibility.

2.4 The LSTK contractor's shall clear away periodically any rubbish, scrap materials, etc. and dump the same in the area indicated by the OWNER/PMC. All construction material shall be neatly stacked in an orderly manner as directed by the owner and care shall be taken to allow proper access to workmen and easy movement of men, vehicles, cranes and materials.



2.5 The LSTK contractor shall maintain all the drawings carefully mounted on the board of appropriate size and well protected from the ravages of weather termites and other insects.

2.6 The LSTK contractor shall not permit the entry to the site of any person not directly connected/concerned with the work without first having obtained the written permission of OWNER.

2.7 The LSTK contractor shall submit a list of plant, equipments, tools, tackles, etc. which he will use, to perform the work. The contractor shall submit a list in duplicate of all materials, tools and tackles etc. brought inside the plant site duly signed by owner's security staff as per the rules laid by owner. These tools, etc. shall not be removed from the site till the completion of job. A gate pass must be obtained from the owner in order to remove from site any plant, machinery, tools, materials and equipment.

2.8 All items such as instructions and other pertinent data regarding erection/commissioning and maintenance should be typed and classified for transmittal in a manner approved by the owner.

2.9 All employees of the LSTK contractor shall conform to any rules of conduct, etc. established by owner. Failure to comply with the rules of conduct will be sufficient cause for removal of such person from the site.

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2.10 The LSTK contractor will be responsible for providing all plant, tools and tackles, consumables and scaffolding required for the execution of his work as per the best engineering practices.

2.11 The receipt, unloading, movement and storage at site of all the LSTK contractor plant, tools and materials is his responsibility. The receipt, movement & storage of material issued by owner also shall be the responsibility of the LSTK CONTRACTOR/CONSTRUCTION CONTRACTOR.

2.12 **ELECTRICITY**

DELETED

2.13 **CONSTRUCTION WATER**

DELETED

2.14 **FIRST AID**

The LSTK contractor may have access to the Owner's qualified first aid personnel and ambulance, in case of accidents, if available. The contractor will, however provide a first aid post for minor injuries to their staff.

3.0 SUPERVISION OF WORK

3.1 The LSTK contractor shall submit to the Owner resume of his site supervisors for approval prior to commencement of the work. Once approved, the LSTK contractor shall not remove his site supervisors without prior concurrence of the Owner.



3.2 The entire work is to be completed as per the agreed time schedule. The programme of work in details shall be submitted by the LSTK contractor before commencement of work. The detailed programmes prepared by the LSTK contractor shall conform to the targets set forth in the time schedule and will be subject to the approval of the owner. All the work shall be carried out in such a manner that the work of other agencies at site is not hampered due to any action of the LSTK contractor.

4.0 INSPECTION

The work of the LSTK contractor shall be subject to inspection by the OWNER/PMC at all times.

5.0 EMPLOYMENT OF LABOUR

5.1 The LSTK contractor will be expected to employ on the work only his regular skilled employees with experience of this particular work. The permission of the Owner must be obtained before tradesman is recruited locally for the work. This rule does not apply to unskilled labour. No female labour shall be employed in dark hours/ i.e. hours prohibited under the applicable law. No person below the age of eighteen years shall be employed at any point of time.

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- 5.2 All traveling expenses including provision of all necessary transport to and from site, lodging allowances and other payments to the LSTK contractor employees are his own responsibility.
- 5.3 The hours of work on LSTK Contractors / Owner and contractor shall adhere to the same.
- 5.4 All Construction contractors employees shall wear safety helmet and such identification marks as may be provided by LSTK contractor on work site and duly approved by Owner.
- 5.5 All notices displayed on the site and any instructions issued by the Owner shall be strictly adhered to by the LSTK Contractors and/or his LSTK contractor employees.
- 5.6 It shall be the responsibility of LSTK contractor to provide suitable accommodation including necessary facilities for their labour and staff.
- 5.7 LSTK contractor will arrange ID-CARD and Permits for labour as per statutory provisions for its labour, as necessary.
- 5.8 The LSTK contractor shall be required to maintain employment records as covered in relevant Acts and produce documentary evidence to the effect that he has discharged his obligations under the Employees Provident Fund Act 1952 for the workmen working at site.
- 5.9 In case the Owner becomes liable to pay any wages or dues to the labour of the LSTK Contractors or his contractor or any Govt. agency under any of the provision of the Minimum Wages Act, Workmen Compensation Act or any other law due to act of omission of the contractor, the Owner may make such payment and shall recover the sum from Contractor's bills or any other dues.

6.0 COMPLETION OF WORK



Before finally leaving site, all the LSTK contractor store, huts, plant, tools and rubbish shall be removed and the site left clean and tidy. The space allocated by Owner shall be vacated and handed over to the Owner.

7.0 WORKING AND SAFETY REGULATIONS

- 7.1 The LSTK Contractor shall observe all statutory safety and legal requirements regulations issued by Central and State Governments applicable to the work as well as any local regulations applicable to the site issue by the consultant or any other authority.
- 7.2 Particular attention is drawn to the following:
- In case of accident, the Owner shall be informed in writing forthwith.
The LSTK Contractor shall strictly follow regulations laid down by Factory Inspector, Govt. and State authorities in this regard.
 - LSTK contractor shall fence his plant, platforms, excavations etc.
 - Compliance with all electricity regulations.

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- d) Compliance with statutory requirements for inspection and test of all lifting appliances and auxiliary lifting gear.
- e) Safety belts proposed to be used, shall be got checked by Fire & Safety Department of LSTK Contractor / OWNER in written before use.
- f) Before using the lifting or pulling equipment, LSTK contractor shall carryout load test which shall be witnessed by LSTK Contractor / OWNER.
- 7.3 Staircase, doors or gangways shall not be obstructed in any way that will interfere with means of access of escape.
- 7.4 No excavations will be started without the permission of the PMC / OWNER, who will inform the LSTK contractor of the position of any pipes or cables known to be buried in the area. All excavations must be effectively railed off at all times, or completely boarded over properly marked during the hours of darkness by red warning lamps, using Flame proof warning lamps in non smoking areas. Debris or material which cannot be immediately removed must be heaped in such a way as to be immediately remove and also to leave adequate passage way. Any finds such as relics or antiques coins or fossils etc. shall be promptly handed over to the Owner.
- 7.5 The LSTK contractor will notify the Owner of his intention to bring on the site any equipment, such as, space heating or welding apparatus or any container holding liquid or gaseous fuel or other substance which might create a hazard. The Owner will have a right to prohibit the use of such equipment or to prescribe the conditions under which such equipment may be used. The LSTK Contractor will have the right to inspect any construction plant, and to forbid its use if in his opinion it is un-suitable or unsafe. No claim arising there from shall be made by the LSTK Contractor.
- The LSTK contractor or any one acting on his instructions will not bring on to the site any radio active substance or any apparatus using such substances or any X ray apparatus until written permission and direction regarding the use of such equipment has been received from the Owner.
- The LSTK contractor shall be responsible for the safe storage of the radio graphic sources or those of his Construction contractors.
- 7.6 The LSTK contractor will meet all requirements, and act on the instructions of the Owner where it is necessary to operate a permit to work system.
- 7.7 Where it is necessary to provide and/or store petroleum products or petroleum mixtures and explosive, the LSTK contractor shall be responsible for carrying out such provision and/or storage in accordance with the rules and regulation laid down in Petroleum Act 1934, Explosive Act 1948 and Petroleum and Carbide of Calcium Manual Published by the Chief Inspector of Explosive of India. All such storage shall have prior approvals of the OWNER/PMC. In case any approval or clearance from Explosive or any statutory authorities is required, the contractor shall be responsible for obtaining the same.
- 7.8 The LSTK contractor shall have his own Fire Fighting Extinguishers and Equipment.

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7.9 The LSTK contractor shall be responsible for the provision of all safety notices safety equipments including the safety gadgets for his workmen required by both the relevant legislation and such as the Owner may deem necessary.

7.10 While working at heights, safety belts with lifeline shall necessarily be used.

7.11 “LSTK contractor shall employ a safety officer for safe executing the construction activities of the project who will be responsible for implementing safety requirement contained in the documents.

The safety officer shall possess a recognised degree in engineering discipline preferably, F&S or (Any branch of engineering) and had a post qualification construction experience of minimum two years.

In addition, he/she shall also possess a recognised degree or diploma in industrial safety and preferably have adequate knowledge of the language spoken by majority of the workers at the construction sites.

Contractor shall ensure physical presence of safety personnel at each work location wherever Hot Work permit is required. No work shall be started at site until above safety personnel are physically present at site. The contractor shall submit a safety organogram clearly indicating the lines of responsibility and reporting system and elaborate the responsibilities of safety personnel in the HSE MAUAL/Program. The contractor should furnish Bio-Data/Resume of the safety personnel as above, at least 01 month before the mobilization for PMC/OWNER’S approval.

7.12 LSTK contractor shall use only steel planks and clamps executing scaffolding. Wooden planks and rope shall not be allowed for this purpose.

7.13 LSTK contractor shall use asbestos cloth to ensure falling of weld spatters down below during above ground welding to ensure safety of electrical cables and personnel and avoiding any fire hazards.



8.0 ELECTRICAL SAFETY REGULATIONS

8.1 In no circumstances will the LSTK contractor interfere with fuse and electrical equipment belonging to the owner or other contractors.

8.2 Before the LSTK contractor connects any electrical appliances to any plug or socket belonging to the other contractor or owner, he will -

- i. Satisfy the Owner that the appliance is in good working condition.
- ii. Uses of matching sixes plug & does not uses bare wire to insert in socket.
- iii. Inform the Owner of the maximum current rating, voltage and phase of appliance.
- iv. Obtain permission of the Owner dealing the sockets to which the appliance may be connected.
- v. Use distribution board with ELCB for feeding power to hand held tools.

8.3 The Owner will not grant permission to plug in until he is satisfied that-

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- i. The appliance is in good condition and is fitted with a suitable plug.
- ii. The appliance is fitted with a suitable cable having two earth conductors, one of which shall be earthed metal sheath surrounding the cores.

8.4 No electric cable in use by the other LSTK contractor/owner will be distributed without prior permission. No weight of any description be imposed on any such cable and no ladder or similar equipment will rest against or be attached to it. Cables / Wires used shall be in good condition without cuts & in insulation & joints.

8.5 The voltage for all portable equipment e.g. drilling machines, temporary lighting etc. will not exceed 240 volts.

8.6 No work must be carried out on any live equipment. The equipment must be made safe and a "permit to work" issued before any work is carried out.

8.7 LSTK contractor shall employ electrician to maintain his temporary electrical installation.



8.8 Take necessary clearance for working in hazardous area.

9.0 REPORTING



- a) The LSTK contractor must report the following information to the Owner in writing daily. Number of men employed, trades-wise,
 - Progress achieved;
 - Concrete pour card, if any.
- b) If during excavation any materials such as but not limited to precious materials or treasure troves etc are found, the same shall be reported to owner immediately and shall be the property of owner.

10.0 GENERAL SAFETY REQUIREMENTS TO BE OBSERVED DURING SITE FABRICATION AND ERECTION BY THE CONSTRUCTION CONTRACTOR

1. Before starting the work, **LSTK contractor** should get safety work permit and should strictly follow instructions written by the concerned authority in work permit. Permit is required for all types of job i.e. Hot, Cold Excavation, Chipping, Grinding etc.
2. Smoking is strictly prohibited inside factory areas.
3. Safety appraisal and equipments shall be provided to workmen as per the nature of work. Welders shall use gloves, goggles, shields etc. during welding, gas cutting etc. All technicians shall use gloves, goggles during grinding, chipping etc. If any unsafe practice is observed Fire & Safety Sections or the authority issuing the work permit is authorized to stop the work without any prior notice.



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4. Temporary fire extinguishers, water hose shall be available near work place and in case of fire, Owner's Fire & Safety Section should be immediately informed by LSTK contractor from nearest available telephone. Project Manager should also be immediately informed.
5. LSTK contractor shall secure necessary insurance of his workmen for the entire duration of works under the contract. Owner is not responsible for any accident/injury caused whatsoever, to any person employed by the Construction Contractor. However, LSTK contractor has to inform Owner's Fire & Safety Section about accident, if any, immediately.
6. Temporary switch boards, cables, wires and electrical equipments should be installed in accordance with standard electrical practice with proper earthing etc. and should have prior approval of LSTK Contractor / Owner electrical engineer. Switch board shall be suitably protected against rainwater. The cable used for welding machine should have flexible tough rubber sheathing.
7. Temporary cables and wires including welding cables should be routed as not to cluster the work areas. Also any possibility of damage to live wires by falling objects should be avoided. Temporary electrical lines for power & lighting shall run overhead or underground so that they should not hinder the movement of men, materials and vehicles.
8. Portable hand lamps being used by construction crew shall be preferably of 24 Volts supply bulb to be protected with safety shields.
9. Earthing for welding shall not be taken through existing structure or equipments due to the very explosive nature of the plant, raw materials, reaction during process and final product. There is every possibility of fire and explosion in the equipment due to electric spark caused by loose earthing connection etc.
10. LSTK contractor should be careful while excavating so that no underground cable or pipe line is damaged. As soon as any brick cover or under ground cables are exposed he should stop the work and inform Construction Manager immediately for necessary action.
11. LSTK contractor should not leave any welding machine etc. running after the work is stopped. Before leaving the work place, Contractor should ensure that welding sets are disconnected from welding socket outlet.
12. All work areas shall be kept reasonably clear and clean for easy movement of men & material. Also all approach roads shall be free from obstacles for easy movement of cranes, vehicles, fork-lifts, trollies etc. and all debris shall be periodically removed.
13. All temporary structure and supports for erection purpose such as scaffolding, ladders, walkways, platform, shuttering etc. shall be sufficiently strong for safe use and to prevent collapse & accidental fall of workman. Same shall be removed immediately after the work is completed.

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14. All workmen working at unsafe elevation during the construction activity such as concreting, plastering, welding, erection work, painting, insulation etc. shall be safe and sufficient passage and should be properly instructed to take necessary safety precautions and observe safe practice to prevent accidental fall. Safety belts and helmets shall be used wherever necessary.
15. All supervisors, welders, electricians, technicians, riggers, engaged in the work shall be adequately skilled, experienced and acquainted with standard rules, regulation & practices of the work.
16. All open trenches, pits and other excavation carried shall be barricaded out by Construction Contractor, to avoid accident.
17. All lifting tools, tackles & accessories shall be in good working condition and of suitable capacity for the purpose for which they are used. All certificates/permits/licenses etc. required under any law or regulation for the same shall be available and valid during the entire period of the execution of the work under this Work Order/Contract.
18. LSTK contractor shall not use any structure or equipments erected or under erection for fastening, lifting or flying tackle guy-ropes etc. which may impose such loads for which structure or equipments are not designed to carry. However, LSTK contractor has to get prior approval from Construction Manager of Owner before using beams, permanent structure for the above purpose.
19. When work is carried out at high elevations, it is the responsibility of the LSTK contractor to ensure that tools and materials are not left in a position where they can fall on peoples moving /working below. Where necessary, places below should be cordoned off and caution boards be provided by contractor. Also, LSTK contractor should not cut existing hand railing/structure.
20. Contractor's men must not tamper with any machines, switches, valve or equipment not connected with their work. Welding holders should not be tested on running pipe lines.
21. Nylon rope should not be used for scaffolding where hot line is running near by, because there is every possibility of wire rope catching the fire. Also, no scaffolding is to be made on hot as well as insulated lines.
22. Necessary sign boards clearly indicating "RADIOGRAPHY HAZARDS" on all the four sides of the cordoned area surrounding radiography source will have to be displayed by Construction Contractor. Surrounding area will be cordoned with the help of manila rope and his personnel will be kept for watching/guard on all the four sides to prevent entry of personnel till the radiography work is completed. Construction Contractor's personnel should be able to communicate clearly/properly to stop entry of unauthorized personnel within the area cordoned for the radiography work.

Refuse Disposal

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23. Refuse must be removed daily to prevent accumulation. Materials liable to cause persons to slip or trip and fall should be cleared immediately.
24. Refuse removal teams working after work hour should be organized where normal cleaning can not cope with the build up of waste materials.
25. Projecting nails should be removed or bent over.

Personal Protective Equipments

26. Helmets should be provided for all who are exposed to the dangers of falling material or structures they might strike against.
27. Suitable eye protection should be provided for all who are exposed to flying particles, harmful glare and dangerous substances.
28. In the handling of rough objects, gloves should be provided and used.
29. Safety footwear should be provided to all who are exposed to foot injury, should be good fitting and comfortable to wear.
30. Safety belts should be provided where other means are not practicable. Both the anchorage points and lifelines provided for attaching safety belts should be of adequate strength. The umbilical line should be fixed in such a way that user's freefall will not exceed 1 metre.
31. Catch net should be used where persons are liable to fall and these should be securely supported at a level as near as possible to the working level.
32. Noise defenders should be provided for work area where the noise level exceeds 85 dBA.
33. Respiratory protection should be provided by employers and used by workers where the dust level remains high and where control at source is not practicable.



Inspection & Record Keeping

34. Where defects render the scaffolds unsafe, they should be rectified immediately. Where this is not practicable, a sign should be put warning against using it.

Winches

35. Adequate foundations should be provided for winches.

Lifting Gear

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36. All lifting gear and slinging should be tested before use and thereafter inspected regularly by competent engineers. Workers should also check the lifting gear visually before using them.
37. Each piece of lifting gear should bear its safe working load, its identification number and its last inspection date. It could in addition be colour coded according to due date of inspection.
38. Wire ropes should be preserved against rusting, kinking, fraying, birdcaging and heat damage. Defective wires should be destroyed to prevent recycling.

Concrete Mixers

39. Moving parts which are liable to become nip points, such as gears, chains and rollers should be guarded.
40. Where concrete mixers are driven by internal combustion engines, exhaust points should be located away from the workers' work station so as to eliminate their exposure to obnoxious fumes.

Electrical Components

41. All components and conductors used must be in good condition.
42. Proper junction boxes and distribution boards from which electric power could be tapped should be provided at every floor level.



Demolition: General Provisions

43. Uncontrolled collapse of walls or other structures under demolition should be prevented.
44. The throwing of materials over the sides of the buildings should not be permitted.

Waste Handling

45. Where demolition is carried out near public areas:
 - a) Hoardings slopping inwards should be erected around the building.
 - b) Protective nettings should be hung around the building to prevent materials falling outside the periphery shelter.
 - c) Where asbestos materials are present, appropriate dust control and respiratory protection approved by the local authority must be used.

Excavation: General Provisions

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46. Test for toxic gases should be carried out where their presence is suspected.
47. Exposure of shorings to vibration such as that produced by engines or vehicular traffic should be kept to a minimum.

General – Ventilation, Fire Protection/Fighting

48. Where flammable gas concentration could reach explosive levels, it may be necessary to provide intrinsically safe electrical equipments.
49. Adequate lighting and emergency lighting should be provided.
50. Adequate evacuation stairways should be provided for rapid evacuation in case of an emergency.

First Aid

51. Sufficient First Aid Boxes containing simple dressings and supplies should be provided on the site under the control of the foreman.

Awareness

52. The contractor shall brief the visitor about HSE precautions which are required to be taken before proceeding to site and make necessary arrangement to issue appropriate PPE's like HELMET, Safety shoes etc. to the visitors.
The contractor shall promote and develop consciousness about Health, safety and environment among all personnel working for the contractor. Regular awareness programmes and fabrication shop/work site meeting at least on fortnightly basis shall be arranged on HSE activities to cover hazards involved in various operations during construction phase. During the awareness program, step shall be taken by the contractor to motivate & encourage the workmen and supervisory staff by issuing/awarding them the tokens/gifts/mementos/ Monetary incentives.
A verbal warning shall be given to the workers during the first HSE violations. A written warning shall be issued on second violations and thereafter for the third volitions; the services of worker shall be terminated. For all these violations, penalties' shall be imposed, separately on the contractor. Records of warning for each worker shall be kept in the records.

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PART II: TECHNICAL



SECTION – 12.0

PROJECT EXECUTION PLAN

**PLANT: NATIONAL FERTILIZERS LIMITED, NFL, NANGAL,
PUNJAB**



**PROJECTS: INSTALLATION OF NEW 2500 CUBIC METER
CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA
ALONG WITH ITS REFRIGERATION SYSTEM
AT NFL, NANGAL**

0	21.11.2022	21.11.2022	ISSUED FOR NIT	SP	TNN	RRK
REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD

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1.0. PURPOSE:

This procedure has been prepared with the objective of:

- Defining systematic and orderly administrative relationship amongst related parties during the execution and the operation of the plant.
- Progress reporting and review of progress of work

2.0. COMMUNICATION AND GENERAL CORRESPONDENCE:



Project Manager of PDIL/NFL is the sole contract for all activities of the project. Therefore all the correspondence between NFL/PDIL and LSTK Contractor shall be directly done with/by Project Manager or by his authorized representative. The Name, Address, Telephone no, Fax, email id shall be intimated during the kick off meeting.

3.0. PROJECT MANAGEMENT & EXECUTION:

3.1. Kick-Off Meeting:

Immediately after the award of job, a kick-off meeting will be held to finalize and establish the modalities and procedures to be adopted for execution of the contract based on the enquiry document, commitments made by LSTK Contractor and subsequent agreements reached between NFL/PDIL and LSTK Contractor during negotiations. The Kick-Off Meeting will be attended by key members of NFL/PDIL and LSTK Contractor. These will address the following details between NFL/PDIL and LSTK Contractor:

- i) Execution Methodology/ Philosophy, in the line with project requirement.
- ii) Project execution schedule
- iii) Progress Reporting
- iv) Project Co-ordination Procedures.
- v) Organization Chart

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vi) Construction Site related issues.

3.2. Project Procedures and Methodology:

Detailed Technical Requirements along with the Detailed Scope of Work and overall proposed implementation schedule shall be prepared by LSTK Contractor. These will form the basis for formulation of the overall Project schedule of the plant by LSTK Contractor. LSTK Contractor is required to organize his services in a systematic manner to ensure execution and completion of the unit as per the schedule. LSTK Contractor is required to submit along with his bid the methodology/procedure proposed by him for this unit together with the organizational set up proposed and bio-data of Key-personnel.

In order to achieve uniformity in execution of various activities of the Project, LSTK Contractor shall develop Engineering Design Basis and Project Procedures/ Methodologies to be adopted by the executing agency. LSTK Contractor is required to carry-out his supply of Know-How, Process Package, Detailed Engineering, Procurement, Tendering, Construction Supervision and Management, Planning Scheduling, Monitoring, Reviewing, Reporting, and Overall Project Management activities in accordance with the job specifications / procedures developed by LSTK Contractor based on the methodologies / procedures. All activities to be performed/services to be rendered by LSTK Contractor under this contract shall be monitored by NFL/PDIL and will be subject to periodic reviews by the NFL/PDIL. LSTK Contractor shall facilitate such reviews/monitoring by NFL/PDIL.

- 3.2.1. LSTK Contractor's service for Engineering, Procurement, Tendering, Construction, Supervision and Management, Planning, Scheduling, Monitoring, Reporting, and Overall Project Management shall meet the requirements given in this section.
- 3.2.2. English language and Metric Units shall be used in all Documents, Drawings, Reports, and Correspondences etc. under this contract.
- 3.2.3. All the drawings/documents prepared by LSTK Contractor/Sub-bidders/Vendors shall be submitted to NFL/PDIL for review/Information purpose. Such review by NFL/PDIL shall, however, not relieve LSTK Contractor of his responsibilities.

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3.2.4. For achieving the Project schedule it may be necessary in some cases to prepare the drawings in stages and release it for construction so as to take up simultaneous execution of detail engineering and construction. Any revisions involved for the above is included in the scope of work of LSTK Contractor. Also any change required to meet the site conditions / statutory requirements shall have to be carried by LSTK Contractor at no extra cost.

3.2.5. LSTK Contractor is required to organize a Task Force of dedicated specialists from each discipline under a Project Engineering Manager who will be assisted by Engineering Coordinator. An engineering schedule will be prepared and submitted to NFL/PDIL for review. This schedule shall be used for all engineering activities. The engineering coordinator shall coordinate all design and engineering activities and interact with Purchase, Inspection, expediting, C&T, tendering, planning, construction and project groups. His responsibilities shall include.



3.3. Detailed Engineering Services:

The LSTK Contractor shall provide the detailed engineering services for Project as mentioned in this bid document furnished by the NFL/PDIL. The services shall cover the detailed engineering required for execution and completion of the Project along with the utilities to be provided inside the battery limit of the Plant as specified in the tender.

All critical drawings / documents to be prepared by LSTK Contractor /sub-contractors/ vendors as per given in the bid document for review and approval by NFL/PDIL. Obtaining all such approvals shall be the responsibility of the LSTK Contractor and the same is included in his scope of work. Such review and approval by NFL/PDIL shall, however, not relieve the LSTK Contractor of his responsibilities.

For achieving the project schedule, it may be necessary in some cases to prepare the drawings in stages and release it for construction so as to take up simultaneous execution of detail engineering and construction. Any revision involved for the above is included in the scope of work of the LSTK Contractor. Also any change required to meet site conditions/statutory requirements shall have to be carried by LSTK Contractor at no extra cost.

The LSTK Contractor is required to organize a Task Force of dedicated specialists from each discipline under a Project Engineering Manager who will be assisted by engineering Coordinator. An engineering schedule will be prepared and submitted to NFL/PDIL for approval. This approved schedule shall be used for all engineering activities. The engineering coordinator shall coordinate all design and engineering activities and interact with purchase, inspection, expediting, C&T, tendering, planning, construction and project groups. His responsibilities shall include.

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a) Engineering coordination for procurement involving:

- Preparation of Material Requisitions (MRs).
- Technical evaluation of offers received (which may involve technical discussions with vendors and concerned specialists may have to be deputed to vendors works or to NFL/PDIL offices as per requirements) and preparation of recommendations.
- Preparation of Technical Purchase Requisition (PRs) on selection of vendor.
- Review/approval of vendor drawings/documents. (This may call for arranging specialist visits to vendor's works for timely approvals of critical items.)



b) Engineering coordination for sub-contractors involving:

- Preparation of schedule of quantities and specifications for various contracts.
- Technical evaluation and recommendation of offers received. This may involve arranging technical discussions with Bidders at NFL/PDIL office if called for due to job requirements.
- Preparation of technical-agreed variations for incorporation in contracts for the selected Contractor.

In any case, LSTK Contractor has to take owner approval for sub-contractors list prior to scrutiny and award.

c) Engineering coordination for construction involving:



- Timely issue of approved construction drawings including drawings duly approved by NFL/PDIL as per requirements.
- Providing/arranging clarification on drawings and specifications wherever called for including specialists visits to site.
- Making regular periodic visits to project site for review of site requirements in respect of engineering activities.

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- Attending/arranging for discussions with statutory authorities such as Chief Electrical Inspector, Chief Inspector of Boiler, Tariff Advisory Committee, etc. to arrive at design basis/documents acceptable to them wherever required for obtaining statutory approvals and any other local approvals.
- d) Monitoring progress of engineering activities and advising Project Manager on shortfalls and corrective actions needed. He will also attend the review meetings.
- Detailed engineering and construction shall be based on sound engineering practices. List of applicable codes, standards and mandatory rules to be used in design is also mentioned in bid document.
- Drawings/Documents/MRs etc., which are to be generated by LSTK contractor shall be numbered as per the Documents Numbering Procedure of NFL/PDIL or mutually agreed procedure.
- Head Office engineering support of LSTK Contractor shall be provided to site during construction including deployment of engineering specialists for field engineering as and when required by Contractor.

3.4. Procurement:

- 3.4.1. The procurement services to be provided by LSTK Contractor shall cover the purchasing, inspection, expediting, Custom clearance and transportation activities & transportation activities and demurrage charges if any.
- 3.4.2. Purchase: The Purchase activities will cover all equipments and materials required for completion of the Project.
- 3.4.3. Inspection and Expediting: LSTK Contractor is required to organize a proper inspection and expediting system so as to ensure timely delivery of all the items/equipment meeting the specified quality criteria. This function has to be carried out by appropriate deployment of qualified personnel who have wide experience in their respective fields. NFL/PDIL will reserve the right to inspect items deemed necessary by them without any additional cost to LSTK Contractor /Sub- bidder/ vendor.
- 3.4.4. Customs Clearance and Transportation: LSTK Contractor is required to organize a custom clearance and transportation (C&T) system to ensure prompt clearance of imported equipments from customs and transportation of equipments/materials to project site from Ports/Vendors works.

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4.0. PROJECT PLANNING, SCHEDULING & MONITORING SYSTEM:

LSTK Contractor is required to institute and maintain a proper Planning; Scheduling and Monitoring system and employ professionally qualified and experienced Planning Engineer(s) for the Project. The system shall have latest state-of-the-art technique; to this effect. LSTK Contractor shall implement this system through the Primavera Project Planner.



The system developed should be capable to support and enforce proper control Mechanism in the project. It should be based on hierarchical breakdown of works with elaborate level of detailing and control. The levels of controls should be such that it supports and foster controls at activity level, function level and management level with greater emphasis on target, scope and commitment at various stages of contract for accountability and action planning. Such multi-level / multi-tier system of Planning, Scheduling and Monitoring, Supports, Effective Information Generation, Assimilation, Summarization and Reporting in proper and adequate manner.

The system shall be predictive type and should constitute pre-warning mechanism to diagnose and anticipate the problem well in advance and provide preventive features/measures. It is required that work breakdown structure should consist of details of systems, work packages, functions, work items and activities from monitoring point of view at micro level and summarization at higher levels. It is expected that the work breakdown structure coding system / methodology to be followed shall be informed / discussed with the successful LSTK Contractor during the kick-off Meeting.

The system is designed to carry out comprehensive functions for timely completion of project. The following shall be detailed under above mentioned procedure:

- Development of time schedules for execution of project, consistent with the overall requirement of the project and execution philosophy reflecting the latest scope of work agreed with Project NFL/PDIL & LSTK. Schedules also include number of intermediate checkpoints based on LSTK experience on similar projects.
- Establishment of Project Progress Measurement System.
- Establishment of Project Material Management System.
- Establishment of monitoring system, which regularly compares the actual performance with the planned one and suggests preventive and corrective measures to ensure timely completion of the project.
- Development of Billing Schedule
- Monthly measurement certification and invoicing

Following schedules documents/reports shall be prepared and submitted by LSTK Contractor for NFL/PDIL review at various stages of the Project:

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- List of critical drawings.
- Breakdown of work packages to work items level.
- Input requirements of each work item/activities
- Schedule start and finish dates of all milestone/activities in line with overall schedule of the project.
- Overall system-wise, discipline-wise weightages / Progress Measurement Benchmarks for each item/activity.
- 3 month front end schedule / 90 days Look ahead Schedule within a week of award.

In this kick-off meeting, it will be endeavored to reach complete understanding with LSTK Contractor on activities, inputs and logic to establish Planning Documents for Monitoring. Venue of the Kick-off Meeting to be held between the successful LSTK Contractor, PDIL & NFL, shall be either at PDIL Office or NFL's Office preferably at Noida / Site Office and the same would be informed subsequently.



4.1. Overall Project Schedule:

LSTK Contractor shall submit within 30 days of Fax / letter of Intent, the work breakdown structure showing Project work load i.e. preparation of Process Package, tenders, Material Requisitions, Construction Drawings equipments etc. along with a sufficiently detailed overall project schedule in the activity network form, clearly indicating the major milestones, inter relationship / interdependencies between various activities such as process, engineering, procurement tendering, manufacture / delivery, construction etc. together with a computer analysis of critical path and floats as well as quantum of work for major activities.

The schedule will be reviewed by NFL/PDIL and the comments if any shall be incorporated in the network issued for implementation within 2 weeks from receipt of comments. The network thus finalized shall form part of the Contract and will become the basis for developing further detailed activity Network. This schedule shall not be revised without the prior permission from NFL/PDIL during the entire period of contract. The changes made during revision of the contract shall be approved by NFL/PDIL in writing.

4.2. Detailed Activity Network:

LSTK Contractor should develop detailed activity networks (Level 4 / Micro level) for various systems/plant/ unit of the Project, based on approved overall project schedule within 2 months of fax / letter of intent. Such networks would be computerized for further monitoring and reporting.

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4.3. Progress Measurement Methodology:

LSTK Contractor is required to submit during the Kick off Meeting, the detail methodology / Progress Measurement Benchmarks of Engineering, Procurement, Manufacturing / Delivery, computation of total service/physical progress at the unit-wise level and on the overall basis. The progress basis shall be physical realization of work such as in terms of deliverables and construction quantity/volume accomplished. The amalgamation of such output across the project to compute overall progress shall be suitably established with proper rational and norms and maintained throughout the project. NFL/PDIL reserves the right to modify the methodology in part or in full.

4.4. Vendor Scheduling and Monitoring

LSTK Contractor shall establish schedules for pre-ordering and post ordering for follow up. The vendor monitoring preferably should be on logical networks and commitments at least on critical items in order to monitor them on regular basis for effective control. NFL/PDIL may demand such follow up procedure and logical networks for the various critical equipment at any time during the course of order execution. The manufacturing schedule shall be established and agreed with the vendors and acceptance shall be brought to the notice of NFL/PDIL in time.



4.5. Construction Network:

LSTK Contractor shall prepare and submit a detailed construction network with full consideration of logistics, construction studies and method for NFL/PDIL. LSTK Contractor shall describe the resources required and special construction equipments, Tools & Tackles to be mobilized. The network shall be developed subsequent of substantial progress of engineering and ordering with fairly known construction workload and quantities.

4.6. Project Schedule Software:

As indicated elsewhere, Project Schedules as above shall be developed / evolved using the latest version of the Primavera Project Planner Software Package.

4.7. Progress Reporting:

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LSTK Contractor shall submit the following progress reports on a regular basis for NFL/PDIL information/review.

4.7.1. Monthly Progress Report:

This report shall be submitted on a monthly basis within 7 calendar days from cutoff date, or as agreed upon, covering overall scenario of the project. The report shall include, but not limited, to the following:

- Executive summary - Summary of major events/activities.
- Schedule v/s actual percentage progress and progress curves for detailed Engineering, sub-ordering, Manufacturing/Delivery, Contracting, construction commissioning and overall.
- Areas of concern/problem/hold-ups, impact and recovery action plans/catch-up plan.
- Activities executed achievements during the months and targets for the following month.
- Analysis of critical activities and impact on overall completion.
- Chronological achievements of key events indicating schedules and actual occurrence date.
- Annexure giving status summary for drawings material requisitions, equipment and materials delivery, contracting & construction, Resource requirement & deployment status.
- Resource requirement deployment status.
- Statutory requirements / compliance status
- Change order status.
- Invoice status.
- Construction photographs.
- Updated Project Schedule

4.7.2. Weekly Reports

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This report will be prepared for Head Office and construction site in summarized fashion and submitted on every Tuesday taking status as of Sunday by the Contractor on weekly basis and will cover following items:

- Activities completed (engineering, procurement, contracting, construction. etc.)
- Program for subsequent week.
- Resource deployed – man and machine.
- Quantities and productivity achieved in key areas of work.
- Progress on procurement activities including material requisition status reports.
- Constraints, if any.

The report/information may be transmitted preferably through mail to NFL/PDILHO.

4.7.3. Daily Reports (Site Construction Report)

- Important activities for the day at site.
- Site Safety / HSE Report
- Material/equipments receipts for the day.
- Labour deployment report.
- Next Day Plan Activities

5.0. PROJECT TIME CONTROL METHODOLOGY:



5.1. Project Time Completion

The time for completion of the complete scope of work shall be strictly as per the time Schedule given in the tender document.

5.2. Documents required along with Bid

LSTK Contractor shall furnish the following documents along with the bid.

- 5.2.1. An overall schedule in the form of Network, clearly indicating all important milestones in design, engineering, fabrication, procurement construction, testing and commissioning for the plant commensurate with the overall time schedule.

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5.2.2. Resource deployment schedule indicating mobilization of all critical resources including manpower and machinery for the smooth execution of the job at engineering offices, fabrication shops & construction site. The resource schedule shall also contain various construction aids envisaged to be deployed for execution.

5.2.3. Organization structure for effective project management and control, clearly indicating the responsibility center as well as bio-data of the key personnel, who are permanent employees of LSTK Contractor, shall be identified for the project.

5.3. Documents required after Award

5.3.1. Early Planning Document / Look Ahead Schedule



Immediately after the award of contract and pending finalization of overall project schedule, detailed activity chart/network, functional schedules etc., the LSTK Contractor in consultation with NFL/PDIL shall prepare a look ahead schedule as a guideline for the activities to be performed during the relevant periods.

Within 30 days of issue of Fax / letter of intent LSTK Contractor shall finalize with NFL/PDIL the following as:

5.3.2. Overall Project Schedule:

Overall Project Schedule in line with the agreed milestone and detailed to adequate work breakdown structure level covering all phases of the work such as supply of Know-how, Process Package, design engineering, procurement manufacturing, shipment, tendering & field erection. This schedule shall also include the interface activities to be provided by NFL/PDIL and the dates by which such facilities are needed. LSTK Contractor shall get the scheduled submitted & reviewed by NFL/PDIL and the agreed schedule shall form part of the Contract monitoring document based on which performance would be reported and evaluated. This document shall be signed by both the parties. NFL/PDIL shall also review the weightage allotted to various activities and method of reporting to be adopted by LSTK Contractor. During the progress of the contract if in the opinion of NFL/PDIL, desired progress as physically/sequentially is not maintained, it would be obligatory on LSTK Contractor to re-programme the work schedule in order to accommodate the backlog and/or provide work front to other agency, without any obligation to NFL / PDIL.

5.3.3. Detailed Activity Network

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The Contractor should develop detailed activity networks for various systems of the project, based on approved overall project schedule within two months of Fax / letter of Intent. Such networks would be computerized for further monitoring and reporting.

5.3.4. Functional Schedules

The Contractor should prepare resource-based detailed functional schedules in line with detailed activity networks for functional monitoring, scheduling and control. This should clearly reflect strategies and philosophy of execution. NFL/PDIL reserves the right to check the functional schedule and status of activities at anytime and at any location of performance/execution. Further, the functional schedules shall be submitted by the LSTK Contractor on demand by the NFL/PDIL.

5.3.5. Progress Measurement Methodology



The LSTK Contractor is required to submit during the kick-off meeting, the detail methodology of progress measurement of engineering, procurement, manufacturing, delivery, computation of total service/physical progress at the unit-wise level and on the overall basis. The progress basis shall be physical realization of work such as in terms of deliverables and construction quantity/volume accomplished. The amalgamation of such output across the project to compute overall progress shall be suitably established with proper rational and norms and maintained throughout the project. NFL/PDIL reserves the right to modify the methodology in part or in full.

5.3.6. Vendor Scheduling and Monitoring

The LSTK Contractor shall establish schedules for pre-ordering and post ordering for follow up. The vendor monitoring preferably should be on logical networks and commitments at least on critical items in order to monitor them on regular basis for effective control. NFL/PDIL may demand such follow up procedure and logical networks for various critical equipment at any time during the course of order execution. The manufacturing schedule shall be established and agreed with the vendors and acceptance shall be brought to the notice of NFL/PDIL in time.

5.3.7. Construction Network

The LSTK Contractor shall prepare and submit a detailed construction network with full consideration of logistics, construction studies and method for NFL/PDIL approval. The LSTK Contractor shall describe the resources required and special construction equipments, Tools and tackles to be mobilized. The network shall be developed

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subsequent of substantial progress of engineering and ordering with fairly known construction workload and quantities.

5.3.8. Construction Worksheets

The LSTK Contractor shall further detail out the construction network into area-wise details in terms of work, quantity and schedule, to firm up basis for area control. The construction schedule should be worked out based on work front generation criteria which will call for availability of input like drawings, materials and access for each/group of activity to be performed. It may be in the form of resource loaded bar chart with 'S' curve. NFL/PDIL reserves the right to access the same.

5.3.9. Construction Contractor Schedule

The LSTK Contractor shall agree upon the construction schedules with sub-contractors for proper mobilization, monitoring and control. NFL/PDIL reserves the right to ask for such program and status of any time as may be required.



5.3.10. LSTK Contractor at any point of time of operating would be permitted to revise the accepted schedule/control documents with NFL/PDIL without changing the contractual completion date, subject to prior approval by NFL/PDIL in writing.

5.3.11. The review of the performance of work would be made at different levels of management and LSTK Contractor is expected to ensure proper participation for effective reviewing and action plan.

5.3.12. LSTK Contractor should ensure availability of professionally qualified planning Engineer both at H.O and site deemed adequate by NFL/PDIL.



5.3.13. LSTK Contractor at his own cost should maintain a control room at site highlighting all the features, schedule and achievements of the project.

5.3.14. Weighted percentage (Progress measurement Benchmark) of each discipline/group of work shall be mutually agreed to between LSTK Contractor and NFL/PDIL after the award of contract to facilitate compilation of progress.

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ABBREVIATION:

S. No	Abbreviation	Description
1.	LSTK	License Engineering Procurement & Construction
2.	PMC	Project Management Consultant
3.	MR	Material Requisition
4.	C&T	Custom clearance and Transportation
5.	PR	Purchase Requisition
6.	HSE	Health Safety & Environment
7.	KOM	Kick-Off Meeting

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PART II: TECHNICAL

SECTION – 13.0

PERFORMANCE TEST RUN

**PLANT: NATIONAL FERTILIZERS LIMITED, NFL, NANGAL,
PUNJAB**

**PROJECTS: INSTALLATION OF NEW 2500 CUBIC METER
CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA
ALONG WITH ITS REFRIGERATION SYSTEM
AT NFL, NANGAL**

0	20.06.2023	20.06.2023	Issued For NIT	UNM/KR	AKG	NQ
REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD

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2.0	Performance Tests

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1.0 PERFORMANCE TEST RUN PROCEDURE:

1.1 After the Facility have been completed, put into operation and steady state operation is established, performance test of units shall be conducted. Before carrying out of the performance test of units, BIDDER shall develop a procedure / protocol and schedule in consultation with the OWNER/PMC and submit to OWNER/PMC for their approval. Among other things the procedure shall broadly include the following.

- Test Conditions
- Log sheet for recording operating data
- Methods of calculations
- Pre-test run period, if any
- Methodology for interpretation and measurement of tests
- Methodology for taking operating data and its frequency
- Methodology for evaluating the performance of the facility.

1.2 BIDDER shall provide the services of his commissioning engineer during this performance test run period.

BIDDER shall be held responsible for any defects noted during performance test run and attributable to him and shall be dealt as per the relevant provision of the contract.

1.3 The performance test shall be carried out by operating the system continuously for a minimum period of 48 hrs, out of which, the new HS system shall be operated continuously for 24 hrs to establish Performance test as per clause-2.4. The results obtained during that period will form the basis of comparison between the actual performance and Performance guarantees required to be met as per Performance Test clause 2.4.1 i.e. Pressure of liquid ammonia in new Horton sphere shall be maintained between 3.20 to 3.40 kg/cm²g with maximum 2 (Two) refrigeration compressor in line.

1.4 Instruments in the scope of the bidder shall be used for monitoring operating parameters and bidder shall ensure proper calibration of all the instruments and submit calibration certificates.

1.5 If a performance test of units has been carried out successfully for a period as specified to the satisfaction of OWNER/PMC, the performance test shall be deemed to have been successfully completed.

1.6 After completion of a performance test, all relevant operating and relevant data figures shall be recorded in a protocol to be signed by authorised representatives from BIDDER and OWNER / PMC.

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- 1.7 BIDDER shall prepare test report and submit to OWNER/PMC within 3(three) days after the completion of each performance test. OWNER/PMC shall indicate in writing that the performance test was successful within 15 (fifteen) days after submission of the results after review of such performance test.

2.0 PERFORMANCE TESTS

The Plant Performance Tests shall broadly consist of:

- a. Functional Test
- b. Operability Test
- c. Reliability Test
- d. Performance Test

2.1 FUNCTIONAL TESTS

The Functional Tests shall demonstrate that the safety and controls of the plant operate satisfactorily. The Functional Tests shall be part of BIDDER's commissioning program. These tests shall be performed prior to offering the plant for Reliability Test and Performance Tests. The Plant shall be ready in all respects prior to commencement of the Functional Tests. The individual Functional Tests to be demonstrated by the BIDDER and witnessed by the OWNER / PMC for system under bidder scope shall be mutually agreed upon during detail engineering phase.

- 2.1.1 General Functional Tests (applicable for all equipment covered under this project/scope of work)

Functional Tests shall broadly cover, but not be limited to, the demonstration of satisfactory functioning of the following:

- a. Alarm, trip, remote/ manual operation, process and safety interlocks, emergency shutdown of the systems / equipment including interconnection with existing Horton Sphere system, as defined in the system.
- b. Automatic operation of all system controls, bump less changeover of Auto/ manual controls and proper maintenance of the controlled variables within the desired band.
- c. Normal start up & shutdown sequence of the storage system.
- d. Fail safe shutdown in the event of total power failure.

2.2 OPERABILITY TEST

This test shall require the BIDDER to run Sub-System & Individual equipment to be tested for filling of Horton sphere satisfactory outage free operation.

2.3 RELIABILITY TEST

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Reliability Test shall require the BIDDER to operate the facility for 5 (Five) days continuously to demonstrate the reliability of the system. The detailed procedure for conducting the Reliability Test of the Facility shall be submitted by the BIDDER for the approval of the OWNER / PMC during the detail engineering phase, prior to the conduction of the test. The general guidelines for the detailed test procedure are as below:

Prior to the Reliability Test being conducted, BIDDER may perform process adjustments and cleaning procedures of the equipments, such as opening of the equipment for cleaning and polishing, adjust clearances, replace filters or other defective components etc.

BIDDER shall formally notify OWNER in writing that the facility provided by him is ready for the 5 (Five) days Reliability Test.

During the 5 (Five) days Reliability Test all facility under the package shall operate for 120 hrs period to prove capability of system.

In the event that operating conditions are not met for reasons attributable to the BIDDER, the Reliability Test shall be repeated.

If during the Reliability Test the Facility is out of service or operated at partial load for reasons not attributable to the BIDDER for a certain period, the Test shall be extended for the same period after the reasons for interruption is passed in order to complete the 5 (Five) days Reliability Test.

2.4 PERFORMANCE TEST

The following performance shall have to be demonstrated:

- 2.4.1 Contractor shall carry out performance test as per condition mentioned in clause 1.0 Performance Test Run procedure above. Pressure of Ammonia in New Horton Sphere shall be maintained between 3.20 to 3.40 kg/cm²g with maximum 2 (Two) refrigeration compressors running i.e. Performance of Ammonia Refrigeration system in line under following scenarios:
- Liquid ammonia transfer from Ammonia plant at rate of 39.5 Te/hr and additional 50 Te/hr ammonia transfer from LP storage to New Horton sphere through pipeline; Total 89.5 Te/hr for 2 hours.
 - Liquid ammonia transfer from Ammonia plant at rate of 39.5 Te/hr and additional 10 Te/hr ammonia transfer from Ammonia Road Tanker to New Horton Sphere; Total 49.5 Te/hr for 2 hours.

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- c) Continuous filling for 2 hours of Liquid ammonia transfer from Ammonia plant at rate of 39.5 Te/hr - design flow rate to New Horton Sphere.
- d) Simultaneous filling of liquid Ammonia in new Horton Sphere as per scenario a) mentioned above as well as transfer of ammonia to Urea Plant at rate of 40Te/hr design flow rate.

2.4.2 Demonstration of Guaranteed Noise Levels as indicated in Section- 3.0 Process Design Basis.

Bidder shall demonstrate the Guaranteed Noise Levels for each Refrigeration compressor etc. of Horton Sphere system unit.

After commissioning activities completed and steady state operation of system is established then performance test of system shall be conducted. The performance test is to be carried out as soon as practicable after the commissioning not later than 1 (one) month.

Performance tests shall be conducted in the presence of the OWNER / PMC to demonstrate compliance with the performance as set herein and as quoted by the BIDDER in its Bid offer.

BIDDER shall be held responsible for any defects attributed to him and shall be dealt as per relevant provision of contract. The entire unsuccessful test shall be repeated after BIDDER carries out necessary modification / repair.

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PART II: TECHNICAL

SECTION – 14.0

SPARE PARTS

**PLANT: NATIONAL FERTILIZERS LIMITED, NFL, NANGAL,
PUNJAB**

**PROJECTS: PMC SERVICES (PRE & POST LSTK AWARD)-NEW
2500M3 HORTON SPHERE FOR STORAGE OF AMMONIA
AT NFL, NANGAL**

	<p align="center">SPARE PARTS NEW 2500M3 HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL</p>	PC183-TFL-4012-603-SEC VI-14.0	0	
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SPARE PARTS

A. SPARES PARTS FOR COMMISSIONING:



Contractor shall supply free of cost spare parts and consumables required during Pre-commissioning & Commissioning of the plants until the plant is handed over to the Owner after Performance Test.

B. MANDATORY SPARE PARTS FOR TWO YEARS OPERATION

Contractor shall supply mandatory spares for Horton sphere Package as listed below; below list of parts is minimum requirement for the fire fighting package system. Vendor may offer and supply number of sets based on his past experience for smooth 02 Years operation of Fire Fighting system.

C. VENDOR'S RECOMMENDED SPARE PARTS

Contractor shall submit list of recommended spare parts of specialised items not covered mandatory spares, along with itemised price. Owner will review and decide the recommended spares required for the project. However, these spares shall not be considered in Price evaluation.

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1.0 PIPING :

Sl. No.	Part Description	Size Range (NB)	Quantity Required (% or part or fraction of as built quantity)	Remark
1	Pipes for each size, rating/thk. & material	≤1.5"	5%	min. qty. 6 mtr.
2	Pipes for each size, rating/thk. & material	≥ 2"	2%	min. qty. 6 mtr.
3	Fittings for each size, rating/thk. & material	≤1.5"	5%	min. qty. 1 No.
4	Fittings for each size, rating/thk. & material	≥ 2"	2%	min. qty. 1 No.
5	Flanges for each size, rating/thk. & material	up to 6"	5%	min. qty. 1 No.
6	Flanges for each size, rating/thk. & material	8" to 24"	2%	min. qty. 1 No.
7	Valves for each size, rating/thk. & material	up to 14"	5%	min. qty. 1 No.
8	Hose box, RRL hose (63mm) with couplings, jet nozzle with branch pipe, hydrant valve, landing valve		5%	min. qty. 1 No.
9	Hose reel with valve, nozzle, drum & mountings		5%	min. qty. 1 No.
10	Monitor (Per type & capacity)		1 no. each	
11	Portable fire extinguisher per type & capacity (upto 10 kg)		1%	min. qty. 1 No.
12	Wheel mounted fire extinguisher per type & capacity (greater than 10 kg)		1 no. each	
13	Bolts, Nuts & Gaskets (For each size, rating, material)		10%	min. qty. 1 No.
14	Expansion Bellow (For each size, rating, material)		10%	min. qty. 1 No.
15	Strainer element (For each size, rating, material)		10%	min. qty. 1 No.
16	Spray / sprinkler head per size, rating & material		10%	min. qty. 1 No.
17	Complete Gear Box for gear operated Valves	≥ 16"	5%	min. qty. 1 No.
18	Bolt torque wrenches (Manual)		1 set	min. qty. 1 set.

Notes :

1. Percent of quantity required as mandatory spares is for each item consumed in as built.
2. No substitution in size, rating and material is allowed.
3. Pipe length in meter and other items in No. or Set shall be supplied.
4. Fractional part of quantity shall be converted into nearest upward whole part.

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2.0 PRESSURE VESSEL

1.0 SPARES PARTS FOR COMMISSIONING:

Contractor shall supply free of cost (Include in the scope) spare parts and Consumables (except raw materials and Utilities supplied by others) required during Pre-commissioning & Commissioning of the plants till the plant is handed over to the Owner after Performance Test.

2.0 SPARE PARTS FOR TWO YEARS OPERATION (MANDATORY):

Contractor shall supply spare parts as per list of spares for 2 years operation of the plant as detailed below:

2.1 STATIC EQUIPMENTS:

Sl.No	Spare Items	Quantities (per item)
1.0	Heat Exchangers – Shell & Tube	
1.1	Bolts	10% excess, min. 2nos (Girth flange & Nozzles with blind flange)
1.2	Gaskets	200 %(Girth flange & Nozzles with blind flange)
1.3	Tube Plug	5 % of tube holes
2.0	Pressure Vessels /Horton Sphere	
2.1	Gaskets	200 %(Girth flange & Nozzles with blind flange)
2.2	Bolts	10 % excess, Min. 2nos (Girth flange & Nozzles with blind flange)
2.3	Spare for internals Clamps Nuts/Bolts Washer Bubble Caps / valve	2 % excess, min. 5 piece 10% excess, min. 2 nos. 20 % excess, min. 3 piece 10%
2.4	Sight glass	300%
3.0	TANKS	
3.1	Gasket for each nozzle having blind flange and companion flange	200%
3.2	Internal & external bolting for each nozzle having blind flange and companion flange	10% (Min. 4 pieces)
5.0	Filters	
5.1	Bolts	10% excess, min. 2nos (Girth flange & Nozzles with blind flange)
5.2	Gaskets	200 %(Girth flange & Nozzles with blind flange)
5.3	Filter Elements	100% filter elements

Notes:

- 1) Quantities shown are for each size and type of part.
- 2) The parts listed are the principal parts only. Other parts shall be considered for recommendation in quantities consistent with the above table.
- 3) All special tools and tackles required for maintenance for critical items shall be supplied along with equipment.
- 4) Above mentioned spare philosophy is also applicable for each Integral static equipment with in

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a package item.

- 5) Wherever % age is identified, contractor shall supply next rounded figure.
- 6) This specification does not cover spares for electrical, instrumentation, piping, rotating etc. These shall be as per the respective disciplines specifications attached with the NIT document (as applicable).

3.0 VENDOR'S RECOMMENDED SPARE PARTS:

Contractor shall submit list of recommended spare parts of specialised items not covered under 2 years operation spares, along with itemised price. Owner will review and decide the recommended spares required for the project.

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3.0 MACHINERY

1.0 SPARES PARTS FOR COMMISSIONING:

LSTK Contractor shall supply free of cost spare parts and consumables (except raw materials and Utilities supplied by others) required during Pre-commissioning & Commissioning of the plants until the plant is handed over to the Owner after Performance Test.

2.0 MANDATORY SPARE PARTS

LSTK Contractor shall supply mandatory spare parts as per list of spares as detailed below:

2.1 Reciprocating Compressor:

Sl. No.	DESCRIPTION	QUANTITY
1.0	Compressor	
1.1	Main bearings	1 set
1.2	Crankshaft journal bearings	1 set
1.3	Big end bearing	1 set
1.4	Cross head pin bearings	1 set
1.5	Complete Set of Connecting rod with fasteners	1 Set of each size
1.6	Complete Set Cross head body & guide assembly with fasteners	1 set of each size
1.7	Piston assembly complete with piston rod, piston, piston rings & lock nut etc. for each stage	1 set
1.8	Piston rings for each piston	2 sets
1.9	Complete stuffing box internal packing	1 set
1.10	Oil slinger ring	1 set
1.11	Liner for each stage	1 set
1.12	Complete inlet valves assembly with internals for each cylinder	1 set
1.13	Complete discharge valves assembly with internals for each cylinder	1 Set
1.14	Complete Set of all Gasket and O-Ring .	2 sets
2.0	Gas Coolers	
2.1	Tubes for gas cooler	1 set
2.2	Tubes for oil cooler (when tube are easily replaceable)	5 % for each cooler
2.3	Complete set of Gaskets for coolers & pressure Vessels	2 sets
3.0	Lube Oil System	
3.1	Spares for lube oil pump :	
	a) gears with Shaft	1 set
	b) complete set of bearings	1 set
	c) complete set of seal	2 sets
3.2	Lube oil filter cartridges	4 sets
3.3	Cylinder lubrication system :	
	a) Complete set of Lubricator bearings	1 set
	b) Pumping unit assembly	1set
	c) Check valves of each size	1 set of each size

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	d) Sight glass	1 set
4.0	Accessories	1 set
4.1	Set of spares for all valves (Isolation, control, safety, non return etc.) in gas lines consisting of spindle, seat , disc, flap, packing , fasteners etc.	1 set
5.0	Instrumentation	
	As per Instrumentation specification enclosed with enquiry / order specification.	

Note :- Set means complete replacement of particular part in one machine.

3.0 VENDOR'S RECOMMENDED SPARE PARTS:

LSTK Contractor shall submit list of recommended spare parts of specialised items not covered mandatory spares, along with itemised price. Owner will review and decide the recommended spares required for the project.

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4.0 INSTRUMENTATION:

Spares List for Instrument Items, to be supplied by BIDDER

Sr. No.	Item Category	Qty Required
1	Field instruments	
1.1	Pressure Gauges, Differential Pressure Gauge, Draft Gauges, Field Indicators, RTD/T/C with Thermowells, welded thermowell, Skin Thermocouple Sets, Speed Probes, Vibration Probes, Speed Transmitter, Proximometers of diff. model, Sensors of Gas Detectors, Probe Extension cable, Flame scanners, Different types of JB, Vibration system, Vibration cable conduit, Hydrastep related accessories, Magnetic flowmeter, Mass flowmeter, RADAR type, Ultrasonic Level/Flow transmitter, etc.	10% of each type of instruments, subject to minimum 1 no. of each type, including all peripheral accessories
1.2	Transmitters for Flow, Pressure, Level, Temperature, Diff. Pressure application, Transmitter for LEL/GAS Detector System, etc.	10% of each type of instruments, subject to minimum 1 nos. of each type
1.3	Accessories such as Oval flange o-ring, 5 valve manifold, 2 valve manifold, isolation valve, drain plug, blind plugs etc.	10% of each type subject to minimum 10 nos. of each type
2	Displacer type Level Transmitters	10% of each type of instruments Head with Torque Tube Assembly and Transmitter, subject to minimum 1 no. of each type
2.1	Radar type Level Transmitters	A) 10 % complete instrument - minimum 1 no. of each type/Range/material B) 10 % Electronic module/Cards - minimum 1 no. of each type
2.2	Electronic Drum Level Indicator (Hydrastep)	20 % Electronic module/Cards/Probe subject to minimum 1 Nos. of each type

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2.2a	Conductivity / pH Transmitters	5 % of each type of instruments, subject to minimum 1 no. of transmitter and electrode of each type
2.2b	Torque RENCH	Minimum 1 no. of each type
3	Control Valve / SAPCV/Self Regulation	
3.1	Soft part / actuator spares, including actuator diaphragm and spring sets, for each type of actuator	10% of each type of instruments, subject to minimum 1 no. of each type of Actuator repair kit/Piston Ring/Actuator Diaphragm
3.2	Trim Set	Min 1 No. of each type Trim set consisting of Seat ring/seal ring. Plug with stem, Cage(wherever applicable), Packing material for each make, type, size, pressure rating valve to be provided as spare
3.3	Gland Packing, O rings, Bonnet gasket, Seat gasket/ Line Gasket	100% for each valve.
3.4	Greases and Grease guns	5 sets of each type of grease and 1 grease gun of each type.
3.5	Solenoid valves	10% of each type of instruments subject to minimum 2 plus 10% repair kit (seal kit, etc.), subject to minimum 2 nos. of each type
3.6	Proximity switches/ Limit Switches/ Position switches including enclosure	10% of each type of instruments, including enclosure- subject to minimum 2 nos. of each type
3.7	SMART Positioner Assembly (including Feedback Arrangement)	10% of each type of instruments, subject to minimum 3 nos. of each type

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3.8	Other accessories like Quick Exhaust relay, Volume Boosters, Air Filter regulators, Lockup relay, AOV (Pilot Valve), Position Transmitters, Change over relay ,NRV/Spare breathers/Silencers/Vent port filter required for all control Valve.	10% of each type of instruments, subject to minimum 3 nos. of each type
3.9	Snubber, Syphon, Gauge saver	10% (subject to minimum of 1) of each item used, whichever is higher
3.10	Air Distribution Manifold (for I.A distribution)	Minimum 1 No of each type
3.11	Compression Fittings, Pipe Fitting	10 % subject to min. 10 No. of each type of installed.
3.12	Panel Mounted Instruments	10 % or minimum 1 no. whichever is higher
3.13	PRDS & De-superheater unit	Same of those of control valves
4	DCS / ESD/ Gas Monitoring system	
4.1	System Pre-fab cables, other than I/O Card cables	5% or min.1 no. of each type with all connectors, plugs, etc.
4.2	Operator Station, View only station, Eng. Station, Server along-with 24" LED type Colour Monitor with all type of cables/power chords	As per annexure attached.
4.3	RAID HDD unit for each machine	1 set of each type with all connectors, plugs, etc.,
4.4	Various Keyboards/ mouse, OEP, Network Switches, Firewall, etc.	5% or minimum 1 no. of each type, comprising the complete set.
4.5	Relays	5% or minimum 1 no. of each type of RELAYs, including relevant terminal modules/sockets, etc.
4.6	Pushbuttons, Lamps, Selector switches, DPM	5% or minimum 1 no. of each type of card, including relevant terminal modules/accessories as a complete SET
4.7	Microprocessor based Annunciator Unit	1 Complete unit of each type

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4.8	I/O Cards	5% of each type of card, including relevant terminal modules/pre-fab system cables, etc., subject to minimum of 1 no. each
4.9	Various System Battery, Terminators	1 no. of each
4.10	All system Fuses and various glass fuses	100% for all fuses
4.11	All PDB fuses, like HRC, GSA Fuses, etc.	50% of total qty. of each type
4.12	24 V DC Bulk Power Supply modules	5% or min.2 nos. of each type
5	Isolation amplifier and IS Barriers/ Power Rail/ Rail power supply assembly	5% of each type of instruments, subject to minimum 1 no. of each type
6	Special control system modules like Electronic Governor, I/H converters, over Speed Trip unit, Anti surge controller etc.	10 % or minimum 1 no. of each type of complete unit for 1:1 replacement
7	Bentley Nevada 3500 Series Vibration Monitoring System Spares	
7.1	Central Rack cards like Power supply card, Vibration/Thrust Monitoring card, Key-phasor module, TMR Relay module, Display unit, Proximity Probes, Extension cables, Proximeters, Relay board, Conduits etc.	10% of each type, subject to minimum 1 no. of each type
8	Sample conditioning system applicable for all analyser system	
	Complete Sample kit for sample pumps inclusive of O-rings, Seal ring, Diaphragm	1 set each type
	Solenoid valve for more than one stream applications	1 No. of each type
	Flow switch	1 No. of each type
	Vaporization system if required which includes vapouriser, thermostat, Electrical tracing cable and Heater	1 set each type
	Cooling system if required, which includes one cooler, flow conditioning system	1 set each type
9	Pressure regulator for Calibration Gas Cylinders	Minimum 2 nos. of each type
10	Flame Scanner	2 complete Instruments of Each type
11	Gas Detectors	5% of each type
12	Power cables	1000 Meters of each type

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13	Signal cables/Low capacitance cable/Extension cable	1000 Meters of each type
14	Communication cables for DCS/ESD, RS-485, MODBUS	500 Meters of each type
15	Loop Powered Indicators	10% (subject to minimum of 2 nos.) of Loop powered indicator used-whichever is higher
16	Tubing (SS)	200 Meter of each type
17	Junction Boxes with cable glands	10 % of installed or minimum of 2 of each type-whichever is higher
18	Tools	Minimum 1 no of special tool of each type
19	Engineering Tool kit	1 No.
20	External Hard disk (2TB) USB powered along with Protective covers	10 Nos.
21	CD/DVD	50 each

Notes

1	The above spares do not include installed spares as well as commissioning spares. The above shall be purely ware house spares
2	Wherever "Each Type" is specified, it is means "of the Type/make/model/size and exactly replaceble"
3	Wherever "% qty." is specified, BIDDER to quote in next higher rounded figure

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5.0 ELECTRICAL:

Sl. No.	Item	Quantity
1.0	LV Switchgear (including Distribution Boards) of each type and rating per substation	
1.1	Spares for LV circuit breakers (of each type & rating)	
A.	Complete CB (ready to use) along with fixed & draw out contacts	1 for each type & rating
B.	Main contact sets/Jaw contact complete	2 sets for each type & rating
C.	Fixed Arcing contact Assembly	2 sets for each type & rating
D.	Moving Arcing contact Assembly	2 sets for each type & rating
E.	Trip coils	3 sets for each type & rating
F.	Closing coils	3 sets for each type & rating
G.	Spring charging motors	2 sets for each type & rating
H.	Arc chute Assembly	1 for each type & rating
I.	Limit switches complete	2 sets
J.	Auxiliary Contactors (of each type)	2 nos.
1.2	Contactors	
A.	Power contactors (of each type & rating)	2 Nos.
B.	Auxiliary contactors (of each type & rating)	4 Nos.
C.	Coils for power contactors (of each type/voltage)	4 Nos.
1.3	Fuse Switch Units (of each type)	2 Nos.
1.4	Thermal Overload Relay (of each type)	2 Nos.
1.5	Push Button (of each type)	3 Nos.
1.6	Instrument Transformers	
A.	Current Transformer (of each rating)	3 Nos.
B.	Voltage Transformer (of each rating)	3 Nos.
1.7	Control Transformers (of each rating)	2 Nos.
1.8	Meters	



SPARE PARTS
NEW 2500M3 HORTON SPHERE FOR
STORAGE OF AMMONIA AT NFL, NANGAL

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Sl. No.	Item	Quantity
A.	Ammeter, Voltmeter (of each range)	2 Nos.
B.	Multifunction Meters (of each type)	2 Nos.
1.9	Fuses (of each type)	
A.	Fuse Link	2 Nos.
1.10	Indicating Lamps Assembly Complete	10 Nos. each colour & voltage
1.11	Control Switches	
A.	Ammeter Selector Switch	2 Nos.
B.	Voltmeter Selector Switch	2 Nos.
C.	Trip-Neutral-Close Control Switch	2 Nos.
D.	Local-Remote Selector Switch	2 Nos.
1.12	MCB's of each rating	3 Nos.
1.13	Protective Relays	
A.	Microprocessor based relay of each type	1 No.
B.	Electromechanical Relays of each type (Lockout relay, Trip Circuit supervision and any other electromechanical relay used)	2 Nos.
C.	Timers - each type/range/voltage	3 Nos.
1.14	Miscellaneous	
A.	Alarm bell	2 Nos.
B.	Alarm Buzzer	2 Nos.
2.0	Auxiliary Service Transformer (of each type & rating) per substation	
A.	Bushing with accessories for all voltage grades	2 Sets
B.	Complete set of Gaskets	2 Sets
C.	Oil Level Gauge (for oil cooled transformer only)	2 Nos.
D.	Complete set of Silica Gel Breather (for oil cooled transformer only)	2 Nos.
E.	Gland packing / O-ring for every valve (for oil cooled transformer only)	2 Nos.



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Sl. No.	Item	Quantity
3.0	LV Motor (of each type & rating)	
A.	Bearings (Driving end)	1 set
B.	Bearings (Non driving end)	1 set
C.	Cooling fan	1 No.
D.	Space heater	2 Nos.
E.	Terminal box	1 No.
F.	Grease nipple & Plug	2 Nos.
G.	Cooling fan cover	1 No.
4.0	Lighting Fixtures (of each type & rating)	
A.	Lighting fixtures (along with control gear)	10% of the total no. of fixtures (rounded off to next higher digit with minimum 5 Nos. of each type).
B.	Lamp holder of each type	5 Nos. of each rating & type
C.	Terminal block of each type	5 Nos.
D.	Heat resistance toughened glass cover of each type	5 Nos.
5.0	Local Control Station (of each type & rating)	
A.	Ammeters of different ranges	20% (rounded off to next higher digit)
B.	Terminal block	20% (rounded off to next higher digit)
C.	Indicating Lamps of different type	20% (rounded off to next higher digit)
6.0	Variable Frequency Drives (of each type & rating)	
A.	Controller Card of each type	1 No.
B.	Power Devices of each type	2 Nos.
C.	Fuses of each types & rating	2 sets
7.0	Cathodic Protection System	
A.	Anode of each type & rating	2 Nos.
B.	Transformer/rectifier unit (complete) of each type & rating	1 No.
C.	Half cells	5 Nos.

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Notes :

- 1) Set means complete replacement of particular part in one machine.
- 2) The above spares do not includes commissioning spares and shall be purely warehouse spare.
- 3) Wherever "Each Type" is specified, it means "of the Type/make/model/size/rating and exactly replaceable"
- 4) Wherever "% qty." is specified, Bidder to quote in next higher rounded figure
- 5) Out of % age spares and minimum qty specified against each item - higher of the two shall be supplied.
- 6) Electrical EQUIPMENT which has not been mentioned in this table and needs spare parts, CONTRACTOR shall consider spare parts for them, the quantities for such spare parts shall then be APPROVED by OWNER/CONSULTANT.

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PART II: TECHNICAL


SECTION – 15.0

INFORMATION REQUIRED IN TECHNICAL PROPOSAL

**PLANT: NATIONAL FERTILIZERS LIMITED, NFL, NANGAL,
PUNJAB**



**PROJECTS: INSTALLATION OF NEW 2500 CUBIC METER
CAPACITY HORTON SPHERE FOR STORAGE OF
AMMONIA ALONG WITH ITS REFRIGERATION SYSTEM
AT NFL, NANGAL**

0	28.12.2023	28.12.2023	ISSUED FOR NIT	ARVIND	SKM	SKM
REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD

	INFORMATION REQUIRED IN TECHNICAL PROPOSAL INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/15.0	0	
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1.0	Design Basis
2.0	Detailed Description of the Process
3.0	Process Flow Diagrams/ Material Selection Diagrams
4.0	Design calculations for sizing of exchangers
5.0	Piping & Instrument Diagram (P & ID)
6.0	Details of Equipment & machinery
7.0	Design Philosophy for Electrical system
8.0	Normal & Emergency Power requirement
9.0	Specifications of chemicals
10.0	Plant layout for Battery Limit Plant
11.0	Details of Instrumentation system
12.0	Detailed Technical Specifications
13.0	Comprehensive Engineering Specifications/ Standards & design codes
14.0	Details of Shop & Field Testing & Inspection Procedures
15.0	Implementation plan
16.0	Project Plan

	INFORMATION REQUIRED IN TECHNICAL PROPOSAL INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/15.0	0	
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17.0	List of Deviations
18.0	Time Schedule Network
19.0	List of Vendor's not covered under ITB Vendor List
20.0	Quality Assurance & Quality Control Procedure
21.0	List of Spare Part

INFORMATION REQUIRED IN THE TECHNICAL PROPOSAL:

The Technical proposal of the bid shall include, but not necessarily be limited to the following:



- 1.0 Design Basis:** Design basis for all Process, Mechanical, Electrical, Instrumentation, Civil & structural items shall be submitted by the Contractor.
- 2.0 A detailed description of the process** offered, including overall process scheme and the specific merits of the process scheme being offered.
- 3.0 Process flow diagrams/ Material Selection Diagrams** indicating the major equipment in proper Flow sequence, Flows, Temperatures, Pressures, Compositions, Critical Instrumentation, Control points and the material of construction adopted for the major lines.
- 4.0 Design calculations**
Calculation for dosing chemical consumption
Details of Treatment process indicating various chemical reactions & chemicals required for treatment processes.

Design calculations for sizing of the exchangers shall cover all process route, showing input and output utility streams as well as composition, volumetric flow,

	INFORMATION REQUIRED IN TECHNICAL PROPOSAL INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/15.0	0	
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molecular weight and densities of principal process streams at inlet and outlet of each equipment.

- 5.0 Piping & Instrument Diagram (P & ID)** for all plants and package items design case and normal case.
- 6.0 Details of Equipment and Machinery** (Mechanical, Electrical, Instrumentation included in the proposal). Data sheets of equipment indicating design code used and sufficient specification such as those used in enquiry documents giving details like, size, overall dimensions, thickness, weight, material of construction, lining/cladding (if any), details of internals and packing materials, distributors, design conditions and corrosion allowances used etc.
- 7.0 Design Philosophy for the Electrical System**, List of Electrical Drives with normal & design ratings, a Single Line Electrical Distribution Diagram showing Loads at various voltage levels, Protection/ metering and interlocking scheme, Hazardous area classification drawing for the plant and list of vendors. Specification of all electrical equipments.
- 8.0 Normal & Emergency Power Requirement** and the list of equipments connected to it.
- 9.0 Specifications of Chemicals** and their estimated Initial and yearly requirement.
- 10.0 Plant Layout for Battery Limit plant** showing principal equipment and machinery including detailed floor plans and elevations. The plot plan should show clearances required, roads and all principal pipe racks.
- 11.0 Details of Instrumentation System** including the proposed models etc. as also details of the proposed control systems (DCS) Safety Interlock and Trip system shall be enclosed. A list of all control valves with purchase specifications, material

	INFORMATION REQUIRED IN TECHNICAL PROPOSAL INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/15.0	0	
		DOCUMENT NO.	REV.	
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of construction, codes/standards used shall be enclosed. Instrumentation Control Philosophy, Logic Diagrams & Safety valve Specifications shall also be enclosed.

12.0 Detailed Technical Specifications of piping & valves with approximate tonnage/quantities in the form of Bill of Material.

13.0 Comprehensive Engineering Specification/Standards and Design Codes for all types of Equipments/items including Mechanical, Electrical, Instrumentation, Civil & Structural proposed to be adopted by the Contractor.



14.0 Details of Shop & Field Testing and Inspection Procedures proposed to be adopted. Inspection of equipment & machinery should be carried out by a Third Party Inspector. Owner also has the right to inspect any equipment, machinery at any stage.

15.0 An Implementation Plan showing man-power deployment schedule during various stages of implementation period, including peak requirements. Contractor shall indicate the schedule, category and number of personnel proposed for supervisory services during different phases of work, indicating clearly as to how many of them would be deployed by Contractor. Contractor shall also indicate the correspondence and documentation system to be followed.

16.0 Project Plan showing Project Organisation, Project team, Project services offered by the Contractor at home office and at site. Contractor would also indicate the activities proposed to be carried out.

17.0 List of Deviations. Contractor shall submit list of deviations to technical ITB indicating clearly clause-wise deviation from ITB. Any deviation listed other than in deviation list shall not be considered.

18.0 Time Schedule Network. A time schedule for the complete project in the form of a Bar Chart and Network indicating the time allocated for various activities. Master

	INFORMATION REQUIRED IN TECHNICAL PROPOSAL INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/15.0	0	
		DOCUMENT NO.	REV.	
		SHEET 6 OF 6		



time schedule/ network (PERT Network/ Bar chart) showing all activities shall be submitted by the Contractor.

19.0 List of Vendor's not covered under ITB Vendor List.

Bidder shall furnish list of vendors for the items not covered under ITB which shall be discussed & finalised with selected contractor.

20.0 Quality Assurance & Quality Control procedure to be followed by Contractor for the implementation of this project.

21.0 List of Spare part. Complete list of itemised commissioning, mandatory & recommended spare (spare parts not covered under mandatory spares list) parts for 2 years operations for all Process, Mechanical, Electrical, and Instrument items considered for this project.



	RECOMMENDED SUB-VENDOR LIST INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P- II/16.0	0	
		DOCUMENT NO	REV	

SECTION VI– 16.0

RECOMMENDED SUB-VENDOR LIST

**PLANT: NATIONAL FERTILIZERS LIMITED, NFL, NANGAL,
PUNJAB**

**PROJECTS: INSTALLATION OF NEW 2500 CUBIC METER
CAPACITY HORTON SPHERE FOR STORAGE OF
AMMONIA ALONG WITH ITS REFRIGERATION SYSTEM
AT NFL, NANGAL**

	RECOMMENDED SUB-VENDOR LIST NEW 2500M3 HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/16.0	0	
		DOCUMENT NO	REV	

CONTENTS

SECTION NUMBER	DESCRIPTION
1.0	Mechanical(Piping)
2.0	Rotating Equipments
3.0	Instrumentation
4.0	Electrical
5.0	Civil & Structural Works



120101 : CS PIPES IS-1239 (BLACK & GI)

CODE	NAME
INDIA	
1 . P0039	AMBICA TUBES CO.
2 . P2055	ANIL METAL CORPORATION
3 . P2253	BHARAT ENTERPRISES (All sizes from PDIL enlisted pipe mills/manufacturer)
4 . P2216	CHETAN STEELS (Upto 6")
5 . P2196	DADU PIPES (P) LIMITED (½" to 6")
6 . P2075	GOOD LUCK STEEL TUBES LTD. (15 mm to 150 mm dia)
7 . P0326	GUJRAT STEEL TUBES LTD.
8 . P2166	HI-TECH PIPES LTD. (ERW MS / GI Pipes:½" NB to 6" NB, (Thickness 2.2 mm to 6.0 mm))
9 . P0814	INDIAN TUBE CO. (TATA DIV. OF TUBES & PIPES) (For >200M)
10 . P0387	INDUS TUBES LIMITED (½" to 6")
11 . P2121	JAY LAKSHMI STEEL & ENGINEERING CO.
12 . P0427	JINDAL PIPES LTD. (1/2" to 4")
13 . P2193	JOTINDRA STEEL & TUBES LTD. (½" to 6")
14 . P2111	KALPESH TUBE(INDIA), (TRADER) (upto a max order value Rs.25.0 lakh)
15 . P0548	MUKAT PIPES LTD
16 . P2178	NAVRATAN PIPE AND PROFILE LTD. (Upto 6")
17 . P2040	P.K.FORGE & FITTING INDUSTRIES



120101 : CS PIPES IS-1239 (BLACK & GI)

CODE	NAME
18 . P2116	SAGAR STEEL CORPORATION (TRADER)
19 . P2110	SANGHVI METALS (TRADER)
20 . P2250	SHRIPAL METAL LIMITED (CS Pipes IS-1239 (Black & GI) All sizes from PDIL enlisted pipe mills/manufacturer)
21 . P0775	SURINDRA ENGINEERING CO. PVT. LTD.
22 . P0776	SURYA ROSHNI LTD. (15mm to 150mm)
23 . P2123	THE BENGAL MILL STORES SUPPLY CO.(TRADER)
24 . P2152	WELSPUN GUJARAT STAHL ROHREN LIMITED (ANJAR) (Upto 6")
25 . P0894	ZENITH LIMITED
26 . P2252	` (UP TO 6" (BLACK), UPTO 4" (GI))



120102 : CS WELDED PIPES IS-3589

CODE	NAME
INDIA	
1 . P2055	ANIL METAL CORPORATION
2 . P2253	BHARAT ENTERPRISES (All sizes from PDIL enlisted pipe mills/manufacturer)
3 . P2196	DADU PIPES (P) LIMITED (6" to 12" (Thickness up to 9.5 mm))
4 . P2069	EVERGREEN HARDWARE STORES
5 . P2075	GOOD LUCK STEEL TUBES LTD. (Upto 150mm dia , 8 mm thick.)
6 . P0326	GUJRAT STEEL TUBES LTD.
7 . P2077	HEAVY METAL & TUBES LIMITED
8 . P2166	HI-TECH PIPES LTD. (ERW MS / GI Pipes: 6" NB OD to 12", (Thickness 2.6 mm to 8.0 mm))
9 . P0387	INDUS TUBES LIMITED (6" to 12")
10 . P2121	JAY LAKSHMI STEEL & ENGINEERING CO.
11 . P0427	JINDAL PIPES LTD. (8" to 14")
12 . P2193	JOTINDRA STEEL & TUBES LTD. (6" to 14")
13 . P2111	KALPESH TUBE(INDIA), (TRADER)
14 . P2124	LALIT PIPES & PIPES LIMITED (16" to 64", thickness upto 20mm)
15 . P0548	MUKAT PIPES LTD
16 . P2178	NAVRATAN PIPE AND PROFILE LTD. (Upto 10")
17 . P2040	P.K.FORGE & FITTING INDUSTRIES



120102 : CS WELDED PIPES IS-3589

CODE	NAME
18 . P2174	PRATIBHA INDUSTRIES LTD., (16" NB to 24" NB, Wall Thickness: 6 mm to 20 mm)
19 . P0661	RATNAMANI METALS & TUBES LIMITED
20 . P2116	SAGAR STEEL CORPORATION (TRADER)
21 . P2110	SANGHVI METALS (TRADER)
22 . P2095	SAW PIPES
23 . P2105	SHRI RAM METALS
24 . P2250	SHRIPAL METAL LIMITED (CS Welded Pipes IS-3589 All sizes from PDIL enlisted pipe mills/manufacture)
25 . P0754	STEEL AUTHORITY OF INDIA LTD.
26 . P0775	SURINDRA ENGINEERING CO. PVT. LTD.
27 . P0776	SURYA ROSHNI LTD. (6" to 16" ,(150mm to 400mm))
28 . P2123	THE BENGAL MILL STORES SUPPLY CO.(TRADER)
29 . P2153	WELSPUN GUJARAT STAHL ROHREN LIMITED (DAHEJ) (Upto 72" (50 mm thk.))
30 . P2152	WELSPUN GUJARAT STAHL ROHREN LIMITED (ANJAR) (Upto 100" (30 mm thk.))

**120103 : CS WELDED PIPES TO API 5L SPIRAL/LONG. WELDED
(SAW/EFSW)**

CODE	NAME
INDIA	
1 . P2253	BHARAT ENTERPRISES (All sizes from PDIL enlisted pipe mills/manufacturer)
2 . P2198	HEAVY METAL PIPE CENTRE (Upto 24" (Upto SCHXXS) (PDIL approved Manufacturer's Make only))
3 . P0427	JINDAL PIPES LTD. (2" TO 14")
4 . P2193	JOTINDRA STEEL & TUBES LTD. (½" to 14")
5 . P2111	KALPESH TUBE(INDIA), (TRADER)
6 . P2124	LALIT PIPES & PIPES LIMITED (16" to 64", thickness upto 20mm)
7 . P0548	MUKAT PIPES LTD
8 . P2040	P.K.FORGE & FITTING INDUSTRIES
9 . P2174	PRATIBHA INDUSTRIES LTD., (16" NB to 24" NB, Wall Thickness: 6 mm to 14.27)
10 . P0661	RATNAMANI METALS & TUBES LIMITED
11 . P2116	SAGAR STEEL CORPORATION (TRADER)
12 . P0754	STEEL AUTHORITY OF INDIA LTD.
13 . P0775	SURINDRA ENGINEERING CO. PVT. LTD.
14 . P0776	SURYA ROSHNI LTD. (Gr. A, 3" to 4", Gr. B, 6" to 14")
15 . P2123	THE BENGAL MILL STORES SUPPLY CO.(TRADER)
16 . P2153	WELSPUN GUJARAT STAHL ROHREN LIMITED (DAHEJ) (Upto 72" (50 mm thk.))
17 . P2152	WELSPUN GUJARAT STAHL ROHREN LIMITED (ANJAR) (Upto 100" (30 mm thk.))



120103 : CS WELDED PIPES TO API 5L SPIRAL/LONG. WELDED
(SAW/EFSW)

CODE	NAME
FRANCE	
18 . P0834	ETS TROUVAY & CAUVIN
19 . P0629	PHOCEENNE
GERMANY	
20 . P0509	MANNESMANN HANDEL AG
21 . P0813	THYSSEN-KRUPP STAHLUNION GmbH
ITALY	
22 . P0191	DALMINE SPA
23 . P2092	RACCORTUBI SRL
JAPAN	
24 . P0464	KOSEI SANGYO LTD
25 . P0517	MARUBENI ITOCHU STEEL
26 . P0539	MITSUBISHI CORPORATION
27 . P0583	NIPPON KOKAN
28 . P0585	NIPPON STEEL CORPORATION
29 . P0587	NISHITANI & CO. LTD.
30 . P0588	NISSHO IWAI CORPORATION
31 . P0601	OKURA & CO. LTD.
32 . P0575	SOJITZ CORPORATION



120103 : CS WELDED PIPES TO API 5L SPIRAL/LONG. WELDED
(SAW/EFSW)

CODE	NAME
33 . P0770	SUMITOMO METAL INDUSTRIES LTD.
KOREA	
34 . P0370	HYUNDAI CORPORATION
U.K.	
35 . P2064	BRITISH STEEL CORPORATION
36 . P0129	CORUS TUBES LIMITED
U.S.A.	
37 . P0703	SAW PIPES USA,INC.



120104 : CS / AS / LTCS SEAMLESS PIPES

CODE	NAME
INDIA	
1 . P2224	ANAND SEAMLESS TUBES PVT. LTD. (CS Seamless Pipes Upto 2")
2 . P2253	BHARAT ENTERPRISES (All sizes from PDIL enlisted pipe mills/manufacturer)
3 . P0115	BHEL (VALVES DIVISION)
4 . P2216	CHETAN STEELS (Upto 12" SCH 80)
5 . P2077	HEAVY METAL & TUBES LIMITED (Upto 8" (thickness upto 18.26 mm))
6 . P2198	HEAVY METAL PIPE CENTRE (Upto 24" (Upto SCHXXS) (PDIL approved Manufacturer's Make only))
7 . P0814	INDIAN TUBE CO. (TATA DIV. OF TUBES & PIPES)
8 . P0800	ISMT LIMITED
9 . P2121	JAY LAKSHMI STEEL & ENGINEERING CO.
10 . P2133	JINDAL SAW LIMITED
11 . P0503	MAHARASHTRA SEAMLESS LTD.
12 . P2040	P.K.FORGE & FITTING INDUSTRIES
13 . P2138	RATNADEEP METAL & TUBES PVT. LTD. (<=168.3mm OD)
14 . P2170	SAINEST TUBES PVT. LTD. (½" NB to 3" Upto Sch 160 (ASTM A106 Gr. B, A333 Gr.1 & 6 & A335 Gr. P11))
15 . P2250	SHRIPAL METAL LIMITED (CS/AS/LTCS Seamless Pipes All sizes from PDIL enlisted pipe mills/manufacturer)
FRANCE	
16 . P0834	ETS TROUVAY & CAUVIN



120104 : CS / AS / LTCS SEAMLESS PIPES

CODE	NAME
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17 . P0629 PHOCEENNE

GERMANY

18 . P0477 HORST KURVERS GmbH

19 . P0509 MANNESMANN HANDEL AG

ITALY

20 . P0191 DALMINE SPA

21 . P2119 GAM RACCORDI S.P.A

22 . P0175 IBF SEAMLESS PIPES Spa

23 . P2092 RACCORTUBI SRL

JAPAN

24 . P0517 MARUBENI ITOCHU STEEL

25 . P0539 MITSUBISHI CORPORATION

26 . P0585 NIPPON STEEL CORPORATION

27 . P0587 NISHITANI & CO. LTD.

28 . P0588 NISSHO IWAI CORPORATION

29 . P0601 OKURA & CO. LTD.

30 . P0575 SOJITZ CORPORATION

31 . P0770 SUMITOMO METAL INDUSTRIES LTD.

KOREA



120104 : CS / AS / LTCS SEAMLESS PIPES

CODE	NAME
32 . P0370	HYUNDAI CORPORATION
SWEDEN	
33 . P0004	AB SANDVIK STEEL
U.K.	
34 . P2064	BRITISH STEEL CORPORATION
35 . P0129	CORUS TUBES LIMITED
36 . P0870	VOMAL INTERNATIONAL LIMITED



120105 : SS SEAMLESS/WELDED PIPES

CODE	NAME
GERMANY	
1 . P2189	H. BUTTING GmbH & CO. (Seamless : Upto 30" (upto 16mm thk) & Welded: Upto 72" (upto 64mm thk.))
INDIA	
2 . P2183	APEX TUBES PVT. LIMITED (Seamless: Upto 8" (Sch80S) & Welded: Upto 48" (Sch160))
3 . P2181	BHANDARI FOILS & TUBES LIMITED (Seamless Upto 4" (Sch. 80) & Welded Upto 20" (Thk. <= 8 mm))
4 . P2253	BHARAT ENTERPRISES (All sizes from PDIL enlisted pipe mills/manufacturer)
5 . P2216	CHETAN STEELS (Upto 6" SCH 40)
6 . P0158	CHOKSI TUBE COMPANY LTD.
7 . P2242	DIVINE TUBES PVT.LTD. (UPTO 8")
8 . P2077	HEAVY METAL & TUBES LIMITED (Upto 8" (thickness upto 18.26 mm))
9 . P2198	HEAVY METAL PIPE CENTRE (Upto 8" (Upto SCH80S) (PDIL approved Manufacturer's Make only))
10 . P2121	JAY LAKSHMI STEEL & ENGINEERING CO.
11 . P2133	JINDAL SAW LIMITED
12 . P2167	KRYSTAL STEEL MANUFACTURING PVT. LTD. (Upto 2" (Material upto Grade SS 321))
13 . P2084	MARDALE PIPES PLUS LTD
14 . P2168	MODERN TUBE INDUSTRIES LIMITED (Upto 2" (Upto SS Grade 321))
15 . P0593	NUCLEAR FUEL COMPLEX
16 . P2040	P.K.FORGE & FITTING INDUSTRIES



120105 : SS SEAMLESS/WELDED PIPES

CODE	NAME
17 . P2089	PRAKASH STEELAGE LIMITED (Seamless : Upto 12" & Welded: Upto 24")
18 . P2182	QUALITY STAINLESS PVT. LTD. (Seamless: Upto 6" (SCH40S), Welded: Upto 20" (SCH40S) (Upto SS Grade 316L))
19 . P2138	RATNADEEP METAL & TUBES PVT. LTD. (Seamless <=168.3mm.OD. Welded <=50.8mm OD)
20 . P0661	RATNAMANI METALS & TUBES LIMITED
21 . P0659	REMI EDELSTAHL TUBULARS LTD.(RAJENDRA MECHANICAL INDUSTRIES (Welded Upto 48" Seamless upto 8" (Thk. Upto 12.7 mm))
22 . P2206	SANDVIK ASIA PVT. LTD. (¾" to 2" (Thk: upto 8.74 mm))
23 . P2110	SANGHVI METALS (TRADER)
24 . P2169	SCORODITE STAINLESS (INDIA) PVT. LTD. (Seamless upto 16" NB, Welding upto 36")
25 . P2246	SHALCO INDUSTRIES PRIVATE LIMITED (SS Seamless Pipes - Up to 8", SS Welded Pipe - Up to 4")
26 . P2250	SHRIPAL METAL LIMITED (SS Seamless/Welded Pipes All sizes from PDIL enlisted pipe mills/manufacturer)
27 . P2157	SHUBHLAXMI METALS & TUBES PVT. LTD. (SS Seamless ¾" NB to 2" NB; Thk: 1.2 mm to 8 mm, L upto 14 mtr; SS Welded ¾" NB to 8" NB; Thk: 1.2 mm to 8 mm Lupto 14 mtr (Material: SS 304, SS 304L, SS316, SS 316L, SS 321, SS 347, SS 347H))
28 . P2154	SURAJ LIMITED (SURAJ STAINLESS LIMITED)
29 . P2123	THE BENGAL MILL STORES SUPPLY CO.(TRADER)
30 . P1205	Venus Pipes & Tubes Private Limited (Up to 16")
31 . P2244	WELSPUN SPECIALITY SOLUTIONS LIMITED (Upto 4" (only for Seamless Pipes))
THE NETHERLANDS	
32 . P2202	SOSTA BV (Upto 72" (thickness upto 25.4 mm))

CHINA



120105 : SS SEAMLESS/WELDED PIPES

CODE	NAME
33 . P2131	ZHEJIANG JIULI STAINLESS STEEL PIPE CO. LTD.
FRANCE	
34 . P0834	ETS TROUVAY & CAUVIN
35 . P0629	PHOCEENNE
GERMANY	
36 . P0477	HORST KURVERS GmbH
37 . P0509	MANNESMANN HANDEL AG
38 . P0813	THYSSEN-KRUPP STAHLUNION GmbH
ITALY	
39 . P0191	DALMINE SPA
40 . P2119	GAM RACCORDI S.P.A (thickness 2" to 24")
41 . P0175	IBF SEAMLESS PIPES Spa
42 . P2092	RACCORTUBI SRL
JAPAN	
43 . P0517	MARUBENI ITOCHU STEEL
44 . P0539	MITSUBISHI CORPORATION
45 . P0585	NIPPON STEEL CORPORATION
46 . P0587	NISHITANI & CO. LTD.
47 . P0588	NISSHO IWAI CORPORATION



120105 : SS SEAMLESS/WELDED PIPES

CODE	NAME
48 . P0601	OKURA & CO. LTD.
49 . P0575	SOJITZ CORPORATION
50 . P0770	SUMITOMO METAL INDUSTRIES LTD.
KOREA	
51 . P0370	HYUNDAI CORPORATION
SPAIN	
52 . P2151	T.T.I. - TUBACEX TUBOS INOXIDABLES, S.A. (Upto 10")
SWEDEN	
53 . P0004	AB SANDVIK STEEL
U.K.	
54 . P2064	BRITISH STEEL CORPORATION
55 . P0129	CORUS TUBES LIMITED
56 . P0870	VOMAL INTERNATIONAL LIMITED



120110 : HDPE/ MDPE PIPES & PIPE FITTINGS

CODE	NAME
INDIA	
1 . P2057	ASTRAL
2 . P2059	AUQUAGUARD PLASTICS & POLYMERS
3 . P2066	CLIMAX SYNTHETICS
4 . P2071	FIBRO PLASTICHEM (I) PVT. LTD.
5 . P2085	NATIONAL ORG CHEMICAL INDIA LTD.
6 . P2207	PARTH POLY VALVES PVT. LTD. (¾" to 8" (150#))
7 . P2001	PENNWALT AGRU PLASTICS LTD. (upto 250mm Dia)
8 . P2094	RELIANCE INDUSTRIES 'RELPIPE'
9 . P1203	SANGIR PLASTICS PRIVATE LIMITED (UPTO 1200 MM OD)
10 . P1039	SONAL ENGG. PLASTIC FABRICATOR



120113 : FITTINGS: CS/AS/SS SEAMLESS & FORGED

CODE	NAME
INDIA	
1 . P2120	AMFORGE INDUSTRIES (Upto 24")
2 . P2055	ANIL METAL CORPORATION
3 . P2216	CHE TAN STEELS (Upto 6" SCH 80)
4 . P0166	COMMERCIAL SUPPLYING AGENCY
5 . P2195	CSA FITTINGS (Forged: ½" to 2" (Upto 9000#) & Seamless: 2" to 8" (Upto SCH XXS))
6 . P0221	EBY FASTNERS
7 . P0222	EBY INDUSTRIES
8 . P2150	FIT-TECH INDUSTRIES (Upto 24")
9 . P2159	FLASH FORGE(P) LTD. (Forged: Upto 4" (Upto 9000#) & Seamless: Upto 42")
10 . P2002	GUJARAT INFRAPIPES PVT. LTD.
11 . P2121	JAY LAKSHMI STEEL & ENGINEERING CO.
12 . P2111	KALPESH TUBE(INDIA), (TRADER) (upto a max order value Rs.25.0 lakh)
13 . P0553	M.S.FITTINGS MANUFACTURING CO.PVT.LTD.
14 . P2084	MARDALE PIPES PLUS LTD
15 . P2162	NAV KAR FORGINGS & FITTINGS PVT. LTD. (Forged: 3" (Upto 6000#) & Seamless: Upto 16" (Sch XXS))
16 . P2251	NEOSEAL ENGINEERING PRIVATE LIMITED (1. I. Fittings(Forged), CS, Up To 1.5", ANSI Class -Up To 3000#, 2. Fittings(SMLS), CS, Up To 10", SCH -Up To 40, 3. Fittings(SMLS), AS, Up To 6", SCH -Up To 40, 4. Fittings(SMLS), SS, Up To 8", SCH -Up To
17 . P2003	NL HAZRA (up to SCH 80)



120113 : FITTINGS: CS/AS/SS SEAMLESS & FORGED

CODE	NAME
18 . P2215	P K TUBES & FITTINGS PVT. LTD. (Forged upto 1 ½" & Seamless upto 24" (SCH 160))
19 . P2040	P.K.FORGE & FITTING INDUSTRIES
20 . P2199	PARAS FITTINGS PVT. LTD. (Forged CS: ½" to 2" & CS Seamless: 2" to 8" (Upto Sch XXS))
21 . P2156	PARMAR TECHNO FORGE (Elbow-1/2" to 12", Tees-1/2" to 8", Reducer (conc. & eccn.)-1/2" to 12", CAPS-1/2" to 18" (CS&SS))
22 . P2088	PERFECT MARKETING (P) LTD,
23 . P2187	PETROCHEM INDUSTRIES (Seamless: upto 16" (all Fittings) & upto 36" (Only Caps) Sch : XXS / 80S, Forged : Upto 3" 6000#)
24 . P2210	RAJENDRA FORGE INDUSTRIES (CS: Upto 12" Sch 40 & SS: 6" Sch 40S)
25 . P0733	S & G ENGINEERS (P) LTD.
26 . P2116	SAGAR STEEL CORPORATION (TRADER)
27 . P2110	SANGHVI METALS (TRADER)
28 . P2004	SAWAN ENGINEERS PVT. LIMITED (Upto 36" (SCH 160))
29 . P0728	SHIVANANDA PIPE FITTINGS LTD.,
30 . P0758	STEWARTS AND LLOYDS OF INDIA LIMITED
31 . P0793	TEEKAY TUBES PRIVATE LIMITED
32 . P2123	THE BENGAL MILL STORES SUPPLY CO.(TRADER)
33 . P2165	TOPAZ PIPING INDUSTRIES (2" to 36" (Sch 10 to Sch 160))
34 . P2006	TUBE BEND (CALCUTTA) PVT LTD (CS FITTINGS ONLY)



120113 : FITTINGS: CS/AS/SS SEAMLESS & FORGED

CODE	NAME
35 . P0835	TUBE PRODUCTS INCORPORATE
36 . P2135	ZOLOTO INDUSTRIES (15mm to 150mm (only CS-Galv.))
ITALY	
37 . P2188	PETROL RACCORD S.P.A. (Seamless: 1" - 42" (Elbows) & 1" - 56" (Tees/ Reducers/Caps))
FRANCE	
38 . P0834	ETS TROUVAY & CAUVIN
39 . P0629	PHOCEENNE
40 . P0853	VALLOUREC
GERMANY	
41 . P0477	HORST KURVERS GmbH
42 . P0509	MANNESMANN HANDEL AG
43 . P0712	SEIKMANN ANLAGEN-TECHNIK GMPH.
44 . P0822	TPS-TECHNITUBE ROHRENWERKE GMBH
ITALY	
45 . P0191	DALMINE SPA
46 . P2119	GAM RACCORDI S.P.A
47 . P0175	IBF SEAMLESS PIPES Spa
48 . P0377	IND MECCANICA BASSI LUIGI & C. SPA
49 . P2083	MANTOVANI SpA



120113 : FITTINGS: CS/AS/SS SEAMLESS & FORGED

CODE	NAME
50 . P2092	RACCORTUBI SRL
51 . P0789	TECHNO FORGE SPA
JAPAN	
52 . P0517	MARUBENI ITOCHU STEEL
53 . P0583	NIPPON KOKAN
54 . P0587	NISHITANI & CO. LTD.
55 . P0588	NISSHO IWAI CORPORATION
56 . P0601	OKURA & CO. LTD.
57 . P0575	SOJITZ CORPORATION
58 . P0770	SUMITOMO METAL INDUSTRIES LTD.
TAIWAN	
59 . P2007	HAITIMA CORPORATION
U.K.	
60 . P2064	BRITISH STEEL CORPORATION
61 . P0129	CORUS TUBES LIMITED
62 . P0245	EUROTUBE LIMITED
63 . P0870	VOMAL INTERNATIONAL LIMITED
U.S.A.	
64 . P2063	BONNEY FORGE



120115 : FRP/PVC PIPE AND PIPE FITTINGS

CODE	NAME
INDIA	
1 . P2058	ASTRAL POLYTECHNIK PVT. LTD. (1/2" TO 12" SIZE)
2 . P0290	GANDHI AND ASSOCIATES
3 . P1039	SONAL ENGG. PLASTIC FABRICATOR



120117 : FORGED FLANGES

CODE	NAME
INDIA	
1 . P2053	AJAY FORGINGS PVT. LTD.
2 . P2120	AMFORGE INDUSTRIES (Upto 24" for upto 1500#; Upto 12" for 2500#)
3 . P0048	ANANDMAYEE FORGINGS PVT. LTD.
4 . P0141	C D ENGINEERING
5 . P2233	CHANDAN STEEL LIMITED (Only SS Flanges: Upto 36" - 150#, upto 24" - 300#, upto 20" - 600#, upto 16" - 900#, upto 12" - 1500#, upto 8" - 2500#)
6 . P2216	CHETAN STEELS (Upto 6" (150#))
7 . P0152	CHW FORGE PRIVATE LIMITED (FORMERLY CHAUDHARY HAMMER WORKS)
8 . P0223	ECHJAY INDUSTRIES LIMITED
9 . P0255	FERROUS ALLOYS FORGINING PVT.LTD.,
10 . P0314	GOLDEN IRON & STEEL WORKS
11 . P2194	GOODLUCK ENGINEERING CO. (½"-12" (Upto 2500#), 14"-16" (Upto 900#), 18"-32" (Upto 600#), 34"-48" (Upto 300#))
12 . P0417	J K FORGINGS (1/2" to 60",ANSI B16.5,Class 150 to 2500)
13 . P2160	KUNJ FORGINGS PVT. LTD. (Upto 60"(upto 300#) & Upto 12"(upto 2500#))
14 . P2175	MAHESH INDUSTRIES (½" to 8" NB, Rating: 150#- SWRF, SORF & BLRF Material: ASTM A105 only; 2" NB to 4" NB, Rating: 150#- Weld Neck RF Flange Material: ASTM A105 only)
15 . P2223	METAL FORGINGS PVT. LTD. (Upto 86" (150#); 60" (300# to 600#); 48" (900#); 24" (1500#); 12" (2500#))
16 . P2251	NEOSEAL ENGINEERING PRIVATE LIMITED (1. Flange (Blind/WN), CS, Up To 36", ANSI Class -Up To 150#, 2. Flange (Blind/WN), CS, Up To 24", ANSI Class -Up To 2500#, 3.Flange (Blind/WN), AS, Up To 24", ANSI Class -Up To 1500#, 4. Flange (Blind/WN), SS,
17 . P2215	P K TUBES & FITTINGS PVT. LTD. (Upto 24" (upto 1500#) & upto 12" (upto 2500#) (Spectacle Blinds and Spacer & Blind only).)



120117 : FORGED FLANGES

CODE	NAME
18 . P2214	PARAMOUNT FORGE (CS, AS & SS: ½" to 42" (Upto 600#), ½" to 24" (Upto 900#), ½" to 16" (Upto 1500#), ½" to 12" (Upto 2500#))
19 . P2088	PERFECT MARKETING (P) LTD,
20 . P2008	PUNJAB STEEL
21 . P2155	R.D. FORGE (A UNIT OF R D CHEMICALS PVT LTD) (½" to 54" - 150#, ½" to 40" - 300#, ½" to 42" - 600#, ½" to 20" - 900#, ½" to 20" - 1500#, ½" to 12" - 2500# (CS, AS & SS))
22 . P2210	RAJENDRA FORGE INDUSTRIES (CS & SS : Upto 12", 300#)
23 . P0733	S & G ENGINEERS (P) LTD.
24 . P2005	SANGHVI FORGINGS & ENGINEERING LTD. (Upto 42" (upto 300#), 36"(600#), 24"(upto1500#) & 12"(2500#))
25 . P2110	SANGHVI METALS (TRADER)
26 . P2004	SAWAN ENGINEERS PVT. LIMITED
27 . P2185	TECHNO FORGE LTD. (Upto 42" (upto 300#), upto 24" (600#), upto 20" (900#), upto 16" (1500#), upto 12" (2500#))
28 . P2006	TUBE BEND (CALCUTTA) PVT LTD
FRANCE	
29 . P0834	ETS TROUVAY & CAUVIN
30 . P0629	PHOCEEENNE
GERMANY	
31 . P0477	HORST KURVERS GmbH
ITALY	
32 . P0414	I.S. INTERNATIONAL
33 . P2083	MANTOVANI SpA



120117 : FORGED FLANGES

CODE	NAME
34 . P0599	OFFICINE NICOLA GALPERTI & FIGLIO S.P.A
35 . P2092	RACCORTUBI SRL
JAPAN	
36 . P0576	NICHINAN SANGYO CO. LTD.,
37 . P0587	NISHITANI & CO. LTD.
38 . P0575	SOJITZ CORPORATION
U.K.	
39 . P0870	VOMAL INTERNATIONAL LIMITED



120118 : PLATE RING FLANGES

CODE	NAME
INDIA	
1 . P2070	FABWELL ENGINEERS
2 . P2175	MAHESH INDUSTRIES (½" to 16" NB, Rating: 150# & 300#- SWRF, SORF & BLRF, Material: MS Plate Flanges of IS 2062 Grade)
3 . P1012	MOD FABRICATORS
4 . P2215	P K TUBES & FITTINGS PVT. LTD. (Upto 48" (Spectacle Blinds and Spacer & Blind only).)
5 . P2214	PARAMOUNT FORGE (CS & SS : ½" to 84")
6 . P2088	PERFECT MARKETING (P) LTD,
7 . P2011	R SQUARE ENGINEERS
8 . P2110	SANGHVI METALS (TRADER)



120119 : FITTINGS: CS/AS/SS WELDED

CODE	NAME
KOREA	
1 . P2238	TK CORPORATION
INDIA	
2 . P2227	PARAS ENGINEERING WORKS (8" to 36" NB, Sch 5 to Sch XXS (CS & SS))
3 . P2216	CHETAN STEELS (Upto 10" SCH 80)
4 . P2150	FIT-TECH INDUSTRIES (Upto 48")
5 . P2159	FLASH FORGE(P) LTD. (Upto 42")
6 . P2162	NAVKAR FORGINGS & FITTINGS PVT. LTD. (Upto 24" (Sch XXS, Material: CS only))
7 . P2251	NEOSEAL ENGINEERING PRIVATE LIMITED (1. Fittings(Welded), CS, Up To 14", SCH -Up To 40, 2. Fittings(Welded), SS, Up To 14", SCH -Up To 10S)
8 . P2215	P K TUBES & FITTINGS PVT. LTD. (Upto 48" (SCH 160))
9 . P2187	PETROCHEM INDUSTRIES (6" to 36" (all Fittings) & 6" to 56" (Only Conc. / Ecc. Reducers) Sch : XXS/ 80S)
10 . P2210	RAJENDRA FORGE INDUSTRIES (CS & SS : Upto 12", Sch 40)
11 . P2004	SAWAN ENGINEERS PVT. LIMITED (Upto 52" (SCH 160))
12 . P2165	TOPAZ PIPING INDUSTRIES (8" to 48" (Sch 10 to Sch 160))
ITALY	
13 . P2188	PETROL RACCORD S.P.A. (4" - 56" (Tees/ Reducers/ Elbows))



120201 : STRAINERS (PERMANENT INCLUDING Y-TYPE)

CODE	NAME
INDIA	
1 . P2117	CHEMTECH INDUSTRIAL VALVES PVT. LTD
2 . P2072	FLAIR STRAINERS & FILTERS (Size upto 42" (Rating upto 1500#))
3 . P2248	FLOTEK INDUSTRIES (Strainer (Y Type) CS, Upto 8", ANSI Class -Upto 2500 #)
4 . P0318	GRAND PRIX ENGINEERING PVT. LTD. (upto 60" pipeline, upto ANSI 1500#)
5 . P0322	GREAVES LIMITED
6 . P0324	GUJARAT OTOFILT
7 . P2218	HAWA ENGINEERS LTD. (½" to 24" (150# / 300# / PN10 / PN40))
8 . P2010	KWIKFLO FILTERS PVT. LTD.
9 . P0487	LEADER VALVES LIMITED (size <= 12" - upto 300#)
10 . P1012	MOD FABRICATORS
11 . P0549	MULTITEX FILTRATION ENGINEERS LTD
12 . P1204	SAP Industries Limited (Up to 6")
13 . P2135	ZOLOTO INDUSTRIES (15mm to 100mm)
CHINA	
14 . P2173	BOTELI VALVE GROUP CO. LTD. (Y - Type only: 14" (150#) & 3" (300# & 600#))



120202 : STEAM TRAPS

CODE	NAME
INDIA	
1 . P0320	GREAVES LTD.
2 . P1012	MOD FABRICATORS (for Drip rings)
3 . P0624	PENNANT ENGINEERING PVT. LTD.
4 . P0865	VIRGO ENGINEERS LTD. (½" to 4" (Upto 600#) (CS/SS))
5 . P2103	YARWAY CORPORATION
6 . P2135	ZOLOTO INDUSTRIES (15mm to 25mm)
GERMANY	
7 . P0307	GESTRA AG
U.S.A.	
8 . P0059	ARMSTRONG INTERNATIONAL INC.
9 . P2086	OGONTZ CORPORATION
10 . P0889	TYCO INTERNATIONAL INC.,U.S.A.



120203 : SPRING SUPPORTS

CODE	NAME
INDIA	
1 . P1185	PIPE SUPPORTS CO. (UPTO 14 MT)
INDIA	
2 . P2106	MYRICS PIPING SYSTEM PVT.LTD.
3 . P0550	PIPE SUPPORTS INDIA PVT. LTD.
4 . P0632	PIPING & ENERGY PRODUCTS (P) LTD.
5 . P0699	SARATHI ENGG. ENTERPRISES PVT. LTD.
6 . P0747	SPRING SUPPORTS MFG. CO.
ITALY	
7 . P0271	FLEXIDER S.P.A.



120301 : GATE/GLOBE/CHECK VALVES CS/SS/AS < 900 Lbs

CODE	NAME
INDIA	
1 . P0003	A V VALVES LIMITED (Cast: Up to 42" (150#), 28" (300#), 24" (600#) & Forge:Upto 2" (800#))
2 . P2052	ADVANCE VALVES (2"- 80" (Upto 600#) (Dual Plate Check Valves only).)
3 . P0072	ASSOCIATED TOOLINGS (I) PVT. LTD. (½" to 2" (Rating upto : 800 #))
4 . P0077	AUDCO INDIA LIMITED(L&T VALVES DIVN.)
5 . P2136	AUTOCAP INDUSTRIES (1/2" to 2", 800 # (only CS & SS))
6 . P2060	BELL-O-SEAL VALVES PVT. LTD. (for zero leakage, hazardous fluids.)
7 . P0115	BHEL (VALVES DIVISION)
8 . P2146	BRIGHTECH VALVES AND CONTROLS PVT. LTD. (Upto 8" x 300# for CS, AS & SS Material)
9 . P2117	CHEMTECH INDUSTRIAL VALVES PVT. LTD
10 . P2229	CHEMTROLS SAMIL (INDIA) PVT. LTD. (Upto 12" - 150-# (Dual Plate Check Valves only))
11 . P2137	CRAWLEY & RAY (FOUNDERS & ENGINEERS) PVT. LTD (<=300 # (only CS))
12 . P0194	DATRE CORPORATION LTD. (Upto 300#, 2-8 "(Gate),2-6"(Globe&Check))
13 . P0202	DEWRANCE MACNEILL & CO. LTD.
14 . P0224	ECONO VALVES PVT.LTD.
15 . P2118	EXPERT ENGINEERING ENTERPRISES (Forged: upto 2"- 800#; Gate & Globe Valve: upto12"- 150# & 300#; Check Valve: upto 32"- 150# & 300#)
16 . P0273	FLOCON SYSTEMS PVT. LTD. (CS upto 6" 150#)
17 . P2248	FLOTEK INDUSTRIES (1. Gate [CAST] -CS, Upto 30", ANSI Class -Upto 300 # 2. Gate [CAST]-AS/SS, Upto 16", ANSI Class -Upto 600 # 3. Globe [CAST] -CS,Upto 14", ANSI Class-Upto 600 # 4.Check [SWING] -CS/AS, Upto 12", Upto 600# 5.Check [DUAL



120301 : GATE/GLOBE/CHECK VALVES CS/SS/AS < 900 Lbs

CODE	NAME
18 . P2172	FLOVEL VALVES PVT. LTD. (Single Disc, Dual Plate & Nozzle Check Valves only: Upto 48" (150#) & 24" (upto 600#))
19 . P2219	FLUIDTECH EQUIPMENT PVT. LTD. (Cast# (CS and SS): 2" to 12" 150# & 2" to 8" 300# and Forged (CS and SS) ½" to 2" (800#))
20 . P2114	FORWARD ALLOYS & CASTINGS (upto 14")
21 . P2145	GURU INDUSTRIAL VALVES PVT. LTD. (Cast CS only: Upto 24"(150#), 20"(300#), 10"(600# & Forged: Upto 2" (800#))
22 . P2218	HAWA ENGINEERS LTD. (Gate Valve:Upto 40" (150#),Upto 26"(300#),Upto 24"(600#),Upto 2" (800#); Globe Valve:Upto 20"(150#),Upto 16" (300#),Upto 12"(600#),Upto 2"(800#); Check Valve:Upto 36" (150#),Upto 24"(300#),Upto 16"(600#),Upto 2" (800#) (Dual Plate:36" (150#
23 . P2013	HAWA VALVES INDIA PVT. LTD. (CS upto 6",150#)
24 . P0897	HI-TECH VALVES PVT. LTD. (CS,<=800# size 1/2"-2", <=300# for size 2"-6)
25 . P0404	INTERVALVE POONAWALLA LIMITED (Cast upto 24" (Upto 300#) & Upto 12" (600#), Forged: Upto 2" (800#))
26 . P2161	JC VALVES & CONTROLS INDIA PVT. LTD. (Cast: Upto 48" (150#), 24" (upto 600#) & Forged: Upto 2" (800#))
27 . P0451	KIRLOSKAR BROTHERS LIMITED (CS upto 12" size, 300#)
28 . P0473	KSB PUMPS LIMITED (VALVES DIVN)
29 . P1101	LARSEN & TOUBRO LIMITED (1/2" to 24")
30 . P0487	LEADER VALVES LIMITED (Casting<=20"- upto 600# & 30"-150#, Forging<=2"- upto 800#)
31 . P2082	M.H. VALVES PVT. LTD. (1/2" to 1 1/2" - 800#, 2"to 6"- 600#)
32 . P2147	MICON ENGINEERS (HUBLI) PVT. LTD. (Cast : Upto 12" (150# & 300#), 6" (600#) & Forged: Upto 2" (800#))
33 . P0094	MICROFINISH VALVES PVT. LTD.
34 . P2243	NEOSEAL ENGINEERING PRIVATE LIMITED (Upto 24" rating upto 600#)



120301 : GATE/GLOBE/CHECK VALVES CS/SS/AS < 900 Lbs

CODE	NAME
35 . P0590	NITON VALVE INDUSTRIES PVT. LTD. (Forging upto 800#, <= 1.5" size)
36 . P2164	NSSL LIMITED (Cast: Upto 80"(150#), 56"(Upto 600#) & Forged: Upto 2" (800#))
37 . P1207	NUTECH CONTROLS (Gate/Check Valve (CS) Up to 12", ANSI Class up to 300#, Globe valve (CS) Up to 10", ANSI Class up to 300#, Gate/Globe/Check Valve (SS/AS) Up to 8", ANSI Class up to 300# & Gate/Globe/check valve (CS/SS/AS) Up to 2", ANSI Class up to 300#)
38 . P2041	OSWAL INDUSTRIES LTD. (Upto 48" (150#), 32" (300#) & 24" (600#))
39 . P2096	S & M INDUSTRIAL VALVES LIMITED (CS Gate & Globe valves 2"- 24" <=300#)
40 . P2249	SAKHI ENGINEERS PVT. LTD. (1. CS/AS/SS, upto 16" , ANSI Class upto 150# 2.CS/AS/SS, upto 12", ANSI Class upto 300)
41 . P1204	SAP Industries Limited (Up to 14")
42 . P2204	SHALIMAR VALVES PVT. LTD. (Cast: Upto 24"(Upto 600#), Forged: ½" to 1½" (800#))
43 . P0731	SHREERAJ INDUSTRIES (CS upto 150#)
44 . P2097	STEEL STRONG VALVES (I) PVT. LTD (Upto 42")
45 . P1206	VALVE TECH INDUSTRIES (<900 LBS (UPTO 24" 600# FOR CS, UPTO 12" 300# FOR SS/AS))
46 . P2014	VENUS PUMP & ENGINEERING WORKS
47 . P2144	VIBA FLUID CONTROL
48 . P0093	WEIR BDK VALVES (A UNIT OF WEIR INDIA PVT. LTD.) (Cast: Upto 36" (150#), 24" (300#), 12" (600#) & Forged: Upto 2"(800#))
49 . P2149	ZED VALVES CO. PVT. LTD. (Upto 14" (600#))
50 . P2135	ZOLOTO INDUSTRIES (40mm to 200mm (Only CS & SS))
CANADA	
51 . P0857	VELAN INC. (Size upto 48" (Rating upto 600#))



120301 : GATE/GLOBE/CHECK VALVES CS/SS/AS < 900 Lbs

CODE	NAME
CHINA	
52 . P2173	BOTELI VALVE GROUP CO. LTD. (Cast: Upto 56" (150#), 36" (300#), 24" (600#) & Forged: Upto 2" (800#))
53 . P2080	Zhejiang Jiehua Valve Co.,Ltd .
GERMANY	
54 . P2016	PEMTO VALVE
ITALY	
55 . P0150	CESARE BONETTI SPA (Cast: Upto 42" (Upto 300#), 24" (600#) & Forged: Upto 1 ½" (800#))
56 . P0253	FASANI S.P.A.
57 . P2179	FRIULCO SPA (Upto 48" (150#), 32" (Upto 600#))
58 . P0476	GTC ITALIA, S.R.L.
59 . P2083	MANTOVANI SpA
60 . P0603	OMB S.P.A.
61 . P0628	PETROL VALVES S.R.L
JAPAN	
62 . P0520	MATSURA H. P MACHINE WORKS CO.LTD.,
63 . P0587	NISHITANI & CO. LTD.
64 . P0575	SOJITZ CORPORATION
NETHERLAND	
65 . P2093	REDPOINT ALLOYS BV
SPAIN	



MECHANICAL – PIPING

120301 : GATE/GLOBE/CHECK VALVES CS/SS/AS < 900 Lbs

CODE	NAME
66 . P0083	BABCOCK BORSIG ESPANA, S.A.
67 . P2201	POYAM VALVES, (AMPO S. COOP.) (Size upto 60"(Rating upto 800#))
68 . P2015	WALTHAN & WEIR
U.A.E.	
69 . P0764	SUFA LIMITED
U.K.	
70 . P0097	BEL VALVES



120302 : GATE/GLOBE/CHECK VALVES CS/SS/AS >=900 Lbs

CODE	NAME
INDIA	
1 . P0003	A V VALVES LIMITED (Cast: Upto 24" (900# & 1500#), 8" (2500#) & Forge: Upto 2" (Upto 2500#))
2 . P2052	ADVANCE VALVES (2"- 36" (900#), 2" - 24" (1500#), 2" -12" (2500#) Dual Plate Check Valves only.)
3 . P0072	ASSOCIATED TOOLINGS (I) PVT. LTD. (½" to 2" (Rating: 900# & 1500#))
4 . P0077	AUDCO INDIA LIMITED(L&T VALVES DIVN.)
5 . P0115	BHEL (VALVES DIVISION)
6 . P2248	FLOTEK INDUSTRIES (1. Gate [CAST]-CS/AS, Upto 6", ANSI Class -Upto 2500 # 2.Globe [CAST]-CS/AS, Upto 4", ANSI Class -Upto 1500 # 3.Check [Swing]-CS/AS, Upto 10", ANSI Class -Upto 2500 # 4.GATE/GLOBE/CHECK VALVES [Forged]-CS/AS/SS, Upto 0.75", ANSI
7 . P2172	FLOVEL VALVES PVT. LTD. (Dual Plate Check Valves only: Upto 24" (900#))
8 . P2218	HAWA ENGINEERS LTD. (Gate Valves: Upto 20" (900#), Upto 10" (1500# & 2500#); Globe Valves: Upto 8" (900# & 1500#), Upto 1" (2500#); Check Valves: Upto 10" (900#), Upto 6" (1500#), Upto 1" (2500#))
9 . P0404	INTERVALVE POONAWALLA LIMITED (Forged: Upto 2" (1500#))
10 . P2161	JC VALVES & CONTROLS INDIA PVT. LTD. (Cast: Upto 12" (upto 1500#), 10" (2500#) & Forged: Upto 2" (2500#))
11 . P0473	KSB PUMPS LIMITED (VALVES DIVN)
12 . P1101	LARSEN & TOUBRO LIMITED (1/2" to 2")
13 . P0487	LEADER VALVES LIMITED (Casting <= 12" - upto 2500#, Forging <= 2" - upto 2500#)
14 . P0533	METROPOLITAN INDUSTRIES (size=200mm, ratings=2500 lb)
15 . P2147	MICON ENGINEERS (HUBLI) PVT. LTD. (Forged: Upto 2" (1500#))
16 . P2243	NEOSEAL ENGINEERING PRIVATE LIMITED (Upto 24", rating upto 2500#)
17 . P2164	NSSL LIMITED (Cast: Upto 36" (900#), 24"(upto 2500#) & Forged: Upto 2"(upto 2500#))



120302 : GATE/GLOBE/CHECK VALVES CS/SS/AS >=900 Lbs

CODE	NAME
18 . P1207	NUTECH CONTROLS (Gate/Globe/Check valve (CS/AS) Up to 2", ANSI Class up to 2500#)
19 . P2041	OSWAL INDUSTRIES LTD. (Upto 12" (900# &1500#))
20 . P2249	SAKHI ENGINEERS PVT. LTD. (CS/AS/SS, upto 4" ANSI Class upto 1500#)
21 . P2204	SHALIMAR VALVES PVT. LTD. (Cast: Upto 20"(900#), Forged: ½" to 1 ½" (1500#))
22 . P1206	VALVE TECH INDUSTRIES (>=900 LBS (UPTO 8" 2500# FOR CS, UPTO 8" 1500# FOR SS/AS))
23 . P0093	WEIR BDK VALVES (A UNIT OF WEIR INDIA PVT. LTD.) (Cast: Upto 12" (Upto 2500#) & Forged: Upto 2"(1500#), 1"(2500#))
CANADA	
24 . P0857	VELAN INC. (Size upto 24" (Rating upto 2500#))
CHINA	
25 . P2173	BOTELI VALVE GROUP CO. LTD. (Cast: Upto 16" (upto 1500#) & 12" (2500#) & Forged: Upto 2" (1500# & 2500#))
26 . P2080	Zhejiang Jiehua Valve Co.,Ltd .
ITALY	
27 . P0103	BFE BONNEY FORGE VALVE LICENSEE
28 . P0150	CESARE BONETTI SPA (Upto 24", (upto 2500#))
29 . P0253	FASANI S.P.A.
30 . P2179	FRIULCO SPA (Upto 32" (900#); 24" (1500#); 14" (2500#))
31 . P0476	GTC ITALIA, S.R.L.
32 . P0603	OMB S.P.A.
33 . P0628	PETROL VALVES S.R.L



120302 : GATE/GLOBE/CHECK VALVES CS/SS/AS >=900 Lbs

CODE	NAME
34 . P2100	VALVITALIA SpA
JAPAN	
35 . P0520	MATSURA H. P MACHINE WORKS CO.LTD.,
36 . P0587	NISHITANI & CO. LTD.
SPAIN	
37 . P0083	BABCOCK BORSIG ESPANA, S.A.
38 . P2201	POYAM VALVES, (AMPO S. COOP.) (Size upto 30" (Rating upto 2500#))
U.A.E.	
39 . P0764	SUFA LIMITED
U.K.	
40 . P0097	BEL VALVES



120303 : BALL VALVES (SOFT SEATED)

CODE	NAME
INDIA	
1 . P0003	A V VALVES LIMITED (Up to 12" (Upto 600#))
2 . P2176	AIRA EURO AUTOMATION PVT. LTD. (Upto 6", Rating: 150# & 300#)
3 . P2056	AQUA VALVES PVT.LTD
4 . P2146	BRIGHTCH VALVES AND CONTROLS PVT. LTD. (4" x 150# for CS, AS & SS Material)
5 . P2117	CHEMTECH INDUSTRIAL VALVES PVT. LTD
6 . P2137	CRAWLEY & RAY (FOUNDERS & ENGINEERS) PVT. LTD (DN 25)
7 . P2163	DELVAL FLOW CONTROLS PRIVATE LIMITED (Upto12" (Upto 900#))
8 . P0273	FLOCON SYSTEMS PVT. LTD. (CS upto 6" 150#)
9 . P2017	FLOW CONTROL
10 . P2073	FLOWCHEM INDUSTRIES (upto 300# and upto 10")
11 . P2219	FLUIDTECH EQUIPMENT PVT. LTD. (Up to 4" (300#))
12 . P2114	FORWARD ALLOYS & CASTINGS (upto 900#)
13 . P2145	GURU INDUSTRIAL VALVES PVT. LTD. (Cast CS only: Upto 12"(Upto300#), 4" (Upto 900#) & Forged: Upto 2" (800#))
14 . P2218	HAWA ENGINEERS LTD. (Upto 16" (150# & 300#), Upto12" (600# & 900#))
15 . P0404	INTERVALVE POONAWALLA LIMITED (Forged: Upto 2" 800#, Cast: Upto 12" (Upto 300#))
16 . P2161	JC VALVES & CONTROLS INDIA PVT. LTD. (Upto 28" (upto 600#), 12" (900#, 1500#), 10" (2500#))
17 . P0473	KSB PUMPS LIMITED (VALVES DIVN) (CS upto 100DN,20 bar)



120303 : BALL VALVES (SOFT SEATED)

CODE	NAME
18 . P0487	LEADER VALVES LIMITED (Casting <= 6" - upto 600#, Forging <= 2" - upto 800#)
19 . P2228	MEVADA ENGINEERING WORKS PVT. LTD., MUMBAI (Upto 2" (800#), (Forged), Material: CS/AS/SS; Upto 14" (300#), Material: CS/AS/SS)
20 . P2147	MICON ENGINEERS (HUBLI) PVT. LTD. (Cast : Upto 6" (150# & 300#) & Forged: Upto 2" (800#))
21 . P0094	MICROFINISH VALVES PVT. LTD.
22 . P2243	NEOSEAL ENGINEERING PRIVATE LIMITED (Upto 12", rating upto 600# and Upto 8", rating upto 2500#)
23 . P2164	NSSL LIMITED (Upto 12" (150# & 300#))
24 . P1207	NUTECH CONTROLS (Ball valve(CS) Up to 10", ANSI Class up to 150#, Up to 2", ANSI Class up to 900#)
25 . P2041	OSWAL INDUSTRIES LTD. (Upto 24" (150#, 300# & 600#))
26 . P2249	SAKHI ENGINEERS PVT. LTD. (1. [Soft Seated] CS, upto 10", ANSI Class upto 300# 2.[Soft Seated] SS, upto 3" ,ANSI Class upto 150#)
27 . P1204	SAP Industries Limited (Up to 16", rating 600#)
28 . P2204	SHALIMAR VALVES PVT. LTD. (Upto 18" (600#) Material: CS/AS/SS)
29 . P1206	VALVE TECH INDUSTRIES (UPTO 24" 600#)
30 . P2144	VIBA FLUID CONTROL ((Upto 300 #))
31 . P0865	VIRGO ENGINEERS LTD. (Upto16" (Upto 600#))
32 . P0093	WEIR BDK VALVES (A UNIT OF WEIR INDIA PVT. LTD.) (Cast: Upto 30" (150# & 300#); 20" NB (600#), 16" (900#), 12" (1500#) & Forged: Upto 2"(800#))
33 . P0264	XOMOX SANMAR LIMITED (FISHER XOMOX)
AUSTRIA	
34 . P0120	BHDT GMBH



120303 : BALL VALVES (SOFT SEATED)

CODE	NAME
CANADA	
35 . P0857	VELAN INC. (Size upto 16" (Rating upto 600#))
CHINA	
36 . P2173	BOTELI VALVE GROUP CO. LTD. (Upto 32" (150# & 300#), 30" (600#), 24" (900#))
37 . P2080	Zhejiang Jiehua Valve Co.,Ltd .
FRANCE	
38 . P0834	ETS TROUVAY & CAUVIN
GERMANY	
39 . P2186	PERRIN GmbH (Size upto 24" (Rating upto 2500#))
ITALY	
40 . P0150	CESARE BONETTI SPA (Cast: Upto 4" (150#) & Forged: Upto 1" (800#) Floating only)
41 . P2179	FRIULCO SPA (Upto 48" (150# & 300 #); 20" (Upto 1500#); 12" (2500#))
42 . P0476	GTC ITALIA, S.R.L.
43 . P2083	MANTOVANI SpA
44 . P0628	PETROL VALVES S.R.L
45 . P0631	PIBIVIESSE SRL (Upto 48", 600#)
SINGAPORE	
46 . P0568	METSO AUTOMATION
SPAIN	
47 . P2201	POYAM VALVES, (AMPO S. COOP.) (Size upto 42" (Rating Upto 2500#))
TAIWAN	



MECHANICAL – PIPING

120303 : BALL VALVES (SOFT SEATED)

CODE	NAME
48 . P2007	HAITIMA CORPORATION



120304 : BALL VALVES (METAL SEATED)

CODE	NAME
INDIA	
1 . P2176	AIRA EURO AUTOMATION PVT. LTD. (Upto 6", Rating: 150# & 300#)
2 . P2146	BRIGHTECH VALVES AND CONTROLS PVT. LTD. (4" x 150# for CS, AS & SS Material)
3 . P2163	DELVAL FLOW CONTROLS PRIVATE LIMITED (Upto12" (Upto 900#))
4 . P2145	GURU INDUSTRIAL VALVES PVT. LTD. (Cast CS only: Upto 12"(Upto300#), 4" (Upto 900#) & Forged: Upto 2" (800#))
5 . P2218	HAWA ENGINEERS LTD. (Upto 16" (150# & 300#), Upto12" (600# & 900#))
6 . P0404	INTERVALVE POONAWALLA LIMITED (Upto 12" (150#))
7 . P2161	JC VALVES & CONTROLS INDIA PVT. LTD. (Upto 28" (upto 600#), 12" (upto 1500#), 10" (2500#))
8 . P2147	MICON ENGINEERS (HUBLI) PVT. LTD. (Cast : Upto 6" (150# & 300#) & Forged: Upto 2" (800#))
9 . P0094	MICROFINISH VALVES PVT. LTD.
10 . P2243	NEOSEAL ENGINEERING PRIVATE LIMITED (Upto 12", rating upto 600#)
11 . P2164	NSSL LIMITED (Upto 12" (150# & 300#))
12 . P2041	OSWAL INDUSTRIES LTD. (Upto 24" (150#, 300#, & 600#))
13 . P1206	VALVE TECH INDUSTRIES (UPTO 16" 300#)
14 . P0865	VIRGO ENGINEERS LTD. (Upto16" (Upto 600#))
15 . P0093	WEIR BDK VALVES (A UNIT OF WEIR INDIA PVT. LTD.) (Cast: Upto 30" (150# & 300#); 20" NB (600#), 16" (900#), 12" (1500#) & Forged: Upto 2"(800#))
CANADA	
16 . P0857	VELAN INC. (Size upto 16" (Rating upto 600#))
CHINA	



120304 : BALL VALVES (METAL SEATED)

CODE	NAME
17 . P2173	BOTELI VALVE GROUP CO. LTD. (Upto 32" (150# & 300#), 30" (600#), 24" (900#))
GERMANY	
18 . P2186	PERRIN GmbH (Size upto 24" (Rating upto 2500#))
ITALY	
19 . P2054	ALFA VALVOLE Srl
20 . P0150	CESARE BONETTI SPA (Upto 24" (150#) & 4" (Upto 1500#) Trunnion Mounted only)
21 . P2179	FRIULCO SPA (Upto 48" (150# & 300#); 20" (Upto 1500#); 12" (2500#))
22 . P0594	GE POWER (NUOVO PIGNONE SPA)
23 . P0476	GTC ITALIA, S.R.L.
24 . P0628	PETROL VALVES S.R.L
25 . P0631	PIBIVIESSE SRL (Upto 48", 600#)
26 . P2100	VALVITALIA SpA
NETHERLAND	
27 . P2093	REDPOINT ALLOYS BV
SINGAPORE	
28 . P0568	METSO AUTOMATION
29 . P0606	ORBIT VALVES PLC
SPAIN	
30 . P2201	POYAM VALVES, (AMPO S. COOP.) (Size upto 42" (Rating Upto 2500#))



120305 : BUTTERFLY VALVES

CODE	NAME
INDIA	
1 . P0003	A V VALVES LIMITED (Upto 48" (150#))
2 . P2052	ADVANCE VALVES (2" - 120" (Upto 150#), 2" - 80" (Upto 900#))
3 . P2176	AIRA EURO AUTOMATION PVT. LTD. (Upto 48", Rating: Upto 300#)
4 . P0077	AUDCO INDIA LIMITED(L&T VALVES DIVN.)
5 . P2018	BDK PROCESS CONTROLS PVT. LTD. (upto 1600mm)
6 . P2117	CHEMTECH INDUSTRIAL VALVES PVT. LTD
7 . P2137	CRAWLEY & RAY (FOUNDERS & ENGINEERS) PVT. LTD (40mm - 1000mm)
8 . P2163	DELVAL FLOW CONTROLS PRIVATE LIMITED (Upto 24" (Upto 300#))
9 . P0273	FLOCON SYSTEMS PVT. LTD. (CS upto 12" 150#)
10 . P2248	FLOTEK INDUSTRIES (1. Triple Offset, Material - CS/AS, Upto 18", ANSI Class -Upto 300 # 2. Double Offset & Concentric-CS, Upto 36", ANSI Class -Upto 150 #)
11 . P2219	FLUIDTECH EQUIPMENT PVT. LTD. (Up to 12" (300#))
12 . P0281	FOURESS ENGINEERING (I) LTD.
13 . P2218	HAWA ENGINEERS LTD. (2" to 48" (PN10/PN16/150#/300#))
14 . P2013	HAWA VALVES INDIA PVT. LTD. (CS upto 6", 150#)
15 . P2134	HI-TECH BUTTERFLY VALVES INDIA PVT. LTD. (<300#,<30"(Teflon/Rubber) ,<72"(Metal))
16 . P0400	INSTRUMENTATION LTD. (PALAKKAD)
17 . P0404	INTERVALVE POONAWALLA LIMITED (Upto 72" (150#) & Upto 16" (300#))



120305 : BUTTERFLY VALVES

CODE	NAME
18 . P2161	JC VALVES & CONTROLS INDIA PVT. LTD. (Upto 20" (150#) & 10" (300#))
19 . P1101	LARSEN & TOUBRO LIMITED (1/2" to 24")
20 . P0487	LEADER VALVES LIMITED (size <=16" - 150#)
21 . P0519	MATHER & PLATT (INDIA) LTD. (A Subsidiary of WILO SE German (upto DN 1600,PN10 Double flange type)
22 . P0533	METROPOLITAN INDUSTRIES (size=2000mm)
23 . P2147	MICON ENGINEERS (HUBLI) PVT. LTD. (Upto 24" (PN10 & PN16))
24 . P2249	SAKHI ENGINEERS PVT. LTD. (1. upto 6", ANSI Class upto 150#)
25 . P1204	SAP Industries Limited (Up to 32", rating PN10, Up to 18", rating 150#)
26 . P1206	VALVE TECH INDUSTRIES (UPTO 48" 300# & UPTO 24" 600#)
27 . P2014	VENUS PUMP & ENGINEERING WORKS (upto 600NB,150#)
28 . P0865	VIRGO ENGINEERS LTD. ((Triple Offset only): 3" to 24", Upto 600# (CS/SS))
29 . P0093	WEIR BDK VALVES (A UNIT OF WEIR INDIA PVT. LTD.) (Upto 56" (Upto 250#); 24" (300#))
30 . P0264	XOMOX SANMAR LIMITED (FISHER XOMOX)
JAPAN	
31 . P2200	TOMOE VALVE CO. LTD. (Upto 48" (150# & 300#), Upto 24" (600#, 900# & 1500#))
AUSTRIA	
32 . P0120	BHDT GMBH
CANADA	
33 . P0857	VELAN INC. (Size upto 48" (Rating upto 600#))



120305 : BUTTERFLY VALVES

CODE	NAME
CHINA	
34 . P2173	BOTELI VALVE GROUP CO. LTD. (36" (150# & 300#))
35 . P2080	Zhejiang Jiehua Valve Co.,Ltd .
FRANCE	
36 . P2076	GRISS SAPAG INDUSTRIAL VALVES
GERMANY	
37 . P2051	ADAMS ARMATUREN
ITALY	
38 . P0476	GTC ITALIA, S.R.L.
TAIWAN	
39 . P2007	HAITIMA CORPORATION
U.K.	
40 . P0489	LEEDS VALVE LTD
U.K	
41 . P2101	WEIR VALVES & CONTROLS DIVISION.
U.S.A.	
42 . P2068	CURTIS WRIGHT FLOW CONTROL CORPORATION
43 . P0679	EMERSON PROCESS MGT
44 . P0488	LEAR SIEGLER MEAS. CTRLS. CORP.
45 . P0174	SPX VALVES & CONTROLS (COPES-VULCAN LTD)
46 . P0889	TYCO INTERNATIONAL INC.,U.S.A.



120305 : BUTTERFLY VALVES

CODE	NAME
47 . P2102	XOMOS(CRANE CO)



120307 : SAMPLING VALVES/ NEEDLE VALVES

CODE	NAME
INDIA	
1 . P0072	ASSOCIATED TOOLINGS (I) PVT. LTD. (½" to 1-1/2" (Rating: 800#))
2 . P2117	CHEMTECH INDUSTRIAL VALVES PVT. LTD
3 . P0248	EXCELSIOR ENGG WORKS
4 . P2118	EXPERT ENGINEERING ENTERPRISES (Upto 12" - 150# & 300#)
5 . P2248	FLOTEK INDUSTRIES (Needle Valve- SS, Upto 0.5-0.75", ANSI Class -Upto 800-2500 #)
6 . P0487	LEADER VALVES LIMITED (size <= 1 1/2" - 800#)
7 . P0792	TECNOMATIC (INDIA) PVT. LTD.
8 . P0093	WEIR BDK VALVES (A UNIT OF WEIR INDIA PVT. LTD.) (Upto 50 mm size (Upto 2500#))



120308 : PLUG VALVES (NON LUBRICATED)

CODE	NAME
INDIA	
1 . P0003	A V VALVES LIMITED (Upto 20" (150#) (CS & SS))
2 . P0077	AUDCO INDIA LIMITED(L&T VALVES DIVN.)
3 . P2177	AZ ARMATUREN GMBH (½" NB to 20" NB, 150#, 300#, 600# (Matl. CS, SS & AS))
4 . P2018	BDK PROCESS CONTROLS PVT. LTD.
5 . P2117	CHEMTECH INDUSTRIAL VALVES PVT. LTD
6 . P2229	CHEMTROLS SAMIL (INDIA) PVT. LTD. (Upto 12" - 150# & 300#)
7 . P2137	CRAWLEY & RAY (FOUNDERS & ENGINEERS) PVT. LTD (DN 200)
8 . P2219	FLUIDTECH EQUIPMENT PVT. LTD. (Up to 4" (300#))
9 . P2145	GURU INDUSTRIAL VALVES PVT. LTD. (Cast CS only: Upto 12"(Upto300#), 4" (Upto 900#) & Forged: Upto 2" (800#))
10 . P2218	HAWA ENGINEERS LTD. (½" to 8" (150#))
11 . P2161	JC VALVES & CONTROLS INDIA PVT. LTD. (Upto 12" (upto 300#))
12 . P1101	LARSEN & TOUBRO LIMITED (1/2" to 24")
13 . P0487	LEADER VALVES LIMITED (size <= 6" - upto 300#)
14 . P1204	SAP Industries Limited (Up to 12", rating 150#)
15 . P0093	WEIR BDK VALVES (A UNIT OF WEIR INDIA PVT. LTD.) (Upto 16"(150#), 12" (300#), 3" (600#))
16 . P0264	XOMOX SANMAR LIMITED (FISHER XOMOX)
CHINA	



120308 : PLUG VALVES (NON LUBRICATED)

CODE	NAME
17 . P2080	Zhejiang Jiehua Valve Co.,Ltd .
ITALY	
18 . P0612	O.M.S. SALERI DI SALERI P & FIGLI S.M.C.
SPAIN	
19 . P2201	POYAM VALVES, (AMPO S. COOP.) (Upto 30" (Upto 900#) for Lift Plug valves only.)



120309 : PLUG VALVES (LUBRICATED)

CODE	NAME
INDIA	
1 . P0003	A V VALVES LIMITED (Upto 20" (150#) (CS & SS))
2 . P0077	AUDCO INDIA LIMITED(L&T VALVES DIVN.)
3 . P2018	BDK PROCESS CONTROLS PVT. LTD.
4 . P2139	ECONO VALVES PVT. LTD. (<=8"(150-300#), <=1-1/2" (<=800#))
5 . P2219	FLUIDTECH EQUIPMENT PVT. LTD. (Up to 4" (300#))
6 . P2145	GURU INDUSTRIAL VALVES PVT. LTD. (Cast CS only: Upto 12"(Upto300#), 4" (Upto 900#) & Forged: Upto 2" (800#))
7 . P2218	HAWA ENGINEERS LTD. (½" to 8" (150#))
8 . P2161	JC VALVES & CONTROLS INDIA PVT. LTD. (Upto 12" (upto 300#))
9 . P0093	WEIR BDK VALVES (A UNIT OF WEIR INDIA PVT. LTD.) (Upto 8" (125#))
CHINA	
10 . P2080	Zhejiang Jiehua Valve Co.,Ltd .
ITALY	
11 . P2108	DELTA VALVES EUROPE
12 . P0612	O.M.S. SALERI DI SALERI P & FIGLI S.M.C.
SPAIN	
13 . P0083	BABCOCK BORSIG ESPANA, S.A.



120311 : DIAPHRAGM VALVES / RUBBER LINED CHECK VALVES

CODE	NAME
INDIA	
1 . P0003	A V VALVES LIMITED (Upto 12" (125#))
2 . P0029	AKAY INDUSTRIES PVT LTD
3 . P2018	BDK PROCESS CONTROLS PVT. LTD. (upto 150#, 6 mm to 350mm)
4 . P2117	CHEMTECH INDUSTRIAL VALVES PVT. LTD
5 . P2137	CRAWLEY & RAY (FOUNDERS & ENGINEERS) PVT. LTD (25 NB to 200 NB)
6 . P2218	HAWA ENGINEERS LTD. (½" to 8" (PN10))
7 . P0093	WEIR BDK VALVES (A UNIT OF WEIR INDIA PVT. LTD.) (Upto 14" (PN16))



120313 : PVC/CPVC VALVES

CODE	NAME
INDIA	
1 . P2058	ASTRAL POLYTECHNIK PVT. LTD. (SIZE 1/2"-6",BUTTERFLY VALVE UPTO 24")
2 . P2096	S & M INDUSTRIAL VALVES LIMITED (32mm - 80mm Size)



120401 : ASBESTOS/RUBBER GASKETS

CODE	NAME
INDIA	
1 . P0256	FERROLITE JOINTINGS (P) LTD. (Asbestos,CAF only)
2 . P0294	GASKETS (INDIA) PVT. LTD. (Asbestos,CAF only)
3 . P2112	GOODRICH GASKET PVT. LTD. (upto 24")
4 . P0350	HINDUSTAN ASBESTOS & ALLIED PRODUCTS
5 . P0354	HINDUSTAN COMPOSITES LIMITED
6 . P2079	HINDUSTAN FERREDO LTD.
7 . P0373	IGP ENGINEERS LIMITED
8 . P0501	MADRAS INDUSTRIAL PRODUCTS (upto 48")
9 . P0525	MECHANICAL PACKING INDUSTRIES LTD.,
10 . P2243	NEOSEAL ENGINEERING PRIVATE LIMITED (Upto 80", rating 150# (Only Rubber Gaskets))
11 . P0614	PACKINGS & JOINTINGS (P) LTD.
12 . P2088	PERFECT MARKETING (P) LTD,
13 . P2090	PRASHANT ENGG STORES
14 . P0663	REINZ TALBROS PRIVATE LIMITED
15 . P0745	SPIRASEAL GASKETS PVT. LTD. (CAF & Teflon)
16 . P2115	STARFLEX SEALING INDIA PVT. LTD.
17 . P2123	THE BENGAL MILL STORES SUPPLY CO.(TRADER)



MECHANICAL – PIPING

120401 : ASBESTOS/RUBBER GASKETS

CODE	NAME
18 . P2184	UNIQUE INDUSTRIAL PACKINGS PVT. LTD.



120402 : SPIRALLY WOUND GASKETS

CODE	NAME
INDIA	
1 . P0294	GASKETS (INDIA) PVT. LTD.
2 . P2112	GOODRICH GASKET PVT. LTD. (up to 24")
3 . P0373	IGP ENGINEERS LIMITED (10 to 3550mm size, 150#-2500# for exch gskt)
4 . P0501	MADRAS INDUSTRIAL PRODUCTS (upto 52")
5 . P2243	NEOSEAL ENGINEERING PRIVATE LIMITED (Upto 84", rating upto 150# and upto 30" rating upto 600#)
6 . P0614	PACKINGS & JOINTINGS (P) LTD.
7 . P2088	PERFECT MARKETING (P) LTD,
8 . P2090	PRASHANT ENGG STORES
9 . P0745	SPIRASEAL GASKETS PVT. LTD. (SS upto 12" & 150#)
10 . P2115	STARFLEX SEALING INDIA PVT. LTD.
11 . P2123	THE BENGAL MILL STORES SUPPLY CO.(TRADER)
12 . P2184	UNIQUE INDUSTRIAL PACKINGS PVT. LTD. (Upto 42"(600#) & Upto 24" (2500#))
CHINA	
13 . P2080	Zhejiang Jiehua Valve Co.,Ltd .



120403 : LENS GASKETS & RING JOINT (METALLIC)

CODE	NAME
INDIA	
1 . P0294	GASKETS (INDIA) PVT. LTD.
2 . P2112	GOODRICH GASKET PVT. LTD. (0.5" to 24")
3 . P0373	IGP ENGINEERS LIMITED (150# - 2500#)
4 . P0501	MADRAS INDUSTRIAL PRODUCTS
5 . P0533	METROPOLITAN INDUSTRIES (3mm thickness , ratings=300 lb)
6 . P2243	NEOSEAL ENGINEERING PRIVATE LIMITED (Upto 30", rating upto 900# and Upto 20" rating upto 2500#)
7 . P0614	PACKINGS & JOINTINGS (P) LTD.
8 . P2090	PRASHANT ENGG STORES
9 . P0745	SPIRASEAL GASKETS PVT. LTD.
10 . P2115	STARFLEX SEALING INDIA PVT. LTD.
11 . P2184	UNIQUE INDUSTRIAL PACKINGS PVT. LTD. (Ring Joint Gaskets only, Upto 16" (1500#))
AUSTRIA	
12 . P0120	BHDT GMBH
ITALY	
13 . P2083	MANTOVANI SpA



120405 : EXPANSION JOINTS & BELLOWS

CODE	NAME
INDIA	
1 . P0177	CORI ENGINEERS PVT. LTD. (For Rubbber)
2 . P0217	D.WREN & CO. (For Rubber & Fabric)
3 . P0269	FLEXATHERM EXPANLLOW PVT. LTD. (Circular: Upto 240", Rectangular: No bar for size, (Up to 600#))
4 . P0270	FLEXICAN BELLOWS & HOSES PVT. LTD.
5 . P0274	FLUIDYNE ENGINEERS (I) PVT. LTD. (Metallic Bellows upto 800 mm dia)
6 . P0443	KELD ELLENTOFT INDIA PVT. LTD. (For Fabric)
7 . P0498	LONESTAR INDUSTRIES
8 . P0530	MB METALLIC BELLOWS PVT. LTD.
9 . P2090	PRASHANT ENGG STORES
10 . P0752	STANDARD PRECISION BELLOWS
GERMANY	
11 . P2019	TUBOFLEX
ITALY	
12 . P0271	FLEXIDER S.P.A.



120406 : FASTENERS

CODE	NAME
INDIA	
1 . P0017	AEP COMPANY
2 . P0146	CAPITAL INDUSTRIES
3 . P2020	CONSOL ENGG. & FASTNERS INDUSTRIES
4 . P0221	EBY FASTNERS
5 . P0265	FIT TIGHT NUTS & BOLTS LTD.
6 . P0266	FIX FIT FASTENERS MFG. PVT. LTD.
7 . P2245	HEM INDUSTRIES (Upto 4")
8 . P2180	INDUSTRIAL ENGINEERING CORPORATION (Size upto 4" (M100))
9 . P2212	MEGA ENGINEERING PRIVATE LIMITED (½" to 3" Material: CS/AS/SS)
10 . P0532	METRO MECHANICAL PVT.LTD.
11 . P0559	NAGBHUSHANAM INDUSTRIES
12 . P0586	NIREKA ENGG. CO. PVT. LTD.
13 . P2021	PACIFIC FORGING & FASTENERS PVT. LTD. (M 10 to M125)
14 . P2088	PERFECT MARKETING (P) LTD,
15 . P2022	PIONEER NUTS & BOLTS PVT. LTD. (Up to 3.5")
16 . P0641	PRECISION AUTO ENGINEERS
17 . P0642	PRECISION ENGINEERING INDUSTRIES





120406 : FASTENERS

CODE	NAME
18 . P0650	PTD FASTNERS PVT. LTD.
19 . P2110	SANGHVI METALS (TRADER)
20 . P0772	SUNDARAM FASTENERS LIMITED
21 . P2099	UDHERA FASTENERS





120507 : SMOKE / GAS DETECTOR

CODE	NAME
INDIA	
1 . P2107	CEASEFIRE INDUSTRIES LTD
2 . P2091	PYROTEK INDUSTRIES (INDIA) PVT. LTD.
3 . P2029	UNITECH MACHINES LTD.
4 . P2104	ZENITH FIRE SEVICES INDIA PVT. LTD

	RECOMMENDED SUB-VENDOR LIST NEW 2500M3 HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E- 1/P-II/16.0	0	
		DOCUMENT NO	REV	



FIRE FIGHTING

1.	FIRE FIGHTING SYSTEM	
1	AGNICE FIRE PROTECTION LTD.	INDIA
2	BHARTIYA CACCIALANZA FIRE SYSTEMS LTD	INDIA
3	BLUE STAR LTD.	INDIA
4	DE'S TECHNICO	INDIA
5	DE'S TECHNICO PVT. LTD.	INDIA
6	FUTECH CONSULTANTS PVT. LTD.	INDIA
7	GENERAL MECHANICAL WORKS	INDIA
8	HD FIRE PROTECTION COMPANY	INDIA
9	LAL ENTERPRISES	INDIA
10	MATHER & PLATT (INDIA) LTD. (A Subsidiary of WILO SE German)	INDIA
11	MX SYSTEMS INTERNATIONAL PVT. LTD.	INDIA
12	NEWFIRE ENGINEERS SERVICES	INDIA
13	PRAGATI ENGG. (PVT.) LTD.	INDIA
14	PYROTEK INDUSTRIES (INDIA) PVT. LTD.	INDIA
15	RADIANT FIRE PROTECTION ENGINEERS	INDIA
16	STEELAGE INDUSTRIES LTD.	INDIA
17	TECHNOFAB ENGG.	INDIA
18	TRI-PARULEX FIRE PROTECTION SYSTEMS	INDIA
19	UNITECH MACHINES LTD	INDIA
20	VIJAY FIRE PROTECTION SYSTEM LTD.	INDIA
2.0	HOSE PIPE (METALLIC) & CAM LOCK COUPLING	
1	AEROFLEX INDUSTRIES LIMITED (Size 6mm to 250mm dia. (SS Corrg. Flex. Hose with Braid, Braid & Assembly)	INDIA
2	CHHATARIA RUBBER CHEMICALS INDUSTRIES	INDIA
3	D. WREN & CO.	INDIA
4	FLEXATHERM EXPANLLOW PVT. LTD. (1/2" to 6")	INDIA
5	GAYATRI INDUSTRIES	INDIA
6	GAYATRI INDUSTRIAL CORPORATION (UPTO 6" ID)	INDIA
7	HELIFEX HYDRAULICS & ENGG CO. LTD.	INDIA
8	NEW AGE FIRE FIGHTING CO.LTD.	INDIA
9	SENIOR INDIA PVT. LTD.	INDIA

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FIRE FIGHTING

3.0	HOSE PIPE (NON-METALLIC) & CAM LOCK COUPLING	
1	CHHATARIA RUBBER CHEMICALS INDUSTRIES	INDIA
2	D. WREN & CO.	INDIA
3	GAYATRI INDUSTRIES	INDIA
4	GAYATRI INDUSTRIAL CORPORATION (UPTO 8" ID)	INDIA
5	HELIFEX HYDRAULICS & ENGG CO. LTD.	INDIA
6	PADMINI INDUSTRIES LIMITED	INDIA
7	PYROTEK INDUSTRIES (INDIA) PVT. LTD.	INDIA
8	SENIOR INDIA PVT. LTD.	INDIA
4.0	HYDRANT VALVE /LANDING VALVE	
1	MINIMAX	INDIA
2	NEW AGE FIRE FIGHTING CO.LTD.	INDIA
3	SHAH BHOGILAL JETHALAL & BROTHERS	INDIA
4	SAFEX	INDIA
5.0	WATER AND WATER CUM FOAM MONITOR	
1	HD FIRE	INDIA
2	FIRETECH EQUIPMENTS & SYSTEMS PVT. LTD.	INDIA
3	NEW AGE FIRE FIGHTING CO.LTD.	INDIA
4	SHAH BHOGILAL JETHALAL & BROTHERS	INDIA
6.0	HOSE REEL	
1	MINIMAX	INDIA
2	NEW AGE FIRE FIGHTING CO.LTD.	INDIA
3	SHAH BHOGILAL JETHALAL & BROTHERS	INDIA
7.0	UNIVERSAL TRIPPLE PURPOSE NOZZLE / AIR RELEASE VALVE / HOSE BOX	
1	MINIMAX	INDIA
2	NEW AGE FIRE FIGHTING CO.LTD.	INDIA
3	SHAH BHOGILAL JETHALAL & BROTHERS	INDIA
8.0	SPRAY NOZZLE / WATER CURTAIN NOZZLE/QBD	
1	HD FIRE	INDIA
2	NEW AGE	INDIA
3	SHAH BHOGILAL JETHALAL & BROTHERS	INDIA
4	TYCO SAFETY PRODUCTS	INDIA

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FIRE FIGHTING

5	VIKING	INDIA
9.0	PORTABLE FIRE EXTINGUISHERS & FIRE FIGHTING CHEMICALS	
1	CEASEFIRE INDUSTRIES LTD.	INDIA
2	KANADIA FYR FYTER (MAKE- KANEX)	INDIA
3	MINIMAX	INDIA
4	PYROTEK INDUSTRIES (INDJA) PVT. LTD.	INDIA
5	SAFEX FIRE	INDIA
6	SUPREMEX EQUIPMENTS	INDIA
7	UNITECH MACHINES LTD.	INDIA
8	ZENITH FIRE SEVICES INDIA PVT. LTD	INDIA
10.0	DELUGE VALVE	
1	DARLING MUESCO (I) PVT.LTD	INDIA
2	HD FIRE	INDIA
3	TYCO SAFETY PRODUCTS	INDIA
4	VIKING	INDIA
11.0	CLEAN AGENT SYSTEM	
1	HONEYWELL	INDIA
2	GUNNEBO INDIA PVT. LTD	INDIA
3	MX SYSTEMS INTERNATIONAL PVT. LTD.	INDIA
4	NOHMI BOSAI INDIA PVT. LTD.	INDIA
5	SEVO SYSTEMS	INDIA
6	SIEMENS	INDIA
7	ROTAREX ENGG INDIA PVT. LTD.	INDIA
8	UTC FIRE & SECURITY INDIA LTD.	INDIA
12.0	PERSONNEL PROTECTION EQUIPMENT(SAFETY EQUIPMENTS)	
1	VIJAY SABRE SAFETY PVT. LTD.	INDIA
2	SURE SAFETY INDIA LTD.	INDIA
3	DRAGER	
13.0	SAFETY SHOWER	
1	UNICARE	
2	SURE SAFETY INDIA LTD.	
14.0	FIRE FIGHTING EQUIPMENTS	

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FIRE FIGHTING

1	DE'S TECHNICO PVT. LTD.	INDIA
2	HD FIRE PROTECT PVT. LTD.	INDIA
3	PYROTEK INDUSTRIES (INDIA) PVT. LTD.	INDIA
4	VENUS PUMP & ENGG. WORKS	INDIA
5	WINCO VALVES PVT. LTD.	INDIA
6	ZENITH FIRE SEVICES INDIA PVT. LTD	INDIA
Note:	Fire fighting equipments shall include hydrant post, hydrant valve, deluge valve, monitor, foam tank/can, safety equipment, personnel protection equipment, foam chamber, deflector, fire extinguisher, spray & sprinkler	

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2.0 ROTATING EQUIPMENTS:

Bidder shall select sub vendors from the vendor list as specified below. Bidder shall ensure that sub vendor for the specified item has supplied item for the specified service & the supplied item is in satisfactory service since last 3 years as on date of offer.



Vendor shall have well proven record for the specified services and shall be subjected to owner/consultant approval.

SL.NO	VENDOR'S NAME	COUNTRY
COMPRESSOR		
RECIPROCATING COMPRESSOR		
1.	ANEST IWATA MOTHERSON PVT. LTD.	INDIA
2.	ATLAS COPCO INDIA LTD (FOR AIR SERVICE ONLY)	INDIA
3.	BHARAT PUMPS & COMPRESSORS LTD	INDIA
4.	DRESSER-RAND INDIA PVT LTD.	INDIA
5.	BURCKHARDT COMPRESSION (INDIA) PVT. LTD.	INDIA
6.	CAMERON COMPRESSION SYSTEM	INDIA
7.	ELGI SAUER COMPRESSORS LTD.	
8.	INGERSOLL RAND INDIA LTD. (FOR AIR & N2)	INDIA
9.	KIRLOSKAR PNEUMATIC CO. LTD	INDIA
10.	HOWDEN (FORMERLY BURTON CORBLIN)	FRANCE
11.	KWANGSHIN MACHINE INDUSTRY CO. LTD.	KOREA
12.	LINDE AG WERKSGRUPPE	GERMANY
13.	NEUMAN & ESSER GmbH & Co. KG	GERMANY
14.	GE POWER (NUOVO PIGNONE SPA)	ITALY
15.	ISHIKAWAJIMA HARIMA HEAVY INDS CO. LTD (IHI)	JAPAN
16.	KOBE STEEL LTD.	JAPAN
17.	mitsui ENGINEERING & SHIP BUILDING CO. LTD	JAPAN
18.	BURCKHARDT COMPRESSION AG	SWITZERLAND
19.	THOMASSEN TURBINE SYSTEMS B.V	NETHERLANDS

COUPLINGS		
1.	CUBIC TRANSMISSION PVT LTD (Flexible disc coupling 2Kw-60MW, Flexible gear coupling- upto 6600 Kw @100 RPM	INDIA
2.	ELECON ENGG. CO. LTD (FOR FLEXIBLE COUPLING)	INDIA
3.	FENNER INDIA LTD. (FOR FLEXIBLE COUPLING)	INDIA
4.	HI-CLIFF (FOR GEAR COUPLING)	INDIA
5.	RATHI TRANSPower PVT. LTD	INDIA
6.	RATHI TURBOFLEX PVT. LTD	INDIA



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COOLING WATER PUMPS (HORIZONTAL)		
1.	A.R WILFLEY INDIA PVT. LTD	INDIA
2.	BEACON WEIR LTD	INDIA
	BHARAT PUMPS & COMPRESSORS LTD	
3.	FLOWMORE LTD (FORMALLY FLOWMORE PVT. LTD.)	INDIA
4.	FLOWMORE INDIA CONTROLS PVT. LTD	
5.	JYOTI LIMITED	INDIA
6.	KIRLOSKAR BROTHERS LTD.	INDIA
7.	MATHER & PLATT (INDIA) LTD. (A SUBSIDIARY OF WILO SE GERMAN)	INDIA
8.	SAM TURBO INDUSTRY PRIVATE LTD. (CHEMICAL PUMPS CAPACITY- 440 M3/HR. HEAD- 44 M)	INDIA
9.	VOLTAS LTD. (PUMPS & PROJECTS BUSINESS DIVISION)	INDIA
10.	KSB AG	GERMANY
11.	mitsubishi heavy industries ltd	JAPAN
12.	SHIN NIPPON MACHINERY CO. LTD	JAPAN
13.	TORISHIMA PUMP MFG. CO. LTD	JAPAN
14.	FLOWSERVE (IDP)	U.K
ROTARY PUMP/ SCREW PUMP		
1.	AIRAUTO INDUSTRIES	INDIA
2.	DELTA CORPORATION	INDIA
3.	ROTO PUMPS LTD	INDIA
4.	UT PUMPS & SYSTEMS LTD (Single screw cap- 5m3/hr, Pr 3.6 bar; Twin Screw : Cap-25m3/hr pr- 25bar ; Triple Screw-: Cap-53.4m3/hr Pr- 10 bar)	INDIA
PUMPS FOR MISC. SERVICE		
1.	A.R WILFLEY INDIA PVT. LTD	INDIA
2.	BHARAT PUMPS & COMPRESSORS LTD	
3.	GOMA ENGINEERING PVT LTD (Range: 0-1500 kg/cm2, Capacity: 150 m3/hr, Max HP – 700 H.P.)	
4.	KSB PUMPS LTD.	INDIA
5.	SULZER PUMPS INDIA LTD	INDIA
6.	V.K PUMPS INDUSTRIES PVT. LTD (FOR NON CRITICAL USE)	INDIA
7.	UT PUMPS & SYSTEM PVT. LTD (HP TRIPLEX PLUNGER PUMPS CAPACITY 215 LPH, PR. 250 BAR)	INDIA
8.	LEWA HERBERTOTT GMBH & CO	GERMANY
9.	URACA PUMPENFABRIK GMBH & CO	GERMANY
10.	DOSAPRO MILLTON ROY	ITALY
11.	PERONI POMPE SPA (CAPACITY = 95 M3/HR, PRE = 306 KG/CM2)	ITALY
12.	NIGATA WORTHINGTON PUMPS	JAPAN
13.	NIKKISO CO. LTD.	JAPAN
14.	BRAN & LUEBBE LTD.	U.K



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3.0 INSTRUMENTATION:



Sl. No.	NAME OF VENDOR	COUNTRY
GAS ANALYSERS (IR, THERMAL CONDUCTIVITY, PARAMAGNETIC)		
1	ABB LTD (BU – ANALYTICAL &ADV)&	INDIA
2	ABB AUTOMATION LIMITED	INDIA
3	EMERSON PROCESS MANAGEMENT (I) PVT. LTD	INDIA
4	YOKOGAWA INDIA LTD.	INDIA
6	SIEMENS AG	GERMANY
7	EMERSON PROCESS MANAGEMENT SINGAPORE LTD	SINGAPORE
8	AMETEKINC	U.S.A
9	CHEMTROLS INDUSTRIES LIMITED	INDIA
PH, CONDUCTIVITY & ORP ANALYSER		
1	EMERSON PROCESS MANAGEMENT (I) PVT. LTD	INDIA
2	HONEYWELL INC	INDIA
3	ABB INDIA LIMITED	INDIA
4	FORBES POLYMETRON PVT. LTD.	INDIA
5	ZELLWEGE SA	FRANCE
6	YOKOGAWA ELECTRIC CORPORATION	JAPAN
7	EMERSON PROCESS MANAGEMENT SINGAPORE LTD	SINGAPORE
8	PACIFIC	
SOX/ NOX ANALYSER		
1	ABB INDIA LTD.	INDIA
2	EMERSON PROCESS MANAGEMENT (I) PVT. LTD	INDIA
3	G.E PANAMETRIC	INTERNATIONAL
4	TELEDYNE MAKE	INTERNATIONAL
5	HORIBA LTD	JAPAN
6	YOKOGAWA ELECTRIC CORPORATION&	JAPAN
7	EMERSON PROCESS MANAGEMENT SINGAPORE LTD	SINGAPORE
8	CHEMTROLS INDUSTRIES LIMITED	INDIA
9	ANACON PROCESS CONTROLS PVT LTD.	INDIA
10	THERMO ENVIRONMENT INSTRUMENTS INC	U.S.A
MASS SPECTROMETER		
1	VG GAS ANALYSIS SYSTEMS	U.K
2	ORBITAL SCIENCE CORPORATION	U.S.A
3	ABB	USA/UK
GAS CHROMATOGRAPH		
1	APPLIED AUTOMATION INC	SINGAPORE

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2	FOXBARO FAR EAST PTE LTD	SINGAPORE
3	SIEMEN	INDIA
4	AXIS ENGINEERING PTE LTD.	INDIA/SINGAPORE
5	ABB PROCESS ANALYTICS	U.K
6	YOKOGAWA INDIA LTD.	INDIA
7	CHEMTROLS INDUSTRIES LIMITED	INDIA
FLUE GAS ANALYSER (ZRO2 TYPE)		
1	ABB LTD (BU – ANALYTICAL &ADV)	INDIA
2	EMERSON PROCESS MANAGEMENT (I) PVT. LTD	INDIA
3	AMETEK INC	U.S.A
4	GE PANAMETRICS	IRELAND
5	YOKOGAWA INTERNATIONAL	JAPAN
6	ANACON PROCESS CONTROLS PVT LTD.	INDIA
7	CHEMTROLS INDUSTRIES LIMITED	INDIA
SYSTEM HOUSE ANALYSERS		
1	ABB LTD (BU – ANALYTICAL &ADV)	INDIA
2	CHEMTROLS INDUSTRIES LIMITED &	INDIA
3	EMERSON PROCESS MANAGEMENT (I) PVT. LTD	INDIA
4	YOKOGAWA	JAPAN
5	AXIS ENGINEERING PTE LTD.	INDIA/SINGAPORE
DENSITY ANALYSERS		
1	EMERSON PROCESS MANAGEMENT (I) PVT. LTD (CORIOLIS TYPE)	INDIA
2	BOPP & REUTHER MESSTECHNIK GMBH (CORIOLIS TYPE)	GERMANY
3	SOLARTRON MOBREY&	U.K
4	CHEMTROLS INDUSTRIES LIMITED	INDIA
MOISTURE ANALYSERS		
1	GE PANAMETRICS	ITALY
2	AMETEK INC	U.S.A
3	SICK MAIHEK	GERMANY
GAS & FIRE DETECTION SYSTEM		
1	ANDREW YULE & COMPANY LTD. (FIRE)	INDIA
2	HONEYWELL AUTOMATION INDIA LIMITED (GAS)	INDIA
3	J B BODA AND BROTHERS PVT. LTD. (GAS MAKE-INTERNATIONAL SENSOR TECHNOLOGY)	INDIA
4	TELEDYNE FLUID SYSTEMS (GAS)	THAILAND
5	GENERAL MONITORS (GAS)	U.K
6	JOSEPH LESLIE DRAGEER	INDIA
7	MSA INDIA LTD	INDIA
8	SAFCO ENGINEERING	ITALY

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9	DETECTION INSTRUMENT PVT LTD.	INDIA
10	KIDDE INDIA LTD	INDIA
11	ANACON PROCESS CONTROLS PVT LTD.	INDIA
FLOW ELEMENT: ORIFICE/ VENTURI/ FLOW NOZZLE		
1	INSTRUMENTATION LTD, PALAKKAD	INDIA
2	MICRO PRECISION PRODUCTS PRIVATE LTD.	INDIA
3	TECHNOMATIC SPA	ITALY
4	DANIEL MEASUREMENT & CONTROL	U.S.A
5	CHEMTROL INDUSTRIES LTD	INDIA
6	EMERSON PROCESS MANAGEMENT	INDIA
7	BALIGA LIGHTING EQUIPMENTS LIMITED	INDIA
8	GENERAL INSTRUMENT CONSORTIUM	INDIA
9	TEMP TECH.	INDIA
PITOT TUBE/ ANNUBAR		
1	EMERSON PROCESS MANAGEMENT (I) PVT. LTD	INDIA
2	MICRO PRECISION PRODUCTS PRIVATE LTD.	INDIA
3	TECHNOMATIC SPA	ITALY
4	ISA CONTROLS LIMITED	U.K
5	DIETRICH STANDARD LTD.&	USA
6	GENERAL INSTRUMENT CONSORTIUM	INDIA
7	SWITZER (FOR ANNUBAR)	INDIA
8	CHANDAK INSTRUMENT PVT LTD.	INDIA
ROTAMETERS AND ROTAMETER TRANSMITTERS		
1	INSTRUMENTATION ENGINEERS PVT. LTD.	INDIA
2	KROHNE MARSHALL PVT. LTD.	INDIA
3	PLACKA INSTRUMENTS & CONTROLS PVT. LTD. (PURGE ROTAMETER ONLY)	INDIA
4	TOKYO KEISO CO. LTD.	JAPAN
5	YAMATAKE CORPORATION	JAPAN
MASS FLOW METER (CORIOLIS TYPE)		
1	EMERSON PROCESS MANAGEMENT (I) PVT. LTD.	INDIA/SINGAPORE
2	BOPP & REUTHER MESSTECHNIKGBMH	GERMANY
3	ENDRESS + HAUSER GMBH& CO.	GERMANY
4	KROHNE	GERMANY
5	SCHLUMBERGER RESOURCE MANAGEMENT LTD.	U.S.A
TURBINE FLOWMETER		
1	FMCSANMAR LTD.	INDIA
2	ABB INDIA LTD.	INDIA
3	BOPP & REUTHER MESSTECHNIKGBMH	GERMANY
4	YAMATAKE CORPORATION	JAPAN

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5	EMERSON PROCESS MGT	U.S.A/ INDIA
VORTEX METER		
1	KROHNE MARSHALL PVT. LTD.	INDIA
2	YOKOGAWA LIMITED	INDIA/ JAPAN
3	ABB	INDIA/ INTERNATIONAL
4	BOPP & REUTHER MESSTECHNIKGBH	GERMANY
5	ENDRESS + HAUSER GMBH& CO.,	GERMANY
6	KROHNE	GERMANY
MAGNETIC FLOW METER		
1.	EMERSON PROCESS MANAGEMENT (I) PVT. LTD.	INDIA/ SINGAPORE
2	KROHNE MARSHALL PVT. LTD.	INDIA
3	BOPP & REUTHER MESSTECHNIKGBH	GERMANY/ INTERNATIONAL
4	YAMATAKE CORPORATION	JAPAN
ULTRASONIC FLOW METER		
1	ENDRESS + HAUSER (INDIA) PVT. LTD.	INDIA
2.	SIEMENS LTD.	INDIA
3.	KROHNE MARSHALL PVT LTD.	INDIA
4.	FLEXIM	USA
5	CHEMTROLS INDUSTRIES LIMITED	INDIA
PRESSURE GAUGES		
1.	GENERAL INSTRUMENTS CONSORTIUM,	INDIA
2.	CIRRUS INTERNATIONAL (FOR NAGANO MAKE)	INDIA
3.	EMECON CONTROLS (FOR SPRIANO MAKE)	INDIA
4.	WIKA INSTRUMENTS PVT.LTD	INDIA
5.	WIKA ALEXENDER WIEGARD GMBH& CO.	GERMANY
6.	NAGANO KEIKI SEISAKUSHO	JAPAN
7.	BUDENBERG GAUGE CO. LTD	U.K
8	MASIBUS (FOR NAGANO MAKE)	INDIA
9	WAAREE INSTRUMENTS	INDIA
LOCAL D/P INDICATORS, LOOP POWER INDICATOR		
1.	P&F	INDIA
2.	EMERSON PROCESS MANAGEMENT INDIA PVT LTD.	INDIA
PRESSURE & D/P TRANSMITTERS		
1.	EMERSON PROCESS MANAGEMENT (I) PVT. LTD.	INDIA/SINGAPORE
2.	HONEYWELL AUTOMATION INDIA LIMITED	INDIA
3.	YOKOGAWA LIMITED	INDIA/ JAPAN
4.	ABB LTD	INDIA
5	FUJI ELECTRIC INSTRUMENTS CO.LTD	JAPAN

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6.	YOKOGAWA ELECTRIC CORPORATION	JAPAN
7.	HONEYWELL INC.	U.S.A
VOL. SEAL PR./DP TRANSMITTER		
1.	HONEYWELL AUTOMATION INDIA LIMITED	INDIA
2.	YOKOGAWA LIMITED	INDIA/ JAPAN
3.	ABB LTD.	INDIA
4.	EMERSON PROCESS MANAGEMENT (I) PVT. LTD.	INDIA/ SINGAPORE
5.	FUJI ELECTRIC SYSTEMS CO., LTD. (EXCEPT UREA SERVICE)	INDIA/ JAPAN
6.	YOKOGAWA ELECTRIC CORPORATION	JAPAN
PRESSURE & D/P SWITCHES INCLUDING VOL. SEAL		
1.	BARKSDALE INC	USA
2.	SUPRIANO (VOLUMETRIC SEAL ONLY)	ITALY
3.	PRECISION INDUSTRIES (FOR ASHCRAFT MAKE ONLY)	INDIA
4.	NAGANO KEIKI SEISAKUSHO	JAPAN
5.	MASIBUS (FOR NAGANO MAKE)	INDIA
6.	DELTA CONTROLS LTD.	U.K
7.	SOR INC.	U.S.A
8.	UNITED ELECTRIC CONTROLS CO.	U.S.A
TRANSPARENT/ REFLEX / BICOLOR MAG.LEVEL GAUGES		
1.	CHEMTROLS SAMIL(INDIA) PVT LTD.	INDIA
2.	LEVCON INSTRUMENTS PVT.LTD (FOR NON CRITICAL SERVICE)	INDIA
3.	TECNOMATIC (INDIA) PVT. LTD.(FOR NON CRITICAL SERVICE)	INDIA
4.	KLINGER	UK
5.	RICHARD KLINGER AG	AUSTRIA
6.	CLARK-RELIANCE CORP	U.S.A
7.	JERGUSON GAUGE & VALVE CO.	U.S.A
8.	TYCO INTERNATIONAL INC.(KEYSTONE)	U.S.A
9.	BLISS ANAND PRIVATE LTD.	INDIA
10.	MAGNETROL	INDIA
LEVEL SWITCHES (FLOAT & DISPLACER TYPE)		
1.	CHEMTROLS ENGINEERING LIMITED FOR ECKARDT MAKE	INDIA
2.	EMERSON PROCESS MANAGEMENT	INDIA/ SINGAPORE
3.	MAGNETROL INTERNATIONAL N.V.	INDIA/BELGIUM
4.	SOR INC.	U.S.A
DISPLACER TYPE LEVEL TRANSMITTERS		
1.	CHEMTROLS INDUSTRIES LIMITED (ECKDART MAKE ELECTRONICS)	INDIA
2.	DRESSER VALVE INDIA PVT LTD (RATING <= 600#)	INDIA
3.	YAMATAKE	JAPAN
4.	DRESSER MASONEILAN	FRANCE
5.	FOXBORO ECKARDTGMBH	GERMANY

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TANK LEVEL INSTRUMENTS		
1.	ENDRESS + HAUSER GMBH& CO., (NON-CONTACT & SERVO)	GERMANY
2.	KROHNE (NON-CONTACT TYPE)/	GERMANY
3.	VEGA KG	GERMANY
4.	MAGNETROL	INDIA
RADAR GUIDED WAVE		
1.	ENDRESS + HAUSER (INDIA) PVT. LTD	INDIA
2.	VEGA KG	GERMANY
3.	MAGNETROL	INDIA
4.	KROHNE	GERMANY
TEMPERATURE ELEMENTS (THERMOCOUPLE, RTD)		
1.	TECHNOMATIC	INDIA
2.	INSTRUMENTATION LIMITED	INDIA
3.	GENERAL INSTRUMENTS CONSORTIUM	INDIA
4.	FUJI ELECTRIC (INCL.HIGH TEMP & SYN CONVERTER)	JAPAN
5.	WIKA ALEXANDER WIEGAND & CO.GMBH	GERMANY
6.	W.C. HERAEUSGMBH	GERMANY
7.	THERMO ELECTRIC CO. LTD	US/INDIA
8.	PYRO ELECTRIC INSTRUMENT GOA PVT LTD.	INDIA
9.	TEMP TECH.	INDIA
10.	ALTOP INDUSTRIES LTD.	INDIA
11.	THERMAL INSTRUMENT INDIA PVT LTD.	INDIA
BIMETALLIC THERMOMETER		
1.	GENERAL INSTRUMENTS CONSORTIUM	INDIA
2.	WIKA	INDIA/ INTERNATIONAL
3.	FORBES MARSHALL PVT. LTD.	INDIA
4.	PRICISION (FOR:ASHCROFT ONLY)	INDIA
5.	TECHNOMATIC SPA	ITALY
TEMPERATURE TRANSMITTERS		
1.	EMERSON PROCESS MANAGEMENT (I) PVT. LTD.	INDIA
2.	HONEYWELL AUTOMATION INDIA LIMITED	INDIA
3.	YOKOGAWA LIMITED	INDIA
4.	ABB LTD	INDIA
5.	FUJI ELECTRIC INSTRUMENTS CO.LTD	JAPAN
6.	YOKOGAWA ELECTRIC CORPORATION	JAPAN
7.	EMERSON PROCESS MGT SINGAPORE LTD	SINGAPORE
8.	HONEYWELL INC.	U.S.A
GATE/PLUG VALVES		
1.	AUDCO INDIA LIMITED(L&T VALVES DIVN.)	INDIA
2.	BHEL(VALVES DIVISION)	INDIA

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3.	CHEMTROLS ENGINEERING LIMITED (PLUG VALVES)	INDIA
4.	KSB PUMPS LIMITED (VALVES DIVN)	INDIA
5.	FLOWSERVE INDIA CONTROL PVT. LTD.(PLUG VALVE UPTO 12"300# UPTO 6" 600#)	INDIA
6.	VELAN INC.	CANADA
7.	MALBRANQUES.A.	FRANCE
8.	CESAREBONETTI	ITALY
9.	FASANI S.P.A.	ITALY
10.	PETROL VALVES S.R.L	ITALY
11.	MATSURA H. P MACHINE WORKS CO.LTD.	JAPAN
12.	BEL VALVES	U.K
GLOBE / ANGLE VALVES		
1.	DRESSER VALVE INDIA PVT LTD (RATING <= 600# , SIZE 3/4 TO 6")	INDIA
2.	EMERSON PROCESS MANAGEMENT INDIA LTD	INDIA
3.	INSTRUMENTATION LTD.	INDIA
4.	GE POWER SYSTEMS (NUOVO PIGNONE)	INDIA
5.	BOHLER	AUSTRIA
6.	YAMATAKE CORPORATION (=<2500#)	JAPAN
7.	FISHER XOMOX (=< 2500#)	SINGAPORE
8	KOSO VALVES	INDIA
BALL VALVES		
1.	TYCO VALVES & CONTROLS (I) LTD	INDIA
2.	DRESSER VALVES INDIA PVT LTD.	INDIA
3.	FISHER XOMOX	INDIA
4.	GE POWER SYSTEMS (NUOVO PIGNONE)	INDIA
5.	INSTRUMENTATION LTD.	INDIA
6	ABB INDA	INDIA
7.	METSO AUTOMATION (=<2500#)	ITALY
8	KITZ CORPORATION(ON-OFF)	ITALY
9	KOSO VALVES	INDIA
BUTTERFLY VALVES		
1.	INSTRUMENTATION LTD. (PALAKKAD) (=< 300#)	INDIA
2.	METSO AUTOMATION (UPTO 2500#)	SINGAPORE
3.	TYCO VALVES & CONTROLS (I) LTD (=< 150 #)	INDIA
4	PARCOL SPA (=< 2500# UREA SERVICE ALSO)	ITALY
5	KEYSTONE (UPTO 2500#)	SINGAPORE
6	LEEDS VALVE LTD	U.K
7	KITZ CORPORATION(ON-OFF)	ITALY
8	KOSO VALVES	INDIA
9	FLOW SERVE INDIA CONTROLS LTD.	INDIA

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PRDS & SPRAY NOZZLE, VENT VALVES UPTO 2500#		
1.	CCI VALVE TECHNOLOGY AB	SWEDEN
2.	ARCA MAKE	GERMANY
3.	BOMABA	GERMANY
AIR FILTER REGULATOR		
1	PLACKA INSTRUMENTS & CONTROLS PVT. LTD.	INDIA
2	SHAVO NORGREN(INDIA) PVT LTD.	INDIA
3	ABB INDIA LIMITED	INDIA
SELF ACTUATED PRESSURE CONTROL VALVE		
1	CARRARO SRL	ITALY
TURBINE BYPASS VALVES		
1.	CIRCOR FLOW TECHNOLOGIES INDIA PVT. LTD. (2 TO 24" UPTO 2500#)	INDIA
PROGRAMABLE LOGIC CONTROLLER		
1.	YOKOGAWA	INDIA
2.	HONEYWELL AUTOMATION INDIA LIMITED (SAFETY SYSTEM)	INDIA
3.	LARSEN & TOUBRO LTD.(CONTROL& AUTOMATION (NON FAILSAFE)-FOR HMA MAKE ONLY	INDIA
4.	TRICONEX (FAULT TOLERANT TMR)	SINGAPORE
5.	GE FANUC AUTOMATION NORTH AMERICA, INC. (FAULT TOLERANT TMR)	U.S.A
DISTRIBUTED CONTROL SYSTEM		
1.	HONEYWELL AUTOMATION INDIA LIMITED	INDIA
2.	YOKOGAWA LIMITED	INDIA
3	GE (MARK VIe SYSTEM)	INDIA
ALARM ANNUNCIATOR		
1.	M.T.L., U.K.	U.K
2.	ROCHESTER INSTRUMENT SYSTEMS LTD.	U.K
3.	IIC	INDIA
4.	MINILAC	INDIA
BARRIER/ISOLATOR/TRIP AMPLIFIER		
1.	PEPPERL + FUCH	INDIA
2.	PEPPERL + FUCH	GERMANY
CCTV / ACCESS SYSTEM		
1.	HONEYWELL AUTOMATION INDIA LIMITED	INDIA
2.	YOKOGAWA LIMITED	INDIA
3.	24 Systems Pvt. Ltd	INDIA
ANTI SURGE CONTROLLER		
1.	COMPRESSOR CONTROL CORPORATION	SINGAPORE
INSTRUMENT POWER & CONTROL CABLES		
1.	LAPP INDIA	INDIA
2.	ASSOCIATED FLEXIBLES & WIRES PVT. LTD.	INDIA
3.	CABLE COROPORATION OF INDIA	INDIA

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4.	DELTON CABLES LTD	INDIA
5.	UNIVERSAL CABLES LTD.	INDIA
6.	UDEY PYROCABLES PRIVATE LTD	INDIA
7.	NICCO CORPORATION LTD	INDIA
8.	KERPEN CABLE	GERMANY
9.	AEI CABLE	UK
10.	TECHNOMATIC	ITALY
11.	RPG (POWER CABLE FROM ELECTRICAL)	INDIA
12.	CORDS CABLE INDUSTRIES LTD.	INDIA
13.	KEI INDUSTRIES LIMITED	INDIA
14.	POLYCAB WIRES PVT.LTD	INDIA
EXTENSION & COMPENSATING CABLES		
1.	UDEY PYROCABLES PRIVATE LTD	INDIA
2.	ASSOCIATED FLEXIBLES & WIRES PVT. LTD.	INDIA
3.	NICCO CORPORATION LTD	INDIA
4.	UNIVERSAL CABLES LTD.	INDIA
5.	KEI INDUSTRIES LIMITED	INDIA
6.	LAPP INDIA	INDIA
MULTI TRANSIT INLET SYSTEM		
1.	MCTBRATTBERGAKTIEBOLAG	SWEDEN
2.	ROXTECAB	SWEDEN
3.	HAWKE INTERNATIONAL	U.K
JUNCTION BOX & CABLE GLAND		
1.	BALIGA LIGHTING EQUIPMENTS LIMITED	INDIA
2.	FCG FLAMEPROOF CONTROL GEARS P.LTD	INDIA
3.	FLAMEPROOF EQUIPMENTS PVT. LTD.	INDIA
4.	FCG POWER INDUSTRIES PVT.LTD	INDIA
5.	LEGRAND INDIA PVT LTD	INDIA
6.	HENSEL ELECTRIC	INDIA
7.	R STAHL &	INDIA
8.	COMET BRASS PRODUCT (CABLE GLANDS ONLY)	INDIA
SS TUBES		
1.	CHOKSI TUBE COMPANY LTD.	INDIA
2.	NUCLEAR FUEL COMPLEX	INDIA
3.	RATNAMANI METALS & TUBES LIMITED	INDIA
4.	SWAGELOK CO. (COMPRESSION FITTINGS OF SWAGELOK MAKE ONLY ARE ACCEPTABLE AS PER ITB)	INDIA
5.	ITOCHU CORPORATION (REP.KUBOTACORPN.)	JAPAN
6.	NISHITANI& CO. LTD.	JAPAN
7.	SUMITOMO METAL INDUSTRIES LTD.	JAPAN



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COMPRESSION FITTINGS		
1.	SWAGELOCK COMPANY/CREXIMCO	U.S.A
INSTRUMENT MINIATURE VALVES		
1.	FLUID CONTROL PVT LTD	INDIA
2	EXCELSIOR ENGG WORKS	INDIA
3	PANAM ENGINEERING	INDIA
PURGE ROTAMETER		
1.	INSTRUMENTATION ENGINEERS PVT. LTD.	INDIA
2.	PLACKA INSTRUMENTS & CONTROLS PVT. LTD.	INDIA
3.	EURECA INDUSTRIAL EQUIPMENTS PVT LTD	INDIA
VALVE MANIFOLDS		
1	ASTEC VALVES & FITTINGS PVT. LTD.	INDIA
2	FLUID CONTROL PVT LTD	INDIA
3	EXCELSIOR ENGG WORKS	INDIA
4	PANAM ENGINEERING	INDIA
CALIBRATION EQUIPMENT & SERVICES		
1	YOKOGAWA INDIA LTD.	INDIA
OPTICAL FIBRE		
1	BIRLA ERRECTION OPTIOCAL LIMITED	INDIA
LIMIT SWITCH		
1	P&F	INDIA
THERMO WELL		
1	PYRO ELECTRIC INSTRUMENT GOA PVT LTD	INDIA
2	ALTOP INDUSTRIES LTD.	INDIA
3	TEMP TECH.	INDIA
SPECIAL THERMO COUPLE/ SKIN THERMOCOUPLES		
1	PYRO ELECTRIC INSTRUMENT GOA PVT LTD	INDIA



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4.0 ELECTRICAL



ITEM	NAME OF THE VENDOR	COUNTRY
INDUCTION MOTORS – LV (415 V) (SAFE/HAZARDOUS AREA)		
1.	ASEA BROWN BOVERI LTD.	INDIA
2.	BHARAT BIJLEE LTD.	INDIA
3.	SIEMENS LTD.	INDIA
4.	CG POWER AND INDUSTRIAL SOLUTION LIMITED	INDIA
5.	KIRLOSKAR ELECTRIC COMPANY LTD.	INDIA
6.	LAXMI HYDRAULICS PVT. LTD.	INDIA
LV POWER, CONTROL AND EARTHING CABLES, FLEXIBLE CABLES/WIRES		
1.	RAVIN CABLES LIMITED	INDIA
2.	KEC INTERNATIONAL LIMITED (FORMERLY RPG CABLES LIMITED)	INDIA
3.	KEI INDUSTRIES LTD.	INDIA
4.	NICCO CORPORATION LIMITED	INDIA
5.	TORRENT CABLES LIMITED	INDIA
6.	UNIVERSAL CABLES LTD.	INDIA
7.	POLYCAB INDIA LIMITED	INDIA
SWITCHBOARDS – LV (415 V) (MCC/PCC/PMCC/EPMCC)		
1.	LARSEN & TOUBRO LTD.	INDIA
2.	AREVA	INDIA
3.	SIEMENS LTD.	INDIA
AC VARIABLE FREQUENCY DRIVE		
1.	ASEA BROWN BOVERI LTD.	INDIA
2.	LARSEN & TOUBRO LTD. (EL. PRODUCTS DIVN.)	INDIA
3.	SIEMENS LTD.	INDIA
4.	ROCKWELL AUTOMATIC INDIA LTD.	INDIA
5.	DANFOSS INDUSTRIES PVT. LTD. (UPTO 1400KW)	INDIA
6.	TMEIC INDUSTRIAL SYSTEMS INDIA PVT. LTD. (UPTO 5000 KVA)	INDIA
7.	FUJI ELECTRIC SYSTEMS CO. LTD.	JAPAN
DRY TYPE TRANSFORMERS		
1.	INDCOIL TRANSFORMERS PVT. LTD.	INDIA
2.	KALPA ELECTRICAL PVT. LTD. (UP TO 100 KVA)	INDIA
3.	IMP POWER LTD.	INDIA
4.	MEHRU ELECTRICALS (FORMERLY AUTOMATIC ELECTRIC LTD.)	INDIA
5.	GUJARAT PLUG-IN DEVICES PVT. LTD. (UP TO 300	INDIA

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ITEM	NAME OF THE VENDOR	COUNTRY
	KVA)	
6.	ESENNAR TRANSFORMERS (P) LTD.	INDIA
FLAMEPROOF LOCAL CONTROL STATION, JUNCTION BOX, LIGHTING FITTING, PLUG, SOCKET, HAND LAMP, ACCESSORIES LIGHTING, DISTRIBUTION BOARD & CONTROL PANEL		
1.	FCG FLAMEPROOF CONTROL GEARS PVT. LTD.	INDIA
2.	BALIGA LIGHTING EQUIPMENTS LTD.	INDIA
3.	SUDHIR SWITCHGEARS PVT. LTD.	INDIA
4.	FLAMEPROOF EQUIPMENTS PVT. LTD.	INDIA
5.	FLEXPRO ELECTRICALS PVT. LTD.	INDIA
STREET/FLOOD LIGHTING FIXTURES		
1.	CG POWER AND INDUSTRIAL SOLUTION LIMITED	INDIA
2.	PHILIPS INDIA LTD.	INDIA
3.	BAJAJ ELECTRICALS LTD.	INDIA
4.	WIPRO LIGHTING	INDIA
5.	HAVELL'S INDIA LTD.	INDIA
LIGHTING POLES		
1.	BHARATI EXPORTS	INDIA
2.	METALITE INDUSTRIES	INDIA
3.	PREMIER POWER PRODUCTS (CALCUTTA) PVT. LTD.	INDIA
4.	SADHANA ENGINEERING CORPORATION	INDIA
HOSE PROOF/WEATHERPROOF INDUSTRIAL LIGHTING FIXTURES, LAMPS & TUBES		
1.	BAJAJ ELECTRICALS LTD.	INDIA
2.	CROMPTON GREAVES LTD.	INDIA
3.	PHILIPS INDIA LTD.	INDIA
4.	WIPRO LIGHTING	INDIA
HOSE PROOF LOCAL CONTROL STATION/INDUSTRIAL TYPE SWITCH SOCKET & PLUG		
1.	BALIGA LIGHTING EQUIPMENTS LIMITED	INDIA
2.	FLAMEPROOF EQUIPMENTS PVT. LIMITED	INDIA
3.	FCG POWER INDUSTRIES LTD.	INDIA
4.	FCG FLAMEPROOF CONTROL GEARS PVT. LTD.	INDIA
CABLE TRAYS		
1.	GLOBE ELECTRICAL INDUSTRIES	INDIA
2.	METALITE INDUSTRIES	INDIA
3.	STEALITE ENGINEERING CO.	INDIA
4.	RUKMINI ELECTRICALS & COMPONENTS PVT. LTD.	INDIA



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ITEM	NAME OF THE VENDOR	COUNTRY
5.	PAREKH ENGINEERING COMPANY	INDIA
6.	SADHANA ENGINEERING CORPORATION	INDIA
7.	INDIANA ENGG. WORKS PVT. LTD.	INDIA
8.	PREMIER POWER PRODUCTS (CALCUTTA) PVT. LTD.	INDIA
FLOOR MOUNTED DISTRIBUTION BOARDS		
1.	ELECMECH CORPORATION	INDIA
2.	INTRELEC	INDIA
3.	CONTROLS & SWITCHGEAR CO. LTD.	INDIA
4.	GLOBE ELECTRICAL INDUSTRIES	INDIA
5.	REUNION ELECTRICAL MANUFACTURERS (P) LTD.	INDIA
6.	UNIVERSAL INDUSTRIAL PRODUCTS	INDIA
7.	VIDHYUT CONTROL (INDIA) PVT. LTD.	INDIA
WALL MOUNTED DISTRIBUTION BOARDS		
1.	ELECMECH CORPORATION	INDIA
2.	INTRELEC	INDIA
3.	CONTROLS & SWITCHGEAR CO. LTD.	INDIA
4.	GLOBE ELECTRICAL INDUSTRIES	INDIA
5.	REUNION ELECTRICAL MANUFACTURERS (P) LTD.	INDIA
6.	HAVELLS INDIA LTD.	INDIA
7.	INDO ASIAN FUSEGEAR LTD.	INDIA
8.	LEGRAND INDIA LTD.	INDIA
EARTHING & LIGHTNING PROTECTION MATERIAL – (GI) WIRE/STRIP		
1.	ANAND ELECTRIC TRADING CO.	INDIA
2.	BHARTI EXPORTS	INDIA
3.	C&S ELECTRIC LTD.	INDIA
4.	JAYANT METAL MFG. CO.	INDIA
5.	METALITE INDUSTRIES	INDIA
6.	PREMIER POWER PRODUCTS (CALCUTTA) PVT. LTD.	INDIA
CATHODIC PROTECTION SYSTEM CONTRACTOR		
1.	ELECTRO PROTECTION SERVICES INDIA PVT. LTD.	INDIA
2.	SARK EPC PROJECTS PVT. LTD.	INDIA
3.	UNDERGROUND PIPELINE & NDT SERVICES PVT. LTD.	INDIA
4.	UNIVERSAL CORROSION PREVENTION INDIA	INDIA
PROTECTIVE RELAYS		
1.	AREVA	INDIA



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ITEM	NAME OF THE VENDOR	COUNTRY
2.	ASEA BROWN BOVERI LTD.	INDIA
3.	LARSEN & TOUBRO LTD. (EL. PRODUCTS DIVN.)	INDIA
4.	SIEMENS LTD.	INDIA
AC VENTILATION SYSTEM		
1.	AIR CONDITIONING CORPN. LTD.	INDIA
2.	BLUE STAR LTD.	INDIA
3.	VOLTAS LTD.	INDIA
4.	S. K. SYSTEM PVT. LTD.	INDIA
HIGH MAST LIGHTING		
1.	CROMPTON GREAVES LTD.	INDIA
2.	PHILIPS INDIA LTD.	INDIA
3.	BAJAJ ELECTRICALS LTD.	INDIA
FLAMEPROOF CABLE GLAND		
1.	BALIGA LIGHTING EQUIPMENTS LIMITED	INDIA
2.	COMET BRASS PRODUCTS	INDIA
3.	COMET INDUSTRIES	INDIA
4.	DOWELL'S ELECTRICALS	INDIA
5.	FCG FLAMEPROOF CONTROL GEARS PVT. LTD.	INDIA
6.	FCG POWER INDUSTRIES LTD.	INDIA
7.	FLAMEPROOF EQUIPMENTS PVT. LTD.	INDIA
8.	FLEXPRO ELECTRICALS PVT. LTD.	INDIA
GI PIPES & CONDUITS		
1.	BHARTI EXPORTS	INDIA
2.	INDIAN TUBE CO. (TATA DIV. OF TUBES & PIPES)	INDIA
3.	JINDAL PIPES LTD.	INDIA
4.	MEGHJYOT ENTERPRISES	INDIA
5.	RUKMINI ELECTRICALS & COMPONENTS PVT. LTD.	INDIA
6.	STEELCRAFT	INDIA
PVC PIPES & CONDUITS		
1.	A.K.G.	INDIA
2.	FINOLEX INDUSTRIES LTD. (PIPES & PVC DIVN.)	INDIA
3.	KALINGA CABLES & CONDUIT CO.	INDIA
4.	POLYPACK	INDIA
5.	PRAKASH INDUSTRIES LTD.	INDIA

MAKE OF LV SWITCHBOARDS & DISTRIBUTION BOARDS COMPONENTS		
S.N.	Component Description	Manufacturers / Vendor



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1.	AIR CIRCUIT BREAKER	L&T (OMEGA) / SIEMENS (SIEPAN 8PO) / GE POWER / ABB (EMAX)
2.	MCB / MPCB / MCCB / ELCB / RCCB	LEGRAND / SCHNEIDER / ABB / SIEMENS
3.	SWITCH	L&T / SIEMENS / ALSTOM POWER / ABB
4.	FUSE	L&T / SIEMENS / ALSTOM POWER / ABB
5.	CONTACTOR	L&T / SIEMENS / ABB
6.	THERMAL O/L RELAY	L&T / SIEMENS / ABB
7.	PROTECTIVE RELAYS	SCHNEIDER ELECTRIC / ABB / SIEMENS
8.	AUXILIARY RELAYS	ABB / SCHNEIDER / SIEMENS
9.	TIMERS	ALSTOM POWER / SIEMENS / ABB / SCHNEIDER / L&T
10.	SINGLE PHASING PREVENTOR	L&T / SIEMENS / ABB
11.	CURRENT TRANSFORMER	SIEMENS / INDCOIL / PRECISE / KAPPA ELECTRICALS / AREVA / PRAGATI / JYOTI / ABB / SCHNEIDER
12.	POTENTIAL TRANSFORMER	L&T / SIEMENS / ALSTOM POWER / KAPPA ELECTRICALS / INDCOIL / AREVA / PRAGATI / JYOTI / ABB / SCHNEIDER
13.	CONTROL TRANSFORMER	L&T / SIEMENS / ALSTOM POWER / KAPPA ELECTRICALS / INDCOIL / ABB
14.	INSTRUMENTS (METERS)	IMP / AE / SCHNEIDER / L&T / ABB / SIEMENS
15.	PUSH BUTTONS	L&T / SIEMENS / ALSTOM POWER / ABB / SCHNEIDER
16.	CONTROL SWITCHES	L&T / SIEMENS / ALSTOM POWER / KAYCEE / ABB
17.	SIGNAL LAMPS	L&T / SIEMENS / ALSTOM POWER / BINOY / ABB
18.	CABLE GLANDS	BALIGA / COMET / FCG / ELECTROMAC
19.	CABLE LUGS	DOWELL / FORWARD ENGG. INDUSTRIES / POWER ENGG. CO. / S J METAL INDUSTRIES (JAINSON)
20.	TERMINAL BLOCKS	ELMEX / SIEMENS / L&T / CONNECTWELL

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		/ WAGO / PHOENIX
21.	MULTIFUNCTION METER	SCHNEIDER ELECTRIC / ABB / L&T / SIEMENS
22.	ALARM ANNUNCIATOR	PROTON / APLAB
23.	INSULATING SLEEVE / SHROUD	RAYCHEM
24.	TRANSDUCER	AE / SIEMENS / ABB / L&T



MAKE OF CP SYSTEM EQUIPMENT/COMPONENT		
S.N.	DESCRIPTION OF MATERIAL	MANUFACTURERS / VENDOR
1.	TRANSFORMER RECTIFIER UNIT	ADVANCE ELECTRONIC SYSTEMS / RAYCHEM RPG / KRISTRON SYSTEM
2.	TEST STATIONS / ANODE JUNCTION BOX / CATHODE JUNCTION BOX (WEATHERPROOF)	AES / CORROSION CONTROL SERVICES, MUMBAI / CORR-TECH INTERNATIONAL, AHMADABAD / SUKRIT INDUSTRIES / UNDTs / SARK EPC
3.	TEST STATIONS / ANODE JUNCTION BOX / CATHODE JUNCTION BOX (FLAMEPROOF)	FCG / FEPL / FLEXPPO / BALIGA
4.	PERMANENT REFERENCE ELECTRODE	BORIN USA / M.C. MILLER USA / M/S ELECTROCHEMICAL DEVICES USA / HARCO USA / CER ANODE USA
5.	SURGE DIVERTER FOR M IJS	DEHN GERMANY / OBO BETTERMANN GERMANY
6.	MONOLITHIC ISOLATING JOINTS	AES / ALFA ENGINEERING / SRL, ITALY / ZUNT, ITALY / R.M.A. ITALY / ADVANCE PRODUCTS, USA
7.	CALCINED PETROLEUM COKE BREEZE	GOA CARBON (GOA) / INDIA CARBON (CALCUTTA) / PETRO CARBON & CHEM. COMPANY HALDIA
8.	ZINC GROUNDING ELECTRODE / CELL / ZINC RIBBON ANODE	SARGAM METALS CHENNAI / SCIENTIFIC METALS KARAIKUDI / SHAKHTI ENTERPRISE
9.	MAGNESIUM ANODES (FOR TCP)	SARGAM METALS CHENNAI / SCIENTIFIC METALS KARAIKUDI / SHAKHTI ENTERPRISE
10.	MMO TUBULAR ANODES	CERANODE (USA) / TITANOR COMPONENTS (INDIA) / MATCOR- USA / M/S ELTECH. NETHERLANDS / XIAN

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		ANODES / MAGNETOCHIEME, HOLLAND
11.	FACTORY PREPACKAGED MMO WIRE ANODE / CONDUCTIVE POLYMERIC ANODE	SEAL FOR LIFE INDIA PVT. LTD. / MATCOR
12.	SOILD STATE DECOUPLER	DAIRYLAND, USA / KRISTRON / DEHN / RUSTROL
13.	DIGITAL MULTI METER	BECKMANN / FLUKE / MOTWANE
14.	DC CLIP-ON METER	HCK (GERMANY) / KYORITSU ELECT (JAPAN) / FLUKE / SWAIN



NOTE:

1. Make of the equipment not indicated and any other make for the specified equipment shall be subject to owner's / consultant's approval.



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5.0 CIVIL & STRUCTURAL



SL. NO.	ITEM	NAME	LOCATION	BRAND NAME
1.0	FLOOR FINISHING			
1.1	CEMENT TILES (FLOOR/WALL)	a) EUROCON b) ALTRA TILE PVT. LTD. c) DAZZLE		
1.2	TERRAZZO TILES	a) NITCO b) HINDUSTAN TILES	DELHI DELHI	NITCO HINDUSTAN TILES
1.3	CERAMIC TILES	a) SPARTEK CERAMICS b) BELL CERAMICS c) SOMANY CERAMICS d) H&R JOHNSON CERAMICS e) KAJARIA CERAMICS f) ORIENT CERAMICS	CHENNAI BARODA NEW DELHI MUMBAI DELHI DELHI	SPARTEK BELL CERAMICS JOHNSON KAJARIA ORIENT
1.4	HEAVY DUTY FLOOR TILES	a) BHARAT TILES b) RESTILE CERAMICS c) PELICAN CERAMIC INDUS. d) DIAMOND REGINA e) SONA TILES	MUMBAI DELHI DELHI AHMEDABA D BARODA	STILAN RANAMITE PELICAN DIAMOND REGINA SONA TUFF
1.5	INDUSTRIAL FLOOR HARDENER ADMIXTURE	a) SAMKOCK CHEMICALS (P) LTD. b) STRUCTURAL WATER PROOFING CO. (P) LTD.	AHMEDABA D KOLKATA DELHI	SAMHARD STD DURONITE CICOSURFACE HARDNER
1.6	PVC ROLLS	a) PREMIER VINYL b) ARMSRONG INARCO c) PREMIER POLYFILM	DELHI MUMBAI DELHI	ROBUST ARMADA POLYFLOOR
1.7	PVC TILES	a) BHOR INDUSTRIES b) ARMSTRONG c) SHYAM VINYLES	DELHI MUMBAI CHENNAI	MARBLEX CARARA/SPECTRA SHYAM VINYLES
1.8	PVC TILES/ROLL ANTISTATIC	a) PREMIER VINYL b) PREMIER POLYFILM c) ARMSTRONG	DELHI DELHI MUMBAI	ANSTAT POLYFLOOR ANTISTATIC ARMSTRONG ANTISTATIC
1.9	ACID RESISTANT TILES(BATTERY ROOM)	a) H&R JOHNSON OR APPROVED EQUIV.	NEW DELHI	
1.10	MOSSAIC TILE	a) ITALIA b) SPECIFIC GLASS MUSSAIC INDIA LTD.		
2.0	WOOD WORK			
2.1	FLUSH DOOR	a) SITAPUR PLYWOOD b) WOODCRAFT PRODUCTS c) KITPLY PRODUCTS	SITAPUR(UP) CALCUTTA CALCUTTA	SITAPUR WOODCRAFT KITPLY
2.2	PLY WOOD/BLOCK BOARD	a) WOODCRAFT PRODUCTS b) KITPLY PRODUCTS c) GREEN PLY	CULCUTTA CALCUTTA KOLKATA	WOODCRAFT KITPLY
2.3	PARTICLE BOARD	a) BHUTAN BOARD	BHUTAN	BHUTAN BOARD

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	(EXTRA GRADE)	b) BEST BOARD c) NOVAPAN INDIA LTD. d) THE BOMBAY BURMAN TRACING CORPN. LTD.	DELHI HYDERABAD DELHI	HIBOND NOVAPAN NOVATEAK EASYLAM
2.4	MDF BOARD/MD PARTICLE BOARD (EXTRA GRADE) VENEEREED/LAMINATED	a) NUCHEM LTD. b) MANGALAM TIMBER PRODUCTS LTD. c) WESTERN BIO SYSTEMS LTD.	DELHI DELHI PUNE	NUWUD MDF DURATUFF ECOBOARD
2.5	DECORATIVE LAMINATES	a) THE BOMBAY BURMAN TRADING CORPN. LTD. b) GREENPLY INDUS. LTD. c) BAKELITE HYLAM LTD. d) RAMMICA INDUSTRIES	DELHI DELHI DELHI DELHI	FORMICA/LUCKY GREENLAM DECOLAME/DECOLITE RAMMICA
2.6	MARINE PLYWOOD	a) INDIAN PLYWOOD MFG. CO. LTD. b) SWASTIC PLYWOOD	DELHI DELHI	ANCHOR SWASTIK
2.7.0	DOORS & WINDOWS FITTINGS			
2.7.1	MORTICE LOCKS WITH HANDLES	a) GODREJ & BOYCE b) EVERITE AGENCIES (P) LTD. c) GOLDEN INDUSTRIES	MUMBAI DELHI DELHI	GODREJ EVERITE GOLDEN
2.7.2	CYLINDRICAL PIN TUMBLER LOCK WITH KNOBS	a) SECURE INDUSTRIES b) GOLDEN INDUSTRIES c) GODREJ & BOYCE	DELHI DELHI MUMBAI	SECUR GOLDEN GODREJ
2.7.3	HYDRAULIC DOOR CLOSER (OVER HEAD/ FLOOR)	a) DOORKING INDUSTRIES b) EVERRITE AGENCIES (P) LTD. c) HARDWYN	DELHI DELHI DELHI	DOORKING EVERRITE HARDWIN
2.7.4	MISC. DOOR FITTINGS HINGES, TOWER BOLTS, LATCHES, SOPPER, STAYS, ALDROPS ETC.	a) EVERITE AGENCIES (P) LTD. b) EBCO DINSUTRIES c) ECIE (P) LTD. d) NU-LITE INDUSTRIES e) HARDWYN	DELHI DELHI MUMBAI DELHI DELHI	EVERITE e.g. EBCO ECIE NU-LITE HARDWYN
2.7.5	THREE WAY BOLTING LOCKING DEVICE HANDLE	a) SRIMA SALES & SERVICES b) DHIMAN INDUSTRIES	MUMBAI DELHI	SRIMA SALES CUM-DHIMAN STEEL WITH
2.7.6	PANIC BAR LATCH (FOR EMERGENCY DOOR)	a) SRIMA SALES & SERVICES OR APPROVED EQUIV.	MUMBAI	SRIMA SALES
2.7.7	UPVC WINDOWS	a) FENESTA b) ENCRAFT c) WINDOW MAGIC		
2.7.8	FASTENERS	a) HILTI INDIA PVT. LTD. b) FISCHER	NEW DELHI	
3.0	STEEL/ ALUMINIUM DOORS, WINDOWS & VENTILATOR			
3.1	PRESSED STEEL DOORS WINDOWS &	a) RAYMUS ENGINEERS b) DHIMAN STEEL	GURGOAN/ DELHI	

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	SECTION DOORS WINDOWS/ROLLING SHUTTER	c) RDG ENGINEERING d) SUPER STEEL WINDOW CO. e) SKS STEEL INDUS.	MUMBAI DELHI DELHI	
3.2	ALUMINIUM / DOORS/ WINDOWS SECTIONS	a) JINDAL ALUMINIUM LTD. b) HINDALCO INDUSTRIES c) INDAL		
3.3	FIRE-PROOF DOORS(APPROVED)	a) NAVAIR INTERNATIONAL b) RDG ENGINEERING	DELHI MUMBAI	VIPER(TAC) RADIANT
3.4	PVC DOORS / WINDOWS	a) SINTEX Or APPVD EQUIV.	DELHI	SINTEX
3.5	PVC WATER TANKS	a) SINTEX Or APPVD EQUIV.	DELHI	SINTEX
4.0	PLASTERING			
4.1	WATERPROOFING/ COMPOUND IN CEMENT PLASTER	a) STRUCTURAL WATER PROOFING CO. (P) LTD. b) PIDILITE INDUSTRIES	DELHI MUMBAI	CICO NO.1 PIDIPROOF LW
5.0	ROOF TREATMENT (WATER PROOFING)			
5.1	BRICK BAT COBA	a) INDIA WATER PROOFING CO. b) OVERSEAS WATERPROOFING CORPN.	MUMBAI DELHI	
5.2	ACRYLIC BASED CEMENTIOUS PRIMER COATING FOR ROOF WATERPROOFING	a) STRUCTURAL WATER PROOFING CO. (P) LTD. b) SIKA QUALCRETE LTD.	DELHI DELHI	TAPCRETE SEALOCFLEX
5.3	APP MODIFIED POLYMERIC WASTER PROOFING MEMBRANE	a) PIDILITE INDUSTRIES LTD. b) STP TEXAS LTD. c) BITUMET CO. LTD.	MUMBAI GURGOAN BANGALOR E	
5.4	POLYURETHANE COATING	a) AMCHEM PRODUCTS PVT. LTD b) CIPY POLYURETHANE COATING c) EZECOAT by M/s INDUSTRIAL PRODUCTS d) M/s SLP INDUSTRIES LTD. e) M/s SHIVALIX AGRO- POLY PRODUCTS	NOIDA PUNE	EZECOAT SIPGUARD SHIVABOND 903
6.0	PAINTING WORKS			
6.1	PLASTIC EMULSION (INTERIOR/EXTERIOR)	a) ICI INDIA LTD. b) BERGER PAINTS LTD. c) ASIAN PAINTS LTD. d) SHALIMAR PAINTS e) KANSAI NEROLAC PAINTS LTD.		DULUX BERGER ASIAN PAINTS SHALIMAR NEROLAC
6.2	DRY OILBOUND DISTEMPER	a) ASIAN PAINTS LTD. b) KANSAI NEROLAC PAINTS LTD.		ASIAN PAINTS NEROLAC
6.3	INDUSTRIAL / EXPOXY/ SYNTHETIC ENAMEL PAINTS	a) ICI/AKZO NOBEL INDIA b) BERGER PAINTS LTD. c) ASIAN PAINTS LTD.		

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		d) SHALIMAR PAINTS e) INTERNATIONAL MARINE COATINGS PVT. LTD. f) KANSAI NEROLAC PAINTS LTD. g) BOMBAY PAINT		
6.4	WATERPROOF CEMENT PAINT	a) KILLICK NIXON LTD. b) RAJDOOT PAINTS	MUMBAI DELHI	SNOWCEM PLUS ACROCEM
6.5	WOOD MELAMINE POLISH	a) ASIAN PAINTS b) SHALIMAR PAINTS		ASIAN PAINTS MELLAC
6.6	WATER PROOFING TRANSPARENT EXTERIOR WALL COATING (OVER PAINTED SURFACE)	a) PIDILITE INDUSTRIES b) INDUSTRIAL PROD. MFG c) STRUCTURAL WATER-PROOFING CO.(P) LTD.	DELHI PUNE DELHI	REPELLIN S-101 WALL GUARD EWITEX PERFECT CICO- SEALCOTE
6.7	FIRE PROOF COATING	a) NAVAIR INTERNATIONAL OR APPVD. EQUIV.	DELHI	VIPER
7.0	ROOFING SHEETS & ACCESSORIES			
7.1	ASBESTOS SHEETS	a) ETERNIT EVEREST LTD. b) CHARMINAR INDUSTRIES	DELHI HYDERABAD	EVEREST CHARMINAR
7.2	C.G.I. SHEETS	a) ISPAT INDUSTRIES LTD. b) STEEL AUTHORITY OF INDIA c) TATA STEEL	DELHI	NIPPON DENRO SAIL TISCO
7.3	PRECOATED G.I. PROFILE SHEETS FOR ROOFING & WALL CLADDING	a) ISPAT INDUSTRIES LTD. b) SHREE PRECOATED STEELS LTD. c) INTERARCH BUILDING PRODUCTS (P) LTD. d) HARDCASTLE & WAUD MFG. CO. LTD. e) LLOYD INSULATION (I) LTD. f) SHIV SHAKTI FIBER UDYOG	DELHI DELHI NOIDA MUMBAI DELHI DELHI	NIPPON DENRO META COLOR TRACDEK FERO COLOR LLOYDECK
7.4	ALUMINIUM SHEET (PLAIN/PROFILE)	a) INDIAN ALUMINIUM CO. LTD. Or APPROVED EQUIVALENT	CALCUTTA	INDAL
7.5	FIBRE GLASS SHEETS & PANELS (MACHINE MOULDED)	a) SHIV SHAKTI FIBER UDYOG b) ROOFCLAD INFRA(P).	DELHI	
7.6	PROOFING J/L HOOKS, BOLTS & OTHER ACCESSORIES (POLYMER COATED)	a) KATALIST CONSULTANT (P) LTD. b) ADVANCED MACHINE	PUNE BANGALORE	DRIPGRIP
8.0	SANITARY PLUMBING FITTINGS & FIXTURES			
8.1	SANITARY FITTINGS (W.C. WASH BASIN, URINAL ETC.)	a) HINDUSTAN SANITARY WARE & INDUS. LTD. b) PARRYWARE SANITARY WARE c) MADHUSUDAN CERAMICS d) NYCER CERAMICS	CALCUTTA CHENNAI DELHI CHENNAI	HINDUSTAN PARRYWARE CERA NYCER

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8.2	PLUMBING FITTINGS & FIXTURES	a) GEM b) PARKO c) KINGSTON		
8.3	GLASS/MIRROR (SHEET/ FLOAT/ TOUGHENED/ LAMINATION)	a) GUJARAT GUARDIAN LTD. b) SAINT GOBAIN c) ASAHI FLOAT	DELHI CHENNAI NEW DELHI	MODIGUARD
8.4	GI PIPES	a) JINDAL b) SURYA c) PRAKASH d) SWASTIK		
9.0	FLASE CEILING, FLASE FLOORING & UNDERDECK INSULATION			
9.1	FLASE CEILING / WALL CLADDING (ALUMINIUM STRIP/ TRAY TYPE)	a) INTERARCH BUILDING PRODUCTS (P) LTD. b) HUNTER DOUGLAS c) MASCOT OVERSEAS	NOIDA MUMBAI DELHI	TRAC LUXALON TRULON
9.2	FALSE FLOORING	a) MULTI INTERIORS PVT. LTD. b) BESTLOCK SYSTEM & CONCEPTS c) LLOYD INDUSULATION (I) LTD. d) UNITED INSULATION e) A.R. & BROTHERS	DELHI MUMBAI DELHI MUMBAI CHENNAI	
9.3	UNDERDECK/WALL HEAT INSULATION	a) BAKELITE HYLAM LTD. b) U.P. TWIGA F.G. LTD. c) LLOYD INDULATION (I) LTD.	DELHI DELHI DELHI	PHENOTHERM TWIGA ROCKLOYD SLAB
9.4	OVERDECK HEAT INSULATION	a) LLOYD INSULATION (I) LTD. b) BEST PLASTRONICS LTD.	DELHI DELHI	LLOYD SPRAY FAOM BESTPLASTRONICS
9.5	GYPSUM BOARD TILES (FIBRE GLASS REINFORCED)	a) INTERARCH BUILDING PRODUCTS (P) LTD. b) INDIA GYPSUM LTD.	NOIDA DELHI	TRAC GRG GYPBOARD
10.0	SPECIALITY PRODUCTS (CEMENT ADDITIVES/ ADMIXTURES/CORROSION INHIBITORS/ SURFACE TREATMENT/ GROUT & ANCHORS/SEALING/ COASTING)	a) FOSROC b) SIKA c) MYK Arment Pvt Ltd d) JAY CHEMICALS INDUSTRIES PVT LTD (K2)	NOIDA DELHI HYDERABAD AHMEDABAD	
10.1	EPOXY FLOOR COATING (BATTERY ROOM)	a) FOSROC b) SIKA c) FAIRMATE d) MYK Arment Pvt Ltd e) JAY CHEMICALS INDUSTRIES PVT LTD (K2)	NOIDA DELHI HYDERABAD AHMEDABAD	
11.0	MISCELLANEOUS ITEMS			
11.1	WOOD PRESERVATIVE	a) ASCU HICKSON LTD.	CALCUTTA	ASCU
11.2	WALL SURFACE TEXTURED COATING	a) UNITILE b) SPECTRUM PAINTS	DELHI DELHI	UNITILE SPECTRUM

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		c) BAKELITE HYLAM	DELHI	HERITAGE
11.3	PVC PLUMBING FITTINGS	a) PRAYAG POLYMERS (P) LTD.	DELHI	SYMET
11.4	REINFORCED FIBRE GLASS WATERPROOFING FELT	a) FGP LTD. b) U.P. TWIGA F.G. LTD.	DELHI DELHI	FGP
11.5	ANTI TERMITE TREATMENT	a) PCI Or APPRVD EQUIV.		
11.6	MATERIAL TEST HOUSE	a) SHRIRAM TEST HOUSE b) SPECTRO ANALYTICAL LABS c) BHARAT TEST HOUSE	DELHI DELHI DELHI	
12.0	CEMENT	a) ACC b) J K CEMENT c) BINANI CEMENT d) JP CEMENT e) GUJARAT AMBUJA f) ALTRA TECH CEMENT g) BIRLA CORPN. LTD. h) GRASIM i) SHREE	MUMBAI KOLKATTA MUMBAI MUMBAI KOLKATTA MP RAJASTHAN	
12.1	SULPHUR RESISTANT CEMENT	a) SAURASHTRA CEMENT LTD. b) SHREE DIGVIJAY CEMENT		
13.0	RCC DESIGN MIX	a) IIT DELHI b) SHRIRAM TEST HOUSE		
14.0	FIRE PROOFING MATERIAL	a) CAFCO b) CARBOLINE		
15.0	STRUCTURAL STEEL / CS PLATE	a) SAIL b) TATA STEEL c) RINL d) JINDAL e) ESSAR f) ISPAT INDUSTRIES g) JINDAL STEEL & POWER LTD.		
15.1	MS PIPES (HAND RAIL APPLICATION)	a) HITEX b) ASHWANI STEELS c) SURYA d) PRAKASH e) VIKRANT ISPAT UDYOG		
16.0	TMT BAR / REBAR	a) SAIL b) TATA STEEL c) RINL d) SHYAM STEEL INDUSTRIES LIMITED e) ELECTROSTEEL STEELS LTD. f) SHRI RATHI STEEL LTD. g) SRMB SRIJAN PRIVATE LIMITED h) JINDAL STEEL & POWER LTD. i) SHRI BAJRANG POWER & ISPAT LTD (GOEL TMT)		

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		j) SPS STEEL ROLLING MILLS LIMITED.		
17.0	GRATINGS/HANDRAILS	a) WESTCOAST ENGINEERING b) GREATWELD GRATING c) KANADE ANAND UDYOG		
18.0	WELDING ELECTRODE	a) ADOR b) ESAB c) D & H d) HANOVAR e) Bohler group f) Mailam g) Advani Orlikon		

GENERAL NOTES:

- i. Only 'First' Quality materials shall be used
- ii. OWNER / CONSULTANT reserve the right to choose any of the approved make / vendor as per this list. Make of the item not indicated and any other make for the specified item shall be subject to owner's / consultant's approval.
- iii. Specifications of manufacturer's items shall be checked against tender item / specifications before selecting any product or brand name. In case of any discrepancy, tender item / specifications shall prevail, and any such brand of item shall not be used which is not conforming to tender specifications even if it is listed in this vendor list.
- iv. In case of non-availability of any material among approved vendors / makes in a particular site / region, alternate vendor / make conforming to IS / BS etc. Shall be used subject to approval by OWNER / CONSULTANT.



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SECTION VI – 17.0

DRAWINGS & DOCUMENTS



**PLANT: NATIONAL FERTILIZERS LIMITED, NFL, NANGAL,
PUNJAB**

**PROJECTS: INSTALLATION OF NEW 2500 CUBIC METER
CAPACITY HORTON SPHERE FOR STORAGE OF
AMMONIA ALONG WITH ITS REFRIGERATION SYSTEM AT
NFL, NANGAL**

	DRAWINGS & DOCUMENTS INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/17.0	0	
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2.0	Category of Documents	5
3.0	AS BUILT DRAWINGS	6
4.0	List of Drawings & Documents	8

	DRAWINGS & DOCUMENTS INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/17.0	0	
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1.0 DRAWINGS & DOCUMENTS:

This chapter details out various drawings and documents to be generated at various stages during the course of execution of the Project by the Contractor for different project activities.

The efficient handling of drawings and documents to be prepared by the Contractor under the contract is the key to the timely completion of the plants. The Contractor undertakes to ensure that all drawings and documents to be submitted by him to the PMC/Owner shall be of professional quality and conforming to the contractual requirements. The Contractor also undertakes to institute a formal drawing control system which will be documented and submitted to the PMC/Owner (herein, the term "PMC/Owner" shall mean "PMC/Owner/TPI" regarding review/approval of datasheets/drawings/documents) for review or approval. All data sheets, drawings submitted by the contractor will have to be reviewed and approved by PMC/Owner. Third Party Inspection (TPI) shall be in the scope of contractor.

Compliance of this chapter on drawings and documents is mandatory and is non-negotiable.

The drawings / documents are to be generated by the Contractor at various stages of the project covering different activities. The drawings / documents generated will be in the category of Approval/ Review/ Information. The list of drawings and documents required is enclosed; however, the categorisation for the drawings/ documents will be informed separately. However, this will in no way relieve the Contractor of responsibility to conform to drawings, standards, specification, codes and contractual requirements / obligations.

The Contractor shall prepare the drawing numbering procedure and submit to PMC/Owner for approval. Each Drawing submitted by the Contractor shall be clearly marked with the name of the PMC/Owner, with revision number & date. It should contain the minimum following details:

- a. Size of Drawing.
- b. Discipline of Engineering for which the drawing is issued.
- c. Drawing No.
- d. Drawing Title

Contractor to note that the number corresponds related to this job and shall be prefixed to all related documents/deliverables which shall be indicated to successful bidder.



Autocad 2015/2019 and MS-Office shall be used to produce the drawings & documents.

All documents before forwarding to PMC/Owner will have to be vetted in detail by the Contractor/duly approved engineering sub-contractor appointed by the Contractor.

The review by the PMC/Owner shall not be construed by the contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications and drawings.

Each drawing submitted by the Contractor shall be clearly marked with the name of the PMC/Owner, Unit Designation, Specifications, Title, Specification number and the name of the Project with revision number and date. If standards, catalogue pages are to be submitted, the applicable items shall be indicated therein. All titles, noting, markings and writings on the drawings shall be in English.

All the dimensions should be in metric units. Upon receiving comments on Drawings & Documents by the contractor, the subsequent submission should give compliance report, separately on each of the comments, document wise. Comments given by PMC/Owner to be discussed and finalised within agreed schedule.



	DRAWINGS & DOCUMENTS INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/17.0	0	
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The schedule of submission of the Drawings & Documents shall be in accordance with project plans only. The detailed list under different category, document wise, shall be prepared by the Contractor for approval of PMC/Owner. This activity is to be completed within one month of Fax of Intent.

Sequence of submission of drawing is essential for proper review of documents and timely completion of the project is to be adhered. In case sequence is not maintained, the documents submitted will not be reviewed by PMC/Owner and responsibility of timely execution of plant shall be to the Contractor's account.



Drawings / documents shall be submitted in quantities / Nos. , by Contractor to PMC/Owner, as specified below:

- 4 hard copies & 1 soft copy shall be supplied for approval/information of each document as per approved DCI by PMC/Owner.
- 3 complete sets of field records shall be signed by both the Contractor's and PMC/Owner's Representative at the site.
- Original approvals and related drawings and documents from the statutory authority.
- Copies of correspondence with the statutory authorities.

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2.0 CATEGORY OF DOCUMENTS:

Category	Description	Action by PMC/ OWNER
1	Records/ Information	Contractor can continue to progress with the work. This drawings or documents will be retained with PMC/Owner for information only. PMC/Owner reserves the right to advise the Contractor of any comments (deviations from the contract) at any time and the contractor is liable to respond to satisfy that the work being done is in accordance with the contract; deviations, if any will be bidder's risk and cost.
2	Review/Approval	<p>PMC/Owner will review and advise the Contractor of any Comments on Contractor's Drawings / documents within specified schedule (15 working days), from date of receipt in PMC/Owner office of Contractor's drawings/documents. The review period is defined as date of receipt of documents by PMC/Owner, to date of issue of comments by PMC/Owner. This review period shall be valid only if submission of drawings is done by Contractor in accordance with approved drawings / documents schedule as indicated in ITB. In case of any non-conformity to the above by Contractor due to which the period of review extends beyond 2 weeks by the PMC/Owner, schedule delay, if any will have to be absorbed by the Contractor.</p> <p>Review of documents / drawings shall be categorized as follows:</p> <ul style="list-style-type: none"> i) Code-3: Not accepted. New Document / Drawing to be submitted ii) Code-2: Accepted with comments as marked iii) Code-1: Final approval

	DRAWINGS & DOCUMENTS INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/17.0	0	
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The documents falling under Review category will be returned with comments within specified time schedules subject to fulfilling other conditions enumerated. The information category document will be retained for information only but however PMC/Owner reserves the right to comment at any stage of the Project.

Where clearance of PMC/Owner is required for ordering of equipment materials, enquiry documents and one technically selected offer is to be submitted for review. The unpriced copies of purchase orders detailing both technical and commercial aspects for all items shall be submitted to PMC/Owner within 15 days of issue of the same.

Each purchase order forwarded should contain complete technical documents. It is obligatory for the Contractor to obtain acceptance on all the technical documents and accepted copy only to be forwarded to PMC/Owner . Any inaccuracies /omissions/inconsistencies noticed and brought to the notice of the contractor at any stage of the project will be rectified/ replaced by Contractor without any cost & time implication to the PMC/Owner .

Material specifications & bill of quantities of long lead bought out items (like pumps, diesel engines, couplings, gear boxes, EOT cranes, MOVs, monitors) shall be submitted by contractor to PMC/Owner for review within 1 month after receipt of order for this project.

Material specifications & bill of quantities of bought out bulk items shall be submitted by contractor to PMC/Owner for review at least 21 days before ordering them. Detailed manufacturing schedules of fabricated/ manufactured items shall submitted to PMC/Owner for review shall be submitted within a fortnight of ordering, Vendor drawings of bought out items shall be submitted to PMC/Owner for review within 1 month of ordering. Status report for all the items in detail will be submitted once in a fortnight. All Quality Assurance Plans (QAP) & test procedures for testing of items at site shall be submitted to PMC/Owner for review at least 15 days before such tests. Site test reports shall be submitted to PMC/Owner for review within 3 days of testing of items.



Documents to statutory authorities shall be submitted after getting the documents reviewed by PMC/Owner at least 1 month before submission to statutory authority. To any other agencies, documents shall be submitted under intimation to PMC/Owner.

3.0 AS BUILT DRAWINGS



Contractor will furnish reproducible and electronic files of all the drawings under their scope to PMC/Owner, certified as "As-Built Issue" by Third Party Inspection Agency (TPIA) for Vendor Items coming under Third Party Inspection / Contractor for all other drawings.

Upon completion of identifiable units or components of the fabrication, construction and installation phase of the project the Contractor will complete all the related plans to the "as built" stage including all Vendor drawings and furnish Owner/PMC with the following:

- One complete set of all original tracings/autocad copies.
- One complete set of reduced size (A3-297x420 mm) copies of all drawings.
- One set of CD/Pen Drive for all documents/drawings/data



	DRAWINGS & DOCUMENTS INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/17.0	0	
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- All the as built drawings duly certified should be scanned and converted into electronic files made on magnetic/discs/optical long storage.
- All other project documents such as operating and maintenance manuals, manufacturers' Catalogues etc. shall also be scanned on magnetic/optical discs for safe storage and retrievals by the Owner when needed.
- 10 complete sets of full size prints of the drawings and 4 sets of reduced size prints.
- 10 complete bound sets of Manufacturer's specifications including design calculations.
- 10 complete sets in hard binders of the Manufacturers data book including certified prints and data for all items including test reports. Data Books shall be complete with index as tag numbers associated with Manufacturer's data shown. Equipment data shall include as a minimum requirement the principal and description of operation, drawings and dimensions, spare parts lists and un-priced purchase orders and bill of material.
- 10 bound copies each of the Spare Parts data books and the Lubricants inventory Schedule.
- 10 complete sets of field records shall be signed by both the Contractor's and Owner's Representative at the site.
- Original approvals and related drawings and documents from the statutory authority, as applicable.
- Copies of correspondence with the statutory authorities, as applicable.



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4.0 LIST OF DRAWINGS & DOCUMENTS



SI. No	Description	With Bid (Y/N)	For Review/ Approval	For Information	Final/ Approved / As-built
A.	PROCESS				
1.0	Basis of Design	N	Y	-	Y
2.0	Fire System Description	N	Y	-	Y
3.0	P & I Diagrams	N	Y	-	Y
4.0	Schematic diagram/PFD	N	Y	-	Y
5.0	Utility Requirements	N	Y	-	Y
6.0	Data sheet of all equipment and machinery	N	Y	-	Y
7.0	Specifications of equipments	N	Y	-	Y
8.0	Valve Specifications	N	Y	-	Y
9.0	Safety requirements compliance report	N	Y	-	Y
10.0	Design calculation & adequacy check results of Equipment, Piping and each system network.	N	Y	-	Y
11.0	Operating Manuals and maintenance manuals	N	-	Y	Y

	DRAWINGS & DOCUMENTS INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/17.0	0	
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Sl. No.	Description	With Bid (Y/N)	For Review/ Approval	For Information	Final/ Approved/ As-built
B.	MACHINERY (ROTATING)				
	PUMPS				
1.0	List of drawings / documents including drawing number, revision number, description and approval status	N	Y	-	Y
2.0	Detailed manufacturing programme (Time bar chart)	N	Y	-	Y
3.0	Certified dimensional outline drawing	N	Y	-	Y
4.0	Cross sectional drawing and bill of material	N	Y	-	Y
5.0	Shaft seal drawing and bill of material	N	Y	-	Y
6.0	Shaft coupling assembly drawing and bill of materials including allowable misalignment clearances, shaft bores & key ways dimensions with tolerances and the style of coupling guard	N	Y	-	Y
7.0	Primary & auxiliary sealing schematic and bill of materials including seal fluid, fluid flows, pressure pipe and valve sizes, instrumentation, orifice sizes, and piping arrangement drawings	N	Y	-	Y
8.0	Cooling or heating schematic and bill of materials including cooling & heating media, fluid flows, pressure, pipe and valve sizes, instrumentation, orifice sizes and piping arrangement drawings	N	Y	-	Y
9.0	Lube oil schematic and bill of materials	N	Y	-	Y
10.0	Lube oil system arrangement drawing including sizes, rating and location of all customer connections	N	Y	-	Y
11.0	Lube oil component drawings data	N	Y	-	Y
12.0	Electrical and instrumentation schematics, wiring diagrams and bill of materials	N	Y	-	Y
13.0	Electrical and instrumentation arrangement drawing and list of components	N	Y	-	Y
14.0	Performance curves	N	Y	-	Y
15.0	Pump specification sheet with complete details in Performance enclosed with enquiry / order	N	Y	-	Y
16.0	Certified foundation assembly drawing of pump with driver & all accessories mounted on base plate with load diagram for foundation design (In case of motor being procured by purchaser, motor frame details will be supplied to vendor within 4 weeks.)	N	Y	-	Y

	DRAWINGS & DOCUMENTS INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/17.0	0	
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Sl. No.	Description	With Bid (Y/N)	For Review/ Approval	For Information	Final/ Approved/ As-built
B.	MACHINERY (ROTATING)				
	PUMPS				
17.0	Engineering flow diagram showing: - Lubrication & sealing lines - Flushing / washing lines - Cooling / steam lines	N	Y	-	Y
18.0	Reference list for pumps supplied in past for similar duty conditions. Reference list shall contain complete address of user, user's purchase order number, brief specifications and date of commissioning	N	-	-	Y
19.0	Lube oil schedule	N	-	-	Y
20.0	Automatic recirculation valve assembly drawing, sectional drawing with bill of material	N	Y	-	Y
21.0	Quality Assurance Plan.	N	Y	-	-
22.0	Material test certificates and Inspection & performance test report along with dispatch clearance certificates from inspector	N	-	-	Y
23.0	Instruction manuals describing installation, operation and maintenance procedures	N	-	-	Y
24.0	Spare parts recommendations and price list	N	-	-	Y
25.0	Parts catalogue complete with reference drawing nos. and sketches etc.	N	-	-	Y

	DRAWINGS & DOCUMENTS INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/17.0	0	
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Sl. No.	Description	With Bid (Y/N)	For Review/ Approval	For Inforati on	Final/ Appro ved/ As- built
B.	MACHINERY (ROTATING)				
	COMPRESSORS				
1.0	List of drawings / documents including drawing number, revision number, description and approval status	N	Y	-	Y
2.0	Detailed manufacturing programme (Time bar chart)	N	Y	-	Y
3.0	Specification sheet/ Data Sheet complete filled in PDIL/NFL proforma enclosed with enquiry/order.	N	Y	-	Y
4.0	Equipment layout with main overall dimensions including those required for foundations and piping design for compressor and auxiliaries. (This layout shall include the driven equipment and its auxiliaries).	N	Y	-	Y
5.0	Certified foundation scope drawing of the compressor with driver and all accessories resting on the foundation including for supports, platforms and control panel.	N	Y		Y
6.0	Overall dimensional drawings with all main dimensions including type, size, and location of piping connection for compressor and its auxiliaries.	N	Y	-	Y
8.0	a) Engineering flow diagram indicating all instrument marked with limit of supply of : -Process Gas lines -Cooling Water lines -Lubricating Oil lines -Condensate drain, - and vent lines. The above drawings shall identify all components by make, size, capacity, pressure rating, material, and other data as applicable.	N		Y	Y
	b) Piping service Index and valve specifications.	N		Y	Y

	DRAWINGS & DOCUMENTS INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/17.0	0	
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9.0	Piping layout plan and elevation drawing for : - -Process Gas lines -Cooling Water lines -Lubricating Oil lines -Utility Lines	N		Y	Y
10.0	Piping support location drawings with weights for cold pipes and forces, moments, and movements for hot pipes, details support sketches.	N		Y	Y
11.0	Piping isometrics for gas, water and lube oil lines				
12.0	X-sectional drawing of the compressor with parts nos. Materials of construction showing all parts and design features. Cross sectional drawings of auxiliaries including valves.	N	Y		Y
13.0	Coupling drawings indicating make, size and type indicating the location and coverage of coupling guards	N	Y		Y
14.0	Driver : a) Speed - torque diagram. b) GD2 of the rotating masses of the compressor referred to the motor speed. c) Tangential force diagram d) Compressor factor e) Degree of irregularity f) Single / Double bearing motor	N		Y	Y
15.0	Direction and magnitude of all unbalanced forces, couples and centre of gravity. Direction of rotation shall also be mentioned.	N	-	Y	Y
16.0	Certified allowable forces, moments, movements, and stresses for nozzles of compressor and auxiliaries.	N		Y	Y
17.0	Balancing procedure for reciprocating masses.	N		Y	Y
18.0	Cross head load reversal diagram for each load step.	N		Y	Y
19.0	Analytical Report of lateral and torsional vibration of the whole set including the compressor, driver, and speed reducer or multiplier if any, for all specified loading step	N		Y	Y
20.0	Calculations & fabrication working drawings for heat exchangers and pressure vessels. Thermal calculations for heat exchangers.	N			Y

	DRAWINGS & DOCUMENTS INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/17.0	0	
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21.0	Description of lubrication, sealing system, and capacity control.	N	Y		Y
22.0	Vendor's recommendations for protection requirements during storage and prolonged shutdown of the equipment at site.	N			Y
23.0	Location and size of conduit box (if electric motor driven) from the driver end.	N			Y
24.0	Inspection and test procedure.	N			Y
25.0	Quality Assurance Plan.	N	Y		
26.0	Inspection and test reports, material test certificates, radiographic reports duly approved by specified inspecting authority, certificates for compressors, heat exchangers, pressure vessels, piping's, valves, instruments and other auxiliaries.	N	-	-	Y
27.0	Lubrication schedule	N	-	-	Y
28.0	Instruction manual for erection, installation, operation and maintenance of compressor and its accessories (important clearances to be maintained should be clearly specified.) Manual should also include the torque value for all stud & bolting.	N	-	-	Y
29.0	Recommended list of spares for two years trouble free operation	N	-	-	-
30.0	List of special tools	N	-	Y	Y
31.0	Detailed spare parts drawings for compressor and its auxiliaries.	N			Y
32.0	Installation list of similar machines shall also include the following : a) Client, location and year of installation b) Drive c) Model No. and type of compressor d) Duty condition of the compressor e) Speed and KW rating	Y	-	-	-
32.1	Performance data				
32.2	Performance Curve or Table of Power and Capacity Versus Suction Pressure with parameter of Discharge Pressure. Showing effect of Unloading Devices and any operating limitation.	N		Y	Y

	DRAWINGS & DOCUMENTS INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/17.0	0	
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32.3	Rod Load and Gas load for each load step including inertia forces and rod reversal magnitude and duration	N			Y
33.0	Road Load , Gas Load and reversal calculation.	N			Y
34	Predicated and Adiabatic discharge temperature rise	N	Y		Y
35	The combined road load and gas load for each 5 degree revolution of crankshaft for each specified loading and fully unloaded condition	N		Y	Y
36	Rod reversal at operating condition and for all specified operating load steps including unloading condition.	N		Y	Y
37	Control of Pulsation and Vibration Study	N		Y	Y

	DRAWINGS & DOCUMENTS INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/17.0	0	
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SL. No.	Description	With Bid (Y/N)	For Review/ Approval	For Inform ation	Final/ Appr oved/ As-built
C.	PIPING				
1.0	Fire fighting layout drawing.	Y	Y	-	Y
2.0	Piping Layout drg.	N	Y	-	Y
3.0	Quality Assurance Plan / Inspection Test Plan	N	Y	-	Y
3.0	Test procedures	N	Y	-	Y
4.0	Filled in Valve Data Sheet.	N	Y	-	Y
5.0	Design data and layout.	N	Y	-	Y
5.1	Design basis	N	Y	-	Y
5.2	Piping material specification	N	Y	-	Y
6.0	Issued for construction (IFC) Drawing.	N	Y	-	Y
6.1	Piping GA Drg.	N	Y	-	Y
6.2	Isometrics	N	-	Y	Y
6.3	Piping supports, operating platforms drg.	N	-	Y	Y
7.0	Material Take-offs	N	-	Y	Y
7.1	Line wise BOQ, Area wise BOQ(if any), Consolidated BOQ	N	-	Y	Y
8.0	Material and Purchase Requisitions	N	-	Y	Y
9.0	Design calculation / Documents.	N	-	-	Y
9.1	Flexibility Analysis of Piping	N	-	-	Y
9.2	Support and load data	N	Y	-	Y
10.0	Vendor Drawings	N	Y	-	Y
10.1	Valves	N	Y	-	Y
10.2	Strainers	N	Y	-	Y
10.3	Expansion bellows	N	Y	-	Y
10.4	Fire Fighting equipments / items	N	Y	-	Y
11.0	As Built Drgs	N	-		Y
11.1	Piping GAD's	N	-	Y	Y
11.2	Isometrics	N	-	Y	Y
11.3	All inspection, testing & NDT Records.	N	-	Y	Y

	DRAWINGS & DOCUMENTS INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/17.0	0	
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Sl. No	Description	With Bid (Y/N)	For Review/ Approval	For Information	Final/ Approved/ As-built
D.	ELECTRICAL				
1.0	Load List indicating rated and absorbed power of loads and duty type (Continuous / Standby / Intermittent) at different voltages including emergency loads.	N	-	Y	Y
2.0	Load Data indicating normal, peak, starting and construction power requirement at various voltage levels.	N	-	Y	Y
3.0	Single line distribution diagram (power, lighting, DC and UPS supply) including protection and metering details giving rating of each equipment.	N	Y	-	Y
4.0	Filled in Specification Sheets and Technical Particulars of Electrical Equipment	N	Y	-	Y
5.0	General arrangement and foundation drawings of all equipment.	N	-	Y	Y
6.0	Equipment layout showing location of all electrical equipment.	N	Y	-	Y
7.0	Cable schedule.	N	Y	-	Y
8.0	Cable rack / trench layout	N	Y	-	Y
9.0	Power Layout	N	Y	-	Y
10.0	Schematic diagram for all control panel & switch boards.	N	Y	-	Y
11.0	Feeder Details of all switch boards	N	Y	-	Y
12.0	Interconnection & Terminal connection diagram	N	-	Y	Y
13.0	List of controls, interlocks, indication & metering at various locations for all drives.	N	-	Y	Y
14.0	Characteristic curves for motor/ relays etc.	N	-	Y	Y
15.0	Sizing Calculations for Electrical System and Equipment.	N	Y	-	Y
16.0	Design calculations (for system design and equipment sizing, earthing & Lightning, lighting, cables etc.)	N	Y	-	Y
17.0	Earthing and lightning protection layout	N	Y	-	Y
18.0	Lighting layout of Pump House,	N	Y	-	Y
19.0	Drawings and documents asked for each equipment as per respective Technical Specifications	N	Y	-	Y

	DRAWINGS & DOCUMENTS INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/17.0	0	
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20.0	Control & operation write up/Block logic diagrams.	N	Y	-	Y
21.0	Fire Alarm Layout drawing of buildings & Plant	N	-	Y	Y
22.0	Calculation for Fire Alarm System	N	-	Y	Y
23.0	Design calculation for ICCP system	N	-	Y	Y
24.0	Catalogues for all bought out items	N	-	Y	Y
25.0	Bill of Materials covering all electrical equipment and installation materials	N	-	Y	Y
26.0	Installation operation and maintenance Manual	N	-	-	Y
27.0	Spare Parts list	N	-	Y	Y
28.0	Test Certificates	N	-	Y	Y
30.0	Guarantee Certificates	N	-	Y	Y
31.0	Quality Assurance Plan & Formats	N	Y	-	Y
32.0	Erection Drawings & Details	N	Y	-	Y
33.0	Construction & Commissioning specification and procedure for all equipment.	N	-	Y	Y
34.0	Technical Data sheet & drawings for fire alarm equipments & components including fire alarm panel, detectors, MCP, Repeater panel etc	N	-	Y	Y
35.0	Basic & Details Engineering drawing/documents for Impressed current cathodic protection system for pipeline including installation drawing	N	-	Y	Y
36.0	Any other drawings & data as required for satisfactory installation, operation & maintenance.	N	Y	Y	Y

	DRAWINGS & DOCUMENTS INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/17.0	0	
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SL. No	Description	With Bid (Y/N)	For Review/ Approval	For Information	Final/ Approved/ As-built
E.	INSTRUMENTATION				
1	List of Instruments (tag wise) indicating type of Instrument, make, model no., quantity etc.	N	Y	-	Y
2	Instrument mounting and connection details	N	Y	-	Y
3	Instrument layout drawings	N	Y	-	Y
4	Catalogue of Instruments & System	N	Y	-	Y
5	List of spares (item wise and quantity) for Commissioning and 2 years of operation	N	Y	-	Y
6	Specification of Instruments	N	Y	-	Y
7	Detail wiring/ interconnection diagram	N	Y	-	Y
8	P and I Diagram	N	-	Y	-
9	I/O list	N	-	Y	-
10	Loop Diagram	N	-	Y	-
11	Logic Diagram for interlock & safety (if any)	N	-	Y	-
12	J.B. termination drawings	N	Y	-	Y
13	Instrumentation, operating, maintenance manuals	N	Y	-	Y
14	Instrument Test Certificate	N	-	Y	
15	Vendor to indicate power requirement (if any) for the control system	N	Y	-	Y
16	Other documents necessary to have a clear understanding of the system	N	Y	-	Y
17	List of alarms	N	Y	-	Y
18	Schematic drawings for controls	N	Y	-	Y
19	Control room layout/System Architecture	N	Y	-	Y

	DRAWINGS & DOCUMENTS INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/17.0	0	
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SL. No	Description	With Bid (Y/N)	For Review/ Approval	For Information	Final/ Approved/ As-built
20	Field Operator Room layout	N	Y	-	Y
21	System Architecture	N	Y	-	Y
22	Control Philosophy	N	Y	-	Y
23	Instrument Air Consumption Requirement	N	Y	-	Y
24	UPS power & Heat Load Requirement	N	Y	-	Y
25	Bill of Material	N	Y	-	Y

	DRAWINGS & DOCUMENTS INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/17.0	0	
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SI.No	Description	With bid Y/N	For Review/ Approval	For Information	Final/ Approved/ As-built
F.	CIVIL				
1	Standards for steel structures	N	Y	-	-
2	Standards for concrete construction	N	Y	-	-
3	Architectural drawings	N	Y	-	Y
4	Overall General arrangement drawing	N	Y	-	Y
5	Design calculations, design analysis for Steel/RCC structures including foundations, and super structure	N	Y	-	Y
6	Foundation layout and detail engg. Drawings	N	Y	-	Y
7	Structural layout & detail engg. drawings of super structure - Structural Sectional drawings, platforms, Ladders, Walkways & Staircases	N	Y	-	Y
8	Fabrication & bar bending schedule	N	N	Y	Y
9	Finishing schedule	N	Y	-	Y
10	Drainage/ Sewage layout drawings	N	-	Y	Y
11	Road / paving drawings	N	Y	-	Y

	DRAWINGS & DOCUMENTS INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/17.0	0	
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S. No	Description	With Bid (Y/N)	For Review/ Approval	For Information	Final/ Approved/ As-built
G.	STATIC EQUIPMENTS				
1.	Filled in Data Sheets of pressure equipment along with outline sketches showing thickness of main parts, weight (erection & operating) and anchorage details	N	Y	-	Y
2.	General arrangement for package items showing plan, elevation & end view	N	Y	-	Y
3.	Recommended spares for commissioning & 2 years operation	Y	Y	-	-
4.	Details of internals including demister, i.e. make and model No., free volume, wire dia, surface area, and density of material and separation efficiency.	N	Y	-	Y
5.	Civil load data including details of foundation/anchor bolts	N	-	Y	Y
6.	Drawing list	N	Y	-	Y
7.	Mechanical & Structural Design calculations, Hydrodynamic calculation for Internals including fabrication drgs. of main equipment & Internals complying with the specifications and codes.	N	Y	-	Y
8.	Specifications for Acid/Alkali cleaning	N	-	-	Y
9.	Welding procedure and performance records approved by inspecting authority (**)	N	-	Y	Y
10.	Operating/Maintenance manual for mechanical items wherever required	N	-	-	Y
11.	Transportation drawing showing overall dimension, C.G. weight and handling instructions duly approved by appropriate authority	N	-	Y	Y
12.	Procedure for hydraulic test and heat treatment (**)	N	-	Y	Y
13.	Procedure for tube to tubesheet joint (**)	N	-	Y	Y
14.	Procedure for repair of damaged tubes (**)	N	-	Y	Y
15.	Procedure for site jobs like assembly, heat treatment, testing ,application of painting & insulation etc. (**)	N	-	Y	Y
16.	NDT procedures (**)	N	-	Y	Y
17.	QAP/ITP procedure (**)	N	Y	-	Y
18.	Records of NDT tests e.g. Radiography, Ultrasonic Testing(UT),	N	-	-	Y

	DRAWINGS & DOCUMENTS INSTALLATION OF NEW 2500 CUBIC METER CAPACITY HORTON SPHERE FOR STORAGE OF AMMONIA AT NFL, NANGAL	PC281-NFL-N/E-1/P-II/17.0	0	
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S. No	Description	With Bid (Y/N)	For Review/ Approval	For Information	Final/ Approved/ As-built
	Magnetic Particle / Penetrant Testing (MP/PT), hardness etc. (**)				
19.	Records of vacuum box test plumbness, roundness, peaking, banding etc. (**)	N	-	-	Y
20.	Materials test certificates duly stamped by inspecting authority (**)	N	-	-	Y
21.	PWHT Charts (**)	N	-	-	Y
22.	Mock-up test for Tube To Tube sheet joint (**)	N	-	-	Y
23.	Test on production test coupons (**)	N	-	-	Y
24.	Corrosion test reports including C, Cr, Ni, Mo and ferrite contents report of raw materials, weldments, HAZ etc. (**)	N	-	-	Y
25.	Hydraulic/pneumatic/Hydro-Pneumatic test reports (**)	N	-	-	Y
26.	Strain gauge measurement (**)	N	-	-	Y
27.	Foundation settlement check record(**)	N	-	-	Y
28.	Calibration report (**)	N	-	-	Y
29.	All final As- built shop drgs. & design calculations duly certified by Third Party inspecting authority (**)	N	-	-	Y
30.	Records/ drawings, charts duly approved, signed and stamped by Statutory Authorities (**)	N	-	-	Y
31.	All Radiography films (**)	N	-	-	Y
32.	Mechanical Guarantee Certificate (**)	N	-	-	Y
33.	Inspector's final certificate (**)	N	-	-	Y

Notes:

1. Final documentations including approved documentation from statutory design verifying authority shall be supplied in hard copies as well as soft copies in CD formats. Applicable software's are MS Office, Word, Access and Excel.
2. Bidder shall submit the soft copy of design calculation (PV-Elite, etc) of static equipment during the stage of checking and approval of design calculation & detail fabrication drawings.
3. Document marked as (**) are to be approved by authorised Inspection Agency and Statutory Authorities as applicable.
4. Bidder shall submit document in required number of sets as stated elsewhere in commercial part.

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SLNo	Description	With Bid (Y/N)	For Review/ Approval	For Information	Final/ Approved/ As-built
H.	GENERAL				
1.0	Master Time Schedule/Network (PERT Network/ Bar chart) showing all the activities	Y	-	Y	Y
2.0	Reference list for similar packages supplied and executed by the bidder with details.	Y	Y	-	Y
3.0	Detailed Painting Specifications	N	Y	-	Y
4.0	Complete Spare Part List for the whole package	N	Y	-	Y
5.0	List of all construction equipments, tool-tackles & man power resources proposed to be used.	Y	-	Y	Y
6.0	Description and Catalogues of Auxiliary items	-	-	Y	Y
7.0	Material Test certificates.	-	-	Y	Y

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PART II: TECHNICAL

ANNEXURE— 1

PROPOSED LAYOUT FOR NEW HORTON SPHERE

**PLANT: NATIONAL FERTILIZERS LIMITED, NFL, NANGAL,
PUNJAB**

**PROJECTS: PMC SERVICES (PRE & POST LSTK AWARD)-
NEW 2500M3 HORTON SPHERE FOR STORAGE OF
AMMONIA AT NFL, NANGAL**

0	10.07.2024	10.07.2024	ISSUED FOR TENDER	AK	SKM	PK
REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD

	PROJECTS AND DEVELOPMENT INDIA LTD.	PC281-NFL-N/E-1/P-II/ANN		
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PART II: TECHNICAL

ANNEXURE— 2


PIPING MATERIAL SPECIFICATION (PMS) & VALVE MATERIALS SPECIFICATION (VMS)

**PLANT: NATIONAL FERTILIZERS LIMITED, NFL, NANGAL,
PUNJAB**

**PROJECTS: PMC SERVICES (PRE & POST LSTK AWARD)-
NEW 2500M3 HORTON SPHERE FOR STORAGE OF
AMMONIA AT NFL, NANGAL**

0	10.07.2024	10.07.2024	ISSUED FOR TENDER	AK	SKM	PK
REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD

ANNEXURE 2

		Service Index (SI) of Piping Material Classes		TFL-PDS-600		5
				DOCUMENT NO.		REV. NO.
SL.NO.	PMC	SERVICE	RATING, FACE ,D.TEMP.	BASIC MATERIAL	CORROSION ALLOW. (MIN.)	REV. NO.
1	B14	AG,AL,FG	CLASS 150, RF,250°C Max, - 33°C Min.	LTCS	1.5 MM	1
2	B20	CW (UG)	CLASS 150, RF, 70°C Max	CS	1.5MM	1
3	B22G	DW	CLASS 150, RF, 70°C Max	CS (GALV)	1.5MM	1
4	B22IS	CONST.WATER	CLASS 150, FF, 80°C Max	CS	1.5 MM	1
5	B22ISG	FW	CLASS 150, FF, 80°C Max	CS (GALV)	1.5 MM	0
6	B24	BD,CW,CWS,CWR,DO,ES,FG,FN,FO,FW,IAW,NI,,PA,PG,PN, PV,PW,SA,SC,SW,TC,WW.	CLASS 150, RF, 200 °C Max	CS	1.5 MM	1
7	B24D	WASTE EFFLUENT	CLASS 150, FF, 50°C Max	HDPE	0.0 MM	0
8	B24FL	EFFLUENT,ACIDIC H2O ETC.	CLASS 150, FF, 80°C Max	CS FRP LINED	1.5 MM	0
9	B24G	FW	CLASS 150, FF, 200 °C Max	CS (GALV)	1.5 MM	0
10	B24P	ETP	CLASS 150, FF, 80°C Max	CPVC	0.0 MM	0
11	B24RL	EFFLUENT, WASTE H2O, CHLORINATED H2O	CLASS 150, FF, 80°C Max	CSRL	1.5 MM	0
12	B24S	SL,SC (IBR)	CLASS 150, RF, 240°C Max	CS	1.5 MM	0
13	B24Z	FLARE	CLASS 150, RF, 400 °C Max	CS	3.0 MM	1
14	B40	CD,FG,HG,PA,PC	CLASS 150, RF,150°C Max	304L SS	0.0 MM	0
15	B50	AF, AW, CD, DW, HZ, IA, MDA, PC, PH, VS	CLASS 150, RF,150°C Max	304 SS	0.0 MM	1
16	B52	UL, WET ACID FLARE GAS	CLASS 150, RF,150°C Max	316L SS	0.0 MM	2
17	D14	AG,AL,FG	CLASS 300, RF,70°C Max, - 35°C Min.	LTCS	1.5 MM	1
18	D24	AG,AL,AW,FG,FN,HG,IAH,IAW, PA	CLASS 300, RF,280°C Max	CS	1.5 MM	0
19	D50	AW,PH,PC	CLASS 300, RF,200°C Max	304 SS	0.0 MM	0
20	D52	UL	CLASS 300, RF,150°C Max	316L SS	0.0 MM	2
21	F24	AW,HG,PA,PC,PN,SG	CLASS 600, RF,425°C Max	CS	1.5 MM	0
22	F24S	BB,BF,SC,SM	CLASS 600, RF,425°C Max	CS(IBR)	1.5 MM	0
23	H24S	BB,BF,SC,SH	CLASS 1500, RJ,340°C Max	CS(IBR)	1.5MM	0
24	J36S	SC,SH	CLASS 2500, RJ,540°C Max	AS(IBR)	1.5 MM	1

Abbrev.	Service
AF	Antifoam solution
AG	Ammonia Gaseous
AL/LA	Ammonia Liquid
AW	Ammonia water
BB	Boiler BlowDown
BD	Blow Down
BF	Boiler feed water
CD	CO2/Steam mixture
CW	Cooling water
CWS	Cooling water supply
CWR	Cooling water return
DM	DM water
DW	Drinking Water
DO	Diesel Oil
ES	Exhaust steam
FG	Fuel gas
FO	Fuel oil
FN	Fuel Naphtha
FW	Fire Water
HC	Mixed Hydrocarbons
HG	Hydrogen Gas
HZ	Hydrazine
IA	Instrument air
IAH	Instrument air(High pressure)
IAW	Instrument air(Wet)
IG	Inert gas
NG	Natural gas
NI	Nitrogen
PA	Process Air
PC	Process condensate
PG	Process Gas

Abbrev.	Service
PH	Phosphate Solution
PN	Process Naphtha
PV	Vent gas
PW	Process Water
SA	service air
SC	Steam condensate
SG	Synthesis Gas
SH/HPS/HP	High Pressure Steam
SL/LP/LPS	LP Steam
SM/MPS	Medium Pressure Steam
SW	Service water
TC	Turbine Condensate
UL	Urea solutions handling
WW	Waste Water



Class: B24

PROJECTS AND DEVELOPMENT INDIA LIMITED

SERVICE BD,CWS,CWR,DO,ES,FG,FN,FO,FW,IAW,NI,PA,P G ETC		TEMPERATURE LIMITS (Deg.C) Ref.SI Ref.SI					
RATING ASME 150# RF	CORROSION ALLOWANCE 1.5 MM(MIN.)	MATERIAL CS					
ITEM	NOTES	SIZE (NPS)	SCH/ RAT	END	DESCRIPTION	COMM CODE	SPCL REV
PIPE							
PIPE		2 - 6	SCH 40	BE	SMLS,API 5L GR.B,ASME B36.10,	PPA111300	
PIPE		8 - 10	SCH 20	BE	ERW,API 5L GR.B,ASME B36.10,	PPA211300	
PIPE		12 - 12	SCH 20	BE	ERW,API 5L GR.B,ASME B36.10,	PPA211300	
PIPE		1/2 - 3/4	SCH 80	PE	SMLS,API 5L GR.B,ASME B36.10,	PPA121300	
PIPE		1 - 1 1/4	SCH 80	PE	SMLS,API 5L GR.B,ASME B36.10,	PPA121300	
PIPE		1 1/2 - 1 1/2	SCH 80	PE	SMLS,API 5L GR.B,ASME B36.10,	PPA121300	
PIPE		14 - 14	SCH 10	BE	ERW,API 5L GR.B,ASME B36.10,	PPA211300	
PIPE		16 - 18	SCH 10	BE	LSAW,API 5L GR.B,ASME B36.10,	PP9611300	
PIPE		20 - 20	SCH 10	BE	LSAW,API 5L GR.B,ASME B36.10,	PP9611300	
PIPE		22 - 24	SCHSTD	BE	LSAW,API 5L GR.B,ASME B36.10,	PP9611300	
PIPE		26 - 28	SCHSTD	BE	LSAW,API 5L GR.B,ASME B36.10,	PP9611300	
PIPE		30 - 32	SCHSTD	BE	LSAW,API 5L GR.B,ASME B36.10,	PP9611300	
PIPE		34 - 34	SCHSTD	BE	LSAW,API 5L GR.B,ASME B36.10,	PP9611300	
PIPE		36 - 38	SCH XS	BE	LSAW,API 5L GR.B,ASME B36.10,	PP9611300	
PIPE		40 - 42	SCH XS	BE	LSAW,API 5L GR.B,ASME B36.10,	PP9611300	
PIPE		44 - 46	SCH XS	BE	LSAW,API 5L GR.B,ASME B36.10,	PP9611300	
PIPE		48 - 48	SCH XS	BE	LSAW,API 5L GR.B,ASME B36.10,	PP9611300	
FLANGE							
FLANGE		1/2 - 24	150#	SO-RF 125 AARH	CS ASTM A105,ASME B16.5,SLIP ON	FL0260801	
LONG W.N.FLANGE		1 1/2 - 1 1/2	300#	WN-RF 125 AARH	CS ASTM A105,ASME B16.5,24mm Bore,200mm Long	LN0270802	
W.N.FLANGE		26 - 48	150#	WN-RF 125 AARH	CS ASTM A105,ASME B16.47 SR.B,WELD NECK	WN0270701	
SPACER AND BLIND		14 - 48	150#	RF 125 AARH	CS ASTM A105,ASME B16.48,	RS022P001	
SPECL BLIND		1/2 - 12	150#	RF 125 AARH	CS ASTM A105,ASME B16.48,	SP022P001	
BLIND FLANGE							
BLIND FLANGE		26 - 48	150#	RF 125 AARH	CS ASTM A105,ASME B16.47 SR.B,	BF0220701	
BLIND FLANGE		1/2 - 24	150#	RF 125 AARH	CS ASTM A105,ASME B16.5,	BF0220801	
GASKET							
GASKET		1/2 - 24	150#	SPRL-WND RF	TP304 SS WDG;GPH FLR;TP304 SS INR RNG;CS OTR RNG,ASME B16.20,	GSON30301	
GASKET		26 - 48	150#	SPRL-WND RF	TP304 SS WDG;GPH FLR;TP304 SS INR RNG;CS OTR RNG,ASME B16.20/B16.47 SR.B,	GSON30J01	
STUD & NUTS							
STUD & 2NUTS HVY		-			ASTM A193 GR.B7/ASTM A194 GR.2H,,	SNDE00000	
HEX							
DRIP RING							
DRIP RING		3 - 3	150#	RF 125 AARH	CS ASTM A105,PDIL-PDS-600,	DR022QK01	
FITTING (BW)							
BRANCH WELD		2 - 48		BW	CARBON STEEL,ASME B31.3,	RWOJ11200	
BRANCH WELD WITH RP		2 - 48		BW	CARBON STEEL,ASME B31.3,	WBOJ11200	
CAP		2 - 48		BW	ASTM A234 WPB-SMLS,ASME B16.9,	CP7310900	
ELBOW		2 - 6		BW	ASTM A234 WPB-SMLS,ASME B16.9,	EL7310900	
ELBOW		8 - 48		BW	ASTM A234 WPB-WLDD,ASME B16.9,	ELOY10900	L
ELBOW		8 - 48		BW	ASTM A234 WPB-WLDD,PDIL-PDS-600,R=3D	ELOY1QK00	3
ELBOW		8 - 48		BW	ASTM A234 WPB-WLDD,PDIL-PDS-600,R=5D	ELOY1QK00	5
ELBOW		8 - 48		BW	ASTM A234 WPB-WLDD,PDIL-PDS-600,R=7D	ELOY1QK00	7
REDUCER CONC.		2 - 6		BW	ASTM A234 WPB-SMLS,ASME B16.9,	RC7310900	
REDUCER CONC.		8 - 48		BW	ASTM A234 WPB-WLDD,ASME B16.9,	RCOY10900	
REDUCER ECC.		2 - 6		BW	ASTM A234 WPB-SMLS,ASME B16.9,	RE7310900	
REDUCER ECC.		8 - 48		BW	ASTM A234 WPB-WLDD,ASME B16.9,	REOY10900	
TEE		2 - 6		BW	ASTM A234 WPB-SMLS,ASME B16.9,	TE7310900	
TEE		8 - 48		BW	ASTM A234 WPB-WLDD,ASME B16.9,	TEOY10900	



Class: B24

PROJECTS AND DEVELOPMENT INDIA LIMITED

SERVICE BD,CWS,CWR,DO,ES,FG,FN,FO,FW,IAW,NI,PA,P G ETC		TEMPERATURE LIMITS (Deg.C)					
		Ref.SI	Ref.SI				
RATING ASME 150# RF	CORROSION ALLOWANCE 1.5 MM(MIN.)	MATERIAL CS					
ITEM	NOTES	SIZE (NPS)	SCH/ RAT	END	DESCRIPTION	COMM CODE	SPCL REV
WELDOLET		2 - 48		BW	CS ASTM A105,MSS SP 97,	WL0213300	
FITTING (SW)							
CAP		1/2 - 11/2	3000#	SOCW	CS ASTM A105,ASME B16.11,	CP0230207	W
COUPLING		1/2 - 11/2	3000#	SOCW	CS ASTM A105,ASME B16.11,	CN0230207	W
ELBOW		1/2 - 11/2	3000#	SOCW	CS ASTM A105,ASME B16.11,	EL0230207	
HALF COUPLING		1/2 - 11/2	3000#	SOCW	CS ASTM A105,ASME B16.11,	HF0230207	
SOCKOLET		1/2 - 48	3000#	SOCW	CS ASTM A105,MSS SP 97,	SL0233307	
TEE		1/2 - 11/2	3000#	SOCW	CS ASTM A105,ASME B16.11,	TE0230207	
FITTING (THD)							
CAP		1/2 - 11/2	3000#	THD	CS ASTM A105,ASME B16.11,	CP0240207	T
COUPLING		1/2 - 11/2	3000#	THD	CS ASTM A105,ASME B16.11,	CN0240207	T
PLUG		1/2 - 11/2		THD	CS ASTM A105,ASME B16.11,ROUND HEAD	PG0240200	
THREDOLET		1/2 - 48	3000#	THD	CS ASTM A105,MSS SP 97,	TL0243307	
NIPPLE							
NIPPLE		1/2 - 11/2	SCH160	PLN-PLN	SMLS,API 5L GR.B,ASME B36.10,	NPA151312	1
NIPPLE		1/2 - 11/2	SCH160	PLN-THD	SMLS,API 5L GR.B,ASME B36.10,NPT	NPA161312	2
NIPPLE		1/2 - 11/2	SCH160	THD	SMLS,API 5L GR.B,ASME B36.10,NPT	NPA141312	3
SWAGE NIPPLE							
SWAGE (CONC)		1/2 - 11/2		PE	ASTM A234 WPB-SMLS,MSS SP 95,	NC73J4500	P
SWAGE (CONC)		1/2 - 11/2		PLN-THD	ASTM A234 WPB-SMLS,MSS SP 95,	NC7364500	T
SWAGE (ECC)		1/2 - 11/2		PE	ASTM A234 WPB-SMLS,MSS SP 95,	NE73J4500	P
SWAGE (ECC)		1/2 - 11/2		PLN-THD	ASTM A234 WPB-SMLS,MSS SP 95,	NE7364500	T
STRAINER							
T-TYPE STRAINER		2 - 24	150#	FLGD	CS ASTM A216 GR WCB,TTS210,	TTS210	
Y-TYPE STRAINER		1/2 - 11/2	600#	SOCW	CS ASTM A105,YTS201,	YTS201	
Y-TYPE STRAINER		2 - 24	150#	FLGD	CS ASTM A216 GR WCB,YTS210,	YTS210	
VALVES							
GATE VALVE		1/2 - 11/2	800#	SOCW	CS BODY ASTM A105,GAV201,	GAV201	
GATE VALVE		2 - 48	150#	FLG	CS BODY ASTM A216 GR WCB,GAV210,	GAV210	
GLOBE VALVE		1/2 - 11/2	800#	SOCW	CS BODY ASTM A105,GLV201,	GLV201	
GLOBE VALVE		2 - 12	150#	FLG	CS BODY ASTM A216 GR WCB,GLV210,	GLV210	
CHECK VALVE		1/2 - 11/2	800#	SOCW	CS BODY ASTM A105,CHV201,	CHV201	
CHECK VALVE		2 - 24	150#	FLG	CS BODY ASTM A216 GR WCB,CHV210,	CHV210	
BALL VALVE		1/2 - 11/2	800#	SOCW	CS BODY ASTM A105,BAV201,	BAV201	
BALL VALVE		2 - 24	150#	FLG	CS BODY ASTM A216 GR WCB,BAV210,	BAV210	
BUTTERFLY VALVE		2 - 24	150#	RF	CS BODY ASTM A216 GR WCB,BUV203,LUG TYPE	BUV203	
BUTTERFLY VALVE		26 - 48	150#	FLG	CS BODY ASTM A216 GR WCB,BUV204,	BUV204	
PLUG VALVE		1/2 - 1	600#	THRD	CS BODY ASTM A105,PLV201,	PLV201	
PLUG VALVE		11/2 - 24	150#	FLG	CS BODY ASTM A216 GR WCB,PLV202,	PLV202	



Class: B24G

PROJECTS AND DEVELOPMENT INDIA LIMITED

SERVICE FW	TEMPERATURE LIMITS (Deg.C)						
	Ref.SI	Ref.SI					
RATING ASME 150#	CORROSION ALLOWANCE 1.5 MM(MIN.)	MATERIAL CS(GALVANIZED)					
ITEM	NOTES	SIZE (NPS)	SCH/ RAT	END	DESCRIPTION	COMM CODE	SPCL REV
PIPE							
PIPE		1/2 - 3/4	SCH 80	THD	SMLS,API 5L GR.B,HOT DIP GALV.,ASME B36.10,	PPW231300	
PIPE		1 - 1 1/4	SCH 80	THD	SMLS,API 5L GR.B,HOT DIP GALV.,ASME B36.10,	PPW231300	
PIPE		1 1/2 - 2	SCH 80	THD	SMLS,API 5L GR.B,HOT DIP GALV.,ASME B36.10,	PPW231300	
PIPE		2 1/2 - 3	SCH 40	THD	SMLS,API 5L GR.B,HOT DIP GALV.,ASME B36.10,	PPW231300	
PIPE		4 - 4	SCH 40	THD	SMLS,API 5L GR.B,HOT DIP GALV.,ASME B36.10,	PPW231300	
PIPE		6 - 6	SCH 40	BE	SMLS,API 5L GR.B,HOT DIP GALV.,ASME B36.10,	PPW211300	
FLANGE							
FLANGE		1/2 - 4	150#	THD-RF 125 AARH	ASTM A105 HOT DIP GALV.,ASME B16.5,	FLFDK0801	
W.N.FLANGE		6 - 6	150#	WN-RF 125 AARH	ASTM A105 HOT DIP GALV.,ASME B16.5,	WNFD70801	
SPECL.BLIND		1/2 - 6	150#	RF 125 AARH	ASTM A105 HOT DIP GALV.,ASME B16.48,	SPFD2P001	
BLIND FLANGE							
BLIND FLANGE		1/2 - 6	150#	RF 125 AARH	ASTM A105 HOT DIP GALV.,ASME B16.5,	BFFD20801	
GASKET							
GASKET		6 - 6	150#	SPRL-WND RF	TP304 SS WDG:GPH FLR:TP304 SS INR RNG:CS OTR RNG,ASME B16.20,	GSON30301	
GASKET		1/2 - 4	150#	3.0 MM THK RF	BUTYL RUBBER,ASME B16.21,	GS6720401	
STUD & NUTS							
STUD & 2NUTS HVY		-			ASTM A193GR.B7/A194GR.2H,HOT DIP GALV.,,	SNZC00000	
HEX							
FITTING (BW)							
CAP		6 - 6		BW	ASTM A234 WPB-SMLS,HOT DIP GALV.,ASME B16.9,	CPPD10900	
ELBOW		6 - 6		BW	ASTM A234 WPB-SMLS,HOT DIP GALV.,ASME B16.9,	ELPD10900	
REDUCER CONC.		6 - 6		BW	ASTM A234 WPB-SMLS,HOT DIP GALV.,ASME B16.9,	RCPD10900	
REDUCER ECC.		6 - 6		BW	ASTM A234 WPB-SMLS,HOT DIP GALV.,ASME B16.9,	REPD10900	
TEE		6 - 6		BW	ASTM A234 WPB-SMLS,HOT DIP GALV.,ASME B16.9,	TEPD10900	
FITTING (THD)							
CAP		1/2 - 4	3000#	THD	ASTM A105 HOT DIP GALV.,ASME B16.11,	CPFD40207	
COUPLING		1/2 - 1 1/2	3000#	THD	ASTM A105 HOT DIP GALV.,ASME B16.11,	CNFD40207	
ELBOW		1/2 - 4	3000#	THD	ASTM A105 HOT DIP GALV.,ASME B16.11,	ELFD40207	
PLUG		1/2 - 1 1/2		THD	ASTM A105 HOT DIP GALV.,ASME B16.11,ROUND HEAD	PGFD40200	
REDUCER CONC.		1/2 - 4	3000#	THD	ASTM A105 HOT DIP GALV.,ASME B16.11,	RCFD40207	
REDUCER ECC.		1/2 - 4	3000#	THD	ASTM A105 HOT DIP GALV.,ASME B16.11,	REFD40207	
TEE		1/2 - 4	3000#	THD	ASTM A105 HOT DIP GALV.,ASME B16.11,	TEFD40207	
THREDOLET		1/2 - 1 1/2	3000#	THD	ASTM A105 HOT DIP GALV.,MSS SP 97,	TLFD43307	
NIPPLE							
NIPPLE		1/2 - 6	SCH160	THD	SMLS,API 5L GR.B,HOT DIP GALV.,ASME B36.10,NPT	NPW241312	
SWAGE NIPPLE							
SWAGE (CONC)		1/2 - 1 1/2		THD	ASTM A234 WPB-SMLS,HOT DIP GALV.,MSS SP 95,	NCPD44500	
SWAGE (ECC)		1/2 - 1 1/2		THD	ASTM A234 WPB-SMLS,HOT DIP GALV.,MSS SP 95,	NEPD44500	
VALVES							
GATE VALVE		2 - 6	150#	FLG	CS BODY ASTM A216 GR WCB,GAV210,	GAV210	
GATE VALVE		1/2 - 1 1/2	800#	THRD	CS BODY ASTM A105,GAV207,	GAV207	
CHECK VALVE		1/2 - 1 1/2	800#	THRD	CS BODY ASTM A105,CHV207,	CHV207	
CHECK VALVE		2 - 6	150#	FLG	CS BODY ASTM A216 GR WCB,CHV210,	CHV210	



Class: B24S

PROJECTS AND DEVELOPMENT INDIA LIMITED

SERVICE SL,SC (IBR)	TEMPERATURE LIMITS (Deg.C)						
	Ref.SI	Ref.SI					
RATING ASME 150# RF	CORROSION ALLOWANCE 1.5 MM(MIN.)	MATERIAL CS					
ITEM	NOTES	SIZE (NPS)	SCH/ RAT	END	DESCRIPTION	COMM CODE	SPCL REV
PIPE							
PIPE		2 - 6	SCH 40	BE IBR	SMLS,ASTM A106 GR.B,ASME B36.10,	PP03A1300	
PIPE		8 - 10	SCH 20	BE IBR	SMLS,ASTM A106 GR.B,ASME B36.10,	PP03A1300	
PIPE		12 - 12	SCH 20	BE IBR	SMLS,ASTM A106 GR.B,ASME B36.10,	PP03A1300	
PIPE		1/2 - 3/4	SCH 80	PE IBR	SMLS,ASTM A106 GR.B,ASME B36.10,	PP03B1300	
PIPE		1 - 1 1/4	SCH 80	PE IBR	SMLS,ASTM A106 GR.B,ASME B36.10,	PP03B1300	
PIPE		1 1/2 - 1 1/2	SCH 80	PE IBR	SMLS,ASTM A106 GR.B,ASME B36.10,	PP03B1300	
PIPE		14 - 16	SCH 10	BE IBR	SMLS,ASTM A106 GR.B,ASME B36.10,	PP03A1300	
PIPE		18 - 20	SCH 10	BE IBR	SMLS,ASTM A106 GR.B,ASME B36.10,	PP03A1300	
PIPE		24 - 24	SCHSTD	BE IBR	SMLS,ASTM A106 GR.B,ASME B36.10,	PP03A1300	
PIPE		26 - 28	SCHSTD	BE IBR	EFW,ASTM A671 GR.CC60 CL.22,ASME B36.10,	PPRXA1300	
PIPE		30 - 32	SCHSTD	BE IBR	EFW,ASTM A671 GR.CC60 CL.22,ASME B36.10,	PPRXA1300	
PIPE		34 - 34	SCHSTD	BE IBR	EFW,ASTM A671 GR.CC60 CL.22,ASME B36.10,	PPRXA1300	
PIPE		36 - 38	SCH XS	BE IBR	EFW,ASTM A671 GR.CC60 CL.22,ASME B36.10,	PPRXA1300	
PIPE		40 - 42	SCH XS	BE IBR	EFW,ASTM A671 GR.CC60 CL.22,ASME B36.10,	PPRXA1300	
PIPE		44 - 46	SCH XS	BE IBR	EFW,ASTM A671 GR.CC60 CL.22,ASME B36.10,	PPRXA1300	
PIPE		48 - 48	14.27 MM	BE IBR	EFW,ASTM A671 GR.CC60 CL.22,ASME B36.10,	PPRXA1300	
FLANGE							
FLANGE		1/2 - 24	150#	SO-RF 125 AARH IBR	CS ASTM A105,ASME B16.5,SLIP ON	FL02F0801	
W.N.FLANGE		26 - 48	150#	WN-RF 125 AARH IBR	CS ASTM A105,ASME B16.47 SR.B,WELD NECK	WN02G0701	
SPACER AND BLIND		14 - 24	150#	RF 125 AARH IBR	CS ASTM A105,ASME B16.48,	RS02BP001	
SPECL BLIND		1/2 - 12	150#	RF 125 AARH IBR	CS ASTM A105,ASME B16.48,	SP02BP001	
BLIND FLANGE							
BLIND FLANGE		26 - 48	150#	RF 125 AARH IBR	CS ASTM A105,ASME B16.47 SR.B,	BF02B0701	
BLIND FLANGE		1/2 - 24	150#	RF 125 AARH IBR	CS ASTM A105,ASME B16.5,	BF02B0801	
GASKET							
GASKET		1/2 - 24	150#	SPRL-WND RF	TP304 SS WDG;GPH FLR;TP304 SS INR RNG;CS OTR RNG,ASME B16.20,	GSON30301	
GASKET		26 - 48	150#	SPRL-WND RF	TP304 SS WDG;GPH FLR;TP304 SS INR RNG;CS OTR RNG,ASME B16.20/B16.47 SR.B,	GSON30J01	
STUD & NUTS							
STUD & 2NUTS HVY HEX		-			ASTM A193 GR.B7/ASTM A194 GR.2H,,	SNDE00000	
FITTING (BW)							
BRANCH WELD		2 - 48		BW IBR	CARBON STEEL,ASME B31.3,	RWOJA1200	
BRANCH WELD WITH RP		2 - 48		BW IBR	CARBON STEEL,ASME B31.3,	WBOJA1200	
CAP		2 - 48		BW IBR	ASTM A234 WPB-SMLS,ASME B16.9,	CP73A0900	
ELBOW		2 - 24		BW IBR	ASTM A234 WPB-SMLS,ASME B16.9,	EL73A0900	
ELBOW		26 - 48		BW IBR	ASTM A234 WPB-WLDD,ASME B16.9,	ELOYA0900	
REDUCER CONC.		2 - 24		BW IBR	ASTM A234 WPB-SMLS,ASME B16.9,	RC73A0900	
REDUCER CONC.		26 - 48		BW IBR	ASTM A234 WPB-WLDD,ASME B16.9,	RCOYA0900	
REDUCER ECC.		2 - 24		BW IBR	ASTM A234 WPB-SMLS,ASME B16.9,	RE73A0900	
REDUCER ECC.		26 - 48		BW IBR	ASTM A234 WPB-WLDD,ASME B16.9,	REOYA0900	
TEE		2 - 24		BW IBR	ASTM A234 WPB-SMLS,ASME B16.9,	TE73A0900	
TEE		26 - 48		BW IBR	ASTM A234 WPB-WLDD,ASME B16.9,	TEOYA0900	
WELDOLET		2 - 48		BW IBR	CS ASTM A105,MSS SP 97,	WL02A3300	
FITTING (SW)							
CAP		1/2 - 1 1/2	3000#	SOCW IBR	CS ASTM A105,ASME B16.11,	CP02C0207	W
COUPLING		1/2 - 1 1/2	3000#	SOCW IBR	CS ASTM A105,ASME B16.11,	CN02C0207	



Class: B24S

PROJECTS AND DEVELOPMENT INDIA LIMITED

SERVICE SL.SC (IBR)	TEMPERATURE LIMITS (Deg.C)						
	Ref.SI	Ref.SI					
RATING ASME 150# RF	CORROSION ALLOWANCE 1.5 MM(MIN.)	MATERIAL CS					
ITEM	NOTES	SIZE (NPS)	SCH/ RAT	END	DESCRIPTION	COMM CODE	SPCL REV
ELBOW		1/2 - 11/2	3000#	SOCW IBR	CS ASTM A105,ASME B16.11,	EL02C0207	
HALF COUPLING		1/2 - 11/2	3000#	SOCW IBR	CS ASTM A105,ASME B16.11,	HF02C0207	
SOCKOLET		1/2 - 48	3000#	SOCW IBR	CS ASTM A105,MSS SP 97,	SL02C3307	
TEE		1/2 - 11/2	3000#	SOCW IBR	CS ASTM A105,ASME B16.11,	TE02C0207	
FITTING (THD)							
CAP		1/2 - 11/2	3000#	THD IBR	CS ASTM A105,ASME B16.11,	CP02D0207	T
PLUG		1/2 - 11/2		THD IBR	CS ASTM A105,ASME B16.11,ROUND HEAD	PG02D0200	
THREDOLET		1/2 - 48	3000#	THD IBR	CS ASTM A105,MSS SP 97,	TL02D3307	
NIPPLE							
NIPPLE		1/2 - 11/2	SCH160	PLN-PLN IBR	SMLS,ASTM A106 GR.B,ASME B36.10,	NP03E1312	1
NIPPLE		1/2 - 11/2	SCH160	PLN-THD IBR	SMLS,ASTM A106 GR.B,ASME B36.10,NPT	NP03F1312	2
NIPPLE		1/2 - 11/2	SCH160	THD IBR	SMLS,ASTM A106 GR.B,ASME B36.10,NPT	NP03D1312	3
SWAGE NIPPLE							
SWAGE (CONC)		1/2 - 11/2		PE IBR	ASTM A234 WPB-SMLS,MSS SP 95,	NC73Q4500	P
SWAGE (CONC)		1/2 - 11/2		PLN-THD IBR	ASTM A234 WPB-SMLS,MSS SP 95,	NC73F4500	T
SWAGE (ECC)		1/2 - 11/2		PE IBR	ASTM A234 WPB-SMLS,MSS SP 95,	NE73Q4500	P
SWAGE (ECC)		1/2 - 11/2		PLN-THD IBR	ASTM A234 WPB-SMLS,MSS SP 95,	NE73F4500	T
VALVES							
GATE VALVE		1/2 - 11/2	800#	SOCW IBR	CS BODY ASTM A105,GAV201S,	GAV201S	
GATE VALVE		2 - 48	150#	FLG IBR	CS BODY ASTM A216 GR WCB,GAV210S,	GAV210S	
GLOBE VALVE		1/2 - 11/2	800#	SOCW IBR	CS BODY ASTM A105,GLV201S,	GLV201S	
GLOBE VALVE		2 - 12	150#	FLG IBR	CS BODY ASTM A216 GR WCB,GLV210S,	GLV210S	
CHECK VALVE		1/2 - 11/2	800#	SOCW IBR	CS BODY ASTM A105,CHV201S,	CHV201S	
CHECK VALVE		2 - 24	150#	FLG IBR	CS BODY ASTM A216 GR WCB,CHV210S,	CHV210S	

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Class: B40

PROJECTS AND DEVELOPMENT INDIA LIMITED

SERVICE CD,FG,HG,PA,PC		TEMPERATURE LIMITS (Deg.C)					
		Ref.SI	Ref.SI				
RATING ASME 150# RF	CORROSION ALLOWANCE NONE	MATERIAL SS 304L					
ITEM	NOTES	SIZE (NPS)	SCH/ RAT	END	DESCRIPTION	COMM CODE	SPCL REV
PIPE							
PIPE		26 - 28	SCH 10	BE	EFW,STR.WELD,ASTM A312 TP304L,ASME B36.10,	PPZ511300	
PIPE		30 - 32	SCH 10	BE	EFW,STR.WELD,ASTM A312 TP304L,ASME B36.10,	PPZ511300	
PIPE		34 - 36	SCH 10	BE	EFW,STR.WELD,ASTM A312 TP304L,ASME B36.10,	PPZ511300	
PIPE		2 - 4	SCH10S	BE	EFW,STR.WELD,ASTM A312 TP304L,ASME B36.19,	PPZ511400	
PIPE		1/2 - 3/4	SCH40S	PE	SMLS,ASTM A312 TP304L,ASME B36.19,	PP8521400	
PIPE		1 - 1 1/4	SCH40S	PE	SMLS,ASTM A312 TP304L,ASME B36.19,	PP8521400	
PIPE		1 1/2 - 1 1/2	SCH40S	PE	SMLS,ASTM A312 TP304L,ASME B36.19,	PP8521400	
PIPE		6 - 8	SCH10S	BE	EFW,STR.WELD,ASTM A312 TP304L,ASME B36.19,	PPZ511400	
PIPE		10 - 12	SCH10S	BE	EFW,STR.WELD,ASTM A312 TP304L,ASME B36.19,	PPZ511400	
PIPE		14 - 16	SCH10S	BE	EFW,STR.WELD,ASTM A312 TP304L,ASME B36.19,	PPZ511400	
PIPE		18 - 20	SCH10S	BE	EFW,STR.WELD,ASTM A312 TP304L,ASME B36.19,	PPZ511400	
PIPE		22 - 24	SCH10S	BE	EFW,STR.WELD,ASTM A312 TP304L,ASME B36.19,	PPZ511400	
FLANGE							
LONG W.N.FLANGE		1 1/2 - 1 1/2	300#	WN-RF 125 AARH	ASTM A182 F304L,ASME B16.5,38mmBORE,200mmLONG	LN8170802	
W.N.FLANGE		26 - 36	150#	WN-RF 125 AARH	ASTM A182 F304L,ASME B16.47 SR.B,WELD NECK	WN8170701	
W.N.FLANGE		1/2 - 24	150#	WN-RF 125 AARH	ASTM A182 F304L,ASME B16.5,WELD NECK	WN8170801	5
W.N.FLANGE		1/2 - 24	300#	WN-RF 125 AARH	ASTM A182 F304L,ASME B16.5,WELD NECK	WN8170802	6
SPACER AND BLIND		14 - 24	150#	RF 125 AARH	ASTM A182 F304L,ASME B16.48,	RS812P001	
SPECL BLIND		1/2 - 12	150#	RF 125 AARH	ASTM A182 F304L,ASME B16.48,	SP812P001	
BLIND FLANGE							
BLIND FLANGE		26 - 36	150#	RF 125 AARH	ASTM A182 F304L,ASME B16.47 SR.B,	BF8120701	
BLIND FLANGE		1/2 - 24	150#	RF 125 AARH	ASTM A182 F304L,ASME B16.5,	BF8120801	1
BLIND FLANGE		1/2 - 24	300#	RF 125 AARH	ASTM A182 F304L,ASME B16.5,	BF8120802	2
GASKET							
GASKET		1/2 - 24	150#	SPRL-WND RF	TP304 SS WDG; GPH FLR; TP304 SS INR RNG/ OTR RNG,ASME B16.20,	GSOL30301	1
GASKET		1/2 - 24	300#	SPRL-WND RF	TP304 SS WDG; GPH FLR; TP304 SS INR RNG/ OTR RNG,ASME B16.20,	GSOL30302	2
GASKET		26 - 36	150#	SPRL-WND RF	TP304 SS WDG; GPH FLR; TP304 SS INR RNG/ OTR RNG,ASME B16.20/B16.47 SR.B,	GSOL30J01	
STUD & NUTS							
STUD & 2NUTS HVY		-			ASTM A193 GR.B8 CL.2/ASTM A194 GR.8,,	SNA600000	
HEX							
DRIP RING							
DRIP RING		3 - 3	150#	RF 125 AARH	ASTM A182 F304L,PDIL-PDS-600,	DR812QK01	
FITTING (BW)							
BRANCH WELD		2 - 36		BW	STAINLESS STEEL,ASME B31.3,	RWOK11200	
BRANCH WELD WITH RP		2 - 36		BW	STAINLESS STEEL,ASME B31.3,	WBOK11200	
CAP		2 - 36		BW	ASTM A403 WP304L-SMLS,ASME B16.9,	CP8310900	
ELBOW		2 - 36		BW	ASTM A403 WP304L-WLDD,ASME B16.9,	EL8410900	L
ELBOW		2 - 36	19.05 MM	BW	ASTM A403 WP304L-WLDD,PDIL-PDS-600,R-3D	EL841QK60	3
ELBOW		2 - 36	19.05 MM	BW	ASTM A403 WP304L-WLDD,PDIL-PDS-600,R-5D	EL841QK60	5
REDUCER CONC.		2 - 36		BW	ASTM A403 WP304L-WLDD,ASME B16.9,	RC8410900	
REDUCER ECC.		2 - 36		BW	ASTM A403 WP304L-WLDD,ASME B16.9,	RE8410900	
TEE		2 - 36		BW	ASTM A403 WP304L-WLDD,ASME B16.9,	TE8410900	
WELDOLET		2 - 36		BW	ASTM A182 F304L,MSS SP 97,	WL8113300	
FITTING (SW)							
CAP		1/2 - 1 1/2	3000#	SOCW	ASTM A182 F304L,ASME B16.11,	CP8130207	W
COUPLING		1/2 - 1 1/2	3000#	SOCW	ASTM A182 F304L,ASME B16.11,	CN8130207	
ELBOW		1/2 - 1 1/2	3000#	SOCW	ASTM A182 F304L,ASME B16.11,	EL8130207	
HALF COUPLING		1/2 - 1 1/2	3000#	SOCW	ASTM A182 F304L,ASME B16.11,	HF8130207	
SOCKOLET		1/2 - 36	3000#	SOCW	ASTM A182 F304L,MSS SP 97,	SL8133307	



Class: B40

PROJECTS AND DEVELOPMENT INDIA LIMITED

SERVICE CD,FG,HG,PA,PC	TEMPERATURE LIMITS (Deg.C)						
	Ref.SI	Ref.SI					
RATING ASME 150# RF	CORROSION ALLOWANCE NONE	MATERIAL SS 304L					
ITEM	NOTES	SIZE (NPS)	SCH/ RAT	END	DESCRIPTION	COMM CODE	SPCL REV
TEE		1/2 - 11/2	3000#	SOCW	ASTM A182 F304L,ASME B16.11,	TE8130207	
FITTING (THD)							
CAP		1/2 - 11/2	3000#	THD	ASTM A182 F304L,ASME B16.11,	CP8140207	T
PLUG		1/2 - 11/2		THD	ASTM A182 F304L,ASME B16.11,ROUND HEAD	PG8140200	
THREDOLET		1/2 - 36	3000#	THD	ASTM A182 F304L,MSS SP 97,	TL8143307	
NIPPLE							
NIPPLE		1/2 - 11/2	SCH80S	PLN-PLN	SMLS,ASTM A312 TP304L,ASME B36.19,	NP8551413	1
NIPPLE		1/2 - 11/2	SCH80S	PLN-THD	SMLS,ASTM A312 TP304L,ASME B36.19,NPT	NP8561413	2
NIPPLE		1/2 - 11/2	SCH80S	THD	SMLS,ASTM A312 TP304L,ASME B36.19,NPT	NP8541413	3
SWAGE NIPPLE							
SWAGE (CONC)		1/2 - 11/2		PE	ASTM A403 WP304L-SMLS,MSS SP 95,	NC83J4500	P
SWAGE (CONC)		1/2 - 11/2		PLN-THD	ASTM A403 WP304L-SMLS,MSS SP 95,	NC8364500	T
SWAGE (ECC)		1/2 - 11/2		PE	ASTM A403 WP304L-SMLS,MSS SP 95,	NE83J4500	P
SWAGE (ECC)		1/2 - 11/2		PLN-THD	ASTM A403 WP304L-SMLS,MSS SP 95,	NE8364500	T
VALVES							
GATE VALVE		1/2 - 1	800#	SOCW	SS BODY ASTM A182 GR F304,GAV501,	GAV501	
GATE VALVE		11/2 - 11/2	800#	SOCW	SS BODY ASTM A182 GR F304,GAV501,	GAV501	W
GATE VALVE		11/2 - 11/2	150#	FLG	SS BODY ASTM A351 GR CF8,GAV510,	GAV510	F
GATE VALVE		2 - 24	150#	FLG	SS BODY ASTM A351 GR CF8,GAV510,	GAV510	
GLOBE VALVE		1/2 - 11/2	800#	SOCW	SS BODY ASTM A182 GR F304,GLV501,	GLV501	
GLOBE VALVE		2 - 12	150#	FLG	SS BODY ASTM A351 GR CF8,GLV510,	GLV510	
CHECK VALVE		1/2 - 11/2	800#	SOCW	SS BODY ASTM A182 GR F304,CHV501,	CHV501	
CHECK VALVE		2 - 24	150#	FLG	SS BODY ASTM A351 GR CF8,CHV510,	CHV510	
BALL VALVE		1/2 - 1	800#	THRD	SS BODY AISI 316,BAV501,	BAV501	
BALL VALVE		11/2 - 11/2	800#	THRD	SS BODY AISI 316,BAV501,	BAV501	T
BALL VALVE		11/2 - 11/2	150#	FLG	SS BODY ASTM A351 GR CF8M,BAV510,	BAV510	F
BALL VALVE		2 - 12	150#	FLG	SS BODY ASTM A351 GR CF8M,BAV510,	BAV510	

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Class: D14

PROJECTS AND DEVELOPMENT INDIA LIMITED

SERVICE AG,AL,FG	TEMPERATURE LIMITS (Deg.C)						
	Ref.SI	Ref.SI					
RATING ASME 300# RF	CORROSION ALLOWANCE 1.5 MM(MIN.)	MATERIAL LT CS					
ITEM	NOTES	SIZE (NPS)	SCH/ RAT	END	DESCRIPTION	COMM CODE	SPCL REV
PIPE							
PIPE		2 - 6	SCH 40	BE	SMLS,ASTM A333 GR.6,ASME B36.10,	PPP611300	
PIPE		8 - 10	SCH 30	BE	SMLS,ASTM A333 GR.6,ASME B36.10,	PPP611300	
PIPE		12 - 14	SCH 40	BE	SMLS,ASTM A333 GR.6,ASME B36.10,	PPP611300	
PIPE		1/2 - 3/4	SCH 80	PE	SMLS,ASTM A333 GR.6,ASME B36.10,	PPP621300	
PIPE		1 - 1 1/4	SCH 80	PE	SMLS,ASTM A333 GR.6,ASME B36.10,	PPP621300	
PIPE		1 1/2 - 1 1/2	SCH 80	PE	SMLS,ASTM A333 GR.6,ASME B36.10,	PPP621300	
PIPE		16 - 18	SCH 40	BE	SMLS,ASTM A333 GR.6,ASME B36.10,	PPP611300	
PIPE		20 - 22	SCH 40	BE	SMLS,ASTM A333 GR.6,ASME B36.10,	PPP611300	
PIPE		24 - 24	SCH 40	BE	SMLS,ASTM A333 GR.6,ASME B36.10,	PPP611300	
FLANGE							
LONG W.N.FLANGE		1 1/2 - 1 1/2	300#	WN-RF 125 AARH	ASTM A350 LF2 CL.1,ASME B16.5,38mmBORE,200mmLONG	LN3570802	
W.N.FLANGE		1/2 - 24	300#	WN-RF 125 AARH	ASTM A350 LF2 CL.1,ASME B16.5,WELD NECK	WN3570802	
SPACER AND BLIND		14 - 24	300#	RF 125 AARH	ASTM A350 LF2 CL.1,ASME B16.48,	RS352PO02	
SPECL BLIND		1/2 - 12	300#	RF 125 AARH	ASTM A350 LF2 CL.1,ASME B16.48,	SP352PO02	
BLIND FLANGE							
BLIND FLANGE		1/2 - 24	300#	RF 125 AARH	ASTM A350 LF2 CL.1,ASME B16.5,	BF3520802	
GASKET							
GASKET		1/2 - 24	300#	SPRL-WND RF	TP304 SS WDG;GPH FLR;TP304 SS INR RNG;CS OTR RNG,ASME B16.20,	GSON30302	
STUD & NUTS							
STUD & 2NUTS HVY		-			ASTM A320 GR.L7/ASTM A194 GR.7,,	SNDA00000	
HEX							
FITTING (BW)							
BRANCH WELD WITH RP		2 - 24		BW	LT CARBON STEEL,ASME B31.3,	WBE211200	
CAP		2 - 24		BW	ASTM A420 WPL6-SMLS,ASME B16.9,	CP4910900	
ELBOW		2 - 24		BW	ASTM A420 WPL6-SMLS,ASME B16.9,	EL4910900	
REDUCER CONC.		2 - 24		BW	ASTM A420 WPL6-SMLS,ASME B16.9,	RC4910900	
REDUCER ECC.		2 - 24		BW	ASTM A420 WPL6-SMLS,ASME B16.9,	RE4910900	
TEE		2 - 24		BW	ASTM A420 WPL6-SMLS,ASME B16.9,	TE4910900	
WELDOLET		2 - 24		BW	ASTM A350 LF2 CL.1,MSS SP 97,	WL3513300	
FITTING (SW)							
CAP		1/2 - 1 1/2	3000#	SOCW	ASTM A350 LF2 CL.1,ASME B16.11,	CP3530207	W
COUPLING		1/2 - 1 1/2	3000#	SOCW	ASTM A350 LF2 CL.1,ASME B16.11,	CN3530207	
ELBOW		1/2 - 1 1/2	3000#	SOCW	ASTM A350 LF2 CL.1,ASME B16.11,	EL3530207	
HALF COUPLING		1/2 - 1 1/2	3000#	SOCW	ASTM A350 LF2 CL.1,ASME B16.11,	HF3530207	
SOCKOLET		1/2 - 24	3000#	SOCW	ASTM A350 LF2 CL.1,MSS SP 97,	SL3533307	
TEE		1/2 - 1 1/2	3000#	SOCW	ASTM A350 LF2 CL.1,ASME B16.11,	TE3530207	
FITTING (THD)							
CAP		1/2 - 1 1/2	3000#	THD	ASTM A350 LF2 CL.1,ASME B16.11,	CP3540207	T
PLUG		1/2 - 1 1/2		THD	ASTM A350 LF2 CL.1,ASME B16.11,ROUND HEAD	PG3540200	
THREDOLET		1/2 - 24	3000#	THD	ASTM A350 LF2 CL.1,MSS SP 97,	TL3543307	
NIPPLE							
NIPPLE		1/2 - 1 1/2	SCH160	PLN-PLN	SMLS,ASTM A333 GR.6,ASME B36.10,	NPP651312	1
NIPPLE		1/2 - 1 1/2	SCH160	PLN-THD	SMLS,ASTM A333 GR.6,ASME B36.10,NPT	NPP661312	2
NIPPLE		1/2 - 1 1/2	SCH160	THD	SMLS,ASTM A333 GR.6,ASME B36.10,NPT	NPP641312	3
SWAGE NIPPLE							
SWAGE (CONC)		1/2 - 1 1/2		PE	ASTM A420 WPL6-SMLS,MSS SP 95,	NC49J4500	P
SWAGE (CONC)		1/2 - 1 1/2		PLN-THD	ASTM A420 WPL6-SMLS,MSS SP 95,	NC4964500	T
SWAGE (ECC)		1/2 - 1 1/2		PE	ASTM A420 WPL6-SMLS,MSS SP 95,	NE49J4500	P
SWAGE (ECC)		1/2 - 1 1/2		PLN-THD	ASTM A420 WPL6-SMLS,MSS SP 95,	NE4964500	T
VALVES							



Class: D14

PROJECTS AND DEVELOPMENT INDIA LIMITED

SERVICE AG,AL,FG	TEMPERATURE LIMITS (Deg.C)			
	Ref.SI	Ref.SI		
RATING ASME 300# RF	CORROSION ALLOWANCE 1.5 MM(MIN.)	MATERIAL LT CS		

ITEM	NOTES	SIZE (NPS)	SCH/ RAT	END	DESCRIPTION	COMM CODE	SPCL REV
GATE VALVE		1/2 - 1	800#	SOCW	LTCS BODY ASTM A350 GR LF2,GAV101,	GAV101	
GATE VALVE		1 1/2 - 1 1/2	800#	SOCW	LTCS BODY ASTM A350 GR LF2,GAV101,	GAV101	W
GATE VALVE		1 1/2 - 1 1/2	300#	FLG	LTCS BODY ASTM A352 GR LCB,GAV111,	GAV111	F
GATE VALVE		2 - 24	300#	FLG	LTCS BODY ASTM A352 GR LCB,GAV111,	GAV111	
GLOBE VALVE		1/2 - 1 1/2	800#	SOCW	LTCS BODY ASTM A350 GR LF2,GLV101,	GLV101	
GLOBE VALVE		2 - 8	300#	FLG	LTCS BODY ASTM A352 GR LCB,GLV111,	GLV111	
CHECK VALVE		1/2 - 1 1/2	800#	SOCW	LTCS BODY ASTM A350 GR LF2,CHV101,	CHV101	
CHECK VALVE		2 - 24	300#	FLG	LTCS BODY ASTM A352 GR LCB,CHV111,	CHV111	
BALL VALVE		1/2 - 1	800#	SOCW	LTCS BODY ASTM A350 GR LF2,BAV101,	BAV101	
BALL VALVE		1 1/2 - 1 1/2	800#	SOCW	LTCS BODY ASTM A350 GR LF2,BAV101,	BAV101	W
BALL VALVE		1 1/2 - 1 1/2	300#	FLG	LTCS BODY ASTM A352 GR LCB,BAV111,	BAV111	F
BALL VALVE		2 - 14	300#	FLG	LTCS BODY ASTM A352 GR LCB,BAV111,	BAV111	

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	PROJECTS & DEVELOPMENT INDIA LTD	TFL-PDS-600	1
		DOCUMENT NO	REV

BRANCH TABLE : TABLE-A1
APPLICABLE PIPING MATERIAL SPECIFICATIONS : B14, D14, B20, B22IS, B24, D24, B24S, B24Z
PRESSURE RATING <= 300#

<-----B R A N C H S I Z E----->

3 1 1 2 1 1 1 1 1 2 2 2 2 2 3 3 3 3 3 4 4 4 4 4 5 5 5 5 5

M Q 1 Q M 2 M 3 4 6 8 0 2 4 6 8 0 2 4 6 8 0 2 4 6 8 0 2 4 6 8 0 2 4 6 8

M T
3Q E T
1 E E T
1Q
1M E E E T
2 S S S E T
2M S S S E E T
3 S S S E E E T
4 S S S S E E E T
6 S S S S W W E E T
8 S S S S W W W E E T
10 S S S S W W W W E E T
12 S S S S W W W W W E E T
14 S S S S W W W W W W E E T
16 S S S S W W W W W W P E E T
18 S S S S W W W W W W P P E E T
20 S S S S W W W W W W P P P E E T
22 S S S S W W W W W W P P P P E E T
24 S S S S W W W W W W P P P P P E E T
26 S S S S P P P P P P P P P P P E E T
28 S S S S P P P P P P P P P P P P E E T
30 S S S S P P P P P P P P P P P P P E E T
32 S S S S P P P P P P P P P P P P P P E E T
34 S S S S P P P P P P P P P P P P P P P E E T
36 S S S S P P P P P P P P P P P P P P P P E E T
38 S S S S P P P P P P P P P P P P P P P P P E E T
40 S S S S P P P P P P P P P P P P P P P P P P E E T
42 S S S S P P P P P P P P P P P P P P P P P P P E E T
44 S S S S P E E T
46 S S S S P E E T
48 S S S S P E E T
50
52
54
56
58
A-

E TE REDUCING TEE
P WB BRANCH WELD WITH RP
S SL SOCKOLET
T TE EQUAL TEE
W WL WELDOLET

 PROJECTS & DEVELOPMENT INDIA LTD	TFL-PDS-600		1
	DOCUMENT NO		REV

BRANCH TABLE: TABLE-A2

**APPLICABLE PIPING MATERIAL SPECIFICATIONS: B40,B50,B52,D50,D52 .
PRESSURE RATING <=300#**

<-----B R A N C H S I Z E----->

3 1 1 2 1 1 1 1 1 2 2 2 2 2 3 3 3 3 3 4 4 4 4 4 5 5 5 5 5

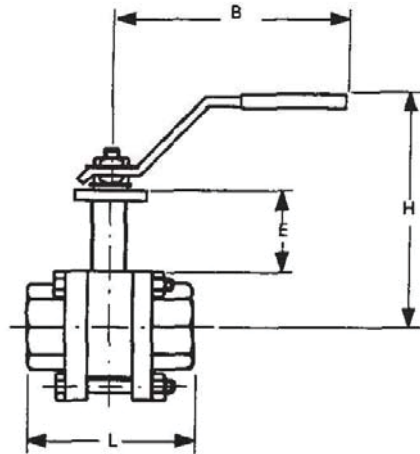
M Q 1 Q M 2 M 3 4 6 8 0 2 4 6 8 0 2 4 6 8 0 2 4 6 8 0 2 4 6 8 0 2 4 6 8

M T
3Q E T
1 E E T
1Q
1M E E E T
2 S S S E T
2M
3 S S S E E T
4 S S S S E E T
6 S S S S P E E T
8 S S S S P P E E T
10 S S S S P P P E E T
12 S S S S P P P P E E T
14 S S S S P P P P P E E T
16 S S S S P P P P P P E E T
18 S S S S P P P P P P P E E T
20 S S S S P P P P P P P P E E T
22 S S S S P P P P P P P P P E E T
24 S S S S P P P P P P P P P P E E T
26 S S S S P P P P P P P P P P P E E T
28 S S S S P P P P P P P P P P P P E E T
30 S S S S P P P P P P P P P P P P P E E T
32 S S S S P P P P P P P P P P P P P P E E T
34 S S S S P P P P P P P P P P P P P P P E E T
36 S S S S P P P P P P P P P P P P P P P P E E T
38 S S S S P P P P P P P P P P P P P P P P P E E T
40 S S S S P P P P P P P P P P P P P P P P P P E E T
42 S S S S P P P P P P P P P P P P P P P P P P P E E T
44 S S S S P E E T
46 S S S S P E E T
48 S S S S P E E T
50
52
54
56
58
A-

E TE REDUCING TEE
P WB BRANCH WELD WITH RP
S SL SOCKOLET
T TE EQUAL TEE



BALL VALVE



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	BAV 101	
PRESSURE RATING CLASS	800	
FACE	SW	
CONSTRUCTION		
BODY	THREE PIECES TYPE FULL BORE FLOATING BALL	
EXTENDED STEM	YES b)	
WRENCH OPERATED	YES	
GEAR OPERATED	NO	
FIRE SAFE	YES	
NOMINAL SIZE	1/2" - 1 1/2"	
MATERIALS		
BODY	A 350 Gr. LF2	
BALL	AISI 316	
BODY SEAT RING	PTFE	
STEM PACKING	PTFE GRAPHITE	
STEM	13 Cr.	
DESIGN CONDITIONS		
PRESSURE RATING	API 602	
FLUID	Kg/cm ² g	°C

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED
- 2.
3. IF NOT OTHERWISE STATED THE VALVES SHALL BE FULL BORE

MANDATORY STANDARDS:

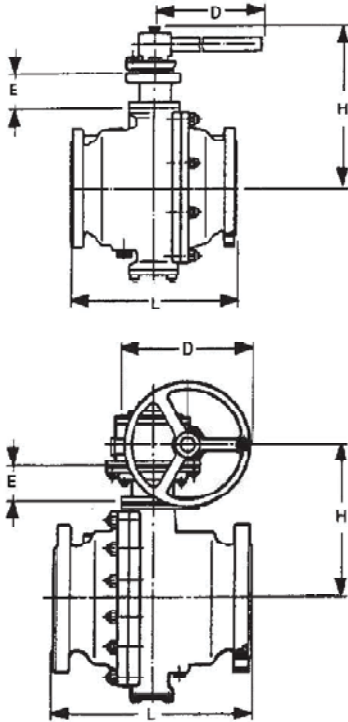
API 598, API 602, API 607, API 608, ANSI B16.11, ANSI B16.34

NOTES:

- a) SEAT RATING ACC. TO MANUFACTURER'S STANDARD
- b) STEM EXTENSION E = 120MM (FOR MAX. 70MM COLD INSULATION)



BALL VALVE



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	BAV 111	
PRESSURE RATING CLASS	300	
FACE	RF	
CONSTRUCTION		
BODY	SPLIT BODY, FULL BORE FLOATING BALL = < 4" TRUN. MOUNT BALL > 4" LONG PATTERN	
EXTENDED STEM	YES b)	
WRENCH OPERATED	1 1/2" - 6"	
GEAR OPERATED	8" - 14"	
FIRE SAFE	YES	
NOMINAL SIZE	1 1/2" - 14"	
MATERIALS		
BODY	A 352 Gr. LCB	
BALL	AISI 316 OR C.S. CHROMEPLATED	
BODY SEAT RING	PTFE	
STEM PACKING	PTFE GRAPHITE	
STEM	13 Cr.	
DESIGN CONDITIONS		
PRESSURE RATING	ANSI B16.34	
FLUID	Kg/cm ² g	°C

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED
- 2.
3. IF NOT OTHERWISE STATED THE VALVES SHALL BE FULL BORE

MANDATORY STANDARDS:

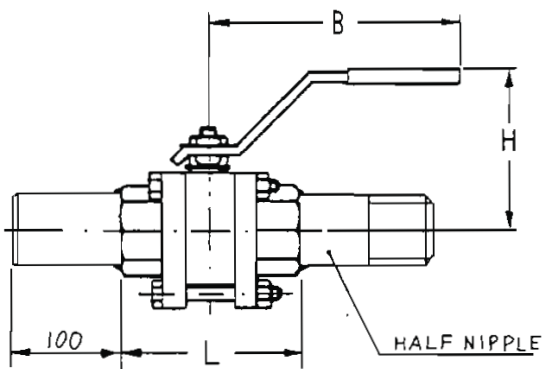
API 598, API 607, API 608, ANSI B16.10, ANSI B16.34, ANSI B16.5

NOTES:

- a) SEAT RATING ACC. TO MANUFACTURER'S STANDARD
- b) STEM EXTENSION E = 150mm (FOR MAX 100mm COLD INSULATION)



BALL VALVE



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	BAV 201
PRESSURE RATING CLASS	800
FACE	SW b)
CONSTRUCTION	
BODY	THREE PIECES TYPE FULL BORE FLOATING BALL
EXTENDED STEM	NO
WRENCH OPERATED	YES
GEAR OPERATED	NO
FIRE SAFE	YES
NOMINAL SIZE	1/2" - 1 1/2"
MATERIALS	
BODY	A 105
BALL	AISI 316
BODY SEAT RING	PTFE
STEM PACKING	PTFE GRAPHITE
STEM	13 Cr.
DESIGN CONDITIONS	
PRESSURE RATING	API 602

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED
2. IF OTHERWISE STATED THE VALVES SHALL BE FULL BORE

MANDATORY STANDARDS:

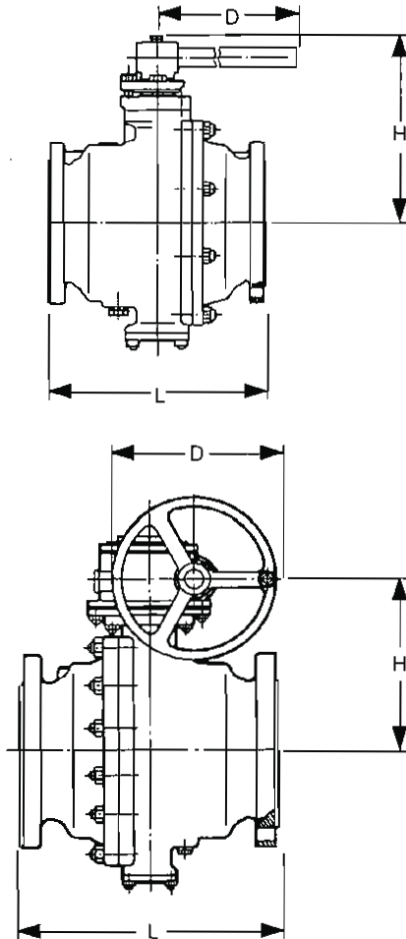
API 598, API 602, API 607, API 608, ANSI B16.11, ANSI B16.34

NOTES:

- a) SEAT RATING ACC. TO MANUFACTURER'S STANDARD
- b) VALVE PROVIDED WITH EXTENDED ENDS, 100mm LONG SCH 80/HALF NIPPLE



BALL VALVE



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	BAV 210	
PRESSURE RATING CLASS	150	
FACE	RF	
CONSTRUCTION		
BODY	SPLIT BODY, FULL BORE FLOATING BALL = <4" TRUN. MOUNT BALL >4" LONG PATTERN	
EXTENDED STEM	NO	
WRENCH OPERATED	2" - 6"	
GEAR OPERATED	8" - 24"	
FIRE SAFE	YES	
NOMINAL SIZE	2" - 24"	
MATERIALS		
BODY	A 216 Gr. WCB	
BALL	AISI 316 OR C.S. CHROMEPLATED	
BODY SEAT RING	PTFE	
STEM PACKING	PTFE GRAPHITE	
STEM	13 Cr.	
DESIGN CONDITIONS		
PRESSURE RATING	ANSI B16.34	
FLUID	Kg/cm ² g	°C

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED
2. IF NOT OTHERWISE STATED THE VALVES SHALL BE FULL BORE

MANDATORY STANDARDS:

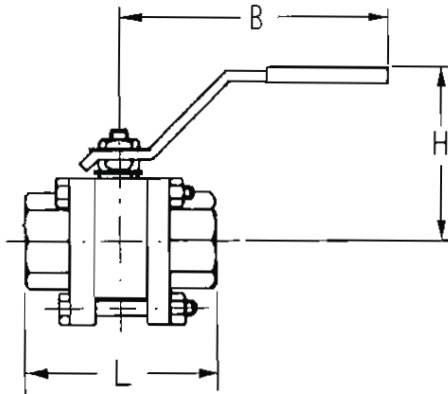
API 598, API 607, API 608, ANSI B16.10, ANSI B16.34, ANSI B16.5

NOTES:

- a) SEAT RATING ACC. TO MANUFACTURER'S STANDARD



BALL VALVE



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	BAV 501
PRESSURE RATING CLASS	800
FACE	THREADED (NPT)
CONSTRUCTION	
BODY	THREE PIECES TYPE FULL BORE FLOATING BALL
EXTENDED STEM	NO
WRENCH OPERATED	YES
GEAR OPERATED	NO
FIRE SAFE	YES
NOMINAL SIZE	1/2" - 1 1/2"
MATERIALS	
BODY	AISI 316
BALL	AISI 316
BODY SEAT RING	PTFE
STEM PACKING	PTFE GRAPHITE
STEM	AISI 316
DESIGN CONDITIONS	
PRESSURE RATING	API 602

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED
2. IF NOT OTHERWISE STATED THE VALVES SHALL BE FULL BORE

MANDATORY STANDARDS:

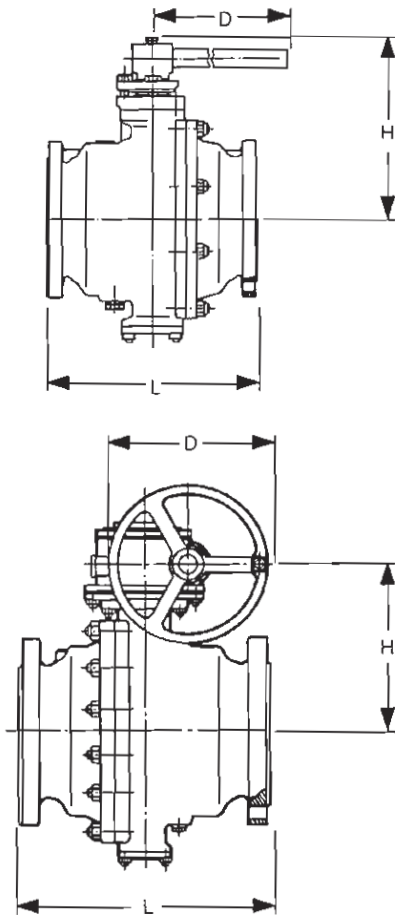
API 598, API 602, API 607, API 608, ANSI B16.11, ANSI B16.34

NOTES:

- a) SEAT RATING ACC. TO MANUFACTURER'S STANDARD
- b) BOTH ENDS FEMALE SCREWED



BALL VALVE



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	BAV 510
PRESSURE RATING CLASS	150
FACE	RF
CONSTRUCTION	
BODY	SPLIT BODY, FULL BORE, FLOATING BALL = < 4" TRUN. MOUNT BALL > 4" LONG PATTERN
EXTENDED STEM	NO
WRENCH OPERATED	2" - 6"
GEAR OPERATED	8" - 12"
FIRE SAFE	YES
NOMINAL SIZE	2" - 12"
MATERIALS	
BODY	A 351 Gr. CF 8M
BALL	AISI 316
BODY SEAT RING	PTFE
STEM PACKING	PTFE GRAPHITE
STEM	AISI 316
DESIGN CONDITIONS	
PRESSURE RATING	ANSI B16.34

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED
2. IF NOT OTHERWISE STATED THE VALVES SHALL BE FULL BORE

MANDATORY STANDARDS:

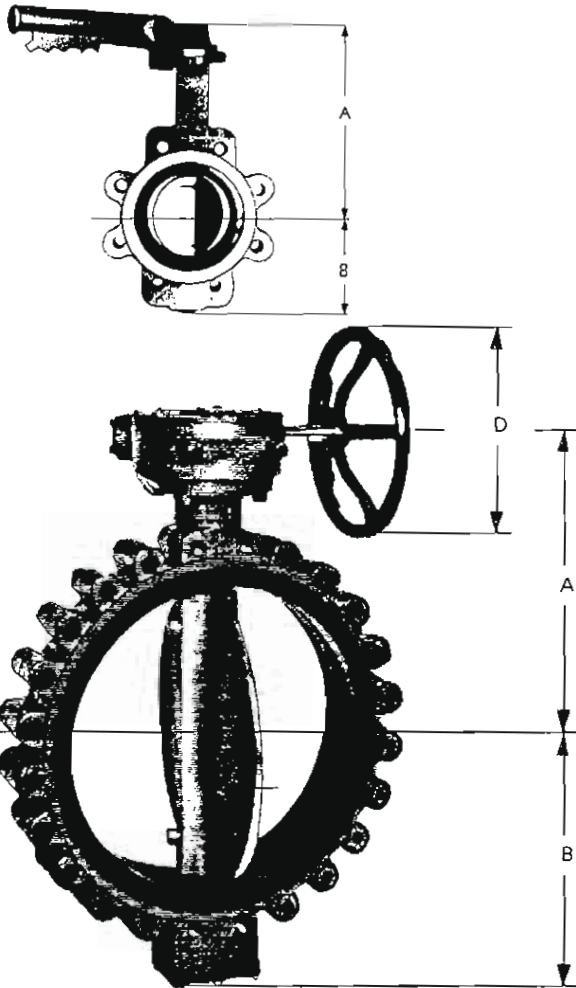
API 598, API 607, API 608, ANSI B16.10, ANSI B16.34, ANSI B16.5

NOTES:

- a) SEAT RATING ACC. TO MANUFACTURER'S STANDARD



BUTTERFLY VALVE



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	BUV 203
PRESSURE RATING CLASS	150
FACE	RF
CONSTRUCTION	
BODY	CAST
	LUG TYPE WITH
	THREADED HOLES
	RUBBER LINED
GEAR OPERATED	YES $\geq 8"$
NOMINAL SIZE	2" - 24"
MATERIALS	
BODY	A 216 Gr. WCB
BODY LINING	ETHYLENE-PROPYLENE
DISC	A216 GR.WCB+
SHAFT	13 Cr
SHAFT PACKING	PTFE
DESIGN CONDITIONS	
PRESSURE RATING	API 609

rev.1

GENERAL

1. RUBBER LINING: THE WETTED SURFACES OF VALVE SHALL BE FULLY LINED AND THE LINING SHALL EXTEND OVER THE FLANGE SEALING FACE
2. LEVER OPERATORS SUITABLE FOR THROTTLING PURPOSES SHALL BE PROVIDED FOR VALVES 6" AND SMALLER
3. FACE-TO-FACE DIMENSIONS SHALL BE PER API 609
4. COPPER AND COPPER ALLOYS NOT PERMITTED

MANDATORY STANDARDS:

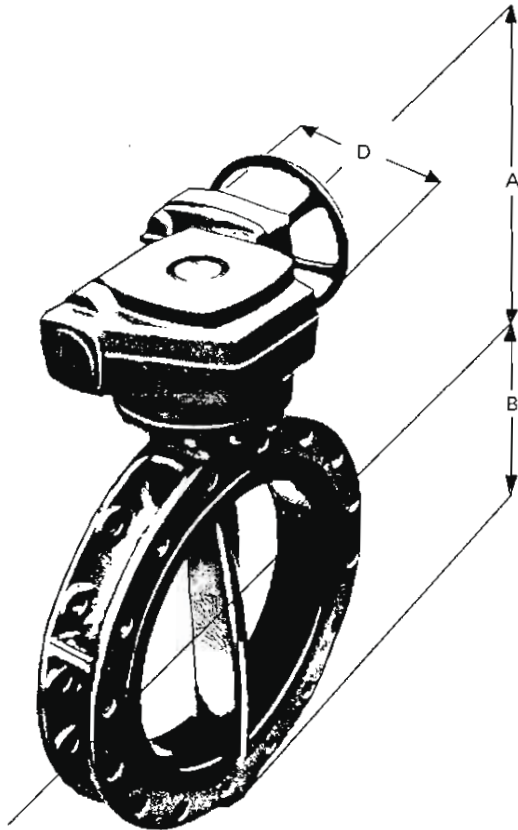
API 609, ANSI B16.5

NOTES:

- a) THE VALVE SHALL BE DESIGNED FOR CLOSURE IN DEAD-END-PIPING



BUTTERFLY VALVE



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	BUV 204
PRESSURE RATING CLASS	150
FACE	RF
CONSTRUCTION	
BODY	FLANGED SHORT BODY
	FULL-DRILLED
	BOLTHOLES IN FLANGES
	RUBBER LINED
GEAR OPERATED	YES
NOMINAL SIZE	26" - 64"
MATERIALS	
BODY	A 216 Gr. WCB
BODY LINING	ETHYLENE-PROPYLENE
DISC	A216 GR.WCB+ RUBBER LINED
SHAFT	13 Cr
SHAFT PACKING	PTFE
DESIGN CONDITIONS	
PRESSURE RATING	ASME B16.47

rev.1

rev.1

GENERAL

1. RUBBER LINING: THE WETTED SURFACES OF VALVE SHALL BE FULLY LINED AND LINING SHALL EXTEND OVER THE FLANGE SEALING FACE
2. FACE-TO-FACE DIMENSIONS SHALL BE PER AWWA C 504 SHORT-BODY
3. COPPER AND COPPER ALLOYS NOT PERMITTED

MANDATORY STANDARDS:

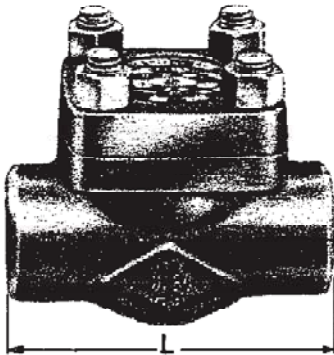
AWWA C 504, ASME B16.47

NOTES:

- a) THE VALVE SHALL BE DESIGNED FOR CLOSURE IN DEAD-END-PIPING
- b) FLANGES ACC. TO ASME B16.47 SERIES B



CHECK VALVE



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	CHV 101	
PRESSURE RATING CLASS	800	
FACE	SW	
CONSTRUCTION		
BODY	FORGED	
BONNET TO BODY CONNECTION	BOLTED	
SEAT RING	RENEWABLE	
TYPE OF DISC	BALL	
NOMINAL SIZE	1/2" - 1 1/2"	
MATERIALS		
BODY	A 350 Gr. LF2	
BODY SEAT RING	AISI 304	
DISC	AISI 304	
DESIGN CONDITIONS		
PRESSURE RATING	API 602	
FLUID	Kg/cm ²	°C

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED
2. IF NOT OTHERWISE STATED THE VALVE SHALL BE FULL BORE

MANDATORY STANDARDS:

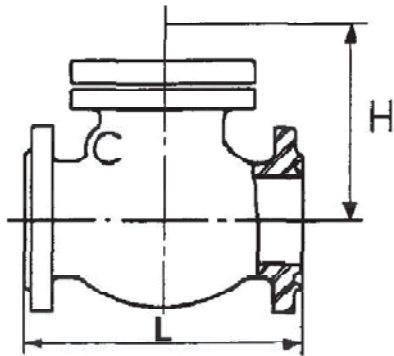
API 598, API 602, ANSI B16.11, ANSI B 16.34

NOTES:

- a) VALVE DESIGN SHALL GENERALLY COMPLY WITH API 602



CHECK VALVE



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	CHV 111	
PRESSURE RATING CLASS	300	
FACE	RF	
CONSTRUCTION		
BODY	CAST	
BONNET TO BODY CONNECTION	BOLTED	
SEAT RING	RENEWABLE	
TYPE OF DISC	SWING TYPE	
ACCESSORIES	NO	
BY-PASS	NO	
NOMINAL SIZE	2" - 24"	
MATERIALS		
BODY	A 352 Gr. LCB	
BODY SEAT RING	AISI 304	
DISC	AISI 304	
HINGE PIN	AISI 304	
DESIGN CONDITIONS		
PRESSURE RATING	ANSI B16.34	
FLUID	Kg/cm ² g	°C
AMMONIA GAS	30	50/33
AMMONIA LIQUID	40	50/33

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED

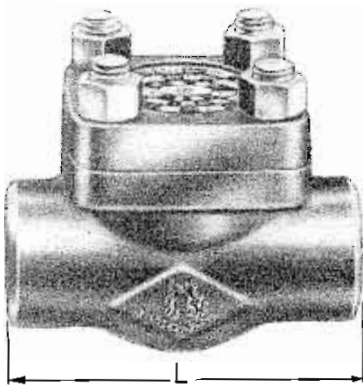
MANDATORY STANDARDS:

API 59B, API 600, ANSI B16.10, ANSI B16.34, ANSI B16.5, MSS-SP 45

NOTES:



CHECK VALVE



ITEM NO	CHV 201
PRESSURE RATING CLASS	800
FACE	SW
CONSTRUCTION	
BODY	FORGED
BONNET TO BODY CONNECTION	BOLTED
SEAT RING	RENEWABLE
TYPE OF DISC	BALL
NOMINAL SIZE	1/2" - 1 1/2"
MATERIALS	
BODY	A 105
BODY SEAT RING	A 182 Gr. F6a STELLITED
DISC	A 182 Gr. F6a
DESIGN CONDITIONS	
PRESSURE RATING	API 602

DESIGN (ILLUSTRATIVE ONLY)

GENERAL

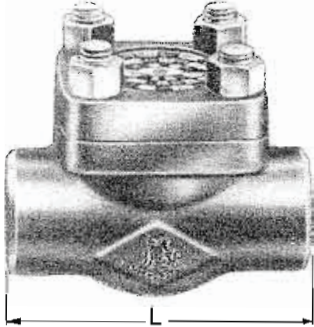
1. COPPER AND COPPER ALLOYS NOT PERMITTED
2. IF NOT OTHERWISE STATED THE VALVE SHALL BE FULL BORE

MANDATORY STANDARDS:

API 598, API 602, ANSI B16.11, ANSI B 16.34

NOTES:

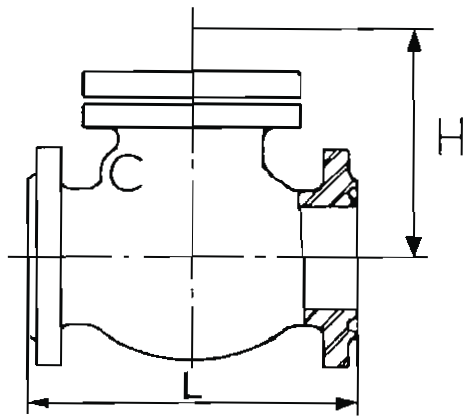
- a) VALVE DESIGN SHALL GENERALLY COMPLY WITH API 602

CHECK VALVE		ITEM NO	CHV 201S
		PRESSURE RATING CLASS	800
		FACE	SW IBR
		CONSTRUCTION	
		BODY	FORGED
		BONNET TO BODY CONNECTION	BOLTED
		SEAT RING	RENEWABLE
		TYPE OF DISC	BALL
		NOMINAL SIZE	1/2" - 1 1/2"
		MATERIALS	
		BODY	A 105
BODY SEAT RING	A 182 Gr. F6a STELLITED		
DISC	13 Cr Stellite.		
DESIGN CONDITIONS			
PRESSURE RATING	API 602		
DESIGN (ILLUSTRATIVE ONLY)			
<p><u>GENERAL</u></p> <p>1. COPPER AND COPPER ALLOYS NOT PERMITTED 2. IF NOT OTHERWISE STATED THE VALVE SHALL BE FULL BORE</p> <p><u>MANDATORY STANDARDS:</u> API 598, API 602, ANSI B16.11, ANSI B16.34</p> <p><u>NOTES:</u></p> <p>a) VALVE DESIGN SHALL GENERALLY COMPLY WITH API 602 b) VALVE TO BE SUPPLIED WITH IBR CERTIFICATION</p>			

rev.1



CHECK VALVE



ITEM NO	CHV 210
PRESSURE RATING CLASS	150
FACE	RF
CONSTRUCTION	
BODY	CAST
BONNET TO BODY CONNECTION	BOLTED
SEAT RING	RENEWABLE
TYPE OF DISC	SWING TYPE
ACCESSORIES	NO
BY-PASS	NO
NOMINAL SIZE	2" - 24"
MATERIALS	
BODY	A 216 Gr. WCB
BODY SEAT RING	A 105 STELLITED
DISC	A 216 Gr. WCB 13Cr. FACED
HINGE PIN	13 Cr.
DESIGN CONDITIONS	
PRESSURE RATING	ANSI B16.34

DESIGN (ILLUSTRATIVE ONLY)

GENERAL

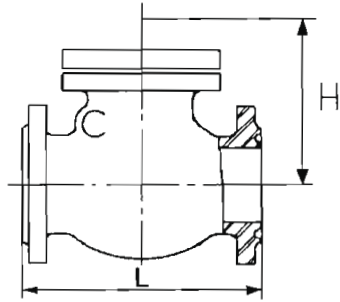
1. COPPER AND COPPER ALLOYS NOT PERMITTED

MANDATORY STANDARDS:

API 598, ANSI B16.10, ANSI B16.34, ANSI B16.5, MSS-SP 45



CHECK VALVE



ITEM NO	CHV 210S	
PRESSURE RATING CLASS	150	
FACE	RF IBR	
CONSTRUCTION		
BODY	CAST	
BONNET TO BODY CONNECTION	BOLTED	
SEAT RING	RENEWABLE	
TYPE OF DISC	SWING TYPE	
ACCESSORIES	NO	
BY-PASS	NO	
NOMINAL SIZE	2" - 24"	
MATERIALS		
BODY	A 216 Gr. WCB	
BODY SEAT RING	A105 STELLITED	
DISC	A 216 Gr. WCB 13Cr. FACED	
HINGE PIN	13 Cr.	
DESIGN CONDITIONS		
PRESSURE RATING	ANSI B16.34	
FLUID	Kg/cm ² g	°C

rev.1

DESIGN (ILLUSTRATIVE ONLY)

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED

MANDATORY STANDARDS:

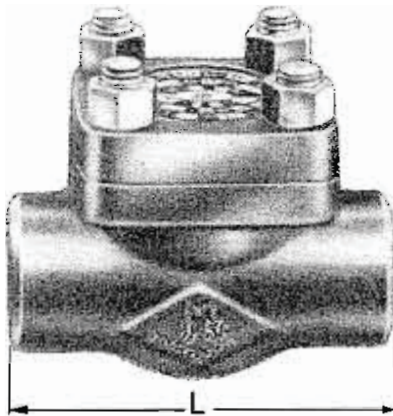
API 598, ANSI B16.10, ANSI B16.34, ANSI B16.5, MSS-SP 45

NOTES:

a) VALVE TO BE SUPPLIED WITH IBR CERTIFICATION



CHECK VALVE



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	CHV 501
PRESSURE RATING CLASS	800
FACE	SW
CONSTRUCTION	
BODY	FORGED
BONNET TO BODY CONNECTION	BOLTED
SEAT RING	RENEWABLE
TYPE OF DISC	BALL
NOMINAL SIZE	1/2" - 1 1/2"
MATERIALS	
BODY	A 182 Gr. F304
BODY SEAT RING	AISI 304
DISC	AISI 304
DESIGN CONDITIONS	
PRESSURE RATING	API 602

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED
2. IF NOT OTHERWISE STATED THE VALVE SHALL BE FULL BORE

MANDATORY STANDARDS:

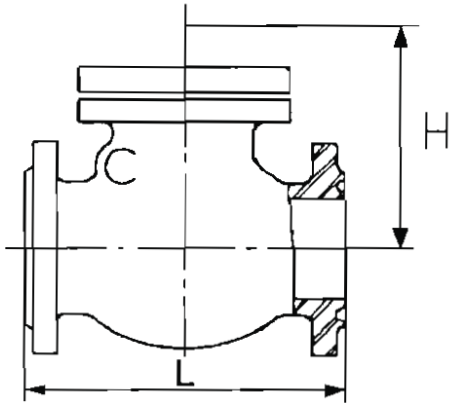
API 598, API 602, ANSI B16.11, ANSI B 16.34

NOTES:

- a) VALVE DESIGN SHALL GENERALLY COMPLY WITH API 602



CHECK VALVE



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	CHV 510
PRESSURE RATING CLASS	150
FACE	RF
CONSTRUCTION	
BODY	CAST
BONNET TO BODY CONNECTION	BOLTED
SEAT RING	INTEGRAL
TYPE OF DISC	SWING TYPE
ACCESSORIES	NO
BY-PASS	NO
NOMINAL SIZE	2" - 24"
MATERIALS	
BODY	A 351 Gr. CF8
BODY SEAT RING	A 182 Gr. F304 OR INTERGRAL
DISC	AISI 304
HINGE PIN	A 276 Gr. 304
DESIGN CONDITIONS	
PRESSURE RATING	ANSI B16.34

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED

MANDATORY STANDARDS:

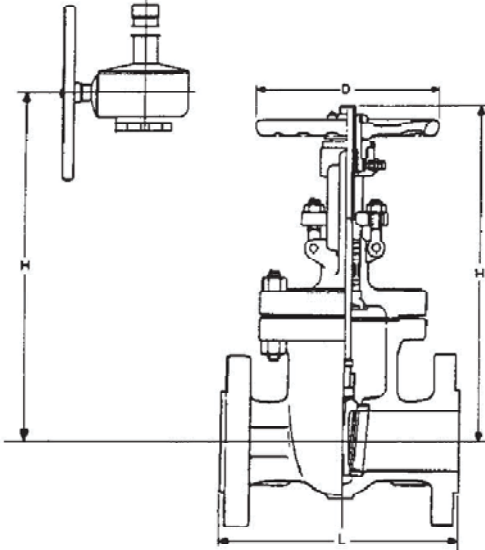
API 598, ANSI B16.10, ANSI B16.34, ANSI B16.5, MSS-SP 45

NOTES:

GATE VALVE				ITEM NO	GAV 101			
				PRESSURE RATING CLASS	800			
				FACE	SW			
				CONSTRUCTION				
				BODY	FORGED			
				BONNET TO BODY CONNECTION	BOLTED			
				HANDWHEEL	NON-RISING			
				STEM	RISING			
				STEM AND YOKE TYPE	OS & Y			
				GATE TYPE	WSS			
				GEAR OPERATED	NO			
BY-PASS VALVE	ND							
NOMINAL SIZE				1/2" - 1 1/2"				
MATERIALS								
BODY	A 350 Gr. LF2							
BODY SEAT RING	AISI 304							
GATE	AISI 304							
STEM	AISI 304							
STEM PACKING	Graphoil							
TRIM NUMBER				2				
DESIGN (ILLUSTRATIVE ONLY)				DESIGN CONDITIONS				
GATE SYMBOLS	TYPE OF SEAT	TYPE OF GATE	TYPE OF BLOCKAGE	PRESSURE RATING		API 602		
				FLUID	Kg/cm ²	°C		
WSS	WEDGE	SINGLE	SOLID WEB					
WSF			FLEX. SOLID WEB					
WDF	PARALLEL	DOUBLE	SLIP ON OR SPLIT					
PDF			FLEXIBLE					
GENERAL								
1. COPPER AND COPPER ALLOYS NOT PERMITTED								
2. GLAND SHALL BE SUITABLE FOR REPACKING UNDER PRESSURE WHEN VALVE IS FULLY OPEN								
3. IF NOT OTHERWISE STATED THE VALVES SHALL BE FULL BORE								
MANDATORY STANDARDS:								
API 598, API 602, ANSI B16.11, ANSI B16.34								
NOTES:								
a) LENGTH TO BE VERIFIED BY MANUFACTURER								



GATE VALVE



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	GAV 111
PRESSURE RATING CLASS	300
FACE	RF
CONSTRUCTION	
BODY	CAST
BONNET TO BODY CONNECTION	BOLTED
HANDWHEEL	NON-RISING
STEM	RISING
STEM AND YOKE TYPE	OS & Y
GATE TYPE	WSF OR WDF
GEAR OPERATED	YES > = 10"
BY-PASS VALVE	NO
NOMINAL SIZE	1 1/2" - 24"
MATERIALS	
BODY	A 352 Gr. LCB
BODY SEAT RING	AISI 304
GATE	AISI 304
STEM	AISI 304
STEM PACKING	Graphoil
TRIM NUMBER	2

GATE SYMBOLS	TYPE OF SEAT	TYPE OF GATE	TYPE OF BLOCKADE	DESIGN CONDITIONS		
				PRESSURE RATING	ANSI B16.34	
				FLUID	Kg/cm ² g	°C
WSS	WEDGE	SINGLE	SOLID WEB			
WSF			FLEX. SOLID WEB			
WDF	PARALLEL	DOUBLE	SLIP ON OR SPLIT			
PDF			FLEXIBLE			

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED
2. GLAND SHALL BE SUITABLE FOR REPACKING UNDER PRESSURE WHEN VALVE IS FULLY OPEN
3. IF NOT OTHERWISE STATED THE VALVES SHALL BE FULL BORE
4. VALVES > = 10" AND > = 600" RATING SHALL HAVE BOSSES FOR BY-PASS CONNECTION ACC. TO API 600 AND MSS-SP 46, LOCATION E-F

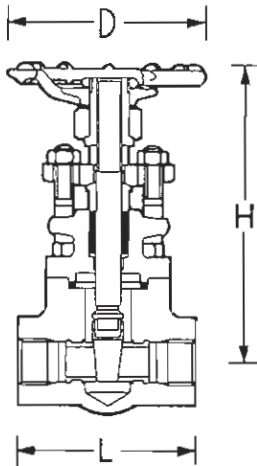
MANDATORY STANDARDS:

API 598, API 600, ANSI B16.10, ANSI B16.34, ANSI B16.5, MSS-SP 45

NOTES:



GATE VALVE



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	GAV 201
PRESSURE RATING CLASS	800
FACE	SW
CONSTRUCTION	
BODY	FORGED
BONNET TO BODY CONNECTION	BOLTED
HANDWHEEL	NON-RISING
STEM (NO CASTING)	RISING
STEM AND YOKE TYPE	OS & Y
GATE TYPE	WSS
GEAR OPERATED	NO
BY-PASS VALVE	NO
NOMINAL SIZE	1/2" - 1 1/2"
MATERIALS	
BODY	A 105
BODY SEAT RING	A 182 Gr. F6a STELLITED
GATE	A 182 Gr. F6a
STEM	13 Cr.
STEM PACKING	GRAFOIL/GRAPHITE
TRIM NUMBER	8

GATE SYMBOLS	TYPE OF SEAT	TYPE OF GATE	TYPE OF BLOCKADE
WSS	WEDGE	SINGLE	SOLID WEB
WSF			FLEX. SOLID WEB
WDF	PARALLEL	DOUBLE	SLIP ON OR SPLIT
PDF			FLEXIBLE

DESIGN CONDITIONS	
PRESSURE RATING	API 602

GENERAL


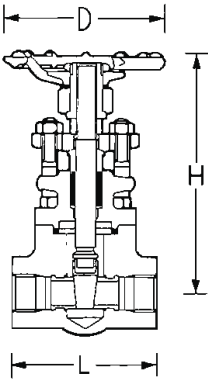
1. COPPER AND COPPER ALLOYS NOT PERMITTED
2. GLAND SHALL BE SUITABLE FOR REPACKING UNDER PRESSURE WHEN VALVE IS FULLY OPEN
3. IF NOT OTHERWISE STATED THE VALVES SHALL BE FULL BORE

MANDATORY STANDARDS:

API 598, API 602, ANSI B16.11, ANSI B16.34

NOTES:

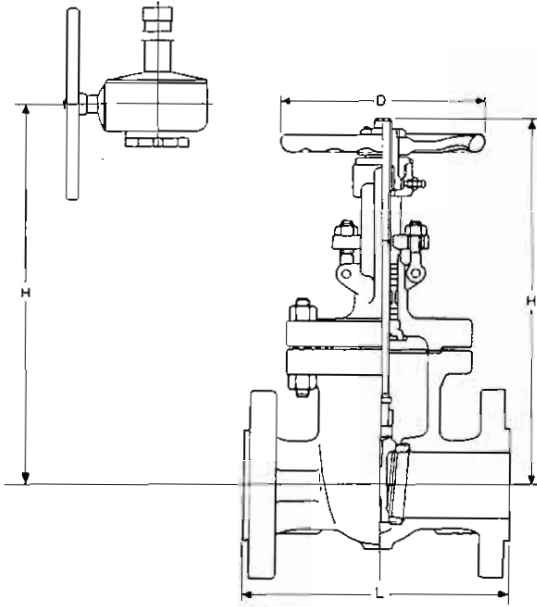
- a) LENGTH TO BE VERIFIED BY MANUFACTURER

				GATE VALVE	
				ITEM NO	GAV 201S
				PRESSURE RATING CLASS	800
				FACE	SW IBR
				CONSTRUCTION	
				BODY	FORGED
				BONNET TO BODY CONNECTION	BOLTED
				HANDWHEEL	NON-RISING
				STEM	RISING
				STEM AND YOKE TYPE	OS & Y
				GATE TYPE	WSS
GEAR OPERATED	NO				
BY-PASS VALVE	NO				
NOMINAL SIZE	1/2" - 1 1/2"				
MATERIALS					
BODY	A 105				
BODY SEAT RING	A 182 Gr. F6a STELLITED				
GATE	A 182 Gr. F6a				
STEM	13 Cr.				
STEM PACKING	GRAPHITE				
TRIM NUMBER	8				
DESIGN (ILLUSTRATIVE ONLY)				DESIGN CONDITIONS	
GATE SYMBOLS	TYPE OF SEAT	TYPE OF GATE	TYPE OF BLOCKADE	PRESSURE RATING	API 602
WSS	WEDGE	SINGLE	SOLID WEB		
WSF			FLEX. SOLID WEB		
WDF	PARALLEL	DOUBLE	SLIP ON OR SPLIT		
PDF			FLEXIBLE		
GENERAL					
1. COPPER AND COPPER ALLOYS NOT PERMITTED 2. GLAND SHALL BE SUITABLE FOR REPACKING UNDER PRESSURE WHEN VALVE IS FULLY OPEN 3. IF NOT OTHERWISE STATED THE VALVES SHALL BE FULL BORE					
MANDATORY STANDARDS:					
API 598, API 602, ANSI B16.11, ANSI B16.34					
NOTES:					
a) LENGTH TO BE VERIFIED BY MANUFACTURER					
b) VALVE TO BE SUPPLIED WITH IBR CERTIFICATION					

rev.1



GATE VALVE



DESIGN (ILLUSTRATIVE ONLY)

GATE SYMBOLS	TYPE OF SEAT	TYPE OF GATE	TYPE OF BLOCKADE
WSS	WEDGE	SINGLE	SOLID WEB
WSF			FLEX. SOLID WEB
WDF	PARALLEL	DOUBLE	SLIP ON OR SPLIT
PDF			FLEXIBLE

ITEM NO	GAV 210
PRESSURE RATING CLASS	150
FACE	RF
CONSTRUCTION	
BODY	CAST
BONNET TO BODY CONNECTION	BOLTED
HANDWHEEL	NON-RISING
STEM	RISING
STEM AND YOKE TYPE	OS & Y
GATE TYPE	WSF OR WDF
GEAR OPERATED	YES $\geq 14"$
BY-PASS VALVE	NO
NOMINAL SIZE	2" - 48"
MATERIALS	
BODY	A 216 Gr. WCB
BODY SEAT RING	A 105 STELLITED
GATE	A 216 Gr. WCB 13 Cr. FACED
STEM (NO CASTING)	13 Cr.
STEM PACKING	GRAFOIL /GRAPHITE
TRIM NUMBER	8

DESIGN CONDITIONS	
PRESSURE RATING	ANSI B16.34

GENERAL

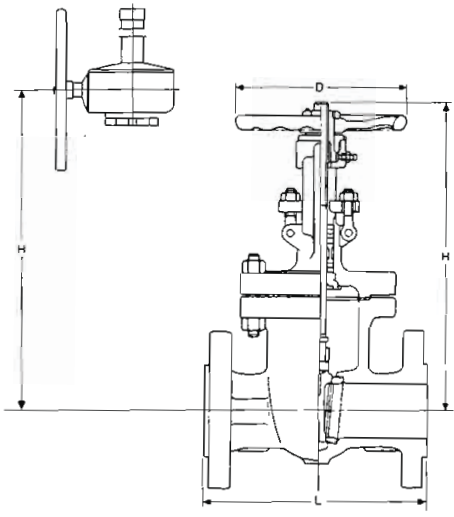
1. COPPER AND COPPER ALLOYS NOT PERMITTED
2. GLAND SHALL BE SUITABLE FOR REPACKING UNDER PRESSURE WHEN VALVE IS FULLY OPEN
3. IF NOT OTHERWISE STATED THE VALVES SHALL BE FULL BORE
4. VALVES $\geq 10"$ AND $\geq 600"$ RATING SHALL HAVE BOSSES FOR BY-PASS CONNECTION ACC. TO API 600 AND MSS-SP 45, LOCATION E-F

MANDATORY STANDARDS:

API 598, API 600, ANSI B16.10, ANSI B16.34, ANSI B16.5, MSS-SP 45, ASME B16.47

NOTES:

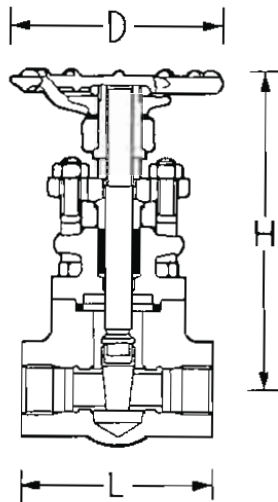
- a) FLANGES $> 24"$ ACC. TO ASME B16.47 SERIES B

GATE VALVE				ITEM NO	GAV 210S
				PRESSURE RATING CLASS	150
				FACE	RF IBR
				CONSTRUCTION	
				BODY	CAST
				BONNET TO BODY CONNECTION	BOLTED
				HANDWHEEL	NON-RISING
				STEM	RISING
				STEM AND YOKE TYPE	OS & Y
				GATE TYPE	WSF OR WDF c)
				GEAR OPERATED	YES > = 14"
BY-PASS VALVE	NO				
DESIGN (ILLUSTRATIVE ONLY)				NOMINAL SIZE	1 1/2" - 48"
				MATERIALS	
				BODY	A 216 Gr. WCB
				BODY SEAT RING	A 105 STELLITED
				GATE	A 216 Gr. WCB 13 Cr. FACED
				STEM	13 Cr.
				STEM PACKING	GRAPHITE
				TRIM NUMBER	8
				DESIGN CONDITIONS	
				PRESSURE RATING	ANSI B16.34
GATE SYMBOLS	TYPE OF SEAT	TYPE OF GATE	TYPE OF BLOCKADE		
WSS	WEDGE	SINGLE	SOLID WEB		
WSF			FLEX. SOLID WEB		
WDF	PARALLEL	DOUBLE	SLIP ON OR SPLIT		
PDF			FLEXIBLE		
GENERAL					
1. COPPER AND COPPER ALLOYS NOT PERMITTED					
2. GLAND SHALL BE SUITABLE FOR REPACKING UNDER PRESSURE WHEN VALVE IS FULLY OPEN					
3. IF NOT OTHERWISE STATED THE VALVES SHALL BE FULL BORE					
4. VALVES > = 10" AND > = 600" RATING SHALL HAVE BOSSES FOR BY-PASS CONNECTION ACC. TO API 600 AND MSS-SP 45, LOCATION E-F					
MANDATORY STANDARDS:					
API 598, API 600, ANSI B16.10, ANSI B16.34, ANSI B16.5, MSS-SP 45, ASME B16.47					
NOTES:					
a) FLANGES > 24" ACC. TO ASME B16.47 SERIES B					
b) VALVE TO BE SUPPLIED WITH IBR CERTIFICATION					
c) WSF IS ACCEPTABLE FOR SIZES < = 12" ONLY					

rev.1



GATE VALVE



DESIGN (ILLUSTRATIVE ONLY)

GATE SYMBOLS	TYPE OF SEAT	TYPE OF GATE	TYPE OF BLOCKADE
WSS	WEDGE	SINGLE	SOLID WEB
WSF			FLEX. SOLID WEB
WDF	PARALLEL	DOUBLE	SLIP ON OR SPLIT
PDF			FLEXIBLE

ITEM NO	GAV 501
PRESSURE RATING CLASS	800
FACE	SW
CONSTRUCTION	
BODY	FORGED
BONNET TO BODY CONNECTION	BOLTED
HANDWHEEL	NON-RISING
STEM	RISING
STEM AND YOKE TYPE	OS & Y
GATE TYPE	WSS
GEAR OPERATED	NO
BY-PASS VALVE	NO
NOMINAL SIZE	1/2" - 1 1/2"
MATERIALS	
BODY	A 182 Gr. F304
BODY SEAT RING	A 182 Gr. F304
GATE	A 182 Gr. F304
STEM	A 276 Gr. 304
STEM PACKING	GRAFOIL /GRAPHITE
TRIM NUMBER	2

DESIGN CONDITIONS	
PRESSURE RATING	API 602

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED
2. GLAND SHALL BE SUITABLE FOR REPACKING UNDER PRESSURE WHEN VALVE IS FULLY OPEN
3. IF NOT OTHERWISE STATED THE VALVES SHALL BE FULL BORE

MANDATORY STANDARDS:

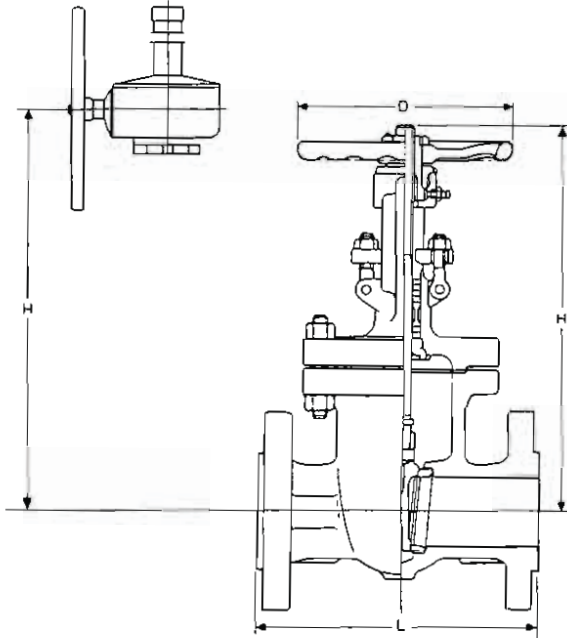
API 598, API 602, ANSI B16.11, ANSI B16.34

NOTES:

- a) LENGTH TO BE VERIFIED BY MANUFACTURER



GATE VALVE



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	GAV 510
PRESSURE RATING CLASS	150
FACE	RF
CONSTRUCTION	
BODY	CAST
BONNET TO BODY CONNECTION	BOLTED
HANDWHEEL	NON-RISING
STEM	RISING
STEM AND YOKE TYPE	OS & Y
GATE TYPE	WSF OR WDF
GEAR OPERATED	YES $\geq 14"$
BY-PASS VALVE	NO
NOMINAL SIZE	2" - 24"
MATERIALS	
BODY	A 351 Gr. CF8
BODY SEAT RING	A 182 Gr. F304
GATE	AISI 304
STEM	A 276 Gr. 304
STEM PACKING	GRAFOIL /GRAPHITE
TRIM NUMBER	2

GATE SYMBOLS	TYPE OF SEAT	TYPE OF GATE	TYPE OF BLOCKADE
WSS	WEDGE	SINGLE	SOLID WEB
WSF			FLEX. SOLID WEB
WDF	PARALLEL	DOUBLE	SLIP ON OR SPLIT
PDF			FLEXIBLE

DESIGN CONDITIONS	
PRESSURE RATING	ANSI B16.34

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED
2. GLAND SHALL BE SUITABLE FOR REPACKING UNDER PRESSURE WHEN VALVE IS FULLY OPEN
3. IF NOT OTHERWISE STATED THE VALVES SHALL BE FULL BORE
4. VALVES $\geq 10"$ AND $\geq 600"$ RATING SHALL HAVE BOSSES FOR BY-PASS CONNECTION ACC. TO API 600 AND MSS-SP 45, LOCATION E-F

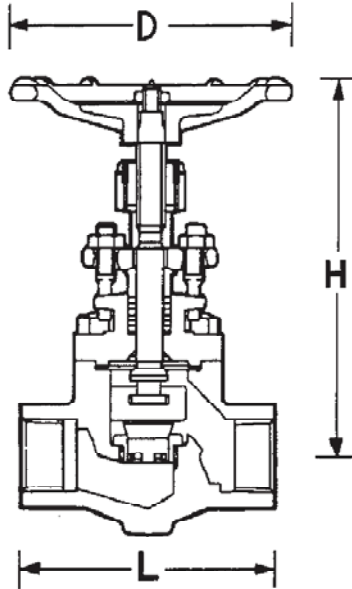
MANDATORY STANDARDS:

API 598, API 600, ANSI B16.10, ANSI B16.34, ANSI B16.5, MSS-SP 45

NOTES:



GLOBE VALVE



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	GLV 101
PRESSURE RATING CLASS	800
FACE	SW
CONSTRUCTION	
BODY	FORGED
BONNET TO BODY CONNECTION	BOLTED
HANDWHEEL	RISING
STEM	RISING
STEM AND YOKE TYPE	OS & Y
DISC TYPE	SWIVEL PLUG
GEAR OPERATED	NO
BY-PASS VALVE	NO
NOMINAL SIZE	1/2" - 1 1/2"
MATERIALS	
BODY	A 350 Gr. LF2
BODY SEAT RING	AISI 304
DISC	AISI 304
STEM	AISI 304
STEM PACKING	GRAPHOIL
TRIM NUMBER	
DESIGN CONDITIONS	
PRESSURE RATING	API 602

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED
2. GLAND SHALL BE SUITABLE FOR REPACKING UNDER PRESSURE WHEN VALVE IS FULLY OPEN
3. IF NOT OTHERWISE STATED THE VALVES SHALL BE FULL BORE

MANDATORY STANDARDS:

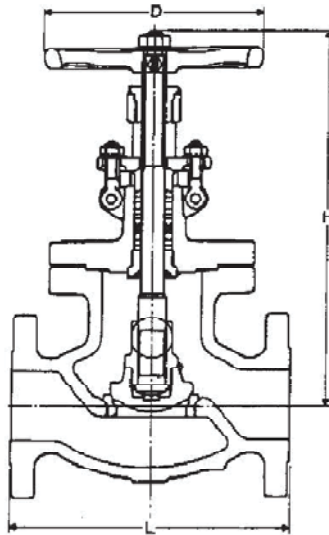
API 598, API 602, ANSI B16.11, ANSI B16.34

NOTES:

- a) VALVE DESIGN SHALL GENERALLY COMPLY WITH API 602
- b) LENGTH TO BE VERIFIED BY MANUFACTURER



GLOBE VALVE



DESIGN (ILLUSTRATIVE ONLY)

RATED Cv VALUES: (+-10%)

SIZE	2"	3"	4"	6"	8"	10"	12"
Cv	50	120	220	490	900	1400	2100

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED
2. GLAND SHALL BE SUITABLE FOR REPACKING UNDER PRESSURE WHEN VALVE IS FULLY OPEN
3. IF NOT OTHERWISE STATED THE VALVES SHALL BE FULL BORE
4. VALVES $\geq 10"$ AND $\geq 600"$ RATING SHALL HAVE BDSSES FOR BY-PASS CONNECTION ACC. TO ANSI B16.34 AND MSS-SP 45, LOCATION E-F

MANDATORY STANDARDS:

API 598, API 600, ANSI B16.10, ANSI B16.34, ANSI B16.5, MSS-SP 45

ITEM NO **GLV 111**PRESSURE RATING CLASS **300**FACE **RF****CONSTRUCTION**

BODY	CAST
BONNET TO BODY CONNECTION	BOLTED
HANDWHEEL	RISING
STEM	RISING
STEM AND YOKE TYPE	OS & Y
DISC TYPE	PARABOLIC
GEAR OPERATED	NO
BY-PASS VALVE	NO

NOMINAL SIZE **2" - 8"****MATERIALS**

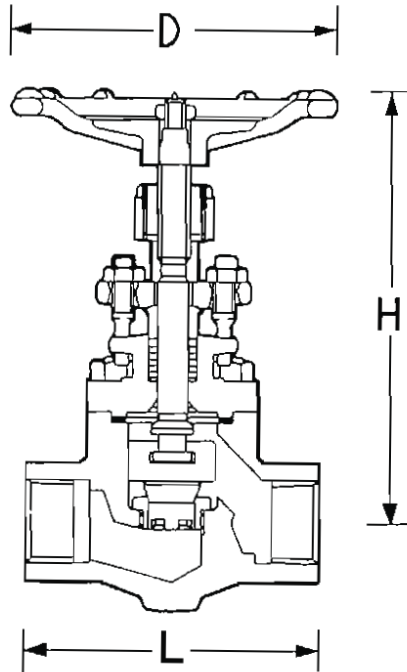
BODY	A 352 Gr. LCB
BODY SEAT RING	AISI 304
DISC	AISI 304
STEM	AISI 304
STEM PACKING	GRAPHOIL
TRIM NUMBER	

DESIGN CONDITIONS

PRESSURE RATING	ANSI B16.34	
FLUID	Kg/cm ² g	°C



GLOBE VALVE



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	GLV 201
PRESSURE RATING CLASS	800
FACE	SW
CONSTRUCTION	
BODY	FORGED
BONNET TO BODY CONNECTION	BOLTED
HANDWHEEL	RISING
STEM	RISING
STEM AND YOKE TYPE	OS & Y
DISC TYPE	SWIVEL PLUG
GEAR OPERATED	NO
BY-PASS VALVE	NO
NOMINAL SIZE	1/2" - 1 1/2"
MATERIALS	
BODY	A 105
BODY SEAT RING	A 182 Gr. F6a STELLITED
DISC	A 182 Gr. F6a
STEM (NO CASTING)	13 Cr.
STEM PACKING	GRAFOIL/GRAPHITE
TRIM NUMBER	
DESIGN CONDITIONS	
PRESSURE RATING	API 602

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED
2. GLAND SHALL BE SUITABLE FOR REPACKING UNDER PRESSURE WHEN VALVE IS FULLY OPEN
3. IF NOT OTHERWISE STATED THE VALVES SHALL BE FULL BORE

MANDATORY STANDARDS:

API 598, API 602, ANSI B16.11, ANSI B16.34

NOTES:

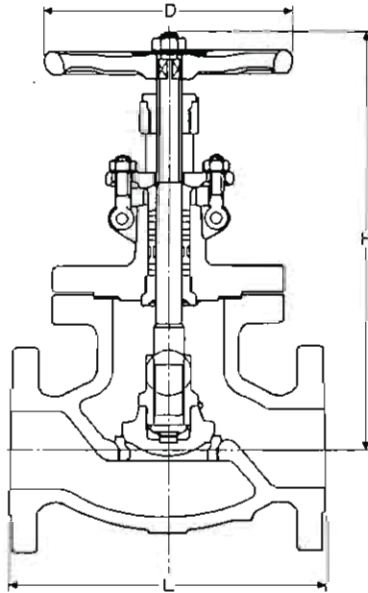
- a) VALVE DESIGN SHALL GENERALLY COMPLY WITH API 602
- b) LENGTH TO BE VERIFIED BY MANUFACTURER

GLOBE VALVE		ITEM NO	GLV 201S
		PRESSURE RATING CLASS	800
		FACE	SW IBR
		CONSTRUCTION	
		BODY	FORGED
		BONNET TO BODY CONNECTION	BOLTED
		HANDWHEEL	RISING
		STEM	RISING
		STEM AND YOKE TYPE	OS & Y
		DISC TYPE	SWIVEL PLUG
		GEAR OPERATED	NO
BY-PASS VALVE	NO		
NOMINAL SIZE	1/2" - 1 1/2"		
MATERIALS			
BODY	A 105		
BODY SEAT RING	A 182 Gr. F6a STELLITED		
DISC	A 182 Gr. F6a		
STEM	13 Cr.		
STEM PACKING	GRAPHITE		
TRIM NUMBER			
DESIGN CONDITIONS			
PRESSURE RATING	API 602		
DESIGN (ILLUSTRATIVE ONLY)			
<p><u>GENERAL</u></p> <ol style="list-style-type: none"> 1. COPPER AND COPPER ALLOYS NOT PERMITTED 2. GLAND SHALL BE SUITABLE FOR REPACKING UNDER PRESSURE WHEN VALVE IS FULLY OPEN 3. IF NOT OTHERWISE STATED THE VALVES SHALL BE FULL BORE <p><u>MANDATORY STANDARDS:</u></p> <p>API 598, API 602, ANSI B16.11, ANSI B16.34</p> <p><u>NOTES:</u></p> <ol style="list-style-type: none"> a) VALVE DESIGN SHALL GENERALLY COMPLY WITH API 602 b) LENGTH TO BE VERIFIED BY MANUFACTURER c) VALVE TO BE SUPPLIED WITH IBR CERTIFICATION 			

rev.1



GLOBE VALVE



DESIGN (ILLUSTRATIVE ONLY)

RATED Cv VALUES: (+-10%)

SIZE	2"	3"	4"	6"	8"	10"	12"
Cv	50	120	220	490	900	1400	2100

ITEM NO **GLV 210**

PRESSURE RATING CLASS 150

FACE RF

CONSTRUCTION

BODY	CAST
BONNET TO BODY CONNECTION	BOLTED
HANDWHEEL	RISING
STEM	RISING
STEM AND YOKE TYPE	OS & Y
DISC TYPE	PARABOLIC
GEAR OPERATED	NO
BY-PASS VALVE	NO
NOMINAL SIZE	2" - 12"

MATERIALS

BODY	A 216 Gr. WCB
BODY SEAT RING	A 105 STELLITED
DISC	A 216 Gr. WCB 13 Cr. FACING
STEM (NO CASTING)	13 Cr.
STEM PACKING	GRAFOIL/GRAPHITE
TRIM NUMBER	

DESIGN CONDITIONS

PRESSURE RATING ANSI B16.34

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED
2. GLAND SHALL BE SUITABLE FOR REPACKING UNDER PRESSURE WHEN VALVE IS FULLY OPEN
3. IF NOT OTHERWISE STATED THE VALVES SHALL BE FULL BORE
4. VALVES $\geq 10"$ AND $\geq 600"$ RATING SHALL HAVE BOSSES FOR BY-PASS CONNECTION ACC. TO ANSI B16.34 AND MSS-SP 45, LOCATION E-F

MANDATORY STANDARDS:

API 598, ANSI B16.10, ANSI B16.34, ANSI B16.5, MSS-SP 45

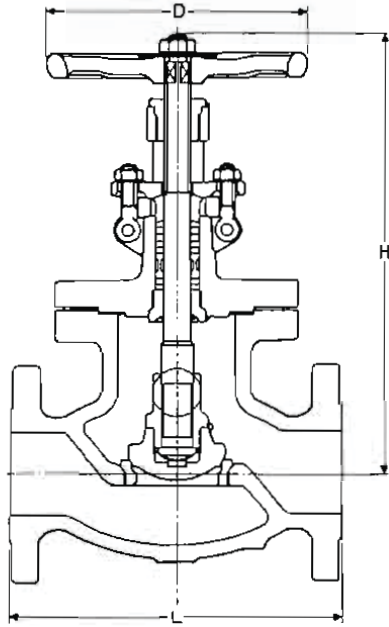
NOTES:

GLOBE VALVE		ITEM NO	GLV 210S						
		PRESSURE RATING CLASS	150						
		FACE	RF IBR						
		CONSTRUCTION							
		BODY	CAST						
		BONNET TO BODY CONNECTION	BOLTED						
		HANDWHEEL	RISING						
		STEM	RISING						
		STEM AND YOKE TYPE	OS & Y						
		DISC TYPE	PARABOLIC						
		GEAR OPERATED	NO						
BY-PASS VALVE	NO								
		NOMINAL SIZE	2" - 12"						
		MATERIALS							
		BODY	A 216 Gr. WCB						
		BODY SEAT RING	A 105 STELLITED						
		DISC	A 216 Gr. WCB 13 Cr. FACING						
		STEM	13 Cr.						
		STEM PACKING	GRAPHITE						
		TRIM NUMBER							
		DESIGN CONDITIONS							
		PRESSURE RATING	ANSI B16.34						
DESIGN (ILLUSTRATIVE ONLY)									
RATED Cv VALUES: (+/-10%)									
SIZE	2"	3"	4"	6"	8"	10"	12"		
Cv	50	120	220	490	900	1400	2100		
<u>GENERAL</u>									
1. COPPER AND COPPER ALLOYS NOT PERMITTED									
2. GLAND SHALL BE SUITABLE FOR REPACKING UNDER PRESSURE WHEN VALVE IS FULLY OPEN									
3. IF NOT OTHERWISE STATED THE VALVES SHALL BE FULL BORE									
4. VALVES $\geq 10"$ AND $\geq 600"$ RATING SHALL HAVE BOSSES FOR BY-PASS CONNECTION ACC. TO ANSI B16.34 AND MSS-SP 45, LOCATION E-F									
<u>MANDATORY STANDARDS:</u>									
API 598, ANSI B16.10, ANSI B16.34, ANSI B16.5, MSS-SP 45									
<u>NOTES:</u>									
a) VALVE TO BE SUPPLIED WITH IBR CERTIFICATION									

rev.1



GLOBE VALVE



DESIGN (ILLUSTRATIVE ONLY)

RATED Cv VALUES: (+-10%)

SIZE	2"	3"	4"	6"	8"	10"	12"		
Cv	50	120	220	490	900	1400	2100		

ITEM NO	GLV 510
PRESSURE RATING CLASS	150
FACE	RF
CONSTRUCTION	
BODY	CAST
BONNET TO BODY CONNECTION	BOLTED
HANDWHEEL	RISING
STEM	RISING
STEM AND YOKE TYPE	OS & Y
DISC TYPE	PARABOLIC
GEAR OPERATED	NO
BY-PASS VALVE	NO
NOMINAL SIZE	2" - 8"
MATERIALS	
BODY	A 351 Gr. CF8
BODY SEAT RING	A 182 Gr. F304
DISC	AISI 304
STEM	A 276 Gr. 304
STEM PACKING	GRAFOIL
TRIM NUMBER	
DESIGN CONDITIONS	
PRESSURE RATING	ANSI B16.34

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED
2. GLAND SHALL BE SUITABLE FOR REPACKING UNDER PRESSURE WHEN VALVE IS FULLY OPEN
3. IF NOT OTHERWISE STATED THE VALVES SHALL BE FULL BORE
4. VALVES $\geq 10"$ AND $\geq 600"$ RATING SHALL HAVE BOSSES FOR BY-PASS CONNECTION ACC. TO ANSI B16.34 AND MSS-SP 45, LOCATION E-F

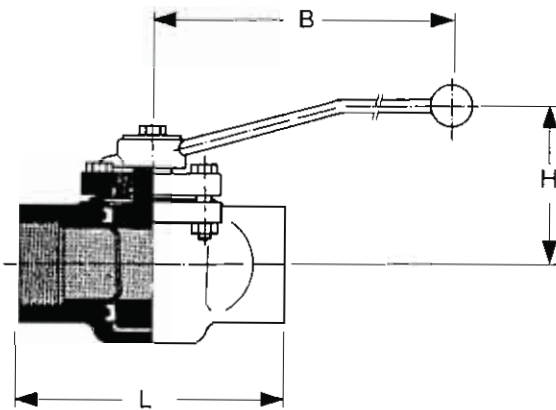
MANDATORY STANDARDS:

API 598, API 600, ANSI B16.10, ANSI B16.34, ANSI B16.5, MSS-SP 45

NOTES:



PLUG VALVE



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	PLV 201
PRESSURE RATING CLASS	600
FACE	TREADED (NPT)
CONSTRUCTION	
BODY	FULL BORE NON-LUBRICATED
PLUG	TAPER PLUG
WRENCH OPERATED	YES
GEAR OPERATED	NO
FIRE SAFE	NO
NOMINAL SIZE	1/2" - 1"
MATERIALS	
BODY	A 105 a)
PLUG	A 105 CHROMEPLATED a)
BODY SEAT RING	REINFORCED PTFE
STEM PACKING	PTFE
DESIGN CONDITIONS	
PRESSURE RATING	ANSI B16.34

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED

MANDATORY STANDARDS:

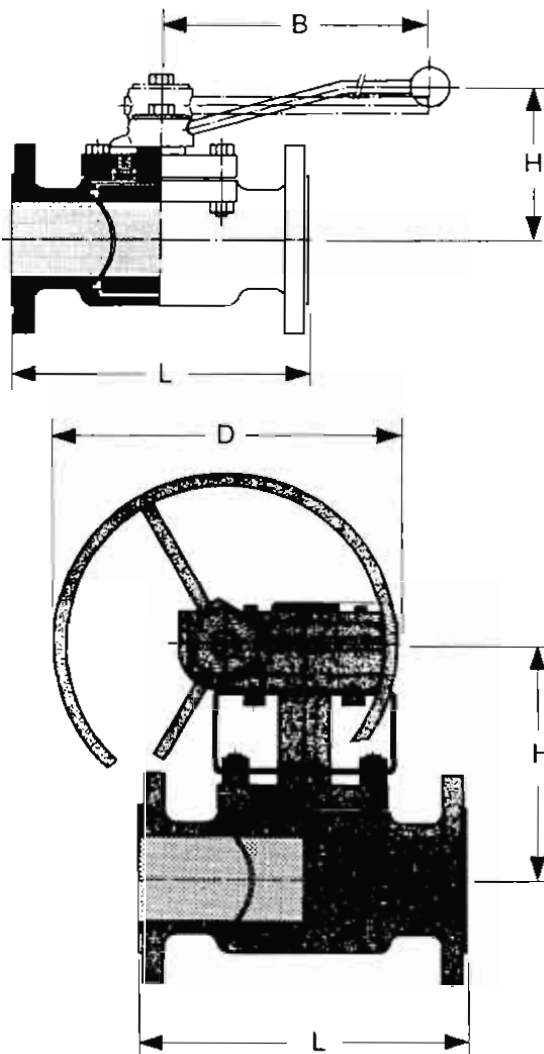
API 598, API 6D, ANSI B16.11, ANSI B16.34

NOTES:

a) EQUIVALENT CAST MATERIAL IS ACCEPTABLE



PLUG VALVE



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	PLV 202
PRESSURE RATING CLASS	150
FACE	RF
CONSTRUCTION	
BODY	NON-LUBRICATED FULL BORE
PLUG	TAPER PLUG
WRENCH OPERATED	1 1/2" - 4"
GEAR OPERATED	6"
FIRE SAFE	NO
NOMINAL SIZE	1 1/2" - 6"
MATERIALS	
BODY	A 216 Gr. WCB
PLUG	A 105 CHROMEPLATED a)
BODY SEAT RING	REINFORCED PTFE
STEM PACKING	PTFE
DESIGN CONDITIONS	
PRESSURE RATING	ANSI B16.34

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED

MANDATORY STANDARDS:

API 598, API 599, ANSI B16.10, ANSI B16.5

NOTES:

a) EQUIVALENT CAST MATERIAL IS ACCEPTABLE

	PROJECTS AND DEVELOPMENT INDIA LTD.	PC281-NFL-N/E-1/P-II/ANN		
		DOCUMENT NO.		
		REV. P	Page 1 of 1	

PART II: TECHNICAL

ANNEXURE— 3

INSULATION STANDARD

**PLANT: NATIONAL FERTILIZERS LIMITED, NFL, NANGAL,
PUNJAB**

**PROJECTS: PMC SERVICES (PRE & POST LSTK AWARD)-
NEW 2500M3 HORTON SPHERE FOR STORAGE OF
AMMONIA AT NFL, NANGAL**

0	10.07.2024	10.07.2024	ISSUED FOR TENDER	AK	SKM	PK
REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD

	PROJECTS & DEVELOPMENT INDIA LIMITED	PC281-TS-6700	P
		DOCUMENT NO.	REV
		SHEET 1 OF 21	

TECHNICAL SPECIFICATION
FOR
THERMAL INSULATION
(GENERAL REQUIREMENT)

P	09.12.2022	FOR COMMENTS	V	NS	HOD
REV	DATE	PURPOSE	PREPD	REVWD	APPD

	TECHNICAL SPECIFICATION THERMAL INSULATION GENERAL REQUIREMENT	TS-6700	P
		DOCUMENT NO	REV
		SHEET 2 OF 21	

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1.5.2	Storage of material
1.5.3	Hydrostatic test for pipes
1.5.4	Protection of incomplete jobs.
2.0	INSULATION SUPPORTS (CLEATS) TO BE PROVIDED BY EQUIPMENT SUPPLIER
3.0	MATERIAL REQUIREMENTS
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3.2	Auxiliary Materials for jacketing
a)	Aluminum jacket
b)	Screws
c)	S-Clips
d)	Bands for securing jacket
e)	Quick release clips for removable covers
f)	Reinforcing fabric.
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6.0 MEASUREMENT**7.0 GUARANTEE**

Annexure – I : INSULATION SUPPORTS (CLEATS) TO BE PROVIDED BY EQUIPMENT SUPPLIER.

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1.0 GENERAL

1.1 SCOPE

This standard covers the requirement for supply and application of materials for thermal insulation of equipment, piping and other items.

1.2 REFERENCE STANDARDS

IS 14164	Code of Practice for Industrial Application and finishing of thermal insulation material at temperature -80°C and up to 750°C .
IS 737	Wrought aluminium and aluminium alloys, sheet, strip
IS 1254	Specification for corrugated aluminum sheet
TS 6701	Thermal Insulation – Hot service
TS 6702	Thermal Insulation – Cold service
ASTM C-680	Standard Practice for Heat Loss or Gain and Surface Temp.

1.3 Deviations: Should unforeseen difficulties arise to comply with requirements of this standard.

Alternative material and application techniques superior to the requirements of this standard be submitted with complete details for approval of owner.

In case of contradiction between requirements of this standard and the NIT/Work order, the later will be followed.

1.4 LIMITATIONS

Temperature Limits.

This standard deals with insulation applied externally on piping equipments etc. as per the table below:-

Maximum Operating Temperature	Type of Insulation
60°C to 750°C for C.S., A.S. & S.S.	HOT
-180°C to 20°C	COLD

1.5 THICKNESS DESIGN BASIS

Thickness calculation method as per procedure given in ASTM C-680

1. Hot Insulation

Design Ambient Temperature	: 35°C
Design Surface Temperature	: 60°C
Permissible Heat Loss	: $150 \text{ kcal./m}^2 \text{ hr.}$

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Permissible Wind Velocity Outside : 1 m/sec
 Permissible Wind Velocity Inside : 0.25 m/sec

2. Cold Insulation

Design Ambient Temperature : 35°C
 Design Surface Temperature : 2 °C below ambient/ 0.5 Deg C above the Dew Point
 Permissible Heat Gain : 10-12 kcal/m² hr
 Relative Humidity : 85%
 Permissible Wind Velocity Outside : 1 m/sec.
 Permissible Wind Velocity Inside : 0.25 m/sec.

1.6 GENERAL REQUIREMENTS.

1.6.1 Information to be supplied to contractor

- Material of construction / dimension of equipments / pipes required to be insulated.
- Temperature
- Location of equipment (Indoor/Outdoor/Elevn.)
- Requirement of removable box type insulation if any
- Special requirements if any regarding type of insulation material and other properties.
- These information shall be supplied in form of insulation schedule.

1.6.2 STORAGE OF MATERIAL

Insulation material shall at no time be stacked directly on the ground; instead it will be stored at a level higher than ground level. It should not only be covered by tarpaulin but other effective protections against weather are also to be provided. The contractor shall provide a properly covered storage to the satisfaction of engineer-in-charge (Refer IS: 10556)..

1.6.3 HYDROSTATIC TEST FOR PIPES

Before taking up insulation job on piping or vessels it shall be ensured that hydrostatic test of the concerned equipment / piping is completed. Where it is felt necessary to take up the insulation job before such testing are performed all welded and mechanical joints shall be left un-insulated for a length of at least 150mm on either side of the joint.

1.6.4 PROTECTION OF INCOMPLETE JOBS

Any part of insulation job which is not provided with final weather proofing will be adequately protected by means of tarpaulins and other aids. After the day's work similar protection should be provided for the partially completed jobs to be continued the next day to avoid any absorption of rain / moisture during the night.

2.0 INSULATION SUPPORTS (CLEATS) TO BE PROVIDED BY EQUIPMENT SUPPLIER

Suitable supports (cleats) in the form of rings, lugs, studs or pins shall be provided on equipment by equipment supplier as per Annexure-I, However should any additional supports or anchorage be felt necessary by the insulation contractor the same will be recommended by

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them to the Engineer-in-charge for his approval before installation. These will be installed by the contractor free of any extra cost.

3.0 MATERIAL REQUIREMENTS

3.1 INSULATION MATERIALS

3.1.1 General

- Whenever reference to any Standard is made it is presumed that the latest revision as on date should be considered unless otherwise specified.

3.1.2 Specification and other requirements

Specification and other requirements will be as per TS-6701 for Hot Service and TS-6702 for Cold Service.

3.2 AUXILIARY MATERIALS FOR CLADDING

a) Aluminium Cladding

- Horizontal Vessels

Aluminium sheet as per IS-737 (designation 31000, condition H3 for flat sheet & 31500/51300, H4 for corrugated sheets)) shall be used for cladding. Insulation on overall piping, vessel and equipment, cladding will be coated on the side in contact with insulation with 3 mil thick polysurlyn film.

Specifications for aluminium Cladding material shall be as follows :

Material	Reference Code / Standard	Thickness	Application
Aluminium sheet with applied moisture barrier of 3 mil thick Polysurlyn coating	IS : 737 / ASTM C-653	22 SWG (0.71mm)	For all piping, tanks, vessels, heat exchanger, flanges, valves, equipments etc. upto 24" outside dia
		20 SWG (0.91mm)	For piping, tanks, vessels, heat exchanger, flanges, valves etc. above 24" outside dia
Removable cover for flanges, valves etc. shall be made out of 1.0mm thickness Aluminium Sheets.			

- Vertical Vessels

Cladding material for vessels with insulation O.D. 900 mm and less shall be same as for pipes. For vessels above 900 mm insulation O.D. 22 SWG corrugated aluminium sheet as per IS-1254 or ribbed aluminium sheet 32 mm x 5 mm deep corrugations may be used.

b) Screws

Screws used with aluminium sheeting shall be of self tapping type, A No.8x12mm long cadmium plated / SS of high quality at intervals of 150mm..

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- e) **S-Clips.**
Aluminium, 20x1.5mm or 25mm wide stainless steel banding bent to form a shape of “S” provide a minimum lap of 50mm.
- d) **Bands for securing cladding.**
Aluminium of dimensions 12mm width x 0.56 mm thick (24 SWG) for pipes. Stainless Steel bands Type 304, 0.4mm thick x 13mm wide for large dia pipes (above 24”) and cylindrical equipment up to outside dia 900mm, 0.5mm thick x 19mm wide for cylindrical equipment above 900mm outside dia meter.
- e) **Quick release clips for removable covers.**
Suitable quick release clips will be made as shown in fig. 7 from 20Cm width x 20 SWG aluminium sheet and some fig.7 from 20mm width x 20 SWG aluminium sheet and some suitable rectangular ring.
- f) Sealant for cladding joints with MAS 94/ Foster 91-44 Mastics or equivalent.
- g) **Rivets**
Aluminium ‘POP’ blind eye type / Stainless Steel 9.5mm long x 5mm dia meter.

4.0 INSPECTION.

4.1 General

All insulation material shall be subject to inspection by owner before application. In case of doubt Owner’s representative will have the liberty to get the material tested by the contractor at any approved test laboratory. Any material not meeting specified requirement will be rejected and the rejected material shall have to be replaced by the contractor with material of specified type and quality. Insulation found to be improperly installed shall be removed and reinstalled properly.

4.2 Inspection

Inspection of materials and / or installation by owner shall not relieve the contractor of his responsibility to ensure that finished insulation conform to specified requirements and is free from defects, contractor shall correct any defects due to poor workmanship.

4.3 Test for thickness

Test for thickness shall be carried out after application. Thickness at any point shall not be less than 2mm than the indicated thickness and excess thickness up to 115% of the specified thickness is Permissible. .

4.4 Testing for bulk density

Testing of bulk density of the insulating materials shall be carried out before the application of insulation. This should be within $\pm 15\%$ of the specified value. Test location shall be selected by owner and its repair shall be done by contractor.

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5.0 APPLICATION

5.1 General

Insulation thickness shall be as specified in the insulation schedule/specification/isometric drawings prepared for equipments/piping. Wherever the thickness is not indicated the same may be selected from TS-6701 & 6702.

Insulation for pipes should be in preformed shape in two halves upto 14"nb dia meter for first Layer and beyond that mattress to be used.

5.2 No. of Layers

When insulation thickness exceeds 75 mm, the insulation shall be applied in multi-layers with all joints staggered. Each layer will be separately secured with metallic bands/wires.

No. of layers shall be as follows:

<u>Insulation Thickness</u>	<u>No. of Layers (Min.)</u>
Up to 75mm	1 Layer
76 to 150 mm	2 Layers
151 and above	3 Layers or more.

5.3 GENERAL REQUIREMENTS

5.3.1 Surface preparation

- Surface to be insulated shall be cleaned of all dirt. Oil loose scale etc. by wire brushing. All insulation shall be applied at ambient temperature and both the metal surface and insulation material shall be dry prior to application of insulation.
- The surface for cold insulation shall be then coated with a bitumen emulsion or a mastic coating.
- If the vessel is made of stainless steel, it shall be wire-brushed. with stainless steel wire brush.

5.3.2 Expansion / contraction joint

Depending on the type of insulation used the operating temperatures and nature of the material it may be necessary to provide expansion/contraction joints on vessels or pipes to prevent the insulation from rupturing/buckling when the surface expands/contracts. It is recommended that expansion joints will be provided in the intervals as follows:

Temperature	Intervals	Remarks
201 ⁰ C to 300 ⁰ C	4 ^M Interval	This is not reqd. where flexible wool is used as insulation
301 ⁰ C to 400 ⁰ C	3 ^M Interval	
401 ⁰ C & above	2 ^M Interval	
Cold service	5 ^M Interval	

- Expansion joints in horizontal vessel insulation shall be close to fixed support saddle (s)

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- At the expansion joint there shall be a complete cut through the insulation.
- On piping, expansion joints shall be provided on both sides and within 900 mm of each bend (within the above guide line for interval).
- The cut out in insulation shall be at-least 25 mm wide and dry filled with loose insulation.

5.3.3 Filling of Voids

All voids, irregularities and joints shall be packed with loose insulation material/insulation cement trowelled smooth whichever is applicable.

5.4 INSULATION PROCEDURE

5.4.1 Insulation procedure shall be as per TS-6701 & TS-6702 for hot & cold service respectively.

5.5 Metal Jacketing

a) General

- All joints shall have minimum 75 mm overlap arranged such as to shed water. For horizontal vessels and pipes, horizontal overlap shall be installed within 5-6-7 O - clock position.
- Jacket shall be secured to the spacer rings and to itself by self tapping screws, described earlier, at a pitch of 150 mm for longitudinal joints and 100 mm for circumferential joints or by metal bands.
- All outlets and cut outs shall be cut as close as possible to nozzles, manholes, supports, branch connections etc. and sealed weather proof. (Ref Fig.3).
- At all joints, edges of the jacket will be grooved.
- All openings through insulation finish shall be flashed weather tight by vapour seal mastic, particularly where connections are not insulated.
- Insulation of flange assemblies, valves, manholes hand-holes removable heads of heat exchangers etc. shall be of removable type.

b) Horizontal Vessels

Jacketing for dished heads shall be fabricated in form with the radial overlapped joint (with adequate overlap) secured by self tapping screws @100 mm pitch where it is not possible, suitable metal bands shall be provided as approved by Engineer-in-charge. The ends shall be secured to the vessels sheeting (Cylindrical shell) by circumferentially tensioned bands and reinforced by self tapping screws set at 150 mm pitch.

c) Vertical Vessel

Corrugated / Ribbed aluminium sheeting shall be adequately rolled and installed parallel to the axis of the vessels as shown in fig. 4 and shall be secured to the insulation supports available on the vessels. Otherwise they shall be secured to themselves and rings provided by the contractor by self tapping screws. All individual sheets shall be overlapped by at least 75 mm on longitudinal joints and 2 corrugations on circumferential joints, to shed water wherever possible. All joints shall be staggered.

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Circumferential end laps shall be supported with S-clips so that top section can rest on the lower one and top section.

-Heads

Guide lines for horizontal vessels will be followed.

- d) Corrugated / Ribbed aluminium sheet shall be fixed with the help of suitable pop rivets on the sides of the tank. Flat sheet will be used for top of tank. Sheet to sheet longitudinal joints shall be sealed only with pop rivets and no screws shall be used. Circumferential joints need not be riveted.
- e) **Heat Exchangers**
Guide line for vessels shall be followed.
- f) **Machineries like pumps, Turbines, Compressors etc.**
Wherever sheeting will be required it will be specifically asked for and contractor shall submit his proposed details for each equipment for approval of the Engineer-in charge.
- g) **Spherical Vessels**
Guide lines for horizontal vessels shall be followed.
- h) **Piping Items:**

Elbows / Bends

On piping cladding shall be supplied with longitudinal and circumferential laps of 50 mm and secured by aluminium bands spaced 300 mm centres or by aluminium self tapping screws at 150 mm centers. Longitudinal laps on horizontal pipes shall be arranged minimum 300 below the horizontal centre line to shed water. Circumferential lap joints should be sealed with suitable adhesive sealer.

Cladding of insulation over large bends shall be as per Fig.5 Cladding of insulation over elbows shall be spun aluminium jacket and the joint with cladding of adjacent straight pipe shall be flashed and banded as shown in fig. 5 (a).

- Valves & Flanges.

Where flanges and valves are not insulated, the end of insulation on both sides shall be suitably covered as shown in Fig.6 when these are required to be insulated they will have removable box or pad insulation as indicated on Fig. 7,8,9 & 10.

Cladding of insulation over valves and flanges shall be prefabricated in half-sections and screwed together. The ends joining adjacent pipe jacket shall lap 50 mm and be sealed weather tight with reinforced mastic. In case of pad insulation, the pads will be tied tightly over the valves and flanges with suitable arrangements.

6.0 MEASUREMENT OF INSULATION WORK.

- 6.1 Measurement of insulation works shall be as per IS: 14164.

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7.0 GUARANTEE

- The guarantee test shall be carried out when plant is fully operative.
- The surface temperature, reading shall be taken at six points per pipe line and at each point it shall be taken on all four sides in top, bottom, left side and right side.
- The above reading shall be taken at 2 hours intervals and shall be taken for 18 hours starting from 11 a.m. in the morning
- Simultaneously ambient temperature shall be taken as per IS: 14164
- A graph shall be plotted between ambient and surface temperature reading
- From this graph the surface temperature against ambient temperature shall be found out
- The ambient and surface temperature shall be measured by the instrument provided by the contractor. The instrument shall be calibrated to the satisfaction of owner/consultant.
- The contractor is required to guarantee the surface temperature of 60 °C (max.) for equipments and piping in case of Hot Insulation. For cold insulation of equipments and piping, the difference between skin temperature and ambient temperature shall not exceed 2 °C .

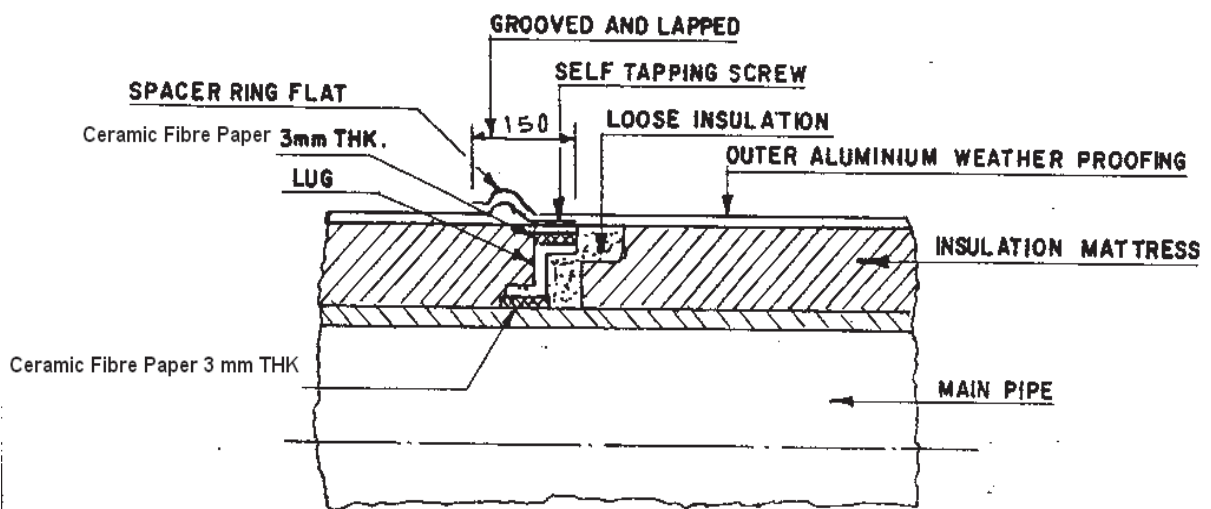
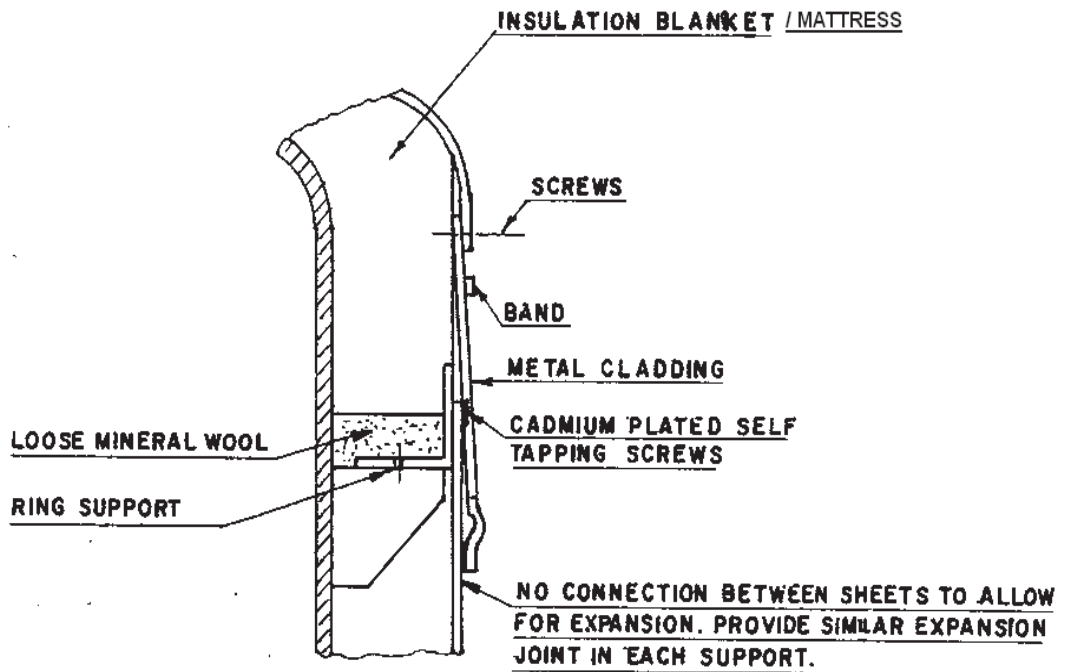
Ambient temperature and surface temperature shall be measured by duly calibrated instruments provided by CONTRACTOR.

The CONTRACTOR shall undertake immediate replacement of insulation material damaged in transit, storage or application.

Insulation contractor shall produce required number of copies of test certificates as per relevant IS/ASTM Standard. Insulation contractor shall certify that:

- All materials are new and unused and are as per specifications called for in this standard.
- The operating thermal conductivity shall be as specified
- The workmanship shall be in accordance with good practice.
- Other terms & conditions of the guarantee clause shall be as per NIT / purchase order.

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APPLY MASTIC TO BEVELED PIPE INSULATION. INSTALL JACKET SNAPPING ENDS TO BEND OVER BEVEL AND ALONG PIPE.

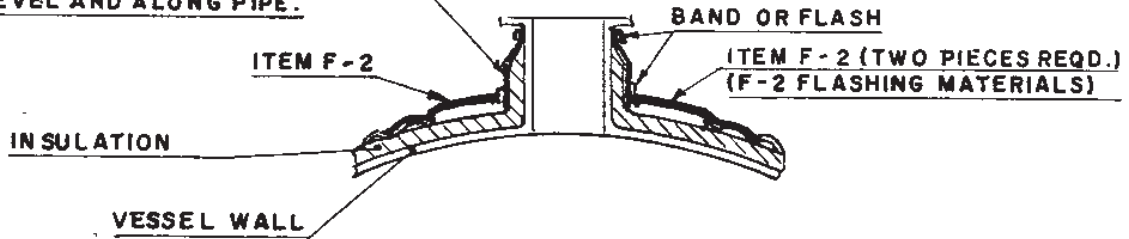
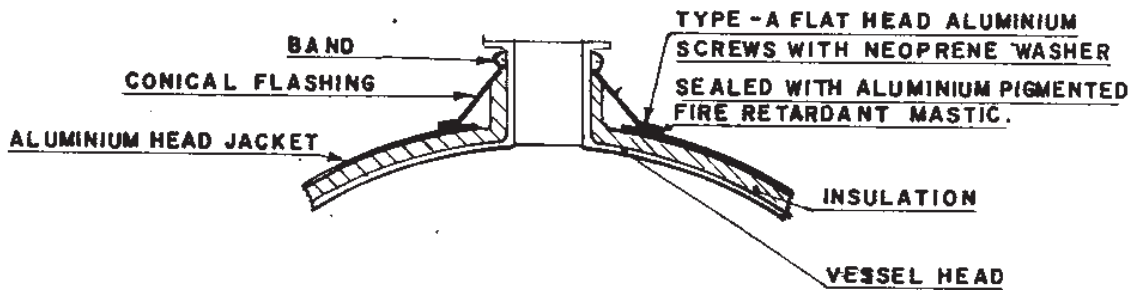


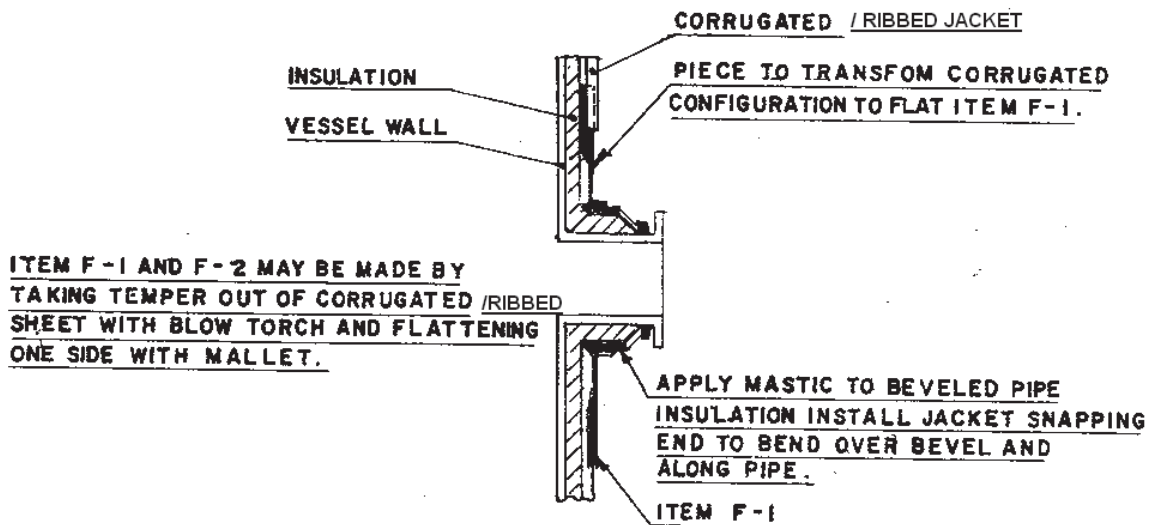
FIG. 3a



JACKETING DETAILS TOP OUTLET FLASHING

FIG. 3b

TOP OUTLET FLASHING DETAIL MAY BE USED FOR SIDE OUTLET AFTER TRANSFORMATION OF SHAPE FROM CORRUGATED TO FLAT HAS BEEN TAKEN CARE OF .



ITEM F-1 AND F-2 MAY BE MADE BY TAKING TEMPER OUT OF CORRUGATED /RIBBED SHEET WITH BLOW TORCH AND FLATTENING ONE SIDE WITH MALLET.

JACKETING DETAILS SIDE OUTLET FLASHING

FIG. - 3c

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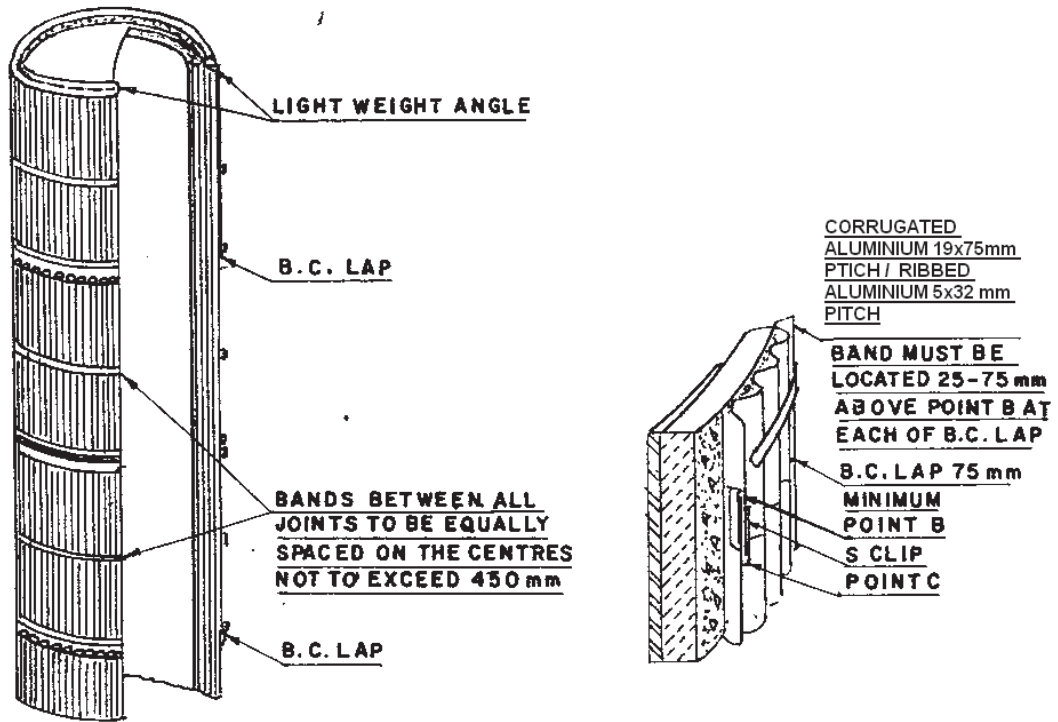


FIG. 4

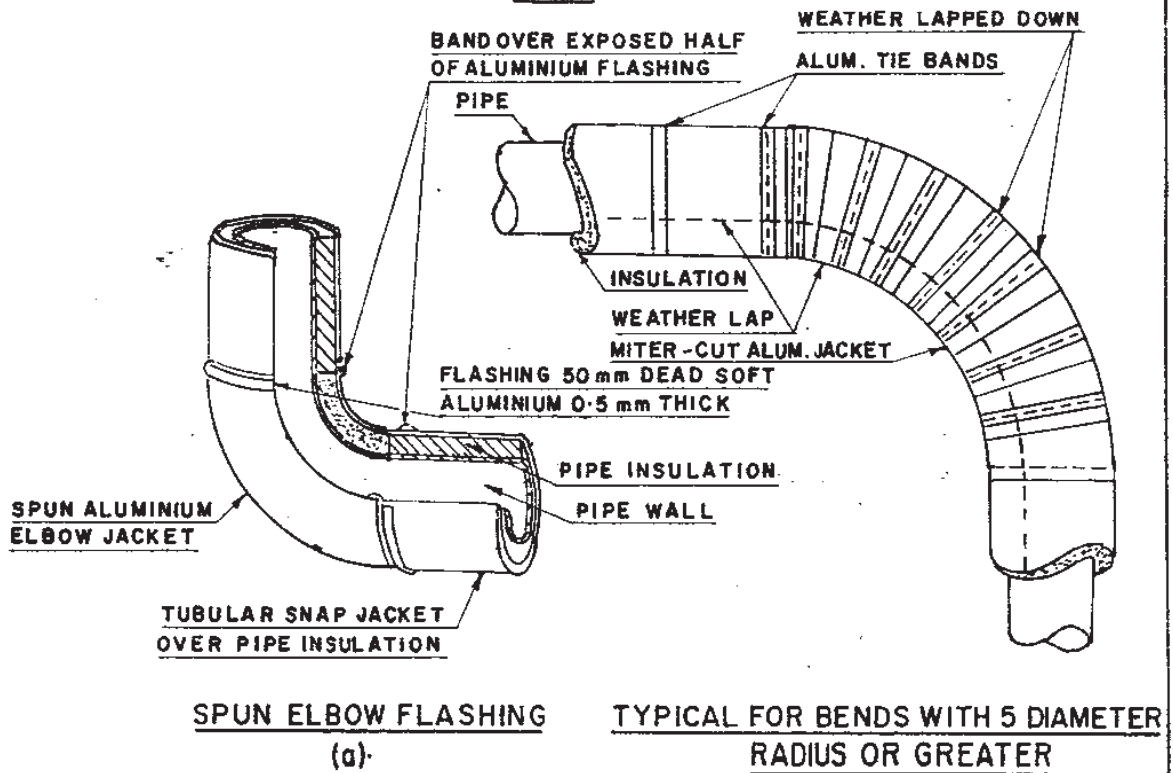
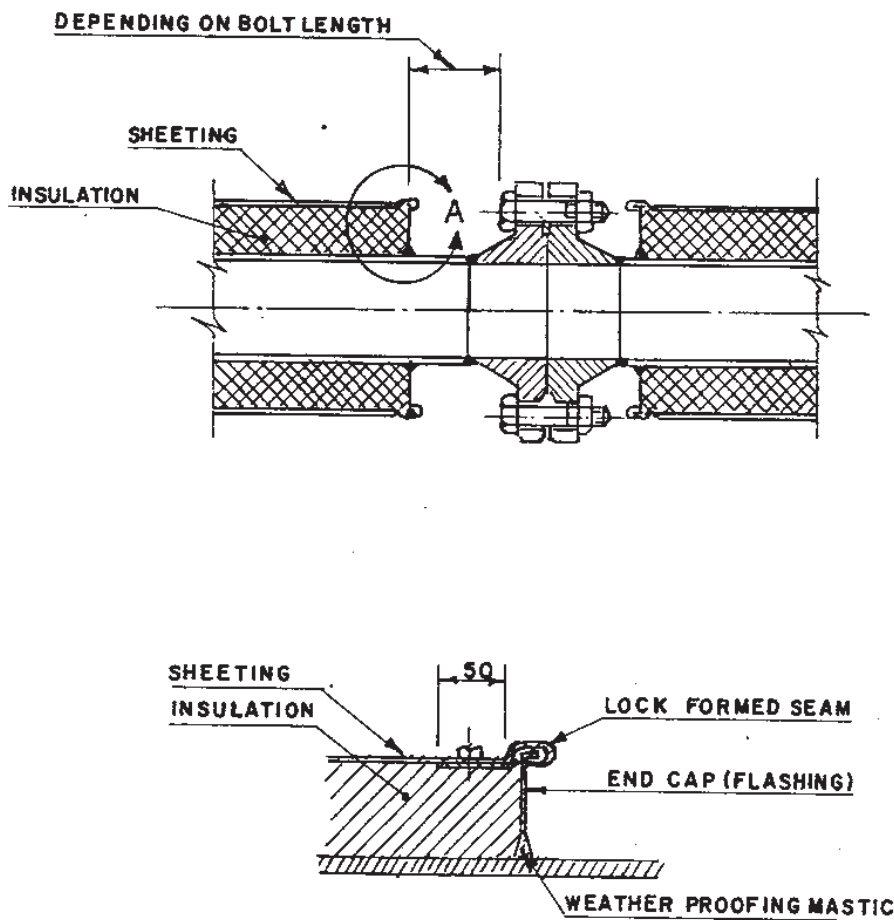


FIG. 5

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DETAIL - A

FIG. - 6 FLANGE ASSEMBLIES - UN INSULATED

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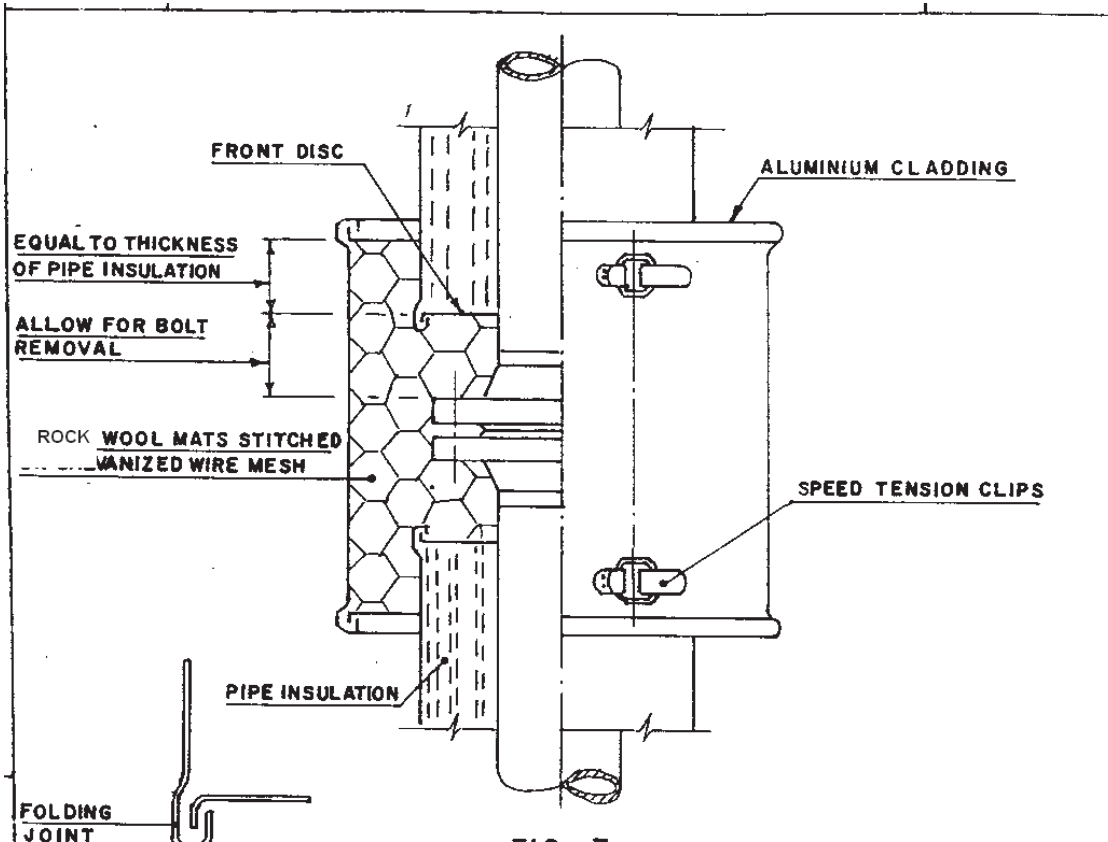


FIG - 7
REMOVABLE FLANGE BOX IN HORIZONTAL LINES (HOT SERVICE)

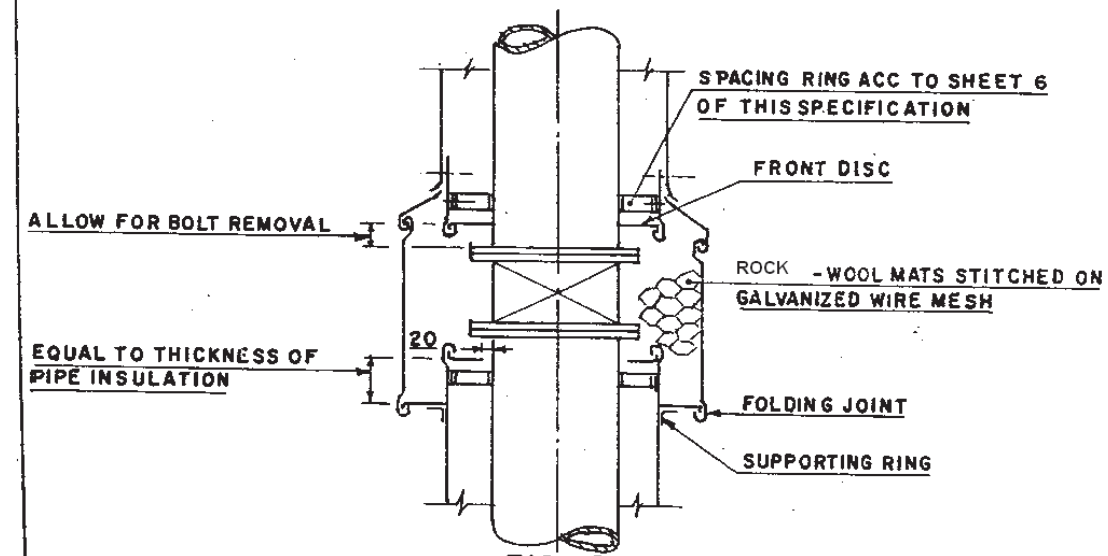
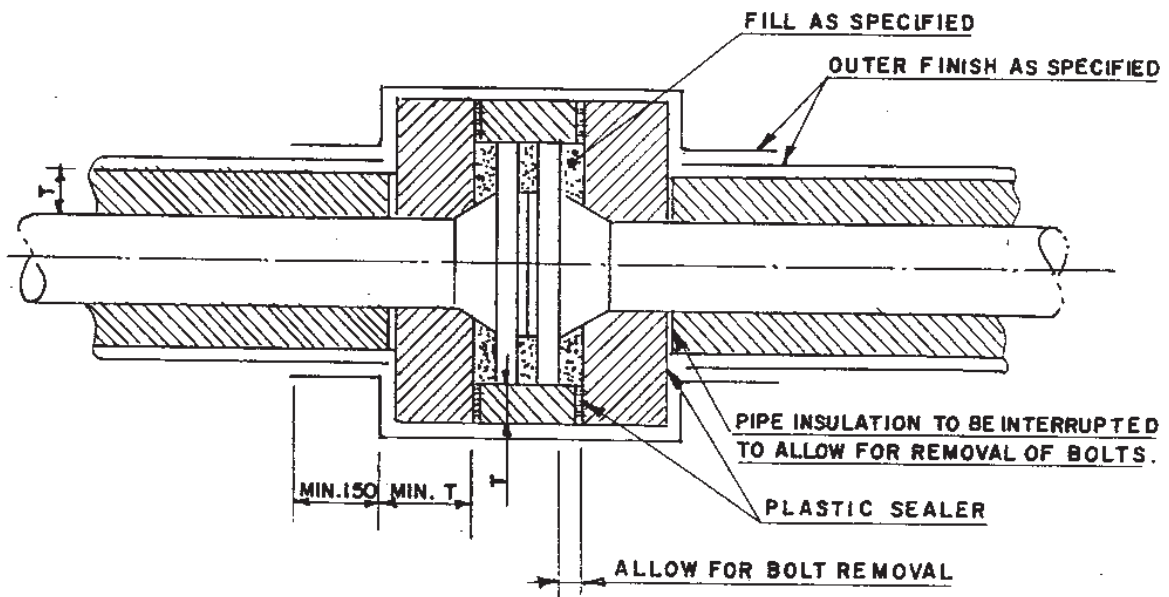


FIG - 8
**TYPICAL DETAILS FOR REMOVABLE BOXES FOR VALVE & FLANGE
CONNECTIONS IN VERTICAL LINES (HOT SERVICE)**

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**REMOVABLE BOX FOR FLANGE ASSEMBLY
USING BLOCK INSULATION**

FIG. - 9

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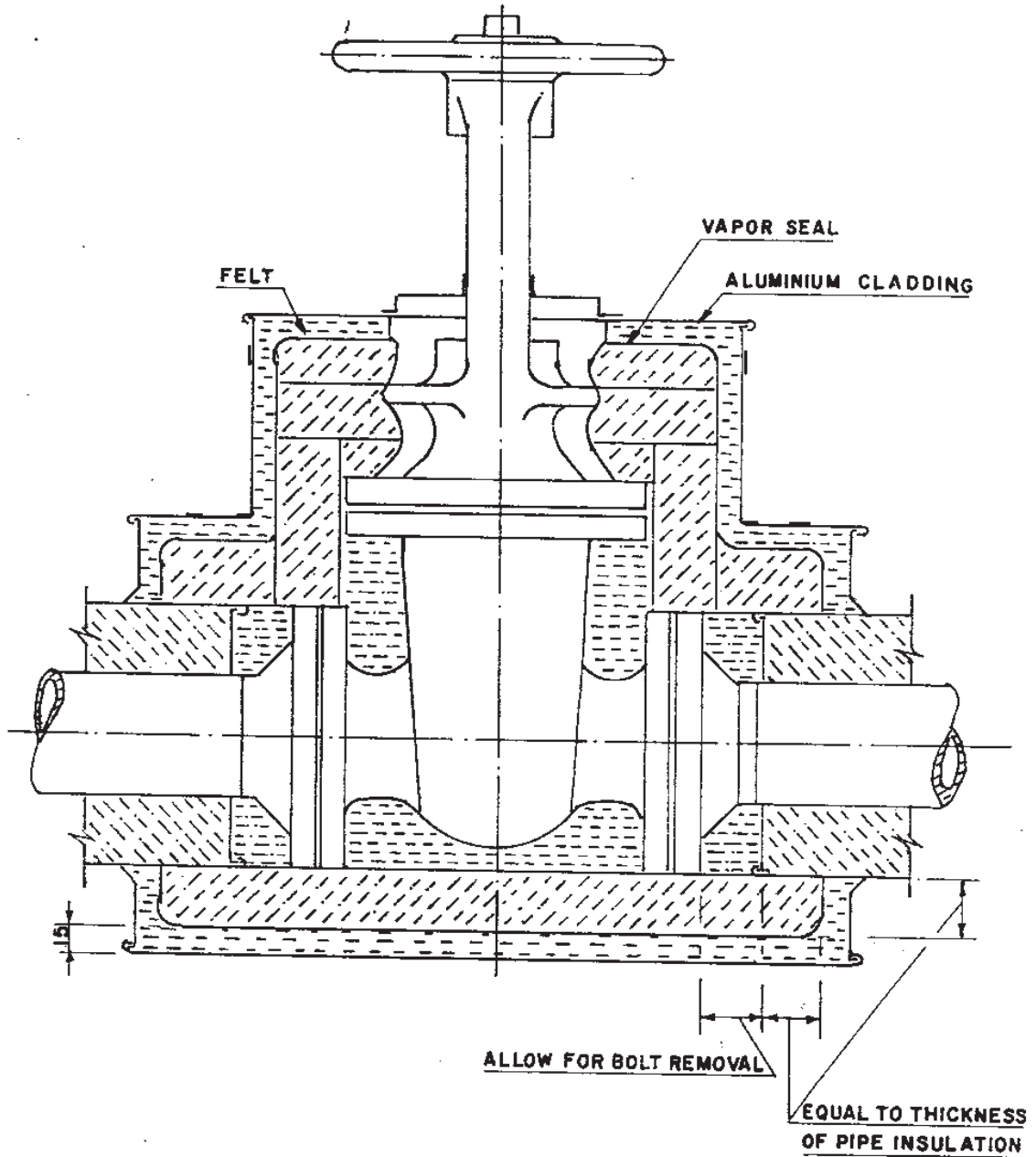


FIG - 10

**TYPICAL DETAIL FOR VALVE INSULATION BOX
(USING BLOCK INSULATION)**

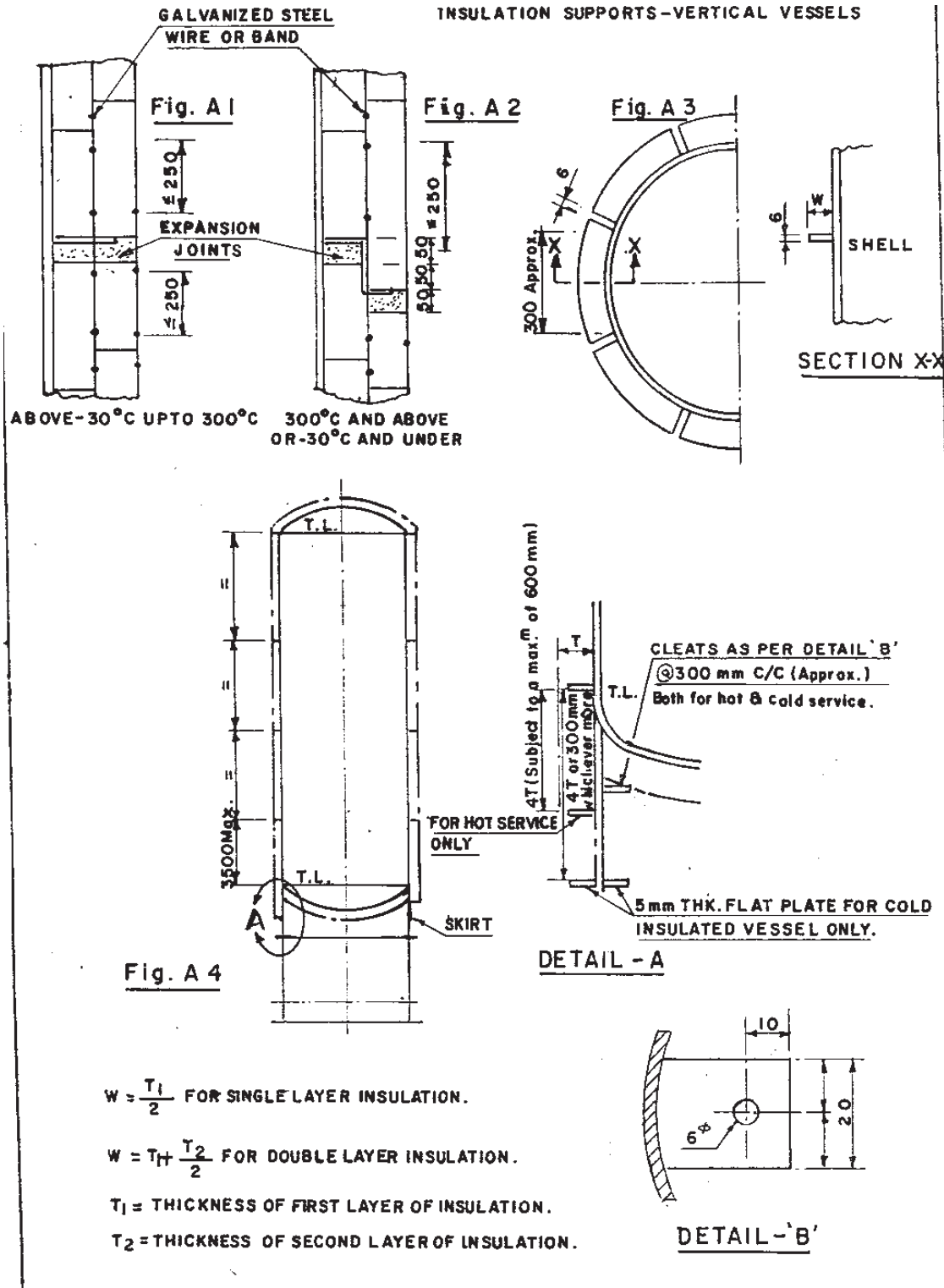
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ANNEXURE - I

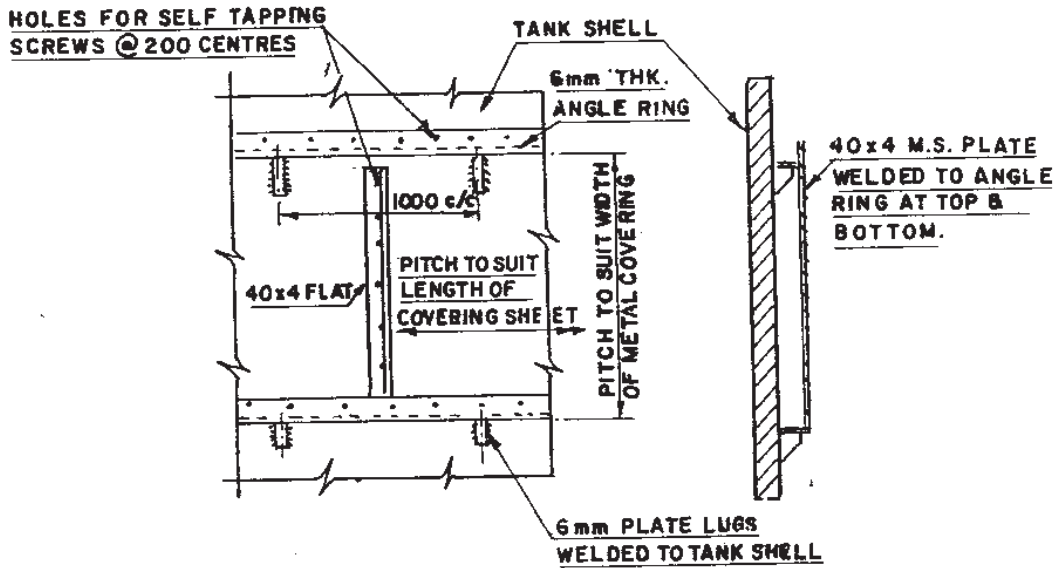
INSULATION SUPPORTS ON VESSELS

- 1 Suitable supports in the form of rings, lugs, studs or pins shall be used to support insulation on vessel and pipes. Block insulation of vertical vessels and piping shall be supported by support rings. Welding studs are not to be used on any vessel having shell thickness less than 3 mm or shells of aluminium or other alloy materials where spot weldings is not permitted on the vessel surface. Approval must be obtained from the Engineer before welding will be permitted on any vessel or equipment. Normally insulation supports are provided after final erection of the plant. If site welding is not permitted then same should be considered at the design stage itself.
- 2 Support ring shall be 6 mm. thick and shall be as per fig. A I-A6. In case of stress relieved vessels insulation supports shall preferably be shop welded.
- 3 If support rings are used on a vessel, the insulation of the head shall be held in place with bands radiating from a floating ring made of 6 mm. round M.S. rod. The bands shall be spaced not more than 300 mm. apart at the tangent line. In case of cold insulation, lugs or supports shall in no case be more than 75% of the total insulation thickness in order to not to puncture the vapour barrier.
- 4 Stiffener angles, weld protrusions, ladder supports, insulation support rings, pipe hangers or any metal connections not otherwise scheduled to receive insulation shall be insulated if in direct contact with the cold surface in case of cold insulation. The insulation over such protrusions shall have an insulation thickness over them of at least 80% of the thickness of the adjoining insulation. In all such cases the insulation shall be extended to ensure that the nearest exposed surface has a temperature above 0°C or above dew point as specified by purchaser.
- 5 On large vertical vessels of a height of 6 m or more and on continuous run of 6 m or more of vertical pipe, support rings shall be provided at not more than 3 m interval, such rings shall encompass the vessel and pipe, and the material lugs thereon shall have a length equal to 75% of the total insulation thickness. Extra insulation shall be provided over the support rings. This shall extend for 25 cm. on each side of the ring and shall be mitred to 45 cm. for water-shed on the upper.
- 6 Where studs, clips or pins are used to support insulation, their spacing shall be approximately 600 mm centre for blanket insulation and one per block for block insulation. Split pins, if used, shall be spread, bent over and imbedded into the insulation.

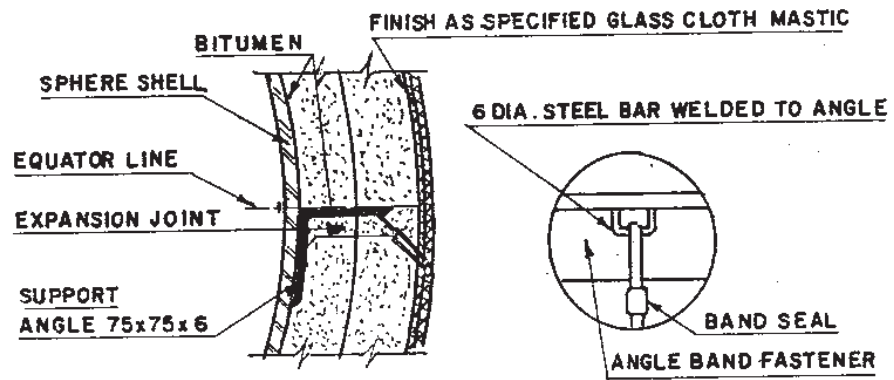
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TYPICAL DETAIL OF SUPPORT TANK
FIG -A5




SUPPORT ANGLE DETAIL FOR HORTON SPHERE
FIG. - A6

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TECHNICAL SPECIFICATION
FOR
THERMAL INSULATION
HOT SERVICE

P	09.12.2022	FOR COMMENTS	V	NS	HOD
REV	DATE	PURPOSE	PREPD	REVWD	APPD

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- 2.1 Insulation Material
 - 2.1.1 General
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- 2.2 Auxiliary materials
 - 2.2.1 Paints
 - 2.2.2 Insulation Cement
 - 2.2.3 Hard setting plaster
 - 2.2.4 Wire (netting & stitching wire)
 - 2.2.5 Banding wire
 - 2.2.6 Lacing wire
 - 2.2.7 Bands for sewing insulation material
 - 2.2.8 Foil for wrapping S.S. surface
 - 2.2.9 Spacer rings
 - 2.2.10 Aluminium jacket
 - 2.2.11 Heat transfer putty for tracers (viz. Thermo-bond).

3.0 APPLICATION OF INSULATION

- 3.1 Thickness of Insulation
- 3.2 General Requirements
 - 3.2.1 Extent of Insulation

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3.2.2 Insulation of S.S. Surface

3.3 Insulation Procedure

3.3.1 Vessels & Columns

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3.3.1.2 Vessel head

3.3.2 Tanks

3.3.3 Heat Exchangers


3.3.4 Machineries (Pumps, Turbines, Compressors etc.)

3.3.5 Pipings

a) General

b) Hot services

c) Steam traced lines

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1.0 GENERAL

1.1 SCOPE

This standard covers the requirement for supply and application of materials for thermal insulation of equipment, piping and other items for Hot Service. TS -6700 is supplementary to this standard and all the applicable requirements of TS-6700 shall be complied with in conjunction with the requirements specified here in.

1.2 REFERENCE STANDARDS

TS-6700	Thermal Insulation – General Requirements
IS:14164	Code of Practice for Industrial Application and finishing of thermal insulation material at temperature -80°C and up to 750°C.
IS:8183	Specification for bonded mineral wool
IS: 9842	Specification for performed fibrous pipe insulation
IS:8154 / IS:9428	Calcium silicate pipe sections & blocks
IS:9743	Insulating cement
IS:9742	Specification for spray able mineral wool.
IS : 15402	Specification for Ceramic Fibre Insulation
ASTM C-680	Standard Practice for Heat Loss or Gain and Surface Temp.
ASTM C-795	Standard Specification for Insulation use over Austenitic Stainless Steel.

1.3 DEVIATIONS


Should unforeseen difficulties arise to comply with requirements of this standard.

- Alternative materials and application techniques equivalent or superior to the requirements of this standard may be submitted with complete details for approval of PDIL.
- In case of contradiction between requirements of this standard and the NIT/work order, the latter will be followed.

1.4 LIMITATIONS

Temperature Limits

This standard deals with insulations applied externally on piping / equipments etc. for temperature ranging from 60°C to 750°C.

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1.5 GENERAL REQUIREMENTS

1.5.1 Personnel Protection (PP)

Insulation for personnel protection is usually called for when the surface temperature is above 60°C and process requirement does not necessitate any insulation. Wherever, requirement of such insulation for P.P. is indicated, extent of insulation will be as follows:

- a) Insulation all such portions of the surface which could be touched in the course of normal operation / maintenance duties.
- b) Insulate up to a height of 2.5 M above grade level/working platform level.
- c) Insulate all portions of the surface within a distance of 600 mm from the edge of any walk way / operating platform/ladder.

2.0 MATERIAL REQUIREMENTS


2.1 INSULATION MATERIALS

2.1.1 General

- Wherever reference to any standard is made it is presumed that the latest revision as on date should be considered.

2.1.2 Specification and other requirements as per table below:

Sl. No.	Specification	Applied density Kg/m ³ (minim.)	Temp. limit °C	Maxim. Thermal conductivity mW/cm °C at 100°C mean temp. # .
1	2	3	4	5
A)	For Vessels/Equipments/Large Pipes			
	i) Bonded rock wool mattress/slabs as per IS:8183 Gr.3	100	400	0.51
	ii) Bonded glass wool mattress/slabs as per IS:8183 Gr.3	85	400	0.51
	iii) Bonded rock wool mattress / slabs as per IS:8183 Gr.3	150	401-550	0.51
B)	For Pipes			
	i) Preformed bonded Rock wool/glass wool pipe sections as per IS:9842 Gr. 2	85	400	0.51


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	ii) Preformed bonded rock wool pipe sections as per IS:9842 Gr. 2	150	550	0.51
	iii) Preformed calcium silicate pipe sections as per IS:8154/9458 & ASTM C 533.	250	750	0.6
C)	Ceramic Fibre Blanket Insulation as per IS : 15402	128	750	0.76 at 200°C
D)	Ceramic Fibre Pad Insulation	128	750	0.76 at 200°C
E)	Inner layer Ceramic Fibre and subsequent outer layers Rockwool Insulation	128 & 150	501-750	0.76 at 200°C
F)	Ceramic Fibre Rope 18-24mm for Insulation of Impulse / Small dia pipelines (1 ½ inch & below) as per IS : 15402	250	750	0.76 at 200°C

Please also refer Thermal Conductivity Values at different mean Temperatures.

NOTES:

1. Insulation material manufactured from slag is not acceptable.
2. Bonding agent will not be more than 4.5% by weight in the insulation material.
3. Insulation material on application directly over austenitic stainless steel (upto 450°C) shall not contain leachable chloride more than 10 ppm. For application on C.S. & A.S. surfaces and on S.S. surfaces covered with aluminium foil (upto 450°C), leachable chloride in the insulation material up to 100 ppm could be permitted. In case of calcium silicate, suitable corrosion inhibitor (sodium silicate) shall be added and sodium silicate content shall not be less than 20 ppm for each ppm of leachable chloride. Factory inhibited insulation shall be preferable, whereby sodium silicate solution will be sprayed on to the Insulation at factory.
4. Where foot traffic is expected on the insulated surface, the minimum density of applied insulation will be 150 Kg/m³ irrespective of temperature.
5. Sprayable Mineralwool as per IS: 9742 or Ceramic Pads as per IS:15402 may be considered for irregular shaped equipments like turbines, pumps, valves, flanges etc.
6. All optional requirements as per cl.3.10.3, 3.10.5, 3.10.6, 3.10.7 of IS: 8183 and cl.3.12.1, 3.12.4 of IS: 9842 shall be complied with.
7. Large pipe means pipe having nominal size 26" NB and higher.
8. Pipe sections shall be applied up to 14" NB Dia pipelines.
9. For multi layer insulation, only first layer to be pipe sections and subsequent layers with mattress insulation.

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10. For water prone areas Water Repellant Grade insulation to be used as per BS: 2972.

2.2 AUXILIARY MATERIALS

2.2.1 Paints

- a) Heat resisting (for application on S.S. surface Hot Service)

Type	Single pack
Composition	Silicon resin based with aluminium flakes as pigment.
Dry film thickness	20 microns / coat (minim.)
No. of coats	2 coats
Other requirement	It should be suitable to with stand temperature up to 550°C.

2.2.2 Insulation Cement

This is used for filling voids & surface irregularities. This shall be high grade mineral wool/calcium silicate plastic composition based cement having a volumetric shrinkage not exceeding 20% of wet coverage and with a max thermal conductivity of 0.01 mw/cm degree C at 205°C mean temperature.

2.2.3 Hard Setting Plaster

Hard setting plaster shall be a mixture of cement sand or cement mineral fibre or plaster of paris - mineral fibre. This will be applied over the specified wire netting/chain link mesh. The plaster shall conform to IS: 9743.

2.2.4 Wire (for netting, lacing or stitching)

Wire netting for machine stitched mattresses shall be galvanized steel wire of dia 0.56 mm (minimum) making 25 mm hexagon meshes. Lacing wire to bind the ends of wire netting shall be galvanized steel wire of minimum dia 0.56 mm.

2.2.5 Banding Wire


Wire for securing insulating blankets or sections shall be galvanized soft, annealed steel wire of 1.625 mm diameter for pipes and 2.640 mm dia for vessels.

2.2.6 Lacing Wire

Lacing Wire to stitch wire netting of adjacent mattresses shall be of G.I. wire of 22 SWG.

2.2.7 Bands for securing Insulation material

Shall be aluminium or S.S. 20x0.5 mm. For spherical surfaces only S.S. bands will be used.

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2.2.8 Foil for wrapping S.S. surfaces

Aluminium foil of 0.1mm thickness, free from pin holes.

2.2.9 Spacer Ring

- Spacer rings shall be provided when mattress insulation is used to provide frame work on which aluminium sheeting (Refer Fig. 1) used for protecting the insulation, is cladded. These rings shall be fabricated from 25 x 3 mm MS flats.

Spacer rings are not required when pipe lines are insulated with performed pipe section.

The outside dia of these rings shall be equivalent to the diameter of the pipes/vessels measured over the insulation. Spacer rings shall not be required when insulation in the form of performed rigid pipe sections is used.

- Spacer rings may not be used for pipes where insulation O.D. is less than 150 mm.
- Spacer rings shall be provided with “Z” shaped stays fabricated from the same size MS flats. Stays shall be provided at intervals of not more than 300 mm along the circumference of the insulation, subject to a minimum of 3 stays spacer rings shall be provided on the pipes at a pitch of not more than 900 mm.
- To minimize direct heat conduction through the stays, a packing of 2 sheets of 3 mm thick Ceramic Fibre Paper (density 320 kg/m³) shall be provided at the joints of the stays and pipes, while the joints of stays and MS rings shall be riveted by 6 mm dia. MS rivets with 2 sheets of 3 mm thick Ceramic Fibre paper interposed as shown in Fig. 1.

2.2.10 Aluminium cladding with inner side coated with Polysurlyn coating – As per TS: 6700

2.2.11 Heat transfer putty (viz. thermo bond) for tracers.

3.0 APPLICATION OF INSULATION


3.1 THICKNESS OF INSULATION

Insulation thickness shall be as specified in the insulation schedule/specification/isometric drawings prepared for equipments/piping. Wherever the thickness is not indicated the same may be selected from Table – I.

3.2 GENERAL REQUIREMENT

3.2.1 Extent of Insulation

- All steam traced lines, steam jacketed piping and vessels shall be insulated.
- Stem trap and piping downstream of it shall not be insulated.
- Turbines, pumps and compressors operating below 120°C shall not be insulated unless otherwise specified.

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- Flanges & flanged valves on lines operating above 65°C but below 200°C shall normally not be insulated expect for personnel protection. In such cases, insulation shall terminate at such a distance from the joints as to provide sufficient space for removal of bolts.
- Drain and vent piping for hot service up to the first valve on insulated equipment shall be insulated with similar type of insulation and finish as the equipment to which attached.
- Steam supply headers, and tracer lines used for steam tracing as shown on steam trap hook-ups shall be insulated.
- All instruments which are steam traced shall be insulated for heat conservation.
- All sample connections and drains on steam lines shall be insulated.
- All name plates and vessel markings should remain visible.

3.2.2 Insulated of S.S. Surface

For operating temperatures up to 450°C the stainless steel surface shall be wrapped with minimum 0.05 mm thick aluminium foil with 50 mm overlap at longitudinal and circumferential joints before application of insulation. All joints of the aluminium foil shall be lapped and sealed to be Proof against leakage. Aluminium foil shall be firmly secured on to the stainless surfaces by aluminium bands at a pitch of 450 mm. Care shall be taken while applying aluminium foil over the pipes to ensure that the foil is not punctured at any place during wrapping and clapping with aluminium bands.

For operating temperatures from 451 to 550°C, the stainless steel surfaces shall be painted with two coats of heat resistant paint before application of insulation. When the paint becomes dry, the painted surfaces shall show no discontinuity.

In case of factory made inhibited grade insulation within 10 ppm, same can be applied directly on to the SS surface upto 450°C

3.3 INSULATION PROCEDURE


The application procedure described in for rock/glass wool. For other insulations, the application procedure shall be submitted by the tenderers .

3.3.1 Vessels and Columns

3.3.1.1 General

Insulation blankets shall be applied with the retaining wire mesh exposed on the outside. The edges of blankets shall be well butted up to each other and laced together with galvanized wire and secured to the vessel with circumferential bands as shown in Fig. 2, 3, 4 & 5 when two layers are to be applied the first layer may be secured by means of galvanized wire in lieu of the bands.

On flat surfaces, blankets/blocks/slabs shall be applied by impaling them over 9 gauge galvanized wire pins welded perpendicular to the surface. The extending ends of the wires shall then be bent upward at right angles and pressed into the blanket. The edges of blankets shall be tightly butted and laced together with galvanized wire. Where more than one layer of insulation is applied, securing bands of the layers shall not coincide with each other. All joints in successive layer shall be staggered.

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3.3.1.2 Vessel Heads

Insulation on heads shall be secured by radial bands from a floating ring centred at the crown of head and tied to a circumferential band placed approx 300 mm inside the tangent line on insulation O.D. Ref. Fig. 2. On to heads of vertical vessels, these radial bands protecting the blanket insulation shall be provided with distance pins placed every 300 mm and of a length equal to insulation thickness. The pins shall be welded or riveted to the strip steel.


For bottom heads, in all skirt supported vessels insulation supports are provided inside the skirt as indicated in the equipment drawings. Floating rings or wire loops around the nozzle and bands may be used to support downward facing of insulation. Such a floating ring may be supported from the lagging support ring fixed inside the skirt. Blanket shall be shaped and secured on to the head by means of bands stretched across the floating ring and insulation support rings. The insulation shall be covered with galvanized wire netting firmly laced together and secured in place. Insulation details shall be as per Fig. 6. All wire ends shall be cut short and turned into the insulation.

For vertical vessels having temperatures more than or equal to 450°C, the upper 600 mm of the supporting skirt shall be insulated both on inside and outside.

3.3.2 Tanks

The details of support cleats will be as indicated in Fig. 7.

- Mineral wool mattresses faced with galvanized iron wire netting shall be pressed onto the supporting pins of 8 SWG GI wire. All joints shall be closely butted as shown in Fig. 7 A, B.
- For the top of tank the following procedure shall be adopted where angle supports/wire lugs are not provided by fabricator. All these will be supplied by insulation contractor.
- Laying of central and peripheral angle rings and details are shown in fig. 3, 3a, 3b.
- Welding M6 studs of length $T + 6$ mm (where T = thickness of insulation) at 300 mm pitch to MS flats shall then be laid on the tank top connecting the central and peripheral rings riveted/welded at both ends. Fix the 15 x 6 mm flat cross stiffeners with stud welded.
- Fix resin bonded mineral wool slabs of required thickness by pressing on to the studs.
- Stretch 20 SWG chain link mesh, anchoring it to the M.S. studs by means of speed washers.
- Apply approx. 19 mm thick hard setting plaster trowelled to a smooth and even finish.
- When hard setting compound is completely dry apply a standard four course bitumen felt, water proof treatment as per IS: 1346 or 3mm thick APP modified Bitumen Felt.
- Fix a “shed-water” shroud constructed from 200 galvanized iron plain sheets at the periphery of the tank. This shall be fitted prior to the application of the hard setting compound.

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3.3.3 Heat Exchangers

Exchangers shall be insulated with insulation mattresses as specified for vessel. Channels and channel covers will be insulated with removable aluminium covers lined with insulation. Unless otherwise mentioned flange bolting shall be left un-insulated for hot service ref. Fig. 4.

3.3.4 Machineries like pumps, turbines, compressors etc.

In general these will be insulated in such a way that the same is of removable type to allow easy maintenance. The contractor shall supply insulation detail to engineer-in-charge for approval.

3.3.5 Piping

a) General

- Vertical lines shall be provided with welded support rings Ref. Fig. 8 spaced at approximately 4000 mm. Expansion/contraction joints shall be provided under each support ring for hot./cold service.
- Insulation around support shoes etc. shall be trimmed closely and thoroughly sealed with vapour seal mastic. For hanger support special care shall be given for weather proofing jacket and sealing mastic. Ref. Fig. 9 & 10.

b) Hot Service

The performed pipe section of required thickness shall be fixed on the pipe surface with the help of 20 mm x 24 SWG aluminium band.

The blankets shall be wrapped round the pipe closely, completely covering the outer surface. Edges shall be tightly butted and laced with galvanized wire Ref. Fig. 11 & 12. The blankets shall be secured in place with galvanized bands/wires spaced at 300 mm. Ends of the wire loops shall be twisted and pressed back into the insulation. All voids, irregularities and joints shall be painted up and trowelled smooth with insulations cement. Longitudinal joints in jackets on horizontal pipes shall be located 30° below center line of pipe. Spacer rings as shown in Fig. 1 shall be installed at 100 mm interval to support the jacket.

In consideration of possible pipe line movement with change in fluid temperature different pipes should be separately insulated.


For temperatures above 500°C, combination of first layer Ceramic Fibre (25mm) followed by Rockwool Mattress will be tied with SS bands.

Flanges, valves & expansion joints shall be insulated with removable type pad arrangement as per requirement of TS: 6700.

For Small dia pipes of 1 inch & below Ceramic Fibre rope (18-24mm dia) may also be used and covered with Aluminium tape wherever exposed to atmosphere.

c) Steam Traced Lines

The steam traced line shall first be wrapped with 24 SWG x 3/4" hexagonal mesh GI wire netting so that it passes round the supporting hooks for the tracer line or lines. Thus ensuring tracer pipe bearing tightly against the line which is steam traced. This prevents the insulating material from entering the air jacket formed between the insulation and the pipes.


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The details are give in Fig. 13 & 14. In case of steam traced lines with thermo-bond or with Al foil the material supply and application, as per ES: 6016 will be in the scope of insulation contractor.

For stainless steel main lines having steam tracer, the method of application of insulation shall be the same as described in above except that an aluminium foil, shall be wrapped round the main pipe and tracer pipe as per the procedure described in clause 3.3.2.

For Electric traced lines, the tracer wires to be wrapped over the pipes and held in position with aluminium tape. Subsequently insulation mattress is to be applied and tied with bands.

- 3.3.6 Aluminium cladding with inner side (in contact with insulation) coated with Polysurlyn shall be applied over the finished insulation surface as per TS:6700.

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**TABLE-1
INSULATION THICKNESS (MM) FOR HOT SERVICE**

DESIGN CRITERIA

AMBIENT TEMPERATURE	:35 Deg. C
SURFACE TEMPERATURE	: 60 Deg. C
WIND VELOCITY	: 1 m/s
DESIGN HEAT LOSS	: 150 Kcal/hr.m ²
MATERIAL	: ROCKWOOL (Density =100 Kg/m ³ up to 400 Deg. C & 150 Kg/m ³ from 401-650 Deg. C as per IS 8183 Gr. 3)

OPERATING TEMPERATURE (Deg. C)														
PIPE DN (MM)	HOT INSULATION											PERSONNEL PROTECTION		
	<=150	151- 200	201- 250	251- 300	301- 350	351- 400	401- 450	451- 500	501- 550	551- 600	601- 650	UPTO 250	251- 400	401- 500
15	25	25	35	40	50	60	70	80	80	95	110	30	30	30
20	25	25	35	45	55	65	75	85	85	100	115	30	30	30
25	25	30	35	45	55	65	80	90	90	105	125	30	30	30
32	25	30	40	50	60	70	80	95	95	110	130	30	30	30
40	25	30	40	50	60	70	85	100	100	115	135	30	30	30
50	25	30	40	50	60	75	90	105	105	125	140	30	30	30
65	25	30	40	55	65	80	90	105	110	130	150	30	30	30
80	25	30	45	55	65	80	95	110	115	135	155	30	30	30
100	25	35	45	55	70	85	100	120	125	145	165	30	30	40
125	25	35	45	60	75	90	105	125	130	150	175	30	30	40
150	25	35	45	60	75	90	110	130	135	160	185	30	30	40
200	25	35	50	65	80	95	115	135	145	170	200	30	30	50
250	25	35	50	65	80	100	120	145	155	180	210	30	40	50
300	25	35	50	65	85	105	125	150	160	190	220	30	40	50
350	25	35	50	65	85	105	130	150	160	190	225	40	40	50
400	25	35	50	70	90	110	130	155	165	195	230	40	40	50
450	25	40	55	70	90	110	135	160	170	200	235	40	40	50
500	25	40	55	70	90	110	135	160	175	205	240	40	50	50
550	25	40	55	70	90	115	135	160	175	210	245	40	50	50
600	25	40	55	75	90	115	140	165	180	210	245	40	50	50
>600/ Flat Surface	25	40	60	80	100	130	160	195	220	270	325	40	50	50

- NOTE 1:** For temperatures above 500deg.C, first layer of 50mm Ceramic Fibre Blanket of density 128 kg/m³ to be applied and subsequent layers with Rockwool Mattress
- 2.** Flat surface includes Equipments and large dia pipes (DN>600).


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TABLE -2


INSULATION THICKNESS (MM) FOR HOT SERVICES

DESIGN CRITERIA


AMBIENT TEMPERATURE	:35 Deg. C
SURFACE TEMPERATURE	: 60 Deg. C
WIND VELOCITY	: 1 m/s
DESIGN HEAT LOSS	: 150 Kcal/hr.m ²
MATERIAL	: CALCIUM SILICATE

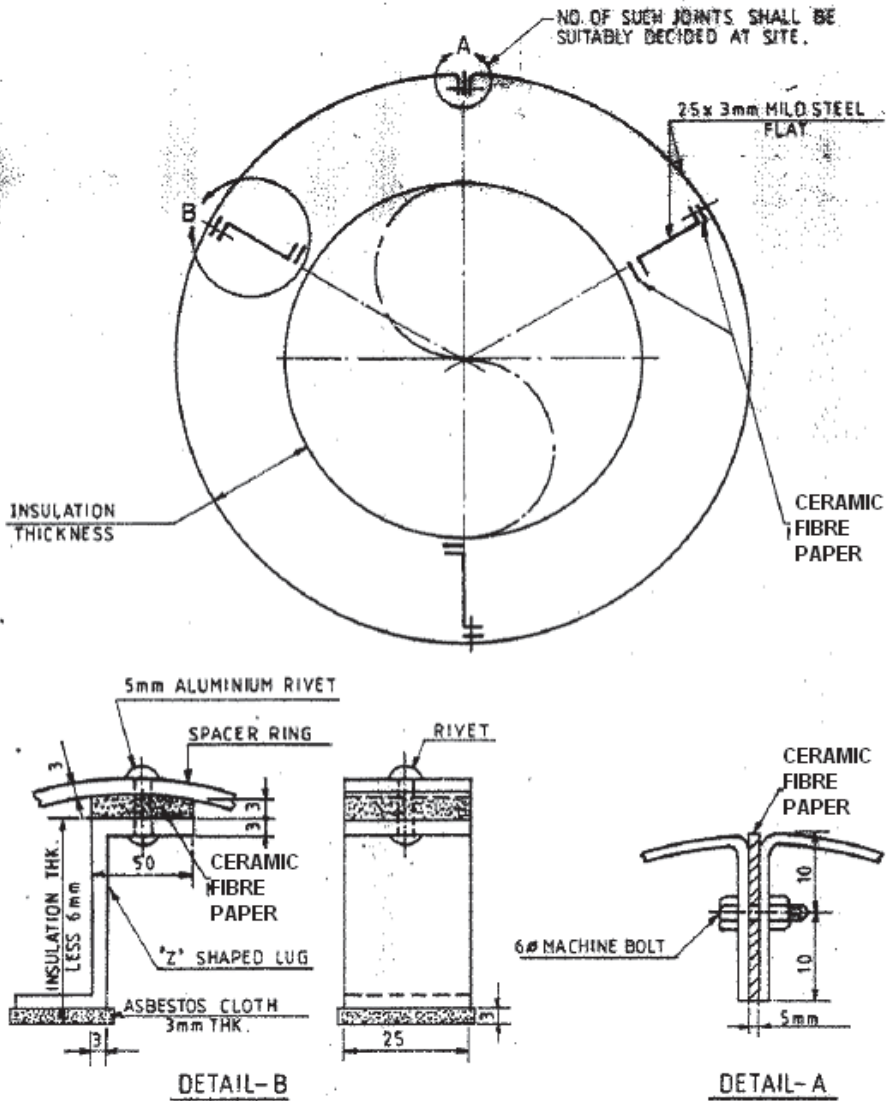
OPERATING TEMPERATURE (Deg. C)											
HOT INSULATION											
PIPE DN (MM)	<=150 °C	151-200 °C	201-250 °C	251-300 °C	301-350 °C	351-400 °C	401-450 °C	451-500 °C	501-550 °C	551-600 °C	601-650 °C
15	25	35	45	50	60	70	80	90	105	120	135
20	25	35	45	55	65	75	85	95	110	125	145
25	30	40	45	55	65	75	90	100	115	135	150
32	30	40	50	60	70	80	95	110	125	140	160
40	30	40	50	60	70	85	95	110	125	145	165
50	30	40	55	65	75	90	100	115	135	150	175
65	30	45	55	65	80	90	105	120	140	160	180
80	35	45	5	70	80	95	110	125	145	165	190
100	35	45	60	70	85	100	115	135	155	175	200
125	35	50	60	75	90	105	120	140	160	185	215
150	35	50	65	75	90	110	125	145	170	195	225
200	35	50	65	80	95	115	130	155	180	210	235
250	35	50	65	85	100	120	140	165	190	220	250
300	35	55	70	85	105	125	145	170	195	225	260
350	35	55	70	85	105	125	150	175	200	230	260
400	35	55	70	90	110	130	150	175	205	235	270
450	35	55	75	90	110	130	155	180	210	240	275
500	40	55	75	90	110	135	155	185	210	245	280
550	40	55	75	95	115	135	160	185	215	250	285
600	40	55	75	95	115	135	160	190	220	255	290
>600/ Flat Surface	40	60	80	105	130	160	190	230	275	325	385

Note Flat surface includes Equipments and large dia pipes (DN>600).

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Thermal Conductivity Table for Insulation Materials											
Sl.No.	Mean Temp. Deg.C	Rockwool			Rockwool			Calcium Silicate		Ceramic Fibre	
		Density-100kg/m ³ IS 8183			Density-150/144 kg/m ³ IS 8183/9842			Density-250 kg/m ³ IS 8154		Density -128 kg/m ³ IS 15402	
		w/mk	mW/cm	kcal/mhr	w/mk	mW/cm	kcal/mh r	w/mk	kcal/mh r	w/mk	kcal/mh r
			deg. C	deg C		deg. C	deg C		deg C		deg C
1	100	0.052	0.52	0.0447	0.052	0.52	0.0447	0.06	0.052		
2	150	0.062	0.62	0.0533	0.062	0.62	0.05331	0.07	0.06		
3	200	0.073	0.73	0.06276	0.068	0.68	0.05795	0.08	0.069	0.076	0.06535
4	250	0.084	0.84	0.07222	0.08	0.8	0.06878	0.09	0.077		
5	300	0.095	0.95	0.08168	0.09	0.9	0.07738	0.1	0.086	0.081	0.06964
6	400									0.122	0.1049
7	500									0.15	0.12897

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DETAILS OF SPACER RING
FIG. I

NOTE:- SPACER RINGS SHALL NOT BE REQUIRED WITH PREFORMED PIPE SECTION.

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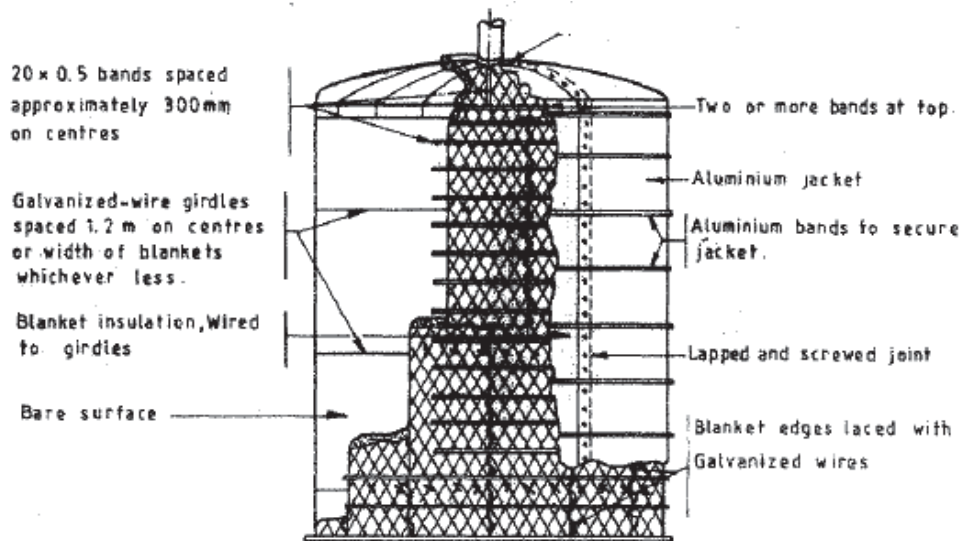


FIG. 2 Application of mineral wool blanket insulation for tanks 3m dia and above.

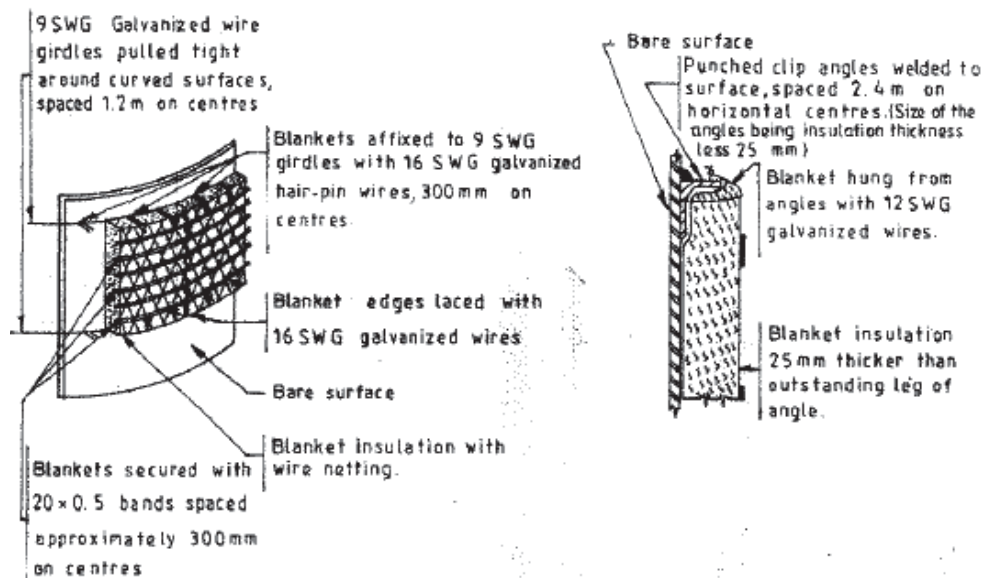

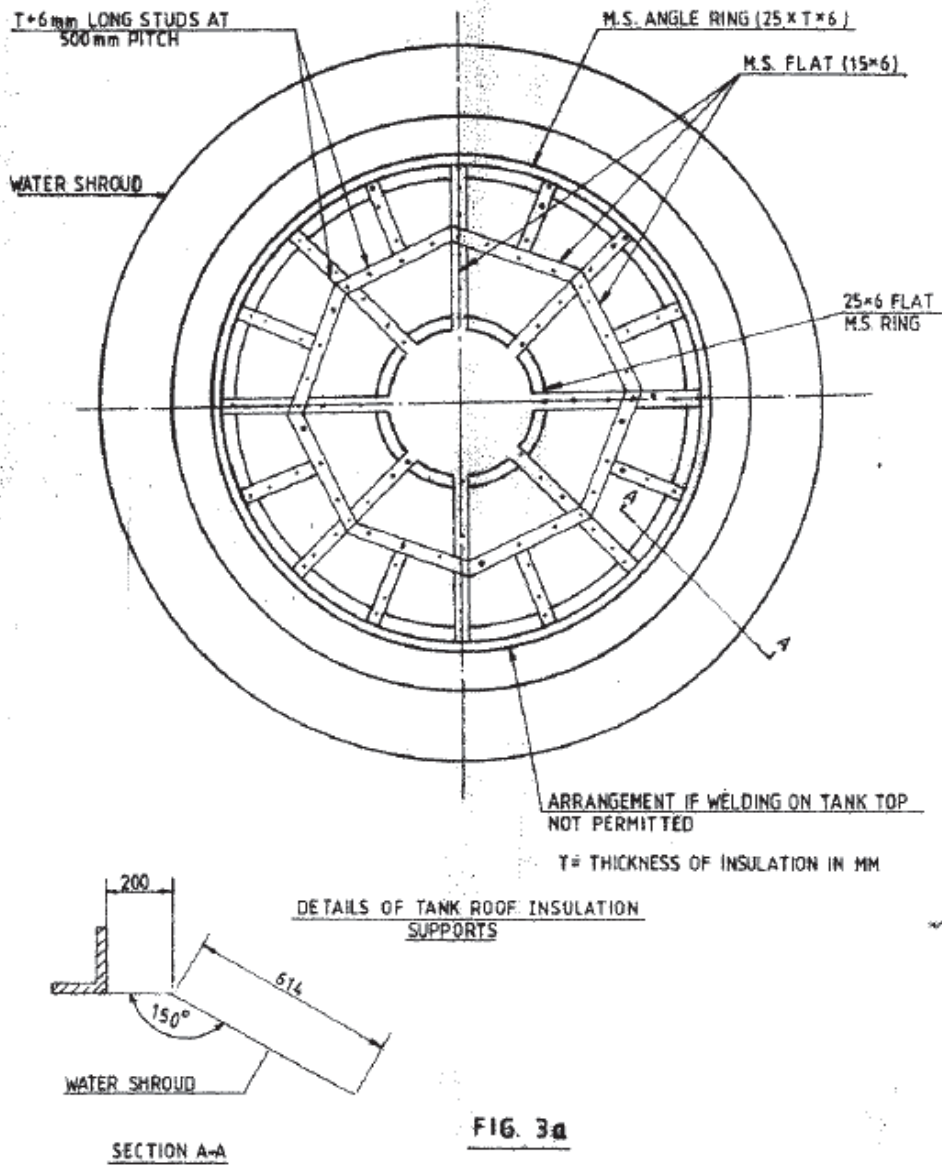
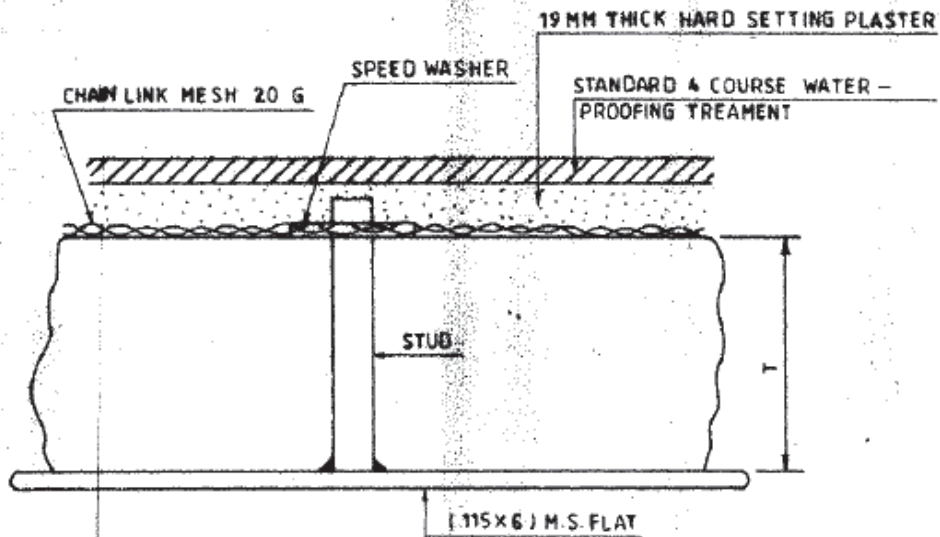


FIG. 3 Methods of fixing mineral wool blankets

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T = THICKNESS OF INSULATION IN MM.

DETAILS OF TANK TOP SETTING PLASTER FINISH

FIG. 3b

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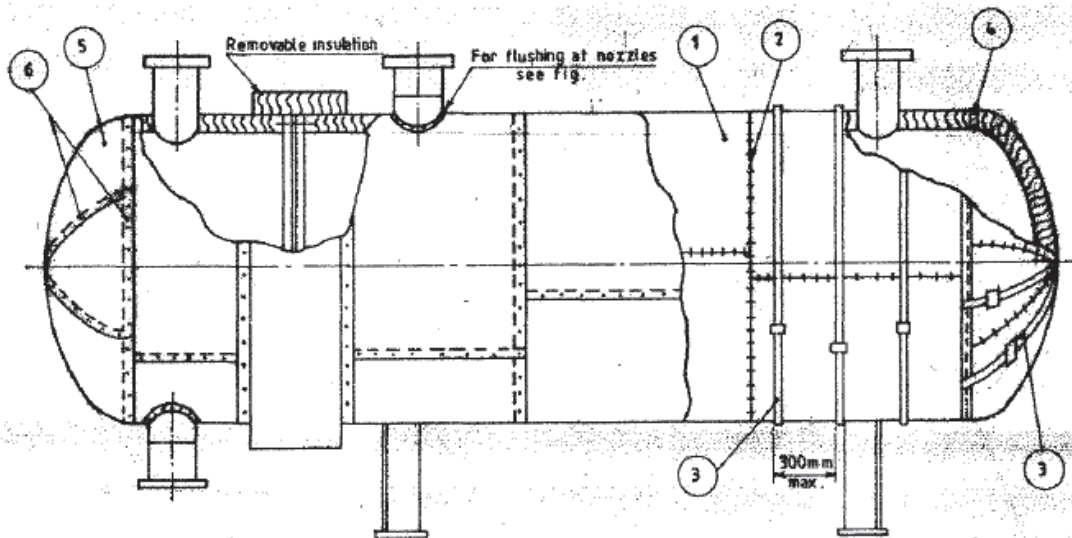


FIG. 4 HORIZONTAL VESSELS AND EXCHANGERS-HOT INSULATED

1. Insulation material blankets or blocks
2. Hog clips spacing 100mm (When blanket insulation)
3. Band ϕ 20 \times 0.5
4. Angle ring and brackets
5. Aluminium jacket
6. Self tapping screws



**TECHNICAL SPECIFICATION
THERMAL INSULATION – HOT SERVICE**

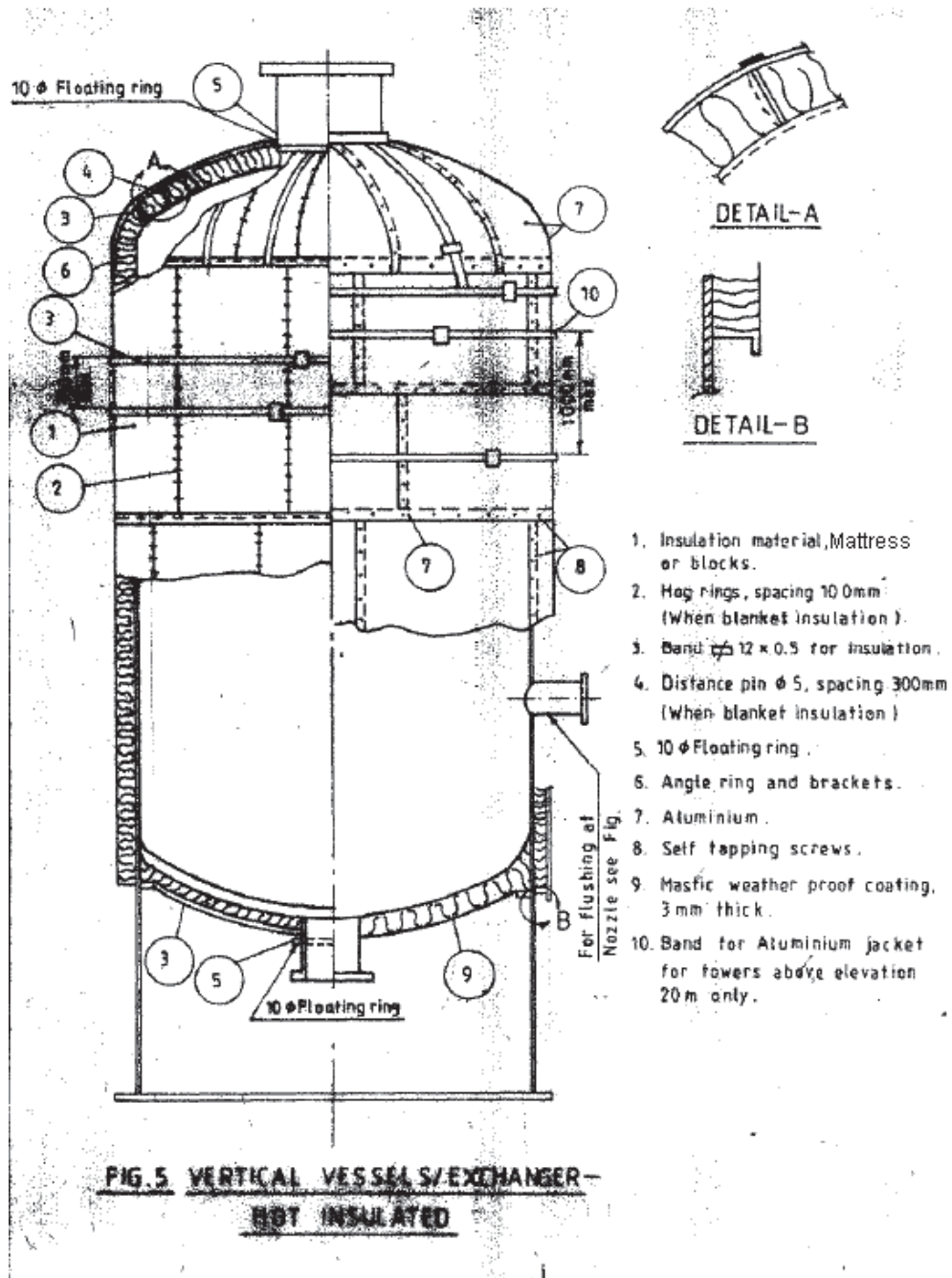
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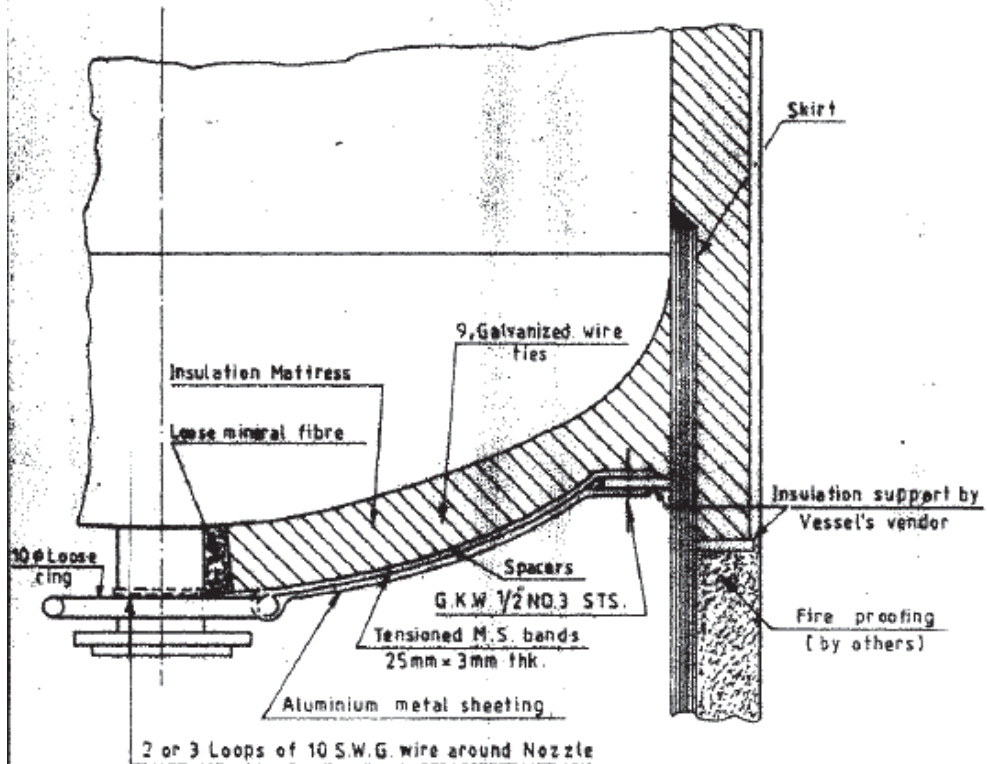
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**FIG. 6 BOTTOM HEAD WEATHER PROOFING
FOR VERTICAL VESSELS**

**TECHNICAL SPECIFICATION
THERMAL INSULATION – HOT SERVICE**

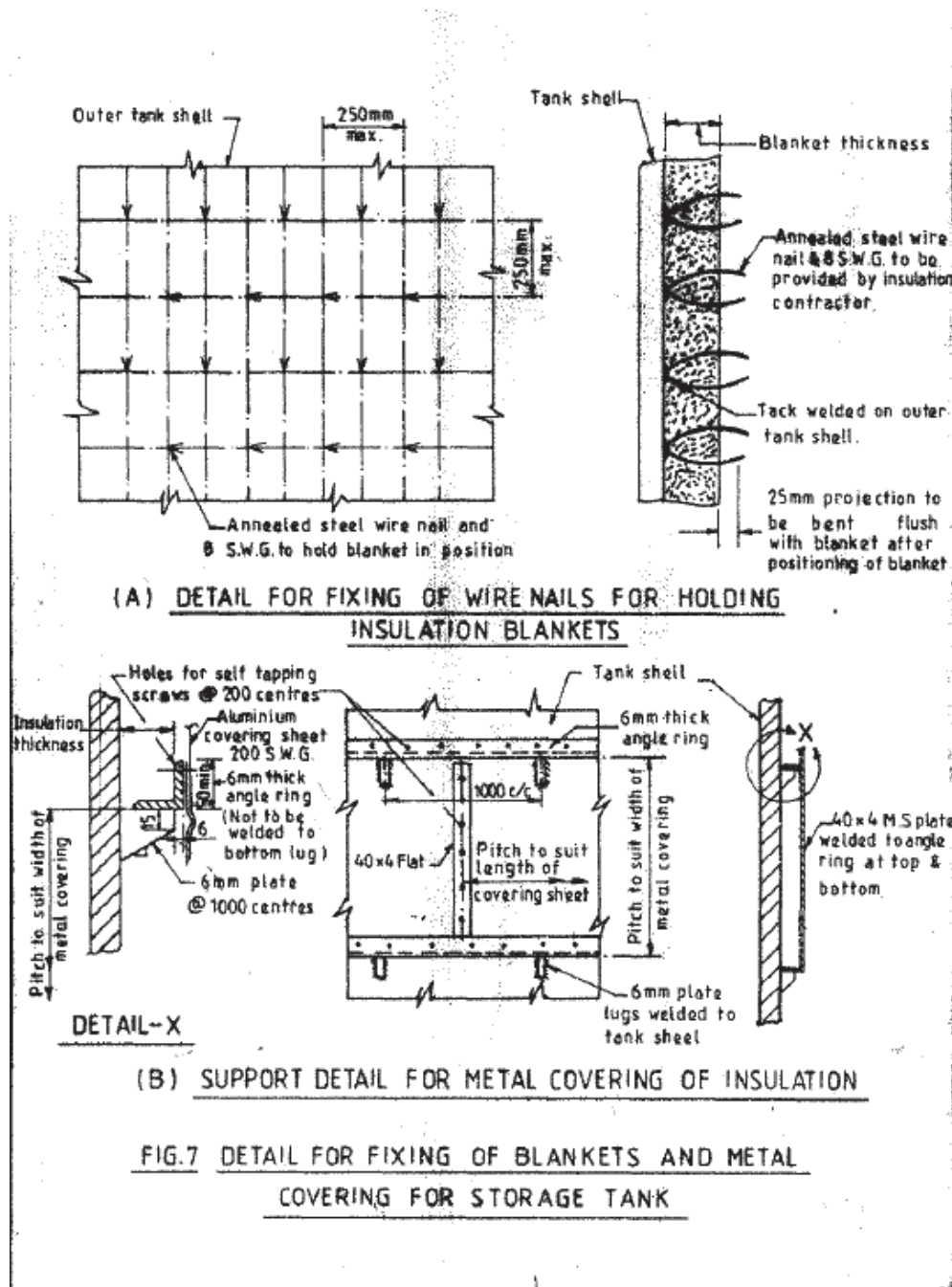
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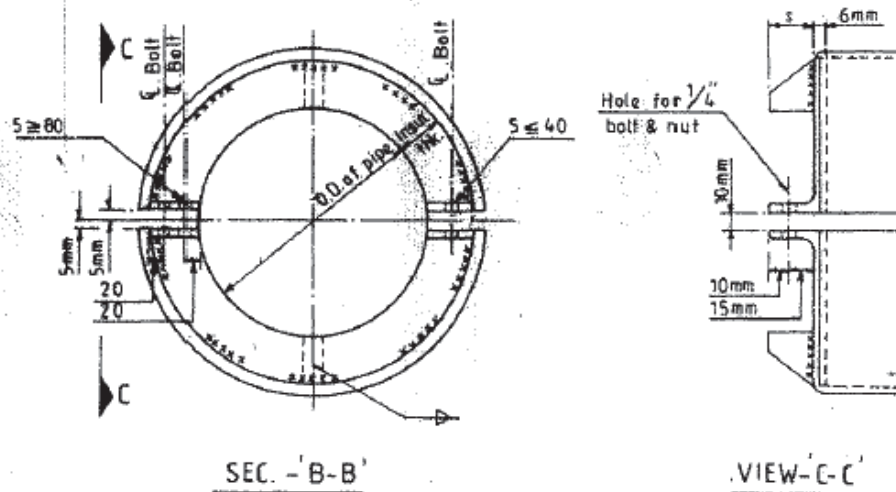
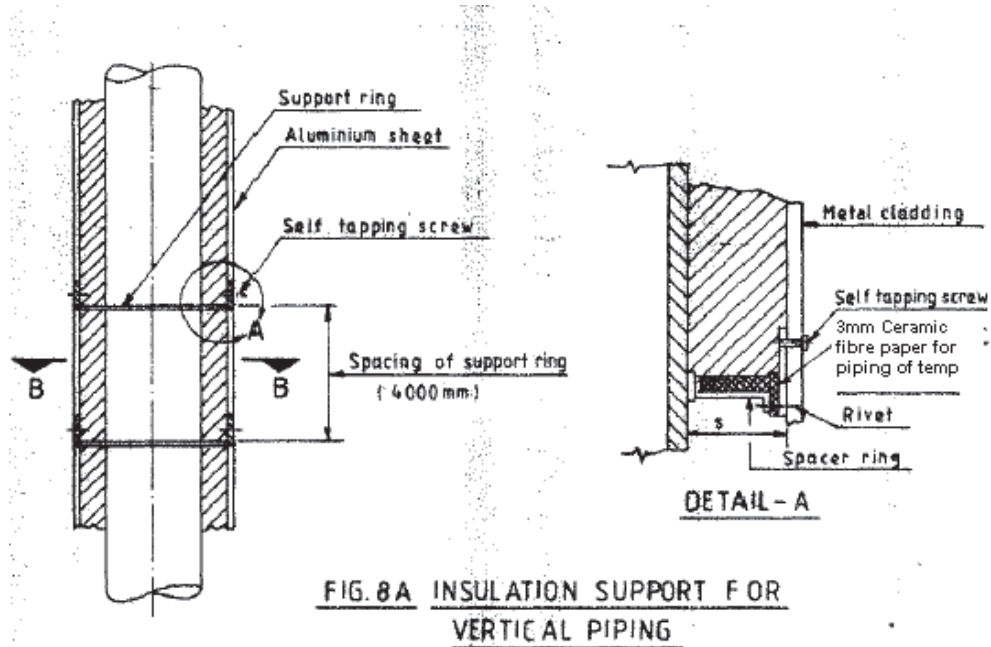
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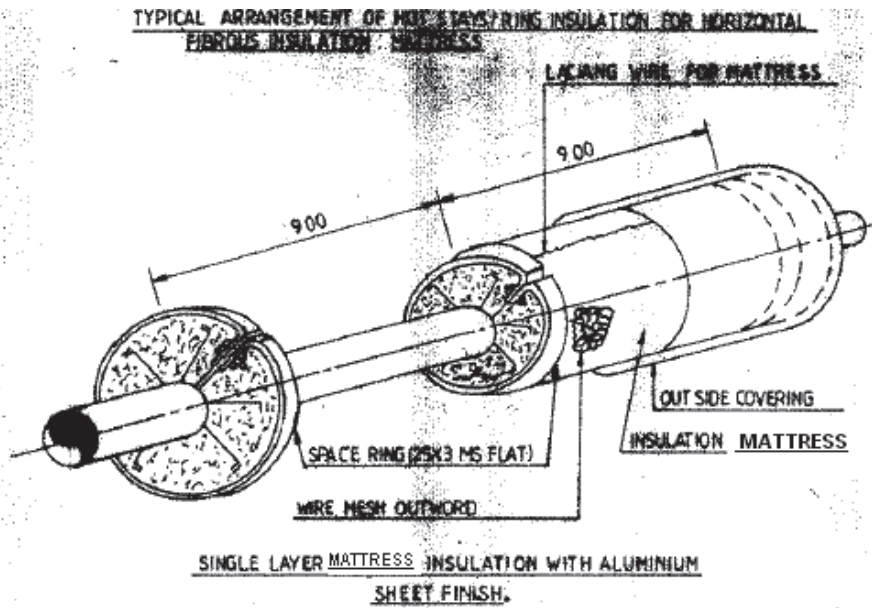


FIG. 8 c

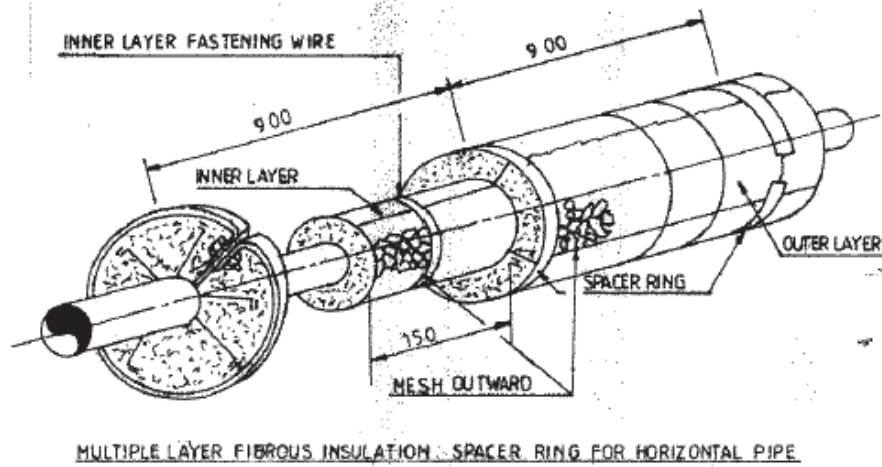


FIG. 8 d

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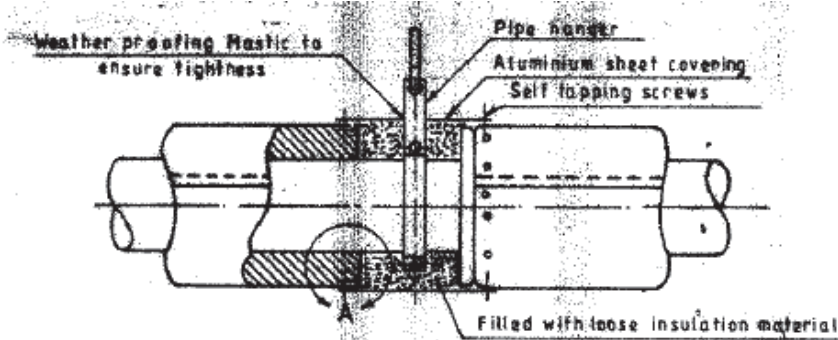
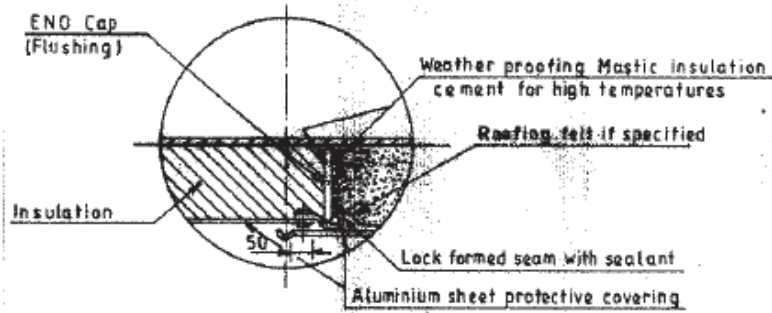


FIG.9 HANGER SUPPORT (Hot service)



DETAIL-A

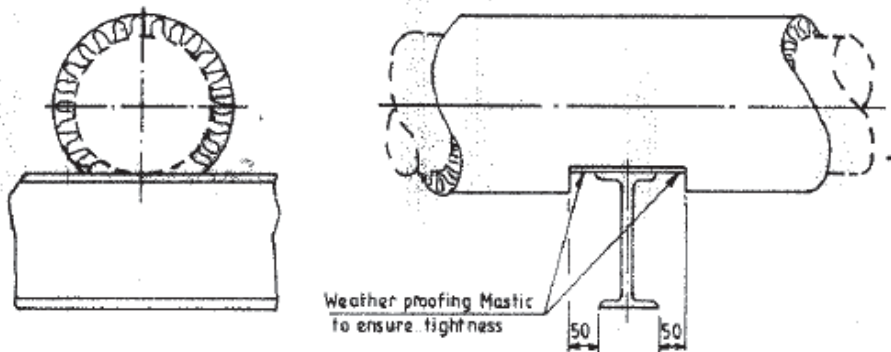



FIG.10 RESTING SUPPORT (Hot service)

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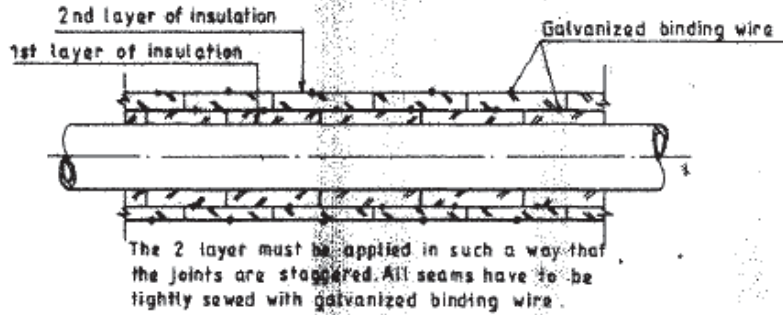


FIG.11 DOUBLE THICKNESS INSULATION

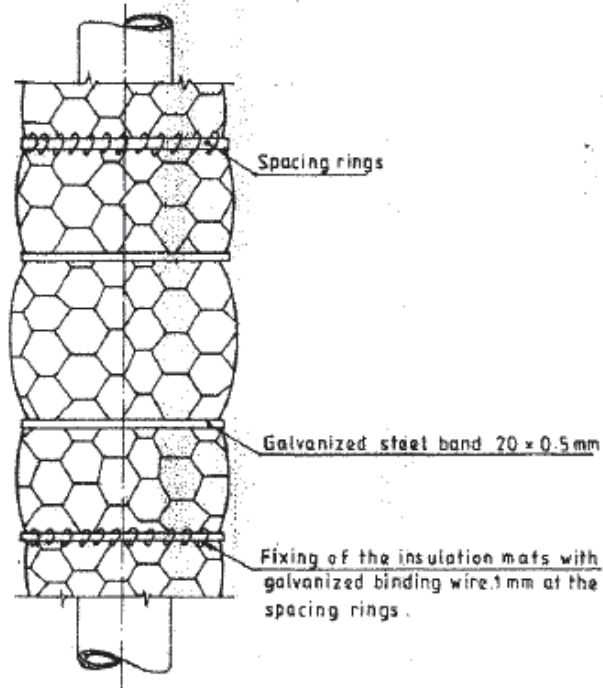



FIG.12 APPLICATION OF INSULATION MATS ON VERTICAL LINES

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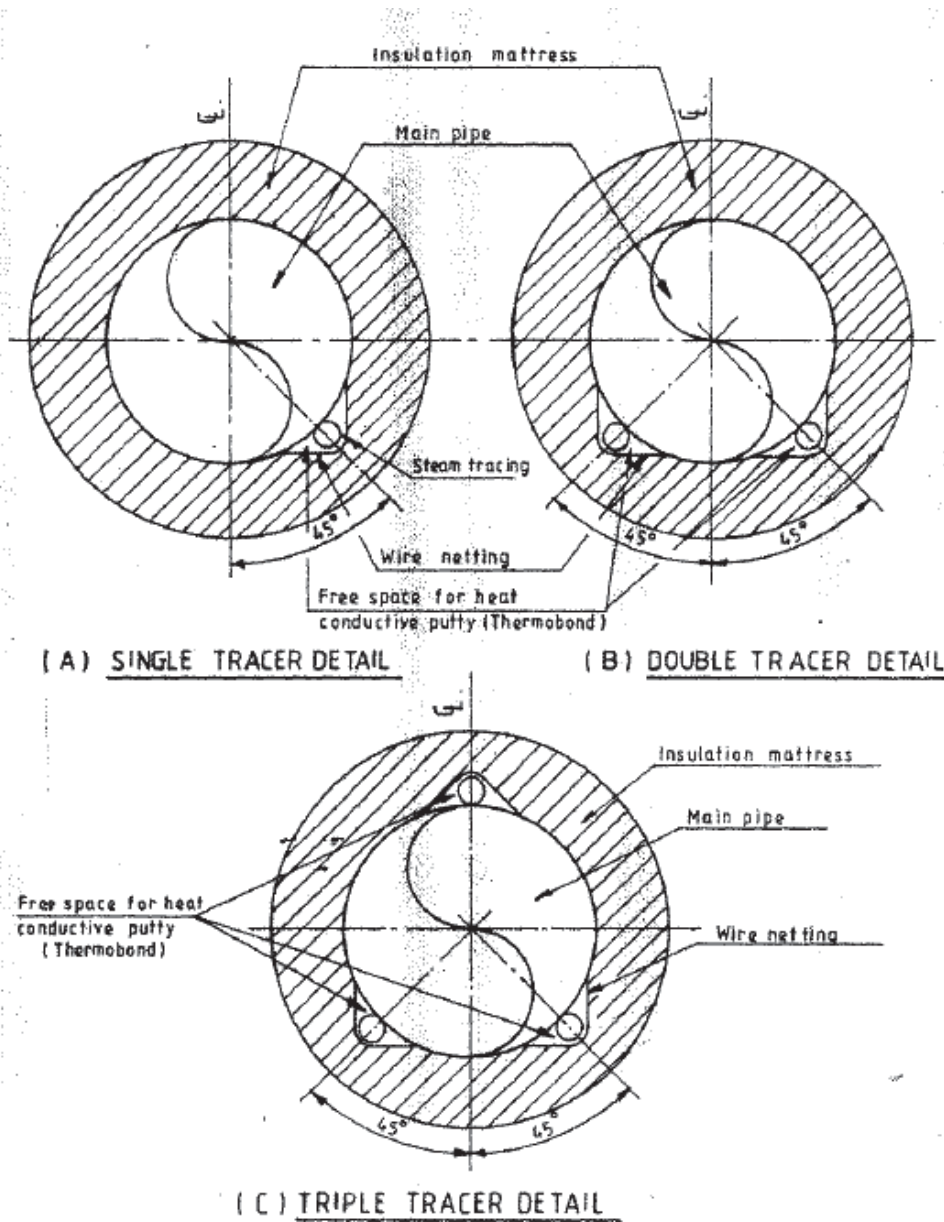



FIG.13 STEAM TRACING INSULATION

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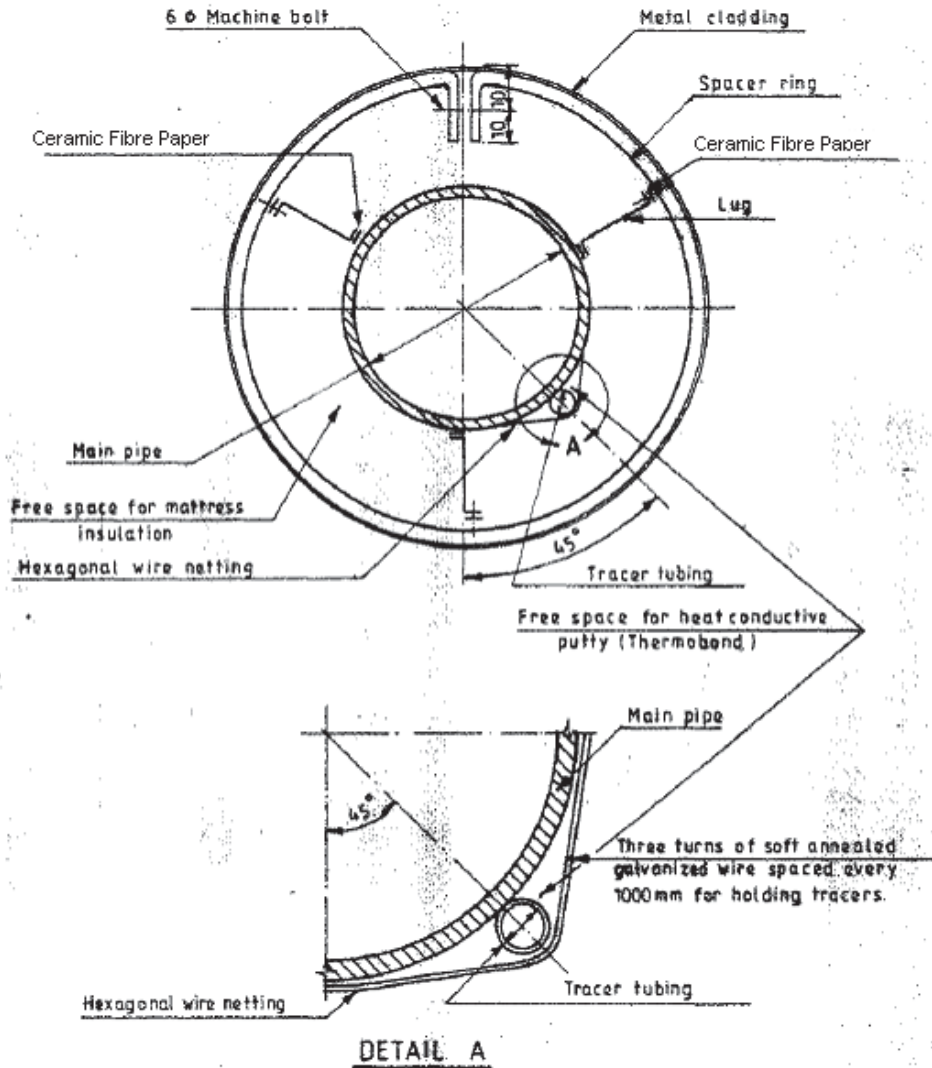


FIG.14 DETAILS OF INSULATION ON STEAM TRACING
(WITH SPACER RING)

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TECHNICAL SPECIFICATION
FOR
THERMAL INSULATION
COLD SERVICE

P	09.12.2022	FOR COMMENTS	V	NS	HOD
REV	DATE	PURPOSE	PREPD	REVWD	APPD

	TECHNICAL SPECIFICATION THERMAL INSULATION – COLD SERVICE	TS-6702	P
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- 1.2 Reference Standards
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- 3.2 Extent of Insulation
- 3.3 Insulation Procedure
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 - 3.3.1.1 General
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 - 3.3.3 Piping
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1.0 GENERAL

1.1 SCOPE

This standard covers the requirement for supply and application of materials for cold insulation of equipment, piping and other items except Horton sphere.

1.2 REFERENCE STANDARDS

TS-6700	Thermal Insulation – General Requirements
IS:14164	Code of Practice for Industrial Application and finishing of thermal insulation Materials at temperatures - 80°C to 750° C.
IS:12436	Specification for preformed rigid Polyurethane and Poly-isocyanurate foams for thermal insulation.
IS : 13205	Specification for Cast-in-Situ Polyurethane and Polyisocyanurate Foams for Thermal Insulation
ASTM C-680	Standard Practice for Heat Loss or Gain and Surface Temperature.

1.3 DEVIATION

Should unforeseen difficulties arise to comply with requirements of this standard.

- Alternative materials and application techniques superior to the requirements of this standard may be submitted with complete details for approval of Owner.
- In case of contradiction between requirements of this standard and the NIT/work order, the latter will be followed.

1.4 LIMITATIONS

Temperature Limits

This standard deals with insulations applied externally on piping's/equipments etc. for working temperatures between -180°C to 20°C.

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2.0 MATERIAL REQUIREMENTS

2.1 INSULATION MATERIALS

2.1.1 General

Whenever reference to any standard is made it is presumed that the latest revision as on date should be considered.

2.1.2 Specification and other requirements as per below:

- Polyurethane / Polyisocyanurate Cast-in-Situ application of density 36 ± 2 kg/m³, thermal conductivity 0.03 W/mK (0.026 kcal/m²hr) at 50 °C mean temp Or 0.023W/mK (0.020 kcal/m²hr) at 10°C to be applied over pipes, tanks and equipments upto -50 °C.
- Cleaning of the surface and preparation for cold insulation as per standard practice shall be done by contractor
- Application of bituminous primer as per standard practice.
- Fixing of 20 SWG (0.91mm) Aluminium Sheet cladding with the help of PUF blocks as per standard practice for cold in-situ insulation.
- Cast in-situ work of PUF insulation for 100mm thickness and density 36 ± 2 kg/m³.
- Application of metal sealant/vapor barrier as per standard practice for cold insulation to avoid ingress of moisture.
- Application of 3/4" x 20/22 SWG Aluminium Band (approx. 36 Nos.) Over the insulation in position as per requirement & as per standard practice for Horton sphere insulation.
- Ammonia Chiller. Required thickness of PUF insulation 100mm.
- Synthesis Gas Pipeline (12") from Purifier to Synthesis Compressor:
- Required thickness of PUF insulation 100mm.
- Misc Piping: Pipes of sizes 1", 4", 6" & 8" to be insulated with PUF of thickness 55, 80, 85 & 100 mm respectively.

NOTE:

In case of dual temp application where the system is expected to be steam cleaned or where the temp may rise occasionally beyond 120 deg C, first layer of bonded mineral wool as per IS:8183 of suitable thk to ensure interface temp. <100 deg C.

2.2 AUXILIARY MATERIALS:

2.2.1 Paints

- a) Asphaltic/Bitumen base primer density about 1200 kg/cu.mtr (IS:1322)

2.2.2 Joint Sealer

MAS-35 or Foster 30- 45.

2.2.3 Coating and vapour seal mastic

MAS- 130 or Foster 60 - 35coating.

2.2.4 Banding wire

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Wire for securing insulation shall be galvanized, soft, annealed steel wire of 1.625 mm diameter.

- 2.2.5 Bands or straps for securing insulation material aluminium or S.S. 20x0.5mm thk. For spherical surfaces only S.S. bands shall be used.
- 2.2.6 Reinforcing fabric (for cold insulation) 10x10x5 micron mesh glass fabric
- 2.3 Insulation material, joint sealer, vapour seal mastic and glass fabric shall be approved by PDIL.

3.0 APPLICATION

3.1 THICKNESS OF INSULATION

Insulation thickness shall be as specified in the insulation schedule/specification prepared for equipments/piping. Wherever the thickness is not indicated the same may be selected from Table – I.

3.2 EXTENT OF INSULATION

For cold service all portions of piping, connections for drains, instrument connections, sample points along with valve flanges etc. shall be insulated, only name plates of equipments will be kept visible.

3.3 INSULATION PROCEDURE

3.3.1 Surface Preparation

The surface of the tanks, vessels, piping and valves etc. on which cold insulation is to be applied shall be free of dust, loose paints or any other foreign matters.

3.3.2 Vessels and Columns

3.3.2.1 General

In general, vessels and columns for cold services shall be insulated by “in situ” application as per IS: 13205 specifications.

Suitable curved blocks or mitre-cut blocks of Specified thickness to fit the diameter of the vessels shall be employed. Insulation blocks shall be installed with all joints staggered and tightly butted. Joints shall be carefully fitted and filled with a joint sealer. The inner most layer is normally dry-set however with joints duly sealed with sealant.

All butt edges and ends of the blocks shall be sealed with recommended thickness of Joint sealer.

Final layer of insulation shall be secured in place with bands at 300 mm centers, Ref. Fig. 1. Band shall be provided with band-seals. When banding is impracticable banding wire shall be used. Inner layers, however require to be held in place using pressure sensitive adhesive tapes.

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When multi layers of insulation is required the outer layer shall have side and end joints staggered over proceeding layer, so that two joints do not coincide and each layer shall be separately secured in place.

For Cast-in-Situ application, spacer blocks equal to the thickness of insulation to be applied over the vessel / tank surface at 300mm centre to centre and held in position with aluminium bands. Aluminium sheet cladding to be fixed over the spacer blocks and band applied over it. Holes will be drilled through the aluminium cladding and chemicals will be poured. The procedure to be from bottom to top. Finally the holed to be capped.

Insulation for hand holes, manholes etc. shall be carried out in semi-removable construction as shown in Fig. 2.

Nozzles in cold service shall be insulated as shown in Fig. 2 & 3.

3.3.2.2 Vessel Heads

Insulation on heads shall be secured by radial bands from a floating ring (made by 2-3 loops of wire) centred at the crown of head and tied to a circumferential band placed approx 300 mm inside the tangent line on insulation O.D.

Supporting legs and skirts shall be insulated simultaneously with the insulation of the vessel. The insulation shall be extended on the legs up to a length equal to four times the insulation thickness. The insulation thickness on the supports shall have the same thickness as that of the vessel and shall be laid starting from the supporting plate welded to the vessel. The insulation shall be sealed with mastic carefully.

In case the vessel is resting on a metal plate skirt, the skirt shall be insulated as shown in Fig. 1.

3.3.3 Machineries like pumps, turbines, Compressors etc.

In general these will be insulated in such a way that the same is of removable pad type to easy maintenance. (The contractor shall supply insulation detail to engineer-in-charge for approval). All such Insulation normally cannot be re-used.

3.3.4 Piping

a) General

Insulation shall be applied to piping in the form of moulded pipe sections (upto 14" NB pipe dia) covering of specified thickness with all successive layers of insulation with cut slab pieces staggered and tightly butted and sealed with recommended thickness of joint sealer. In general application of various pipes shall be as per Fig. 5. For typical details of supported horizontal lines Ref. Fig. 6.

The final layer of insulation shall be secured with aluminium bands at 300 mm centers on all pipe covering.

In single layer application for temperatures below 0°C shiplap finished edge pipe sections are to be used.

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For Cast-in-Situ applications suitable cavity to be formed over the pipe surface equivalent to the thickness of insulation by placing insulation blocks over the pipe surface fixed with adhesives placed at 300mm centre to centre & held in position by applying bands. Aluminium sheet cladding will be fixed over the spacers and held in position with self tapping screws & bands. Finally insulation chemicals will be poured through drilled holes on the cladding. The drilled holes to be finally sealed with caps. Application shall be in compliance with IS: 13205 specifications.

Flanges, valves and other fitting shall be insulated employing larger sections of pipe covering the same specified thickness as for adjacent pipes as illustrated in Fig. 6. Bends shall be insulated with mitre-cut insulation to suit the curvature of the bend. Valves shall be insulated upto the backing gland.

3.4 WEATHER PROOFING

3.4.1 Vapour Seal Mastic

- a) After insulation is installed, before jacketing over it, heavy adhesive coat vapour seal mastic shall be applied by spraying, brushing or trowelling. While still tacky, glass fabric shall be laid smooth and embedded in the coating. Care must be exercised that weave does not rupture and fabric is overlapped 75mm at joints. A final coating of vapour seal mastic shall be applied over the glass fabric uniformly to give a total dry thickness of as per recommendation.
- b) Junctions of insulation at supports shall be vapour sealed as follows:

While the second coat of vapour seal mastic is still tacky at the support, a 300 mm. wide glass fabric shall be laid smooth and embedded in the coating. The fabric shall overlap at least 75mm at the joint. A second coat of vapour seal mastic is applied over the glass cloth as in para 3.4.1 (a).
- c) Subsequently a 25 mm thick bonded mineral wool blankets shall be applied tightly over the vapour seal mastic and fixed with 20 x 0.5 thk. bands at a spacing of 300 mm.
- d) The insulation shall be finished with aluminium Cladding with inner side (in contact with insulation) coated with 3 mil thick polysurlyn.

INSULATION THICKNESS TABLE FOR COLD INSULATION

DESIGN CRITERIA

AMBIENT TEMPERATURE	:	35 Deg. C
RELATIVE HUMIDITY	:	85%
SURFACE TEMPERATURE	:	33 Deg. C
WIND VELOCITY	:	1 m/s
DESIGN HEAT GAIN	:	10-12 Kcal/hr.m ²

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MATERIAL : POLYURETHANE (PUF) (Density 36±2Kg/m3) /
POLYISOCYANURATE
(PIR) FOAM (Density 32±2Kg/m3)

OPERATING TEMPERATURE (Deg. C)																	
DN(M M)	20	10	10 - 00	-01- -10	-11-- -20	-21- -30	-31- -40	-41- -50	-51- -60	-61- -70	-71- -80	-81- -90	-91 - 100	-101- -120	-121- -140	-141- -160	-161 - -180
15	25	30	40	50	55	65	70	80	85	95	100	110	115	135	155	180	195
20	25	35	45	55	60	70	75	85	90	100	110	115	125	145	165	190	205
25	25	35	45	55	65	75	80	90	100	105	115	125	130	150	170	200	215
32	25	40	50	60	70	80	85	95	105	115	120	130	140	160	180	210	225
40	25	40	50	60	75	85	90	100	110	120	125	135	145	165	190	220	235
50	25	40	55	65	80	90	95	105	115	125	135	145	155	175	200	230	245
65	30	45	55	70	80	90	100	110	120	130	140	150	160	180	210	245	265
80	30	45	60	75	85	95	105	115	130	140	150	160	175	195	220	260	285
100	30	50	65	80	90	100	115	125	135	150	165	175	190	210	235	270	300
125	30	50	65	85	95	110	120	135	145	155	170	180	195	215	250	285	320
150	35	50	70	85	100	115	125	140	150	170	175	195	210	230	270	300	325
200	35	55	75	90	105	120	135	150	165	175	190	210	215	235	280	310	335
250	35	60	80	95	110	125	140	155	170	190	205	215	230	250	295	315	350
300	35	60	80	100	115	135	150	165	185	195	210	220	235	260	305	330	360
350	35	60	80	100	120	135	150	165	185	195	210	225	240	270	315	345	375
400	40	65	85	100	125	140	155	170	185	195	210	230	245	280	320	360	395
450	40	65	85	105	125	140	160	175	190	210	225	235	250	285	325	375	405
500	40	65	85	105	125	140	160	175	190	210	225	240	255	285	325	380	415
550	40	65	85	110	125	140	165	180	195	210	225	240	255	290	335	380	425
600	40	65	85	110	125	145	165	180	195	215	230	255	270	300	345	390	425
>600 / Flat Surface	40	65	85	110	125	145	165	180	200	220	245	260	285	320	360	405	440

Note: - 1.Flat surfaces include Equipments and large dia pipes(DN>600).
2.Upto 60 mm thickness only single layer of Insulation shall be used.

TECHNICAL SPECIFICATION THERMAL INSULATION – COLD SERVICE

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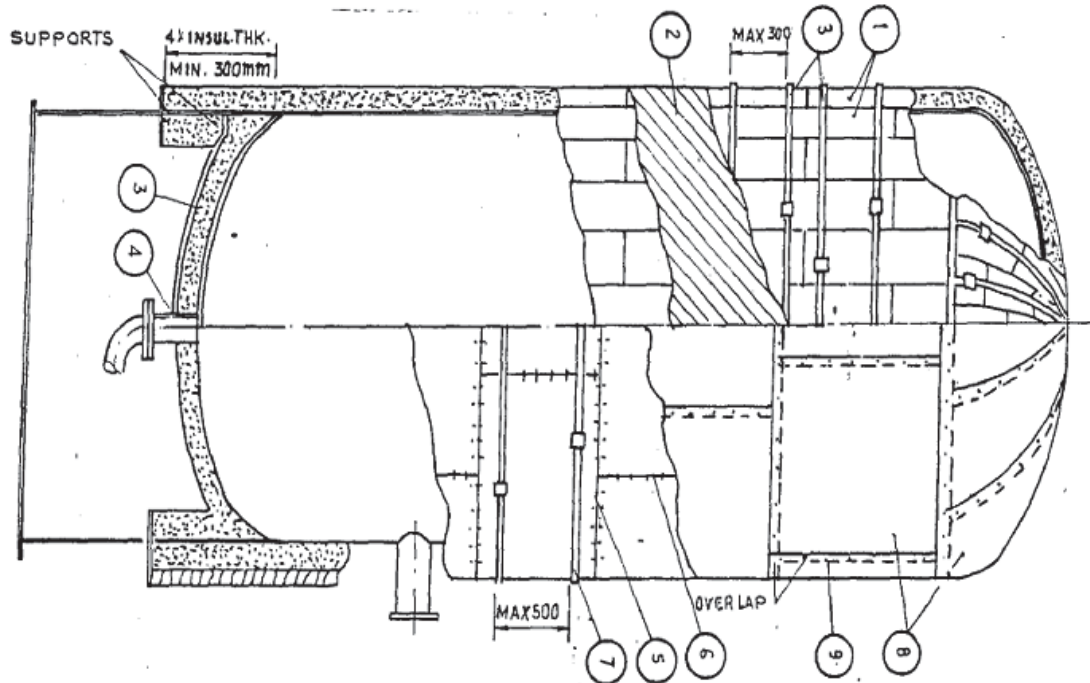
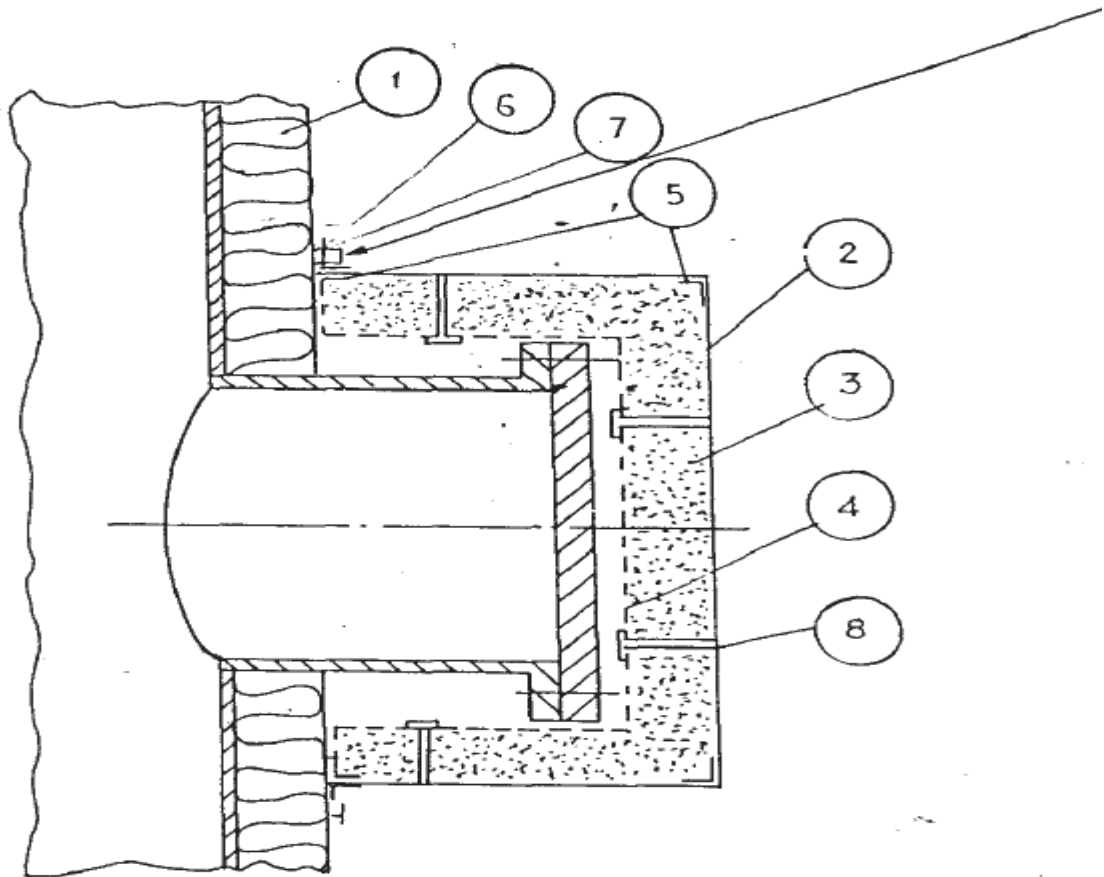


FIGURE - I
COLD INSULATED VESSELS

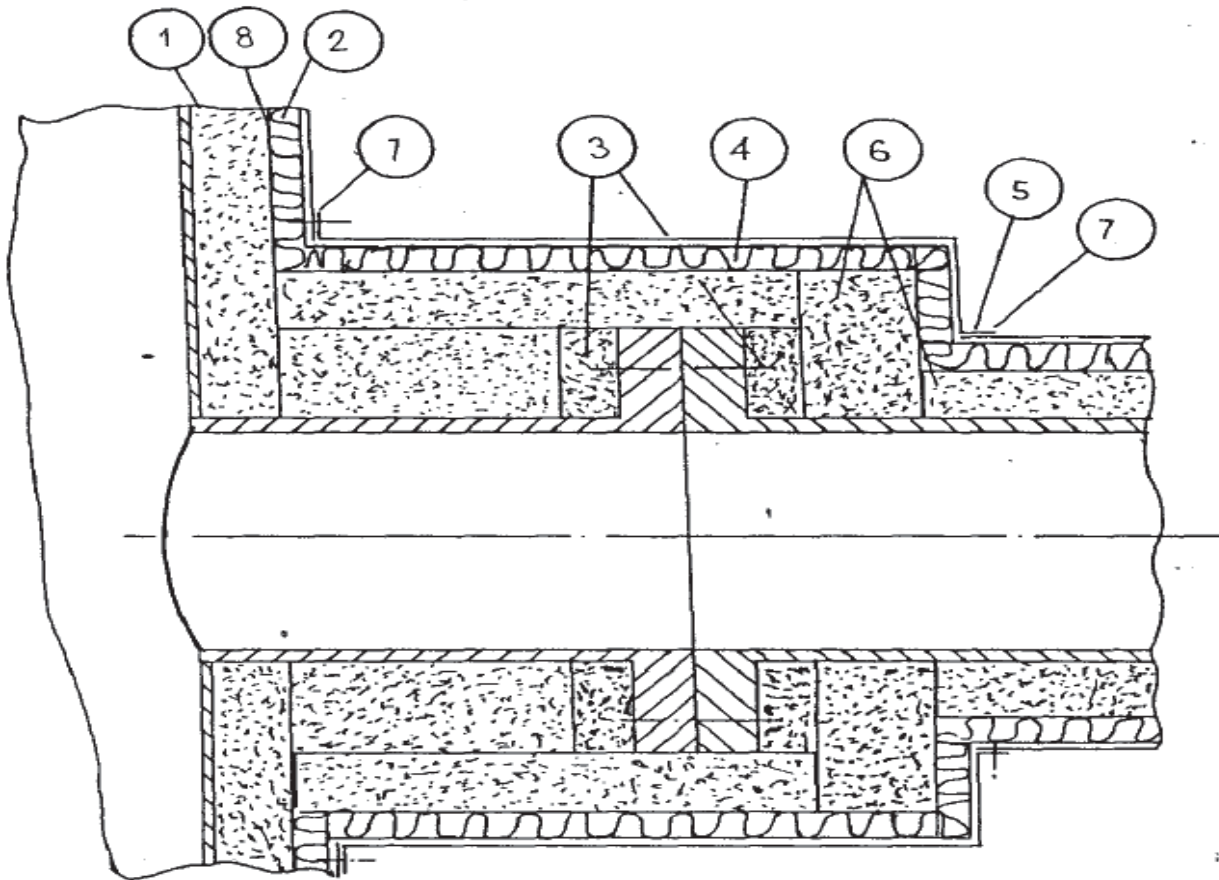
- | | |
|---|-----------------------------|
| 1. INSULATION. | 6. HOG RINGS, SPACING 100MM |
| 2. VAPOUR Barrier | 7. BAND FOR MINERAL WOOL |
| 3. BAND FOR POLYURETHANE SEC. | 8. ALUMINIUM JACKET |
| 4. Glows Cloth | 9. SELF TAPPING SCREWS. |
| 5. 25 mm BONDED MINERAL WOOL WITH WIRE MESH | |

FIG. - 2
REMOVABLE GAP FOR MANHOLE AND HANDHOL



1. FIXED INSULATION
2. REMOVABLE HOOD
3. INSULATION
4. GALV. WIRE MESH
5. SECTIONAL REINFORCEMENT OR ANGLES.
6. WEATHER PROOFING MASTIC
7. SNAP FASTENER
8. CLIPS TO FIX INSULATION TO HOOD

FIG.-3

 PIPE TO VESSEL CONNECTION OF COLD
INSULATED VESSELS


1. INSULATION BLOCK.
2. 25 mm BONDED MINERAL WOOL BLANKET FOR PROTECTION OF VAPOUR SEAL
3. RAW STUFFING MATERIAL
4. ALUMINIUM JACKET
5. SELF TAPPING SCREWS
6. PLASTIC SEALER
7. WEATHER PROOFING MASTIC
8. VAPOUR SEAL

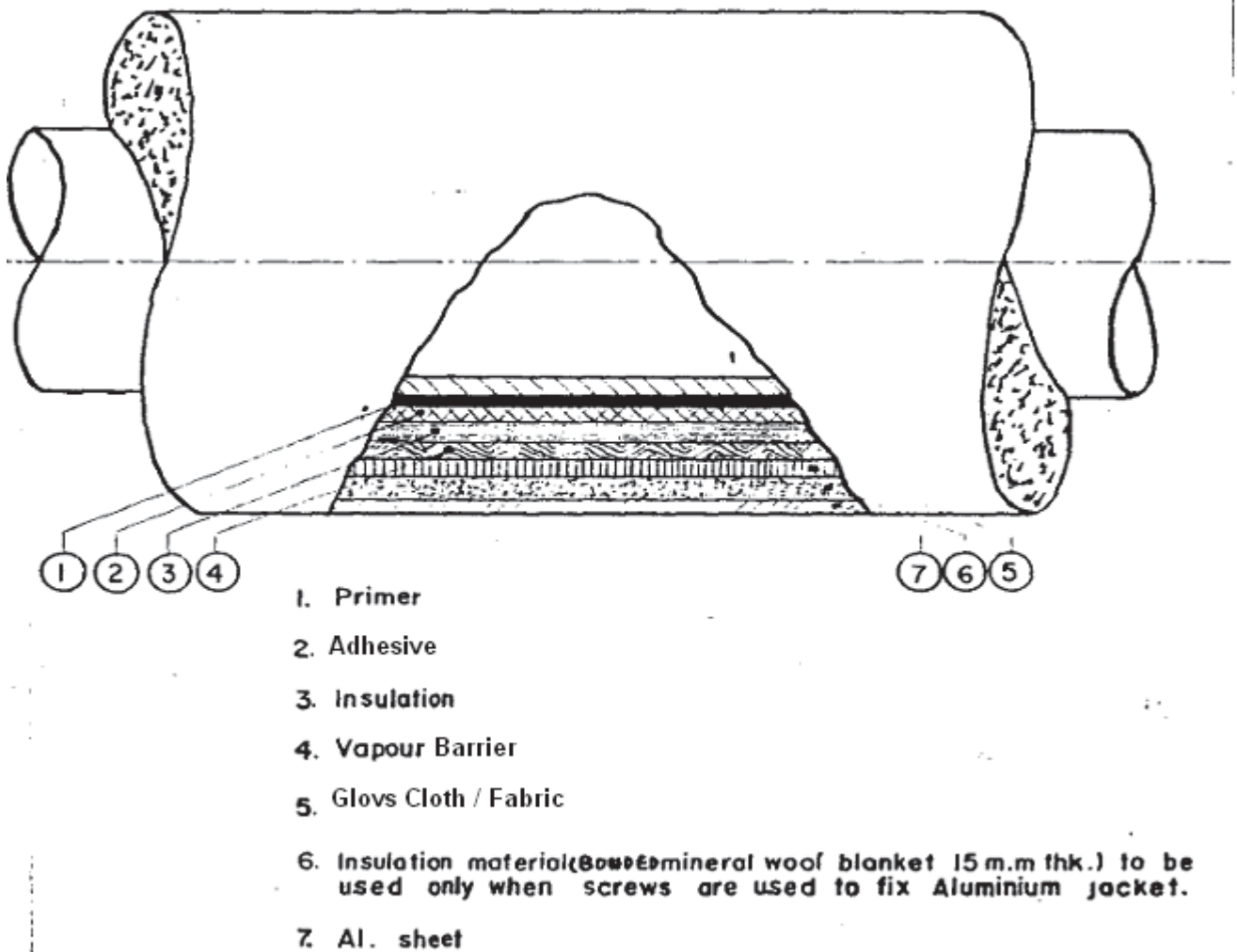


Fig. 4 Different Layers of piping Insulation (Cold service.)

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THERMAL INSULATION – COLD SERVICE**

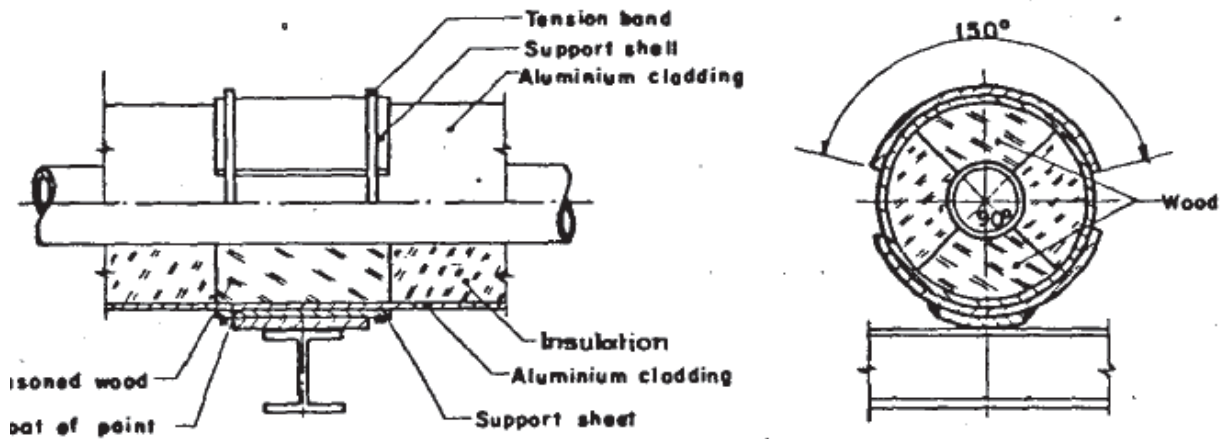
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FIG.-5 COLD INSULATION - SUPPORTED HORIZONTAL LINES

Notes:

- (1) Material for support sheet – Carbon steel
- (2) The length of the wood underlayer equals the length of the support sheet

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PART II: TECHNICAL

ANNEXURE— AA

PESO APPROVED DRAWINGS & DOCUMENTS

**PLANT: NATIONAL FERTILIZERS LIMITED, NFL, NANGAL,
PUNJAB**

**PROJECTS: PMC SERVICES (PRE & POST LSTK AWARD)-
NEW 2500M3 HORTON SPHERE FOR STORAGE OF
AMMONIA AT NFL, NANGAL**

0	10.07.2024	10.07.2024	ISSUED FOR TENDER	AK	SKM	PK
REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD



भारत सरकार

भारत सरकार/Government of India

वाणिज्य और उद्योग मंत्रालय/Ministry of Commerce & Industry

पेट्रोलियम तथा विस्फोटक सुरक्षा संगठन (पेसो)/Petroleum & Explosives Safety Organisation (PESO)

पांचवा तल, ए-ब्लॉक, सी.जी.ओ.कॉम्प्लेक्स, सेमिनरी हिल्स

नागपुर- 440006

5th Floor, A-Block, CGO Complex, Seminary Hills,

Nagpur - 440006

ई-मेल/E-mail : explosives@explosives.gov.in

फोन/फैक्स/Phone/Fax No : 0712 -2510248, Fax-2510577

संख्या /No : A/S/HO/PB/03/383 (S109537)

तारीख/Dated : 14/12/2023

सेवा मे/To,

M/s. NATIONAL FERTILIZERS LIMITED,
National Fertilizers Limited- Nangal Unit,,
Naya Nangal
Naya Nangal,
Nangal,
Taluka: Nangal,
District: RUPANAGAR
State : Punjab
PIN : 140126

विषय/Sub : 72NFL nangal जिला : ,Nangal,Taluka : Nangal,District : RUPANAGAR राज्य : , State: Punjab PIN : 140126 में AMMONIA गैस के प्रेशर वेसल्स में प्रस्तावित भंडारण - स्थिर एवं गतिशील दाब पात्र (अज्वलित) नियम, 2016 के अंतर्गत प्रस्ताव का अनुमोदन जारी करने हेतु।

Proposed storage of AMMONIA in pressure vessels in the bottling plant at Village -72NFL nangal,Nangal,Taluka : Nangal,District : RUPANAGAR, State: Punjab PIN : 140126 Grant of approval of under SMPV (U) Rules, 2016.

महोदय/Sir(s),

कृपया अपने पत्र संख्या OIN1518876 दिनांक 15/11/2023 का अवलोकन करें।

Reference: your letter No. OIN1518876 dated 15/11/2023

संदर्भित पत्र के साथ विषयांतर्गत प्रस्ताव के बारे में प्राप्त निम्नलिखित ड्राइंग इस कार्यालय के अनुमोदन के अनुसार पाया गया तथा ड्राइंग के दो सेट विधिवत पृष्ठांकित कर भेजे जा रहे हैं।

The following drawings received with your letter under reference in respect subject proposal meets with the approval of this office and two set thereof is sent herewith duly endorsed.

Sr No	Drawing Date	Drawing Number	Drawing Description
1	12/09/2023	PC281-4611-1000 CAD version	Any Other Drawing
2	14/11/2023	PC-281-4611-1000	Any Other Drawing
3	22/07/2023	4811-921	Site plan drawing
4	14/11/2023	PC-281-4611-1000, Rev. PA	Installation detailed drawing
5	22/07/2023	1	Site layout with 100 meters / 500 meter premises around installation
6	16/02/2023	PC281-4040-PID-0020, Rev. 0	P&ID for vessel, equipment and system proposed to be installed

Conditions of the Approval:-

Prior approval may be granted with following conditions, (1) To start the construction of proposed installation only after obtaining NOC from District Magistrate / Authority. (2) DM NOC along with drawing to be obtained LSDA Module only, shall forward to the Chief Controller of Explosives, Nagpur as per Rule 47 of SMPV(U) Rules 2016. (3) In final drawing, following details to be shown. (a) To provide water sprinkler arrangement in Pump/compressor shed and same to be shown in final layout drawing. (b) Safety kits room containing self birthing apparatus at near entry gate shall be provided and same to be shown in the final drawing. (c) All uploaded final drawings to be signed and sealed by the authorized person of the organization. (4) Copy of approved fabrication drawing as well as letter of Ammonia storage vessels along with COC of the vessels to be uploaded. (5) Vessels serial nos. as well as CCE approval no. to be mentioned in final drawing.(6) Details of safety facilities i.e. gas detector, fire hydrant / monitors, EDSs, self breathing apparatus, number and their location to be mentioned in tabular form in layout drawing. (7) Compliance of recommendation of HAZOP study and QRA report to be submitted.(8) In final site plan, location and capacity of water storage tank/s shall be shown. (9) Adequate precautions shall be taken during the work at site to avoid any unwanted incidents. (10) After grant of license, premises shall be used for storage of Ammonia.

आपको अनुमोदन के लिए निम्नलिखित अतिरिक्त चित्र और दस्तावेज जमा करने का अनुरोध किया गया है।/You are requested to submit the following additional drawings and documents for approval .

कृपया नोट करें कि स्टेज इन्सपैक्शन के अंतर्गत मान्यताप्राप्त थर्ड पार्टी इन्सपैक्शन एजेंसी द्वारा संगठन से अनुमोदित डिजाइन ड्राइंग के अनुसार अनुमोदित निर्माता द्वारा वेसल फॅब्रिकेट किया जाएगा।

Please note that the vessels shall be fabricated by an approved manufacturer as per design drawings approved by this department under stage inspection by a recognized 3rd Party Inspecting Agency.

अनुमोदित ड्राइंग के अनुसार सुविधाओं की स्थापना के पश्चात अनुज्ञप्ती जारी करने हेतु, स्थिर एवं गतिशील दाब पात्र (अज्वलित) नियम, 2016 के अंतर्गत प्ररूप एलएस-1क में निम्नलिखित दस्तावेज इस कार्यालय को प्रस्तुत करें।

After installation of the facilities as per the approved drawings,you may submit the following documents for grant of licence in Form LS-1A of SMPV(U) Rules,2016.

1. प्ररूप –एस-1 में आवेदन (तीन प्रतियों में)/Application in Form AS-1.
 2. 'ऐज बिल्ट' साईट, लेआउट, फाउंडेशन, प्रत्येक प्रेशर वेसल के पी एण्ड आई ड्राइंग तथा फॅब्रिकेशन ड्राइंग - की 4 प्रतियां 1/4 copies of 'as-built' site, layout, foundation, P&I drawings and fabrication drawings of each pressure vessel.
 3. नियम 12 के अंतर्गत मान्यता प्राप्त थर्ड पार्टी निरीक्षण एजेंसी द्वारा जारी सर्टिफिकेट ऑफ कंट्रोल (मूल + 2 प्रतियां) जो कि संगठन की वेबसाइट <http://peso.gov.in> पर "सक्षम व्यक्ति" ऑनलाइन मॉड्यूल के माध्यम से बनाया गया हो।/Test & inspection certificates (certificate of control) issued by recognized 3rd Party Inspecting Agency(Original + 2 copies).
 4. नियम 33 के अंतर्गत मान्यता प्राप्त सक्षम व्यक्ति द्वारा जारी किए गए सुरक्षा प्रमाणपत्र (मूल + 2 प्रतियां) जो कि संगठन की वेबसाइट <http://peso.gov.in> पर "सक्षम व्यक्ति" ऑनलाइन मॉड्यूल के माध्यम से बनाया गया हो।/Safety certificates under rule 33 issued by recognized competent person(Original + 2 copies).
 5. नियम 18 और 19 के अंतर्गत वेसल और सुरक्षा वाल्व के आवधिक परीक्षण के प्रमाण पत्र की 3 प्रतियां (नए पात्रों के लिए आवश्यक नहीं।) जो कि संगठन की वेबसाइट <http://peso.gov.in> पर "सक्षम व्यक्ति" ऑनलाइन मॉड्यूल के माध्यम से बनाया गया हो।/3 copies of certificate of periodic tests of vessel and safety valve under rules 18 & 19 (not required for new vessels).
 6. एसएमपीवी (यू) नियम, 2016 के नियम 47 के तहत निर्धारित प्रपत्र के अनुसार जिला प्राधिकरण (एलएसडीए) मॉड्यूल के लाइसेंसिंग सिस्टम के माध्यम से जारी किया गया अनापत्ति प्रमाण पत्र, उनके हस्ताक्षर और मुहर के साथ पृष्ठांकित आरेखण /प्लान के साथ ही। युआरएल : <https://lsda.peso.gov.in/LSDAOnline/Login.aspx> के माध्यम से ऑनलाइन एनओसी आवेदन, ई-फाइलिंग किया जा सकता है।/No objection certificate issued under Rule 47 of the SMPV (U) Rules, 2016 as per prescribed proforma by the District Authority through Licensing System for District Authority (LSDA) module only together with a copy of drawings/plans endorsed with his sign and seal. Online NOC application eFiling may be accessed through URL : <https://lsda.peso.gov.in/LSDAOnline/Login.aspx>
 7. स्थित स्थिर एवं गतिशील दाब पात्र (अज्वलित) नियम, 2016 के तहत ऑनलाइन आवेदन पोर्टल पर उपलब्ध ई-भुगतान सुविधा के माध्यम से अपेक्षित अनुज्ञप्ती शुल्क ऑनलाइन जमा किया जाना है (प्रथम 5000 लिटर या उसके हिस्से के लिए ₹ 5000/- तथा प्रत्येक अतिरिक्त 1000 लीटर या उसके हिस्से के लिए ₹ 2500/-, प्रति वर्ष अधिकतम ₹ 50000/- तक ही सीमित हैं - अधिकतम 5 साल का अनुज्ञप्ति शुल्क स्वीकार्य हैं।) देय शुल्क : एक वर्ष के लिए गैस की कुल **2.5e+006** लिटर जल क्षमता हेतु ₹. 50000/-./Requisite licence fee to be submitted online through e-payment facility available on online application portal under Static and Mobile Pressure Vessels (Unfired) Rules, 2016 (Rs. 5000/- for first 5000 lit or part thereof, and Rs. 2500 for every additional 1000 lit or part thereof, limited to maximum of Rs. 50,000/- per year - maximum 5 years licence fees is acceptable).
- Fee to be paid: For 2.5e+006 litres total water capacity of Gas for one year is Rs.50000.**
8. इस विषय में पत्राचार करने हेतु अधिकृत व्यक्तियों के नमूना हस्ताक्षर।/Specimen signatures of persons authorized to make correspondence in the subject matter.

9. Other Documents :-

- i. Copy of Hazop Study & Risk Analysis Report.
- ii. Copy of On-Site Emergency Plan.
- iii. Copy of Safety Report under Rule 10 of MSIHC Rule, 1989.

तथापि, यह अनुमोदन / अनुमति अन्य प्राधिकारियों से आवश्यक अनुमति / क्लीरन्स प्राप्त करने से या यथा लागू अन्य विधियों से छूट नहीं देता है।/This approval/permission, however, does not absolve from obtaining necessary permission/clearance from other authorities or under other statutes as applicable.

Note:

I) सार्वजनिक क्षेत्र के तेल कंपनियों के लिए दस्तावेज़ 9 (डी) से (आई) की आवश्यकता नहीं है।/Documents 9 (d) to (i) not required for Public Sector Oil Companies.

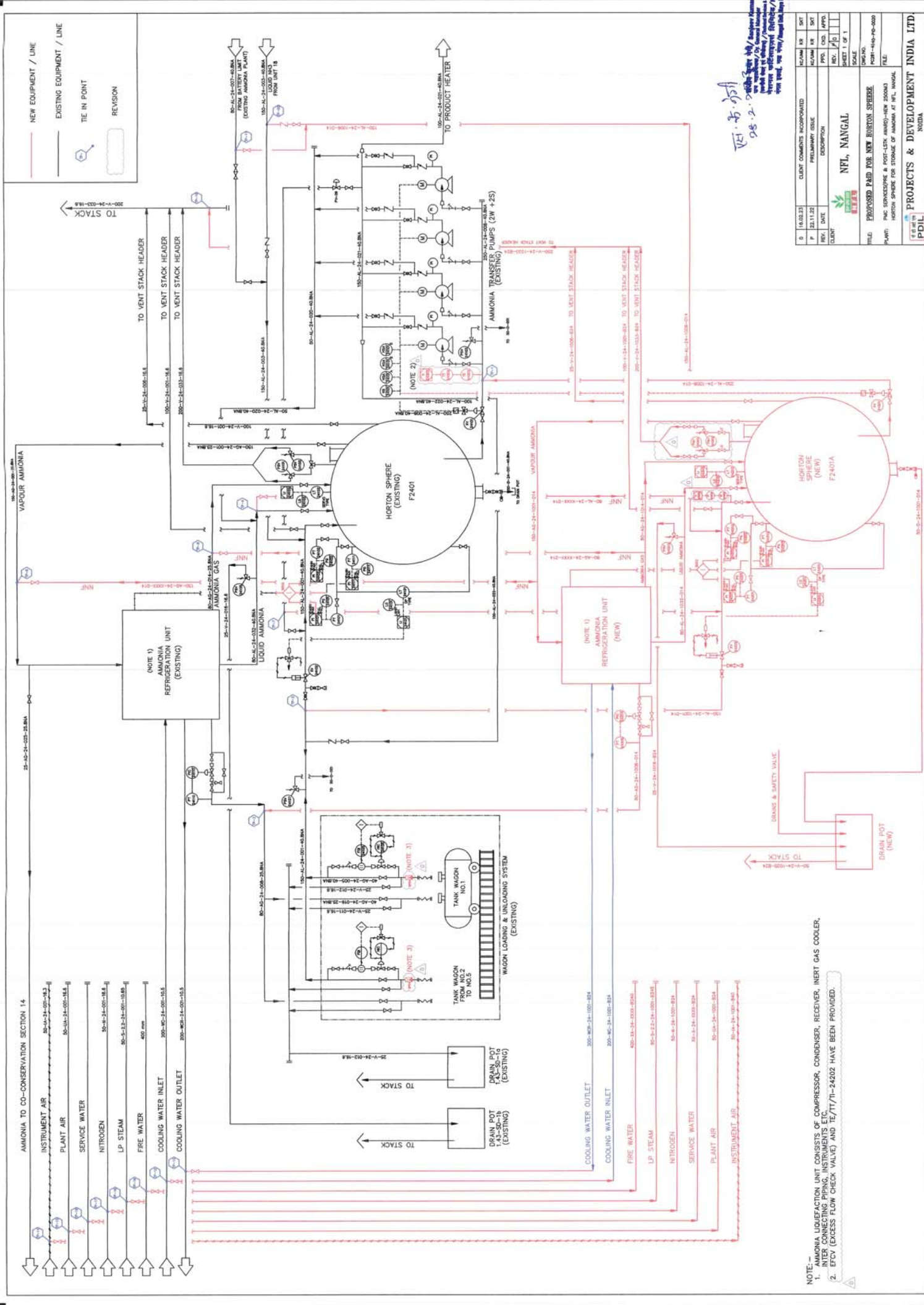
II) गैस सिलिंडरों के नियमों के तहत पृथक अनुमोदन भेजा जा रहा है - संदर्भ फाइल संख्या _____./Separate approval under Gas Cylinders Rules being sent - Reference file Nos _____.

भवदीय/Yours faithfully,

((बासुदेव बसाक)
(Basudev Basak))
विस्फोटक नियंत्रक
Controller of Explosives
कृते मुख्य विस्फोटक नियंत्रक
For Chief Controller of Explosives
नागपुर/Nagpur

(अधिक जानकारी जैसे आवेदन की स्थिति, शुल्क आदि के लिए हमारी वेबसाइट <http://peso.gov.in> देखें।)/(For more information regarding status, fees and other details please visit our website <http://peso.gov.in>)

Note:-This is system generated document does not require physical signature.



AMMONIA TO CO-CONSERVATION SECTION 14

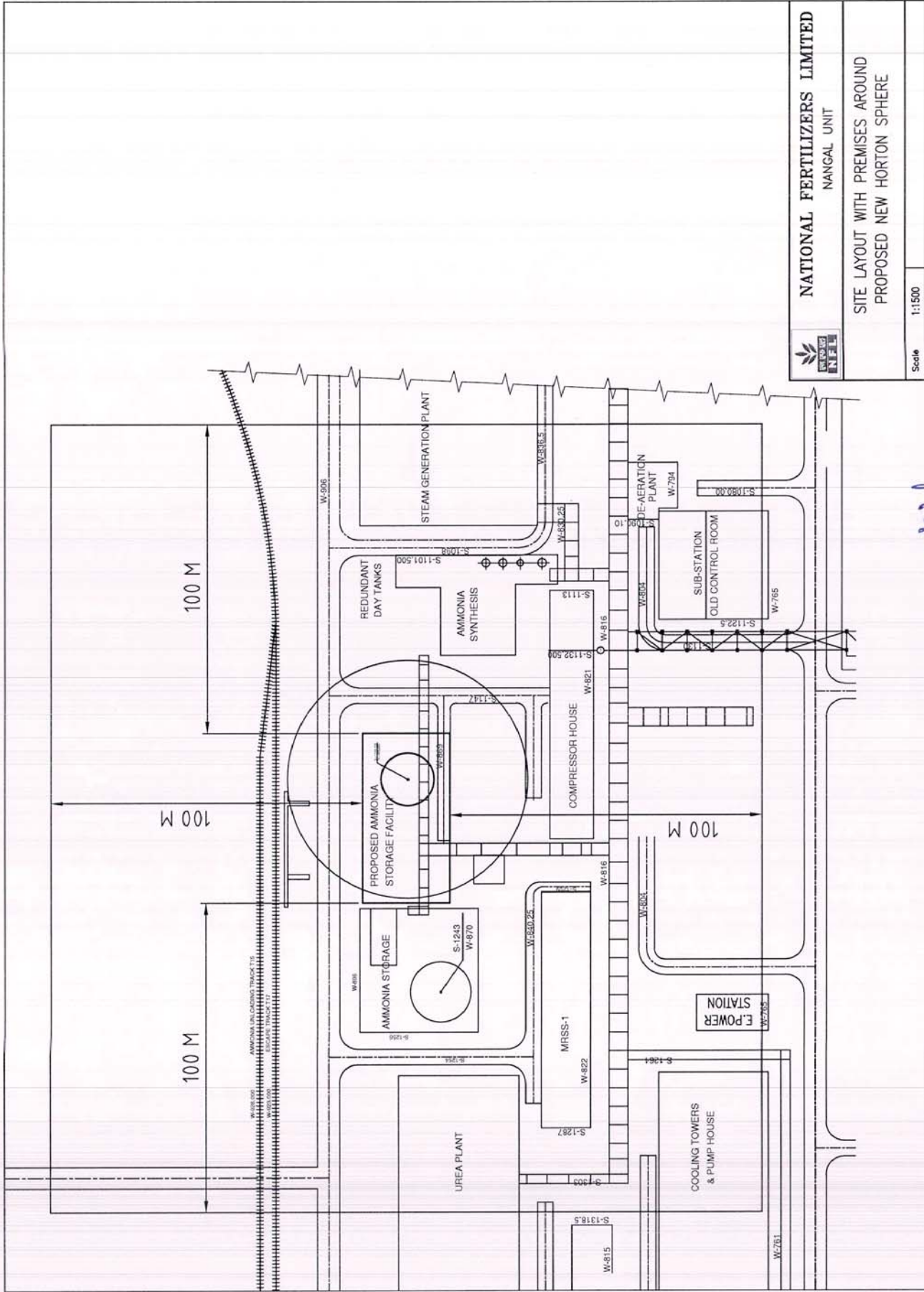
INSTRUMENT AIR
PLANT AIR
SERVICE WATER
NITROGEN
LP STEAM
FIRE WATER
COOLING WATER INLET
COOLING WATER OUTLET

NEW EQUIPMENT / LINE
EXISTING EQUIPMENT / LINE
TIE IN POINT
REVISION

NO.	16.02.23	CLIENT COMMENTS INCORPORATED	16/JAN/18	SKT
P	25.11.22	PRELIMINARY ISSUE	16/JAN/18	SKT
REV.	DATE	DESCRIPTION	PRO. DED. APPRO.	
CLIENT			REV.	1/1
			SCALE	SHEET 1 OF 1
NFI, NANGAL				
PROJECTS & DEVELOPMENT INDIA LTD NOIDA				
TITLE: AMMONIA LIQUEFACTION UNIT FOR NEW HORTON SPHERE				
PLANT: P&ID SUBSYSTEMS & P&ID FOR AMMONIA LIQUEFACTION				
PURPOSE: HORTON SPHERE FOR STORAGE OF AMMONIA AT NFI, NANGAL				
FILE:				

Handwritten notes:
 VE. S. J. S. J.
 05.12.22
 1. Ammonia Liquefaction Unit
 2. Ammonia Liquefaction Unit
 3. Ammonia Liquefaction Unit
 4. Ammonia Liquefaction Unit

NOTE: AMMONIA LIQUEFACTION UNIT CONSISTS OF COMPRESSOR, CONDENSER, RECEIVER, INERT GAS COOLER,
 1. WATER CONNECTING PIPING, INSTRUMENTS ETC.
 2. EFCV (EXCESS FLOW CHECK VALVE) AND TE/TI-24202 HAVE BEEN PROVIDED.



NATIONAL FERTILIZERS LIMITED
NANGAL UNIT

SITE LAYOUT WITH PREMISES AROUND
PROPOSED NEW HORTON SPHERE

Scale 1:1500

22.7.2023
Sanjeev Kumar Negi
General Manager
N.F.L.