

 पी डी आई एल PDIL	PROJECTS & DEVELOPMENT INDIA LTD	PC-211/102/P-II/5.5	0	 रिफ्लेक्टिव फ्लूइड कंट्रोल लिमिटेड REFLECTIVE FLUID CONTROL LIMITED
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PART II: TECHNICAL

SECTION – 5.5

DESIGN SPECIFICATION – CIVIL & STRUCTURAL WORKS

FOR

IMPLEMENTATION OF ZERO LIQUID DISCHARGE (ZLD) UNIT



AT

RAMAGUNDAM FERTILIZERS AND CHEMICALS LIMITED (RFCL),

TELANGANA, INDIA

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GENERAL DESCRIPTION OF SCOPE

All the clauses mentioned below are applicable for **EFFLUENT TREATMENT PLANT WITH ZLD SYSTEM RFCL, RAMAGUNDAM, TELANGANA** and associate allied services within battery limit.

- The scope of Civil Structural and Architectural Works under this Contract shall include carrying out Demolishing, Disposal, Filling, Grading & Leveling, Detailed Design, Drawings, Supply, Procurement of all materials, Construction, Demolitions (if required), Supervision of all relevant Civil and Structural Works including providing all labour, supervision, material, scaffolding, construction equipment, tools, tackles and plants, supplies, transportation, all incidental items though not indicated or specified but reasonably implied or necessary for successful completion of the project.
- Construction Water shall be provided by owner at a single point.

BROAD PLANT DESCRIPTION

Various process units, utilities and storage facilities are planned to be constructed. The tentative sizes of these structures are provided in the Plot Plan.



Scope of the CONTRACTOR shall include but not limited to the following: -

- a) Dismantling of 2 No. abandoned tanks shall be carried out including disposal of dismantled debris and handing over of serviceable materials like reinforcement bars etc to RFCL. Further, the void created after complete dismantling of these tanks shall be filled up suitably to bring it to the desired grade level. The method statement for dismantling of tanks, shall be got approved by PDIL/RFCL. In case, explosive/detonation is to be permitted, then prior analysis of shock waves/blast impact on nearby structures/buildings shall be included in the scope of Contractor. Further, arrangements of all statutory permissions/license and associated fee payments, if any, for using explosives/detonation for dismantling, shall also be in the scope of LSTK Contractor.

Details of Circular tank to be demolished (for reference only) are as follows-

- i. The outer diameter is nearly 45m(Approx).
- ii. The top cover slab thickness is nearly 250mm(Approx)
- iii. The wall thickness observed to be in the range 350mm to 400mm.
- iv. Visible Height of tank above the surrounding NGL is around 2.7m (Approx)
- v. Internal Depth of tank up to its bed level might be nearly 5m(Approx).

Pictures of circular RCC tank for reference:-

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- b) Jungle/ shrubs clearing.
- c) Engineering/Survey related to site leveling & preparation.
- d) Land development (Backfilling with good earth brought from outside of plant , layer wise compaction, leveling , micro-grading up to F.G.L.)
- e) Soil Investigation, as per requirement of design.
- f) Design, engineering & construction of all concrete foundations/structure.
- g) Design, engineering & construction of all approach roads.
- h) Design, engineering & construction of storm water drain & sanitary sewer from tie-in to ETP and their disposal / storage as per pollution control board / environmental regulatory authority guidelines.
- i) Effluent collection and handling system within battery limit.
- j) Structural Analysis and design calculations as per specifications laid down in Civil Engineering Design Basis, enclosed in the tender for all Civil works.
- k) Architectural design and drawings including elevation, sections roofing plan details for doors, windows, partitions, floors, false floor, false ceiling, lighting, IT cable, fire fighting system, toilet, finishes etc.
- l) General Arrangement and detail drawings for footings, rafts, pile, pile-cap, foundations, plinth beams etc, based on the soil investigation carried out by the bidder for the proposed site.
- m) General Arrangement and structural drawings at grade level showing foundations, extent of paving, trenches, drains, sewer, pits etc.
- n) General Arrangement drawings for superstructure (RCC and structural steel) at all levels.
- o) RCC drawings showing all necessary details, pockets, bolts, grouting for all foundations and structures.
- p) Fabrication, Structural steel detail drawings for all steel structures.
- q) Bar Bending Schedules for all RCC works.

- r) General Arrangement and detail drawings for access roads, storm water drains, effluent drains, cable trenches, sewerage, manholes, pits, sumps with all necessary details including invert, top levels.
- s) Coordination with OWNER / PMC for various activities including approvals of design basis, concept note, drawings, material samples, laboratory test results etc.
- t) Procurement of all items necessary for completion of scope of work.
- u) As built drawings & final documentation.
- v) Obtaining Statutory Approvals for construction work as applicable
- w) Adherence to Quality Assurance Plan
- x) Vetting of drawing from PMC/client
- y) Approval of drawing, materials from client/PMC
- z) The following plants and facilities shall be under the scope of the LSTK CONTRACTOR shall include but not limited to the following:-

Sr. No.	TENTATIVE LIST OF FACILITIES	TYPE OF STRUCTURE
FOR PLANT AREA		
1)	OPERATOR ROOM REST ROOM WITH WC	RCC framed Structure
2)	SUB-STATION	RCC framed Structure
3)	CHEMICAL HOUSE (Proposed new Chemical House shall be planned to cater storage/stocking requirements of plant chemicals and consumables for a period of 15 days. Further, proposed other utilities to include Storage shed with handling & loading provisions for Solids/salts generated at the end of Treatment Cycle)	RCC framed Structure
4)	ETP WITH ZLD	RCC water retaining structure / RCC foundation for portable type
5)	EXTENSION OF CONTROL ROOM	RCC framed structure
6)	PIPE SUPPORT FOR UTILITIES	RCC
7)	MODIFICATION OF PUMP FOUNDATION	RCC
8)	OTHER UTILITIES BUILDINGS	As per design requirement

*All facilities shall comply EC norms.

- Z1) All underground foundation/structures including top surface of foundations including exposed RCC face above ground shall be painted with two coats of hot bitumen paint of grade 20/30 with quantity of bitumen at least 1.2 kg/m² per coat.

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1.0 DETAILED SCOPE OF WORK

1.1. Soil Investigation

- 1.1.1 The Geo-technical Report is attached with the Tender Document as Annexure-VIII for reference. This is indicative only and is enclosed purely for information / guidance purpose to the bidder. However, the CONTRACTOR shall carry out his own soil investigation for design specific requirement.
- 1.1.2 The CONTRACTOR shall adopt, open type isolated, raft foundations, pile foundation as per foundation requirements of structure, loads, settlement & other design criteria.
- 1.1.3 Foundations of Important structures, all other process equipment etc shall be as per requirement.
- 1.1.4 The CONTRACTOR shall design and construct all foundations as per requirements with no extra cost to OWNER / Project Management Consultant (PMC).

1.2 Topographical / Contour Survey

The Topographical / spot level report is attached with the Tender Document as Annexure-IX for reference.

Before commencement of work, the CONTRACTOR shall clear the site from all the debris / shrubs on the site.

The CONTRACTOR shall establish the finished grade levels after studying the existing site conditions, high flood level, +0.300 M from existing road between proposed plant and existing plant facilities, whichever is higher, so as to maintain proper efficient drainage of the plant area at no extra cost to OWNER / PMC.

At bidding stage, the CONTRACTOR shall visit the site and study the existing site conditions & existing structures, etc.

1.2.1 Site Conditions

Levels like Finished Ground Level (FGL) and Highest Point of Paving (HPP) shall be finalized by the CONTRACTOR in consultation with OWNER / PMC based on contour survey of the unit, levels of adjacent units and levels of adjacent roads.

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1.2.2 Site Conditions – Road Levels

The CONTRACTOR shall carryout contour survey of roads adjacent to the unit and also roadways around the unit as defined in plot plan drawing.

1.3 Grading

- 1 Land development shall be in the bidder's scope. The CONTRACTOR shall visit the site and study the existing site conditions & existing structures, etc.
- 2 The CONTRACTOR shall establish the finished grade levels of buildings after studying the existing site conditions, high flood level so as to maintain proper efficient drainage of the plant area at no extra cost to OWNER / PMC. These grade levels shall be approved by the OWNER / PMC.
- 3 The LSTK Contractor shall be responsible for planning, designing, reshaping and contouring the Site to final grade elevations after study and verification of existing site conditions in consultation with OWNER / PMC.

The CONTRACTOR shall be responsible for planning, designing, reshaping and contouring the site to final grade elevations after study and verification of existing site conditions.

The CONTRACTOR shall perform earthwork, excavation and filling to arrive at finished grade level for micro grading. Final leveling (micro grading) shall be in the bidder's scope. Wherever filling / cutting is involved stone pitching shall be provided as slope protection to protect the areas.

1.4 Disposal of surplus earth

The CONTRACTOR shall dispose-off all surplus and unserviceable earth (if any), inside factory premises at his own cost with the consent of OWNER.

1.5 Site cleaning

During construction and on completion of construction (inclusive all internal and external finishes), cleaning all the debris, waste materials scattered in and around the site and disposal of the same shall be in the scope of the CONTRACTOR with the consent of the OWNER.

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1.6 **Roads**

- a) The CONTRACTOR shall be responsible for complete planning and construction of the roads for access to all buildings and units of the plant from the existing roads including necessary tie-in connections. All works associated with shifting of Roads and related services (e.g. all type of drainages, sewer, culverts etc.) as required, for the proposed site, shall be in the scope of contractor. All roads shall be bituminous type of roads with sealer coat.

1.7 **Surface Drainage**

The CONTRACTOR shall ensure proper drainage of all components of the Plant. For the purpose of drainage the Contractor's scope is not limited only up to the Unit Battery Limit but shall extend up to the adjacent drainage network around the unit. The CONTRACTOR shall provide proper drainage system for all roads. Storm Water Drains shall be connected to the existing drainage system by providing suitable tie-in points. The CONTRACTOR shall study the existing drainage system as per actual site conditions. The CONTRACTOR shall decide tie-in points for storm water drain based on existing drainage system in consultation with OWNER and PMC during detail engineering. The drainage system shall be by gravity. Storm water drains shall be sized for the peak discharge.



1.8 **Contaminated Rain Water System and Oily Water Sewer (OWS) System**

The CONTRACTOR shall provide proper underground drainage system for contaminated rain-water and OWS. These shall be as per the philosophy mentioned in this tender document or in consultation with PMC/OWNER. The treated (oil/ grease separation) oily water shall be pumped to Owner's ETP plant. Details of Tie-in points at battery limit shall be provided during detail design stage.

1.9 **Sewage Disposal Scheme**

The CONTRACTOR shall provide proper underground sewage system for sewage disposal scheme. This shall be as per the philosophy mentioned in this tender document with septic tanks/interceptor tank or in consultation with PMC/OWNER. These shall be connected to existing sewerage system at suitable tie-in points to be decided in consultation with OWNER and PMC during detailed engineering.

1.10 **Paving**

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The CONTRACTOR shall provide RCC pavement for the complete area of the plant and truck parking area as job specific requirement. All other pavement area except plant area shall be hard stand.

1.11 Structures buildings etc.

Contractor's scope shall include various technological structures steel & R.C.C. structures, pipe rack, buildings, equipment foundations, pits, cable trench, sheds, etc. as per the approved Plot Plan or mentioned in this tender document, required for the complete execution and commissioning of the plant.

1.12 Surface Finishing's

The CONTRACTOR shall be responsible for complete planning and detailing of all surfaces finishes viz. painting, flooring etc as per specifications given in the Tender.

1.13 Acid / Alkali Proof Lining

The CONTRACTOR shall be responsible for surface treatment of floors, exposed portion of foundations, pits and basins against acid / alkali/effluent as per process requirement.

1.14 Anti-termite Treatment / Damp proof course / Water proofing

The CONTRACTOR shall provide anti-termite treatment, damp proof course and water proofing as per design basis. Water proofing (for all open terraces) of all buildings shall be done by waterproofing treatment with APP Membrane with all protective layers.



1.15 Miscellaneous

These shall include local platforms, pipe sleepers, local foundations, local supports, etc. as per requirement.

1.16 Engineering and construction

Preparation of detailed design, drawings, supply and construction of all civil, structural, architectural, plumbing & sanitary and building works shall be in the scope of contractors work.

1.17 Removal of Underground and Above Ground Structures

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All above ground existing structures demolition shall be in the scope of contractor.
All underground facilities/structures shall be demolished/ removed by the contractor provided removal of former will not disturb the functions of existing plant.

1.18 Transfer of benchmark

The Benchmark will be made available inside plant premises. However, it may be verified at CONTRACTOR's side.

1.19 Sizing of various facilities

Sizing, nos., location etc. of various facilities viz. buildings, pipe rack, structures, equipments, etc. shall be in the scope of the bidder.

Any change of sizing, addition of any structure / facility, indicated by Owner/PMC, based on functional requirements and as well as local rules and regulations, etc, shall be in the Contractor's scope, at no extra cost to OWNER / PMC.

1.20 Scope of work in outside battery limit (OSBL) Area

Scope includes work in OSBL area, if required, such as pipe racks, local platforms, local supports, road crossings / culverts from tie-in points to new units.

1.21 Rules and regulations

All the facilities shall conform to all Local Rules and Regulations, Factory Inspector, Rules, TAC rules etc. whichever is more stringent.

Getting the approval of the various documents through the various authorities shall be in the Contractor's scope at no extra cost to OWNER / PMC.

2.0 DETAILED ENGINEERING

2.1. General

2.1.1 The CONTRACTOR shall carryout Analysis and Design of the structures required for this document and shall prepare all the required Architectural, Civil and Structural drawings needed for correct and accurate construction as per the Design Specifications given in this document.

2.1.2 The CONTRACTOR shall submit a Detailed Schedule for release of documents and drawings for review / approval to PMC/CLIENT, within 2 weeks/or mutually period of date of award of the Contract. Such a schedule shall be made in line with the overall Project Schedule given in the document.

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The CONTRACTOR shall strictly adhere to the approved schedule.

The Format of Submission of the above mentioned schedule shall be mutually discussed and finalized after award of the job.

- 2.1.3 Construction of various structures / facilities, whose designs and / or drawings are specially identified in the document submission requirements for approval by PMC, shall not be taken up for construction at site till they are approved by PMC and comments given by PMC are incorporated.

For other structures / facilities, the CONTRACTOR shall directly submit the Approved for Construction (AFC) drawings to PMC for information before, taking up construction including Vetting of drawings.

- 2.1.4 It shall be the responsibility of the CONTRACTOR to accommodate all the functional requirements such as access, cutouts, clearances, interference etc. while designing / detailing of various structures / facilities.
- 2.1.5 Complete analysis, design and all drawings of each independent structure / facility shall be submitted in one lot so as to facilitate overall systematic review by PMC.
- 2.1.6 Design drawings of buildings shall be submitted for information only after approval of necessary architectural drawings. These drawings shall only be reviewed by PMC after the necessary architectural drawings are approved by the OWNER / PMC to their satisfaction.
- 2.1.7 The CONTRACTOR shall keep the OWNER / PMC informed of any major design revisions simultaneously in progress.

2.2 Design calculations



The CONTRACTOR shall prepare the design calculations based on the standard accepted practice and guidelines from PMC / OWNER.

All design calculations shall be written systematically, legibly and submitted for approval as per standard accepted practice.

For structures, analysis and design shall be done on latest version of **STAADPRO SOFTWARE**.

For other miscellaneous works Excel and Word shall be used. Design calculations shall be done on A4 size sheet only.

2.3 Drawings

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The CONTRACTOR shall prepare

- a. Civil & structural design & construction drawings, architectural drawings based on the standard accepted practice and guidelines from PMC / OWNER.
- b. Bar bending schedules.
- c. Fabrication drawings.
- d. As-built drawings.
- e. Detailing / drafting shall be done on AUTOCAD Latest Version only. Drawing size used shall be preferably of A1 size only. For foundation layout, drainage plans and paving plans, A0 size drawings can be used if necessary.

3.0 CONSTRUCTION

3.1. General

- 3.1.1 Construction of all civil and structural works including all material, labor, supervision, tools and tackles etc. MTC, required testing shall be carried out by the CONTRACTOR
- 3.1.2 Procurement and supply of all materials viz. cement, reinforcement, structural steel etc. shall be in the scope of CONTRACTOR.
- 3.1.3 All materials shall be procured in consultation with the Owner or as per the approved vendor list given elsewhere in this document. All materials of construction must be of ISI approved brand.
- 3.1.4 All materials and construction shall confirm to the specification given elsewhere in this document.
- 3.1.5 Materials of construction, construction methodology etc. shall be such, so as to protect the structures and foundations against the harmful effect of chemical, fumes etc. present in the plant, its vicinity, in ground and / or subsoil water.
- 3.1.6 The CONTRACTOR shall be responsible for obtaining the statutory approval from local authorities such as Inspector of Factories, Development Authorities and other concerned authorities before starting the work.
- 3.1.7 The CONTRACTOR shall ensure that the facilities are constructed in accordance with the APPROVED FOR CONSTRUCTION drawings and specifications.

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3.1.8 The CONTRACTOR shall maintain and operate an adequate system of control of availability of latest drawings and specifications, at all the places where work is performed.

3.1.9 Construction shall include excavation in all types of soils / rock inclusive of necessary dewatering as applicable.

3.1.10 The CONTRACTOR shall redo / repair all the existing facilities viz. roads, paving, drainage etc. which are damaged during transportation, construction and erection activities performed by him.

3.1.11 CONTROL ROOM

- a) Control Room Roof shall be provided with roof water proofing treatment, as specified elsewhere in the technical specification. Suitable arrangement shall be provided so as to prevent ingress of water into the cable trenches inside the building from cable entry locations-
- b) All air - conditioned areas, shall be provided with the suspended permanently colour coated Aluminium false ceiling system with under deck insulation. Roof water proofing treatment shall be done with APP membrane with protective layer. 50mm thick average thickness Foam concrete insulation shall be provided conforming to IS: 13205. Control room shall consist of separate entry and exit doors (doors must be fire rated).
- c) Control panel room for control room near shall be provided with toughened glass (min. 5.5 mm thick) on all sides so as to permit operators to have full view.
- d) Adequate aluminum doors and toughened glazed windows shall be provided for natural lighting, ventilation and view. All windows in air conditioned rooms shall have hermetically sealed double glazing. All external walls of all buildings to have Acrylic Exterior Emulsion and Internal walls to have Plastic Emulsion with POP.
- e) False floor for laying cable/fire control system/detection system etc shall be in contractor's scope.

4.0 QUALITY ASSURANCE PLAN

Contractor shall ensure the quality of civil works by engaging a third party supervision /inspection and provide test results to Owner/PMC for information. The

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Quality Assurance Plan is attached for reference as Annexure VIII and the contractor is obliged to follow it.

5.0 COMPLETENESS OF WORK/CONTRACT

- 5.1. The scope of work mentioned in the contract/NIT is not the comprehensive one, but gives total idea/outline of the scope of work; however contractor shall be responsible for completeness of the job for the purpose indicated elsewhere to make the system fully functional and operational.
- 5.2. The work furnished shall be complete in every respect with all mounting, fittings, fixtures and standard accessories etc. normally provided for such item/equipment and or needed/required for erection, completion and safe operation of the item/equipment/system as required by applicable codes though they may not have been specifically detailed in the respective specifications, unless included in the list of exclusions.
- 5.3. Any additional items and materials which are not specifically mentioned but are required to complete the system offered, in every respect in accordance with the technical specifications and required for safe operation and guaranteed performance shall also be deemed as included in the scope of work of this tender. Contractor shall not be eligible for any extra payment in respect of such mountings, fittings, fixtures, accessories etc. which are needed/required for safe operation of the item/ equipment/system, as required by applicable codes of the country though they may not have been explicitly spelt out in the NIT/Contract.

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ANNEXURE - I

DESIGN PHILOSOPHY – ARCHITECTURAL





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1.0 GENERAL

1.1 SCOPE

The design philosophy defines the minimum design requirements and procedures for carrying out architectural design and engineering of buildings covered under this project. Relevant criteria shall be taken into consideration to achieve satisfactory and trouble free performance of the facilities.

1.2 UNITS OF MEASUREMENT

Units of measurement in design shall be in metric system.

1.3 DEFINITIONS



Owner	RFCL
PMC	PDIL
LSTK Contractor	Successful LSTK bidder of the tender (To be selected)
CCE	Chief Controller of Explosives
TAC	Tariff Advisory Committee
NFPA	National Fire Protection Association
IS	Bureau of Indian Standards

1.4 CODES AND STANDARDS

The design shall be in accordance with established codes, sound engineering practices and shall conform to the applicable statutory regulations.

The main codes, standards and statutory regulations considered as minimum requirements are as follows. Latest revision of these shall be followed.

- 1.0 National Building Code of India
- 2.0 Factories Act of State
- 3.0 Local Municipality or any other Authority's Bye-laws as applicable.
- 4.0 Bye-Laws applicable of Town & Country Planning Organization.

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- 5.0 Code of practice for building bye-laws IS : 1256
- 6.0 TAC (Tariff Advisory Committee) Rules
- 7.0 Indian Electricity Rules
- 8.0 Bureau of Indian Standards

Note: The above list is suggestive and not exhaustive. Apart from the basic codes any other related codes shall also be followed wherever required.

1.4.1 Order of Precedence

In case of any conflict / deviations amongst various documents, the order of precedence shall be as follows:

- Statutory Regulations
- Job Specifications
- Engineering Design Basis
- Standard Specifications

2.0 DESIGN PHILOSOPHY / CRITERIA – GENERAL

2.1 ARCHITECTURAL DESIGN



Architectural design of buildings / sheds shall be in accordance with this design basis and references as stated herein, to facilitate the intended functions. The various types of requirements to be considered are described further. In Plant Area no underground/ basement shall be provided in the building.

2.2 BUILDING REQUIREMENTS

2.2.1 Spatial Requirements

Spatial requirements inside a building / shed shall be decided based on activities to be performed in the building and consequent occupancy pattern, equipment layout etc. Spaces can be generally classified as functional spaces, circulation spaces, amenity spaces, utility spaces. They are elaborated further.

2.2.1.1 Functional Spaces

 पी डी आई एल PDIL	IMPLEMENTATION OF ZERO LIQUID DISCHARGE (ZLD) UNIT AT RFCL, RAMAGUNDAM PLANT DESIGN SPECIFICATION – CIVIL & STRUCTURAL WORKS	PC-211/102/P-II/5.5	0	 रामगुंडम फॉसफोरस एवं सीमेंट लिमिटेड
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Functional areas of any building / shed is constituted by the main activity for which the building is required. Various spaces/rooms shall be judiciously sized and shall be integrated logically to generate the total building plan taking into account the following parameters :-

- a) Activities, group of activities and consequent work-flow pattern.
- b) Site conditions i.e., dimensions, contours etc.
- c) Climatic conditions vis-à-vis orientation.
- d) Safety regulations.
- e) Lighting and ventilation.
- f) Green building Concept as per Govt. Guidelines for the state
- g) Acoustics
- h) Services
- i) Security
- j) Economy
- k) Aesthetics
- l) Specific requirement pertaining to particular buildings, if any
- m) All other established architectural design parameters in practice.

The objective of spatial arrangement shall be to satisfy functional requirements and physical comfort and safety regulations as well as aesthetics which has significant role in creating a favorable working environment.

2.2.1.2 Circulation Spaces

Following spaces are classified as circulation spaces. These spaces shall be provided as per required building services, for integrating various types of spaces and as means of access / exit / escape.

- a) Corridors & passages.
- b) Staircases
- c) Elevator
- d) Entrance lobby / Foyer including Reception & waiting.
- e) Gangway / walkways.
- f) Equipment loading / unloading platforms
- g) Emergency Exits

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2.2.1.3 Amenity Spaces

Following spaces are classified as amenity spaces :

- a) Toilet (Gents & Ladies).
- b) Drinking Water Facility.
- c) Locker & Change Room.
- d) Rest room / Lunch Room.
- e) First-Aid Room
- f) Janitor Room

Out of the above mentioned areas, a) Toilet, b) Drinking water, c) First Aid enclosures shall be mandatory requirement for occupied buildings / sheds. Other facilities shall be provided as required.

2.2.1.4 Utility Spaces



Utility spaces are space requirements which materialize due to provision of services like air-conditioning, pressurization, fire fighting, electrical, telephone, **LAN** etc. Following are examples. These spaces shall be provided as per required building services.

- i) Air-conditioning plant room.
- ii) Air handling rooms.
- iii) Pressurization blower plant room.
- iv) Electrical distribution panels rooms.
- v) Service ducts
- vi) Firefighting equipment room.
- vii) Telephone exchange equipment room.
- viii) UPS room.
- ix) Battery room.
- x) Server/data room

2.2.1.5 Sizes of Spaces

Sizes of various type of spaces shall be decided based on occupancy / equipment / Panel / furniture layout, clearance, maintenance & safety requirements & ventilation requirements.

However, following are the limiting sizes / dimensions for various purposes, which shall be adhered to :

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- a) Minimum area of any habitable room = 9.5 m² with minimum dimension restricted to 2.5 m
- b) Minimum ht of any habitable room = 3 m which may be reduced to 2.75 m for air-conditioned areas. Due provision / clearance may be made for AC ducts above false ceiling if any. Headroom below beams should be min. 2.4 m.
- c) Maximum ht of habitable rooms = As stipulated by the local bye-laws
- d) Scale of accommodation for industrial work spaces = @ 14 m³ per occupants. Minimum clear height of such workspaces shall be 3.6 m. Heights above 4.25 m shall not be taken into account.

2.2.2 Day Lighting and Ventilation

2.2.2.1 Day Lighting

Established level of illumination shall be maintained for all parts of the buildings by means of windows, ventilators, skylights, etc. Following references shall be adhered to in this regard.

- a) National Building Code of India, Part-VIII, Section-1
- b) IS:2440: IS 3646 (Part-II) : IS:7662 (Part-I)
- c) State Factories Rules
- d) Any other relevant rules / code etc.

Following architectural norms shall be adopted:

- a) Direct solar illumination shall not be considered and only sky radiation shall be taken as contributing to illumination of the building.
- b) Openings shall be provided with shading devices to avoid glare.

For the purpose of illumination, day lighting shall also be supplemented by artificial illumination.

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Safety from fire and like emergencies shall be taken into account in building / shed design. Buildings / sheds meant for human occupancy shall be provided with exits

sufficient to permit safe escape of occupants in case of an emergency. The exits shall be in terms of doorway, corridors, passage ways to internal / external staircase or to areas having access to the outside. Following references shall be adhered to this regard. Max distance to an exit from any point in a building shall not exceed 30 m. Control Room building shall be provided with emergency exit on the other side of entrance.

A minimum of two staircases and two exits per floor shall be provided in each building. Width of passage / corridor shall not be less than 1500 mm. Following references shall be referred to for the purpose design of Control Room building.

- National Building Code of India, Part-IV
- State Factories Rules.
- Any other relevant rules / codes.

2.2.5 Site Planning & Landscaping

Site planning of building shall take into account aspects like inter-relationship of the buildings with the whole system, movement pattern, traffic and road net-work, safety regulations, service network, fire safety, climatic and environmental aspects.

Main and service / maintenance entrances of buildings shall be provided with vehicular access. All exit points shall also be provided with footpath / vehicular access. Truck movement space in accordance with traffic pattern shall be provided for the building as per the location of hoisting bay / loading, unloading platform. Road network and open space around the buildings shall be designed considering movement and functioning of fire tenders and cranes, etc.

Suitable landscaping treatment shall also be done around Control Room. Such treatment shall generally consist of lawns, road side plantation and beautification of building entrance areas. Standard landscape elements such as earth contours, paving, flower beds, hedges, shrubs, ground cover and ornamental trees shall be incorporated in landscape treatment. Necessary water supply / sprinklers shall also be provided.



2.3 BUILDING SERVICES

Following services shall be provided for all building / sheds as essential services.

2.3.1 Water supply, Distribution and Drainage, Sanitary Services.

The service is essential for all habitable buildings / sheds. All buildings with human occupancy shall have toilet and drinking water facility and accordingly water supply, distribution and drainage, sanitary services as per following references.

- National Building Code of India, Part-IX, Section 1 & 2.
- State Factories Rules.

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c) CPHEEO Manual.

Drinking water provisions, including one number water cooler per area (of approx 20 m x 20 m) shall be provided within an enclosure separated from the toilets. Space for janitor shall be provided in the toilets. All service pipes showing on the external wall shall be suitably concealed or shall be provided within a shaft.

Each building shall be equipped with approved overhead water tank of capacity not less than 2000 liters.

2.3.2 Electrical Services

This service shall be provided as essential service for all building / sheds. Electrical services for buildings shall consist of electrical supply and distributions, electrical lighting installations, telephone network, fans, exhaust fans, lighting protection system etc. including all accessories, cabling etc. including emergency power supply, all as per requirement. All electrical switches / sockets shall be of modular type as per the approved makes given separately.

Air conditioning and Heating

Areas of control room, spaces housing equipment / machinery / panels etc. which required conditioned environment and certain specified areas like offices, specific office accommodation shall be suitably air-conditioned by window / split / package / centrally air-conditioned type units, as per requirement with respect to other relevant Design Basis.

Accordingly, AC Plant / AHU etc. of the required capacity, whenever required, shall be provided and housed, suitably.

2.4 AESTHETICS

Apart from the fulfillment of functional & safety requirement, aesthetic requirement of the buildings / sheds shall be taken care of in the design. As specific guidelines for achieving required aesthetics are difficult to establish, following guidelines shall be followed:

- a) Preliminary Drawings including perspective views indicating architectural treatment minimum three different alternative proposals shall be submitted for Owner's approval.
- b) Following elements shall be considered as contributory elements to aesthetics and their design etc. shall be subjected to the Owner's approval. Any change / modifications sought for aesthetics improvements with regards to these elements shall be carried out. Any incidental elements like brickwork, RCC work etc. required for such changes / modifications shall also be added.
 - i) Building / shed shape and features
 - ii) Canopies, overhangs & shading devices
 - iii) Gutters
 - iv) Entrance / exit steps, door
 - v) Window / Ventilator composition
 - vi) External wall location with respect to columns
 - vii) Colour scheme, grooves in plaster
 - viii) Spatial arrangement
 - ix) Aesthetic of the buildings should match with the surrounding existing facilities at the site.

2.5 BUILDING ELEMENTS

2.5.1 Plinth protection

All the buildings & sheds shall be provided with minimum 1000 mm wide plinth protection around the building / shed. Level wise, it shall be 100 mm high above top of approach road level. In order to avoid accumulation of water outside the buildings, requirement of surface drains shall be examined on case to case basis for individual building and provided if necessary.

2.5.2 Finished Floor Level (Plinth FFL)

In general, Plinth FFL of the buildings, sheds shall be determined with respect to top of approach road or pavement. Unless noted otherwise on the reference drawings, following schedule shall be adhered to for FFL of various buildings & sheds.

a)	Sub Station Building		
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	> Cable cellar floor	-	Top level of approach road + 450 mm
	> Transformer bay with pebbles	-	Top level of approach road + 150 mm
	> Single storey substation with trenches	-	F.G.L. (+) approx. 1000 mm high from top of road
b)	Transformer bay	-	Top level of approach road + 150 mm
c)	Vehicle, scooter, cycle shed including fire tender bays, repair shop	-	Top level of approach road + 300 mm
d)	False floor areas (Control Room)	-	As specified in the Instrumentation section of NIT
e)	Loading, Unloading bays, platforms	-	Top level of approach road + 1100 mm
f)	Electrical rooms	-	As specified in the Electrical section of NIT
g)	Other Buildings / Shed (Process Operator's Cabin)	-	Top level of approach road + 450 mm from surrounding ground level.

Notes:

- In case of approaches with different top levels, the highest top level of approach road / pavement shall be considered.
- FFL shall be same throughout in a building / shed. Split levels any be considered in exceptional cases due to ground terrain etc.
- FFL of external loading / unloading bays / platforms, toilet, pantry, kitchen shall be 6 – 12 mm lower than that of the building / shed's FFL to check ingress / spillage of rainwater.
- FFL of Warehouses, stores may be kept lower than loading / unloading bays / platforms where forklifts etc. are used for internal movement of items. Adequate arrangement for negotiating the level difference shall be provided in that case.
- Where applicable, existing levels of building / sheds shall be followed.

2.5.3 Steps / Ramps

Steps / ramps shall be provided for access to the buildings / sheds for pedestrian /vehicular movement, equipment entry, etc. Minimum 1500 mm wide platform shall be provided in between entrance door and steps / ramps. Following dimensions of the steps / ramps shall be adhered to:

a)	Tread	:	300 mm minimum
b)	Riser	:	175 mm maximum
c)	Slope of ram	:	Not steeper than 1:12 slope
d)	Ratio of tread & riser	:	2 Riser + Tread = 600 to 650 mm

e)	Landing width	:	1500 mm minimum
f)	Flight width	:	1500 mm minimum

Edge of treads shall be provided with friction grip strips

2.5.4 Wall

Following schedule shall be adhered to for wall material and thickness

1	Blast Proof Wall	Min 230 mm thk.RCC wall
2	Rain water duct / shaft	Min. 230 mm thk. hollow/ solid concrete block work
3	External walls	230 mm thk. hollow/ solid concrete block work
4	Fire wall (Around transformers)	240 mm thk RCC or 345 mm (excluding plastering) thick hollow/ solid concrete block work wall / OR as per Electrical requirements. (IER/TAC)
5	Internal partition wall	230 / 115 mm thk. hollow/ solid concrete block work wall depending on the overall length and height of the wall (refer notes below)
6	Control Room	230 mm thick brick wall

Notes:

- 115 mm thick partition walls shall be provided with RCC transoms and mullions for suitability.
- Wherever conduits or pipes are required to be concealed within partition wall, the local wall thickness shall be increased suitably.

2.5.5 Doors

Doors shall be provided for access, security and safety to all rooms, functional areas in a building. Air tight door shall be provided in pressurized area and in gaseous protection area. Emergency door shall be opened outwards. Sizes of the doors shall be determined on the basis of the following schedule:

a)	Equipment, Panel area	:	Maximum size of equipment including packing
b)	Other areas	:	Volume of movement through door

c)	Minimum door size at entrance	:	1500 mm x 2500 mm (masonry opening size)
d)	W.C. bath Cubicle door	:	800 mm x 2100 mm (masonry opening size)
e)	Minimum size of other doors	:	1000 mm x 2100 mm (masonry opening size)

Notes:

- Entrance doors shall be provided covering full width of the entrance lobby. In that case the door shall be of composite type consisting of openable shutters & fixed panels. Entrance lobby shall be provided with elaborate canopy.
- Rolling shutters min 2500 mm wide shall be provided for equipment entry for Switchgear room, Electrical room, A.C. Plant room etc. and also wherever size of opening exceeds 2500 mm x 2500 mm.
- Mechanically operated rolling shutters shall be provided for main equipment entry opening, and also where opening size exceeds 6 m².
- Fireproof door shall be with two hours fire rating as per statutory requirements.

2.5.6 Windows / Ventilators

Windows / ventilators shall be provided in all areas for natural lighting, ventilation, and visibility of working level. For the purpose of ventilation, total openable area of the windows / ventilators shall be as per Factories Act subject to a minimum of 15% of the floor area to be ventilated. However, for control room and in office areas, etc. where visibility from inside is also important, increased window area (as per discussion with Owner/PMC) shall be provided. Areas accommodating panels / equipment shall be normally provided with ventilators at high level for uniformity distributed lighting.

Notes :

- Requirements of window / ventilation area as stipulated above is for maximum room height of 4000 mm. For heights more than 4000 mm, additional window / ventilator shall be provided in the same manner at every work area / platforms at all levels.
- Wherever due to limitation of external wall area or other reasons, stipulated area of window / ventilator cannot be provided, suitable mechanical / electrical system shall be employed.
- Fly mesh shutters shall be provided for windows / ventilators in Kitchen, Pantry, Dining hall etc.
- Ventilator shall be able to serve as smoke vents in the event of fire.
- For structures like workshop / warehouse / compressor shed with color coated non-asbestos sheet, suitable monitor may be added to provide proper ventilation.

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UPVC rain water pipes shall be provided for roof water drainage. Number of rain water pipes shall be decided on the basis of roof area, slope and rainfall intensity as per NBC-IX, Section-2. Rain water pipes shall be concealed as far as possible. RCC or GI spouts may be used for drainage of chajja / small canopies of ground floor. Dia of rain water pipe shall be 150 minimum. Rain Water Pipe Spouts to be provided with gratings on mouth.

2.5.12 Entrance Lobby

Entrance lobby shall be provided as a common entrance for all buildings / sheds accommodating separate functional spaces integrated together. Individual entries to such functional spaces shall be from this lobby by means of passages / corridors. Apart from common entry lobby, separate independent entries to these functional spaces shall also be provided if functionally required. Size of the entrance lobby shall be decided on the basis of volume of movement. Air lock lobby shall be provided for all entries with centrally air-conditioned spaces, and pressurized.

2.5.13 Passage / corridors

Passage / corridors shall be provided to integrate various spaces. Width of the passage / corridors shall be as per statutory requirement, subject to a minimum width of 1500 mm.

2.5.14 Service Entry

Separate service entry shall be provided for service areas such as kitchen, air-condition / pressurization plant room, electrical rooms. A common service entry may be provided depending on spatial arrangement.

2.5.15 Emergency Exits

Emergency exits shall be provided for all the building / sheds as per statutory requirements. Emergency exits for individual function spaces such as console area, cable cellar, and switchgear hall shall also be provided. Emergency exits shall be located in such a manner that escape route is unobstructed & without passing through any other function areas. Corridors / staircases shall be provided as escape route.

2.5.16 Staircases

Staircases shall be provided in multi floor buildings for vertical circulation & emergency exits. Number of staircases shall be based on building / shed sizes, emergency exit requirements, and travel distances to exit points as per statutory regulations. More than 500 sq m ground covered area shall have at least two stairs in line with NBC-Part-IV. Emergency exit requirements shall be as per safety distance requirement. At least one

staircase shall be provided for access to the flat roof tops for maintenance. Following dimensions for staircases shall be adhered to.

a)	Stairs width	:	1500 mm minimum, (1000 mm minimum for emergency exit)
b)	Tread	:	300 mm minimum
c)	Riser	:	150 mm maximum

2.5.17 Railings

Railings shall be provided in roofs, stairs and in all unprotected openings in slabs as a safety device. Railings in high level loading / unloading bay of substations shall be of removable type. Parapets shall be given precedence over railings in roofs. All staircases in Control Room to have SS Handrails, while other buildings shall have MS Handrails.

2.5.18 Toilets

Toilets shall be provided for all habitable buildings / sheds. Gents & ladies Toilet, drinking water enclosure & janitor space, all shall be provided as required. The fittings / fixtures provided for bath / toilet shall be of luxury / colored type.

2.5.19 Partitions



If required partitions shall be provided for flexible space arrangement in office spaces, Control room etc. The partitions shall be modular, dismantle-able type of approved make.

2.5.20 False Ceiling

False ceilings shall be provided for following purposes:-

- To reduce room volume and hide ducting etc. for air conditioned spaces.
- To maintain acoustic level inside any space.
- To reduce habitable room, corridor, lobby, toilet heights located in high ceiling building / shed to a reasonable and satisfactory height of minimum 3000 mm.
- In fire rated areas where walls and doors are required to be fire rated, false ceiling shall also have complementing fire rating. It is appreciated that false ceiling have limitations in their fire performance due to openings in them for lighting and air conditioning. Therefore alternative systems to prevent puncturing the ceiling must be employed.
- Specification for false ceiling shall be as follows:

Providing and fixing false ceiling at all heights with 15 mm thick integral densified micro edge lightweight calcium silicate false ceiling tiles reinforced with fibre and natural filler

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false ceiling tiles of Size 595x595 mm of approved texture, design and patterns having NRC (Noise Reduction coefficient) of 0.50 (minimum) as per IS 8225:1987, Light reflectance of 85% (minimum). Non combustible as per BS:476 (part-4), fire performance as per BS:476 (part 6 & 7), humidity resistance of 100%, thermal conductivity < 0.043 W/m Kas per ASTM 518:1991, in true horizontal level suspended on inter-locking metal powder coated T-Grid of hot dipped galvanised iron section of 0.40 mm thick on Silhouette profile, rotary stitched double webbed white with 6 mm reveal profile (white/black), comprising of main-T runners of size 15x42 mm of length 3000 mm, cross - T of size 15x42 mm of length 1200 mm and secondary intermediate cross-T of size 15x42 mm of length 600mm to form grid module of size 600 x 600 mm, suspended from ceiling using galvanised mild steel items (galvanizing @ 80 grams per sqm) i.e. 50 mm long, 8mm outer diameter M-6 dash fasteners, 6 mm dia fully threaded hanger rod upto 1000 mm length and L-shape level adjuster of size 85x25x2 mm. Galvanised iron perimeter wall angle of size 22x19x0.40 mm of length 3000 mm to be fixed on periphery wall /partition with the help of plastic rawl plugs at 450 mm center to center and 40mm long dry wall S.S screws..

2.5.21 Under deck Insulation

Under deck insulation below RCC roof and over false ceiling (both locations) shall be provided for air-conditioned office / space. Under deck insulation of approved make may be used as per manufacturer's specification.

2.5.22 False / Cavity flooring

False / cavity flooring, consisting of medium grade Filled Steel anti static high pressure Lamination of 800H grade (FS800H) on the top, of approved make / as directed by Engineer in charge, shall be provided to accommodate under floor cabling in all areas. Extent of false / cavity flooring shall be as per functional requirements.

False flooring shall be fire rated to the level of fire rating of the walls, doors and suspended ceiling in the compartment.

Specification for False/Cavity flooring shall be as follows:

Providing and fixing removable raised/false access flooring with system and its components of approved make for different plenum height with possible height adjustment up to 50 mm, comprising of modular load bearing floor panels supported on G.I. rectangular stinger frame work and G.I. Pedestal etc. all complete, as per the architectural drawings, as specified and as directed by Engineer-in-charge consisting of

- Providing at required spacing to form modular framework, pedestals made out of GI tube of thickness minimum 2 mm and 25 mm outer diameter, fully welded on to the



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G.I. Base plate of size 100mm x 100mmx 3mm at the bottom of the pedestal tube, G.I. pedestal head of size 75mmx75mmx3.5 mm welded with GI fully threaded stud 16mm outer diameter with two GI Check nuts screwed on the stud for level adjustment up to 50mm, locking and stabilizing the pedestal head in position at the required level. The pedestals shall be fixed to the subfloor (base) through base plate using epoxy based adhesive of approved make or the machine screw with rawl plug.

- Stringers system in all steel construction hot dipped galvanized of rectangular size 570x20x30x0.80mm thick having holes at both ends for securing the stringers on to the pedestal head using fully threaded screws ensuring maximum lateral stability in all directions, the grid formed by the pedestal and stringer assembly shall receive the floor panel, this system shall provide adequate solid, rigid support for access floor panel, the system shall provide a minimum clear uninterrupted clearance between the bottom of the floor for electrical conduits and wiring etc. all complete as per the architectural drawings, as specified and as directed by the Engineer-in-charge.
- Providing and fixing Access Floor panel of 600x600x32 mm medium grade Filled Steel anti static high pressure Lamination of 800H grade(FS800H). Access Floor panel shall be steel welded construction with an enclosed bottom pan with uniform pattern of 64 hemispherical cones. The top and bottom plates of Steel Gauges: top 0.6 mm and bottom 0.7mm fused spot welded together (minimum 64 welds in each dome and 20 welds along each flange). The panel should be corrosion resistant epoxy coated for lifetime rust protection and cavity formed by the top and bottom plate is filled with Pyro grip non combustible Portland cementitious core mixed with lightweight foaming compound. The access floor shall be factory finished with Anti-static High Pressure laminate with Non Warp technology up to 1mm thickness for superior adhesion and Surface flatness within 0.75mm. The panel is to withstand a Concentrated Load of 363 kgs applied on area 25mm x 25mm without collapse in the centre of the panel which is placed on four steel blocks. The panel will withstand and Uniformly Distributed Load (UDL) minimum 1250 kg/sqm and, an impact load of 50kg all complete as per the approved manufacturers specification and as per the direction of Engineer-in-charge. All specification must be printed on the side of the panel to ensure the quality of the product.

2.5.23 Waterproofing on roofs

Waterproofing on roofs shall be APP membrane based with protective layer as directed by Engineer in charge (E. I. C).

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Note:

Skirting shall be provided in all areas, which shall be of same material as that of flooring.
Glass strip panel shall be provided in cement concrete flooring.

4.2.2 Internal Wall Finishes

- a) Entrance lobby, Corridor lobby:

Granite stone cladding and plastic emulsion paint.

- b) Office areas of Buildings:

Cement plaster, POP punning & plastic emulsion paint

- c) Circulation areas (Corridor / Passage etc. excepting Entrance lobby) of Buildings

Cement plaster, POP punning & plastic emulsion paint

- d) Rack Room, Office Rooms, Operators Room

Cement plaster, POP punning & plastic emulsion paint

- e) Switchgear Room / Electrical Room

Cement plaster & OBD (Switchgear Room)

- f) Battery Room

Acid/Alkaline resistant tiles for floor & 1500 high dado OBD above 1500 height.

- g) Toilet, Drinking water area

Granite stone cladding / Marble / Ceramic tiles as directed by E.I.C

4.2.3 Internal Ceiling Finishes

- a) Toilet Electric Operator, Rack room, MCC panel room, UPS

As described in Instrumentation and Electrical specifications

- b) Other areas which do not have false ceiling

Cement plaster & white / color wash, plastic emulsion paint etc., as in the case of wall finish.

4.3 DOORS, WINDOWS & VENTILATORS

4.3.1 DOORS

All wooden door frames shall be in Sal/chap wood in size 125 x 65 mm.

- a) All doors in Toilet / WC / Bath

Wooden flush door with 1 mm thick lamination up to 900 mm high

- b) All doors of Electrical Room, A.C. Plant Room, Battery Room

Pressed steel frame with pressed steel shutter (or as specified in Electrical section).

- c) Inside Control Room

Fire check door with 2 hours rating as required in perfect partition wall separating various fire zones (or as specified in Instrumentation section)

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1.1.4 Elevations shall show sciography to highlight features, human figures for scale, automobiles for headroom, trees and foliage for appearance.

1.1.5 False ceiling area shall be shown by hatching suitably.

1.1.6 False flooring area shall be shown by hatching suitably.

1.1.7 Air-conditioned rooms shall be identified suitably.

5.2 DESIGN

5.2.1 Entrances shall be elaborate and well sheltered to accommodate pedestrians and vehicles.

5.2.2 Provision for future extension, vertical and horizontal shall reflect in the work.

5.2.3 Toilet, kitchen and pantry floors with waterproofing and sloped for drainage. The finished floor level shall be 25 mm below the general finished floor level. Tile drops shall be indicated where required. For example from general floor to toilet floor, toilet floor to WC / Shower floor, general floor to pantry, general floor to entrance platforms and so on.

5.2.4 Plumbing works, external drainage, schematic, flow, shall be indicated.

5.2.5 Water tanks, AC plant, cooling tower, Chiller units etc., where required, shall be located on building roof as far as possible and it shall be positioned and supported to transfer its load on to beams and columns and not to the slab. Such facilities should not be visible from outside. Suitable side cladding shall be provided for this purpose.

5.2.6 Access to all roofs via steel ladder. In case of accessible roofs at least one staircase shall go up to the roof.

5.2.7 Plinth beams level shall clear trenches if any.

5.2.8 Vertical ducts for running services must be examined.

5.2.9 Ventilator arrangement shall be provided unless situations strongly prevent or make it unnecessary. In addition to ventilation requirements, ventilators shall have the capacity to vent smoke in the event of fire.

5.2.10 Layout shall take into account the type of air-conditioning and built-in provisions shall be made to accommodate the equipment.

5.2.11 Walls on steel beams shall be constructed after wall below and up to the steel beam is constructed. This shall appear in the 'Notes' if applicable.

5.2.12 Gaps in floor cut outs shall be sealed with fireproof material for fire safety.

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5.2.13 Openings in wall / cladding for pipes and cables from pipe rack / trays shall be made water tight primarily by means of design features.

5.3 BUILDING REQUIREMENTS

5.3.1 All free edges of chajjas and slab projections shall have drip mould in plaster 50 mm wide and 20 mm drop, unless the need is resolved in some other manner.

5.3.2 Floor slab in WC areas shall be sunk by 500 mm and toilet, pantry; kitchen floor slabs shall be sunk by 200 mm at all levels (including terrace, where future extension is envisaged).

5.3.3 All partition walls within toilet kitchen areas shall be 115 mm thick and 2200 mm high.

5.3.4 All supporting framework members of partition walls within false ceiling areas shall go up to roof level, partitions shall go up to false ceiling level except where there are fire compartment wall where it shall be from floor to ceiling.

5.3.5 Preferably all cut out in slab shall be provided with 200 high kerb.

5.3.6 Groove in plaster, 20 wide x 10 deep shall be provided aesthetically to break extensive areas of plaster.


5.3.7 Flooring shall be done in panels, preferably in 3000X3000 size with expansion joints provided at 25000 c/c.



5.3.8 Flooring contraction joint shall be provided as per design.

5.3.9 Roofs of RCC buildings should have mild slope towards rain water gutters.

5.3.10 All Instrument / Electrical cables at the junction of the building (outside) shall be covered with pre-cast RCC slab. Sleeve pipes should be provided for the cable in the masonry wall including its sealing.

5.3.11 All new buildings shall be designed for vertical extension in future

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ANNEXURE II

DESIGN PHILOSOPHY – GENERAL CIVIL & DESIGN BASIS



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1.0 GENERAL

1.1 SCOPE

This engineering design basis defines the design criteria that shall form the basis for carrying out design and engineering of items under general civil, viz. roads, paving, drainage, etc.

1.2 UNITS OF MEASUREMENTS

Units of measurement in design shall be metric system.

1.3 DEFINITIONS



Owner	RFCL
Consultant	To be selected
LSTK Contractor	Successful bidder of the tender
CCE	Chief Controller of Explosives
TAC	Tariff Advisory Committee
NFPA	National Fire Protection Association
IS	Indian Standards

1.4 CODES AND STANDARDS

The design shall be in accordance with established codes, sound engineering practices and shall conform to the statutory regulations applicable to the country.

- 1.4.1 The main codes, standards and statutory regulations considered as minimum requirements are as follows. Latest revision of these shall be followed.

IS: 456	Code of practice for plain and reinforced concrete
IS: 800	Code of practice for general construction in steel
IS: 875	Code of practice for design loads (Other than earthquake for buildings & Structures
IS: 1172	Code of basic requirements for water supply, drainage & sanitation

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IS: 1742	Code of practice for building drainage
IS: 1905	Code of practice for structural use of unreinforced masonry
IS: 2065	Code of practice for water supply in buildings
IS: 2212	Code of practice for brick work
IS: 8835	Guidelines for design of surface drains.
IRC: 6	Code of practice for road bridges, Section-II Loads and stresses
IRC: 19	Standard Specifications and Code of Practice for Water Bound Macadam
IRC: 37	Design of flexible pavements
IRC: 58	Design of rigid pavements
	Factory Rules for State

Note: The above list is suggestive and not exhaustive. Apart from these basic codes any other related codes shall be followed wherever required.

1.4.2 In case of any conflict / deviations amongst various documents, the order of precedence shall as follows –

- Statutory regulations
- Job specifications
- Engineering design basis
- Standard specification

2.0 DESIGN CRITERIA –GENERAL

2.1 SITE GRADING

2.1.1 The work area shall be cleared and stripped completely of all bushes, roots, trees, Shrubs and other vegetation, organic matter and other objectionable materials. All these should be completely uprooted and removed, and not merely scraped at the surface.

2.1.2 The land is provided ‘as is’ condition. Filling and levelling shall be done by the bidder with the following:

- | | | | |
|----|--------------|---|---|
| A. | Filling Area | : | Compacted in layers not exceeding 20cm to achieve minimum 90% of maximum dry density for sand and minimum 95% for soil. |
|----|--------------|---|---|

2.1.3 Site grading philosophy shall be based on following:

Levels like Finished Ground Levels (FGL) and Highest Point of Paving (HPP) shall be finalised by the CONTRACTOR, in consultation with OWNER / PMC, based on contour survey of the Unit, levels of adjacent units and levels of adjacent Roads.

2.1.4 Slope in Graded Areas

- | | | | |
|----|--|---|-----------------------|
| a | General Site Grading | : | 1 in 500 to 1 in 1000 |
| b. | Micro grading, after completion of major Construction (for road corridors) | : | 1 in 200 |
| c. | Tanks Farms | : | 1 in 200 to 1 in 300 |

2.2 ROADS



Contractor shall design cross section of roads, including roads for crane access, as per IRC 37. However, the minimum section to be adopted shall be as given in clause 2.2.7 Ruling gradient shall not exceed 1 in 20. If existing roads are to be used for erection purposes, the same should be strengthened to cater for erection loads. It should be ensured that use of existing roads does not hinder normal activities in existing plants.

2.2.1 ROAD WIDTH

Category	Width*	Carriageway Width
I. Road around unit and its Primary access	12.5 m	10.5 m (three lane road or width to suit crane type)
ii. Roads for high lifts crane	2.0 m+ c.w. width	3 m + outer width of crawlers of required Capacity crane.
iii. Plant approach road	9. 0m	7.0 m (two lane)
iv. Roads around tank farm	7.5 m	5.5 m
v. Patrolling roads (along boundary wall)	6.0 m	4.0 m
vi. Access to building	5.5 m	3.5 m
vii. Foot path	1.0 m	.....

* Width of the road to be finalised as per site condition in consultation with client / PMC.

2.2.2 Camber

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2.2.3 Radius of curve: 12 m for 8 m wide carriage way roads, 8 m for 5.5 m wide Carriage way width & 15 m for roads of higher carriageway width.

2.2.5 Extents: As per Plot Plan / Equipment Layout drawing / scope drawing.

2.2.6 Clearance: Minimum 8.0 m to underside of pipe racks.

2.2.7 Minimum Cross Section

- i. Sub base: The sub base shall be 300 mm layer of crushed / broken size stones on well compacted earth or approved fill.
- ii. Base course: The base course shall be 225 mm stone size thick water mix Macadam (WMM) consisting of 3 layers of 75 mm each.
- iii. Bituminous wearing course: Uniform Bituminous Wearing Course of 75mm thickness shall be considered in 2 layers i.e. 25mm of Pre-mix Carpet laid over 50mm of Bituminous Macadam.

2.2.8 Crossings

- a) Pipe Ways under roads & rails : RCC Box Culverts with Wing Walls and Parapets.
- b) Storm Water Culverts Under road / rail : RCC Box Culverts with Wing Walls and Parapets.

2.2.9 Finished Road Top Levels Above FGL.

When box culverts for pipe ways	:	1.05 m (minimum)
Ways are provided	:	1.6 m at box culvert location with a slope from 1.05 m to 1.6 m above FGL
When overhead bridges are	:	1.05 m around hazardous units
Provided for pipe ways	:	0.40 m to 0.60 m for others areas
Other areas	:	0.40 m to 0.60 m

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2.3 HARD STAND/ CONCRETE PAVING (WITHIN PLANT AREAS)

2.3.1 General

- 1) All areas inside battery limit (apart from Bituminous Roads) wherever heavy vehicular/heavy crane movement is not possible or not envisaged, shall be paved with RCC Hard Stand designed to with-stand loads due to Hydra movement, Loaded Fire Tender Movement.
- 2) The heavy crane movement areas shall be paved minimum 200thk RCC. At present heaviest crane available with RFCL has 230 Te Capacity.
- 3) Below Pipe Rack area shall be paved PCC M-20 Grade, up to nearest storm water drain/hardstand/pavement/road.
- 4) In tank farms (inside Dyke Wall region), PCC M-20 Grade paving shall be provided.
- 5) Under-ground utility corridor shall be placed inside trenches to the extent possible with heavy duty covers in crane movement areas and in other areas also u/g corridor shall be placed inside trenches with covers or the corridor shall be paved with heavy duty inter-locking paver tiles.

➤ Minimum Cross Section for Vehicular movement area:-

- i. Sub base: The sub base shall be 300 mm layer of Boulder filling on well compacted earth or approved fill.
- ii. Base course: The base course shall be 75 mm thick M20 PCC.
- iii. Surface course: Surface Course of 200mm thick M25 RCC.

➤ Minimum Cross Section for non- Vehicular movement area:-

- i. Sub base: The sub base shall be 300 mm layer of Boulder filling on well compacted earth or approved fill.
- ii. Base course: The base course shall be 75 mm thick M20 PCC.
- iii. Surface course: Surface Course of 150mm thick M25 RCC.

2.3.2 Joints

Expansion joint of 20 mm shall consist of 20 thick impregnated fibre boards. Filled at top with joint sealing compound 20 x 25.

Equipment / column pedestals will be separated from paving with 20 thick sand fill and Sealing compound 20 x 25.

Contraction joints will be sealed by sealing compound 10 x 40.

2.3.3 Slope: 1 in 100 (minimum)

2.3.4 Minimum requirements of paving in various areas

- a. Paving within Process & Utility : 200 mm thk. RCC
areas for maintenance compatible
to crane movements / dropout
/ Loading / Unloading areas /
Vehicular movement areas
- b. **Non vehicular movement areas**
 - i. Unit : 150 mm thk. RCC
 - II. Offsite pump station : 150 mm thk. RCC
 - II. Bullet Area : 150 mm thk. RCC
 - II. Utilities : 150 mm thk. RCC
- c. **Pipe rack** : PCC M20 (100 mm thick)

Paving and trenches including covers in process units shall be suitable for Hydra crane movement. Where movement of bigger cranes for maintenance is envisage paving and trenches including covers shall be designed for the loads arising from the same.

2.4 SURFACE TREATMENT

The surface treatment for the various areas shall be provided as enumerated in the table below.

AREA	RC CONCRETE PAVING	ASPHALT PAVING	50 thick PCC 1:3:6 ON 115 thick brick soling	GRAVEL	100 THK PCC 1:3:6	ACID / ALKALI PROOF COATIN G
Operating Areas of Process units (including crane movement roads)	X (Type I /II Paving as per cl. 2.3.4)					

Around Transformer s In substation						
Roads (excluding roads having crane movement)		X				
Approaches to units		X				
Tank farms			X			
Acid / alkali / storage / handling area						X
Parking		X				
Hardstands	X					
Pathways	X					
Pipe ways					X	
‘ X ’ Indicating applicable option						
Notes: 1. Existing services where interfering with the new construction should be located and rerouted as instructed by Owner / Consultant. 2. Micro-grading shall be carried out by the Contractor over graded areas to bring the FGL to indicated levels including provision of required slopes and finishes.						

2.5 STORM WATER DRAINAGE

2.5.1 Storm water drains shall be sized for the higher discharge arising out of either rain water or fire fighting water.

2.5.2 Rain water run-off shall be computed by the formula:-

$$Q = KIA / 360$$

K is run-off coefficient given below.

A is area (hectares) contributing to the drain

I is rain fall intensity (mm / hr.)

Q is the discharge.

2.5.3 Design of drains shall be based on Manning's formula:-

$$V = R^{2/3} S^{1/2} / n$$

V is velocity of flow m/s,

R is hydraulic radius,

S is slope,

n is roughness coefficient taken as 0.013 for plaster surface, 0.015 for cast-in-situ concrete, 0.017 for brick lined.

The following parameters are to be ensured to be within limits specified while sizing

Minimum velocity of drains	:	0.6 m/s for conduit and for open channel 1.0 m/s
Maximum velocity of drains	:	3.0 m/s for conduit and for open channel 2.4 m/s
Minimum depth of drains	:	300 mm
Minimum width of rectangular drains	:	300mm (for depth<500mm)
Minimum width of drains	:	500 mm (depth > 500mm)

Run off coefficient 'K'



a.	paved area	concrete	-	1.0
		Bituminous	-	0.9
b.	unpaved areas		-	0.7
c.	unusable areas like Green belt		-	0.4

2.5.4 Drains within Process Units

Rain water falling on such portion of paved areas of process unit where it is not likely to get contaminated, shall be collected in open rectangular RCC drains. These drains shall be covered by HDG (Hot-Dip Galvanized) or Electroforged Gratings, and shall be generally connected to periphery drains, which at battery limit shall have a double valve chamber. This will permit discharging the rain water either to storm water network, or to the battery limit CRWS manhole. Drains shall be designed for the maximum of rainwater / firewater on same principles as storm water drains.

2.5.5 Culverts and Road/Rail Crossings

Road / Rail and storm water drain crossing shall by RCC box culverts, designed for the Relevant IRC loads for roads, and track loads for rail. The relevant lateral loads due to

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wheel / track loads on the soil adjacent to wall on crossing shall be considered on the walls.

Drain to adjacent to roads / pavement where heavy crane movement is anticipated shall be Concrete drains, designed to resist the lateral thrust due to wheel loads.

Pipe culverts, if instructed to use by Owner/PMC, shall comprise of R.C.C. pipes (class NP-3, IS: 458) under roads; and R.C.C. pipes (class NP-4, IS: 458) under rail lines.

2.5.6 Tank Farm Drainage

Tank farm drainage system should be provided in such a way that the storm water discharge shall be either sent to storm water open ditch or to the oily water sewer by providing valve pit outside the dyke wall depending on its contamination.

2.5.7 Disposal of Storm Water

Storm water drains shall not be combined with oily waste sewer / CRWS/combined sewer system, etc. For disposal of storm water references shall be made to the 'scope' document.

2.5.8 Oil Catcher

An oil catcher with baffle wall type arrangement shall be provided a storm water ditch before it leaves the battery limit of the unit, & tank farm.

2.6 WATER SUPPLY

2.6.1 Drinking Water System (Plant Service)

- a. Rate of water supply - 200 litres / head / day
- b. System - Underground ring main with Heavy Grade G.I Pipe and Fittings as per IS:1239.
- c. Storage - Overhead tank HDPE Tanks (2000 Litre) with Float Valves based on average daily demand

2.7 SANITARY SEWERS

2.7.1 General

Sanitary sewerage will not be combined with storm water.

Building drainage shall be designed as a dual pipe system with separate soil & waste pipe.

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Sewers shall be designed for discharging 3 times average flow flowing half full in case of lateral sewer, and flowing 2/3 full in case of Main sewer. The minimum and maximum clearing velocities shall be 0.6 m/s and velocity 3.0 m/s respectively.

2.7.2 Flow from septic tank / Interceptor tank shall be led into sewerage system upto Sewer Treatment Plant. During construction time of plant, when sewerage system is not operational, septic tank with soak pit shall be provided.

2.7.3 Cover for Sewer Line shall be minimum 600 mm.

Under road, sewer shall be protected by concrete encasement.

2.7.4 Material of Construction

- a. Material of Construction for Manholes shall leak proof R.C.C. M30 (inner Face shall be Epoxy coated).
- b. Material of Construction for Sewer

Sanitary Sewer


- i. Toilet block to inspection - CI pipes as per IS: 3486/1729
chamber or UPVC, as directed.
- ii. Gravity main & lateral - R.C.C. Pipe (inner
Face shall be Epoxy coated).
- iii. Pressure main - C.I. pipes (as per IS: 1536 an IS: 1537)
- iv. Offsite Pumping, if any - CPVC pipes/GI as per PMS J2A(as directed)
- v. Manhole Cover - Heavy Duty C.I. Covers with Frame.

2.8 CONTAMINATED RAIN WATER SEWERS

2.8.1 Process Unit

Contaminated rain water / floor wash / fine water shall be collected through catch basins located in the contaminated areas of the process unit and shall be send to the oil catcher / CRWS pit / CRWS header. The continuously contaminated area of all pumps shall be segregated by kerb wall; discharge from such kerbed areas shall be collected in OWS network and not in CRWS network.

CRWS shall be designed for contaminated water due to rain water or Fire water, whichever is more.

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The quantities of contaminated rain water shall be worked out based on the contaminated process area in the unit block.

Sewer shall be sized flowing full with peak flows taking future requirements or 2/3 full without future requirements.

CRWS manholes shall be R.C.C. (M30) construction. For trapping of gas or prevention of spread of fire through CRWS from one area to another, a liquid seal of minimum 150 mm shall be provided in manhole along with suitable vents. Location of sealed manholes should be decided accordingly. The vents on the manholes should extend minimum 2.0 m above the pipe rack or 1.0 m above buildings, or if in open areas extending min 3.0 m above FGL with frame arresters.

CRW sewers in process units and tankage areas shall be of mild steel /Carbon steel conforming to IS: 3589

2.8.2 Tank Farm Area

Tank farm areas, not containing tanks for corrosive materials, shall be drained by surface drains. Waste water shall be led to a sand trap and then to a valve chamber which shall either drain the water to storm water drain or oily water drain. Waste water from tank farm areas containing corrosive / hazardous materials shall be collected to a pit and pumped to existing ETP.

2.9 OTHER PROCESS DRAINS

Other process drains shall be oily water sewers, closed blow down sewers or chemical Sewers. Sizing, layout, material specification, corrosion protection etc will be as per u/g piping design Basis.

Dyked areas around emergency booths shall drain into a gully trap which shall be connected to the chemical sewer network.

2.10 STORAGE TANK FOUNDATION

2.10.1 The storage tank foundations shall be designed to sustain the forces at the tank bottom within permissible settlement, under operating and hydro-test conditions.

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Tanks less than 2.5m dia. may rest directly on a concrete pedestal with Acid/Alkali resistant tiles

Tanks greater than 2.5m dia. but less than 10.0 m dia. may be supported on RCC ring all with sand / murrum fill.

For tanks greater than 10m dia, Tank Pad Foundations shall be provided as per relevant design Codes.

- 2.10.2 Anticorrosive layer shall be provided as per specifications for tank pads of 50 mm thick premix Carpet over 50 mm thick bitumen sand mixed with additions of kerosene / oil as required.

2.11 BARRICADE



Contractor shall design a suitable barricading system for protection of existing facilities. Barricade shall be of G.I. sheet cladding with suitable supporting system of height and extent shown in drawings or as instructed by Owner / Consultant. Water spray system shall be incorporated where felt necessary by Owner / Consultant. Localized G.I. sheet barricading shall be provided from operational constraint requirements as directed by Owner / consultant.

2.12 TRENCHES

Trenches shall be of RCC with inserts or other suitable arrangement required to support Cables pipes etc. Pre-cast concrete covers with lifting arrangement shall be provided on top. In paved areas, the top will be flush with finished floor level. Covers shall overlap walls and joints with paving shall be sealed to prevent water entry. In unpaved areas, walls shall be raised above ground level by 100 mm. Trench floors shall be provided with a nominal slope to drain pits, where any water entering trenches can collect and be detained to the nearest contaminated rain water sewer / storm water sewer. Trench covers shall be designed for the vehicle load relevant to the area where the trench is located. Cable trench shall be of leak proof construction.

2.13 HARD SURFACES

Hard surface of PCC M20, (100 mm thick) over suitable bedding shall be provided below all new pipe tracks and / or extended portion of existing pipe Tracks. This shall extend 600 mm on one side for track width less than 6 m, and 900mm On either side for pipe track having width 6 m or more, end it shall have approach @ 500 M c/c from nearest road.

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Hard surface of PCC M20, (100 mm thick) over suitable bedding (brick / stone soling) of approximate size 1 m x 1 m shall be provided with proper approach near drain point of offsite piping, near drinking water installations, at washing facilities, etc., with suitable curbing and drainage arrangements as required for the fluid being handled.

2.0 REMOVAL / REROUTING OF OBSTRUCTIONS

All underground or above ground structures / foundations which will cause obstruction to new structures / foundations, and which can be removed without disturbing any functions of the existing plant, shall be removed by the Contractor.

All existing underground or above ground facilities requiring rerouting due to fouling with new facilities shall be rerouted by the Contractor in such a manner that rerouted facilities keep on functioning as before.

NOTE:

Before finalizing the route connection to existing system, adequacies of existing system shall be checked by the contractor.





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1.0 GENERAL

1.1 SCOPE

This engineering design basis defines the minimum design criteria that shall form the basis for carrying out detailed structural design and engineering of all plant and non-plant structures and buildings. All data required in this regard shall be taken into consideration for acceptable, satisfactory and trouble-free engineering of the structures.

Compliance with this design basis and / or review of any of the contractor documents shall in no case relieve the contractor at the contractual obligations. All structures shall be designed for the satisfactory performance of the functions for which they are being constructed.

1.2 UNITS OF MEASUREMENT

Units of measurement in design shall be in metric system.



1.3 DEFINITIONS

Owner	RFCL
Consultant	To be selected
LSTK Contractor	Successful LSTK bidder of the tender
CCE	Chief Controller of Explosives
TAC	Tariff Advisory Committee
NFPA	National Fire Protection Association
IS	Indian Standards

1.4 CODES AND STANDARDS

The design shall be in accordance with established codes, sound engineering practices and shall conform to the statutory regulations applicable to the country.

- 1.4.1 The main codes and standards and statutory regulations considered as minimum requirements are as follows Latest revision of these shall be followed.

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- 1) National Building Code of India : 2005
- 2) IS: 875 (Part 1) – Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures (Part 1 – Dead Loads).
- 3) IS: 875 (Part 2) - Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures (Part 2 – Imposed Loads).
- 4) IS: 875 (Part 3) - Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures (Part 3 – Wind Loads).
- 5) IS: 1893 (Part 1):2002 –Criteria for Earthquake Resistant Design of Structures (Part 1 – General Provisions and Building).
- 6) IS: 1893 (Part 4):2005 –Criteria for Earthquake Resistant Design of Structures (Part 4 – Industrial Structures including Stack-Like Structures).

1.4.2 STRUCTURAL STEEL

- 1) IS: 800 – Code of Practice for General Construction in Steel
- 2) IS: 802 – Code of Practice for use of structural steel in overhead transmission line towers.
- 3) IS: 1161 – Code of Practice for Circular hollow sections/pipes.
- 4) IS: 4923 – RHS & SHS sections.
- 5) IS: 2629 – Recommended practice for hot dipped galvanizing on iron and steel.
- 6) IS: 2633 – Methods for testing uniformity of coating of zinc coated articles.
- 7) IS: 6533 – Code of Practice for design and construction of steel chimney.
- 8) IS: 6745 – Method for Determination of mass of zinc coating.
- 9) IS: 814 – Covered Electrodes for manual metal arc welding of Carbon and carbon manganese steel.
- 10) IS: 816 – Code of Practice for use of Metal arc welding for General Construction in mild steel.
- 11) SP-06 – (Part 1 to Part 7)- Handbook for Structural Engineers.

1.4.3 REINFORCED CONCRETE AND MASONRY WORK

- 1) IS: 456 – Plain and Reinforced Concrete – Code of Practice
- 2) SP:16 - Design Aids for Reinforced Concrete to IS: 456
- 3) SP: 34 – Handbook of Concrete Reinforcement and Detailing.
- 4) SP:24 – Explanatory Handbook on Indian Standard Code of Practice for Plain and Reinforced

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- 5) SP: 20(S & T) – Explanatory Handbook on Masonry Design and Construction.
- 6) IS: 2911 (Part 1 to Part 4) – Code of Practice for Design and Construction of Pile Foundation.
- 7) IS: 2950 (Part 1) – Code of Practice for design and construction of Raft foundation.
- 8) IS: 2974 (Part 1 to Part 5) – Code of Practice for design and construction of Pile Foundations.
- 9) IS: 3370 - Code of Practice for Concrete Structures for storage of liquids.
- 10) IS:4326 – Code of Practice for earthquake resistant design & construction of buildings
- 11) IS: 13920 – Code of Practice for ductile detailing of reinforced concrete structures subjected to seismic forces.
- 12) IS:1172 - Code of basic requirements for water supply, drainage & sanitation
- 13) IS:1742 - Code of practice for building drainage
- 14) IS:1905 - Code of practice for structural use of unreinforced masonry
- 15) IS: 2212 - Code of practice for brick work

1.4.4 ROADS AND SANITARY WORKS

- 1) IS: 2065 - Code of practice for water supply in buildings
- 2) IS: 8835 - Guidelines for design of surface drains.
- 3) IRC: 6 - Code of practice for road bridges, Section-II Loads and stresses
- 4) IRC: 19 - Standard Specifications And Code of Practice for Water Bound Macadam
- 5) IRC: 37 - Design of flexible pavements
- 6) IRC: 58 - Design of rigid pavements

Note: The above list is suggestive and not exhaustive. Apart from these basic codes any other related codes shall also be followed wherever required.

In case of any difference between Codes provision and this design basis, the stringent one should govern the design.

1.4.5 In case of any conflict / deviations amongst various documents, the order of precedence shall be as follows.

- Statutory Regulations
- Job Specifications
- Engineering Design Basis
- Standard Specifications

2.0. MATERIALS OF CONSTRUCTION

Type of Structure	Materials of Construction
Pipe racks Technological Structures/Platforms Shed type structures (e.g. compressor shed, Pump shed)	Structural Steel (unless required otherwise from process requirement or operation considerations)
Opening Platforms in steel structures All buildings (except blast-proof control-Room) Gratings	Steel gratings RCC frames with hollow/solid concrete block work walls Steel

3.0 DESIGN LOADS (DL)

The following design loadings shall be considered

Dead loads including self weight

Live load

Wind load

Seismic load

Equipment load

Dynamic load

Load from lifting appliances

Erection loads / maintenance loads

Thermal load

Earth pressure / Hydrostatic Loads

Any other load not mentioned above, but applicable



These loadings shall be applicable to all structures irrespective of the material employed for construction.

3.1 DEAD LOADS

Dead load shall comprise of the weight of all permanent construction including walls, fire proofing, floors, roofs, partitions, stairways and fixed services.

Unless noted otherwise following unit weights shall be adopted.

Reinforce Concrete	:	2500 kg/m ³
Plain Concrete	:	2400 kg/m ³
Structural steel	:	7850 kg/m ³
Backfill Soil	:	1800 kg/m ³
Operating floor with grating	:	100 kg/m ²

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Staircase (steel)	:	140 kg/m ²
Ladder	:	40 kg/m ²
False ceiling	:	60 kg/m ²
Heavy duty tar felting	:	30 kg/m ²

3.2 EQUIPMENT LOADS

EQUIPMENT CATEGORY I

The weight of equipment category I such as pumps, compressors, motors etc., shall be derived as far as possible from Manufacturer's data and shall include controls, auxiliary machinery, piping etc. The equipment load shall be categorized if required for use in various loading combinations as empty and operating.

EQUIPMENT CATEGORY II

This category consists of loads from equipments such as vessels, columns, heat exchangers, condensers, settlers, filters and the like, complete with their piping.

In accordance with the various load combinations for the category of equipment, the following weights/loads shall be included in the calculations.

a) EMPTY WEIGHT (ELe)

This is the dead weight of vessels, columns, etc. completely installed) including platforms and ladders, piping, insulation and fireproofing) and ready for operation, however, without liquid filling. Weights will be derived from manufacturer's data.

b) OPERATING LOAD (ELo)

This is the empty weight plus the maximum weight of contents of vessels, columns, etc. during normal operation of the plant, Weight of pipes full of product (liquid/gases) plus the weight of insulation and anchor loads if any.

c) HYDROSTATIC TEST LOAD (ELt)

When Hydrostatic pressure testing of equipment is required at site and is done after installation, the weight of equipment, completely filled with water shall be incorporated in the design of the supporting structure. Only one biggest system shall be considered to be tested at a given time.

The empty / operating / test weight of process equipment including contents and all fixtures, platforms, ladders and attached piping etc, shall be considered. If piping weight is not indicated separately or not included in the weight of the equipment, the same shall be taken as 10% of the weight of the equipment.

3.2.1 Exchangers / Fabricated equipments

When exchangers are supported on structures, the supports shall be designed for vertical and horizontal forces (bundle pulling force or friction forces). The vertical loads shall be categorized into empty weight, operating weight and test weight.

Weight distribution over two (2) saddles of an exchanger shall normally be as follows:

Exchanger Type	Channel Side	Shell Side
Floating head type	60%	40%
Fixed tube sheet type	50%	50%
Kettle type	45%	55%
U-tube and other type	67%	33%

3.2.1.1 Special Considerations

a. Bundle Pull

Bundle pull forces for different types of exchangers shall be taken as under :-

Fixed type	-	Nil
Kettle type	-	0.30 x Bundle weight
All other types	-	0.86 x Bundle weight or 30 N/mm of diameter whichever is greater.

Total Bundles Pull shall be considered on fixed pedestal alone

b. Thermal Expansion

Horizontal force due to thermal expansion of horizontal vessels / exchangers shall be relieved by using slotted holes and slide plates and remaining force derived from the product of the sliding saddle 'gravity load' and the coefficient of friction shall be applied to each support. The coefficient of friction shall be as under:

a. Teflon to Teflon	:	0.08
b. stainless steel to Teflon	:	0.10
c. steel to steel	:	0.30
d. steel to concrete	:	0.45

c. Non-Static Loading

Foundations and structures supporting vessels subject to surge loading, such as Deaerators shall be designed with sufficient stiffness and rigidity to resist a notional horizontal forces of 10% of those derived from the Vessel's operating weight or the given surge load whichever is the greater. The forces shall be applied at the vessel's centre of gravity and act longitudinally OR transversely. Consideration shall be given to bracing these structures.

The design of foundations and structures supporting agitated vessels, centrifuges, reactors and other variable load equipment shall take full account of all the loading data provided by the equipment vendors. Where no loads are available, consideration shall be given to applying force at 10% of operating weight. In addition, for dynamic effect loads will be increased by 50% of steam agitated equipment and 25% for mechanical agitated vessels.

Where two or more similar items of such equipment are supported on a common foundation or structure, the design must be based on the assumption that these items will resonate in phase.

3.3.2 Rotating Equipment

Comprehensive loading data of mechanical equipment, such as, fans, blowers, pumps, compressors, D.G. Sets, turbines, motors engines etc., as furnished by the equipment vendor shall be considered.

3.3 LIVE LOADS (LL)

Live loads shall, in general, be as per IS: 875. However, the following minimum live loads shall be considered in the design of structures to account for maintenance and erection phases; if equipment layout / vendor drawings indicate loads of greater magnitude, the same shall be adopted.

i. Process Building / Technological Structure (Open / Enclosed type)



Operating area	-	5.0 kN/m ²
Maintenance area	-	7.5 kN/m ²
Ground floor	-	10.0 kN/m ²

ii. Compressor House/House



Operating area	-	10.0 kN/m ²
Maintenance area	-	10.0 kN/m ²
Ground floor	-	10.0 kN/m ²

iii. Service Platform

Vessel / Tower	-	3.0 kN/m ²
Isolated platform (for valve operation)	-	2.5 kN/m ²
Access way	-	2.5 kN/m ²
Cross over	-	2.0 kN/m ²
Piperack walkways	-	2.5 kN/m ²

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	Gantry girder walkway	-	3.0 kN/m ²
iv.	Substation / Control Room		
	Panel floor	-	10.0 kN/m ²
	Miscellaneous partition	-	1.0 kN/m ²
	Other areas	-	5.0 kN/m ²
v.	Office building		
	Office area	-	3.0 kN/m ²
	Entrance lobby	-	5.0 kN/m ²
	Exit way	-	5.0 kN/m ²
	Miscellaneous partition	-	1.0 kN/m ²
	Document Storage area	-	10.0 kN/m ²
vi.	Laboratory		
	Upper floors	-	4.0 kN/m ²
	Ground floor	-	5.0 kN/m ²
vii.	Cooling Tower		
	Operating platform /cover	-	3.0 kN/m ²
	Slab of hot water basin & Sump		
viii.	GT Building / DM Plant /ETP		
	Operating platforms	-	3.0 kN/m ²
	Ground floor	-	5.0 kN/m ²
ix.	Staircase		
	Process Building	-	5.0 kN/m ²
	Technological structure	-	5.0 kN/m ²
	Office	-	5.0 kN/m ²
	Substation/Control Room	-	3.0 kN/m ²
	Laboratory	-	4.0 kN/m ²
	Service platform	-	2.5 kN/m ²

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Loads on account of equipment and incidental loads shall be taken over and above the loads indicated in the table.

For all other buildings not covered in above Table as well as roofs of various structures, the imposed loads shall be taken as specified in IS: 875 (Part II)

1 KN/m² allowance shall be made for services supported from below the floor.

Live load on various types of roofs shall be as per the requirements given in IS: 875.

3.4 WIND LOADS (WL)

Wind loads shall generally be as per IS-875 (Part-3) except for switchyard structures and transmission towers for which IS: 802 shall be applicable. Basic wind speed shall be as per the Code. As per IS:875 (Part-3), definition of basic wind speed shall be peak gust velocity averaged over 3 second time interval at 10 m height above mean ground level with 50 years mean return period . The design life span of all structures, except temporary structures, and boundary wall shall be taken as per IS 875. Life span of temporary structures and boundary wall can be lesser and shall be as per IS: 875.

Values of coefficients K_1 , Terrain Category, K_3 for the project site shall be considered as per IS: 875 – Part 3.

Coefficient K_2 shall be worked out based upon structure height, structure class and terrain category mentioned in the table above.

Design wind speed shall be worked out based on basic wind speed and k_1 , k_2 , k_3 using IS 875 Part-3.

Design wind pressure (P_d) shall be worked out based on design wind speed using IS: 875 Part-3.

To account for surface area of piping, platforms and other attachments fixed to the equipment, the surface area of the equipment (vessel/column) exposed to wind shall be increased by 20% or as specified in the mechanical data sheets of the equipment.

Wind force on structural elements shall be calculated using design wind pressure multiplied by elements frontal area, normal to wind direction multiplied by force coefficient as per Table 26, IS 875 Part-3.

In calculation of wind force frictional drag shall be considered where applicable.

3.5 SEISMIC LOADS(SL)

Seismic loads shall be as per IS: 1893 (latest version).

3.6 IMPACT AND VIBRATORY LOADS

Structures subjected to impact or vibratory loads shall be designed as per the provision of IS: 875 & IS: 2974. Requirements for monorails and overhead cranes shall be as per IS: 800, IS: 875 or manufacturer's data, whichever is more stringent.

3.7 BLAST FORCES

Blast resistant Control Room or any other specified structure, subjected to blast forces generated due to accidental blast from hydrocarbon ignitions should be designed to withstand all such forces. Unless specifically mentioned by the process licensor, design blast loads and blast resistant construction shall be as specified below and shall conform to relevant IS codes and good engineering practices.

Buildings located within 30 m from a potential blast source, shall be designed to withstand the maximum combination of loads resulting from any one of the following:

- 1) Blast pressure equivalent to static pressure 21KPa acting on all exterior surfaces.
- 2) Suction blast pressure equivalent to static pressure 7 KPa acting on all extreme surfaces.

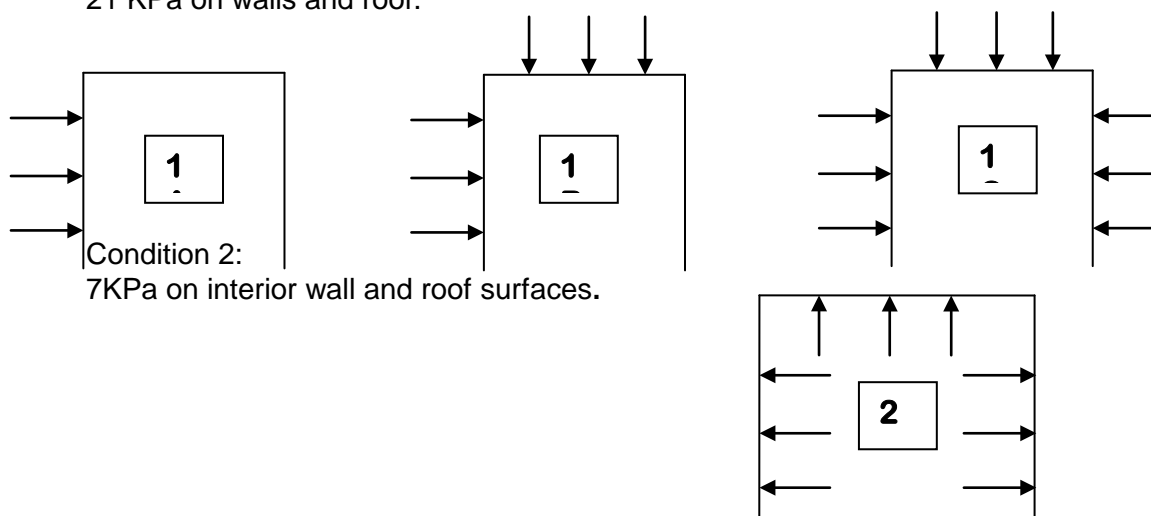
Design of blast resistant control building shall be according to the following minimum blast-loading conditions:

Condition 1:

Any of the following combinations:

1A, 1B, 1C whichever is the most critical

21 KPa on walls and roof.



Control buildings located more than 30 m from a blast source shall be designed to resist maximum combination of loads in accordance with the following table :

Distance versus Design Pressure

Distance from Process Equipment (meter)	Blast Pressure (KPa)	Suction Blast Pressure (KPa)	Wind Velocity Pressure (KPa)
30 to 45	21	7	4
45 to 60	10	3	2
60 to 75	7	2	1
75 to 150	3	1	*
Over 150	*	*	*

Structural Design Criteria

- Design the structure as a shear wall structure with the roof acting as a horizontal diaphragm that transfers the transverse loads to the side shear walls. External shear walls shall be continued up to 1.5 m below GL or up to founding level whichever is less.
- Design of walls and roof shall be based on the “Yield Line Theory”.
- Provide cast-in-situ reinforced concrete walls and roof of load-bearing type, designed to resist bending and transmit horizontal shear. Precast concrete panels may be used but shall be either mechanically bonded to cast-in-situ reinforced concrete columns or provided with built-in load transmitting steel plates or angles so that the panels can be welded in place.
- Anchor walls to foundations and concrete roof slabs with steel reinforcing bars to provide full moment connections.

Provide roof framing with adequate bearing and good anchorage to the supporting walls. Weld roof form decking if used to the top member of the roof frame.

- Distribute loads on roofs and walls in two directions where possible.
- Consider stress reversals at each member and provide a minimum 20% stress reversal.
- Design reinforced concrete members with good ductile properties. Limit tension steel to 1% of the concrete area and 2% of the concrete area for tension plus compression steel. To allow for stress reversal provides reinforcing steel in both concrete faces and set shear bars perpendicular, not inclined.
- Provide local strengthening of concrete at opening by additional reinforcing without local thickening where possible.

Load combinations with blast loads

- For Flexure
1.0 (Dead load + Blast load)
- For shear
1.2 (Dead load + Blast load)

Live load shall not be considered on the roof during blast.

Soil Bearing Capacity

Design bearing pressure shall be taken as equal to twice the allowable static bearing pressure for load combinations with blast load.

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Stability Ratio

Factor of Safety in case of load combinations with blast load shall be as follows:

Overturning	-	1.2
Sliding	-	1.3

Openings:

- Minimize openings in the building enclosure and locate openings to avoid or be shielded from direct blast pressures.
- Windows, if unavoidable shall be limited in size and provided with special glazing.
- Select external doors, louvers and similar items, together with their frames, capable of withstanding the pressures. Do not use glass panels in these doors. Provide for personnel at least for two access doors, located remote from each other and where possible not in opposite walls. The size of equipment doors for maneuvering factory-fabricated control boards into or out of the control room.

3.8 CONTINGENCY LOADS

3.8.1 RCC Structures

All floor slabs and beams shall be designed for a concentrated load of 10 KN acting simultaneously with the uniform live load, but not with actual concentrated loads from equipment, piping etc. This load shall be placed to result in maximum moment and / or maximum shear.

This load shall not be considered for the design of columns, foundations and in overall frame analysis. For floor slabs, the load shall be considered to be distributed over an area of 0.75 m x 0.75 m.

3.8.2 Structural Steel

For process plants, the following contingency additional loading shall be applied to individual beam elements, these shall be applied as point loads to produce worst shear and bending stresses:

Platform Walkways	3 KN
Secondary Floor Trimmers	5 KN
Primary / Grid beams	10 KN

3.9 MISCELLANEOUS LOADS

Apart from the specified live loads, possible overloading during construction / hydro-test maintenance / erection shall also be considered in the design Job specifications shall also be referred to, for any specific loading.

Hydrostatic pressure shall be adequately accounted for, in the design of structures, below ground water table.

All the handrails, parapets, parapet walls, balustrades shall be designed for horizontal load mentioned in Table 3 of IS-875 (Part-2).

3.10 LOAD COMBINATIONS

Structural analysis and design shall take into consideration, worst combination of the above loads under different phases, such as, Erection, Operation, Hydro-test, Shutdown, Maintenance, and Blast for control room, as applicable.

A) For Foundation Design :

LOAD CONDITION	LOAD COMBINATION
OPERATING	$DL + LL + EL_O$
	$DL + LL + EL_O \pm WL$
	$DL + EL_O \pm WL$
	$0.6 \times (DL + EL_O) \pm WL$
	$DL + EL_O + LL \pm SL$
	$DL + EL_O \pm SL$
	$0.6 \times (DL + EL_O) \pm SL$
ERECTION	$DL + EL_e \pm WL$
	$0.6 \times (DL + EL_e) \pm WL$
TESTING	$DL + EL_t \pm WL$
	$0.6 \times (DL + EL_t) \pm WL$

B) FOR CONCRETE DESIGN

LOAD CONDITION	LOAD COMBINATION
OPERATING	$1.5 \times (DL + LL + EL_O)$
	$1.2 \times (DL + LL + EL_O \pm WL)$
	$1.5 \times (DL + EL_O \pm WL)$
	$0.9 \times (DL + EL_O) \pm 1.5 \times WL$
	$1.2 \times (DL + EL_O + LL \pm SL)$
	$1.5 \times (DL + EL_O \pm SL)$
	$0.9 \times (DL + EL_O) \pm 1.5 \times SL$

ERECTION	$1.5 \times (DL + EL_e \pm WL)$
	$0.9 \times (DL + EL_e) \pm 1.5 \times WL$
TESTING	$1.5 \times (DL + EL_t \pm WL)$
	$0.9 \times (DL + EL_t) \pm 1.5 \times WL$

C) FOR STRUCTURAL STEEL DESIGN

LOAD CONDITION	LOAD COMBINATION
OPERATING	$DL + LL + EL_o$
	$0.75 \times (DL + LL + EL_o \pm WL)$
	$0.75 \times (DL + EL_o \pm WL)$
	$0.75 \times (DL + EL_o + LL \pm SL)$
	$0.75 \times (DL + EL_o \pm SL)$
ERECTION	$0.75 \times (DL + EL_e \pm WL)$
	$0.8 \times (DL + EL_e)$
TESTING	$0.75 \times (DL + EL_t \pm WL)$
	$0.8 \times (DL + EL_t)$

The design shall be governed by worst load combinations.

4.0 DESIGN CRITERIA FOR FOUNDATIONS

4.1 GENERAL

Foundation sizing shall be based on working loads, not on loads which may have been increased by factors for the purpose of concrete design.

4.2 TYPE OF FOUNDATIONS

Type of foundations to be adopted and the pertinent details there of shall be as per provisions of scope and job specifications documents.

Following clauses describe the general guidelines to be followed while designing the foundations; these clauses do not per se stipulate the type of foundations to be followed.

4.3 SHALLOW FOUNDATIONS

- 4.3.1 For gravity loading, allowable net bearing capacity of soil shall be based on the following settlement criteria:

Foundation Type	Allowable Settlement(mm)
Foundations in unit areas, utility areas and Foundations for plant buildings including substation, Compressor house, control room, technological structures	25
Machine foundations and critical equipment with interconnected piping	25
Foundations supporting non-plant buildings	40

- 4.3.2 For transient loadings, such as wind / seismic, allowable net bearing capacity based on shear criteria may be considered.
- 4.3.3 For load combinations including wind, the Safe Soil Bearing Pressure may be increased by 25%.
- 4.3.4 For load combinations including earthquake, the Safe Bearing Pressure of Soil may be increased as permitted in IS: 1893.
- 4.3.5 Under blast (due to hydrocarbon explosion) load combinations if any, the design bearing pressure of soil shall not exceed twice the allowable static bearing pressure of soil.
- 4.3.6 Allowable Loss of contact area between underside of foundation and soil (due to resultant Overturning Moment) under different loading conditions shall be as given below.

	Load Combination description	Allowable % Loss of Contact Area
A	Operating Load case (Plant operating, with or without Live Loads, for worst cases)	0 % to 10%
	Operating Load Case with Wind or Earthquake (with or without Live Loads, for worst cases)	up to 25%
B	Operating Load case (Plant operating, with or without Live Loads, for worst cases)	0 % to 20%
	Operating Load Case with Wind or Earthquake (with or without Live Loads, for worst cases)	up to 30%

Where

A = Foundations on Soil

B = Foundations on Rock

4.3.7 Soil and hydrostatic pressure on walls below grade.

In the design of walls below grade, provision shall be made for the lateral pressure of adjacent soil. Due allowance shall be made for possible surcharge from fixed or moving loads. When a portion or whole of the adjacent soil is below a free water surface, computations shall be based on the weight of the soil, diminished by buoyancy, plus full hydrostatic lateral pressure.

The lateral pressure from surcharge loads shall be taken in addition the lateral earth pressure loads.

4.3.8 Stability of foundations

Foundations shall be checked for stability against overturning, sliding & uplift. While checking against uplift, the following shall be considered.

FOUNDATION DESIGN – FACTORS OF SAFETY

Type of Structures	Minimum factor of safety against overturning		Minimum factor of safety against Sliding		% Weight of Overburden over projected plan area of footing
	With wind or seismic	Without wind or seismic	With wind or seismic	Without wind or seismic	
All Buildings/ Structures / Eqpt. In Units	1.5	2.0	1.5	1.5	100
Pipe Rack (Offsite)	1.5	2.0	1.5	1.5	50
Flood Light Mast	1.5	-	1.5	1.5	50**
Retaining Wall	1.5	2.0	1.5	1.75	100
Over Head water tank	1.5(empty) 2.0(full)	-	1.5	-	50**
Blast Resistant Structures	1.5	2.0	1.5	1.5	100
Flare supporting Structures	1.5	-	1.5	-	50**

** In case area is paved, overburden shall be based on NGL (for area under filling) or 600 mm below HPP, whichever is lower. In case of unpaved area, it shall be w.r.t. FGL.



Minimum factor of safety against uplift shall be 1.2 for all structure. (Note: In case of sumps, lining weight shall not be included). Beneficial load of backfill can be included on in circumstances where it will never be removed.

Buoyancy from high ground water levels shall be taken into account in investigating stability against uplift.

4.4 PILED FOUNDATIONS

Piles shall be designed as per IS: 2911. However, pile capacity shall be proven by a sufficient number of initial load tests before preparing piling plans.

The increase in Safe Working Load permitted as per codal provisions, under load combinations including wind / earthquake shall apply equally to uplift and sheer conditions, subject to confirmations by the piling Contractor with respect to the particular

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piling system. Pile capacity may be similarly increased in blast condition to 1.5 times the permissible capacity under compression, tension and shear modes.

When any major machinery is to be supported on piles, behavior of the piles under dynamic, loading conditions, as established by necessary field test, shall be considered.

The capacity of pile groups shall be obtained by applying appropriate group efficiency factors. Where piles pass through filed ground, the available pile safe working load shall be suitably reduced to account for negative skin friction caused by settlement of fill. Where suitable, consideration shall be given to reducing drawdown effects by slip coating the piles

While computing horizontal capacity, piles shall be treated as fixed head or free head depending on the degree of fixity at the top.

4.5 MACHINE/EQUIPMENT FOUNDATIONS:

Machine / Mechanical equipment foundations shall satisfy the requirements of IS: 2974 and any other parameters as per machine vendors.

Generally, foundations and structures supporting rotating machinery shall be so proportioned that their natural frequency shall not fall within the range of 0.8 to 1.2 of normal operating speed of the equipment. Further for major rotating machinery such as main compressor, the amplitude of foundation of structure during normal operation shall not exceed the allowable amplitude specified by the equipment manufacturer. The above consideration may be omitted for centrifugal pumps and fans and other minor rotating equipment weighing less than 1 ton or if the mass of the rotating parts are less than $1/100^{\text{th}}$ of the mass of foundation installed directly on concrete provided that the weight of foundation is not less than 3 times of the equipment weight. In such cases, dynamic analysis is not necessary.

When dynamic analysis is called for, the combined centre of gravity of the machine and foundation system shall, as far as possible, pass through the centre of area of the foundation raft or centroid of the pile group. Wherever unavoidable, eccentricity shall be less than 5% for block foundations and 3% for frame foundations. However, in highly compressible soils, no eccentricity shall be permitted.

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Foundations shall be so designed that natural frequency of the foundation system shall not resonate with the following:

- Operating speed of the motor / turbine
- Operating speed of the machine
- 2 x Operating speed of the machine
- Critical speed of the machine (for centrifugal machines)

It shall be ensured that there is no transfer of vibrations from machine foundations to any part of the adjoining structures. In case such machines are sitting on building floors, approved damping pads shall be used with prior approval of the Owner / Consultant.

Where deviations (resulting from inaccuracies in soil parameter measurements, approximations in design method, etc.) from calculated natural frequencies, leading to amplitudes in excess of specified limits are foreseen, provision for increasing the foundation mass without removal of the machine and without affecting surrounding space availability or connected piping shall be made, if possible.

4.6 CONCRETE GRADE



Grade of concrete to be used in foundation shall in general be as per the philosophy adopted for the entire structure. However, minimum cement content, type of cement and any remedial actions, if required for foundations due to aggressiveness of subsoil water, shall be as stated elsewhere in this document. For underground structures, such as, foundations, manholes M30 grade reinforced concrete shall be used.

4.5 FOUNDATION BOLTS

All holding down bolts or threaded rods for non-post tensioned applications shall be out of Mild Carbon steel conforming to IS: 2062 with $F_y = 250$ MPa unless Noted Otherwise. For scrubbing section and acid storage section, holding down bolts should conform to SS 316.

4.7.1 Minimum cover to Foundation Bolts

Minimum distance between a Standard Holding down Bolt or Anchor Sleeve and the face of Foundation/pedestal shall not be less than 6 x (dia of bolt) mm.

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- 4.7.2 All equipment foundation bolts / templates shall be designed and supplied by equipment vendor. Foundation bolts for steel structures shall be designed and supplied by contractor as per standard drawings or approved equivalent.

4.7.3 Other Inserted And Embedded Items

Unless otherwise specified, all structural steel shall be weldable structural steel “Standard Quality” (Fe 410 WA), in accordance with code IS: 2062.

All embedded steel items (exposed to atmosphere) shall be hot-dip galvanized in accordance with IS: 2629, except if noted otherwise on the design drawings.

All inserted and embedded items shall be accurately placed or template in and be securely anchored prior to placing concrete.

At sliding ends of vessels and horizontal exchangers, sets of plain steel plates shall be provided. In order to reduce the horizontal force due to friction at sliding ends sets to PTFE bonded steel plates may be provided.

4.8 PEDESTAL HEIGHTS

Building plinth	: 600 mm above FGL or as per requirement
Pedestals for structural columns	: As per design requirement
Open paved area	: 300 mm (min.) OR as indicated in Equipment Layout drawing
Open unpaved area	: 300 mm
Covered area(building etc.)	: 300 mm (min.) OR as indicated in drawing
Storage tank foundation	: As per equipment layout



All equipment supporting foundations / pedestals

Open area	: As required but not less than 300 mm
Covered area	: As required but not less than 150 mm
Stair Pedestals	: 300 mm (min.) OR as indicated in equipment Layout drawing.
Ladder pedestals	: 300 mm

4.9 GROUTING

The minimum thickness of grout shall be 25 mm.

All anchor bolts sleeves / pockets and spaces under column bases, shoe plates etc. shall be grouted with free flow, non shrink (premix type) grout, with 28 days minimum cube crushing strength of 40 N/mm². Ordinary grout consisting of 1 part of OPC and 2 parts of clean, dry well graded sand mixed with water to obtain the required consistency shall only

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be used under the base plates of cross-overs, short pipe supports (not exceeding 1.5 m height) and small operating platforms (not exceeding 2 m height) not supporting any equipment.

For rotating equipment bases, (above 300 kw rating), grout shall be as per requirements of equipment vendor, as per the approved list / as per the decision of EIC.

5.0 DESIGN CRITERIA FOR REINFORCED CONCRETE STRUCTURES

5.1 GENERAL

- a) All buildings, structures, foundations, machine equipment foundations, liquid retaining storage structures, trenches, pits etc. shall be of RCC and designed based on the following IS codes (latest revision with all amendments, issued there to) in general, and other relevant IS codes applicable : IS:456, 875, 1893, 1904, 2911, 2950, 2974, 3370, 4326, 4991, 4998, 5249, 6403, 8009, 13920.
- b) Only limit state method as per IS: 456 shall be followed for the design unless otherwise specified elsewhere in this document for special structures.
- c) All skeletal structures shall be of frame type construction, and detailing shall be as per provision of IS: 13920.
- d) Where the specified design depth of groundwater table so warrants, all underground pits, tunnels, basements, etc. shall be leak-proof R.C.C. construction using water proofing compounds and corrosion inhibiting admixture.

5.2 LIQUID RETAINING R.C.C. STRUCTURES AND BASEMENTS

- 5.2.1 All liquid retaining / storage R.C.C. structures shall be leakproof with minimum grade of M30 and designed as uncracked section in working stress method as per IS:3370. However, the parts of such structures not coming in contact with the liquid, shall be designed according to IS:456 except ribs of beams of suspended floor slabs and counterforts of walls (located on the side remote from liquid) and roof of liquid retaining structures which shall be designed as uncracked section. Hot/cold water basin, and other primary framing members of Cooling Towers and similar liquid retaining structures, which remain constantly in contact with water (stored / sprayed) shall be designed as uncracked sections. No increase in permissible stresses in concrete and reinforcement shall be made under wind or seismic conditions for such structures.

5.2.2 All liquid retaining / storage structures shall be designed assuming liquid up to the full height of wall, irrespective of provision of any overflow arrangement. Pressure relief valves or similar pressure relieving devices shall not be considered in underground water retaining RCC structures. Hot water basin in cooling tower shall be designed for the weight of water up to top of parapet wall.

5.2.3 Following conditions shall be also considered for design of liquid retaining structures, basement, trenches and other underground structure:-

- Only water pressure from inside and no earth pressure, groundwater pressure or surcharge from outside wherever such a condition is likely to exist either in operation or during installation / testing.
- Earth pressure, surcharge pressure or ground water pressure from outside and no water pressure from inside.
- Base slab shall also be designed for the empty condition during construction and maintenance stages with maximum ground water table. Pressure Relief Valves shall not be used.
- Intermediate dividing walls of pump sumps shall be designed considering water in one pump only and the other sump being empty for maintenance.

5.2.4 The walls and base slabs of liquid retaining storage structures shall be provided of thickness minimum 200 mm with reinforcement on both faces.

5.2.5 In all liquid retaining structures, PVC water bars (230 mm wide, 6 mm thick) shall be provided at each construction joint. PVC water bars shall be of minimum 150/230 mm width and 6 mm thickness, and generally shall be rified/serrated type with a central bulb Kicker type PVC water bars shall be used for the base slab and in other areas where it is required to facilitate concreting.

5.4 CONCRETE GRADE

All cast-in-situ structural concrete shall be Reinforced Concrete conforming to IS:456 and shall be of minimum grade M30 for all Sub-structures and M25 grade for all Super-structures. For compressor M30 grade concrete shall be used. Pre-cast concrete shall be of minimum grade M35.

From durability consideration the minimum cement content and maximum water-cement ratio shall be as follows:-

Type of Cement	Plain concrete	Reinforced concrete	Remarks Exposure
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	Minimum cement content (kg/m ³)	Maximum water- cement ratio	Minimum cement content (kg/m ³)	Maximum water- cement ratio	Condition
53 Grade- OPC/PPC	240	0.55	330 (for shallow fdns-400 (for piles)	0.45	Moderate

Maximum cement content shall not exceed 450 kg/m³. If soil investigation report recommends high cement content and / or specified type of cement, the same shall have precedence.

75 mm thick lean concrete of grade M10 (nominal mix) shall be provided under all RCC foundations except under base slab of liquid retaining structures where 100 thick concrete of mix M10 (nominal mix) shall be used.

The lean concrete shall extend 50 mm beyond the foundation for normal foundations and 75 mm under liquid retaining structures.

Concrete for encasing shall be M20 with 10 mm down aggregate.

Plain cement concrete (PCC) of grade M15 (nominal mix) of minimum 150 mm thickness shall be provided under all masonry wall foundations.

Plain cement concrete of grade M20 of minimum 40 mm thickness shall be provided as damp proof course, at plinth level of all masonry walls with 10mm & down size graded crushed stone aggregates in two layers of 20mm thick with two coats of hot Bitumen (Grade A90/S90 conforming to IS:73) applied @ 1.7 Kg/sq.m. over each layer"

Lean concrete of grade 1:5:10 shall be used as filler material wherever loose sub-grade exists by removing the loose soil/fill.

Any specific requirement regarding grade and thickness of PCC to be provided shall be incorporated in the drawing.

5.4 REINFORCEMENT BARS

High yield strength deformed TMT steel bars of grade Fe500D conforming to IS: 1786 shall be used. The Minimum dia. used shall be 8mm. All structural steel and reinforcements shall be procured from SAIL / TISCO /RINL or Owner's approved Vendor List.

Binding wire used for tying the reinforcement shall conform to IS: 280 unless specifically mentioned herein or in engineering drawings or other engineering design basis prepared for the individual units/structures.

Wherever warranted by soil investigation report, HYSD Fe500 corrosion resistant bars confirming to IS: 1786 shall be used in foundations, piles and pile caps.

5.6 MINIMUM THICKNESS OF STRUCTURAL CONCRETE ELEMENTS


For structural concrete elements, the following minimum thickness shall be followed:-

Footings (All types with or without beams) Note: Tapered footings shall not have thickness less than 150 mm at the edges. Minimum average thickness shall not be less than 300 mm	:	300 mm
Pile Cap	:	500 mm
Basement walls	:	150 mm
Basement slab with beams / without beams	:	200/300 mm
Slab thickness in raft foundations with beam & slab construction	:	150 mm
Floor / roof slab, walkway, canopy slab	:	150 mm
Cable / Pipe Trench, Launder Walls & Base Slab	:	125 mm
Parapet	:	100 mm
Louvre/Fin (not in contact with liquid)	:	100 mm
Louvre (in contact with liquid)	:	100 mm
Precast Trench Cover / Precast Floor Slab	:	125 mm
Liquid retaining / Leak proof structures, Underground Pits	:	200 mm
Walls	:	150 mm
Base slab with beams	:	200 mm
Base slab without beams	:	300 mm

5.7 MINIMUM COVER TO REINFORCEMENT

The following minimum clear cover shall be provided to all steel reinforcement including links.

- Slab (roof & floors, canopy, cantilever, waist slab): 30 mm

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- Beam (roof, floor tie, & lintel) : 30 mm or dia. of bar
Whichever is greater
- Column, Pedestal : 40 mm above FGL
50 mm below FGL
- Retaining wall, Basement and Pit Wall
 - a. Face in contact with earth : 50 mm
 - b. Free face : 30 mm or dia.of bar
whichever is greater
- Liquid retaining structure
 - a. Face in contact with liquid : 30 mm or dia.of bar
whichever is greater
 - b. Face away from liquid but
in contact with earth : 50 mm
 - c. Free face : 30 mm or dia.of bar
whichever is greater
- Foundation slab, base slab, plinth beam : 50 mm
- Pile Cap
 - a. Bottom face : 100 mm
 - b. Top face : 50 mm

5.8 EXPANSION JOINTS

Expansion points in concrete structures shall be provided at 30-35 m centers.

Expansion Joints in liquid retaining structures may be avoided to the extent possible.

The expansion joint shall be provided preferably by way of twin columns on a common foundation. Sliding joints shall be avoided as far as possible.

5.9 DEFLECTIONS

- 5.9.1 Deflections in concrete structures shall in general be limited by adherence to the limits on span by depth ratio for beams and slabs and length to lateral dimension ratios for columns as prescribed in IS: 456. Where special functional / serviceability requirements or large spans demand actual deflections and / or crack widths shall be calculated and the following limits adhered to:

Total vertical deflection due to all loads including the : Span/250

Effects of temperature creep and shrinkage

Crack width (for non-liquid retaining structure) : 0.3 mm

Total horizontal deflection between two floors : Storey height/200

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5.10 MISCELLANEOUS APPLICATIONS

5.10.1 Admixtures

Admixtures shall conform to IS: 9103 and to be mixed with concrete (if required) strictly as per manufacturer's recommendations.

5.10.2 Water for Construction

Water used for mixing and curing shall be clean and free from injurious amounts of soils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. Portable water is generally considered satisfactory for mixing concrete. It should meet the requirement of IS: 456-2000.

5.10.3 Aggregates

These shall conform to IS: 383, specification for Coarse and Fine Aggregates from Natural resources.

5.10.4 Plinth protection

Each building shall be provided with 1.0 m wide concrete M10, 100 thick laid on 75 mm thick M7.5 concrete with 8 Tor @ 250 c/c both ways Reinforcement bars all round as plinth protection. A surface drain with HDG Gratings to be provided along-with plinth protection which shall be connected to the drainage system.

5.10.5 Ramps



Ramps for building entrance shall be cast in situ R.C.C. designed as a grade slab and the slope of ramps shall not be less than 1 in 10. Minimum thickness of the slab shall be 150 mm.

5.10.6 Hot Bitumen Paint

All underground structures including top surface of foundations shall be painted with two coats of hot bitumen paint of grade 20/30 with quantity of bitumen at least 1.2 kg/m² per coat.

5.10.7 Masonry Wall

- All masonry walls from ground floor shall be placed on R.C.C. grade beams. However, light internal partitions may be placed on ground floor slab.

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- b. All brick masonry (M 7.5 MPa) grade walls shall be considered as 230 mm thick, except for partition walls which will be 115 mm thick. However, for fire barrier walls minimum thickness shall be considered as 350 mm.
- c. All in-filled brick (M 7.5 MPa grade) panels shall be designed to transfer horizontal loads from wind and seismic to the structural frameworks without damage and the extent of brick panel dimensions shall be as per the recommendations in IS. All brickworks shall be provided with reinforcement consisting of 2 Nos. of 6 mm diameter bars at every fourth layer.
- d. Brick used in masonry work shall be sourced from fly ash brick manufacturing plant. Red burnt brick use is limited to 30% of total requirements

5.10.8 Anti-termite treatment

Anti-termite treatment shall be provided under all buildings as per IS:6313. Materials shall be as per IS:8944.

5.10.9 Insulation



For equipment with temperatures over 200° C, or sub zero temperatures, insulation shall be provided between equipment base / lugs and concrete / steel structure.

6.0 DESIGN CRITERIA FOR STEEL STRUCTURES

6.1 GENERAL / DESIGN METHODS



- 6.1.1 Design fabrication and erection of the above work shall be carried out in accordance with the following IS Codes as applicable to the specific structures, viz, IS:800, 801, 802, 806, 814, 816, 875, 1893, 6533, 9595, etc. Basic consideration of structural frame work shall primarily be stability, ease of fabrication/erection and overall economy, satisfying relevant Indian Standard Codes of Practice. Steel structures adequately braced in vertical and horizontal planes, consistent with functional requirements, shall be preferred over structure having moment connections. Moment connections, if adopted, shall be fully rigid as per IS:800. Where fully rigid joints are adopted they shall generally be confined to the major axis of the column member. Flare stack supporting structure shall be adequately braced on all four faces.

Structural elements, continuously exposed to temperatures above 200° C, shall be designed for reduced stress as per Table-4 of IS: 6533 (Part-2). The expected temperature of steel components shall not be allowed to exceed 400 ° C. The structures

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connected to column, heater vessels working at high temperatures shall not be rigidly connected with staircase and adjoining structures, which are on ambient temperatures.

- 6.1.2 Crane gantry girders shall generally be of welded construction and of single span length. Chequered plate shall be used for gantry girder walkway flooring.
- 6.1.3 Monorails shall be provided for all pumps and motors located in buildings, sheds and in open areas having rating more than 55 KW. For pumps and motors of smaller ratings, monorails shall be provided if directed by Owner / PMC.
- 6.1.4 Steel staircases shall have channels provided as stringers with minimum clear width of 750 mm and maximum slope of 41 degree. The vertical height between successive landings shall not exceed 4.0 meters. Treads shall be minimum 230 mm wide made of grating (with curved chequered plate nosing) spaced equally so as to restrict the rise to maximum 200 mm. If relevant local by-laws or applicable Factory Act Rules stipulates more stringent requirements in this regard, the same shall be adhered to. All steel staircases to have plan bracings to restrict lateral movement.
- 6.1.5 Hand rails, 1000 mm high, shall be provided to all walkways, platforms, staircases. Toe plate (100 mm x 5 mm) shall be provided for all hand railing (except for staircases). Spacing of uprights shall be 1500 mm (maximum). Two types of hand railing shall be provided.
- For walkways, platforms (except platform around/on circular & horizontal vessels), and staircases: Top rail, mid rail and upright shall be 32 mm dia. (NB) galvanized MS tubes.
 - For platforms around circular vessels : Top rail shall be 32 mm dia. (NB) galvanized MS tubes, but mid rail and upright shall be of structural steel.
- 6.1.6 Electro-forged/Welded hot dip galvanized MS gratings shall be minimum 25 mm deep. The maximum size of voids in the grating shall be limited to 30 mm x 55 mm. The minimum thickness of galvanizing shall be 120 microns. Gratings shall be suitable for the operation and maintenance loads for the floors
- 6.1.7 Welded connections shall be adopted as far as practicable, except for cases where bolted connections are required viz. (Galvanized) electrical switchyard structures and transmission towers. Structural connections shall have minimum two bolts of 16 mm dia. unless otherwise limited by the size of members

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- 6.1.8 Lock nuts shall be provided for anchor bolts of tall structures, tall process columns, vibrating equipment, etc.
- 6.1.9 Minimum two nuts shall used for all anchor bolts except for ladder, stair and hand rail.

6.2 EXPANSION JOINTS

Expansion joints shall be provided at 80 – 100 m centres, where possible, column bracing shall be provided at the center of a longitudinal frame, rather than at the ends so as to avoid constraints on free expansion.

6.3 STEEL GRADE

Structural steel shall be of yield stress of 250 Mpa conforming to grade A of IS: 2062. Tubular steel shall conform to Yst 310 of IS: 1161 & IS: 4923. Structural pipes shall be either seamless or mild welded. Spiral welded pipe is not acceptable.

6.5 LIMITING PERMISSIBLE STRESSES

- Permissible stresses in structural members shall be as specified in:
 - IS: 800 - Hot rolled sections (excluding transmission towers and Switchyard structures).
 - IS: 801 - Cold formed light gauge sections
 - IS: 802 - Transmission towers & switchyard structures
 - IS: 806 - Tubular Structures

- Permissible stresses in bolts shall be as specified in :-

- IS: 800 - Hot rolled sections
- IS: 801 - Cold formed light gauge sections
- IS: 802 - Transmission towers & switchyard structures
- IS: 806 - Tubular Structures

- Permissible stresses in welds shall be as specified in :-

- IS:801 - Cold formed light gauge sections
- IS: 806 - Metal Arc Welding

6.6 LIMITING DEFLECTION

a. The limiting permissible vertical deflection for structural steel members shall be as specified below :-

- | | |
|--|---|
| - Gantry girder for electric overhead crane(Capacity up to 50T) | : L/750 |
| - Gantry girder for electric overhead crane((Capacity over 50T) | : L/1000 |
| - Gantry girder for manually operated crane | : L/500 |
| - Girder beam for supporting dynamic equipment/hoist | : L/450 |
| - Grating / Chequered plate | : L/200 or
6mm
Whichever
Is less |
| - Purlins supporting any type of roofing material
Under (dead load + live load) or (dead load + wind
Load) conditions | : L/200 |
| - Other structural components | : As specified
in relevant IS |

Where “L” represents the span

b. The limiting permissible horizontal deflection for multistoried steel structure/ building including flare stack shall be Height/325.

6.7 MINIMUM THICKNESS



6.7.1 Structural Components

The minimum thickness of various structural components (Rolled Steel sections) shall be as given:-

a. General Construction

- | | |
|--|-------------------|
| Trusses, Purlins, Side Girts, Bracings | : 6 mm |
| Columns, beams | : 7 mm |
| Gussets in trusses & girders | |
| i. Upto and including 12 m span | : 8 mm |
| ii. Above 12 m span | : 10 mm |
| Flare Trestles, Stiffeners | : 8 mm |
| Base plates | : 10 mm |
| Chequered plate | : 6 mm (on plain) |
| Grating | : 5 mm |

b. Transmission tower and Switch yard structure

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The minimum thickness of various structural components shall be as per IS: 802

The minimum thickness for rolled beams and channels shall be mean flange thickness regardless of the web thickness.

The minimum thickness of tubes shall be as specified in IS: 806.

For structural members exposed to marked corrosive action, corrosion allowance shall be added as specified elsewhere, or otherwise suitably protected against corrosion.

The minimum thickness of structural components (except gratings & chequered plates) which are directly exposed to weather and inaccessible for repainting shall be 8 mm.

6.8 ELECTRICAL SWITCHYARD STRUCTURES AND TRANSMISSION TOWERS

All electrical switchyard structures and transmission towers shall have bolted connections, and designed on the basis of IS: 802.

6.9 PAINTING

Painting including shop primer to structural steel shall be Epoxy as per the painting specification for this project, included elsewhere in Technical Specification.



6.10 GROUTING

For structural columns : As required but not less than 25 mm

For equipment : As required but not less than 25 mm

6.11 CLADDING AND RAINWATER GUTTERS

All roof and cladding sheets should be Pre-coated (Galvalume) Steel Sheets (Overall Coated Thickness 0.52mm). Translucent sheets shall be provided, intermittently where day lighting is required. Rainwater gutters of Galvanized / Zinc coated sheets and UPVC rainwater pipes shall be provided for proper roof drainage.

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the calculated loading is higher than 1.25 kN/m², this shall be rounded off to the nearest multiple of 0.25 (i.e., 1.50, 1.75 kN/m²)

Vertical loads of flare pipe shall be taken as one third full of water for piping within units & one sixth full for outside unit battery line. All flare line independent support shall be of four legged braced open lower type construction.

In addition to piping load, gravity loads due to encasement, if any, shall be considered.

8.1.2 Friction Force (Longitudinal & Transverse)

Where the pipes are of similar diameter and service conditions, the friction force at each tier on every portal both in longitudinal and transverse directions, shall be 10% of the design vertical loading of the pipes for four or more pipes supported on a tier and 30% of the design vertical loading of the pipes, for single to three pipes supported on a tier. Longitudinal friction force shall be considered as uniformly distributed over the entire span of the beam at each tier and transverse friction force shall be considered as a concentrated load at each tier level. Friction forces on T-supports and trestles shall be taken as 30% of the vertical loading. Both longitudinal and transverse friction forces shall be considered to be acting simultaneously.

For two-phase fluid flow/transfer lines frictional force shall be minimum 50% of the weight of pipe including contents & insulation, acting simultaneously in transverse & longitudinal direction.

8.1.3 Anchor and Guide Force (Thermal Load)

Anchor and guide force (thermal load) in transverse and longitudinal direction shall be as per piping data.

8.1.4 Loading on intermediate Beam at Tier Level

Intermediate beam at tier level shall be designed for 25% of load on main portal beams in transverse direction. A reduction of 10% in vertical loading shall be considered for main portal beams, if intermediate beams are provided.

8.1.5 Loading on Longitudinal beams

Longitudinal beams connecting portal columns shall be sufficiently strong to sustain 25% of the load on the transverse beams. The total load shall be assumed as two equal concentrated loads acting at 1/3rd span. Other longitudinal axial forces coming on it from the design of the supporting system shall also be simultaneously taken into account in the design of the longitudinal beam. Friction & anchor forces, if specifically given by the Piping Specialist, shall also be catered for in the design. Loads from monorails, when supported from these beams, shall also be considered to be acting simultaneously along with all other loads mentioned above.

8.1.6 Cable Tray and Walkway Loads

The estimated actual load from electrical, instrumentation trays shall be considered at the specified locations, together with walkways, platforms for valve operation, wherever provided.

8.1.7 Wind Force

Transverse wind loading shall be calculated depending on the width of the piperack as per the following table. This force shall be considered irrespective of the height between two tiers.

Width of Pipe rack	Wind Force at each Tier level(N)
Upto 4 m	$1.25 \times p \times s$
Above 4 m but upto 6 m	$1.50 \times p \times s$
Above 6 m but upto 10 m	$2.00 \times p \times s$
Above 10 m	projected height $\times p \times s$

Where p = Horizontal wind pressure as per IS:875 (N/m^2)

s = Spacing of portals (m)

For pipe racks of width greater than 10 m, the projected height shall be lesser of the following two:

- $0.8 \times (\text{diameter of largest pipe including insulation (m)} + \tan 10^\circ \times (\text{width of rack (m)}).$
- height between consecutive tiers

8.1.8 For flare header or any other line supported on extended leg of piperack, the wind force shall be considered separately.

8.1.9 Seismic Loads

8.1.10 Seismic loads shall be as per IS: 1893 (latest version). Pipe racks should be adequately braced in all possible directions, consistent with function requirements.

8.1.11 Limiting permissible horizontal deflection for pipe rack shall be height / 325.

8.1.12 PLATFORMS BELOW AIR COOLERS

If handling pumps or other equipment is located below air coolers located on piperack or technological structures, blind floors shall be provided below air coolers, else, 2 m wide center platform with 3m wide local extension below motors shall be provided.



8.2 CULVERTS

Culverts shall be designed as per the following IRC codes of practices and manual. Where crane access is specified, the culverts shall be designed for the crane loads.

1. Standard specifications and code of practice for Road Bridges IRC 5
(Section – I - General features of design)
2. Standard specifications and code of practice for Road Bridges IRC 6
(Section-II – Load and Stresses)
3. Guidelines for Evaluation of Load Carrying Capacity of Bridges SP 37

Note: The above list is suggestive and not exhaustive. Apart from these basic codes any other related codes shall also be followed wherever required. This list is to be read in conjunction with the list of codes given in Civil Structural job specifications.

Sl. No.	DESCRIPTION		FLOORING TYPE		
			I	II	III
1.a	Sub Grade	Earth fill base compacted to 95% dry density	Yes	Yes	Yes
1.b		Rubble soling	230 Thick	230 Thick	150 Thick
2.a	Structural Grade Slab	Lean concrete 1:5:10 over 1.b layer	50 Thick	50 Thick	50 Thick
2.b		Stable in Grade M20 concrete (Reinforced with 8 mm dia bars @ 200 c/c both ways) over lean concrete	150 Thick	150 Thick	100 Thick
			R/F placed centrally	R/F placed in two layers at top & bottom	No reinforcement required
3	Finish	Floor finish	As/Architectural detail	As/Architectural detail	As/Architectural detail



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TYPE I: Buildings such as Sub-stations, Control Rooms, Process Operators' Room, Pump Houses, Utility Compressor Houses, D.M. Plant, E.T.P., Parking Areas, Stores, Porches etc

TYPE-II: Warehouses, Workshops, Cement Godowns, Fire Stations, Process Compressor House etc



TYPE III: Non Plant Buildings (viz. Administration, Laboratory, Canteen, Time Office, Gate House, Training Centre, Guest House, Residential Building)

Note: 1. Reinforcement steel shall be as per clause 5.5

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ANNEXURE- IV

GENERAL DESCRIPTION - STRUCTURES / FACILITIES

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SCOPE

The dimensions & elevations of various units shall be furnished by LSTK contractor. All dimensions shall be finalized by the contractor during detail engineering phase & shall be got approved by Owner / PMC.

It is the contractor's responsibility to design safe, sturdy and robust structures, foundations etc. to withstand all static and dynamic forces in accordance with design specifications and engineering specifications laid down in the document. The contractor should make suitable choice of foundations, e.g. isolated footings, raft foundation, pile foundation etc. depending on soil data, loads, settlement criteria.

The general description of structures / facilities shall be read in conjunction with the technical requirements & specifications given elsewhere in this document.

a) Compressor House

Structural steel shed with RC foundation, steel roof with monitor, S type louvers, G.I. pre-coated sheets roofing, eaves gutter with rain water down take pipes, G.I. pre-coated sheet cladding below eaves level, gantry girder for crane with walkway having handrail on one side with access ladders & open steel staircases for access at appropriate places.

RC deck mounted foundations for compressors with structural steel operating platform having HDG grating floor & handrail all-round, RC grade slab with flooring of type mentioned elsewhere, RC cable trench & RC floor drains at ground level.

b) Technological Structure

Open steel structure with RC foundations, structural steel platforms & floors at different levels with HDG grating, handrails all-round, supporting arrangement for equipments. Approaches to various levels shall be through structural steel staircases. Open steel staircase from ground to top level with handrails on both sides.

RC foundations for equipments, RC grade slab with RC cable trenches & RC floor drains at ground level.

The foundations of all equipments / structures shall be as per requirement.

c) Control Room (Within main process Plant building)

Control Room is a protective enclosure equipped with control & communication services and environmental treatment.

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Satellite Rack Room / Control room building consists of RCC flat roof building; side cladding shall be Hollow/solid block work. Adequate ventilation and lighting shall be provided. The air-conditioned areas shall be provided with false ceiling.

Control Room should be so placed that whole plant should be visible from one side having window with double layer toughened glass.

Besides housing of control panel/ operator's consoles, rack area for marshalling cabinets, Engineering console room, process operator's room, HVAC/ Air handling room(s), UPS and UPS battery room, toilet, rest rooms etc. shall be accommodated in the control room building in general.

Also the instrumentation engineering specification for Control Room should be followed.

d) Pipe-rack

Structural steel pipe-rack with RCC foundations having multiple tiers for supporting pipes with suitable platforms for control valve operations and walkway, having HDG grating, MS handrails on both sides with local ladders.

In case, air cooler structures are required, it shall be suitably supporting over pipe-rack. Structural steel platforms be provided with HDG grating, handrails and ladders for the entire width of rack below air coolers. Operating platform at top of air coolers with ladder for approach to the same. Open steel staircase for operation & maintenance at required places to be provided from ground to top level with landing at appropriate locations.

Endeavour shall be made to utilize the unoccupied space of the existing pipe rack, after checking the adequacy of the system. Modification/ strengthening, if required shall be carried by the contractor.



RC paving below pipe-rack for entire width.

e) Pipe Sleepers

The suitable arrangement of concrete supports shall be used to support pipes. The top of concrete of pipe sleepers shall be minimum 300mm above the highest paving points. MS steel insert plates with 20mm bar shall be provided on the sleeper top for pipe fixing depending on requirements. Suitable road crossing arrangement shall be provided for pipe sleepers wherever required.

f) Substation

The Sub-Station building shall be a double storied RCC framed building with Hollow/solid block work side covering and flat roof at top. The ground floor shall be utilized as cable cellar for installation of cable trays. The first floor will have LT/HT panels, UPS & battery room, operator's room & toilets. The access to first floor shall be provided through two

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nos. of R.C.C. staircases, each located on either side of building. Transformer bay will be on the rear side of the building, provided with Chain link fencing & gates. Separating walls shall be provided between transformers. The separating walls between sub-station and outdoor transformer bays shall have four hour fire rating.



Also the electrical engineering specification for Substation should be followed

g) Stack Structure and Foundation;

R.C.C. foundation having steel structure with intermediate platform and accessible cat ladders with cage.

h) Miscellaneous

- i) Lifting beams / monorails of required capacity for maintenance and / or erection purpose at various locations as per requirements mentioned elsewhere in this document shall be provided. Statutory provisions shall be applicable for all electrically driven monorails.
- ii) Miscellaneous local platforms, pipe sleepers, local foundations, local supports etc. as per requirement.
- iii) Stainless steel hand rails should be provided in steel staircases at cooling towers or as advised by the Owner/Consultant.

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ANNEXURE-V

ES-2516



TECHNICAL SPECIFICATIONS

FOR

CIVIL, STRUCTURAL

AND

OTHER ALLIED WORKS

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1.0 General

- 1.1 Specifications of materials and workmanship shall be as described in the Central Public Works Department Specifications Vol. I & II (latest) include latest amendments, unless otherwise specified. These CPWD Specifications shall be deemed to form part of this contract. The **CONTRACTOR** shall procure and maintain copies of the latest CPWD Specifications at site for reference.
- 1.2 These technical Specifications shall be supplementary to the specifications contained in the CPWD specifications, wherever at variance, these Particular Specifications shall take precedence over the provisions in the CPWD Specifications. In case of discrepancy in item descriptions, item specifications of CPWD shall be followed.

2.0 Reference Codes & Standards

- 2.1 Wherever reference of IS Specifications/ or IS Codes of Practice are made in the Specifications/ Schedule of Rates or Preambles, reference shall be to the latest edition of IS (Bureau of Indian Standards).

IS - 383	Coarse & Fine aggregates from natural sources for concrete.
IS - 427	Distemper, dry, colour as required.
IS - 432	Mild Steel & Medium tensile steel bars.
IS - 456	Code of Practice for Plain and Reinforced Concrete.
IS - 515	Natural and Manufactured aggregates for use in mass concrete
IS - 730	Hook bolts for corrugated sheet roofing
IS - 800	Code of Practice for General Construction in Steel
IS - 1079	Hot rolled carbon steel sheets & strips
IS - 1081	Code of practice for fixing and glazing of metal (steel & aluminium) doors, windows and ventilators.
IS - 1161	Steel tubes for structural purposes.
IS - 1285	Wrought aluminium & aluminium alloy extruded round tube and hollow sections



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IS - 1361	Steel windows for Industrial Buildings.
IS - 1363	Hexagon head bolts, screws & nuts of product grade C : Part - I Hexagon head bolts (size range M5 to M64)
IS - 1367	Technical supply conditions for threaded steel fasteners
IS - 1566	Hard - Drawn steel wire fabric for concrete reinforcement.
IS - 1786	High strength deformed steel bars & wires for concrete reinforcement.
IS - 2062	Steel for general structural purposes.
IS - 2116	Sand for masonry mortars.
IS - 2212	Code of practice for brickwork.
IS - 2386	Methods of test for aggregates.
IS - 2835	Flat transparent sheet glass
IS - 4021	Timber door, window and ventilator frames
IS - 4923	Hollow Steel sections for structural use.
IS - 4925	Concrete batching and mixing plant.
IS - 5410	Cement Paint
IS - 6477	Dimensions for wrought aluminium & aluminium alloys, extruded hollow sections.
IS - 7318	Fusion welding of steel.
IS - 10262	Recommended guidelines for concrete mix design.
IS - 14871	Products in Fibre Reinforced Cement – Long Corrugated or Asymmetrical Section Sheets and Fittings for Roofing and Cladding - Specification



3.0 Earthwork

3.1 Excavation



- 3.1.1 Excavation shall be carried out in soil of any nature and consistency, in the presence of water or in the dry, met on the site to the lines, levels and contours shown on the detailed drawings and **CONTRACTOR** shall remove all excavated materials to soil

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- heaps on site or transport for use in filling on the site or stack them for reuse as directed by the Engineer-in-Charge.
- 3.1.2 Surface dressing shall be carried out on the entire area occupied by the buildings including plinth protection as directed without any extra cost. The depths of excavation shown on the drawings are the depths after surface dressing.
- 3.1.3 The site around all buildings and structures to a width of 3 metres beyond the edge of plinth protection, ramps, steps, etc. shall be dressed and sloped away from the buildings.
- 3.1.4 Black cotton soil, and other expansive or unsuitable soils excavated shall not be used for filling in foundations, and plinths of buildings or in other structures including manholes, septic tanks etc. and shall be disposed off within the contract area marked on the drawings, as directed, levelled and neatly dressed.
- 3.1.5 In case of trenches exceeding 2 metres depth or where soil is soft or slushy, the sides of trenches shall be protected by timbering and shoring. The **CONTRACTOR** shall be responsible to take all necessary steps to prevent the sides of trenches from caving in or collapsing. The extent and type of timbering and shoring shall be as directed by the **Engineer-in-Charge**.
- 3.1.6 Where the excavation is to be carried out below the foundation level of adjacent structure, the precautions to be taken such as under pinning, shoring and strutting etc. shall be determined by **Engineer-in-Charge**. No excavation shall be done unless such precautionary measures are carried out as per directions of **Engineer-in-Charge**.
- 3.1.7 Specification for Earth work shall also apply to excavation in rock in general. The excavation in rock shall be done such that extra excavation beyond the required width and depth as shown in drawings is not made. If the excavation done in depth greater than required /ordered. The **CONTRACTOR** shall fill the extra excavation with concrete of mix 1:5:10 as the foundation concrete at his own cost.
- 3.1.8 **CONTRACTOR** shall make all necessary arrangements for dewatering / defiling as required to carry out proper excavation work by bailing or pumping out water, which may accumulate in the excavation pit from any cause/ source whatsoever.
- 3.1.9 **CONTRACTOR** shall provide suitable draining arrangements at his own cost to prevent surface water entering the foundation pits from any source.

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- 3.1.10 The **CONTRACTOR** is forbidden to commence the construction of structures or to carry out concreting before **Engineer-in-Charge** has inspected, accepted and permitted the excavation bottom.
- 3.1.11 Excavation in disintegrated rock means rock or Boulders including brickbats which may be quarried or split with crow bars. This will also include laterite and hard conglomerate.
- 3.1.12 Excavations in hard rock - meant excavation made in hard rock to be done manually, and / or pneumatic hammers or Diamond saw cutter.
- 3.1.13 The measurements for excavations shall be restricted and limited to minimum excavation line as per drawing for payment purposes.
- 3.1.14 Adequate protective measures shall be taken to see that the excavation does not affect or damage adjoining structures. The **CONTRACTOR** shall take all measures required for ensuring stability of the excavation and safety of property and people in the vicinity. The **CONTRACTOR** shall erect and maintain during progress of work, temporary fences around dangerous excavations at no extra cost.
- 3.1.15 Excavation in ordinary soil means excavation in ordinary hard soil including stiff heavy clay, hard shale, or compact moorum, or any materials, which can be removed by the ordinary application of spades, shovels, picks and pick axes. This shall also include removal of isolated boulders each having a volume not more than 0.50m³.
- 3.1.16 Excavation in soft rock includes limestone, sandstone, laterite, hard conglomerates, etc. or other rock which can be quarried or split with crowbars or wedges. This shall also include excavation of tarred pavements, masonry work and rock boulders each having a volume of not more than 0.25m³.
- 3.1.17 Excavation in hard rock includes any rock bound in ledges or masses in its original form or cement concrete for which in the opinion of the Engineer-in-Charge, requires the use of compressed air, equipment, sledge hammer or non-explosive materials viz. Acconex manufactured by A.C.C. Ltd. Specifications and instructions for use shall be as per manufacturer.
- 3.1.18 In case of any difficulty concerning the interpretation of type of soil as mentioned above, the Engineer-in-Charge shall decide whether the excavation in a particular material is in ordinary soil, soft rock or hard rock and his decision in this matter shall be final and binding on the CONTRACTOR and without appeal.

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- 3.2.9 If any selected fill material is required to be borrowed, **CONTRACTOR** shall make arrangements and procure such material from outside borrow pits. The material of source shall be subject to prior approval of **Engineer-in-Charge**. **CONTRACTOR** shall make necessary access roads to borrow areas and maintain the same, if such access roads do not exist, at no extra cost.
- 3.2.10 Plinth filling shall be carried out with approved material as described earlier, in layers not exceeding 150mm, watered and compacted with mechanical compaction machines. **Engineer-in-Charge** may however permit manual compaction by hand tampers in case he is satisfied that mechanical compaction is not possible. When filling reaches the finished level, the surface shall be flooded with water, unless otherwise directed, for at least 24 hours, allowed to dry and then the surface again compacted as specified above to avoid settlements at later stage. The finished level of the filling shall be trimmed to the level specified. Compacted surface shall have at least 95% of laboratory maximum dry density. A minimum of one test per 250 sq. meters of compacted area shall be done.
- 3.2.11 Whenever the fill material (earth or soil) is purchased, **CONTRACTOR** shall get the approval of Engineer-in-Charge. The **CONTRACTOR** shall arrange to determine the following properties of the soil and shall get the approval of **Engineer-in-Charge**.
1. Clay content : 15% to 20%
 2. Laboratory dry : Not less than 1600 kg/m³
density
 3. Plasticity Index : Not more than 20
- 3.2.12 The fill shall be compacted using a vibrating compactor of not less than 1.5 tonne. The fill shall be thoroughly compacted in layers as directed but not more than 200 mm thick. Adequate water shall be used for compaction and the density after compaction shall be not less than maximum dry density obtained in test of IS: 2720 Part-8. Compacted surface shall have at least 95% of laboratory maximum dry density. A minimum of one test per 250 sq. meters of compacted area shall be done.
- 3.2.13 The Gravel fill shall be non plastic granular material, well graded, strong, with maximum particle size of 50 mm, with not more than 15% passing a 4.75 mm IS sieve, free of all debris, vegetable matter and chemical impurities.
- 3.2.14 All clods, lumps etc. shall be broken before compaction.
- 3.2.15 In case of grading/banking successive layers of filling shall not be placed, until the layer

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below has been thoroughly compacted to satisfy the requirements laid down in this specification.

Prior to rolling, the moisture content of material shall be brought to within +/-2% of the optimum moisture content as described in IS 2720 Part-7. The moisture content shall preferably be on the wet side for potentially expansive soil.

After adjusting the moisture content as described, the layers shall be thoroughly compacted by means approved by Engineer-in-Charge, till the specified maximum laboratory dry density is obtained.

General, fill shall be placed in layers not exceeding 300 mm thickness and shall be thoroughly compacted to achieve a compaction of at least 90% of laboratory maximum dry density up to a depth of 600 mm below finished grade. Final fill of 600 mm thickness shall consist of preferably natural material in, as dug condition except that stones larger than 100 mm shall be removed. It shall be placed in layers not exceeding 150 mm thickness and compacted to achieve of at least 95% of laboratory maximum dry density. Each layer shall be tested in field for density and accepted by Engineer-in-Charge, subject to achieving the required density before laying the next layer. A minimum of one test per 250 sq meters for each layer shall be conducted.

If the layer fails to meet the required density, it shall be reworked or the material shall be replaced and method of construction altered as directed by Engineer-in-Charge to obtain the required density.

The filling shall be finished in conformity with the alignment, levels, cross-section and dimensions as shown in the drawing.

Extra material shall be removed and disposed off as directed by the **Engineer-in-Charge**.

4.0 Plain and Reinforced Concrete Work

This specifications deals with cement concrete, plain or reinforced, for general use, and covers the requirements for concrete materials, their storage, grading, mix design, strength & quality requirements, pouring at all levels, reinforcements, protection, curing, form work, finishing, painting, admixtures, inserts and other miscellaneous works.

4.1 Materials

4.1.1 Cement: Any of the following cements may be used as required.

IS - 269	Ordinary Portland cement, 33 grade
IS - 8112	43 Grade ordinary Portland cement
IS - 12269	53 Grade ordinary port land cement

4.1.2 Water: Water used for mixing and curing concrete and mortar shall conform to the requirements as laid down in IS: 456. Sea water shall not be used for concrete work.

4.1.3 Aggregates: Coarse and fine aggregates for cement concrete plain and reinforced shall conform to the requirements of IS 383 and / or IS 515. Before using, the aggregates shall be tested as per IS: 2386.

Coarse aggregate: Coarse aggregate for all cement concrete work shall be broken or crushed hard stone, black trap stone obtained from approved Quarries or gravel.

Sand: Fine aggregate for concrete work shall be coarse sand from approved sources. Grading of coarse sand shall be within grading zones I, II or III laid down in IS: 383, table 4. If required the aggregates (both fine and coarse) shall have to be thoroughly washed and graded as per direction of **Engineer-in-Charge**.

4.2 **Mixing**

All cement concrete plain or reinforced shall be machine mixed. Mixing by hand may be employed where quantity of concrete involved is small, with the specific prior permission of the **Engineer-in-Charge**. 10% extra cement shall be added in case of hand mixing as stipulated in IS-456.

For large and medium project sites the concrete shall be sourced from ready- mixed concrete plants or from on site or off site batching and mixing plants (IS 4926)

4.3 **Water Cement Ratio, Laying & Curing**

Water Cement Ratio, Laying & Curing shall be done as per IS:456.

4.4 **Grades of Concrete**

4.4.1 Grades lower than M 25 shall not be used in reinforced concrete.

4.4.2 A sieve analysis test of aggregates shall be carried out as and when the source of supply is changed without extra charge notwithstanding the mandatory test required to be carried out as per CPWD specification.

4.4.5 All tests in support of mix design shall be maintained as a part of records of the contract. Test cubes for mix design shall be prepared by the CONTRACTOR under his own arrangements and at his costs, but under the supervision of the **Engineer-in-Charge**.

4.5 Design Mix Concrete

4.5.1 Design mix shall be allowed for major works where it is contemplated to be used by installing weigh batch mixing plant as per IS 4925. At the time of tendering, the CONTRACTOR, after taking into account the type of aggregates, plant and method of laying he intends to use, shall allow in his tender for the design mix i.e., aggregate/cement and water/cement ratios which he considers will achieve the strength requirements specified, and workability for concrete to be properly finished.

4.5.2 Before commencement of concreting, **CONTRACTOR** shall carry out preliminary tests for design mix on trial mixes proposed by him in design of mix to satisfy the **Engineer-in-Charge** that the characteristic strength is obtained. In this regard, CONTRACTOR may consult govt. approved/reputed institute to get design mix done as per IS 10262 at his own cost. The concrete mix to be actually used shall be approved by the **Engineer-in-Charge**.

4.5.3 Notwithstanding the above, the following shall be the maximum combined weight of coarse and fine aggregate per 50 kg of cement.

Grade of Concrete	Maximum weight of fine & coarse aggregates together per 50 kg of cement (for nominal mix only)
1. M - 10	480 kg
2. M - 15	350 kg
3. M - 20	250 kg

4.5.4 The workability of concrete produced shall be adequate, so that the concrete can be properly placed and compacted. The slump shall be as per IS 456.

4.5.5 The minimum consumption of the cement irrespective of design mix shall not be less than the following:

M 7.5 (1:4:8)	170 kg/cu m
M 10 (1:3:6)	220 kg/cu m
M 15	300 kg/cu m
M 20	350 kg/cu m

4.6 Testing of Concrete

4.6.1 Testing of concrete, sampling and acceptance criteria shall be in accordance with IS 456.

4.7 Proportioning

Mixes of cement concrete shall be as ordered. Where the concrete is specified by grade, it shall be prepared by mixing cement, sand and coarse aggregate by weight as per mix design. In case the concrete is specified as volumetric mix, then dry volume batching shall be done, making proper allowances for dampness in aggregates and bulking in sand. Equivalent volume batching for concrete specified by grade may however be allowed by the **Engineer-in-Charge** at his discretion.

4.8 Pre Cast Concrete

The specifications for pre cast concrete will be similar as for the cast in situ concrete. All pre cast work shall be carried out in a yard made for the purpose. This yard shall be dry, properly levelled and having a hard and even surface. If the ground is to be used as a soft former of the units, shall be paved with concrete or masonry and provided with a layer of plaster (1:2 proportion) with smooth neat cement finish or a layer of MS sheeting. The casting shall be over suitable vibrating tables or by using form vibrators as per directions of **Engineer-in-Charge**.

The yard, lifting equipment, curing tank, finished material storage space etc. shall be designed such that the units are not lifted from the mould before 7 (seven) days of curing and can be removed for erection after 28 (Twenty Eight) days of curing. The moulds shall preferably be of steel or of timber lined with G.I .sheet metal. The yard shall preferably be fenced.

Lifting hooks, wherever necessary or as directed by **Engineer-in-Charge** shall be embedded in correct position of the units to facilitate erection, even though they may not be shown on the drgs. and shall be burnt off and finished after erection.

6.3 In case of FORM-WORK for Liquid Retaining Structures, the use of through Tie-Rods shall be prohibited, only Water Barrier type Nut should be used.

6.4 Stripping Time

Forms shall not be struck until the concrete has reached strength at least twice the stress to which the concrete may be subjected at the time of removal of form work. The strength referred to shall be that of concrete using the same cement and aggregates, with the same proportions and cured under conditions of temperature and moisture similar to those existing on the work. Where possible, the form work shall be left longer as it would assist the curing.

Note 1: In normal circumstances and where ordinary Portland Cement is used, forms may generally be removed after the expiry of the following periods:



1.	Walls, columns and vertical faces of all structural members	24 to 48 hours as may be decided by the Engineer-in-Charge
2.	Slabs (props left under)	3 days
3.	Beam soffits (Props left under)	7 days
4.	Removal of props under slabs 1. Spanning up to 4.5 m 2. Spanning over 4.5 m	7 days 14 days
5.	Removal of props under beams & arches: 1. Spanning up to 6 m 2. Spanning over 6m	14 days 21 days

For other types of cements, the stripping time recommended for ordinary Portland Cement may be suitably modified.

Note 2: The number of props left under, their sizes and disposition shall be such as to be able to safely carry the full dead load of the slab, beam or arch as the case may be together with any live load likely to occur during curing or further construction.

7.0 Cement Concrete Block

Cement concrete block shall be machined made in the proportion of such that mix shall not be leaner than one cement to twelve combined aggregates (by volume) but having

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minimum strength of 7.5 MPa. Combined aggregate shall be graded as near as possible to IS: 383. The fineness modules of combined aggregate shall be between 3.6 and 4. The concrete block shall be properly cured as per IS-456. The surface of conc. block shall have even face without any honeycomb and free from cracks.

7.7.1 **Mortar**

Cement and water shall confirm to the requirements laid down for cement concrete work.

7.7.2 Sand for concrete block masonry mortars shall be coarse sand generally conforming to IS: 2116. Maximum quantities of clay, fine dust, shall not be more than 5% by weight. Organic impurities shall not exceed the limits laid down in IS: 2116.

7.7.3 Mix of mortar for building concrete block shall be as specified in the item of work.

7.7.4 Mixing of the mortar shall be done in a mechanical mixer. When quantity involved is small hand mixing may be permitted by **Engineer-in-Charge**. Any mortar remaining unused for more than 30 minutes after mixing shall be rejected.

7.8 **Concrete Block Masonry**



The thickness of joints shall be 10 mm +- 3mm. Thickness of joints shall be kept uniform. In case of foundation and manholes etc. joints up to 15 mm may be accepted.

7.9 **Half Concrete Block**

All courses shall be laid with stretchers. Reinforcement comprising 2 nos. 6 mm dia MS bars shall be provided over the top of the first course and thereafter at every fourth course.

7.10 **Fixtures**

All iron fixtures, pipes spouts, hold fasts of doors and windows which are required to be built into the wall shall be embedded in cement concrete blocks 1:2:4 mix (1 cement :2 coarse sand :4 graded stone aggregate. 20 mm nominal size) of size indicated in the item.

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7.11 Curing

Concrete block masonry shall be protected from rain by suitable covering when mortar is green. Masonry work shall be kept constantly moist on all faces for a minimum period of seven days.

8.0 STRUCTURAL STEEL WORK

This specification covers the technical requirements for the preparation of shop drawings, supply, fabrication, protective coating, painting and erection of all structural steel rolled sections, built up sections, plates and miscellaneous steel required for the completion of the work.

Steel

All structural steel used in construction within the purview of this contract shall, comply with one of the following Bureau of Indian Standard Specifications, whichever, is appropriate or as specified.

IS – 2062 Hot rolled sections and plates

IS – 1079 Cold formed light gauge sections

IS – 1161 Tubular sections



IS – 4923 Hollow sections (rectangular or square)

Fabrication

Fabrication of steel structure shall be carried out in conformity with the best modern practices and with due regard to speed with economy in fabrication and erection and shall conform to IS-800. All members shall be so fabricated as to assemble the members accurately on site and erect them in correct positions. Before dispatch to site the components shall be assembled at shop and any defect found rectified. All members shall be free from kink, twist, buckle, bend, open joints etc. and shall be rectified before erecting in position. Failure in this respect will subject the defective members to rejection.

Fabrication Drawings:

Connections, splices and other details shall be suitably designed based on good Engineering practice.

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Electrodes:

Electrodes used for welding shall comply with IS-814 or IS - 815.

8.1 MS Black/High Strength Bolts and Nuts

M.S.Black or high strength bolts, nuts and washers etc. shall be as per IS-800, IS-1363 and IS-1367. Manufacturer's test certificate shall be made available to the **Engineer-in-Charge**. For bolted joints, shanks and threaded bolts are to be used to ensure that threaded length do not encroach within the thickness of connected members of dimension beyond the following limit:-

1. 1.5 mm for connected members of thickness below 12 mm and
2. 2.5 mm for connected member of thickness 12 mm and above and that adequate shearing and bearing values required as per design are achieved.



Every portion work shall have its erection mark or numbers stencilled on the member for guidance in erection and bear all necessary marks of erections as directed by the Owner / Consultant.

- 8.2 No part of the work is to be oiled, painted (except contact surfaces) packed, bundled, crated or dispatched until it has been finally inspected and approved by the Owner / Consultant or his authorized representative. The whole steel work before being dispatched from the Contractor's shop shall be dry and after being thoroughly cleaned from dust, mills scale, rust etc., and shall be given two coats of primer and one coat of final paint as per painting specification attached in this enquiry. Unless otherwise specified, all surfaces inaccessible after welding shall be given two coats of primer and two coats of paints as per painting specification attached in this enquiry.

- 8.3 The Owner / Consultant or his authorized representative shall have free access at all reasonable time to all places where the work is being carried out, and shall be provided by the Contractor at his own expenses all necessary facilities for inspection during fabrication and erection. The Owner / Consultant or his authorized representative shall be at liberty to reject the work in whole or in part if the workmanship or materials do not conform to the terms of the specifications mentioned herein. The Contractor shall remove, replace or alter any part of the work as ordered by the Owner / Consultant or his authorized representative.

9.0 PAINTING ON STRUCTURAL STEEL

The following specification shall be used for painting of structural steel work.

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Colour reference number

Method of application

Batch number

Date of Manufacture

Shelf life expiry date

Manufacturer's name or recognised trade mark.

9.6 CODE AND STANDARDS:

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.

9.7 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.

9.8 Other Standards:

9.8.1 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.

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Sodium chloride, less than 50 microgram / cm²;

Soluble iron salts, less than 7 microgram / cm²; and

pH between 6 – 8

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.

9.10.4 Abrasive blasting

All C.S materials shall be abrasive blast cleaned in accordance with relevant IS Codes. 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.

Abrasive blast cleaning shall NOT be performed when the ambient or the substrate temperatures are less than 3 Degree Celsius 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.

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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

9.11 **Painting system to be used is indicated below:**

1. For PU painting:

- i) P1 – One coat of Ethyl silicate inorganic zinc primer having DFT of 70 microns per coat.
- ii) IP1 – One coat of Epoxy MIO having DFT of 70 microns per coat.
- iii) FP1 - One coat of finish epoxy paint using two pack Polyamide cured epoxy having DFT of 40 microns per coat.
- iv) FP2 - One coat of Aliphatic Acrylic Polyurethane paint having DFT of 40 microns per coat.

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- 9.11.1 All the surfaces must be abrasive blasted and 2 coats of primer plus 1 coat of finish paint applied in the fabrication shop before the same are shifted to site for erection. All the members must be suitably match marked for facilitating proper assembly.

After erection is over all surfaces shall be washed up as follows:

Washing with clean water (pressure 7 kg/cm²) using suitable nozzles. During washing broom corn brushes shall be used to remove foreign matters.



Solvent washing if required to remove traces of oil grease etc.

After washing the surface as indicated above, the surfaces shall be suitably touched up to the extent required so that all the damages to the primed surfaces caused during erection are done up.

- a) The surfaces affected by welding and / or gas cutting during erection shall also be suitably touched up. Before touch up is taken up surfaces shall be prepared by mechanical means such as grinding, power brushing etc. to achieve surface finish to ST-3.
- b) After touch up work is over as indicated above, all the surfaces shall be given one coat of finish paint to the required specification.

9.11.2 The following points must be observed for painting work:

1. Primer and paint shall be compatible to each other and should be from the same manufacturer.
 2. The recommendation of the paint manufacturer regarding mixing, matching and application must be followed meticulously.
 3. Technical representative of paint manufacturer should be available at site as and when required by **Engineer-in-Charge** for their expert advice as well as to ensure that the painting work is executed as per the instruction of paint manufactures.
- c) Paints and primers shall be supplied at site in original container with factory seal otherwise such paints and primers shall not be allowed to be used. Mode of application i.e. by spray, brush or roller shall be strictly as per recommendation of paint manufacturer.
 - d) Painting materials must be used before the expiry date indicated on the containers.
 - e) Number of coats and DFT per coat must be strictly followed as indicated above. If the desired DFT is not achieved for primer and finish paints in two coats (each),

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All roof and cladding sheets should be Non-Asbestos roof/cladding sheets with Acrylic coating and SS hooks

Translucent sheets shall be provided, in non-process areas only, intermittently where day lighting is required.

12.0 FLOORING AND PAVING

12.1 Sub Base of floor



12.1.1 The area to be paved shall be divided into suitable panels. Form work shall be provided. The boarding / battens shall be fixed in position with their toe at proper level, giving slope where required. Alternatively base concrete may be deposited in the whole area at a stretch.

12.1.2 Before placing the base concrete the sub-base shall be properly wetted and rammed. The concrete of the specified mix shall then be deposited between the forms where provided, thoroughly tamped and the surface finished level with the top edge of the forms. The surface of base concrete shall be spreader uniformly. The surface shall be finished rough to provide adequate bond for the topping. Two or three hours after concrete has been laid the surface shall be brushed with wire brush to remove any scum or Latinate and swept clean so that coarse aggregate is exposed.

12.2 Cement Concrete Floor Finishes

12.2.1 The surface of base concrete shall be thoroughly cleaned by scrubbing with coir or steel wire brush. Before laying the topping, the surface shall be soaked with water at least for 12 hours and surplus water mopped up immediately before the topping is laid.

12.2.2 The forms shall be fixed over the base concrete dividing into suitable panels. Where glass dividing strips are provided, thickness of glass dividing strips shall be 4 or as indicated. Before placing the concrete topping, neat cement slurry at the rate of 2 kg/sq.m shall be then thoroughly brushed into the base concrete just ahead of the finish. The topping shall then be laid, thoroughly compacted by using screed board/plate vibrator. The surface floated with a wooden float to a fair and even surface shall be left for some time till moisture disappears from it. Junctions with skirting / dado or wall surfaces shall be rounded off using cement mortar 1:2 curing shall be carried out for a minimum of 7 days.

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13.0 PLASTERING

- 13.1 Sand for plastering shall be 50% fine sand and 50% coarse sand from approved sources.
- 13.2 Preparation of surface shall be done as per CPWD specifications.
- 13.3 Cement mortar shall be of the mix as indicated in the items and shall be mixed as specified in the CPWD specifications.
- 13.4 Joints in walls etc. shall be raked to a depth of 12 mm, brushed clean with wire brushes dusted and thoroughly washed before starting the plaster work.
- 13.5 The surface shall be thoroughly washed with water cleaned and kept wet to saturation point before plastering is commenced.
- 13.6 Cement mortar as indicated, shall be firmly applied to the masonry walls in a uniform layer to the thickness specified and will be pressed into the joints. On concrete surfaces rendering shall be dashed to the roughened surface to ensure adequate bond. The surface shall be finished even and smooth. Hectoring wherever required shall be done as per directions of **Engineer-in-Charge**. Wire mesh on RCC/Masonry junctions at the time of plastering shall be provided.
- 13.7 All plaster work shall be cured for at least 7 days.
- 13.8 Integral water proofing compound shall be mixed with cement in the proportion recommended by the manufacturer. Care shall be taken to ensure that the water proofing material gets well and integrally mixed with cement. All other operations are the same as for general plaster work.
- 13.9 For sand face plaster undercoat of cement plaster 1:4 (1 cement : 4 sand) of thickness not less than 12 mm shall be applied similar to one coat plaster work. Before the under coat hardens the surface shall be scared to provide for the top coat. The top coat also of cement mortar 1:4 shall be applied to a thickness not less than 8 mm and brought to an even surface with a wooden float. The surface shall then be tapped gently with a wooden float lined with cork to retain a coarse surface texture, care being taken that the tapping is even and uniform.

14.0 Exterior Painting or Apex

- 14.1 Exterior painting shall be Apex.

14.2 Where shown on drawings for external surfaces of sand faced plaster, or any other surface, two coats of cement paint shall be applied of tint and shade as approved by the **Engineer-in-Charge**.

14.3 The surfaces shall be prepared as specified for white washing. Before applying cement paint the surface shall be thoroughly wetted to control surface suction. The surface shall be moist but not dripping wet, when the paint is applied. Not less than 24 hours shall be allowed between the two coats. In hot weather the first coat shall be slightly moistened before applying the second coat.

14.4 On external plastered surfaces (one coat primer + minimum 3 coat of paints), sand faced or plain plastered and concrete surfaces, apex weather proof paint shall be vigorously scrubbed on to work the paint into the voids and provide a continuous paint film free from pin holes and other openings.

15.0 GLAZING

15.1 Sheet glass glazing of doors, windows etc. shall be of selected quality glass conforming to IS: 2835. Toughened splinter proof industrial safety glass shall confirm to IS: 2553. No cracked chipped or disfigured glass shall be accepted Glass shall be in one piece for each pan.

15.2 Glazing shall be fixed with timber or steel / aluminium beading as called for. Glass shall be back puttied and fixed with beading for a water tight and rattle free installation. Sizes of timber/ steel / aluminium beading shall be as directed.

16. PROTECTIVE COATING AND LINING SYSTEM

16.1 ACID PROOF TILES: MATERIAL

1) TILES

These tiles shall be made of clays, feldspar, quartz, talc and vitrified at high temperature in ceramic kilns and kept unglazed so as to prevent from slipperiness. Tiles shall not absorb more than 2% of their own dry weight when soaked in water. Compression strength: 700 Kg/cm² Min. & Flexural strength: 200 Kg/cm² Min. It shall not lose more than 1.5% of it weight when soaked in acid.

Chemical compositions of tiles:

- Al₂O₃ : 22-24%
- SiO₂ : 60-65%

- Fe_2O_3 : 1.0-2.0%
- Alkalise : 10-12%

2) K-BASED SILICATE MORTAR

Acid Proof cement KSC is a potassium silicate based corrosion cement. Acid tile linings carried out with KSC cement are not subject to crystal formation in the pores of cement. Besides Bitumastic surface is joint-less, hence there is no danger of Acids percolating through the surface.

Characteristics of K-based Silicate mortar:

- Colour : White
- Density (lbs/Cub. ft.) : 130
- Water Absorption : 2-5 %
- Tensile Strength (Psi) : 400
- Compressive strength (Psi) : 2800
- Bond Strength (Psi) : 180
- Coefficient of thermal expansion : 6.0×10^{-6}

3) BITUMASTIC MORTAR

It shall consist of an acid proof inorganic filler and blended bitumen. It shall be trowelled to concrete having total thickness of 10 mm.

Characteristics of Bituminous compounds:

- Density (Kg/m^3) : 2200
- Water content by mass percent (max) : 0.5
- Flash point $^{\circ}\text{C}$, min. : 35

Consistency

- a) Before setting (test after 1 hr) min. : 100
- b) After setting (test after 24 hr) min. : 80

Mastic shall be heated to $150-300^{\circ}\text{C}$ and shall be applied in 5 mm layers after surface is cleaned and dried.

4) BITUMINOUS PAINT

This is generally of heavy grade bituminous corrosion resisting paint. 2 coats of the paint shall be given, and drying time between the 2 coats shall not be less than 5

hours. Also, its drying time after second coat shall not be more than 8 hours. Its finish shall be smooth, glossy and elastic.

The primer shall confirm to the following requirements:

- Viscosity by standard tar viscometer, 4mm orifice at 25°C: 4 to 24
- Penetration at 25°C, 100g, 5sec in 1/100 cm : 20 to 50
- Water content percent (max) : 0.2

APPLICATION

SL. NO.	DESCRIPTION	ITEM OR AREA
1.	Bituminous Paint (Primer)	Concrete surface
2.	10mm Bitumastic Laying in two layers each shall not be more than 5mm thick	Over Bituminous Paint
3.	One layer, 5mm Acid, K-based Silicate Type mortar	#
4.	38 mm thick Acid proof tiling	Over K-based Silicate

- Tiles should be fixed on bitumastic surface with the help of 5mm K-based silicate mortar.

16.2

EPOXY COATING

A. MATERIAL

1) EPOXY COATING

Characteristics of coated surfaces (after application)

- Compressive strength : min. 90 N/mm²
- Tensile strength : min. 10 N/mm²
- Abrasion resistance : as per Amsler 1.5 mm after 3000 revol.
- Bonding (joining) factor : 1

APPLICATION:

SL. NO	DESCRIPTION	APPLICATION
1.	One coat of two pack interpenetration	Primer coat on Concrete surface

SL. NO	DESCRIPTION	APPLICATION
	polymer (Epoxy Phenolic) Thickness 60 micron per coat	
2.	One coat of two pack interpenetration polymer (Epoxy Phenolic) Thickness 100 micron per coat	Intermediate Coat over Primer Coat
3.	One coat of two pack interpenetration polymer (Polyurethane) Thickness 50 micron per coat	Final Coat over Intermediate Coat
4.	Sealing by polysulphide compound	This will be provided at all joints with foundation, pits & wall etc

16.3 ACID RESISTANT BRICK LINING

A. MATERIAL

These bricks are made of raw materials such as clay or shale of suitable composition with low lime and iron content, feldspar, flint or sand and vitrified at high temperature in ceramic kilns. Bricks shall not absorb more than 2% of their own wt. when soaked in water.

Compression strength: $> 700 \text{ Kg/cm}^2$. Bricks shall not lose more than 1.5% at their own weight when tested for acid resistance.

Chemical compositions of bricks are

- a) Al_2O_3 22-24%
- b) SiO_2 60-65%
- c) Fe_2O_3 1.0-2.0%
- d) Alkalies 10-12%

1) K-BASED SILICATE MORTAR

Acid Proof cement KSC is a potassium silicate based corrosion cement. Acid brick linings carried out with KSC cement are not subject to crystal formation in the pores of cement. Besides Bitumastic surface is joint-less, hence there is no danger of Acids percolating through the surface.

Characteristics of K-based Silicate mortar:

Colour	: White
Density (lbs/Cub. ft.)	: 130
Water Absorption	: 2-5 %
Tensile Strength (Psi)	: 400
Compressive strength (Psi)	: 2800
Bond Strength (Psi)	: 180
Coefficient of thermal expansion	: 6.0×10^{-6}

2) BITUMASTIC MORTAR

It shall consist of an acid proof inorganic filler and blended bitumen. It shall be trowelled to concrete having total thickness of 10 mm.

Characteristics of Bituminous compounds:

Density (Kg/m ³)	: 2200
Water content by mass percent (max)	: 0.5
Flash point °C ,min.	: 35
Consistency	
c) Before setting (test after 1 hr) min.	: 100
d) After setting (test after 24 hr) min.	: 80

Mastic shall be heated to 150-300°C and shall be applied in 5 mm layers after surface is cleaned & dried.

3) BITUMINOUS PAINT(PRIMER)

This is generally of heavy grade bituminous corrosion resisting paint. 2 coats of the paint shall be given, and drying time between the 2 coats shall not be less than 5 hours. Also, its drying time after second coat shall not be more than 8 hours. Its finish shall be smooth, glossy and elastic.

The primer shall confirm to the following requirements:

Viscosity by standard tar viscometer, 4mm orifice at 25°C : 4 to 24

Penetration at 25°C, 100g, 5sec in 1/100 cm : 20 to 50

Water content percent (max) : 0.2

APPLICATION



SL. NO.	DESCRIPTION	ITEM OR AREA
1.	Bituminous Paint (Primer)	Concrete surface
2.	10mm Bitumastic Laying in two layers each shall not be more than 5 mm thick	Over Bituminous Paint
3.	One layer, 5mm Acid, K-based Silicate Type mortar	#
4.	One layer, 38 mm Acid resistant Brick lining	Over K-based Silicate

#:- K-based Silicate mortar should be buttered on all sides of acid-resistant brick except the side facing the surface to be exposed to corrosives

17.0 CULVERT WORK

17.1 Pipe Culverts

- 17.1.1 Reinforced concrete pipes shall be provided between the drain pits of storm water drains to cross the roads. These pipes shall be non-pressure type conforming to IS: 458 and class as specified in the nomenclature of the item. The pipes shall be laid between the drain pits with a uniform slope and with proper bedding, if required, as per approved drawings. The reinforced concrete pipes shall be manufactured by centrifugal process. All pipes shall be true to shape, perfectly straight, sound and free from cracks. The pipes shall be free from defects resulting from imperfect grading of the aggregate mixing or moulding.
- 17.1.2 Reinforced concrete pipes shall be laid, jointed and tested as per IS: 783. Pipes shall be laid true to alignment and gradients over cement concrete bed of 1:2:4 mix and / or encased, if required, as per approved drawings or as directed by Engineer-in-Charge. No deviations from the lines, depths of cuttings or gradients shall be permitted without approval in writing by Engineer-in-Charge. The joint between concrete drain pit wall and concrete pipe shall be done properly to make it water-tight. The pipe joints shall be spigot and socket joint (rigid type) for pipes of 600 mm. diameter and below and collar joint (rigid type) for pipes over 600 mm. diameter. For both types of joints, the annular space shall be filled up with cement and sand mortar 1:2 mix which shall be rammed with caulking tools. After the day's work, any extraneous matter shall be removed from inside of the pipes. Joints shall be cured properly as per IS: 783. Reinforced concrete

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2.0	GENERAL REQUIREMENTS
3.0	CODES & STANDARDS
4.0	MATERIALS
5.0	MANHOLES

1.0 Scope

1.1 This Specification Covers

The supply, laying and installation of pipes / open surface drains for draining off rain / surface water, fire water, sewage, plant effluent / blow down / floor washings etc., with all fittings and fixtures including jointing.

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The supply, laying and installation of pipes for supply of water with all fittings and fixtures including jointing.

The supply and installation of sanitary fixtures like water closets, urinals, wash basins, sinks etc., with all fittings and fixtures.

The supply and installation of toilet accessories like mirrors, shelves, towel rails, liquid soap containers etc., with all fittings and fixtures.

The supply and installation of overhead water tanks with all fittings and fixtures.

The supply and construction of ancillary works like manholes, drop connections, gully chambers, oil traps, soak pits etc., with all fittings and fixtures.

2.0 GENERAL REQUIREMENTS

- 2.1 The Contractor shall furnish all skilled and unskilled labour, plant, equipments, scaffolding, men, materials, etc., required for complete execution of the work in accordance with the drawings and as described herein and / or as directed by the Engineer.
- 2.2 The Contractor shall make his own arrangements for locating the coordinates and positions of all works and reduced levels (RL) at these locations based on two reference grid lines and one bench mark which will be furnished by the owner. The Contractor has to provide at site all the required survey instruments etc., to the satisfaction of the Engineer so that the work can be carried out accurately according to the specification and drawing.
- 2.3 The Contractor shall make good to the satisfaction of the Engineer all cuttings / damages resulting from his operations during the installation.
- 2.4 Only tentative Plant layout shall be furnished by the Owner. Detailed working drawings showing the layout, installation and other details will be prepared by the Contractor and got approved from the Engineer.
- 2.5 The Contractor shall dispose of all unserviceable materials at least 50 m away from the plant boundary, unless otherwise directed by the Engineer. All serviceable material shall be stacked within a lead of 500 m as directed by the Engineer.

- 2.5 In case of any contradiction between the provisions stipulated in this module of technical specification and those of other modules like Excavation and Filling, Cast-in-situ Concrete and Allied works etc., the former shall govern.

All works shall be carried out by qualified / licensed plumbers.

3.0 CODES AND STANDARDS

- 3.1 All standards, specifications, acts, and Codes of practice referred to herein shall be the latest edition including all applicable official amendments and revisions.

- 3.2 In case of conflict between this specification and those (IS Standards, codes etc.) Referred to herein (in para 3.3) the former shall prevail.

- 3.3 Some of the relevant Indian Standards, Acts and Codes referred to herein are given below:

IS	:	458	:	Precast concrete pipes.
IS	:	554	:	Dimensions for pipe threads, where pressure tight joints are made on threads.
IS	:	651	:	Salt glazed stoneware pipes and fittings.
IS	:	771	:	Glazed fire clay sanitary appliances.
(Part-1 to 7)				
IS	:	774	:	Flushing cisterns for water closets and urinals.
IS	:	775	:	Cast iron brackets and supports for wash basins and sinks.
IS	:	778	:	Copper alloy gate, globe and check valves for water works purposes.
IS	:	781	:	Cast copper alloy screw down bib taps and stop valves for water services.
IS	:	782	:	Caulking lead.
IS	:	783	:	Code of practice for laying of concrete pipes.
IS	:	805	:	Code of practice for use of steel in gravity water tanks.
IS	:	1172	:	Code of basic requirements for water supply, drainage and sanitation.
IS	:	1239	:	Mild steel tubes, tubular and other wrought steel fittings.



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IS	:	1536	:	Centrifugally cast (Spun) iron pressure pipes for water, gas and sewage.
IS	:	1703	:	Copper alloy float valves.
IS	:	1726	:	Cast iron manhole covers and frames.
IS	:	1729	:	Sand cast iron spigot and socket, soil waste and ventilating pipes, fittings and accessories.
IS	:	1742	:	Code of practice for building drainage.
IS	:	1795	:	Pillar taps for water supply purposes.
IS	:	2065	:	Code of practice for water supply in buildings.
IS	:	2326	:	Automatic flushing cisterns for urinals.
IS	:	2501	:	Solid drawn copper tubes for general engineering purposes.
IS	:	2548	:	Plastic seats and covers for water closets.
IS	:	2692	:	Ferrules for water services.
IS	:	2963	:	Copper alloy waste fittings for wash basins and sinks.
IS	:	3311	:	Waste plug and its accessories for sinks and wash basins.
IS	:	3438	:	Silvered glass mirrors for general purposes.
IS	:	3486	:	Cast iron spigot and socket drain pipes.
IS	:	3989	:	Centrifugally cast (spun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
IS	:	4111 (Part- 1 to 5)	:	Code of practice for ancillary structure in sewerage system.
IS	:	4127	:	Code of practice for laying of glazed stone-ware pipes.
IS	:	4764	:	Tolerance limits for sewage effluent discharged into inland-surface waters.
IS	:	4827	:	Electro plated coatings of nickel and chromium on copper and copper alloys.
IS	:	5219	:	Cast copper alloys traps.
IS	:	5329	:	Code of practice for sanitary pipe work above ground for buildings.
IS	:	5382	:	Rubber sealing rings for gas mains, water mains and sewers.

IS	:	5822	:	Code of practice for laying of welded steel pipes for water supply.
IS	:	6163	:	Centrifugally cast (spun) iron low pressure pipes for water, gas and sewage.
IS	:	7231	:	Plastic flushing cisterns for water closets and urinals.
IS	:	7740	:	Code of practice for construction and maintenance of road gullies.
IS	:	8931	:	Copper alloy fancy single taps combination tap assembly and stop valves for water services.
IS	:	8934	:	Cast copper alloy fancy pillar taps for water services.
IS	:	9762	:	Polyethylene floats for float valves.
IS	:	10446	:	Glossary of terms for water supply and sanitation.
IS	:	10592	:	Industrial emergency showers, eye and face fountains and combination units.
IS	:	12592	:	Specification for precast concrete manhole covers and frames.
SP	:	35	:	Hand book on water supply and drainage.

4.0 MATERIAL

- 4.1 All pipes, fittings, fixtures, appliances and accessories shall conform to the relevant Indian Standards as listed under Clause No. 3.0. These shall be obtained from an approved reputed manufacturer, and shall be approved, the Engineer. Wherever indicated by the Engineer, the Contractor shall submit samples of materials. These may be retained by him for subsequent comparison when bulk supplies are received at site. Ultimate choice of type lies completely with the Engineer.
- 4.2 The material brought to the site shall be stored in a separate secured enclosure, away from the building materials. Pipe threads, sockets and similar items shall be specially protected till final installation. Brass and other expensive items shall be kept under lock and key. Fragile items shall be checked thoroughly when received at the site and item found damaged shall not be retained at site.
- 4.3 Chromium plating fittings and appliances shall be of grade-2. (10 micron thickness), conforming to IS: 4827.

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4.4 Pipes

Unless otherwise specified, following types of pipes shall be used:

For water supply to buildings, Heavy Grade GI Pipes conforming to IS:1239 shall be used.

For inlet connecting pipes to appliances / fittings, C.P. brass pipe of 15 mm N.B. with union of approved make shall be used. Standard length of 300 mm to 450 mm pipe shall be used to suit the site requirements.

For building sanitary work above ground, UPVC pipes, fittings and accessories conforming to IS: 13592/relevant IS Codes shall be used. Pipes shall be coated with coal-tar by hot dipping process for both inner and outer surfaces.

Glazed stoneware pipes used for sewer and drain shall conform to Grade A of IS: 651.

RCC pipe used for sewer and drain shall conform to IS: 458. Class NP3/NP4 pipe shall be used with Concrete encashment .Epoxy coating shall be provided on inner face.

For drain and sewer line work in bad or unstable ground condition and under building, C.I Pipes with lead caulked joints shall be used.



PVC rain water pipes shall be used for roof drainage.

4.5 Above Ground Level

1) Galvanised mild steel pipes for water supply

For work above ground level, the galvanised mild steel pipes and fittings shall run on the surface of the walls, ceiling or in chase as specified or shown on the drawing. The fixing shall be done by means of standard pattern holder bat clamps, provided at no more than 90 cm and keeping the pipes about 1.5 cm clear of the wall. To conceal the pipes, chasing may be adopted or pipes fixed in the ducts or recess etc. Provided there is sufficient space to work on the pipes with the common tools. The pipes shall not ordinarily be buried in walls or solid floors. Under unavoidable situations, pipes may be buried for short stretch after providing adequate protection against damage. Union joints shall be provided for all required locations to facilitate maintenance.

Where directed by the Engineer, a M.S. tube sleeve shall be fixed at a place the pipe is passing through. In case the pipe is embedded, it should be painted with anti-corrosive bitumastic paints conforming to IS: 158. The pipes shall be oiled and rubbed over the white

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Floor trap shall be 'Nahni' or ordinary type and shall conform to IS:1729. The floor shall be suitably lowered to accommodate the trap and the top of the floor shall be properly sloped towards the trap for effective drainage. A chromium plated/galvanised grating shall be provided on the trap. The sunken floor slab shall be filled with light weight materials like cinder mixed with cement. Sunken slab shall be made watertight by means of Sika water proofing compound as recommended by the manufacturer.

Rain Water Downcomers

Rain water downcomers and fittings shall be standard PVC rainwater downcomers shall run along and be secured to walls, columns etc. Where desired by the Engineer, these may have to be installed in chases cut out in the structure. All pipes shall be well secured to the walls and supported by adequately strong brackets. The brackets may be wrought iron clevis type, lip-ring type or perforated strap iron type, as approved by the Engineer. Suitable spacer blocks shall be provided against the vertical surface on which the pipe is fixed.

All bends and junctions shall be supplied with water tight cleaning eyes. For improving the aesthetic appearance of the portion of building carrying rain water downcomers, the pipes may have to be concealed by encasing them with brick masonry, concrete, etc.



Galvanised M.S. pipes shall be joined by using standard sockets or by welding. For welding of pipes, IS:11906 shall be followed. After welding, the welded area shall be coated with zinc rich paint after proper cleaning and preparation of the surface. Joints between successive lengths of pipe can be by collars according to provision of IS:1742-1983. All rainwater downcomers shall be provided with roof drain head of the shape and type as shown on the drawing. Unless otherwise specified, dome type drain head shall be used.

3) Khurras

The khurras shall be constructed before the brick masonry work in parapet wall is taken up, and it shall be 45x45cm in size, unless otherwise specified and be formed of cement concrete 1 :2:4 (1 cement: 2 sand: 4 graded stone aggregate of 20 mm nominal size).

A PVC sheet 1 mx1 mx400 micron shall be laid under khurras and then cement concrete shall be laid over it to a minimum thickness of 3cm with its top surface lower than the level of adjoining roof surface by not less than 50mm.

The concrete shall be laid to a size greater than the stipulated size of khurra in such a way that the adjoining terracing of brick tile overlaps the concrete on its 3 edges by not less

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4.6 Below Ground Level:

1) Trenches and other Excavation:

Except as mentioned hereunder, all work for earthwork shall be done as specified in relevant chapter of Excavation and Filling. The trenches shall be so dug that the pipe may be laid to the required alignment and at required depth. The cover shall be measured from top soil or other surface of the ground. Turf, top soil or other surface material shall be set aside, turf being carefully removed and stacked for use in reinstatement. The bed of the trench, if in soft or made up earth, shall be well watered and rammed before laying the pipes and the depressions, if any, shall be properly filled with earth and consolidated in 20 cm layers.

If the trench is extremely hard or rocky or loose stony soil, the trench shall be excavated at least 150 mm below the trench grade. Rocks, stone or other hard substances from the bottom of the trench shall be removed and the trench brought back to the required grade by filling with selected earth and compacted so as to provide smooth bedding for the pipe.

The last 7.5 cm. of excavation shall be trimmed and removed as separate operation immediately prior to the laying of the pipe on their foundations. The width of the trench shall be such as to provide not less than 20 cm clearance on either side of the pipe. Excavation in road shall be so arranged as to cause minimum obstruction to traffic.



2) Laying of Pipes:

In no case, pipes shall be rolled and dropped into the trench. After lowering, the pipes shall be arranged so that the spigot of one pipe is carefully centered into the socket of the next pipe and pushed to the distance that it can go.

The pipe shall be laid with socket facing the direction of flow of water. The connection to an existing sewer shall as far as possible be done at the manhole.

3) Filling of Trench

Filling of the trench shall not be commenced until the length of pipes therein has been tested and passed. Special care shall be taken to pack under and sides of the pipes thoroughly with selected material. At least 300 mm over the pipe shall also be filled with selected earth.

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5.0 MANHOLES

5.1 Wherever applicable manhole should be suitably designed & constructed.

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ANNEXURE VII

QUALITY ASSURANCE PLAN

QUALITY ASSURANCE PLAN

SL NO	MATERIAL/ OPERATION	NAME OF TEST	FIELD/ LAB.	TEST PROCEDURE	FREQUENCY OF CHECKING	EXTEN T OF CHECK ING	REFERENC E DOCUMENT
1.	Earthwork in excavation	Lines, levels & depth	Field	Measurement	As per decision of site engr.	100%	Specn.& approved drg.
2.	Concrete work						
	a) Course aggregate	i) % of soft or deleterious materials	Lab.	As per IS 2386 Part IX,1963	Once for each source/supply & shall be repeated in case source is changed	-do-	Specn.& IS 2386 (Pt.IX) & IS-383
		ii) Particle size distribution	Lab/ Field	As per IS 2386 (Pt.I)	-do-	-do-	IS 383, Specn.
	b)Fine aggregate	i) Silt content	Lab	Appendix -D of CPWD Specn.Vol.I	-do-	-do-	CPWD Specn.
		ii)Particle size distribution	Lab./ Field	IS 383	-do-	-do-	Specn. & IS 383
	c) Cement	i) Physical properties	Lab	As per IS 269 & 4031	-do-	-do-	IS 269,1489,4 031 & test certificate
		ii) Chemical properties	-do-	As per IS 4032	-do-	-do-	IS 4032 & test certificate
	d) Reinforcing bars						
	i) Deformed bars	Physical properties & dimensions	Field /Lab	As per IS 1139	-do-	-do-	IS 1139& test certificate
	ii) Cold twisted bars	-do-	-do-	As per IS 1786	-do-	-do-	IS 1786& test certificate
	iii) Hard Drawn Steel Wire Fabric	-do-	-do-	As per IS 1566	-do-	-do-	IS 1566& test certificate
	iv) TMT bars	-do-	-do-	As per IS 1786	-do-	-do-	IS 1786& test certificate
	v) Placement, laps, hooks, spacers etc.	Physical	Field	As per IS 456	ALL	-do-	IS 456 & approved drawings
	e) Water	Chemical test	-do-	As per IS 3025-64	Single Test	-do-	IS 3025-1964
	f) Tests for concrete	i) Slump test	Field	As per IS 1199	For each batch of concreting	-do-	CPWD Specn. & IS 1199
		ii) Cube test at 7/28 days	Field/L ab.	As per IS 516	No. of cubes to be decided as per given in IS 456/ Specn.	-do-	IS 456,IS 516
	g) Shuttering /Formwork	Physical	Field	Measurement	All	-do-	As per drawing,

	Checking of levels, dimensions, unevenness, joints, cleanliness, oiling etc.						CPWD specifications & instruction of E.I.C
3.	Brick Work/Hollow Concrete Block work						
	a) Brick/Hollow Concrete Block work	Physical properties & crushing strength	Field/L ab.	As specified in Specn & IS 1077	Once for each source	100%	Specn. / IS 1077
	b) Mortar	Uniformity in mix	Field	As specified in IS 2250	As & when required	-do-	IS 2250
4.	Steel works using tubular, angles, plates, channels etc.						
	i) Structural steel & plates	Dimension, manufacturers, Specn. test certificates	Lab.	IS:226 & 2062	Once for each source/supply	100%	IS Codes & test certificates
	ii) Welding electrodes	-do-	-do-	IS:814 & 815	-do-	-do-	-do-
	iii) Welding	Quality of weld, weld reinforcement, contour etc.	Field	Visual	As per discretion of site engr.	-do-	IS: 823
	iv) Painting on steel works (synthetic enamel paint over 3 coats red oxide coat zinc primer)	Cleaning off rust dirt, grease etc. of coats.	-do-	IS:123 1962	-do-	-do-	IS Code, Relevant Specn.
5.	Providing & laying water proofing on roof	Thickness, slope etc.	-do-	As per Specn. & IS 2115	-do-	-do-	-do-
6.	Flooring						
	i) Cement concrete floor	Physical	Field	As per IS 1443	All	-do-	IS 1443
	i) Glazed tiles	Physical	Field	As per IS 13630	All	-do-	IS 13630 & Manufacturer's certificate
7.	Pre-coated G.I sheet roofing laying & fixing.	Physical	-do-	As per IS 277 & 513	Once for each source/supply	-do-	IS code, spec. & Manufacturer's certificate
8.	Gypsum board false ceiling/ Prima board Armstrong false ceiling	Physical	-do-	IS 2095 & 2542	All	-do-	IS code, specn. & Manufacturer's certificate
9.	Doors/windows/ventilators						
	i) Glazing	Physical	-do-	IS 1081 & 2835	All	-do-	IS code, specn. &

							Manufacturer's certificate
	ii) Flush door shutters	Physical	-do-	IS 2095 & 2542	All	-do-	IS code, specn. & Manufacturer's certificate
	iii) Aluminium	Physical	-do-	IS 1948 & 1949	All	-do-	IS code, specn. & Manufacturer's certificate
	iv) Steel	Physical	-do-	IS 1038	All	-do-	IS code, specn. & Manufacturer's certificate
10	Plastering	Physical	-do-	As per specn.	All	-do-	Specn.
11	White washing, snowmen, distemper	Physical	-do-	IS 712, 428 & 5410	All	-do-	IS code & specn.
12	Toiletries & sanitary fixtures						
	IWC, EWC, Urinals, washbasins, G.I pipes & fittings, C.I pipes & stoneware pipes etc.	Physical	-do-	IS 771, 775, 774, 1239, 2065, 781, 1729, 1726, 651, 4127 etc.	All	-do-	IS code, specn. & Manufacturer's certificate

Note: Parameters/guidelines fixed for the quality control in accordance with the contract document, IS Codes/Technical Specification etc. are just the synopsis of the whole constructional activities in a bid to visualise the total involvement at a glance. Mere compliance of the QAP does not relieve the contractor from overall responsibility to render best quality of work in conformity with all the relevant documents and the best engineering practices. In order to minimise the size of QAP, only salient/important features have been taken into account and other small/minor involvement will be dealt with individually as per the provision of contract.

Job No: 3531

**REPORT ON
GEOTECHNICAL INVESTIGATION WORK FOR
REVIVAL OF RAMAGUNDAM FERTILIZER COMPLEX OF FCIL
AT RAMAGUNDAM, TELANGANA**

**VOLUME 1
(Main Report with Conclusions)**

Client:

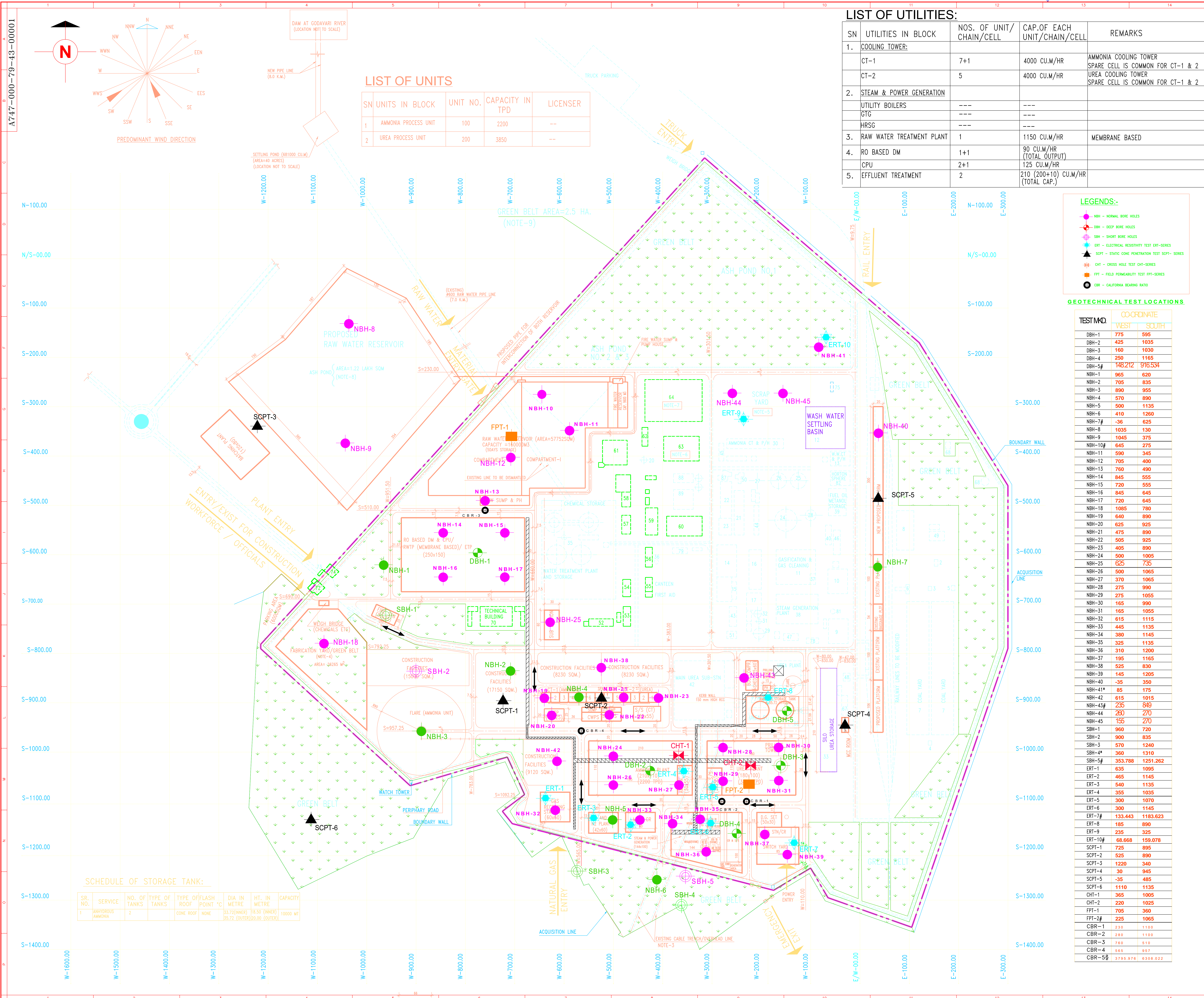
**M/s. Ramagundam Fertilizers and Chemicals Limited
(Joint Venture Company of NFL, EIL & FCIL)
Scope Complex, Core-3, 7 Institutional Area,
Lodhi Road, New Delhi**

Foundation Consultants:

C. E. Testing Company Pvt. Limited
An ISO 9001, 14001& OHSAS 18001 Certified Company
NABL Accredited Laboratory
124A, N.S.C. Bose Road : Kolkata - 700 092
Phones: 2428-6221/6222/6223 Fax: (033) 2428-6220
Email: cetest@cetestindia.com

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LIST OF UNITS

SN	UNITS IN BLOCK	UNIT NO.	CAPACITY IN TPD	LICENSER
1	AMMONIA PROCESS UNIT	100	2200	---
2	UREA PROCESS UNIT	200	3850	---

LIST OF UTILITIES:

SN	UTILITIES IN BLOCK	NOS. OF UNIT/CHAIN/CELL	CAP.OF EACH UNIT/CHAIN/CELL	REMARKS
1.	COOLING TOWER:			
	CT-1	7+1	4000 CU.M/HR	AMMONIA COOLING TOWER SPARE CELL IS COMMON FOR CT-1 & 2
	CT-2	5	4000 CU.M/HR	UREA COOLING TOWER SPARE CELL IS COMMON FOR CT-1 & 2
2.	STEAM & POWER GENERATION			
	UTILITY BOILERS	---	---	
	GTG	---	---	
	HRSG	---	---	
3.	RAW WATER TREATMENT PLANT	1	1150 CU.M/HR	MEMBRANE BASED
4.	RO BASED DM	1+1	90 CU.M/HR (TOTAL OUTPUT)	
	CPU	2+1	125 CU.M/HR	
5.	EFFLUENT TREATMENT	2	210 (200+10) CU.M/HR (TOTAL CAP.)	

LEGENDS:-

- NBH - NORMAL BORE HOLES
- DBH - DEEP BORE HOLES
- SBH - SHORT BORE HOLES
- ERT - ELECTRICAL RESISTIVITY TEST ERT-SERIES
- SCPT - STATIC CONE PENETRATION TEST SCPT-SERIES
- CHT - CROSS HOLE TEST CHT-SERIES
- FPT - FIELD PERMEABILITY TEST FPT-SERIES
- CBR - CALIFORNIA BEARING RATIO

GEOTECHNICAL TEST LOCATIONS

TEST MD.	COORDINATE	
	WEST	SOUTH
DBH-1	775	595
DBH-2	425	1035
DBH-3	160	1030
DBH-4	250	1165
DBH-5	148.212	916.534
NBH-1	965	620
NBH-2	705	835
NBH-3	890	955
NBH-4	570	890
NBH-5	500	1135
NBH-6	410	1260
NBH-7	-36	625
NBH-8	1035	130
NBH-9	1045	375
NBH-10	645	275
NBH-11	590	345
NBH-12	705	400
NBH-13	760	490
NBH-14	845	555
NBH-15	720	555
NBH-16	845	645
NBH-17	720	645
NBH-18	1085	780
NBH-19	640	890
NBH-20	625	925
NBH-21	475	890
NBH-22	505	925
NBH-23	405	890
NBH-24	500	1005
NBH-25	625	735
NBH-26	500	1065
NBH-27	370	1065
NBH-28	275	990
NBH-29	275	1055
NBH-30	165	990
NBH-31	165	1055
NBH-32	615	1115
NBH-33	445	1135
NBH-34	380	1145
NBH-35	325	1135
NBH-36	310	1200
NBH-37	195	1165
NBH-38	525	830
NBH-39	145	1205
NBH-40	-35	350
NBH-41*	85	175
NBH-42	615	1015
NBH-43*	235	849
NBH-44	260	270
NBH-45	155	270
SBH-1	960	720
SBH-2	900	835
SBH-3	570	1240
SBH-4*	360	1310
SBH-5*	353.788	1251.262
ERT-1	635	1095
ERT-2	465	1145
ERT-3	540	1135
ERT-4	355	1035
ERT-5	300	1070
ERT-6	300	1145
ERT-7*	133.443	1183.623
ERT-8	185	890
ERT-9	235	325
ERT-10*	68.668	159.078
SCPT-1	725	895
SCPT-2	525	890
SCPT-3	1220	340
SCPT-4	30	945
SCPT-5	-35	485
SCPT-6	1110	1135
CHT-1	365	1005
CHT-2	220	1025
FPT-1	705	360
FPT-2*	225	1065
CBR-1	230	1100
CBR-2	280	1100
CBR-3	760	510
CBR-4	565	957
CBR-5*	3795.976	6308.822

REF. DWG. NO. 15 OVERALL PLOT PLAN

REFERENCE DRAWING TITLE

NOTES:-

1. ALL DIMENSIONS, LEVEL & CO-ORDINATES ARE IN METRE.
2. CHANGES IN TERMINATION CRITERIA AS PER MAIL DATED 09.07.2015 ARE AS FOLLOWS.
3. ALL DBH SHALL BE TERMINATED AT 20M DEPTH.
4. ALL NBH SHALL BE TERMINATED AFTER PENETRATING 5.0M IN THE ROCK LAYER.
5. ALL SBH SHALL BE TERMINATED AFTER PENETRATING 2.0m IN ROCK LAYER OR 10.0m (MAXIMUM) WHICHEVER IS EARLIER.
6. SCPT-7 TO SCPT-22 & CHT-3 DELETED.

Notes :-

1. * - Tests were cancelled at these locations as per instruction of Engineer - In - Charge.
2. # - Test locations were shifted due to obstructions in consultation with Engineer - In - Charge.
3. \$ - CBR-5 is located near Ramagundam Railway Station.

EXISTING FACILITIES & BUILDINGS TO BE USED AFTER REPERBISHING/ASSESMET OF REUSE

33	UREA STORAGE
34	BAGGING PLANT (EXISTING TO BE MODIFIED EXPANDED)
12	WASH WATER SETTLING BASIN
52	TRAINING CENTRE
53	TRAINING CENTRE WORKSHOP
54	AMMONIA PLANT OFFICE
55	CANTEN & FIRST AID POST
56	FIRE STATION & SAFETY OFFICE (TO BE USED AS MAY BE SITE OFFICE)
57	TRANSPORT POOL
58	AUTO SHOP
59	ELECT. & INST. WORKSHOP
60	MECHANICAL WORKSHOP
61	PETROL PUMP
62	TEMP. WARE HOUSE
63	PERMANENT WARE HOUSE
70	TECHNICAL BUILDING
72	SECURITY OFFICE
74	TELEPHONE EXCHANGE
64	STEEL & SCRAP YARD (TO BE USED AS MAY BE FABRICATION YARD)

AREA CHART:

TOTAL AREA = 155.14 HA. (INCLUDING OUTSIDE PLANT BOUNDARY LIMIT AREA 15.14HA)

EXISTING PLANT AREA = 57.14 HA.

NEW PLANT AREA = 47 HA.

GREEN BELT AREA = 51 HA. (INCLUDING EXISTING GREEN BELT AREA 2.5 HA.)

LEGENDS:

- REUSED PLANT
- REUSED BUILDING
- PROPOSED FACILITIES
- EXISTING FACILITIES
- GREEN BELT AREA
- PROPOSED ROAD
- EXISTING ROAD
- PIPE RACK
- PIPE SLEEPERS
- CRANE MOVEMENT

REVISIONS

REV	DATE	REVISIONS	BY	CHKD	APPD	PERMTC
4	21-08-2015	AS BUILT (CBR Locations are incorporated)				
3	10-08-2015	AS BUILT				
2	06-08-2015	REVISED AND SIGNED FOR EXECUTION	YR	SRVGH	BM	
1	06-08-2015	REVISED AND SIGNED FOR EXECUTION	YR	SRVGH	BM	
0	06-08-2015	ISSUED FOR EXECUTION	YR	SRVGH	BM	

CLIENT

RAMAGGUNDAM FERTILIZER & CHEMICALS LTD(RFCL)

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NEW AMMONIA UREA COMPLEX

भूमिक अमेगा येम

GEOTECHNICAL INVESTIGATION SCHEME

SCALE 1:2500

JOB NO. A747-000-79-43-00001

UNIT 16

DIVN. 1

DEPT. 6

DWG. NO. 01

REV. 4

6. SUMMARY & RECOMMENDATIONS

Based on the field tests and the foregoing discussion the following are summarised.

1. The subsoils in general are of good quality. Underlying a filled up soil layer, it is characterized by a stiff to very stiff silty clay / clayey silt layer. A layer of hard, silty clay / clayey silt with rock fragments follows the above. Around some boreholes a layer of very dense silty sand is observed. After that weathered rock layer is encountered and continues upto the terminating depth of all the boreholes.
2. Considering the predominant subsoil condition and the type of the structure to be constructed at the present site, it is suggested to go for open foundation. However deep foundation in the form of pile can also be used.

3. Use of Shallow Foundation:

The determination of bearing capacity is discussed in the previous section. The recommended Bearing Capacity is presented below.

Name of Structure	Foundation Location	Depth of Foundation below EGL (m)	Width of Foundation (B in m)	NSBC (t/sqm)	Net Allowable Bearing Capacity (t/sqm)	
					S = 25mm	S = 40mm
RO Based DM & CPU / RWTP(Membrane Based) / ETP	NBH-14 & 16	1.50	$B \leq 3.0$	19.31	15	18
			$3.0 < B < 6.0$	18.87	14	18
			$B \geq 6.0$	21.17	--	15
		2.50	$B \leq 3.0$	32.77	30	32
			$3.0 < B < 6.0$	31.60	30	30
			$B \geq 6.0$	34.95	--	30
		3.50	$B \leq 3.0$	57.69	40	40
			$3.0 < B < 6.0$	54.97	40	40
			$B \geq 6.0$	59.99	--	40
	DBH-01, NBH-15 & 17	1.50	$B \leq 3.0$	28.29	25	28
			$3.0 < B < 6.0$	27.65	25	26
			$B \geq 6.0$	31.00	--	25
		2.50	$B \leq 3.0$	40.93	30	40
			$3.0 < B < 6.0$	39.47	30	38
			$B \geq 6.0$	43.65	--	30
		3.50	$B \leq 3.0$	54.82	40	40
			$3.0 < B < 6.0$	52.23	40	40
			$B \geq 6.0$	57.01	--	40
Ammonia Plant	DBH-02	2.00	$B \leq 3.0$	22.56	18	22
			$3.0 < B < 6.0$	21.90	16	20
			$B \geq 6.0$	24.40	--	16
		3.00	$B \leq 3.0$	23.93	20	22
			$3.0 < B < 6.0$	22.94	18	22
			$B \geq 6.0$	25.23	--	18
		4.00	$B \leq 3.0$	56.32	40	40
			$3.0 < B < 6.0$	53.36	40	40
			$B \geq 6.0$	57.89	--	40
	NBH-24, 26 & 27	2.00	$B \leq 3.0$	37.10	25	35
			$3.0 < B < 6.0$	36.01	25	35
			$B \geq 6.0$	40.09	--	25

Name of Structure	Foundation Location	Depth of Foundation below EGL (m)	Width of Foundation (B in m)	NSBC (t/sqm)	Net Allowable Bearing Capacity (t/sqm)	
					S = 25mm	S = 40mm
Ammonia Plant	NBH-24, 26 & 27	3.00	$B \leq 3.0$	39.32	30	38
			$3.0 < B < 6.0$	37.69	30	35
			$B \geq 6.0$	41.41	--	30
		4.00	$B \leq 3.0$	56.32	40	40
			$3.0 < B < 6.0$	53.36	40	40
			$B \geq 6.0$	57.89	--	40
Flare (Ammonia Unit)	NBH-03	1.50	$B \leq 3.0$	24.44	22	24
			$3.0 < B < 6.0$	23.89	20	22
			$B \geq 6.0$	26.79	--	20
		2.50	$B \leq 3.0$	25.97	24	25
			$3.0 < B < 6.0$	25.04	22	25
			$B \geq 6.0$	27.71	--	22
		3.50	$B \leq 3.0$	80.22	40	40
			$3.0 < B < 6.0$	83.90	40	40
			$B \geq 6.0$	100.87	--	40
Urea Plant	NBH- 28, 30, & 31	3.00	$B \leq 3.0$	30.93	25	30
			$3.0 < B < 6.0$	29.64	25	28
			$B \geq 6.0$	32.58	--	25
		4.00	$B \leq 3.0$	37.12	30	35
			$3.0 < B < 6.0$	35.17	30	35
			$B \geq 6.0$	38.18	--	30
		5.50	$B \leq 3.0$	48.07	40	40
			$3.0 < B < 6.0$	44.87	40	40
			$B \geq 6.0$	47.88	--	40
Prilling Tower (Urea Plant)	DBH-03	3.00	$B \leq 3.0$	30.93	25	30
			$3.0 < B < 6.0$	29.64	25	28
			$B \geq 6.0$	32.58	--	25
		4.00	$B \leq 3.0$	37.12	30	35
			$3.0 < B < 6.0$	35.17	30	35
			$B \geq 6.0$	38.18	--	30
		5.00	$B \leq 3.0$	112.98	40	40
			$3.0 < B < 6.0$	113.88	40	40
			$B \geq 6.0$	129.77	--	40
Urea S/S (Urea Plant)	NBH-29	1.50	$B \leq 3.0$	14.18	12	14
			$3.0 < B < 6.0$	13.86	10	12
			$B \geq 6.0$	15.56	--	12
		2.50	$B \leq 3.0$	20.53	16	20
			$3.0 < B < 6.0$	19.80	14	18
			$B \geq 6.0$	21.91	--	16
		3.50	$B \leq 3.0$	27.49	20	26
			$3.0 < B < 6.0$	26.20	18	25
			$B \geq 6.0$	28.63	--	20
		5.00	$B \leq 3.0$	46.88	40	40
			$3.0 < B < 6.0$	43.97	40	40
			$B \geq 6.0$	47.17	--	40
CR & SS	DBH-04	14.00*	$B \leq 3.0$	28.29	25	28
			$3.0 < B < 6.0$	27.65	25	26
			$B \geq 6.0$	31.00	--	25
		15.00*	$B \leq 3.0$	31.41	30	30
			$3.0 < B < 6.0$	30.29	30	30
			$B \geq 6.0$	33.51	--	30

Name of Structure	Foundation Location	Depth of Foundation below EGL (m)	Width of Foundation (B in m)	NSBC (t/sqm)	Net Allowable Bearing Capacity (t/sqm)	
					S = 25mm	S = 40mm
CR & SS	DBH-04	18.00*	B≤3.0	106.02	40	40
			3.0<B<6.0	94.68	40	40
			B≥6.0	94.98	--	40
Ammonia Storage Tank.	DBH-05	2.00	B≤3.0	15.95	12	15
			3.0<B<6.0	15.49	10	15
			B≥6.0	17.26	--	12
		3.00	B≤3.0	25.33	18	25
			3.0<B<6.0	24.28	15	24
			B≥6.0	26.70	--	18
		4.00	B≤3.0	32.69	28	32
			3.0<B<6.0	30.98	25	30
			B≥6.0	33.64	--	25
		6.00	B≤3.0	136.99	40	40
			3.0<B<6.0	135.50	40	40
			B≥6.0	150.19	--	40
Near Plant Entry	NBH-01	1.50	B≤3.0	12.90	12	12
			3.0<B<6.0	12.61	10	12
			B≥6.0	14.15	--	10
		2.50	B≤3.0	40.93	30	40
			3.0<B<6.0	39.47	30	38
			B≥6.0	43.65	--	30
		3.50	B≤3.0	72.93	40	40
			3.0<B<6.0	76.24	40	40
			B≥6.0	91.59	--	40
Construction Facilities	NBH-02	1.50	B≤3.0	30.85	25	30
			3.0<B<6.0	30.15	25	30
			B≥6.0	33.81	--	25
		2.50	B≤3.0	34.13	30	34
			3.0<B<6.0	32.91	30	32
			B≥6.0	36.40	--	30
		3.50	B≤3.0	43.13	40	40
			3.0<B<6.0	41.27	40	40
			B≥6.0	45.06	--	40
	NBH- 42	1.50	B≤3.0	25.72	25	25
			3.0<B<6.0	25.14	25	25
			B≥6.0	28.20	--	25
		2.50	B≤3.0	32.77	30	32
			3.0<B<6.0	31.60	30	30
			B≥6.0	34.95	--	30
		3.50	B≤3.0	43.31	35	40
			3.0<B<6.0	41.27	35	40
			B≥6.0	45.06	--	35
	NBH-38 & SBH-02	1.50	B≤3.0	18.03	15	18
			3.0<B<6.0	17.62	14	16
			B≥6.0	19.77	--	15
		2.50	B≤3.0	32.77	30	32
			3.0<B<6.0	31.60	30	30
			B≥6.0	34.95	--	30
		3.50	B≤3.0	54.82	40	40
			3.0<B<6.0	52.23	40	40
			B≥6.0	57.01	--	40

Name of Structure	Foundation Location	Depth of Foundation below EGL (m)	Width of Foundation (B in m)	NSBC (t/sqm)	Net Allowable Bearing Capacity (t/sqm)	
					S = 25mm	S = 40mm
Spare Cell	NBH-04 & 19	1.50	$B \leq 3.0$	30.85	25	30
			$3.0 < B < 6.0$	30.15	25	30
			$B \geq 6.0$	33.81	--	25
		2.50	$B \leq 3.0$	38.21	30	38
			$3.0 < B < 6.0$	36.85	30	35
			$B \geq 6.0$	40.75	--	30
		3.50	$B \leq 3.0$	43.31	40	40
			$3.0 < B < 6.0$	41.27	40	40
			$B \geq 6.0$	45.06	--	40
	NBH- 21 & 23	1.50	$B \leq 3.0$	25.72	24	25
			$3.0 < B < 6.0$	25.14	22	25
			$B \geq 6.0$	28.20	--	22
		2.50	$B \leq 3.0$	32.77	30	32
			$3.0 < B < 6.0$	31.60	30	30
			$B \geq 6.0$	34.95	--	30
		3.50	$B \leq 3.0$	40.43	35	40
			$3.0 < B < 6.0$	38.53	35	38
			$B \geq 6.0$	42.07	--	35
Air and N2 Plant	NBH-05	1.50	$B \leq 3.0$	30.85	25	30
			$3.0 < B < 6.0$	30.15	25	30
			$B \geq 6.0$	33.81	--	25
		2.50	$B \leq 3.0$	38.21	30	38
			$3.0 < B < 6.0$	36.85	30	35
			$B \geq 6.0$	40.75	--	30
		3.50	$B \leq 3.0$	43.31	40	40
			$3.0 < B < 6.0$	41.27	40	40
			$B \geq 6.0$	45.06	--	40
Near Existing Cable trench / Overhead Line	NBH-06	1.50	$B \leq 3.0$	25.72	22	25
			$3.0 < B < 6.0$	25.14	20	25
			$B \geq 6.0$	28.20	--	20
		2.50	$B \leq 3.0$	27.33	25	26
			$3.0 < B < 6.0$	26.36	24	26
			$B \geq 6.0$	29.16	--	24
		3.50	$B \leq 3.0$	40.43	35	40
			$3.0 < B < 6.0$	38.53	35	38
			$B \geq 6.0$	42.07	--	35
Platform Area	NBH-07 & 40	1.50	$B \leq 3.0$	30.85	25	30
			$3.0 < B < 6.0$	30.15	25	30
			$B \geq 6.0$	33.81	--	25
		2.50	$B \leq 3.0$	38.21	30	38
			$3.0 < B < 6.0$	36.85	30	35
			$B \geq 6.0$	40.75	--	30
		3.50	$B \leq 3.0$	43.31	40	40
			$3.0 < B < 6.0$	41.27	40	40
			$B \geq 6.0$	45.06	--	40
Raw water Reservoir (Proposed & Existing)	NBH-08 & 09	6.50	$B \leq 3.0$	149.65	40	40
			$3.0 < B < 6.0$	146.80	40	40
			$B \geq 6.0$	160.75	--	40
	NBH-11 & 12	2.50	$B \leq 3.0$	32.77	30	32
			$3.0 < B < 6.0$	31.60	30	30
			$B \geq 6.0$	34.95	--	30

Name of Structure	Foundation Location	Depth of Foundation below EGL (m)	Width of Foundation (B in m)	NSBC (t/sqm)	Net Allowable Bearing Capacity (t/sqm)	
					S = 25mm	S = 40mm
Raw water Reservoir (Proposed & Existing)	NBH-11 & 12	3.50	$B \leq 3.0$	43.13	40	40
			$3.0 < B < 6.0$	41.27	40	40
			$B \geq 6.0$	45.06	--	40
	NBH-10	1.50	$B \leq 3.0$	18.03	14	18
			$3.0 < B < 6.0$	17.62	12	16
			$B \geq 6.0$	19.77	--	14
		2.50	$B \leq 3.0$	23.25	20	22
			$3.0 < B < 6.0$	22.42	18	22
			$B \geq 6.0$	24.81	--	20
		4.00	$B \leq 3.0$	90.71	40	40
			$3.0 < B < 6.0$	93.57	40	40
			$B \geq 6.0$	110.28	--	40
RW Sump & PH	NBH-13	1.50	$B \leq 3.0$	30.18	25	30
			$3.0 < B < 6.0$	34.21	25	34
			$B \geq 6.0$	46.03	--	25
		2.50	$B \leq 3.0$	60.56	40	40
			$3.0 < B < 6.0$	65.54	40	40
			$B \geq 6.0$	82.76	--	40
Fabrication Yard / Green Belt	NBH-18	2.50	$B \leq 3.0$	33.74	30	32
			$3.0 < B < 6.0$	36.33	30	35
			$B \geq 6.0$	45.48	--	30
		3.50	$B \leq 3.0$	54.82	40	40
			$3.0 < B < 6.0$	52.23	40	40
			$B \geq 6.0$	57.01	--	40
CWTP	NBH-20	1.50	$B \leq 3.0$	28.29	25	28
			$3.0 < B < 6.0$	27.65	25	26
			$B \geq 6.0$	31.00	--	25
		2.50	$B \leq 3.0$	40.93	30	40
			$3.0 < B < 6.0$	39.47	30	38
			$B \geq 6.0$	43.65	--	30
		3.50	$B \leq 3.0$	43.13	40	40
			$3.0 < B < 6.0$	41.27	40	40
			$B \geq 6.0$	45.06	--	40
CWPS	NBH-22	1.50	$B \leq 3.0$	18.03	14	18
			$3.0 < B < 6.0$	17.62	12	16
			$B \geq 6.0$	19.77	--	14
		2.50	$B \leq 3.0$	31.41	30	30
			$3.0 < B < 6.0$	34.02	30	34
			$B \geq 6.0$	33.51	--	30
		3.50	$B \leq 3.0$	43.13	40	40
			$3.0 < B < 6.0$	41.27	40	40
			$B \geq 6.0$	45.06	--	40
Sub Station	NBH-25	1.50	$B \leq 3.0$	30.85	25	30
			$3.0 < B < 6.0$	30.15	25	30
			$B \geq 6.0$	33.81	--	25
		2.50	$B \leq 3.0$	34.13	30	34
			$3.0 < B < 6.0$	32.91	30	32
			$B \geq 6.0$	36.40	--	30
		3.50	$B \leq 3.0$	80.22	40	40
			$3.0 < B < 6.0$	83.90	40	40
			$B \geq 6.0$	100.87	--	40

Name of Structure	Foundation Location	Depth of Foundation below EGL (m)	Width of Foundation (B in m)	NSBC (t/sqm)	Net Allowable Bearing Capacity (t/sqm)	
					S = 25mm	S = 40mm
Gas Receiving Station	NBH-32	1.50	$B \leq 3.0$	23.16	20	22
			$3.0 < B < 6.0$	22.63	18	22
			$B \geq 6.0$	25.39	--	20
		2.50	$B \leq 3.0$	31.41	30	30
			$3.0 < B < 6.0$	30.00	30	30
			$B \geq 6.0$	33.00	--	30
		3.50	$B \leq 3.0$	43.31	40	40
			$3.0 < B < 6.0$	41.27	40	40
			$B \geq 6.0$	45.06	--	40
Main CR	NBH-33	1.50	$B \leq 3.0$	35.98	25	35
			$3.0 < B < 6.0$	34.68	25	34
			$B \geq 6.0$	39.43	--	25
		2.50	$B \leq 3.0$	38.21	30	38
			$3.0 < B < 6.0$	36.85	30	35
			$B \geq 6.0$	40.75	--	30
		3.50	$B \leq 3.0$	43.13	40	40
			$3.0 < B < 6.0$	41.27	40	40
			$B \geq 6.0$	45.06	--	40
HRSG#1	NBH-34	1.50	$B \leq 3.0$	28.29	25	28
			$3.0 < B < 6.0$	31.30	25	30
			$B \geq 6.0$	31.00	--	25
		2.50	$B \leq 3.0$	31.41	30	30
			$3.0 < B < 6.0$	30.29	30	30
			$B \geq 6.0$	33.51	--	30
		3.50	$B \leq 3.0$	80.22	40	40
			$3.0 < B < 6.0$	83.90	40	40
			$B \geq 6.0$	100.87	--	40
GTG Hall	NBH-35	1.50	$B \leq 3.0$	29.57	25	28
			$3.0 < B < 6.0$	28.90	25	28
			$B \geq 6.0$	32.41	--	25
		2.50	$B \leq 3.0$	35.49	30	35
			$3.0 < B < 6.0$	34.23	30	34
			$B \geq 6.0$	37.85	--	30
		3.50	$B \leq 3.0$	43.31	40	40
			$3.0 < B < 6.0$	41.27	40	40
			$B \geq 6.0$	45.06	--	40
	NBH-36	8.50*	$B \leq 3.0$	45.87	40	40
			$3.0 < B < 6.0$	49.50	40	40
			$B \geq 6.0$	62.18	--	40
Sub Station	NBH-37	4.50	$B \leq 3.0$	17.57	16	16
			$3.0 < B < 6.0$	17.27	15	16
			$B \geq 6.0$	19.49	--	16
		6.50	$B \leq 3.0$	31.10	25	30
			$3.0 < B < 6.0$	29.78	24	28
			$B \geq 6.0$	32.69	--	24
		8.00*	$B \leq 3.0$	79.01	40	40
			$3.0 < B < 6.0$	80.20	40	40
			$B \geq 6.0$	92.21	--	40
Switch Yard	NBH-39	10.00*	$B \leq 3.0$	19.95	16	18
			$3.0 < B < 6.0$	19.64	15	18
			$B \geq 6.0$	22.18	--	16

Name of Structure	Foundation Location	Depth of Foundation below EGL (m)	Width of Foundation (B in m)	NSBC (t/sqm)	Net Allowable Bearing Capacity (t/sqm)	
					S = 25mm	S = 40mm
Switch Yard	NBH-39	11.00*	$B \leq 3.0$	31.81	30	30
			$3.0 < B < 6.0$	30.88	30	30
			$B \geq 6.0$	34.38	--	30
		12.50*	$B \leq 3.0$	60.93	40	40
			$3.0 < B < 6.0$	63.58	40	40
			$B \geq 6.0$	76.10	--	40
BOG Compr. Shed	NBH-43	1.50	$B \leq 3.0$	25.72	25	25
			$3.0 < B < 6.0$	25.14	24	25
			$B \geq 6.0$	28.20	--	24
		2.50	$B \leq 3.0$	31.41	30	30
			$3.0 < B < 6.0$	30.29	30	30
			$B \geq 6.0$	33.51	--	30
		4.00	$B \leq 3.0$	56.32	40	40
			$3.0 < B < 6.0$	53.36	40	40
			$B \geq 6.0$	57.89	--	40
Scrap Yard	NBH-44	1.50	$B \leq 3.0$	23.16	22	22
			$3.0 < B < 6.0$	22.63	20	22
			$B \geq 6.0$	25.39	--	22
		2.50	$B \leq 3.0$	40.93	30	40
			$3.0 < B < 6.0$	39.47	30	38
			$B \geq 6.0$	43.65	--	30
		3.50	$B \leq 3.0$	80.22	40	40
			$3.0 < B < 6.0$	83.90	40	40
			$B \geq 6.0$	100.87	--	40
	NBH-45	1.50	$B \leq 3.0$	16.75	14	16
			$3.0 < B < 6.0$	16.37	12	16
			$B \geq 6.0$	18.36	--	14
		2.50	$B \leq 3.0$	40.93	30	40
			$3.0 < B < 6.0$	39.47	30	38
			$B \geq 6.0$	43.65	--	30
		3.50	$B \leq 3.0$	44.50	40	40
			$3.0 < B < 6.0$	46.35	40	40
			$B \geq 6.0$	55.32	--	40
Fire Station	SBH-01	1.50	$B \leq 3.0$	18.03	15	18
			$3.0 < B < 6.0$	17.62	14	16
			$B \geq 6.0$	19.77	--	15
		2.50	$B \leq 3.0$	19.17	16	18
			$3.0 < B < 6.0$	18.49	16	18
			$B \geq 6.0$	20.47	--	16
		3.50	$B \leq 3.0$	51.94	35	40
			$3.0 < B < 6.0$	49.49	35	40
			$B \geq 6.0$	54.02	--	35
Near Gas Entry	SBH-03	1.50	$B \leq 3.0$	15.46	14	15
			$3.0 < B < 6.0$	15.11	12	15
			$B \geq 6.0$	16.96	--	15
		2.50	$B \leq 3.0$	34.13	25	34
			$3.0 < B < 6.0$	31.21	25	30
			$B \geq 6.0$	36.40	--	25
		3.50	$B \leq 3.0$	36.12	30	35
			$3.0 < B < 6.0$	34.42	30	34
			$B \geq 6.0$	37.59	--	30

Name of Structure	Foundation Location	Depth of Foundation below EGL (m)	Width of Foundation (B in m)	NSBC (t/sqm)	Net Allowable Bearing Capacity (t/sqm)	
					S = 25mm	S = 40mm
Near Gas Entry	SBH-03	4.50	$B \leq 3.0$	45.69	40	40
			$3.0 < B < 6.0$	43.07	40	40
			$B \geq 6.0$	46.47	--	40
Emergency Exit	SBH-05	1.50	$B \leq 3.0$	23.16	22	22
			$3.0 < B < 6.0$	22.63	20	22
			$B \geq 6.0$	25.39	--	20
		2.50	$B \leq 3.0$	27.33	25	26
			$3.0 < B < 6.0$	26.36	24	26
			$B \geq 6.0$	29.16	--	24
		3.50	$B \leq 3.0$	44.50	40	40
			$3.0 < B < 6.0$	46.35	40	40
			$B \geq 6.0$	55.33	--	40

Note:

- NSBC = Net Safe Bearing Capacity.
- S = Limiting Settlement
- Limiting settlement inside rock is considered as 12mm irrespective of foundation type.
- For foundation placed inside rock, if any loose pocket is observed at the proposed founding level the same shall be excavated out & filled up with PCC upto the founding level.
- The depth of foundation may be increased depending upon the functional requirement of the facilities / structures.
- For Minor structures (which are not sensitive to settlement) foundation may be placed on the filled up soil. The minimum depth of foundation shall be 1m below EGL and use a net allowable bearing capacity of 5t/sqm
- * - It is assumed that the top filled up soil will be removed and the depth of foundation inside virgin soil will be of the order 1m to 5m or so. The bearing capacity and settlement calculations were carried out accordingly. In case the top filled up soil is not removed, then it is suggested to adopt deep foundation in form of pile at this location (refer Cl. 4 below).
- Considering the subsoil condition, the maximum allowable bearing capacity is restricted to 40t/sqm

4. Use of Pile Foundation:

- Bored cast in-situ piles are preferred due to typical geological formation, availability of construction agencies, ease of construction and low level of noise pollution.
- The determination of pile capacity (vertical, uplift and lateral) for bored cast-in-situ piles is presented in the previous section. The recommended pile capacity values at different pile diameters are presented below.

Location	Depth of Pile Inside Rock (M)	Pile Dia. (mm)	Recommended Pile Capacity		
			Vertical (T)	Uplift (T)	Lateral (T)
NBH-36, 37, 39 & DBH-04	2.00	450	80	45	1.00
		500	100	50	1.25
		600	125	60	1.75

- The swelling pressure and Free Swell Index tests have been performed on few samples. The average swelling pressure and Free Swell Index as found from the tests are 0.29 kg/sqcm and 20.87% respectively. Thus, the subsoil has low swelling characteristics. So, no problem with respect to heaving of the subsoil is anticipated.

6. Chemical tests were performed on few soil & water samples for determining the pH value, Sulphate & Chloride content. It is seen that the pH & Chloride values are within permissible limits but Sulphate content is on the higher side (as per IS 456). **So, either Portland slag cement or Portland Pozzolana cement can be used for the purpose (minimum cement content is 350 kg/m³; in case, Supersulphated Cement or Sulphate Resisting Portland cement is used, the minimum cement content is 330kg/m³).**
7. The Geological Report & geological logging is presented under Section 7.
8. 10 (Ten) nos. ERT were performed at the site and the test results are discussed and presented in Section - 8.
9. 2 (Two) no. Cross Hole Shear Tests were performed at the site and the test results are discussed and presented in Section - 9. For dynamic properties of subsoil strata, Cross Hole test results shall be referred.

For C. E. Testing Company Private Limited,

Prepared By

Checked & Approved By

(S. NATH)

(DR. M. NAYAK)

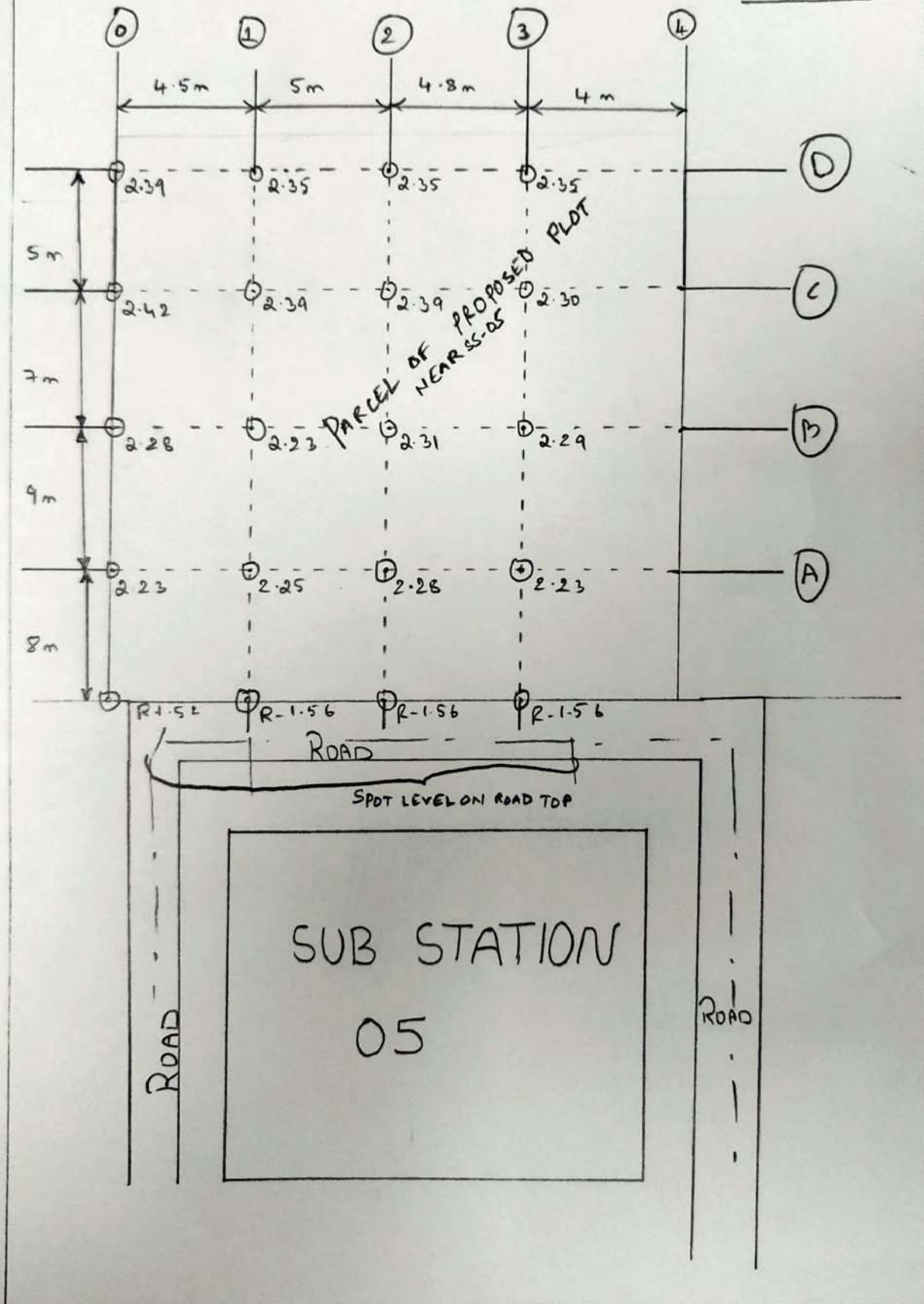
RFCL RAMAGUNDAM



SPOT LEVELS TAKEN ON 18.04.2023 - PROPOSED PLOT FOR ZLD PROJECT, RFCL

N

AREA SURVEYED

18.3 X 29 sqm



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SECTION - 6.0 (TECHNICAL PART)

CONSTRUCTION/ERECTION, PRE-COMMISSIONING, COMMISSIONING AND START-UP

PROJECT: IMPLEMENTATION OF ZERO LIQUID DISCHARGE (ZLD) UNIT AT RFCL, RAMAGUNDAM PLANT

0	10.08.2023	ISSUED FOR TENDER	JKY	JKY	RRK
REV	REV DATE	PURPOSE	PREPD	REVWD	APPD

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1.0 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.

LSTK CONTRACTOR shall provide at SITE an adequate number of qualified pre-commissioning engineers to direct and control pre-commissioning activities.

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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 (ES-2404 is attached as annexure-I for reference only).
- 2.2 LSTK CONTRACTOR to submit detailed Procedure for Chemical cleaning which will be reviewed and approved by Consultant / Client.
Based on approved chemical cleaning procedure, 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 will be done by LSTK CONTRACTOR.
- 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.
- 2.11 Introduction of chemical into and initial operation of treatment plant.

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- 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 Bidder shall arrange following facilities at his own cost for Construction/Erection purpose:

- i. **Construction power supply facilities:** 1 No 11 KV or 415 V Feeder at Existing Substation shall be made available. Tapping of Construction Power (**chargeable** basis & rate shall be as per Amendment-1 to GCC & SCC of Sr. No-3 of NIT) 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.
- ii. **Construction Water Supply facilities:** Construction water shall be supplied at one point at plant location, bidder to make arrangement for construction water supply from given plant location to bidder plant battery limit on **Non-chargeable** basis. Bidder to install meter for consumption measurement.
- iii. Instrument Air required, if any for commissioning/construction/erection.
- iv. Construction sheds
- v. Material storage
- vi. Construction offices
- vii. Temporary Communication facilities

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viii. Office furniture

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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.

On completion of works as above, PMC shall issue certificate of Mechanical Completion for Owner's Approval before the same is handed over to the LSTK CONTRACTOR in accordance with the CONTRACT.

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 and supporting staff and adequate commissioning labour. LSTK Contractor shall associate OWNER's engineers and operating staff with the commissioning work.

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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 7.0:

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 as, but not limits to:

- a) Labour camp/officers camps

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- 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.
 - m) Watering of roads through water tankers for dust suppression.
 - n) All temporary lighting for working during night.
 - o) 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.
 14. Supply to OWNER complete test records within three (3) days after completion of actual testing.
 15. Perform all welding including radiography required.

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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.

2.0 SITE

Finish grading elevation to be as shown on drawing.

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.

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.

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

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. Installation of reinforcement including installation of spacers, supports, tying, wire in accordance with the specifications and drawings.

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4.4 **Anchor Bolts**

Install all anchor bolts, in accordance with the specifications and drawings.

4.5 **Inserted and Embedded Item**

Install all concrete inserts and embedded items in accordance with the specifications and drawings.

4.6 The following WORK is included but not limited to LSTK CONTRACTOR'S scope for installation of major and minor foundations:

- 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.

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.

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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.
- 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.

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.

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.
- 10.3 Fabricate and install concrete walls around tanks and other retaining walls in accordance with the specifications and drawings.

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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.

12.2 **PTFE Sliding Plates**

- Install sliding plates, in accordance with the specification and drawings.

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.
- 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.

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.

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- ☐ Repair work shall be in accordance with the specifications.

16.0 Deleted.

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, 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

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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**

- 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

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- 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 , dykes and ramps , clay layer inside the dyked tankage areas as specified and as quantified on the 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 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 & dismantle after completion of its WORK.
- 23.1 **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 etc.
- 23.2 All costs for replacements shall be borne by LSTK CONTRACTOR.
- 24.0 **WELDING PROCEDURES SPECIFICATIONS AND WELDING PROCEDURE QUALIFICATION RECORDS**

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- 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.
- 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.
- 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 OWNER shall notify LSTK CONTRACTOR of all known existing underground pipes, cables, 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

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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.

- 26.6 Any damage as referred to above at 26.7 shall be reported by LSTK CONTRACTOR. LSTK CONTRACTOR shall repair the damage.
- 26.7 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.
- 26.8 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. No additional payments shall be made to LSTK CONTRACTOR to compensate the financial consequences of soil slides.
- 26.9 Trenches, excavations, and the like shall be maintained in strict accordance with the requirements of the applicable national and local regulations.
- 26.10 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.
- 26.11 Excavation will proceed until all unsuitable material is removed.
- 26.12 Backfill shall be to the elevation shown on the approved drawings or as directed in writing by OWNER.
- 26.13 Special care must be taken in compaction operations over underground pipelines.
- 26.14 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.
- 26.15 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.
- 26.16 All aboveground concrete for supports for steel structures must be smooth finished, and exposed edges of concrete to have a chamfer.
- 26.17 All concrete pours for a given element must be monolithic, except where noted on the drawing or approved by OWNER.
- 25.18 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

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the element is complete. OWNER shall be informed at least twenty-four (24) hours in advance.

- 26.19 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.
- 26.20 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.
- 26.21 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.
- 26.22 The pouring of any reinforced concrete may only start after having obtained Approval of OWNER.
- 26.23 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.
- 26.24 All excavated boulders will be removed from SITE by LSTK CONTRACTOR.
- 26.25 Manholes are to be marked with M.H. Number.
- 26.26 Underground service lines have to be marked at their installation limits to aboveground piping, indicating line size, and service and line number.
- 26.27 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.

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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. **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.

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.

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- ◆ 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, Painting and erect ladders and safety cages in steel structures, as per drawing/spec.

7. **Fabricate and Erect Platform and Walkways**

This item covers all operations required to fabricate, paint, erect platforms and walkways on vessels, towers, structures, etc , as per drawing/spec.

8. **Fabricate and Erect Welded Handrail**

This item covers all operations required to fabricate, paint and erect double rail handrail and tope plate of all welded construction, etc as per drawing/spec.

9. **Fabricate and Erect Galvanized Tubular Handrails**

This item covers all operations required to fabricate, paint and erect double rail tubular galvanized hand railing including all standards, fittings, bends etc , as per drawing/spec.

10. **Fabricate and Install Floor Grating**

This item covers all activities required to fabricate and install galvanized floor grating from large sheets ready for cutting, trimming, etc., to platform shapes as per drawing/spec.

11. **Fabricate and Install Chequer Plate Flooring**

This item covers all activities required to fabricate and erect chequer plate flooring, from sheets as per drawing/spec.

12. **Erect Davits**

This item covers all activities required to erect fabricated davits on exchangers, vessels or in structures as per drawing/spec.

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.

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- ◆ All flashing of ridges, corners gables, door jambs, etc.

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

- ◆ Provision of all tools, equipment and consumables used in the course of the work.

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- ◆ 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.
- Orifice flanges.
- Orifice plates.
- In - line instruments.

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- 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.
- 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.
- 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.
- 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

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- 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 for 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 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

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to be witnessed and approved by OWNER.

- 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 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.
- 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.

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.

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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.

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.
- 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.

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.

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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.

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.

5.8 **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 filter 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**

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**

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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 & 100%RT.

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 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.

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.

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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.
- 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.
- 10.5 All connections which are left open by LSTK CONTRACTOR shall be well protected, so that no sand, dirt or any foreign object comes 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 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.
- 10.12 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 .

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ANNEXEURE- 7 -2D

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

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.

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.

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- ☐ 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.
- ☐ Maximum allowable setting tolerances shall be in accordance with manufacturer's requirements or with the specifications, whichever is more stringent.
- ☐ 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.
- ☐ 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.
 - 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 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.

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- 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.

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 base plate, but prior to grouting.

3.1.6.2 Equipment and drivers shall be doweled to bed plate if required by manufacturer's instructions.

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

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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 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.

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.

4.2 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.

4.2.2 The OWNER shall inspect and certify that the LSTK Contractor executed the job in accordance with drawings and specifications.

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

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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.
- 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.

6.0 **DRAWINGS AND DOCUMENTS**

6.1 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.

6.2 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

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format. LSTK CONTRACTOR drawings receiving "Approved as Noted" stamp may be worked on provided all notes are incorporated.

- 6.3 LSTK CONTRACTOR'S drawings shall be clearly marked with titles, equipment numbers or other item identification.
- 6.4 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.
- 6.5 LSTK CONTRACTOR shall promptly submit reports of each and every test or inspection.
- 6.6 LSTK CONTRACTOR shall submit quality records of the materials, as specified in previous sections and the applicable engineering specifications.
- 6.7 LSTK CONTRACTOR shall furnish an equipment installation record indicating date of installation and tag number of each piece of equipment.
- 6.8 LSTK CONTRACTOR shall furnish an equipment maintenance record indicating date and type or maintenance of each piece of equipment during the LSTK CONTRACTOR period.
- 6.9 LSTK CONTRACTOR shall fill out checklists as required by OWNER.

7.0 **LIFTING, LIFTING EQUIPMENT AND GEAR**

- 7.1 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.
- 7.2 LSTK CONTRACTOR shall only perform the lifts and movements in accordance with approved LSTK CONTRACTOR submitted rigging studies and plans.
- 7.3 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.

7.4 **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.

7.5 **Operation**

- 7.6.1 LSTK CONTRACTOR shall not permit a lifting appliance to be operated otherwise than by a person trained and competent to do so.

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7.6.2 LSTK CONTRACTOR shall take express steps to ensure that all personnel employed by LSTK CONTRACTOR are competent and experienced for their assigned tasks.

8.0 **WELDING**

Welding of or on equipment shall only be permitted with the approval of OWNER.

9.0 **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.
- b) Identification of cables
- c) Fixing of cable to tray / rack

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- 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.
- 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.
- 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.

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- 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.
- 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 Contractor.

- 2.1.2 LSTK CONTRACTOR shall install all instruments as listed in the instrument index and further

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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)
- Stilling Wells.
- Thermo wells and etc.
- Installation of process connections, impulse lines and capillaries.

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- 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.
- 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.

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- 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.
- 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

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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.

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.

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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 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.

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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

- 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.

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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**

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.

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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.

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 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

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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
 - 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.

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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

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 as per std/drg/spec approved by client.

For more details LSTK CONTRACTOR shall follow **Instrument design philosophy elsewhere mentioned in ITB.**

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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

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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
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 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.

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- 1.4 **LIMITATIONS**
 Temperature Limits.
 This standard deals with insulation applied externally on piping equipments etc. as per the table below:-
 Maximum Operating Type of
 Temperature 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 : 45°C
 Permissible Heat Loss : 100 kcal./m² 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/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
- 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).

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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 LTSK'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

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/m3 conforming to IS:8183.
For operating temperature 401-450 deg.C,	Rockwool Mattress of density 150 kg/m3 conforming to IS:8183.
For operating temperature 451-500 deg.C,	1st layer insulation shall be 25mm Ceramic Fibre Blanket of density 128 kg/m3 conforming to IS :15402 and balance layers with Rockwool Mattress of density 150 kg/m3 conforming to IS:8183.
For operating temperature 501-550 deg.C	1st layer insulation shall be 50mm Ceramic Fibre Blanket of density 128 kg/m3 conforming to IS :15402 and balance layers with Rockwool Mattress of density 150 kg/m3 conforming to IS:8183.
For operating temperature	1st layer insulation shall be 75mm Ceramic Fibre

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551-600 deg.C,	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 Mineral2 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 Mineral1 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.

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	ASTM C177

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	0.043 W/(m.K) @ 371°C	
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	

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

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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			
li	External Top Cover Fabric (for cold face)	Polymer Coated Fibre Glass fabric Temp. resistance 300 Deg. C, oil & water resistant			
lii	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			
li	Thickness	25 – 100mm			
lii	Bulk Density	128kg/m3			
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	SiO2%		49-58	
		Al2O3%		41-48	
		ZrO2%		0-7	
		FeO3%		<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			

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		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:

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.

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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 (+85°C if sheet or tube is glued to the object with its whole surface)	EN 14706
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

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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, Smoke Developed Index ≤50	ASTM E84
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.

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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 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

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- 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.

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

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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 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.

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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.

5.3.4 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.

- The CONTRACTOR shall undertake immediate replacement of insulation material damaged in transit, storage or application, at no additional cost to Owner.

8.0 Vendor List (Supply & Application)

Sl.No.	Name of Vendors
1	LLOYDS INSULATION(I) LIMITED
2	INSULREF TECHNOLOGIES PRIVATE LIMITED
3	POINEER INSULATION
4	G+H INSULATION INDIA PVT.LTD.
5	NEWKEM ENGINEERS PVT LTD
6	ASSOCIATED INSULATION COMPANY
7	POLYBOND INSULATION PVT.LTD.
8	ALP AEROFLEX INDIA PVT. LTD.
9	ARMACELL INDIA PVT. LTD. (ARMACELL ENGINEERED SYSTEMS) (Upto Rs. 3.0 Crore (For supply & application of Insulation & Acoustic Works).)
10	AMOL DICALITE LIMITED (For Supply & Application of Perlite Block & Pipe Section)
11	HI-TEC ROCK FIBRE PVT. LTD. (Upto Rs. 2 Crore For the supply of Thermal Insulation materials only).)
12	HYDERABAD INDUSTRIES LTD (For calcium silicate only)
13	SHARAD INSULATIONS & INTERIORS PVT LTD (upto Rs 1.0 Crore)
14	TECHNO ELECTRIC & ENGINEERING CO. LIMITED

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ANNEXURE- 7 - 2H

PAINTING 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:

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.

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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:

- Instructions for storage to avoid exposure as well as extremes of temperature.
- Surface preparation prior to painting.
- Mixing and thinning.
- 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.

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

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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.

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 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.

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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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.

4.1.2 General Requirements for Site Application

Paint shall be stored only in accordance with the manufacturer's instructions.

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.

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.

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4.1.3 Qualifications and Materials

All surface preparation, coatings application and inspection, shall be carried out by personnel experienced in that particular field

4.1.4 Handling and Transport

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.

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.

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 5°C (depending on local condition)
- The metal temperature is less than 3°C above the dew point.
- There is likely hood of an unfavourable change in weather conditions within two hours after painting.

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.

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.

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

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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.

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.

4.4 Damaged or Inaccessible Surfaces

4.4.1 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**.

4.4.2 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;
 - 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.

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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:

- Washing with clean water (Pressure 7 Kg/cm²) using suitable nozzles. During washing, broomcorn brushes shall be used to remove foreign matter.

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.

4.8 Paint Storage: As per manufacturer instruction.

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° 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° C to 200° 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,	Blast cleaning to near white	P1 : One coat of Ethyl Silicate zinc rich with	P1 : 75 microns	Total dry film thickness of paint	

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Ref No.	Application	Surface Preparation	Generic Coating System	Minimum DFT	Remarks	
	valves with operating temp. Over 200° C.	metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	solvent Primer 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.	system: 125 microns.	
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	P1 : 75 microns F3 : 2 x 25 microns for each coat	Total dry film thickness of paint system: 125 microns.	

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Ref No.	Application	Surface Preparation	Generic Coating System	Minimum DFT	Remarks
			mixed Aluminium Paint.		
09	Uninsulated 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).	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.
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,	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.

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Ref No.	Application	Surface Preparation	Generic Coating System	Minimum DFT	Remarks	
	walk ways etc.).					
14	For external surfaces of flue ducts, metal stacks, and similar with operating temp. Above 200°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.	
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	Blast cleaning to near white	P2 : ONE coat of two pack zinc rich epoxy	P2 : 60 microns	Total dry film	Total dry film

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Ref No.	Application	Surface Preparation	Generic Coating System	Minimum DFT	Remarks	
	(External Surface including all stair ways)	metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	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	F1 : 120 – 200 microns F5 : 60 microns	thickness of paint system: 240 microns as per C4 – High Durability	thickness 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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Ref No.	Application	Surface Preparation	Generic Coating System	Minimum DFT	Remarks	
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 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.	
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 alloy Steel. (Upto 200 Deg. C)	Lightly Blast cleaned as per Sa 1.0 Swedish Standards SIS-	F8 : Two coats of high temperature epoxy phenolic (novolac)	F8 : 2 x 125 microns	Total dry film thickness of paint system: 250 microns	

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Ref No.	Application	Surface Preparation	Generic Coating System	Minimum DFT	Remarks
		05-5900 (Latest).			
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 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

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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

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

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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.

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%

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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 - Accelerated weathering	:	Gloss retention: approx. 80 % and colour change approx. DE 1.2 after 3000 hours 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.

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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.

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

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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
- 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	"

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Description	Colour	Ra1	Correspond. Asian Paint colors to be defined – See Note-2
- 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	“
- 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.**

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.

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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 air bone 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.

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.

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)

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)

- Storage Tanks A – 60 mm
- Equipments and piping with O.D. above 600 mm A– 40 mm and
- Equipments and pipings with O.D. from 300 to 600 mm and for machinery of great dimensions A – 20 mm

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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
14" OD & above	100

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

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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

1.1 LSTK CONTRACTOR shall provide a quality control program manual include specific WORK methods and inspections, which assure quality.

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.
- 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.
- Internal cleanliness.
- Proper material use and control.
- Nondestructive testing and its results.
- Workmanship.

3.0 CHECK ON QUALITY OF WORK

3.1 OWNER'S REPRESENTATIVE'S inspector shall have free access to the place where the

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WORK is performed at all times, in order to check the quality of WORK

4.0 **CONTROL SYSTEMS**

LSTK CONTRACTOR shall initiate and maintain the following control systems.

5.0 **Backfilling**

- Compaction tests.

6.0 **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.

7.0 **Asphalt**

- Design mix and approval records.
- Batch plant inspection records. Placement inspection records.

8.0 **Piping**

- Weld x-ray file.
- Pipe and fitting certificate file.
- Isometric weld control sheet. Hydrostatic test records.

9.0 **Grounding**

Earth resistance test records.

10.0 **Electrical Cable and Instrument cable**

- Insulation resistance test records.
- Continuity test records.

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ANNEXURE- 7 – 4

SCHEDULE, PROGRESS EVALUATION AND PROGRESS REPORTING

1.0 GENERAL

1.1 WORK shall start and be completed in the field as indicated on the approved project construction schedule.

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.
- ☐ 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.

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- ☐ 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.

6.0 CONSTRUCTION ACTIVITIES STATUS

This section consists of scheduled versus actual progress curves.

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.

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.

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.

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ANNEXURE- 7 – 5

EXECUTION PLAN

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.

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.

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.

2.0 Job descriptions and personnel resumes

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

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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.**

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.

8.0 QA/QC Program

Bidder shall furnish a summary description of their proposed QA/QC program.

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.

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 :

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ANNEXURE-7-6

Minimum Qualification & Exp. Of Key Supervisory Construction Personnel

SL. NO.	CATEGORY	QUALIFICATION & EXPERIENCE
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

For and on behalf of

Stamp & Signature :

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ANNEXURE-7-7

Deployment Schedule of Supervisory Personnel

SL. NO.	DESCRITPTION	DEPLOYMENT SCHDULE																										
		1	2	3	4	5	6	7	8	9	10	.	.	.	..	..	.	.	..	.	..	.	.	..	35	36	37	TOTAL
1	PROJECT MANAGEM ENT																											
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																											
2.3.6	INSTRUMENTA-TION																											



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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																											
4.3	WELDING TRANS FORMERS/RE C-TIFIERS																											

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		
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	TRANSPORTA-TION 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																									
13.4	CONCRETE PUMP CAR																									
13.5	TRANSIT MIXER																									
13.6	MIXER																									

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				
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	SPECTROMETERS																											

For and on behalf of :...

Stamp & Signature :

Name :

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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-7.0



PERFOMANCE & GUARANTEE TEST

IMPLEMENTATION OF ZERO LIQUID DISCHARGE (ZLD) UNIT

AT

RAMAGUNDAM FERTILIZERS AND CHEMICALS LIMITED (RFCL),

TELANGANA, INDIA

<div><div>पी डी आई एल PDIL</div></div>	IMPLEMENTATION OF ZERO LIQUID DISCHARGE (ZLD) UNIT AT RFCL, RAMAGUNDAM PLANT PERFORMANCE GUARANTEE	PC211/E/001/P-II/Sec-7.0	0	<div><div>रामगुंडम परीक्षण एवं बीजकाल अभियंत्रण</div></div>
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1.0 PERFORMANCE GUARANTEES:

1.1 Performance Guarantees:

1.1.1 ZERO LIQUID DISCHARGE PLANT (ZLD):

LSTK Contractor shall guarantee performance of RO based treatment plant and evaporator system separately as specified in this Clause under the following heads:

1. Sustained Load Test Guarantee
2. Capacity of the plant
3. Quality of the treated water.
4. Total Power consumption excluding plant lighting (as metered at the Energy meters for the plant)
5. Total Steam consumption.
6. Total Chemical consumption.
7. Turn down.
8. Noise Level



Failure to meet capacity of the plants or quality of the treated water shall be breach of contract requiring corrective action by LSTK contractor irrespective of the cost involved. For further details, refer commercial NIT.

1.1.2 RO based Treatment plant with Evaporator system (ZLD):

LSTK Contractor shall guarantee performance of ZLD system for the following:

1. Capacity of RO Based Treatment plant (i.e. 300 m³/hr - Net)
2. Total Chemical consumption.
3. Turndown.
4. Noise level less than 85 db.
5. Total Power consumption excluding plant lighting (as metered at the Energy meters for the plant).
6. Quality of treated water are as given below:

Treated Water Quality from ZLD System:

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a. HRSC clarifier

Clarified water total suspended solid 10 ppm
Sludge consistency Bidder to indicate.

b. DMF

Filtered water total suspended solid 1.0 ppm.

c. UF membrane



SDI <3.0

d. RO-1/RO-2

Sr. No.	Parameters	RO-1 permeate	RO-2 permeate
1.	pH	7-8.5	7-8.5
2.	Total suspended solids, ppm	NIL	NIL
3.	Total dissolved solids, ppm	100	150
4.	Total hardness as CaCO ₃ , ppm	*	*
5.	Ca hardness as CaCO ₃ , ppm	*	*
6.	Mg hardness as CaCO ₃ , ppm	*	*
7.	Mo alkalinity as CaCO ₃ , ppm	*	*
8.	Chloride as Cl,	*	*
9.	Sulphate as SO ₄	*	*
10.	Total iron	*	*
11.	Sodium as Na	*	*
12.	Potassium as K	*	*
13.	Reactive silica as SiO ₂	*	*
14.	colloidal silica as SiO ₂	BDL	BDL
15.	Organic matter as KMnO ₄	*	*
16.	Recovery min.	80% ,	70%

Figures marked as * are to be indicated by Bidder based on the actual RO membrane projections. In case of consideration of RO-3 train for optimization of ZLD (i.e. MVR) capacity, recovery shall be min 50%. Guaranteed Quality of permeate water from RO-3 train will be same as mentioned for RO-2.

Bidder shall submit material balance based of all parameters at the Inlet & outlet of all equipment at the time of bidding with detailed calculation.

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7. MVR type Evaporators

Solid waste consistency, Minimum 50%

Process condensate TDS: 300 ppm.



Final salt from Evaporator System shall be Free Flowing powder form.

8. Operating cost:

SI.No	Raw Material/ Utilities	Unit Price in Rs.	Consumption per day for required capacity as per Specification	Cost Rs. per day
1.	Hypo Solution , 10 % kg	26	-----Kg/day	
2.	PAC(Poly aluminium chloride) Dosing, 100%, Kg	19.53	-----Kg/day	
3.	FeCL3, 40%Kg	7	-----Kg/day	
4.	Slaked lime Dosing, 90% kg	9.44	.....Kg/day	
5.	Dolomite Dosing 60%,Kg	3.6	-----Kg/day	
6.	Anti scalant 100% kg	60	.....Kg/day	
7.	SMBS as 40 % kg	65	.....Kg/day	
8.	HCl as 100% kg	0.1	.....Kg/day	
9.	NaOH as 100% kg	45.45	.....Kg/day	
10.	Polyelectrolyte, as 100%kg	207	.....Kg/day	
11.	Citric Acid as 100%Kg	80	.....Kg/day	
12.	Oxalic Acid as 100% Kg	70	.....Kg/day	
13.	Nitric Acid as 100% Kg	80	.....Kg/day	
14.	Soda Ash as 100%Kg	40	.....Kg/day	
15.	Power, kWh	15	.....KWh/day	
	Guaranteed operating Cost			

Note: All Guaranteed Consumptions including power & chemicals and Cost shall be indicated in price schedule.

1.1.3 Bidder shall submit following documents in the technical bid:

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- ◆ Details of Treatment process indicating various chemical reactions & chemicals required for treatment processes.
- ◆ Details of MVR system.
- Indicative chemical consumption along projections from membrane supplier.
- Power, Steam consumption (for start-up) & chemical requirement for evaporator supplier.
- Expected power consumptions of all pump & drives.

1.2 **Conditions for Guarantees:**

For proving the performance guarantees, the following shall be provided by Owner to the LSTK Contractor.

1.2.1 Raw materials and utilities in sufficient quantities conforming to the range of specifications supplied to LSTK Contractor by Owner and used as the design basis for ZLD system.



1.2.2 ZLD shall operate under the direction and supervision of LSTK Contractor as defined in operating manuals to be supplied by LSTK Contractor/process licensors.

1.3 **Consumption of Raw Materials & Utilities:**

Consumption of raw materials and utilities shall be measured and calculated as per figures indicated by various calibrated instruments. **No instrument tolerance is acceptable during guarantee test and / or different operational phase.** The guaranteed figures shall be inclusive of all instrument tolerances. All measurement instrumentation shall be part of the system/ plant installed by the LSTK Contractor and no special instrumentation for the purpose of guarantee tests shall be required.

1.4 **Sustained Load Test / Trial run Guarantee:**

The contractor guarantees that the Sustained Load test described in this clause will be successfully completed. During the Sustained Load Test the contractor will demonstrate that the complete ZLD system including RO based Treatment plant operate for a minimum of 30 days at an aggregate output of min. 95% of the rated capacity.

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If the contractor fails to achieve any of the requirements of this test, contractor shall remedy the Works to achieve the above guarantee, in a reasonable time frame, in consultation with Owner.

1.5 **Noise Level:**

LSTK contractor shall guarantee the noise level. Noise nuisance from machinery is normally specified as sound pressure level which for standard design shall not exceed, in work areas, 85dB (a) at 1m distance from each source.

2.0 **PERFORMANCE TESTS:**

2.1 **General:**

Performance tests shall consist mainly of two categories.



- i) Functional test.
- ii) Performance guarantee test.

2.1.1 **Functional test:**

The functional test shall be part of the Contractor's commissioning program. These tests shall be performed prior to offering the plant for Performance guarantee Test and Reliability Test. The plant shall be ready in all respects prior to commencement of the functional test. The individual functional test shall be demonstrated by the CONTRACTOR and witnessed by the OWNER/PDIL.

Functional test shall broadly cover, but not be limited to the demonstration of satisfactory functioning of the followings:

- a. Alarm, trip, remote/manual operation, process and safety interlocks, emergency shutdown of the system/ equipment in the plant.
- b. Automatic operation of the system controls, bumpless changeover of Auto/manual control and proper maintenance of the controlled variables within the desired band.
- c. Normal start-up & shutdown sequence of the Unit.
- d. Fail safe shutdown in the event of total power failure.
- e. Plant turndown max. 60% of design capacity without affecting the treated water quality.

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2.1.2 **Performance guarantee test:**

LSTK Contractor shall prove the performance guarantees tests of the RO based Treatment plant & Evaporator Units separately as specified in this clause under the following headlines:

- Sustained Load Test
- Guarantee Test

2.2 **Sustained Load Test / Trial Run:**

After Mechanical Completion has occurred, LSTK Contractor shall commence the Commissioning operations of each Plant separately. After Plant has been commissioned and at least near rated daily capacity has been achieved, LSTK Contractor's authorised representative shall give notice in writing to Owner that Plant is ready for a sustained load test. On receipt of this notice, but not later than 30 days after the notice, Owner shall conduct the sustained load test under the direct supervision of LSTK Contractor for a consecutive period of 30 days or less at the discretion of the Owner. The sustained load test of the composite plant shall be deemed to have been completed if Plant produces an average of not less than 95% of the daily rated capacity. If, during the sustained load test, there are interruptions due to reasons not attributable to the obligations and responsibilities of LSTK Contractor, periods of such interruptions shall be included and regarded as days of operation at min. 95% of design capacities or actual load prior to interruptions whichever is lower. The cumulative period of such interruptions shall be limited to a maximum of 3 days. Owner shall have option to reduce the period of sustained load test of 30 days. LSTK Contractor shall endeavour to complete the sustained load test within a reasonable period after Mechanical completion, but shall complete the same in any case within 120 days from Mechanical completion. If, during the sustained load test corrective measures are required and involve procurement of new items of Equipment or modification of items of Equipment which require longer period for delivery than covered by the 120 days period, the period shall be suitably adjusted as agreed with Owner. However, design engineering and placement of orders shall be completed within 120 days from Mechanical completion. On satisfactory completion of the sustained load test, the results achieved shall be tabulated and jointly signed by LSTK Contractor's and Owner's representatives within ten days of completing the sustained load test. During the sustained load test no standby items of Equipment shall be used in parallel for completing the test.

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Contractor shall also demonstrate for a period of 24 hrs, minimum turndown capacity without sacrificing product quality.

2.3 **Notice of Guarantee Test:**



On successful completion of the sustained load test, LSTK Contractor shall give notice in writing for commencing the guarantee test. On receipt of the notice but not later than 15 days after the notice, Owner shall conduct the guarantee test under the direction and supervision of LSTK Contractor. During the guarantee test, no stand by items of Equipment shall be used in parallel for proving the guarantee. The range of operating conditions shall be within the design conditions.

2.4 **Guarantee Test:**

After the system has been stabilized by the contractor during sustain load test runs, the contractor shall conduct a performance guarantee test run for the package systems after successful commissioning of the plants. The procedure for performance testing shall be submitted to the PDIL/ Owner for review & approval.

LSTK Contractor shall give the guarantee test for individual plant or Combination of any as per discretion by Owner/PMC. The guarantee test shall be carried out for 5 (Five) continuous days without any interruption. In determining the ability of the plant to meet the guarantees all feed rates, product rates and quality, and utility consumption shall be averaged over a period consisting of best continuous 72 hours selected out of the 5 (Five) days test period. The 72 consecutive hours period shall exclude periods during the test when the operating conditions are other than those recommended or approved by LSTK Contractor or periods of noncooperation due to failure of Equipment, lack of sufficient feed or utilities, or any other cause beyond the control of LSTK Contractor including the period required to bring plant back to operation at the rate of production achieved prior to the upset. For the purpose of computing the average performance, LSTK Contractor shall select any best continuous 3 days out of the 5 days test period so long as this includes a continuous and uninterrupted run of 72 (Seventy Two) hours and the aggregate total hours of interruptions do not exceed 48 hours.

LSTK Contractor shall be given the max. 3 nos. chance for PGTR. LSTK Contractor's authorised representative shall give notice in writing to Owner that Plant is ready for a Guarantee Test. On receipt of this notice, and confirmation by PMC/Owner, LSTK Contractor shall conduct the guarantee test for consecutive period of total 5 days for all combination of plants AND/OR Single unit as per mutual discussion with Owner/PMC. In case of failure

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(beyond acceptable limits/ parameters where Mutually Agreed Damages' are levied) of 1st Guarantee test, the LSTK Contractor, within 15 days from the beginning of the 2nd guarantee test, shall give a full and detailed statement in writing to OWNER. The statement shall contain the detailed description and corrective measures which LSTK Contractor intends to take and the time required for the same to be completed and a repeat guarantee test to be made.

LSTK contractor shall wherever possible shall carry out such corrective measures and repeat the guarantee test within the shortest possible time, but not later than 30 days (or for such time as may be mutually agreed between owner & LSTK contractor) from the beginning of the first guarantee test unless otherwise agreed with Owner. Further, refer Commercial clauses.

During the Guarantee Test Run, the Production capacity of the plants & Specific works cost shall be guaranteed.

2.5 **Measurements during Guarantee Test:**



For determination of the average performance achieved during the guarantee test, all inputs and outputs shall be measured through appropriate meters specified and installed in plant by LSTK Contractor and jointly calibrated and certified to be correct by LSTK Contractor and Owner. No metering tolerances shall be allowed. LSTK Contractor shall have all measurements and records certified by Owner during the test.

2.6 **Inconsistent Measurements:**

If any measurement is demonstrably inconsistent with the bulk of the data, or is otherwise suspected to be incorrect, then the data will be adjusted, to achieve consistency and correctness in accordance with generally accepted engineering principles and practice as mutually agreed by Owner and LSTK Contractor. No other adjustments shall be made on the measurements and data recorded during the guarantee test.

2.7 **Deviations from Specifications:**

In the event that the Effluent water or any other conditions is not in accordance with conditions specified or referred to in Contract and are prejudicial to LSTK Contractor or Owner as demonstrated by LSTK Contractor or Owner, Owner and LSTK Contractor shall mutually, reasonably, and in good faith negotiate an adjustment to the performance guarantees. Any such adjustments to the performance guarantees shall be made utilising

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the same methods of calculation as were used in establishing the original performance guarantees to the extent such methods continue to be applicable in accordance with good engineering principles and practice.

2.8 **Guarantee Test Results:**

Within a reasonable period of time but not later than 15 working days from the completion of the guarantee test, Contractor shall determine the results thereof and if in LSTK Contractor's judgement, the performance guarantees have been achieved, submits its calculations and report to Owner for Owner's acceptance. Owner will review the report, calculations and the supporting data and accept the same in writing, if the results are in accordance with the provisions of this Section. In case, Owner does not accept the performance guarantee results, Owner shall indicate in writing to LSTK Contractor in what respect the performance guarantees have not been met, within 15 working days of receipt of the report by Owner from the LSTK Contractor. In the event of rejection of Guarantee test results by Owner, LSTK Contractor shall take immediate actions to set right as per the provisions of the contract and repeat guarantee test to the satisfaction of the owner.

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PART II: TECHNICAL

SECTION – 8.0



DRAWINGS & DOCUMENTS

IMPLEMENTATION OF ZERO LIQUID DISCHARGE (ZLD) UNIT

AT


RAMAGUNDAM FERTILIZERS AND CHEMICALS LIMITED (RFCL),

TELANGANA, INDIA

 पी डी आई एल PDIL	IMPLEMENTATION OF ZERO LIQUID DISCHARGE (ZLD) UNIT AT RFCL, RAMAGUNDAM PLANT PROJECT DESCRIPTION	PC211/E/001/P- II/Sec-8.0	0	 रामगुंडम रिफ़्लेक्टिंग एवं सिविल लिमिटेड
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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 LSTK Contractor for different project activities. Categorization of the documents/ drawings for review/ information/ records of PMC and the review/ approval requirements of the Owner/ PMC along with routing of the documents/ drawings will be conveyed separately as a philosophy.

The efficient handling of drawings and documents to be prepared by the LSTK Contractor under the contract is the key to the timely completion of the plants. The LSTK Contractor undertakes to ensure that all drawings and documents to be submitted by him to the Owner/ PMC shall be of professional quality and conforming to the contractual requirements. The LSTK Contractor also undertakes to institute a formal drawing control system which will be documented and submitted to the Owner/PMC for review or approval.



Compliance of this chapter on drawings and documents is mandatory and is non-negotiable.

The drawings / documents are to be generated by the LSTK 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 LSTK Contractor of responsibility to conform to drawings, standards, specification, codes and contractual requirements / obligations.

The LSTK Contractor shall prepare the drawing numbering procedure and submit to Owner/ PMC for approval. Each Drawing submitted by the LSTK Contractor shall be clearly marked with the name of the Owner, PMC with revision number & date. It should contain the minimum following details:

- Size of Drawing.
- Discipline of Engineering for which the drawing is issued.
- Discipline wise segregation of numbering sequence for example:
100 Series for Process. 200 Series for Mechanical etc.

For drafting of Drawings, Computer aided design and drafting, AutoCAD 2015 shall be used. Further, standard, approved and well established P.C. based computer programmes/software packages, available in market shall only be used by the LSTK Contractor/his subcontractors/vendors etc. The LSTK Contractor shall bring out the list of all such packages in the offer for each discipline for evaluation of bid. Every time a computer aided design is

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submitted for review/ approval to Owner/PMC, it shall accompany with input/output data on Compact disc (CD) along with the name of the software package and operable on any system along with the requisite No. of Hard Copies (specified elsewhere in the Bidding document).

For drawing, data sheet and all graphic works Auto CAD 2015 and for all texts, MS Word Package 2012 shall be used. Hard Copies (4 nos.) and Soft Copies of all calculations & Drawings shall be made available by the Contractor for PMC review. Line List, Data Sheet & spread sheets shall be provided in MS Excel & all text items shall be in MS Word. All other documents like presentations etc. and other data shall be in MS Office; the required operating system for Data Exchange shall be at least Windows.

All documents before forwarding to Owner/PMC will have to be vetted in detail by the LSTK Contractor/duly approved engineering sub-contractor appointed by the LSTK Contractor. Document received without vetting will be returned.



The review by the PMC/Owner shall not be construed by the LSTK 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 LSTK Contractor shall be clearly marked with the name of the 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 LSTK 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.

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 LSTK Contractor for approval of Owner/PMC. 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 Owner/ PMC and responsibility of timely execution of plant shall be to the LSTK Contractor's account.

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2.0 CATEGORY OF DOCUMENTS

Category	Description	Action by Owner/ PMC
1	Records/ Information	LSTK Contractor can continue to progress with the work. This drawings or documents will be retained with Owner/PMC for information only. Owner/ PMC reserves the right to advise the LSTK Contractor of any comments (deviations from the contract) at any time and the LSTK 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>Owner/PMC will review and advise the LSTK Contractor of any Comments on Contractor's Drawings / documents within specified schedule (ie 2 weeks), from date of receipt in PMC office of LSTK Contractor's drawings/documents. The review period is defined as date of receipt of documents by PMC, to date of issue of comments by PMC. This review period shall be valid only if submission of drawings is done by LSTK Contractor in accordance with approved drawings / documents schedule as indicated in ITB. In case of any non-conformity to the above by LSTK Contractor due to which the period of review extends beyond 2 weeks by the PMC, 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

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 Owner/PMC reserves the right to comment at any stage of the Project, but not later than two weeks of receipt.

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Where clearance of Owner/ PMC 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 LSTK Contractor to obtain acceptance on all the technical documents and accepted copy only to be forwarded to Owner / PMC. Any inaccuracies /omissions/inconsistencies noticed and brought to the notice of the LSTK Contractor at any stage of the project will be rectified/ replaced by LSTK Contractor without any cost & time implication to the Owner/ PMC. Detailed manufacturing schedules of fabricated/ manufactured items shall be submitted within one month of ordering, Status report for all the items in detail, will be submitted once in a month.

Documents to Boiler Regulation authorities shall be submitted and getting the documents reviewed by PMC/Owner. To any other agencies, documents shall be submitted under intimation to PMC/Owner.



As built drawings and documents will be generated within one month of completion of activities on respective items of work.

As Built Drawings:



LSTK Contractor will furnish reproducible and electronic files of all the drawings under their scope to Owner / PMC, certified as "As-Built Issue" by Third Party Inspection Agency (TPIA) for Vendor Items coming under Third Party Inspection / LSTK 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:

- a. One complete set of all original tracings copies.
- b. One complete set of reduced size (A3-297x420 mm) copies of all drawings.
- c. One set of CD for all documents/drawings/data
- d. All the as built drawings duly certified should be scanned and converted into electronic files made on magnetic/discs/optical long storage.
- e. 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.



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- f. 3 complete sets of full size prints of the drawings and 4 sets of reduced size prints.
- g. 3 complete bound sets of Manufacturer's specifications including design calculations.
- h. 3 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.
- i. 3 bound copies each of the Spare Parts data books and the Lubricants inventory Schedule.
- j. 3 complete sets of field records shall be signed by both the Contractor's and Owner's Representative at the site.
- k. Original approvals and related drawings and documents from the statutory authority.
- l. Copies of correspondence with the statutory authorities.

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3.0 PROCEDURE

The procedure for compilation of final as-built documents / drawings shall be informed later. However the Procedure for routing the final / as built documents/ drawings to PMC / Owner shall be informed during the execution stage.



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4.0 LIST OF DRAWINGS & DOCUMENTS



No.	Name of Document	With Bid	Drawings/Documents Required After Award of Contract		
			For review/ approval	For information	Final Approved/ As-built
A	MECHANICAL STATIC EQUIPMENT				
STORAGE TANK					
1.1	General arrangement drawings indicating design data , fabricated equipment weight, general notes, nozzle schedule, details of shell, supporting arrangement , main weld seams ,nozzle orientation plan etc.	N	Y	-	Y
1.2	Bottom And Annular Ring Layout & Weld Detail	N	Y		Y
1.3	Detail of sump for drain nozzles	N		Y	Y
1.4	Shell plate layout (showing location of nozzles and manhole)	N		Y	Y
1.5	Mechanical design calculations complying with the specifications and codes.	N	Y	-	Y
1.6	Detail of wind girder	N	Y	-	Y
1.7	Stairways, intermediate & top plate form	N	-	Y	Y
1.8	Roof plate layout & weld detail	N	Y	-	Y
1.9	Detail of nozzles on shell & roof	N	-	Y	Y
1.10	Details of internals like guide rollers, roof stoppers, still wells, dip pipe, heating coil e.t.c	N	-	Y	Y
1.11	Materials test certificates duly stamped by inspecting authority (**)	N	-	-	Y
1.12	QAP & inspection and test plan (**)	N	Y	-	Y
1.13	Welding procedure and qualification test reports (**)	N	-	Y	Y
1.14	Destructive and non destructive procedure & test reports (**)	N	-	Y	Y
1.15	Heat treatment. Hydrotest procedure and time temperature charts (**)	N	-	Y	Y
1.16	Records of vacuum box test, spark test for rubber lining, plumpness, roundness, peaking, banding etc. (**)	N	-	Y	Y
1.17	Radiographic examination reports & films (**)	N	-	-	Y
1.18	All final as- built shop drgs. & design calculations	N	-	Y	Y

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No.	Name of Document	With Bid	Drawings/Documents Required After Award of Contract		
			For review/ approval	For information	Final Approved/ As-built
1.19	Completion certificates (including inspection certificates, hydrostatic test certificate , local code requirements) (**)	N	-	Y	Y
1.20	Inspector's final certificate (**)			Y	Y
1.21	1. Final civil load data including details of foundation/anchor bolts 2. Foundation settlement check record (**)	N	-	Y	Y
1.22	List of spare parts and details	N	Y	-	Y
PRESSURE VESSEL					
1.1	General arrangement drawings indicating design data , fabricated equipment weight, general notes, nozzle schedule, details of shell, heads supporting arrangement , main weld seams ,nozzle orientation plan etc	N	Y	-	Y
1.2	Detail of nozzles, manholes, accessories etc.	N	-	Y	Y
1.3	Detail of internals such as tray, tray support ring, bolting bars etc.	N	-	Y	Y
1.4	Detail of demister	N	Y	-	Y
1.5	Thermal, Mechanical & Structural Design calculations, Hydrodynamic calculation for Internals including fabrication drgs. of main equipment & Internals complying with the specifications and codes.	N	Y	-	Y
1.6	Detail of packing support, demister support, grating & grating support	N	Y	-	Y
1.7	Detail of internal distributor	N	Y	-	Y
1.8	Detail of external clips such as ladder, platform, pipe support	N	-	Y	Y
1.9	Detail of insulation ,fireproofing	N	-	Y	Y
1.10	Detail of pipe davit	N	-	Y	Y
1.11	Detail of lifting lug, tailing lug & trunion etc. including design calculation	N	-	Y	Y
1.12	Shell development drawings incorporating all attachments and weld seams	N	-	Y	Y
1.13	All final as- built shop drgs. & design calculations	N	-	Y	Y
1.15	Data folder as per specification	N	-	Y	Y

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No.	Name of Document	With Bid	Drawings/Documents Required After Award of Contract		
			For review/ approval	For information	Final Approved/ As-built
1.16	Materials test certificates duly stamped by inspecting authority (**)	N	-	-	Y
1.17	QAP & inspection and test plan (**)	N	Y	-	Y
1.18	Welding procedure and qualification test reports (**)	N	-	Y	Y
1.19	Destructive and non destructive procedure & test reports (**)	N	-	-	Y
1.20	Heat treatment, Hydro test procedure and time temperature charts (**)	N	-	Y	Y
1.21	Radiographic examination reports & films (**)	N	-	-	Y
1.22	Records/ drawings, charts duly approved, signed and stamped by Statutory Authorities (**)	N	-	-	Y
1.23	Completion certificates (including inspection certificate, hydrostatic test certificate , local code requirements)	N	-	-	Y
1.24	Inspector's final certificate (**)	N	-	-	Y
1.25	Packing and forwarding instruction (**)	N	-	-	Y
1.26	Transportation drawing showing overall dimension, C.G. weight and handling instructions duly approved by appropriate authority	N	-	Y	Y
1.27	Final civil load data including details of foundation/anchor bolts	N	-	Y	Y
1.28	List of spare parts and details	N	Y	-	Y
HEAT EXCHANGERS					
5.1	General arrangement drawings indicating design data , fabricated equipment weight, general notes, nozzle schedule, details of shell, heads supporting arrangement , main weld seams ,nozzle orientation plan etc.	N	Y	-	Y
5.2	Details of tube sheet & tube layout.	N	Y	-	Y
5.3	Details of nozzles and exchanger support	N	-	Y	Y
5.4	Details of gaskets	N	Y	-	Y
5.5	List of spare parts and details	N	-	Y	Y
5.6	Final civil load data including details of foundation/anchor bolts	N	-	Y	Y

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No.	Name of Document	With Bid	Drawings/Documents Required After Award of Contract		
			For review/ approval	For information	Final Approved/ As-built
5.7	Mechanical design calculations complying with the specifications and codes.	N	Y	-	Y
5.8	Welding procedure and qualification test reports (**)	N	-	Y	Y
5.9	Transportation drawing showing overall dimension, C.G. weight and handling instructions duly approved by appropriate authority	N	-	Y	Y
5.10	Destructive and non destructive procedure & test reports (**)	N	-	Y	Y
5.11	Heat treatment, Hydrotest procedure and time temperature charts (**)	N	-	Y	Y
5.12	Procedure for repair of damaged tubes (**)	N	-	Y	Y
5.13	QAP & inspection and test plan (**)	N	Y	-	Y
5.14	Records of NDT tests e.g. radiography, ultrasonic testing(UT), magnetic partical / Penetrant testing (MP/PT), hardness etc. (**)	N	-	-	Y
5.15	Materials test certificates duly stamped by inspecting authority (**)	N	-	Y	Y
5.16	PWHT charts (**)	N	-	Y	Y
5.17	Test on production test coupons (**)	N	-	-	Y
5.18	Hydraulic/pneumatic test reports (**)		-	-	Y
5.19	Mock-up test for tube to tube sheet joint (**)		-	-	Y
5.20	All final as- built shop drgs. & design calculations	N	-	-	Y
5.21	Radiographic examination reports & films (**)	N	-	-	Y
5.22	Mechanical guarantee certificate	N	-	-	Y
5.23	Inspector's final certificate (**)				Y
5.24	Packing and forwarding instruction (**)	N	-	-	Y



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No.	Name of Document	With Bid	Drawings/Documents Required After Award of Contract		
			For review/ approval	For information	Final Approved/ As-built



LEGEND: Y – Yes, N – No

Notes :



1. Final documentations shall be supplied in hard copies as well as soft copies in Pen drive, CD Formats. Applicable Software are MS Office 2000, Word, Access, and Excel.
2. Document marked as (**) are to be approved by authorized Third Party Inspection Agency and Statutory Authorities as applicable.
3. Final documentation shall be supplied in hard copies (6 prints) and soft (Two Pen drive, CDs) in addition to Submission through email.
4. All drawing & documents shall be submitted in A0/A1/A2/A3 or A4 paper size. Documents in higher paper size shall be submitted in exceptional circumstances or as indicated in MR/Tender.
5. Bill of material (showing part no. MOC, Size, quantity, weight of each part) shall form part of the respective drawing.

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B	ROTARY				
SN	Description	With Bid (Y/N)	For Review/ Approval	For Information	Final/ Approved / As-built
	PUMPS				
1.0	General Description and Equipment List	Y	Y	-	Y
2.0	List of drawings / documents including drawing number, revision number, description and approval status	N	Y	-	Y
3.0	Detailed manufacturing programme (Time bar chart)	N	Y	-	Y
4.0	Certified dimensional outline drawing	N	Y	-	Y
5.0	Cross sectional drawing and bill of material	N	Y	-	Y
6.0	Shaft seal drawing and bill of material	N	Y	-	Y
7.0	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
8.0	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
9.0	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
10.0	Lube oil schematic and bill of materials	N	Y	-	Y

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11.0	Lube oil system arrangement drawing including sizes, rating and location of all customer connections	N	Y	-	Y
12.0	Lube oil component drawings data	N	Y	-	Y
13.0	Electrical and instrumentation schematics, wiring diagrams and bill of materials	N	Y	-	Y
14.0	Electrical and instrumentation arrangement drawing and list of components	N	Y	-	Y
15.0	Performance curves	N	Y	-	Y
16.0	Pump specification sheet with complete details in Performa enclosed with enquiry / order	N	Y	-	Y
17.0	Certified foundation assembly drawing of pump with driver & all accessories mounted on base plate with load diagram for foundation design	N	Y	-	Y
18.0	Engineering flow diagram showing: - Lubrication & sealing lines - Flushing / washing lines - Cooling / steam lines	N	Y	-	Y
19.0	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	Y	-	-	Y
20.0	Lube oil schedule	N	Y	-	Y
21.0	Automatic recirculation valve assembly drawing, sectional drawing with bill of material	N	Y	-	Y
22.0	Quality Assurance Plan.	N	Y	-	-

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23.0	Material test certificates and Inspection & performance test report along with dispatch clearance certificates from inspector	N	-	-	Y
24.0	Instruction manuals describing installation, operation and maintenance procedures	N	-	-	Y
25.0	Spare parts list	Y	-	-	Y
26.0	Parts catalogue complete with reference drawing nos. and sketches etc.	N	-	-	Y
FANS & BLOWERS					
1.0	General Description and Equipment List	Y	Y	-	Y
2.0	Specification sheets completely filled in proforma	N	Y	-	Y
3.0	Characteristic Curves - Performance curves, showing discharge pressure, capacity, and brake horse power at the inlet specified conditions (Pressure, capacity, temperature, molecular weight).	N	Y	-	Y
4.0	Spare parts list	Y	-	-	Y
5.0	Details of Lubrication and sealing system	N	Y	-	Y
6.0	Data for selection of motor :	N	Y	-	Y
	a) Type				
	b) HP absorbed at duty point				
	c) RPM				
	d) Recommended HP				
	e) Max. starting torque as % NRT				

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	f) GD2 figure for rotating mass of the Fan / Blower				
	g) Speed vs. Torque for the Fan / Blower				
7.0	General Arrangement Drawing with all main dimensions, size and location of connections for ducting with all horizontal & vertical clearance necessary for installation and disassembly.	N	Y	-	Y
8.0	Cross sectional drawing of fan with parts list	N	Y	-	Y
9.0	Instruction manual for erection, installation operation and maintenance of fan and its accessories (Important clearances to be maintained should be clearly specified).	N	-	-	Y
10.0	Q.A.P and Test procedure	N	Y	-	Y
11.0	Lubrication schedule	N	Y	-	Y
12.0	Reference list indicating duty condition, location, year of installation, name of client etc.	Y	-	-	-
13.0	GA drawing with all details & dims. Including fan, drive, motor	N	Y	-	Y

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	AGITATORS				
1.0	General Description and Equipment List	Y	Y	-	Y
2.0	Specification sheets completely filled in proforma.	N	Y		Y
3.0	General Arrangement Drawing with all main dimensions, size and location of connections for installation and disassembly.	N	Y		Y
4.0	Spare parts list	Y	Y		Y
5.0	Details of Lubrication and sealing system	N	Y	-	Y
6.0	Q.A.P and Test procedure	N	Y	-	Y
7.0	Instruction manual for erection, Commissioning operation and maintenance.	N	-	-	Y
8.0	Reference list indicating duty condition, location, year of installation and name of client etc.	Y	-	-	Y
	HVAC PACKAGE				
1.0	General Description and Equipment List	Y	Y	-	Y
2.0	List of drawings / documents including drawing number, revision number and description & approval status	N	Y	-	Y
3.0	Specification sheets - Completely filled in proforma.	N	Y	-	Y
4.0	General Assembly drawings - with main overall dimensions including those required for accessories and auxiliaries and all horizontal & vertical clearances for dismantling, direction of rotation etc.	N	Y	-	Y
5.0	Spare Part List	Y	Y	-	Y

<div> पी डी आई एल PDIL</div>	IMPLEMENTATION OF ZERO LIQUID DISCHARGE (ZLD) UNIT AT RFCL, RAMAGUNDAM PLANT PROJECT DESCRIPTION	PC211/E/001/P-II/Sec-8.0	0	<div> रामगुंडम पॉलिगंडम तथा बीएसएन डीपी</div>
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6.0	Description of Lubrication and sealing system	N	Y	-	Y
7.0	Manufacturing schedule, QAP	N	Y	-	Y
8.0	Cross-Sectional drawing of AC Plant and auxiliaries alongwith Bill of Materials	N	Y	-	Y
9.0	Instruction manuals for erection, commissioning, operation and maintenance of AC Plant and accessories.	N	-	-	Y
10.0	Material test certificates and inspection & performance test report alongwith despatch clearance certificates from inspector	N	-	-	Y
11.0	Reference list for similar types of AC Plant 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 along with operating conditions.	Y	-	-	Y
12.0	Lube oil schedule.	N	Y	-	Y

 पी डी आई एल PDIL	IMPLEMENTATION OF ZERO LIQUID DISCHARGE (ZLD) UNIT AT RFCL, RAMAGUNDAM PLANT PROJECT DESCRIPTION	PC211/E/001/P- II/Sec-8.0	0	 रामगुंडम पॉलिगंडम तथा शोधन संस्थान
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Sl. No.	Description	With Bid (Y/N)	For Review/ Approval	For Information	Final/ Approved/ As-built
C	PIPING				
1.0	Equipment layout drawing	Y	Y	-	Y
2.0	Piping Layout drawing	N	Y	Y	Y
3.0	Design data:				
3.1	Design basis	N	Y	-	Y
3.2	Piping material specification	N	Y	-	Y
3.3	Valve material specification(Valve Data Sheet)	N	Y	-	Y
4.0	Material Take-offs (Linewise & consolidated BOQ)	N	-	Y	Y
5.0	Material Requisitions schedule	N	-	Y	Y
6.0	Quality control plan/Inspection test plan	N	-	Y	Y
7.0	Vendor Drawings(Valves, Strainers, Traps etc)	N	Y	Y	Y
8.0	Issued for construction (IFC) Drawing				
8.1	Piping GA drawings	N	-	Y	Y
8.2	Isometrics	N	-	Y	Y
8.3	Piping supports, operating platforms drg.	N	-	Y	Y
9.0	Design calculation / Documents.	N	-	Y	Y
10.0	Flexibility Analysis of Piping	N	Y	-	Y
11.0	Support and load data	N	-	Y	Y
12.0	All inspection, testing & NDT Records.	N	-	Y	Y
13.0	As Built Drgs/Docs/MTCs	N	-	-	Y
14.0	3D model	N	Y	Y	Y

<div> पी डी आई एल PDIL</div>	IMPLEMENTATION OF ZERO LIQUID DISCHARGE (ZLD) UNIT AT RFCL, RAMAGUNDAM PLANT PROJECT DESCRIPTION	PC211/E/001/P-II/Sec-8.0	0	<div> रामगुंडम फ्लूइड ट्रीटमेंट प्लांट</div>
		DOCUMENT NO	REV	
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D	ELECTRICAL		Documents Required (Y / N)		
Sl. No.	Description	With Bid Y/N	For Approval	For Information	Final / Approved / As built
1	Filled in Specification Sheets of all equipment.	Y	Y	--	Y
2	Technical Particulars of all equipment	N	Y	--	Y
3	Load List indicating rated and absorbed power of loads and duty type (Continuous / Standby / Intermittent) at different voltages including emergency loads.	Y	--	Y	Y
4	Load Data indicating normal, peak, starting and construction power requirement at various voltage levels.	Y	--	Y	Y
5	Single line distribution diagram (power, lighting, DC supply, UPS supply) including protection and metering details.	Y	Y	--	Y
6	Power Layout of Plant & Substation	N	--	Y	Y
7	Cable Rack / Trench Layout of Substation & Plant	N	Y	--	Y
8	Earthing & Lightning Layout of Plant & Substation	N	Y	--	Y
9	Lighting Layout of Plant & Substation	N	Y	--	Y
10	Substation Equipment Layout	N	Y	--	Y
11	Civil scope drawing of 415V Switch Boards, MLDB and other	N	--	Y	Y

<div> पी डी आई एल PDIL</div>	IMPLEMENTATION OF ZERO LIQUID DISCHARGE (ZLD) UNIT AT RFCL, RAMAGUNDAM PLANT PROJECT DESCRIPTION	PC211/E/001/P-II/Sec-8.0	0	<div> रामगुंडम पॉलिगंडम तथा बीएसएन डीपी</div>
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	substation equipment.				
12	General arrangement and foundation drawings of all equipment.	N	--	Y	Y
13	Schematic diagram for all switch boards	N	--	Y	Y
14	Interconnection & Terminal connection diagram	N	--	Y	Y
15	List of controls, interlocks, indication & metering at various locations for all drives.	N	--	Y	Y
16	Characteristic curves for motor / relays etc.	N	--	Y	Y
17	Design calculations (for Equipments Sizing, Earthing & Lightning, Lighting, Cables etc.)	N	Y	--	Y
18	Cable Schedule	N	--	Y	Y
19	Interconnection & Terminal Wiring Diagram	N	--	Y	Y
20	Relay Setting & Relay Co-ordination Study Report	N	--	Y	Y
21	Bill of Materials	N	--	Y	Y
22	Installation, Operation & Maintenance Manual	N	--	Y	Y
23	Catalogue of brought out items	N	--	Y	Y
24	List of Spares	Y	Y	--	Y
25	Test Certificates	N	--	Y	Y
26	Guarantee Certificates	N	--	Y	Y
27	Quality Assurance Plan & Formats	N	--	Y	Y
28	Erection Drawings & Details	N	Y	--	Y
29	Construction &	N	--	Y	Y

<div><div>पी डी आई एल PDIL</div></div>	IMPLEMENTATION OF ZERO LIQUID DISCHARGE (ZLD) UNIT AT RFCL, RAMAGUNDAM PLANT PROJECT DESCRIPTION	PC211/E/001/P-II/Sec-8.0	0	<div><div>रामगुंडम फ्लूइड ट्रीटमेंट प्लांट</div></div>
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	Commissioning specification and procedure for all equipment.				
30	Native files (in excel, AutoCAD, ETAP etc.) of Drgs., Docs., Calculations and Relay Setting & Relay Co-ordination System Report.	N	Y	Y	Y

Note:



- 4 hard copies & 1 soft copy shall be supplied with bid.
 - 4 hard copies & 1 soft copy shall be supplied for approval/information after order within 4 weeks.
 - 8 hard copies & 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

 पी डी आई एल PDIL	IMPLEMENTATION OF ZERO LIQUID DISCHARGE (ZLD) UNIT AT RFCL, RAMAGUNDAM PLANT PROJECT DESCRIPTION	PC211/E/001/P-II/Sec-8.0	0	 रामगुंडम फ्लूइडल रिसोर्स कं. लि. रामगुंडम फ्लूइडल रिसोर्स कं. लि.
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Sl.No	Description	With Bid (Y/N)	For Review/ Approval	For Information	Final/ Approved/ As-built
E	INSTRUMENTATION				
1	Drawing & document schedule		Y		Y
2	Instrument Index			Y	
3	Instrument sizing calculations (control vales, safety valves & flow elements)			Y	
4	Utility requirements			Y	
5	Level sketches			Y	
6	Material Requisition		Y		Y
7	Purchase Requisition			Y	
8	Vendor Drawings			Y	
9	Functional Schematic			Y	
10	Logic Diagrams as per ISA 75.2			Y	
11	Instrument loop drawings			Y	
12	Control room layout		Y		Y
13	Layout of equipment inside control room		Y		Y
14	Power supply distribution		Y		Y
15	Wiring diagram for panels			Y	
16	Configuration diagram		Y		Y
17	I/O assignment		Y		Y
18	DCS graphics, report/log formats & other DCS docs.		Y		Y
19	Instrument duct / tray layout			Y	

 पी डी आई एल PDIL	IMPLEMENTATION OF ZERO LIQUID DISCHARGE (ZLD) UNIT AT RFCL, RAMAGUNDAM PLANT PROJECT DESCRIPTION	PC211/E/001/P- II/Sec-8.0	0	 रामगुंडम फ्लूइड ट्रीटमेंट प्लांट
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20	Instrument cable schedule			Y	
21	Instrument location plans			Y	
22	Instrument installation drawings			Y	
23	Bill of material for installation items			Y	
24	Spare part list for :				
	a. Mandatory Spares			Y	
	b. Start up & commissioning			Y	
25	Inspection & test procedures			Y	
26	Complete catalogues with part list for all vendor supplied instruments, control etc.			Y	
27	Installation, operation & maintenance manuals			Y	
28	As Built Drawings			Y	
29	System Architecture	Y		Y	
30	Instrument Control Philosophy	Y		Y	

<div> पी डी आई एल PDIL</div>	IMPLEMENTATION OF ZERO LIQUID DISCHARGE (ZLD) UNIT AT RFCL, RAMAGUNDAM PLANT PROJECT DESCRIPTION	PC211/E/001/P-II/Sec-8.0	0	<div> रामगुंडम पॉलिगंडम तथा सीवेज टिफ्टि</div>
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F	CIVIL & STRUCTURAL'S				
1.0	Technical specifications	Y	Y	-	Y
2.0	Design basis	Y	Y	-	Y
3.0	Overall foundation layout drawings	N	Y	Y	Y
4.0	Design calculations of Equipment foundations	N	Y	-	Y
5.0	GA and RCC details drawing for Equipment foundations	N	-	Y	Y
6.0	Design calculations of foundation for Steel/RCC structures	N	Y	-	Y
7.0	GA and RCC details drawing for Steel/RCC structures foundations	N	-	Y	Y
8.0	Design calculations of super structure for Steel structures	N	Y	-	Y
9.0	GA and details drawing of super-structure for Steel structures	N	-	Y	Y
10.0	Design calculations of super structure for RCC structures	N	Y	-	Y

<div> पी डी आई एल PDIL</div>	IMPLEMENTATION OF ZERO LIQUID DISCHARGE (ZLD) UNIT AT RFCL, RAMAGUNDAM PLANT PROJECT DESCRIPTION	PC211/E/001/P-II/Sec-8.0	0	<div> रामगुंडम पॉलिगंडम तथा सीमेंट कार्खाना लि.</div>
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11.0	GA and RCC details drawing of super-structure for RCC structures	N	-	Y	Y
12.0	GA and details drawing for Acid proof brick lining				
13.0	Drainage/ Sewage layout drawings	N	Y	-	Y
14.0	Road / paving drawings	N	Y	-	Y
15.0	Standards for steel structures	N	-	Y	-
16.0	Standards for concrete construction	N	-	Y	-
17.0	Standards for general civil	N	-	Y	-


<div> पी डी आई एल PDIL</div>	IMPLEMENTATION OF ZERO LIQUID DISCHARGE (ZLD) UNIT AT RFCL, RAMAGUNDAM PLANT PROJECT DESCRIPTION	PC211/E/001/P-II/Sec-8.0	0	<div> राष्ट्रीय फलियाईयन एन डीयन डीयन</div>
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G	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 & Insulation Specifications	N	Y	-	Y
4.0	Complete Spare Part List for the whole package	Y	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	Y

<div><div>पी डी आई एल PDIL</div></div>	PROJECTS & DEVELOPMENT INDIA LTD	PC211/E/001/P-II/Sec-9.0	0	<div><div>रफ़ल</div><div>राजस्थान फ़र्टिलाइज़र एंड केमिकल्स लिमिटेड</div></div>
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PART II: TECHNICAL
SECTION – 9.0
SPARE PARTS

IMPLEMENTATION OF ZERO LIQUID DISCHARGE (ZLD) UNIT
AT
RAMAGUNDAM FERTILIZERS AND CHEMICALS LIMITED (RFCL),
TELANGANA, INDIA

 <div>पी डी आई एल PDIL</div>	IMPLEMENTATION OF ZERO LIQUID DISCHARGE (ZLD) UNIT AT RFCL, RAMAGUNDAM PLANT SPARE PART	PC211/E/001/P- II/Sec-9.0	0	 <div>रामगुंडम फॉसफोरस एवं कैल्शियम लिमिटेड</div>
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CONTENTS

SECTION NUMBER	DESCRIPTION
1.0	SPARES PARTS FOR COMMISSIONING
2.0	SPARE PARTS FOR TWO YEARS OPERATION (MANDATORY SPARES)
3.0	GENERAL NOTES
4.0	VENDOR'S RECOMMENDED SPARE PARTS

1.0 SPARES PARTS FOR COMMISSIONING

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 SPARE PARTS FOR TWO YEARS OPERATION (MANDATORY SPARES)

Contractor shall supply mandatory spares (along with the equipment) for the plant as listed below:



2.1. ROTARY

LSTK Contractor shall supply mandatory spare parts as per list of spares as detailed below:

- i) CENTRIFUGAL FAN / BLOWER
- ii) CENTRIFUGAL PUMP
- iii) RECIPROCATING PUMP
- iv) METERING PUMP
- v) SCREW PUMPS
- vi) AGITATOR
- vii) HVAC

i) CENTRIFUGAL FAN / BLOWER

Sl. No.	DESCRIPTION	QUANTITY
1.0	Completely dynamically balanced rotor assembly including impeller, wheel, key etc.	1 Set
2.0	Shaft sleeve	1 Set
3.0	Complete set of all Bearings	1 Set
4.0	Stuffing box packing rings	1 Set
5.0	Complete set of all Gasket & 'O' rings	1 Set
6.0	Complete mechanical seal , if applicable	1 Set
7.0	Coupling bushes	1 Set
8.0	Complete set of coupling with elements	1 Set.
9.0	Instrumentation	
	As per Instrumentation specification	
10.0	Electrical	
	As per Electrical specification enclosed with enquiry / order specification.	


 <div>पी डी आई एल PDIL</div>	IMPLEMENTATION OF ZERO LIQUID DISCHARGE (ZLD) UNIT AT RFCL, RAMAGUNDAM PLANT SPARE PART	PC211/E/001/P- II/Sec-9.0	0	 <div>रामगुंडम फॉरवार्ड्स एच बीकेएल लिमिटेड</div>
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ii) CENTRIFUGAL PUMP

Sl. No.	Description	Quantity			
		No. of Pumps working			
		1	2	3	4
1.1	Impeller	1 set	1 set	1 set	1 set
1.2	Impeller locking nut	2 sets	2 sets	2 sets	2 sets
1.3	Wear Rings complete set	1 set	2 sets	3 sets	4 sets
1.4	Shaft with keys	1 No.	1 No.	1 No.	1 No.
1.5	Shaft Sleeve	1 set	2 sets	3 sets	4 sets
1.6	Interstage sleeves	1 set	2 sets	3 sets	4 sets
1.7	Interstage Bushes	1 set	2 sets	3 sets	4 sets
1.8	Complete Set of Mech. Seal where applicable	1 set	1 set	2 sets	2 sets
1.9	Constant level Oiler	2 sets	2 sets	2 sets	2 sets
1.10	Deflectors	2 sets	2 sets	3 sets	3 sets
1.11	Complete set of coupling with element and fasteners	1 set	1 set	2 sets	2 sets
1.12	Complete set of all Bearings	1 set	2 sets	2 sets	2 sets
1.13	Complete set of Gaskets & 'O' Rings	2 sets	3 sets	4 sets	6 sets
1.14	Labyrinths	2 sets	3 sets	4 sets	5 sets
1.15	Throat Bushing	1 No.	2 Nos.	3 Nos.	4 Nos.
1.16	Throttle Bushing	1 No.	2 Nos.	3 Nos.	4 Nos.
1.17	Complete set of Oil Seals	2 sets	3 sets	4 sets	6 sets
1.18	Balancing drum & sleeves, as applicable.	1 set	1 set	2 sets	2 sets
1.19	Leak-off valve-gaskets, 'O' Rings and springs	2 sets	3 sets	4 sets	5 sets
1.20	Spares for gear box (complete set of bearings, all gears wheels with shaft and seals)	1 set	1 set	1 set	1 set
2.0	Instrumentation				
	As per Instrumentation specification				
3.0	Electrical				
	As per Electrical specification enclosed with enquiry / order specification.				

iii) RECIPROCATING PUMP



Sl No.	Description	Quantity			
		No. of Pumps working			
		1	2	3	4
A	Main Frame				
1.	Main Bearings	1 set	1 set	1 set	1 set
2.	Big End Bearings	1 set	1 set	1 set	1 set

 <div>पी डी आई एल PDIL</div>	IMPLEMENTATION OF ZERO LIQUID DISCHARGE (ZLD) UNIT AT RFCL, RAMAGUNDAM PLANT SPARE PART	PC211/E/001/P- II/Sec-9.0	0	 <div>रामगुंडम फॉरवार्ड्स एण्ड रीफिल एक्टिविटी</div>
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3.	Thrust Bearings	1 set	1 set	2 sets	2 sets
4.	Crosshead shoes	1 set	1 set	1 set	1 set
5.	Crosshead bushes	1 set	1 set	1 set	1 set
6.	Connecting rod with complete Fasteners for all size	2 sets.	2 sets	4 sets	4 sets
7.	Crank shaft	1 No.	1 No.	1 No.	1 No.
8.	Lube oil pump	1 No.	1 No.	1 No.	1 No.
9.	Spare parts for lube oil pump (set of gears, bushes, gaskets etc.)	1 set	1 set	2 sets	2 sets
10.	Cartridge for oil filter.	2 Nos.	2 Nos.	4 Nos.	4 Nos.
11.	Special gaskets, oil seals, 'O' rings, special bolts etc.	2 sets	2 sets	4 sets	4 sets
B	Fluid End				
1.	Cylinders	1 No.	1 No.	2 Nos.	2 Nos.
2.	Plungers / piston & piston rod assembly, piston rings (if applicable)	1 set	1 set	1 set	1 set
3.	Stuffing box Packings	2 sets	2 sets	4 sets	4 sets
4.	Plunger Packings	2 sets	2 sets	4 sets	4 sets
5.	Complete set of Suction valve & seat	1 set	2 sets	3 sets	4 sets
6.	Complete set of Discharge valve & seat	1 set	2 sets	3 sets	4 sets
7.	Flushing pump (if applicable)	1 No.	1 No.	1 No.	1 No.
8.	Spares for flushing pump.	1 set	1 set	2 sets	2 sets
	- Plunger - Plunger Packings - Valves - Gaskets				
9.	Special gaskets, springs, 'O' rings, and ring nuts for stuffing box packing, cylinder bolts.	2 sets	2 sets	4 sets	4 sets
C	Gear Reducer (If Applicable)				
	Spares for gear box (complete set of bearings, all gears wheels with shaft and seals)	1 set	1 set	2 sets	2 sets
D	Lube Oil Coolers (If Applicable)				
1.	Special gaskets, if any	2 sets	2 sets	4 sets	4 sets
2.	Spare tubes.	10 %	10 %	10 %	10 %
E.	Instrumentation				
	As per Instrumentation specification				
F.	Electrical				
	As per Electrical specification enclosed with enquiry / order specification.				

iv) METERING PUMP



Sl. No.	Description	Quantity			
		No. of Pumps working			
		1	2	3	4

 <div>पी डी आई एल PDIL</div>	IMPLEMENTATION OF ZERO LIQUID DISCHARGE (ZLD) UNIT AT RFCL, RAMAGUNDAM PLANT SPARE PART	PC211/E/001/P- II/Sec-9.0	0	 <div>रामगुंडम फॉरवार्डिंग एंड कंटेनर लिमिटेड</div>
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A	POWER END				
1.	Main Bearings	1 set	1 set	1 set	1 set
2.	Big End Bearings	1 set	1 set	1 set	1 set
3.	Crosshead shoes	1 set	1 set	1 set	1 set
4.	Crosshead bushes	1 set	1 set	1 set	1 set
5.	Connecting rod with complete Fasteners for all size	2 sets.	2 sets	4 sets	4 sets
6.	Special gaskets, oil seals, 'O' rings , special bolts etc.	2 sets	2 sets	4 sets	4 sets
B	FLUID END				
1.	Cylinders	1 No.	1 No.	2 Nos.	2 Nos.
2.	Plungers	1 set	1 set	1 set	1 set
3.	Diaphragm	1 set	2 sets	3 sets	4 sets
4.	Stuffing box Packings	2 sets	2 sets	4 sets	4 sets
5.	Complete set of Suction valve & seat	1 set	2 sets	3 sets	4 sets
6.	Complete set of Discharge valve & seat	1 set	2 sets	3 sets	4 sets
7.	Special gaskets , springs , 'O' rings , ring nuts for stuffing box packing , cylinder bolts	2 sets	2 sets	4 sets	4 sets
C.	Instrumentation				
	As per Instrumentation specification				
D.	Electrical				
	As per Electrical specification enclosed with enquiry / order specification.				

v) SCREW PUMPS

Sl. No.	Description	Quantity			
		No. of Pumps working			
		1	2	3	4
1.1	Complete set of balanced rotor	1 set	1 set	1 set	1 set
1.2	All type Bearings	1 set	1 set	1 set	1 set
1.3	Complete Mechanical Seal	2 sets	2 sets	2 Sets	2 Sets
1.4	All type of gaskets, 'o' rings, oil seals, special bolts etc Complete Coupling	2 set	2 set	4 set	4 set
2.0	Instrumentation				
	As per Instrumentation specification				
3.0	Electrical				
	As per Electrical specification enclosed with enquiry / order specification.				

 <div>पी डी आई एल PDIL</div>	IMPLEMENTATION OF ZERO LIQUID DISCHARGE (ZLD) UNIT AT RFCL, RAMAGUNDAM PLANT SPARE PART	PC211/E/001/P- II/Sec-9.0	0	 <div>रामगुंडम फॉरवार्ड्स एंड रीफिलिंग लिमिटेड</div>
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vi) AGITATOR



Sl. No.	Description	Quantity			
		No. of Agitator working			
		1	2	3	4
1.1	Complete set of all Bearings	1 set	1 set	1 set	1 set
1.2	Complete set of High speed flexible coupling with bushes / elements.	1 set	1 set	1 set	1 set
1.3	High speed Coupling bushes	3 sets	3 sets	4 Sets	4 Sets
1.4	Complete set of Low speed flexible coupling with bushes / elements.	1 set	1 set	1 set	1 set
1.5	Low speed Coupling bushes	3 sets	3 sets	4 Sets	4 Sets
1.6	Complete set of all Oil seal for gear box	1 set	1 set	1 set	1 set
1.7	Complete set of all Oil seal for bearing housing	4 set	4 set	6 set	6 set
1.8	Complete set of Seal packing.	2 sets	2 sets	4 sets	4 sets
2.0	Instrumentation				
	As per Instrumentation specification				
3.0	Electrical				
	As per Electrical specification enclosed with enquiry / order specification.				

vii)HVAC

Sl. No.	Description	Quantity
1.	Consumable	1set/type
2.	v-belt	2set/each unit
3.	Filter	1set/each unit
4.	All rotary equipment i.e. Pump, blower etc	Clause no-2 (Spare parts of rotary equipment)
2.0	Instrumentation	
	As per Instrumentation specification	
3.0	Electrical	
	As per Electrical specification enclosed with enquiry / order specification	

Notes:

1. 'Set' means complete replacement of particular part in one machine.
2. Item wise price against each item shall be furnished in the Performa enclosed with the enquiry

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3. The quotation should contain sectional drawing showing location & part no. (For exact identification) & material specification
4. Unless otherwise mentioned, Spares are to be considered dedicated for each individual machine on respective tag number basis. For similar (same model no./ capacity) machine, if repeatedly comes elsewhere in the plant shall have its own dedicated spares as per the list furnished above Bidder to furnish the list specifying clearly in the bid.

2.2. STATIC EQUIPMENTS

Sl. No	Spare Items	Quantities
1.0	Pressure Vessel (Reactors, Columns, filters & Horizontal/vertical vessel e.t.c)	
1.1	Gaskets for each nozzle with blind flange	200 %
1.2	Bolting for each nozzle with blind flange	10 % (Minimum 2 numbers)
1.3	Gaskets for each girth flange.	200 %
1.4	Bolting for each Girth flange	10 % (Minimum 2 numbers)
1.5	Bolting for internal flange	10 % (Minimum 2 numbers)
1.6	Gasket for internal flange	200 %
1.7	Spare for internals Clamps Washer Stud & bolt	2 % excess, min. 5 piece 20 % excess, min. 3 piece 10%(Minimum 2 numbers)
1.8	Sight/light glass assembly complete with bolting and gasket	300% of each installed glass
1.9	Filter Cartridge/Elements	200%
2.0	Tanks	
2.1	Gaskets for each nozzle with blind flange	200 %
2.2	Bolting for each nozzle with blind	10 % (Minimum 2 numbers)
3.0	Heat Exchangers – Shell & Tube type	
3.1	Bolting for each nozzle with blind flange	10 % (Minimum 2 numbers)
3.2	Gaskets for each nozzle with blind flange	200 %
3.3	Gaskets for each girth flange.	200%
3.4	Bolting for each Girth flange	10 % (Minimum 2 numbers)
3.5	Tube Plug	5 % of tube holes
4.0	Plate type Exchanger	
4.1	Plate gasket	10 %
4.2	Flow plate	10 %
4.3	Nozzle gasket	200 %
4.4	Glue (1 kg pot)	1
4.5	Special spanner tool	1 for each size/ type

Notes:


- 1) Quantities shown are for each equipment installed.
- 2) Above mentioned spare philosophy is also applicable for each Integral static equipment with in a package item.
- 3) Wherever % age is identified, contractor shall supply next rounded figure.
- 4) All spares supplied by contractor shall be properly wrapped and packed so that spares will be preserved in as new condition under the normal condition of storage envisaged and shall be properly tagged & coded so that at a later stage the same can be identified. Packing list shall be furnished so that parts can be identified without uncrating
- 5) Prices of Mandatory Spares shall be included in the quoted price. The mandatory spares shall be supplied to Owner. These spares shall not be used during construction, erection or Commissioning.

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- 6) All special tools and tackles required for maintenance for critical items shall be supplied along with equipment.
- 7) Spare parts shall be identical in all respects to the parts fitted on the main equipment, including dimensions, material of construction, testing & heat treatment.
- 8) The Bidder shall quote for all the mandatory spares as defined above & as applicable to the proposed design of the equipment. In case, any spare which is listed above but not applicable due to specific construction/design of the equipment, the same shall be highlighted as 'Not Applicable' against that spare supported with proper technical explanation.
- 9) 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).

2.3. ELECTRICAL ITEMS

Sl. No.	Item	Quantity
1.0	LV Switchgear (including Distribution Boards) of each type and rating	
1.1	Spares for LV circuit breakers (of each rating)	
A.	Complete CB (ready to use) along with fixed & draw out contacts	1 for each rating
B.	Main contact sets/Jaw contact complete	2 sets for each rating
C.	Fixed Arcing contact Assembly	2 sets for each rating
D.	Moving Arcing contact Assembly	2 sets for each rating
E.	Trip coils	3 sets for each rating
F.	Closing coils	3 sets for each rating
G.	Spring charging motors	2 sets for each rating
H.	Arc chute Assembly	1 for each rating
I.	Vacuum Bottle (of each type)	2 nos.
J.	O ring / Gasket	2 sets
K.	Limit switches complete	2 sets
L.	Auxiliary Contactors (of each type)	2 nos.
1.2	Contactors	
A.	Power contactors (of each type)	2 Nos.
B.	Auxiliary contactors (of each type)	4 Nos.
C.	Coils for 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.

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Sl. No.	Item	Quantity
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	
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.
B.	Fuse Assembly	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.	Auxiliary Contact multiplication relay	10 Nos.
D.	Timers - each type/range/voltage	3 Nos.
1.14	Miscellaneous	
A.	Alarm bell	2 Nos.
B.	Alarm Buzzer	2 Nos.
2.0	LV Motor (of each type & rating)	
A.	Bearings (Driving end)	1 set

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Sl. No.	Item	Quantity
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.
3.0	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 (if applicable) of each type	5 Nos. of each rating & type
C.	Terminal block of each type	5 Nos.
D.	Heat resistance toughened glass cover (if applicable) of each type	5 Nos.
4.0	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)
5.0	Variable Frequency Drives (of each type & rating), if applicable	
A.	Controller Card of each type	1 No.
B.	Power Devices of each type	2 Nos.
C.	Fuses of each types & rating	2 sets
D.	Vacuum Contactor of each type & rating	1 No.

Note:



- 1) The above spares do not include commissioning spares and shall be purely warehouse spares.
- 2) Set means complete replacement of particular part in one machine.
- 3) Item wise unit price against each item shall be furnished.
- 4) Wherever "Each Type" is specified, it means "of the Type/make/model/size/rating and exactly replaceable"
- 5) Commissioning spares as required shall be provided by bidder without any cost implication.

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2.4. INSTRUMENTATION ITEMS

- 1) Set means complete replacement of particular part in one machine.
- 2) Wherever "Each Type" is specified, it means "of the Type/make/model/size/rating and exactly replaceable"
- 3) Wherever "% qty." is specified, Bidder to quote in next higher rounded figure
- 4) Out of % age spares and minimum qty specified against each item - higher of the two shall be supplied.



Sl. No.	DESCRIPTION	QUANTITY
1.0	Field instruments	
	Pressure Gauges, Differential Pressure Gauge, Draft Gauges, Field Indicators, RTD/T/C with Thermowells, welded thermowell, Skin Thermocouple Sets, Speed Probes with Cables and Fixing Screws and Bolts, Vibration Probes, with Cables (including extension cable) and Fixing Screws and Bolts, Speed Transmitter with Cables and Fixing Screws and Bolts, Proximometers of diff. model and Fixing Screws and Bolts, Gas Sensors with Cables and Fixing Screws and Bolts	10% of each type of instruments, subject to minimum 2 nos. of each type
	Pressure Switches, DP Switches, Purge Rotameters	10% of each type of instruments, subject to minimum 2 nos of each type
	Special thermocouples (like reactors) /multipoint thermocouples,	10% of each length subject to minimum 1 number of each type.
	Skin Type Thermocouple-	10% of total subject to minimum 1 number Complete Set of each type.
	Float and micro switch assembly for level switch	10% of each length subject to minimum 1 number of each type.
	Transmitters for Flow, Pressure, Temperature, Level, Diff. Pressure application, Remote Seal Transmitter, Transmitter for LEL/GAS Detector System including Sensors .	10% of each type of instruments, subject to minimum 2 nos of each type
	Hydra Step	1 no. Electronic unit or 10% subject to minimum. 20% or Min 3 Nos of

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		Sensor Probes
	Mass flow meter & Mag Flow meter	A) Power fuses 6 nos per set B) Sensor assembly- 10% min 1 no C) 10% or minimum one number complete electronic head unit
	Vortex Flow Meter	A) One sensing probe ,one set of gasket and Packing for each type and Size B) 10% or minimum one number complete electronic head unit
	Ultrasonic Flow meter	A) 1 pair probe for each instrument B) 1 number electronic card of each type C) 2 numbers fuses of all Types.
	Glass tube Rota meters	20% or min 2 Nos of glass tubes of each size/rating /make.
	Variable Area Metal tube Flow meter (Rota meters)	10% or minimum one no. float & set of Packing for each type, size, rating and material
	Averaging Pitot Tube	Set of Gasket, O-ring, Packing for Retract Mechanism and one no. Needle Valve with each Pitot Tube.
	Flame scanners and optical pyrometer a) Electronics b) Detectors / sensors or spares with limited life	a)10% subject to minimum 1 No. of each type. b)As required for 1 year operation or Min 2 Nos Complete flame scanner
2.0	Displacer type Level Transmitters	A) 10% of each type of instruments head with Torque Tube Assembly and Transmitter, subject to

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		<p>minimum 2 nos of each type. 1 No of float of each type.</p> <p>B) 10% Electronic cards and Display module – Minimum 1 no. of each type</p>
2.1a	Ultrasonic / Guided Wave Radar Type – Level Instrument	<p>A) 10% complete Instrument – Minimum 1 No. of each Type / Range / Material</p> <p>B) 10% Electronic – module / Cards /Display module – Minimum 1 no. of each type</p>
2.2	Level gauge- Transparent / Reflex Type	20% subject to minimum 10 numbers of glass along with pair of Gaskets and glands sets for I/V valves of each type, size (Cushion & Wet Gaskets), whichever is higher.
2.2.1	Level Gauge- Magnetic Type	10% subject to minimum 1 set of Float, Magnet/ball follower-ring gaskets of each type.
3.0	Control Valve, Shut Down, On-Off, Butterfly, Ball Valves, Gate Valves, Angle Valves, PCV, MOV, Safety Valve Spares	
3.1	Soft part / actuator spares, including actuator diaphragm, actuator seal kit and spring sets, for each type of actuator	20% of each type of instruments, subject to minimum 1 no. of each type
3.2	Trim Set	Trim set consisting of seat ring / seal ring, plug with stem, cage (wherever applicable), packing material for each make, type, size, 14reassure rating valve to be provided as spare
3.3	Complete Actuator with Hand Wheel assembly	one complete Actuator for each type and size
3.4	Complete Spare Control Valve for Antisurge Control Valve	One No

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3.5	Gland packing, O rings, Packing and Bonnet gasket, seat gasket	100 % for each valve. i.e. one set for each tag.
3.6	Greases and grease guns	5 sets of each type of grease and 1 grease gun of each type
3.7	Solenoid valves	10% of each type of instruments, subject to minimum 2 nos of each type
3.8	Proximity switches including enclosure	10% of each type of instruments, including enclosure- subject to minimum 2 nos of each type
3.9	SMART Positioners	10% of each type of instruments, subject to minimum 2 nos of each type
3.11	Other accessories: Quick Exhaust relay, Volume Boosters, Air Filter regulators, position Transmitters, change over relay, NRV, Pilot valves.	10% of each type of instruments, subject to minimum 3 nos of each type. Air filter regulator shall be minimum 20%.
3.12	PRDS & De-super heater unit	a)Same as those of Control Valves
		b) Gaskets for valve and connections per unit (if such gaskets, are special and supplied by PRDS/De-Super heater vendor
3.13	For PCV Repair kit consisting of (orifice, plug, spring, gasket, diaphragm, spring, O-ring for each valve.	20% or minimum 1 no. in each type
3.14	HHT loaded with latest HART configurator software (Emerson make)	1 no. minimum
3.15	Safety Valve:	Set of each type/ size. 1 Set comprising of 1 upper adjusting ring, 1 lower adjusting ring, 1 disk, 1 Nozzle, 1 stem & 1 Gasket set
		20% of each size and rating of Discs, Nozzles, bellows, springs etc. Additionally Minimum 2 Nos of Complete PSV for critical application (Very high pressure PSV's e.g

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		Boiler drum application etc.)
4.0	DCS, ESD, F&G PLC, Storage PLC, Analyser PLC, Any other Control and PLC system.	
4.1	CPU	10% or minimum 1 no. each type.
4.1a	Communication cards, Processor cards (Controller) ,FTA cards	2 nos of each type of cards.
4.2	System Pre-fab cables, I/O Card cables, communication bus cables.	10% or min. 5 sets of each type with all connectors, plugs,
4.3	Racks, Backplane units	2 Nos each type
4.4	Local Panel, Hardwire console & annunciator All items like Push buttons, indicators, hand switches lamps, relays selector switches, IS type indicators / Annunciators, holders etc. mounted in the local panel	10% or minimum 2 no. each type.
4.5	HDD unit	2 set of each type (normal as well as Raid-5) with all connectors, plugs.
4.6	Various Keyboards (including operator keyboard) /mouse	2 nos. of keyboard each type and 5 Nos. of mouse.
4.7	Relays	5% of each type of relays, including relevant terminal modules/sockets minimum 5 nos of each type
4.8	Pushbuttons, Lamps, Selector switches	10% of each type , including relevant terminal modules/accessories as a complete set
4.10	All type of system/PDB/Marshalling cabinet /console filters	100%
4.11	All type of system/PDB/Marshalling cabinet/console fan	2 Nos of each type including relevant terminal modules/pre-fab system cables.
4.12	All type of system/PDB/Marshalling cabinet/console Tube light	2 Nos of each type.
4.13	All type of various PDBs Voltmeters	2 Nos of each type.
4.14	I/O Cards	20% of each type of card, including relevant terminal modules/pre-fab system cables, etc., subject to minimum of 5

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		nos. each
4.15	Various System Battery, Terminators	1 no. of each type
4.16	All system Fuses and various glass fuses	100% for imported fuses
4.17	All PDB fuses, like HRC, GSA Fuses	100% of total qty. of each type
4.18	MCBs	5 Nos. of each type
4.19	Terminal Blocks	Spare Terminal Blocks along with DIN rail – 100 nos each type
4.20a	Cables for wiring inside Marshalling Racks of DCS of relevant size	100 mtr of each color and size
4.20b	Cables for wiring inside Marshalling Racks of ESD of relevant size	100 mtr of each color and size
4.21	24 V DC Bulk Power Supply modules	Min. 2 nos of each type
4.22	System DC Power supply for DCS	Min. 2 nos of each type
4.23	System DC Power supply for ESD	Min. 2 nos of each type
4.23a	Diode-o ring modules	10% or minimum 1 no. each type.
4.24	Safety barriers, active isolators, signal convertors, trip amplifiers, signal multipliers	10% of each type of instruments, subject to minimum 5 nos of each type
4.25	Hubs, Bus units, Switches, Routers	20% or Min 1 nos of each type
4.26	OPC / Modbus interface Cards	1 No each along with connectors / cables
4.27	DCS operator and engineering subsystem	
	Communication card Operator Station communication bus	1 No.
	Communication card for Engineering Station communication bus	1 No.
	Motherboard for Operator Workstation	1 No.
	Motherboard for Engineering Workstation	1 No.
	SMPS	1 No.
4.28	PLC operator and engineering subsystem	
	Communication card for PLC programming Station communication bus	1 No.
	Communication card for PLC SOE Station communication bus	1 No.
	Communication card for PLC Operating Station communication bus	1 No.
5.0	Special control system modules a) Woodward Digital Governor, b) Woodward PROTECH 2003/Braun Speed Trip unit, Speed Probes c) Any other Control system module associated with Speed trip and Monitoring system.	1 no. of each (Controller, IOs ,cables, barriers Complete unit). Speed Probe - 2 nos of Speed Governing, 2 nos for Over speed Trip. • 1 no of each

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	d) Voith Make E/H Converters.	electronics & sensor • 1 no I/H converter complete set.
6.0	Bentley Nevada 3500 Series Vibration Monitoring System Spares	
6.1	Central Rack cards : Power supply card, Vibration/Thrust Monitoring card, Axial displacement card, Speed monitor card, Key phasor module, Relay module, Display Unit., transducers and transmitters	20% of each type of cards, subject to minimum 2 nos of each type
6.2	Vibration probes with leads, axial displacement probes with leads, Bearing thermo elements, speed probes with leads, I/H converter, E/H Converter, trip solenoid valves, transducers, barriers for vibration probes/ Proximeter.	10% or minimum 1 no. of each type. Proximeter 20%
7.0	Consumables for DCS	
7.1	Printer papers A3, A4 size	A3- 10 Rims, A4- 50 Rims
7.2	Laser Cartridges (Black and Color)	For 6 month usage, min. 2 sets for each printer
7.3	DATs of HP/ 3-M	25 nos. each
7.4	CDs of HP/Samsung	200 with individual casing
7.5	DVDs of HP/Samsung	200 with individual casing
8.0	GC Spares	
a	Set of Filters	1 set
b	Detector Assembly	1 set
c	PCB assembly Power Supply	2 nos.
d	PCB assembly Digital temp control	2 nos each type
e	Pressure Regulator	1 no
f	Thermocouple Assembly	1 no
g	Sol Valve	1 no
h	Backplane Assembly	1 no
i	PCB Assembly	1 no
j	Ignitor Assembly	1 no
k	Pressure Sensor	1 no
l	Filament Kit	2 nos
m	Set of Fuses	1 no
n	Set of Fittings	1 no
o	Pressure Gauge	1 no
p	Temperature gauge	1 no
q	Sample flow meter	1 no
r	Bypass flow meter	1 no
9.0	Gas Analyzer Spares applicable for all Gas Analyzers / MassSpectrometer	
a	Sample Flow Meter	1 no
b	By pass Flow meter	1 no
c	Solenoid Valve	1 no

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d	Communication board	1 no of each type
e	Display Unit	1 no each type
f	CPU Board	1 no each type
g	Sensor Electronic	1 no each type
h	Modulation Unit	1 no each type
i	Sample Cell	1 no
j	Sensor	1 no each type
k	O Ring	3 sets
l	Thermal fuses	2 sets
m	Heating cartridge	1 set
n	Thermal trip	2 set
o	Analogue module	1 set each type
p	Filter membrane (pack of 25)	1 set
q	Fuse	1 set each type
10.0	pH / Conductivity Analyzer	2 (Two) Complete Analyzer complete with sensor, cables, transmitters etc of each type
11.0	Silica Analyzer/Sodium/chlorine/ moisture /Turbidity /density/O2/CO/NOx/SPM Spares	
a	Sensor board	1 no.
b	Sensor and Detector	1 no each type
c	Rotameter (if applicable)	1 no.
d	Pressure Control Valve (if applicable)	1 no.
e	Fuses	5. sets.
f	Electronic card	1 no. each type
g	Other Aux. Cards	1 each
h	Probe	1 no. each type
i	Filters, O-rings, Gaskets	2 sets
j	Consumable Kit	2 sets
12.0	Sample Conditioning system applicable for all analyzers / Mass spectrometer	
a	Complete sample kit for sample pumps inclusive of 'O' rings, Seal ring, Diaphragm	1 set
b	Solenoid valve for, more than one stream application	1 no
c	Flow switch	1 no
d	Vaporization system if required, which includes vaporizer, thermostat, electrical tracing cable and heater	1 set
e	Cooling system if required, which includes one cooler, flow conditioning system	1 set
f	Sample handling system fitting, valves, pressure gauges, regulators, solenoid valves, flow meters / flow switches and other components, etc	10% or minimum 1 no. of each type
g	Consumables like filters, membranes,	For 1 year of continuous

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	reagents, cal. Gas, carriers	operation
13.0	Flame Scanner	Two complete instrument of each type
13A	Ignition System	
1.	Ignition Transformer	1 no
2.	Trip Amplifier	1 no
3.	Solenoid Operated Valve	1 no
4.	PCV	1 no
5.	Push Buttons	1 Set
6.	Auto Manual Switch	1 Set
7.	Pilot Burner	1 no
8.	Pressure Gauges for each range	1 no + 1 Set
14.0	Ferruling machine	1 no along with printer ribbon and sleeves size of 5.0 mm2 and 3.5 mm2 100 meter each
	Other Items	
15.0	Snubber, Syphon, Gauge Saver	10% (subject to minimum of 2) of each item used, whichever is higher
16.0	Loop powered indicators	10% (subject to minimum of 2) of Loop powered indicators used, whichever is higher
17.0	Panel mounted instruments	10% or minimum one no. whichever is higher
25.0	Tools	
25.1	Technician's Tool Kit Set including screw drivers, slide wrench, O & D Spanners Kits	10 nos
25.2	Crimping Tool for RJ-45 Connector, Tapria	5 nos
25.3	Crimping Tool 0.5 to 4.0 mm2 wire, Tapria	5 nos
25.4	Crimping Tool BNC connector for Bently Nevada	2 nos
25.5	Torque Wrench (Adjustable)	2 nos
25.6	Insulation Remover	5 nos
25.7	IC Puller	2 nos of each type
25.8	Logic probe	2 nos.
25.9	Screw driver kit (Taparia make)	5 set
25.10	Allen Key Set (1mm to 8 mm)	5 set
25.11	Lamp puller	3 nos.
25.12	Torches (LED) handheld	10 nos
25.13	Torches (Head Lamp)	10 nos
25.14	Battery charger alongwith 1 set of batteries	2 nos of each type
26.0	CCTV camera, camera station, lens with zoom, Pan & Tilt Unit, Receiver Unit, electronic unit, , power supply, etc.	10% or minimum one of each type of module.
27.0	EPABX Unit, Electronic Card each type	10% or minimum one of each type of module.

 <div>पी डी आई एल PDIL</div>	IMPLEMENTATION OF ZERO LIQUID DISCHARGE (ZLD) UNIT AT RFCL, RAMAGUNDAM PLANT SPARE PART	PC211/E/001/P- II/Sec-9.0	0	 <div>रामगुंडम फॉरवार्डिंग एंड कंटेनर लिमिटेड</div>
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28.0	Gas Detector system a) Transmitter assembly (including field display) b) Sensors	10% subject to minimum 1 No. of each type. 20% subject to minimum 2 No. of each type
29.0	Smoke Detectors , MCP, Sounders, Hooters	10% or minimum one of each type of module.
30.0	Pressure Relief Valves/Thermal Relief Valves/ Vacuum Relief Valves / Low Pressure Relief Valves / Pilot Operated Valves	10% of minimum one of each type & size for nozzle, disc insert, guide whichever is higher
30.0a	Rupture Disc	2 spare disc for each Tag.
31.0	MOVs Main PCB of each type Local / Remote / off Selector Switch each type Open / close / stop Selector Switch each type	1 Nos 1 Nos 1 Nos
31.0	Installation Material	
31.1	Instrument valves and	10% subject to minimum 1 no. of each type.
31.1.1	Valve manifolds	10% subject to minimum 3 no. of each type.
31.2	Tube fittings	10% subject to minimum 10 no. of each type.
31.3	Tubes	10% of the total length of each type
31.4	Cables	10% of the total length of each type
31.5	Junction boxes and cable glands	10% subject to minimum 1 no. of each type

2.5. PIPING ITEMS

Piping Items:

Following mandatory spares are to be supplied for the Piping items:

Sl. No.	Part Description	Size Range (NB)	Quantity Required (% of as built)	Remark
1	Pipes & Fittings	≤1.5"	5%	min. qty. 6 mtr. / 1 No.
2	Pipes & Fittings	≥ 2"	2%	min. qty. 6 mtr. /1 No.
3	Flanges	≤6"	5%	min. qty. 1 No.
4	Flanges	8" to 36"	2%	min. qty. 1 No.
5	Valves	≤14"	5%	min. qty. 1 No.
6	Valves	≥16" with rating ≥900#		Note-5

<div></div>	IMPLEMENTATION OF ZERO LIQUID DISCHARGE (ZLD) UNIT AT RFCL, RAMAGUNDAM PLANT SPARE PART	PC211/E/001/P-II/Sec-9.0	0	<div> रामगुंडम कचिस्टावर्त एन बीकेएल लिमिटेड</div>
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7	Bolts, Nuts & Gaskets		10%	min. qty. 1 No.
8	Traps		2%	min. qty. 1 No.
9	Expansion Bellow		10%	min. qty. 1 No.
10	Strainer element		10%	min. qty. 1 No.(Note-6)
11	Complete Gear Box for gear operated Valves		5%	min. qty. 1 No.
12	Seal ring for the Pressure seal type valves		5%	min. qty. 10 Nos.
13	Hose assembly		50%	min. qty. 10 Nos.
14	Bolt torque wrenches (Manual)		1 set	min. qty. 1 set (Note-7)
15	Bolt torque wrenches (Hydraulic)		1 set	min. qty. 1 set (Note-7)

Note (Piping items):

1. Percent of quantity required as mandatory spares is for each and every item/size/rating/thickness/material 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.
5. For rating $\geq 900\#$ and sizes $\geq 16"$, minimum one qty. valve spare shall be supplied for each size, rating & material.
6. Percent of quantity required as mandatory spares for strainer element is for each and every Strainer/size/rating/material consumed in as built.
7. Quantity shall be supplied irrespective of as built/installed.

2.6. FIRE FIGHTING

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	$\leq 1.5"$	5%	min. qty. 6 mtr.
2	Pipes for each size, rating/thk. & material	$\geq 2"$	2%	min. qty. 6 mtr.
3	Fittings for each size, rating/thk. & material	$\leq 1.5"$	5%	min. qty. 1 No.
4	Fittings for each size, rating/thk. & material	$\geq 2"$	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.

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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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3.0 GENERAL NOTES



1. The above spares do not include installed spares / commissioning spares. The above shall be 2 years spares.
2. Set means complete replacement of particular part in one machine/equipment/Reformer/Fired heater etc.
3. Item wise price against each item shall be furnished.
4. Wherever "Each Type" is specified, it means "of the Type/make/model/size/rating and exactly replaceable"
5. Wherever "% qty." is specified, LSTK Contractor to quote in next higher rounded figure
6. Out of % age spares and minimum qty specified against each item - higher of the two shall be supplied.
7. Spares mentioned above to be offered as 2 years spares. However, if these spares are not used in the equipments being offered / supplied, the same need not be supplied. Bidder shall clearly indicate against each such spare that these spares / items are not used in their equipments.
8. The above is owner's recommended list of spares. The supplier may add other items as per their recommendations.
9. The quotation should contain sectional drawing showing location & part no. (For exact identification) & material specification.

4.0 VENDOR'S RECOMMENDED SPARE PARTS

DELETED

NOTES

1. The above nos. of spares are minimum.
2. The word 'TYPE' means the Make, Model no., Type, Range, Size/ Length, Rating, Material as applicable.
3. Wherever % age is identified, Contractor shall supply next rounded figure.
4. The terminology used under 'Part Description' is the commonly used name of the part and may vary from manufacturer to manufacturer.
5. Mandatory spares shall be applicable for Electrical / Instrumentation items of sub packages also as per above mandatory spares philosophy.
6. Mandatory spares shall be procured along with the main equipment. These spares include only those spares, which are critical for equipment and require longer delivery periods.
7. The word 'Set' means the quantity required for full replacement of that part in one machine.
8. The Bidder shall quote for all the mandatory spares as defined above & as applicable to the proposed design of the equipment. In case, any spare which is listed above but

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not applicable due to specific construction/design of the equipment, the same shall be highlighted as 'Not Applicable' against that spare supported with proper technical explanation.

9. Spare parts shall be identical in all respects to the parts fitted on the main equipment, including dimensions, material of construction, testing & heat treatment.
10. Mandatory spares as specified elsewhere in the engineering specifications for other items are also to be provided by the contractor before Commissioning of the plant.

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PART II: TECHNICAL

SECTION – 10.0



INFORMATION REQUIRED IN TECHNICAL PROPOSAL

IMPLEMENTATION OF ZERO LIQUID DISCHARGE (ZLD) UNIT

AT



**RAMAGUNDAM FERTILIZERS AND CHEMICALS LIMITED
(RFCL),**

TELANGANA, INDIA



<div> पी डी आई एल PDIL</div>	IMPLEMENTATION OF ZERO LIQUID DISCHARGE (ZLD) UNIT AT RFCL, RAMAGUNDAM PLANT INFORMATION REQUIRED IN TECHNICAL PROPOSAL	PC211/E/001/P-II/Sec-10.0	0	<div> रघुनाथ फॉर्टिफिकेशन एंड रिसोर्स लिमिटेड</div>
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Section Number	Description
1.0	Design Basis
2.0	Detailed Description of the Process
3.0	Process flow Diagrams/ Material Selection Diagrams
4.0	Design Calculations
5.0	Piping & Instrument Diagram (P & ID)
6.0	Details of Equipment and Machinery
7.0	Design Philosophy for the 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 Specification/Standards and Design Codes
14.0	Details of Shop & Field Testing and Inspection Procedures
15.0	An Implementation Plan showing Man-Power Deployment Schedule
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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

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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

Design calculations for sizing of the exchangers shall cover all process route, showing input and output utility streams as well as composition, volumetric flow, 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.

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- 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 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.

<div> पी डी आई एल PDIL</div>	IMPLEMENTATION OF ZERO LIQUID DISCHARGE (ZLD) UNIT AT RFCL, RAMAGUNDAM PLANT INFORMATION REQUIRED IN TECHNICAL PROPOSAL	PC211/E/001/P-II/Sec-10.0	0	<div> रघुनाथ फॉस्फोरस एंड सिमेंट लिमिटेड</div>
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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 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.

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PART II: TECHNICAL

SECTION – 11.0



VENDOR LIST

IMPLEMENTATION OF ZERO LIQUID DISCHARGE (ZLD) UNIT

AT



**RAMAGUNDAM FERTILIZERS AND CHEMICALS LIMITED
(RFCL),**

TELANGANA, INDIA

<div> पी डी आई एल PDIL</div>	IMPLEMENTATION OF ZERO LIQUID DISCHARGE (ZLD) UNIT AT RFCL, RAMAGUNDAM PLANT VENDOR LIST	PC211/E/001/P-II/Sec-11.0	0	<div> <small>राष्ट्रीय फ़ैक्टोरियों एवं कर्मिकों संघ</small></div>
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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.

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1.0 PROCESS EQUIPMENTS



SL	VENDOR'S NAME
CLO2 SYSTEM	
1.	GRUNDFOS
2.	PURITA
3.	IONEXCHANGE
4.	VASU CHEMICALS
5.	CAPITAL CONTROL INDIA PVT LTD
6.	Pennwalt
7.	Toshan Jesco (India) Pvt Ltd
RO MEMBRANES	
1.	DOW
2.	TORAY
3.	HYDRANAUTICS
4.	GE
5.	IONEXCHANGE(HYDRAMEM)
UF MEMBRANES	
1.	NORIT
2.	HITECH
3.	INGE
4.	KOCH
ACTIVATED CABRON	
1.	GLOBAL ADSORBDENT
2.	NORRIT
3.	JACOBI
ION EXCHANGE RESINS	
1.	ION EXCHANGE
2.	THERMAX
3.	DOW
4.	PUROLITE
DOSING SYSTEM	
1.	IONEXCHANGE
2.	MILTON ROY
3.	GRUNDFOS
4.	VASU CHEMICALS
5.	CHEMBOND
6.	Nalco India Ltd
7.	Thermax India Ltd
8.	Aquapharam Chemical Co. Pvt Ltd
HRSCC CLARIFIER	
1.	IONEXCHANGE
2.	PARAMOUNT
3.	EMCO KCP
4.	K PACK
5.	GLOBAL COMPOSITE
STATIC MIXER	
	MAMKO
	PROCESS EQUINIX PTE LTD.

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2.0 STATIC EQUIPMENTS

ITEM DESCRIPTION
VESSELS IN CS/AS/SS PRESSURE UPTO 10 Kg/cm2g
VESSELS IN CS/AS/SS PRESSURE 11 TO 60 Kg/cm2g
SHOP FABRICATED TANKS & NONCODED VESSELS
STORAGE TANKS (Site Fabricated)
DEMISTERS
HEAT EXCHANGERS UPTO 30 Kg/cm2g
PLATE TYPE HEAT EXCHANGERS
FRP/PVC TANKS & VESSELS
FRP/PVC LINING
FILTERS & SEPARATORS
RUBBER LINING



VESSELS IN CS/AS/SS PRESSURE UPTO 10 Kg/cm2g		
1	AERO ENGINEERS	INDIA
2	AIRFRIGE INDUSTRIES	INDIA
3	ARTSON ENGINEERING LIMITED	INDIA
4	B H P V	INDIA
5	BHARAT HEAVY ELECTRICALS LTD.	INDIA
6	FABTECH PROJECTS & ENGINNERS LTD. (For CS Only)	INDIA
7	FLOWLINK INDUSTRIES PVT. LTD. (CS/SS Except Urea Service)	INDIA
8	FURNACE FABRICA (INDIA) LTD. (CS/SS)	INDIA
9	G R ENGINEERING PRIVATE LIMITED	INDIA
10	GANSONS LTD.	INDIA
11	GEMINI ENGI-FAB PVT. LTD. (Excluding AS Mati)	INDIA
12	GHANSHYAM STEEL WORKS LTD. (CS/SS)	INDIA
13	GMM PFAUDLER LIMITED	INDIA
14	GODREJ & BOYCE MFG. CO. LTD	INDIA
15	GRAND PRIX ENGINEERING PVT. LTD. (upto 4m D x 6m L x80mm Thk)	INDIA
16	GRASIM INDUSTRIES	INDIA
17	HEATEX INDIAN CORPORATION	INDIA
18	HINDUSTAN DORR-OLIVER LTD.	INDIA
19	ICEM ENGG. CO. LTD.	INDIA
20	INDIA TUBE MILLS & METAL INDUSTRIES LTD. (For CS/SS only)	INDIA
21	INDUS PROJECTS LTD (FORMERLY INDUS ENGG)	INDIA
22	ISHAN EQUIPMENTS PVT. LTD. (CS/SS only)	INDIA
23	KINETICS TECHNOLOGY INDIA LTD.	INDIA
24	LARSEN & TOUBRO LTD.	INDIA

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25	LLOYDS STEEL INDUSTRIES LIMITD	INDIA
26	LOYAL EQUIPMENTS PVT. LTD. CS/SS and Non IBR only)	INDIA
27	MARS DESIGN PVT. LTD.	INDIA
28	MISTRY PRABHUDAS MANJI ENGG. PVT. LTD.	INDIA
29	MOD FABRICATORS	INDIA
30	MULTI-MAX ENGINEERING WORKS PVT. LTD. (CS and SS Material only)	INDIA
31	NAVA BHARAT FERRO ALLOYS LTD	INDIA
32	NEW FIELD INDUSTRIAL EQUIPMENT PVT. LTD. CS/SS Only)	INDIA
33	NIVITA ENGINEERING WORKS	INDIA
34	NOVATECH PROJECTS INDIA (P) LTD. (CS and SS material only)	INDIA
35	ORIENTAL MANUFACTURERS PRIVATE LIMITED (CS/SS only)	INDIA
36	PATELS AIRTEM (INDIA LIMITED	INDIA
37	PRECISION EQUIPMENTS (CHANNAI) PVT LTD	INDIA
38	PROJECT TECHNOLOGISTS PVT. LTD.	INDIA
39	R.D. ENGINEERS (INDIA) PVT. LTD.	INDIA
40	RAJ ENGG. CO.	INDIA
41	RELIANCE FABRICATIONS PVT. LTD.	INDIA
42	REYNOLDS CHEMEQUIP PRIVATE LIMITED (CS/SS)	INDIA
43	SHRENO LTD. (UNIT 2)	INDIA
44	TAS ENGINEERING CO. (P) LIMITED	INDIA
45	TATA CHEMICALS LTD	INDIA
46	THE ANUP ENGINEERING LIMITED	INDIA
47	ISGEC HEAVY ENGINEERING LIMITED	INDIA
48	TITANIUM EQUIPMENT AND ANODE MFG. CO. LTD.	INDIA
49	TRIVENI STRUCTURALS LTD.	INDIA
50	UNITOP ENGINEERS PVT. LTD. (Max. Shell Dia 4.65, Water vol. 140m3)	INDIA
51	CHEM PROCESS SYTEM PVT. LTD. (CS/SS ONLY)	INDIA
52	COPERION IDEAL PVT. LTD.(CS,SS ND LOW ALLOY STEEL ONLY)	INDIA
53	ESSAR HEAHY ENGINEERING SERVICES	INDIA
54	PHILS HEAVY ENGINEERIG PVT. LTD. (FOR AS(P3 &P4)ONLY)	INDIA
55	PRAJ INDUSTRIES LIMITED (CS/SS ONLY)	INDIA
56	TECHNO PROCESS EQUIPMENT (I) LTD.	INDIA
57	UNIVERSAL HEAT EXCHANGER LIMITED (CS/SS/LTCS only)	INDIA
58	VIJAY TANKS & VESSELS LIMITED	INDIA
59	VIJAY TANKS & VESSELS LIMITED (KANDLA) (CS/ SS ONLY)	INDIA
60	CRYOSTAR TANKS & VESSEL PVT. LTD.(CS/AS/SSONLY)	INDIA
61	BTL EPC LIMITED (CS ONLY)	INDIA
62	THE KCP LIMITED	INDIA
63	TECKSON STEEL INDUSTRIES (SS & CS ONLY)	INDIA
64	ATV PROJECTS INDIA LIMITED (CS ONLY)	INDIA
65	PRECEISION GASIFICATION SERVICES PRIVATE LIMITED (NON IBR)	INDIA
66	NUBERG ENGINEEERING LIMITED	INDIA
67	NUBERG ENGINEEERING LIMITED (CS/SS ONLY)	INDIA
68	SPETECH PLANT EQUIPMENT PVT. LTD. (CS ONLY)	INDIA

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69	APPARATEBAU SCHWEISS TECHNIK GMBH	AUSTRIA
70	SCHOELLER-BLECKMANN NITEC GMBH	AUSTRIA
71	OLMI SPA	ITALY
72	JAPAN STEEL WORKS LTD	JAPAN
73	DOOSAN MECATEC CO. LTD.	KOREA
74	HANJUNG DCM CO. LTD.	KOREA
75	HUNDAI HEAVY INDUSTRIES	KOREA
76	HYOSUNG CORPORATION (CS/SS/LAS only)	KOREA
77	KOREA HEAVY INDUSTRIES & CONSTN. CO. LTD	KOREA
78	SUNGJIN GEOTECH CO. LTD. (CS and SS only)	KOREA
VESSELS IN CS/AS/SS PRESSURE 11 TO 60 Kg/cm2g		
1	ALTECH INFRASTRUCTURE (INDIA) PVT. LTD. (Upto 20 Kg/cm2(g)CS Material)	INDIA
2	ARIEN NEW DELHI PRIVATE LIMITED (CS/SS UP TO 11 to 30 kg/cm2(g))	INDIA
3	B H P V	INDIA
4	BHARAT HEAVY ELECTRICALS LTD.	INDIA
5	EXPO GAS CONTAINERS LTD. (CS Only, For SS Material Upto 30 Kg/sq cm (g))	INDIA
6	FABTECH PROJECTS & ENGINNERS LTD. (For CS Only)	INDIA
7	FURNACE FABRICA (INDIA) LTD. (CS/SS UP TO 11 to 30 kg/cm2(g))	INDIA
8	G R ENGINEERING PRIVATE LIMITED	INDIA
9	GANSONS LTD.	INDIA
10	GHANSHYAM STEEL WORKS LTD (CS/SS)	INDIA
11	GODREJ & BOYCE MFG. CO. LTD	INDIA
12	GRAND PRIX ENGINEERING PVT. LTD.	INDIA
13	GRASIM INDUSTRIES (upto 30Kg/cm2g)	INDIA
14	HEATEX INDIAN CORPORATION	INDIA
15	HINDUSTAN DORR-OLIVER LTD. (CS/SS Only)	INDIA
16	INDIA TUBE MILLS & METAL INDUSTRIES LTD. (For CS/SS only upto 30 Kg/cm2g)	INDIA
17	INDUS PROJECTS LTD (FORMERLY INDUS ENGG)	INDIA
18	ISHAN EQUIPMENTS PVT. LTD. (CS/SS Upto 30 Kg/Cm2(g) only)	INDIA
19	KAVERI ENGG. INDUSTRIES LTD.,	INDIA
20	LARSEN & TOUBRO LTD	INDIA
21	LLOYDS STEEL INDUSTRIES LIMITED	INDIA
22	LOYAL EQUIPMENTS PVT. LTD. (Upto 11-30 Kg/cm2, CS/SS and Non IBR only.)	INDIA
23	MULTI-MAX ENGINEERING WORKS PVT. LTD. (Up to 30 Kg/cm2g (CS and SS Materials only)	INDIA
24	NEW FIELD INDUSTRIAL EQUIPMENT PVT. LTD. (Upto 30 Kg/cm2g (CS/SS Only)	INDIA
25	ORIENTAL MANUFACTURERS PRIVATE LIMITED (CS/SS only)	INDIA

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63	KOREA HEAVY INDUSTRIES & CONSTN. CO. LTD	KOREA
64	SUNGJIN GEOTECH CO. LTD. (CS and SS only)	KOREA
65	ALPEC CO. LTD.(CS & AS ONLY)	KOREA
66	BELLELI S.P.A	ITALY
67	FBM HUDSON ITALIANA S.p.A	ITALY
68	GE POWER (NUOVO PIGNONE SPA)	ITALY
69	ROLLE S.P.A. (11 TO 60 kg/cm2 pr.)	ITALY
70	WALTER TOSTO SpA	ITALY
71	HITACHI ZOSEN	JAPAN
72	KOBE STEEL LIMITED	JAPAN
73	mitsubishi heavy industries LTD.	JAPAN
74	MITSUI ENGINEERING & SHIPBUILDING CO. LTD	JAPAN
75	SCHOELLER-BLECKMANN NITEC GMBH	AUSTRIA
76	BORSING GmbH	GERMANY
77	MECANICA DE LA PENIA S.A.	SPAIN
78	BEAIRD INDUSTRIES LOUISIANA	U.S.A
SHOP FABRICATED TANKS & NONCODED VESSELS		
1	BTL EPC LIMITED (CS Only)	INDIA
2	PRECISION EQUIPMENTS (CHENNAI) PVT. LTD.	INDIA
3	ALTECH INFRASTRUCTURE (INDIA) PVT. LTD.	INDIA
4	ARTSON ENGINEERING LIMITD	INDIA
5	ATV PROJECTS INDIA LIMITED (NON CODED VESSELS ,CS ONLY)	INDIA
6	BAKSHI CHEMPHARMA EQUIPMENTS PVT. LTD.	INDIA
7	CRYOSTAR TANKS AND VESSELS PVT. LTD.	INDIA
8	ESSAR HEAVY ENGINEERING SERVICES	INDIA
9	FLOWLINK INDUSTRIES PVT. LTD. (CS/SS only)	INDIA
10	G R ENGINEERING PRIVATE LIMITED	INDIA
11	GANSONS LTD.	INDIA
12	GAYATRI TANKS & VESSELS	INDIA
13	GEMINI ENGI-FAB PVT. LTD.	INDIA
14	GENERAL MECH & PROCESS EQUIPT. (P) LTD.	INDIA
15	GODREJ & BOYCE MFG. CO. LTD.	INDIA
16	GRANDPRIX ENGINEERING PVT. LTD	INDIA
17	INDIA TUBE MILLS & METAL INDUSTRIES LTD.	INDIA
18	INDUS ENGG. COMPANY	INDIA
19	ISHAN EQUIPMENTS PVT. LTD. (CS/SS only)	INDIA
20	KINETICS TECHNOLOGY INDIA LTD.	INDIA
21	LAXMI ENGINEERING INDUSTRIES (BHOPAL) PRIVATE LIMITD (CS/SS only)	INDIA
22	LLOYDS STEEL INDUSTRIES LIMITED	INDIA
23	MABEL ENGINEERS PVT. LTD.	INDIA
24	MULTI-MAX ENGINEERING WORKS PVT. LTD.	INDIA
25	NEWTON ENGG. & CHEMICALS LTD.	INDIA

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22	SPS ENGINEERING LIMITED	INDIA
23	TAS ENGINEERING CO. (P) LIMITED	INDIA
24	TATA CHEMICALS LTD.	INDIA
25	VIJAY TANKS & VESSELS LIMITED	INDIA
26	TECHNO PROCESS EQUIPMENTS (INDIA) PVT. LTD.	INDIA
DEMISTERS		
1	EVERGREEN INDUSTRIES	INDIA
2	GRAND PRIX ENGINEERING PVT. LTD.	INDIA
3	HAVER STANDARD INDIA PVT. LTD. (Demister pads with grids)	INDIA
4	HEIN LEHMANN (I) LTD.	INDIA
5	MISTER – MESH WIRE PRODUCTS	INDIA
6	COSTACURTA VICO S.P.A	ITALY
7	GLITSH ITALIANA, SPA	ITALY
8	KNITMESH LTD.	U.K.
9	KEVIN ENTERPRISES PVT. LIMITED (MUNTER)	INDIA
HEAT EXCHANGERS UPTO 30 Kg/cm2g		
1	BTL EPC LIMITED (CS ONLY)	INDIA
2	PRECISION EQUIPMENTS (CHENNAI) PVT. LTD.	INDIA
3	AREO ENGINEERS (CS ONLY)	INDIA
4	ARTSON ENGINEERING LIMITED	INDIA
5	B H P V	INDIA
6	BHARAT HEAVY ELECTRICALS LTD.	INDIA
7	CHEM PROCESS SYSTEMS PVT LTD (CS/SS Only)	INDIA
8	CRYSTAR TANKS & VESSELS PVT. LTD. (UPTO 30 KG/CM2(CS ONLY)	
9	ESSAR HEAVY ENGINEERING SERVICES	INDIA
10	EXPO GAS CONTAINERS LTD.(Upto 30 Kg/sq (g) CS/SS Material.	INDIA
11	FAB-TECH WORKS & CONSTRUCTIONS PRIVATE LIMITED	INDIA
12	FABTECH PROJECTS & ENGINEERS LTD. (For CS Only)	INDIA
13	FLOWLINK INDUSTRIES PVT. LTD. (CS/SS Except Urea service)	INDIA
14	G R ENGINEERING PRIVATE LIMITED	INDIA
15	GANSONS LTD.	INDIA
16	GEMINI ENGI-FAB PVT. LTD.	INDIA
17	GHANSHYAM STEEL WORKS LTD. (CS/SS)	INDIA
18	GMM PFAUDLER LIMITED	INDIA
19	GODREJ & BOYCE MFG. CO. LTD.	INDIA
20	GRASIM INDUSTRIES	INDIA
21	HEATEX INDIAN CORPORATION	INDIA
22	HINDUSTAN DORR-OLIVER LTD.	INDIA
23	INDIA TUBE MILLS & METAL INDUSTRIES LTD.	INDIA
24	INDUS PROJECTS LTD. (FORMERLY INDUS ENGG.)	INDIA
25	ISGEC HEAVY ENGINEERING LIMITED	INDIA
26	LARSEN & TOUBRO LIMITED	INDIA
27	LAXMI ENGINEERING INDUSTRIES (BHOPAL) PRIVATE LIMITED (CS/SS only Except Urea service)	INDIA
28	LLOYDS STEEL INDUSTRIES LIMITED	INDIA
29	MABEL ENGINEERS PVT. LTD.	INDIA
30	MANISH UDYOG HEAT EXCHANGERS PVT. LTD.	INDIA

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31	MISTRY PRABHUDAS MANJI ENGG. PVT. LTD.	INDIA
32	MULTI-MAX ENGINEERING WORKS PVT. LTD. (CS and SS Materials only)	INDIA
33	NUBERG ENGINEERING LIMITED	INDIA
34	PATELS AIRTEMP (INDIA LIMITED)	INDIA
35	PHILS HEAVY ENGINEERING PVT. LIMITED. (for AS (P3 & P4) only)	INDIA
36	R.D. ENGINEERS (INDIA) PVT. LTD.	INDIA
37	RADIANT HEAT EXCHANGER PVT. LTD. (CS/SS only)	INDIA
38	RAJ ENGG. CO.	INDIA
39	RELIANCE FABRICATIONS PVT. LTD. (CS/SS only)	INDIA
40	REYNOLDS CHEMQUIP PRIVATE LIMITED (CS/SS)	INDIA
41	TAS ENGINEERING CO. (P) LIMITED	INDIA
42	TATA CHEMICALS LTD	INDIA
43	TECHNO PROCESS EQUIPMENTS (I) LTD.	INDIA
44	TEMA INDIA LIMITED (ACHHAD-UNIT-I)	INDIA
45	TEMA INDIA LIMITED (PANOLI, ANKLESHWAR-UNIT-III & UNIT-IV) (IN Non ASME Certification LIKE U, U2, R ETC. Category)	INDIA
46	TEMA INDIA LIMITED (SILVASSA, UNIT-II (In Non IBR Category))	INDIA
47	THE ANUP ENGINEERING LIMITED	INDIA
48	TITANIUM EQUIPMENT AND ANODE MFG. CO. LTD.	INDIA
49	TITANIUM TANTALUM PRODUCTS LTD. (CS & SS Material)	INDIA
50	UNIQUE CHEMOPLANT EQUIPMENTS	INDIA
51	UNIVERSAL HEAT EXCHANGERS LIMITED (CS/SS/LTCS Only)	INDIA
52	APPARATEBAU SCHWEISSTECHNIK GMBH	AUSTRIA
53	SCHOELLER-BLECKMANN NITEC GMBH	AUSTRIA
54	D'HONDT S.A.	BELGIUM
55	BORSING GmbH	GERMANY
56	BELLELI S.P.A.	ITALY
57	FBM HUDSON ITALIANA S.p.A.	ITALY
58	GE POWER (NUOVO PIGNONE SPA)	ITALY
59	OLMI SPA	ITALY
60	WALTER TOSTO SpA	ITALY
61	HITACHI Zosen	JAPAN
62	KAWASAKI HEAVY INDUSTRIES LTD.	JAPAN
63	KOBE STEEL LIMITED	JAPAN
64	mitsui ENGINEERING & SHIPBUILDING CO. LTD	JAPAN
65	DOOSAN MECATEC CO. LTD.	KOREA
66	HANTECH LIMITED	KOREA
67	HUNDAI HEAVY INDUSTRIES	KOREA
68	KOREA HEAVY INDUSTRIES & CONSTN. CO. LTD.	KOREA
69	HANJUNG DCM CO. LTD	KOREA
70	SUNGJIN GEOTEC LTD. (CS and SS Only)	KOREA
71	MECANICA DE LA PENIA S.A.	SPAIN
72	MANNING & LEWIS ENGINEERING CO.,	U.S.A
	PLATE TYPE HEAT EXCHANGERS	
1	ALFA LAVAL INDIA LIMITED	INDIA
2	APV (PRAJ)	INDIA
3	DOVER INDIA LTD (TRANter PHE DIVN)	INDIA
4	HRS PROCESS SYSTEM LIMITED	INDIA

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5	KELVION NDIA PVT. LTD (FORMERLY GEA ECOFLEX INDIA PVT.) LIMITED	INDIA
6	LARSEN & TOUBRO LIMITED	INDIA
7	SHRACHI ENGINEERINF & INDUSTRIES LTD.	INDIA
8	SONDEX HEAT EXCHANGERS INDIA PVT LTD	INDIA
9	TRANTER INDIA PVT. LTD.	INDIA
10	URISAN HEAT EXCHANGERS PVT. LTD.	INDIA
11	LINDE AG	GERMANY
12	SUMITOMO METAL INDUSTRIES LTD.	JAPAN
13	MECANICA DE LA PENIA S.A.	SPAIN
14	MANNING & LEWIS ENGINEERING CO.,	U.S.A
15	TRANTER PHE, INC.	U.S.A
FRP / PVC TANKS & VESSELS		
1	GANDHI AND ASSOCIATES	INDIA
2	SONAL ENGG. PLASTIC FABRICATOR	INDIA
3	EPP COMPOSITERS PVT LTD.	INDIA
4	APPARATEBAU SCHWEISSTECHNIK GMBH (acid storage tanks upto 3.8 in dia.)	AUSTRIA
FRP / PVC LINING		
1.	GANDHI AND ASSOCIATES	INDIA
2.	EPP COMPOSITERS PVT LTD.	INDIA
FILTERS & SEPARATORS		
1.	COPERION IDEAL PVT. LTD.	INDIA
2.	FIL SEP EQUIPMENTS PVT LTD	INDIA
3.	FILTRATION ENGINEERS PVT. LTD.	INDIA
4.	GANSONS LTD.	INDIA
5.	GRAND PRIX FAB (P) LTD. (CARTRIDGE FILTERS UPTO 1500#, 40" SIZE)	INDIA
6.	HAVER STANDARD INDIA PVT. LTD	INDIA
7.	MULTITEX FILTRATION ENGINEERS LTD	INDIA
8.	OTOKLIN PLANTS & EQUIPMENT LTD.	INDIA
9.	MULTITEX FILTRATION ENGINEERS LTD(UPTO 56" & 600# NOZZLE SIZE & RATING)	INDIA
10.	PETROMAR ENGINEERED SOLUTIONS PVT LTD	INDIA
11.	SUPERFLO FILTERS PVT. LTD.	INDIA
12.	ULTRA FILTER (INDIA) PVT. LTD	INDIA
13.	PEERLESS MFG. COMPANY	SINGAPORE
14.	WATSON PROCESS SYSTEM (FOR VANE TYPE SEPARATORS)	CANADA
15.	MURA CHEMICALS EQUIPMENT CO. LTD (FOR VANE TYPE SEPARATORS)	JAPAN
16.	RAUSCHERI VERFARENSTECHNIK GmbH	GERMANY
17.	NORTHEAST CONTROLS EQUIPMENT CO. LTD (FOR VANE TYPE SEPARATORS)	U.S.A
RUBBER LINING		
1	ARUL RUBBERS PVT. LTD.	INDIA



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Note: LSTK contractor shall select sub vendors from the vendor list as specified. Bidder shall ensure that sub vendor for the specified item has supplied item for the specified service & the supplied item is in satisfactory service.

LSTK contractor shall evaluate and decide present financial, performance, Credential and Shop loading conditions of the vendors.



Integral static equipment in a package shall be fabricated by package vendor/ proven Sub-suppliers. LSTK bidder to furnish list of proven sub-suppliers for static equipment within the package Item with PTR (proven track record) & requisite documents subject to owner's/consultant approval during detail engg. Documents & PTR shall be in English language only.

Any addition to vendor list shall be reviewed and approved by Owner subject to submission of back-up credentials with proven & reliable record of performance for similar or comparable plant design capacity by LSTK contractor.

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3.0 ROTATING EQUIPMENTS

SL.NO	VENDOR'S NAME	COUNTRY
PUMPS FOR CHEMICALS/ ACID/ ALKALI/ BFW/ CONDENSATE USE		
1.	A.R WILFLEY INDIA PVT. LTD	INDIA
2.	AKAY INDUSTRIES PVT. LTD	INDIA
3.	BEACON WEIR LTD	INDIA
4.	ITT CORPORATION INDIA PVT. LTD.	INDIA
5.	KIRLOSKAR BROTHERS LTD.	INDIA
6.	KIRLOSKAR EBARA PUMPS LTD	INDIA
7.	KISHORE PUMPS PVT. LTD	INDIA
8.	KSB PUMPS LTD	INDIA
9.	MICROFINISH PUMPS PVT. LTD	INDIA
10.	SAM TURBO INDUSTRY PRIVATE LTD.	INDIA
11.	SULZER PUMPS INDIA LTD.	INDIA
12.	FLOWSERVE INDIA CONTROLS PVT. LTD.	INDIA
13.	PUMPEN FABRIK ERNST VOGEL	AUSTRIA
14.	ENSIVAL S.A	BELGIUM
15.	GE POWER (NUOVO PIGNONE SPA)	ITALY
16.	WEIR GABBIONETA SRL(FORMERLY POMPE GABBIONETA SPA)	ITALY
17.	ARAI PUMP MFG. CO. LTD	JAPAN
18.	SANWA HYDROTECH CORPORATION	JAPAN
19.	GOULD PUMPS INC.	SINGAPORE
20.	FLOWSERVE (IDP)	U.K
21.	LABOUR PUMP CO. LTD	U.K
COOLING WATER PUMPS (HORIZONTAL)		
1.	A.R WILFLEY INDIA PVT. LTD	INDIA
2.	BEACON WEIR LTD	INDIA
3.	FLOWMORE LTD (FORMALLY FLOWMORE PVT. LTD.)	INDIA
4.	JYOTI LIMITED	INDIA
5.	KIRLOSKAR BROTHERS LTD.	INDIA
6.	MATHER & PLATT (INDIA) LTD. (A SUBSIDIARY OF WILO SE GERMAN)	INDIA
7.	SAM TURBO INDUSTRY PRIVATE LTD.	INDIA
8.	VOLTAS LTD. (PUMPS & PROJECTS BUSINESS DIVISION)	INDIA
9.	FLOWSERVE INDIA CONTROLS PVT. LTD.	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
PUMPS FOR COOLING WATER SERVICE (VERTICAL)		
1.	Beacon Weir Ltd	India
2.	FLOWSERVE INDIA CONTROLS PVT. LTD.	India

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3.	Flowmore Pvt. Ltd	India
4.	Jyoti Limited	India
5.	Kirloskar Brothers Ltd.	India
6.	Mather & Platt (India) Ltd. ((A Subsidiary of WILO SE German)	India
7.	Voltas Ltd. (Pumps & Projects Business division)	India
8.	KSB AG	Germany
9.	Mitsubishi heavy industries Ltd	Japan
10.	Shin Nippon Machinery Co. Ltd	Japan
11.	Torishima Pump Mfg. Co. Ltd	Japan
12.	Flowserve (IDP)	U.K



PUMPS FOR UTILITY SERVICES

1.	AKAY INDUSTRIES PVT. LIMITED	INDIA
2.	BEACON WEIR LTD	INDIA
3.	BEST & CROMPTON ENGG. CO.	INDIA
4.	FLOWMORE LTD. (FORMALLY FLOWMORE PVT. LTD.)	INDIA
5.	FLOWSERVE INDIA CONTROL LTD.	INDIA
6.	KIRLOSKAR BROTHERS LIMITED	INDIA
7.	KIRLOSKAR EBARA PUMPS LIMITED	INDIA
8..	KISHORE PUMPS LTD	INDIA
9.	MICROFINISH PUMPS PVT. LTD	INDIA
10.	SU MOTORS PVT. LTD	INDIA
11.	SULZER PUMPS INDIA LTD.	INDIA
12.	WEIR BDK VALVES (A UNIT OF WEIR INDIA PVT. LTD.)	INDIA
13.	SAM TURBO INDUSTRY PRIVATE LTD	INDIA

PUMPS FOR CHEMICAL DOSING/ METERING

1.	BRAN & LUEBBE INDIA	INDIA
2.	MATZ PUMPS PRIVATE LIMITED	INDIA
3.	MILTON ROY INDIA (P) LTD	INDIA
4.	POSITIVE METERING PUMPS (I) PVT. LTD.	INDIA
5.	S R METERING PUMPS & SYSTEMS	
6.	SHAPO TOOLS	INDIA
7.	SWELORE ENGINEERING PVT. LTD	INDIA
8.	V.K PUMPS INDUSTRIES PVT. LTD	INDIA
9.	VARICON SYSTEMS (MOTOR DRIVEN/ PNEUMATIC)	INDIA
10.	DOSAPRO MILLTON ROY	FRANCE
11.	LEWA HERBERTOTT GMBH & CO	GERMANY
12.	PERONI POMPE SPA	ITALY
13.	NIGATA WORTHINGTON PUMPS	JAPAN
14.	NIKKISO CO. LTD.	JAPAN
15.	BRAN & LUEBBE LTD.	U.K

PUMPS FOR MISC. SERVICE

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1.	A.R WILFLEY INDIA PVT. LTD	INDIA
2.	KSB PUMPS LTD.	INDIA
3.	SULZER PUMPS INDIA LTD	INDIA
4.	V.K PUMPS INDUSTRIES PVT. LTD (FOR NON CRITICAL USE)	INDIA
5.	UT PUMPS & SYSTEM PVT. LTD	INDIA
6.	GOMA ENGINEERING PVT. LTD.	INDIA
7.	LEWA HERBERTOTT GMBH & CO	GERMANY
8.	URACA PUMPENFABRIK GMBH & CO	GERMANY
9.	DOSAPRO MILLTON ROY	ITALY
10.	PERONI POMPE SPA	ITALY
11.	NIGATA WORTHINGTON PUMPS	JAPAN
12.	NIKKISO CO. LTD.	JAPAN
13.	BRAN & LUEBBE LTD.	U.K

ROTARY PUMPS AND SCREW PUMPS



1.	AIRAUTO INDUSTRIES	INDIA
2.	DELTA CORPORATION	INDIA
3.	ROTO PUMPS LTD	INDIA
4.	UT PUMPS AND SYSTEMS LTD	INDIA

FANS & BLOWERS



1.	ABB FLAKT INDIA LTD.	INDIA
2.	AEROVENT PROJECTS PVT.LTD	
3.	AIR CONDITIONING CORPN LTD	
4..	AIR CONTROL & CHEMICAL ENGG. CO.LTD.	
5.	BOLDROCCHI INDIA PRIVATE LIMITED	INDIA
6.	BHEL	INDIA
7.	TLT ENGINEERING INDIA PVT. LTD	INDIA
8.	DRAFT-AIR INDIA PVT. LTD.	INDIA
9.	M/S CB DOCTOR VENTILATORS PVT. LTD.	INDIA
10.	MAXFLOW FANS MANUFACTURING (P) LTD.	INDIA
11.	SWAM PNEUMATICS PVT. LTD.	INDIA
12.	THERMAX BABCOCK & WILCOX LIMITED	INDIA
13.	ILLONNOIS BLOWERS INC	U.S.A
14.	FIMA MASCHINENBAU GMBH	GERMANY
15.	AERZENER MASCHINENFABRIK GMBH.	GERMANY

AGITATORS/ MIXERS

1.	GANSONS LTD.	INDIA
2.	HYTEC GRANT INSTRUMENTS	INDIA
3.	MARS DYE CHEM PVT. LTD	INDIA
4.	RATHI LIGHTNIN MIXERS PRIVATE LIMITED	INDIA
5.	REMI PROCESS PLANT & MACHINERY LTD.	INDIA
6.	SAFE MAX AGITATOR	INDIA



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7.	STANDARD ENGINEERS	INDIA
8.	MILTON ROY	INDIA
AIR CONDITIONING SYSTEM		
1.	AIR CONDITIONING CORP. LTD	INDIA
2.	BLUE STAR LTD.	INDIA
3.	VOLTAS LTD.	INDIA
4.	ANEMO PROJECTS PVT LTD	INDIA
5.	ADVANCE VENTILATION PVT LTD	INDIA
6.	KIRLOSKAR ELECTRIC COMPANY LTD.	INDIA
7.	SUVIDHA ENGINEERS	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.	HEM INDUSTRIES	INDIA
LV POWER, CONTROL AND EARTHING CABLES, FLEXIBLE CABLES/WIRES		
1.	KEC INTERNATIONAL LIMITED (FORMERLY RPG CABLES LIMITED)	INDIA
2.	KEI INDUSTRIES LTD.	INDIA
3.	NICCO CORPORATION LIMITED	INDIA
4.	POLYCAB INDIA LIMITED	INDIA
5.	RAVIN CABLES LIMITED	INDIA
6.	TORRENT CABLES LIMITED	INDIA
7.	UNIVERSAL CABLES LTD.	INDIA
SWITCHBOARDS – LV (415 V) (PMCC/EPMCC)		
1.	LARSEN & TOUBRO LTD. (A UNIT OF SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED)	INDIA
2.	ABB	INDIA
3.	AREVA	INDIA
4.	SIEMENS LTD.	INDIA
5.	GE	INDIA
AC VARIABLE FREQUENCY DRIVE		
1.	ASEA BROWN BOVERI LTD.	INDIA
2.	LARSEN & TOUBRO LTD. (EL. PRODUCTS DIVN.) (A UNIT OF SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED)	INDIA
3.	SIEMENS LTD.	INDIA
4.	MITSUBISHI	INDIA
5.	FUJI ELECTRIC DRIVES	INDIA
6.	ROCKWELL AUTOMATIC INDIA LTD.	INDIA
7.	DANFOSS INDUSTRIES PVT. LTD. (UPTO 1400KW)	INDIA
8.	TMEIC INDUSTRIAL SYSTEMS INDIA PVT. LTD. (UPTO 5000 KVA)	INDIA
9.	YASAKAWA	INDIA
10.	FUJI ELECTRIC SYSTEMS CO. LTD.	JAPAN
CONTROL & RELAY PANEL		

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ITEM	NAME OF THE VENDOR	COUNTRY
1.	AREVA	INDIA
2.	ASEA BROWN BOVERI LTD.	INDIA
3.	LARSEN & TOUBRO LTD. (EL. PRODUCTS DIVN.) (A UNIT OF SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED)	INDIA
4.	SIEMENS LTD.	INDIA
5.	SCHWEITZER ENGINEERING LABORATORIES	INDIA
HT CABLE JOINTING KITS		
1.	RAYCHEM RPG 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

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ITEM	NAME OF THE VENDOR	COUNTRY
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
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
SOFT STARTERS		
1.	YASAKAWA	INDIA
2.	ABB	INDIA
3.	LARSEN & TOUBRO LTD. (EL. PRODUCTS DIVN.) (A UNIT OF SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED)	INDIA
4.	ROCKWELL AUTOMATION INDIA LTD.	INDIA
5.	SIEMENS LTD.	INDIA
6.	DANFOSS INDUSTRIES PVT. LTD. (UPTO 800KW)	INDIA
7.	TMEIC INDUSTRIAL SYSTEMS INDIA PVT. LTD. (UPTO 6000KW MOTORS)	INDIA



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ITEM	NAME OF THE VENDOR	COUNTRY
I/O PANEL & ASSOCIATED ACCESSORIES FOR EXISTING ECS (HONEYWELL MAKE)		
1.	HONEYWELL AUTOMATION INDIA LIMITED	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
PROTECTIVE RELAYS		
1.	AREVA	INDIA
2.	ASEA BROWN BOVERI LTD.	INDIA
3.	LARSEN & TOUBRO LTD. (EL. PRODUCTS DIVN.) (A UNIT OF SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED)	INDIA
4.	SIEMENS LTD.	INDIA
5.	EASUN REYROLLE LIMITED	INDIA
6.	SCHWEITZER ENGINEERING LABORATORIES	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		

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ITEM	NAME OF THE VENDOR	COUNTRY
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
1.	AIR CIRCUIT BREAKER	L&T (OMEGA) (A UNIT OF SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED) / SIEMENS (SIEPAN 8PO) / GE POWER / ABB (EMAX)
2.	MCB / MPCB / MCCB / ELCB / RCCB	LEGRAND / SCHNEIDER / ABB / SIEMENS
3.	SWITCH	L&T (A UNIT OF SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED) / SIEMENS / ALSTOM POWER / ABB
4.	FUSE	L&T (A UNIT OF SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED) / SIEMENS / ALSTOM POWER / ABB
5.	CONTACTOR	L&T (A UNIT OF SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED) / SIEMENS / ABB
6.	THERMAL O/L RELAY	L&T (A UNIT OF SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED) / SIEMENS / ABB
7.	PROTECTIVE RELAYS	SCHNEIDER ELECTRIC / ABB / SIEMENS / L&T (A UNIT OF SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED) / SCHWEITZER ENGINEERING LABORATORIES / EASUN REYROLLE LIMITED
8.	AUXILIARY RELAYS	ABB / SCHNEIDER / SIEMENS / L&T (A UNIT OF SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED)
9.	TIMERS	ALSTOM POWER / SIEMENS / ABB / SCHNEIDER / L&T (A UNIT OF SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED)
10.	SINGLE PHASING PREVENTOR	L&T (A UNIT OF SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED) / SIEMENS / ABB
11.	CURRENT TRANSFORMER	SIEMENS / INDCOIL / PRECISE / KAPPA ELECTRICALS / AREVA / PRAGATI / JYOTI / ABB / SCHNEIDER / NEWTEK

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1. Make of the equipment not indicated and any other make for the specified equipment shall be subject to owner's / consultant's approval.
2. Design and manufacturing of LT Switchboard by channel partner, franchise or sub-vendor of the OEM shall not be acceptable in any case.

5.0 CIVIL



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	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 AHMEDABAD 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.	AHMEDABAD KOLKATA DELHI	SAMHARD STD DURONITE CICOSURFACE HARDNER
1.6	PVC ROLLS	a) PREMIER VINYL b) ARMSRONG c) INARCO d) 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

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				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) CALCUTT A CALCUTT A	SITAPUR WOODCRAFT KITPLY
2.2	PLY WOOD/BLOCK BOARD	a) WOODCRAFT PRODUCTS b) KITPLY PRODUCTS c) GREEN PLY	CULCUTT A CALCUTT A KOLKATA	WOODCRAFT KITPLY
2.3	PARTICLE BOARD (EXTRA GRADE)	a) BHUTAN BOARD b) BEST BOARD c) NOVAPAN INDIA LTD. d) THE BOMBAY BURMAN TRACING CORPN. LTD.	BHUTAN DELHI HYDERABAD DELHI	BHUTAN BOARD 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 ECOBORD
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

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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 EVERITE 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 & SECTION DOORS WINDOWS/ROLLING SHUTTER	a) RAYMUS ENGINEERS b) DHIMAN STEEL c) RDG ENGINEERING d) SUPER STEEL WINDOW CO. e) SKS STEEL INDUS.	GURGOA N/ DELHI 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 /	a) SINTEX Or APPVD	DELHI	SINTEX

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	WINDOWS	EQUIV.		
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 CEMENTATIOUS 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 GURGOA N BANGALORE	
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	a) ASIAN PAINTS LTD.		ASIAN PAINTS

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	DISTEMBER	b) KANSAI NEROLAC PAINTS LTD.		NEROLAC
6.3	INDUSTRIAL EXPOXY/ SYNTHETIC ENAMEL PAINTS	a) ICI/AKZO NOBEL INDIA b) BERGER PAINTS LTD. c) ASIAN PAINTS LTD. 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	WASTERPROOFI NG 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 HYDERAB AD	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.	DELHI DELHI NOIDA MUMBAI DELHI	NIPPON DENRO META COLOR TRACDEK FERO COLOR LLOYDECK

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		d) HARDCASTLE & WAUD MFG. CO. LTD. e) LLOYD INSULATION (I) LTD. f) SHIV SHAKTI FIBER UDYOG	DELHI	
7.4	ALUMINIUM SHEET (PLAIN/PROFILE)	a) INDIAN ALUMINIUM CO. LTD. Or APPROVED EQUIVALENT	CALCUTT A	INDAL
7.5	FIBRE GLASS SHEETS & PANELS (MACHINE MOULDED)	a) SIMBA FRP (P) LTD. b) GE INDIA c) SHIV SHAKTI FIBER UDYOG	DELHI	SIMCRYL
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	CALCUTT A CHENNAI DELHI CHENNAI	HINDUSTAN PARRYWARE CERA NYCER
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

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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) MYK Arment Pvt Ltd d) 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 c) BAKELITE HYLAM	DELHI DELHI DELHI	UNITILE SPECTRUM HERITAGE
11.3	PVC PLUMBING	a) PRAYAG	DELHI	SYMET



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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) j) SPS STEELS ROLLING MILLS LIMITED		
17. 0	GRATINGS/HAND RAILS	a) ERCON COMPOSITES (FRP Gratings) b) FERROTECH STRUCTURALS (INDIA) PVT.LTD. c) INDIANA GRATINGS PVT. LIMITED. d) KANADE ANAND UDYOG PVT. LTD. e) KEMROCK INDUSTRIES & EXPORTS LTD. (For FRP Gratings) f) PENTAX FERRO INCORPORATE (For Gratings/Floor Grill - MS, MS Hot Dipped Galvanized.) g) PINAX STEEL INDUSTRIES PRIVATE LIMITED (Electroforged Gratings) h) SUTTATTI ENTERPRISES LTD.		
18. 0	WELDING ELECTRODE	a) ADOR b) ESAB c) D & H d) HANOVAR e) Bohler group f) Mailam g) Advani Orlikon		

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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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6.0 MECHANICAL – PIPING



	CS PIPES IS-1239 (BLACK & GI)	
1	AMBICA TUBES CO.	INDIA
2	ANIL METAL CORPORATION	INDIA
3	BHARAT ENTERPRISES (All sizes from PDIL enlisted pipe mills/manufacturer)	INDIA
4	CHETAN STEELS (Upto 6")	INDIA
5	DADU PIPES (P) LIMITED (½" to 6")	INDIA
6	GOOD LUCK STEEL TUBES LTD. (15 mm to 150 mm dia.)	INDIA
7	GUJRAT STEEL TUBES LTD.	INDIA
8	HI-TECH PIPES LTD. (ERW MS / GI Pipes:½" NB to 6" NB, (Thickness 2.2 mm to 6.0 mm))	INDIA
9	INDIAN TUBE CO. (TATA DIV. OF TUBES & PIPES) (For >200M)	INDIA
10	INDUS TUBES LIMITED (½" to 6")	INDIA
11	JAY LAKSHMI STEEL & ENGINEERING CO.	INDIA
12	JINDAL PIPES LTD. (1/2" to 4")	INDIA
13	JOTINDRA STEEL & TUBES LTD. (½" to 6")	INDIA
14	KALPESH TUBE(INDIA), (TRADER) (upto a max order value Rs.25.0 lakh)	INDIA
15	MUKAT PIPES LTD	INDIA
16	NAVRATAN PIPE AND PROFILE LTD. (Upto 6")	INDIA
17	P.K.FORGE & FITTING INDUSTRIES	INDIA
18	SAGAR STEEL CORPORATION (TRADER)	INDIA
19	SANGHVI METALS (TRADER)	INDIA
20	SHRIPAL METAL LIMITED (CS Pipes IS-1239 (Black & GI) All sizes from PDIL enlisted pipe mills/manufacturer)	INDIA
21	SURINDRA ENGINEERING CO. PVT. LTD.	INDIA
22	SURYA ROSHNI LTD. (15mm to 150mm)	INDIA
23	THE BENGAL MILL STORES SUPPLY CO.(TRADER)	INDIA
24	WELSPUN GUJARAT STAHL ROHREN LIMITED (ANJAR) (Upto 6")	INDIA
25	ZENITH LIMITED	INDIA
	CS WELDED PIPES IS-3589	
1	ANIL METAL CORPORATION	INDIA
2	BHARAT ENTERPRISES (All sizes from PDIL enlisted pipe mills/manufacturer)	INDIA
3	DADU PIPES (P) LIMITED (6" to 12" (Thickness up to 9.5 mm))	INDIA
4	EVERGREEN HARDWARE STORES	INDIA
5	GOOD LUCK STEEL TUBES LTD. (Upto 150mm dia, 8 mm thick.)	INDIA
6	GUJRAT STEEL TUBES LTD.	INDIA

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7	HEAVY METAL & TUBES LIMITED	INDIA
8	HI-TECH PIPES LTD. (ERW MS / GI Pipes: 6" NB OD to 12", (Thickness 2.6 mm to 8.0 mm))	INDIA
9	INDUS TUBES LIMITED (6" to 12")	INDIA
10	JAY LAKSHMI STEEL & ENGINEERING CO.	INDIA
11	JINDAL PIPES LTD. (8" to 14")	INDIA
12	JOTINDRA STEEL & TUBES LTD. (6" to 14")	INDIA
13	KALPESH TUBE(INDIA), (TRADER)	INDIA
14	LALIT PIPES & PIPES LIMITED (16" to 64", thickness upto 20mm)	INDIA
15	MUKAT PIPES LTD	INDIA
16	NAVRATAN PIPE AND PROFILE LTD. (Upto 10")	INDIA
17	P.K.FORGE & FITTING INDUSTRIES	INDIA
18	PRATIBHA INDUSTRIES LTD., (16" NB to 24" NB, Wall Thickness: 6 mm to 20 mm)	INDIA
19	RATNAMANI METALS & TUBES LIMITED	INDIA
20	SAGAR STEEL CORPORATION (TRADER)	INDIA
21	SANGHVI METALS (TRADER)	INDIA
22	SAW PIPES	INDIA
23	SHRI RAM METALS	INDIA
24	SHRIPAL METAL LIMITED (CS Welded Pipes IS-3589 All sizes from PDIL enlisted pipe mills/manufacturer)	INDIA
25	STEEL AUTHORITY OF INDIA LTD.	INDIA
26	SURINDRA ENGINEERING CO. PVT. LTD.	INDIA
27	SURYA ROSHNI LTD. (6" to 16" ,(150mm to 400mm))	INDIA
28	THE BENGAL MILL STORES SUPPLY CO.(TRADER)	INDIA
29	WELSPUN GUJARAT STAHL ROHREN LIMITED (DAHEJ) (Upto 72" (50 mm thk.))	INDIA
30	WELSPUN GUJARAT STAHL ROHREN LIMITED (ANJAR) (Upto 100" (30 mm thk.))	INDIA
	CS WELDED PIPES TO API 5L SPIRAL/ LONG. WELDED (SAW/EFSW)	
1	BHARAT ENTERPRISES (All sizes from PDIL enlisted pipe mills/manufacturer)	INDIA
2	HEAVY METAL PIPE CENTRE (UPTO 24" (Upto SCHXXS) (PDIL approved Manufacturer's Make only)	INDIA
3	JINDAL PIPES LTD. (2" TO 14")	INDIA
4	JOTINDRA STEEL & TUBES LTD. (½" TO 14")	INDIA
5	KALPESH TUBE(INDIA), (TRADER)	INDIA
6	LALIT PIPES & PIPES LTD. (16" to 64" thickness upto 20mm)	INDIA
7	MUKAT PIPES LTD.	INDIA
8	P.K.FORGE & FITTING INDUSTRIES	INDIA

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9	PRATIBHA INDUSTRIES LTD. (16" to 24" thickness 6mm to 14.27mm)	INDIA
10	RATNAMANI METALS & TUBES LTD.	INDIA
11	SAGAR STEEL CORPORATION (TRADER)	INDIA
12	STEEL AUTHORITY OF INDIA LTD.	INDIA
13	SURINDRA ENGINEERING CO. PVT. LTD.	INDIA
14	SURYA ROSHINI LTD (GR. A, 3" TO 4", GR. B, 6" TO 14")	INDIA
15	THE BENGAL MILL STORES SUPPLY CO.(TRADER)	INDIA
16	WELSPUN GUJARAT STAHL ROHREN LIMITED (DAHEJ) (upto 72" (50 MM THK))	INDIA
17	WELSPUN GUJARAT STAHL ROHREN LIMITED (ANJAR) (upto 100" (30 MM THK.))	INDIA
18	ETS TROUVAY & CAUVIN	FRANCE
19	PHOCEENNE	FRANCE
20	MANNESMANN HANDEL AG	GERMANY
21	THYSSEN-KRUPP STAHLUNION GMBH	GERMANY
22	DALMINE SPA	ITALY
23	RACCORTUBI SRL	ITALY
24	KOSEI SANGYO LTD	JAPAN
25	MARUBENI ITOCHU STEEL	JAPAN
26	MITSUBISHI CORPORATION	JAPAN
27	NIPPON KOKAN	JAPAN
28	NIPPON STEEL CORPORATION	JAPAN
29	NISHITANI & CO. LTD.	JAPAN
30	NISSHO IWAI CORPORATION	JAPAN
31	OKURA & CO. LTD.	JAPAN
32	SOJITZ CORPORATION	JAPAN
33	SUMITOMO METAL INDUSTRIES LTD.	JAPAN
34	HYUNDAI CORPORATION	KOREA
35	BRITISH STEEL CORPORATION	U.K.
36	CORUS TUBES LIMITED	U.K.
37	SAW PIPES USA, INC	U.S.A
	CS/AS/ LTCS SEAMLESS PIPES	
1	ANAND SEAMLESS TUBES PVT. LTD. (CS Seamless Pipes upto 2")	INDIA
2	BHARAT ENTERPRISES (All sizes from PDIL enlisted pipe mills/manufacturer)	INDIA
3	BHEL (VALVES DIVISION)	INDIA
4	CHETAN STEELS (Upto 12", SCH80)	INDIA

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5	HEAVY METAL & TUBES LIMITED (upto 8", thickness upto 18.26mm)	INDIA
6	HEAVY METAL PIPE CENTRE (UPTO 24" (upto SCHXXS) (PDIL approved Manufacturer's make only))	INDIA
7	INDIAN TUBE CO. (TATA DEV. OF TUBES & PIPES)	INDIA
8	ISMT LIMITED	INDIA
9	JAY LAKSHMI STEELS & ENGINEERING CO.	INDIA
10	JINDAL SAW LTD.	INDIA
11	MAHARASHTRA SEAMLESS LTD.	INDIA
12	P.K.FORGE & FITTING INDUSTRIES	INDIA
13	RATNADEEP METAL & TUBES PVT. LTD. (<=168.3MM OD)	INDIA
14	SAINEST TUBES PVT. LTD. (½ " NB TO 3" upto SCH. 160 (ASTM A 106 GR. B, A333 GR. 1 & 6 & A335 GR. P11))	INDIA
15	SHRIPAL METAL LIMITED (CS/AS/LTCS Seamless Pipes All sizes from PDIL enlisted pipe mills/manufacturer)	INDIA
16	ETS TROUVAY & CAUVIN	FRANCE
17	PHOCEENNE	FRANCE
18	HORST KURVERS GMBH	GERMANY
19	MANNESMANN HANDEL AG	GERMANY
20	DALMINE SPA	ITALY
21	GAM RACCORDI S.P.A	ITALY
22	IBF SEAMLESS PIPES SPA	ITALY
23	RACCORTUBI SRL	ITALY
24	MARUBENI ITOCHU STEEL	JAPAN
25	MITSUBISHI CORPORATION	JAPAN
26	NIPPON STEEL CORPORATION	JAPAN
27	NISHITANI & CO. LTD.	JAPAN
28	NISSHO IWAI CORPORATION	JAPAN
29	OKURA & CO. LTD.	JAPAN
30	SOJITZ CORPORATION	JAPAN
31	SUMITOMO METAL INDUSTRIES LTD.	JAPAN
32	HYUNDAI CORPORATION	KOREA
33	AB SANDVIK STEEL	SWEDEN
34	BRITISH STEEL CORPORATION	U.K.
35	CORUS TUBES LIMITED	U.K.
36	VOMAL INTERNATIONAL LIMITED	U.K.
	SS SEAMLESS/ WELDED PIPES	
1	APEX TUBES PVT LIMITED (SEAMLESS upto 8" (SCH. 80S) &	INDIA

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	WELDED upto 48" (SCH160))	
2	BHANDARI FOILS & TUBES LIMITED (SEAMLESS upto 4" (SCH. 80) & WELDED UPTO 20" (THK. <= 8MM))	INDIA
3	BHARAT ENTERPRISES (All sizes from PDIL enlisted pipe mills/manufacturer)	INDIA
4	CHETAN STEELS (upto 6" SCH. 40)	INDIA
5	CHOKSI TUBE COMPANY LTD.	INDIA
6	DIVINE TUBES PVT. LTD. (UPTO 8")	INDIA
7	HEAVY METAL & TUBES LIMITED (UPTO 8" (THICKNESS UPTO 18.26MM))	INDIA
8	HEAVY METAL PIPE CENTRE (UPTO 8" (upto SCH80S) (PDIL APPROVED MANUFACTURER'S MAKE ONLY))	INDIA
9	JAY LAKSHMI STEEL & ENGINEERING CO.	INDIA
10	JINDAL SAW LTD.	INDIA
11	KRYSTAL STEEL MANUFACTURING PVT. LTD. (upto 2" (MATERIAL UPTO GRADE SS 321))	INDIA
12	MARDALE PIPES PLUS LTD.	INDIA
13	MODERN TUBE INDUSTRIES LTD. (upto 2" (upto SS Grade 321))	INDIA
14	NUCLEAR FUEL COMPLEX	INDIA
15	P.K.FORGE & FITTING INDUSTRIES	INDIA
16	PRAKASH STEELAGE LTD. (Seamless: upto 12" & Welded: upto 24")	INDIA
17	QUALITY STAINLESS PVT. LTD. (Seamless: upto 6"(SCH40S), Welded: upto 20"(SCH40S) (UPTO SS GRADE 316L))	INDIA
18	RATNADEEP METAL & TUBES PVT. LTD. (SMLS<=168.3MM O.D., WELDED <=50.8MM O.D.)	INDIA
19	RATNAMANI METALS & TUBES LTD.	INDIA
20	REMI EDELSTAHL TUBULARS LTD. (RAJENDRA MECHANICAL INDUSTRIES (Welded Upto 48" seamless upto 8" (Thk: upto 12.7mm))	INDIA
21	SANDVIK ASIA PVT. LTD. (¾" TO 2" (THK: UPTO 8.74 MM))	INDIA
22	SANGHVI METALS (TRADER)	INDIA
23	SCORODITE STAINLESS (INDIA) PVT. LTD. (Seamless UPTO 16"NB, Welding upto 36")	INDIA
24	SHALCO INDUSTRIES PRIVATE LIMITED (SS Seamless Pipes : upto 8", SS Welded Pipe : upto 4")	INDIA
25	SHRIPAL METAL LIMITED (SS Seamless/Welded Pipes All sizes from PDIL enlisted pipe mills/manufacturer)	INDIA
26	SUBHLAXMI METALS & TUBES PVT. LTD. (SS Seamless: ¾"NB to 2"NB; Thk:1.2mm to 8mm, L upto 14mtr; SS Welded ¾" NB to 8"NB; Thk:1.2 mm to 8mm Lupto 14mtr (Material: SS 304, SS304L, SS316, SS316L, SS321, SS347, SS347H))	INDIA

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27	SURAJ LIMITED (SURAJ STAINLESS LIMITED)	INDIA
28	THE BENGAL MILL STORES SUPPLY CO.(TRADER)	INDIA
29	VENUS PIPES & TUBES PRIVATE LIMITED (UPTO 16")	INDIA
30	WELSPUN SPECIALITY SOLUTIONS LIMITED (UPTO 4"(ONLY FOR SEAMLESS PIPES))	INDIA
31	ZHEJIANG JIULI STAINLESS STEEL PIPE CO. LTD.	CHINA
32	ETS TROUVAY & CAUVIN	FRANCE
33	PHOCEENNE	FRANCE
34	H. BUTTING GMBH & CO. (SEAMLESS : UPTO 30" (UPTO 16MM THK) & WELDED: UPTO 72" (UPTO 64MM)	GERMANY
35	HORST KURVERS GMBH	GERMANY
36	MANNESMANN HANDEL AG	GERMANY
37	THYSSEN-KRUPP STAHLUNION GMBH	GERMANY
38	DALMINE SPA	ITALY
39	GAM RACCORDI S.P.A (THICKNESS 2" TO 24")	ITALY
40	IBF SEAMLESS PIPES SPA	ITALY
41	RACCORTUBI SRL	ITALY
42	MARUBENI ITOCHU STEEL	JAPAN
43	MITSUBISHI CORPORATION	JAPAN
44	NIPPON STEEL CORPORATION	JAPAN
45	NISHITANI & CO. LTD.	JAPAN
46	NISSHO IWAI CORPORATION	JAPAN
47	OKURA & CO. LTD.	JAPAN
48	SOJITZ CORPORATION	JAPAN
49	SUMITOMO METAL INDUSTRIES LTD.	JAPAN
50	HYUNDAI CORPORATION	KOREA
51	T.T.I. – TUBACEX TUBOS INOXIDABLES, S.A. (Upto 10")	SPAIN
52	AB SANDVIK STEEL	SWEDEN
53	SOSTA BV (UPTO 72" (THICKNESS UPTO 25.4 MM))	NETHERLAND S
54	BRITISH STEEL CORPORATION	U.K.
55	CORUS TUBES LIMITED	U.K.
56	VOMAL INTERNATIONAL LIMITED	U.K.
	SS SEAMLESS TUBES	
1	ANIL METAL CORPORATION	INDIA
2	APEX TUBES PVT. LIMITED (UPTO 50.8 MM OD (THICKNESS UPTO 4.0 MM))	INDIA
3	BHANDARI FOILS & TUBES LIMITED (UPTO 50MM OD)	INDIA

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4	BHARAT ENTERPRISES (All sizes from PDIL enlisted pipe mills/manufacturer)	INDIA
5	DIVINE TUBES PVT. LTD. (UPTO 3")	INDIA
6	HEAVY METAL & TUBES LIMITED (UPTO 8" (THICKNESS UPTO 18.26MM))	INDIA
7	KRYSTAL STEEL MANUFACTURING PVT. LTD. (UPTO 50.8 MM OD (MATERIAL UPTO GRADE SS 321))	INDIA
8	MODERN TUBE INDUSTRIES LIMITED (UPTO 50.80 MM OD (UPTO SS GRADE 321))	INDIA
9	PRAKASH STEELAGE LTD. (114.3 mm OD, Thickness upto 6 mm)	INDIA
10	RATNAMANI METALS & TUBES LTD.	INDIA
11	SANDVIK ASIA PVT. LTD. (OD UPTO 60.33 (THK: UPTO 8.74 MM))	INDIA
12	SCORODITE STAINLESS (INDIA) PVT.LTD. (19.05 mm OD TO 50.80mm OD, Thickness upto 3mm)	INDIA
13	SHALCO INDUSTRIES PRIVATE LIMITED (upto 76.2 mm OD)	INDIA
14	SHRIPAL METAL LIMITED (SS Seamless Tubes All sizes from PDIL enlisted pipe mills/manufacturer)	INDIA
15	SURAJ LIMITED (SURAJ STAINLESS LIMITED)	INDIA
16	VENUS PIPES & TUBES PRIVATE LIMITED (upto 50.8 mm OD)	INDIA
17	WELSPUN SPECIALITY SOLUTIONS LIMITED (UPTO 114.3mm OD)	INDIA
18	T.T.I.-TUBACEX TUBOS INOXIDABLES, S.A.(Upto 250.0mm OD)	SPAIN
	SS PIPES UREA GRADE	
1	KEY-TECH ENGINEERING COMPANY (UPTO 8")	INDIA
2	BHDT GMBH	AUSTRIA
3	SCHOELLER-BLECKMANN NITEC GMBH	AUSTRIA
4	ETS TROUVAY & CAUVIN	FRANCE
5	PHOCEENNE	FRANCE
6	HORST KURVERS GmbH	GERMANY
7	MANNESMANN HANDEL AG	GERMANY
8	THYSSEN-KRUPP STAHLUNION GmbH	GERMANY
9	DALMINE SPA	ITALY
10	IBF SEAMLESS PIPES Spa	ITALY
11	MARUBENI ITOCHU STEEL	JAPAN
12	MITSUBISHI CORPORATION	JAPAN
13	NIPPON STEEL CORPORATION	JAPAN
14	NISHITANI & CO. LTD.	JAPAN
15	NISSHO IWAI CORPORATION	JAPAN
16	OKURA & CO. LTD.	JAPAN

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17	SOJITZ CORPORATION	JAPAN
18	SUMITOMO METAL INDUSTRIES LTD.	JAPAN
19	HYUNDAI CORPORATION	KOREA
20	T.T.I- TUBACEX TUBOS INOXIDABLES, S.A. (Upto 10")	SPAIN
21	AB SANDVIK STEEL	SWEDEN
22	BRITISH STEEL CORPORATION	U.K
23	CORUS TUBES LIMITED	U.K
24	VOMAL INTERNATIONAL LIMITED	U.K
	HDPE/MDPE PIPES & PIPE FITTINGS	
1	ASTRAL	INDIA
2	AQUAGUARD PLASTICS & POLYMERS	INDIA
3	CLIMAX SYNTHETICS	INDIA
4	FIBRO PLASTICHEM (I) PVT. LTD.	INDIA
5	NATIONAL ORG CHEMICAL INDIA LTD.	INDIA
6	PARTH POLY VALVES PVT. LTD. (3/4" TO 8" (150#))	INDIA
7	PENNWALT AGRU PLASTICS LTD. (UPTO 250 MM DIA)	INDIA
8	RELIANCE INDUSTRIES "RELPIPE"	INDIA
9	SANGIR PLASTICS PRIVATE LIMITED (UPTO 1200 MM OD)	INDIA
10	SONAL ENGG. PLASTIC FABRICATOR	INDIA
	SS WLEDED TUBES	
1	APEX TUBES PVT. LTD. (Upto 102mm OD (Thickness Upto 4.00mm)	INDIA
2	DIVINE TUBES PVT. LTD (Upto 4")	INDIA
3	KRYSTAL STEEL MANUFACTURING PVT. LTD (Upto 50.8 OD- (Material upto Gr. SS321))	INDIA
4	MAXIM TUBES COMPANY PVT. LTD (6mm to 114.3mm (0.5mm to 4.5mm thk))	INDIA
5	MODERN TUBE INDUSTRIES LTD (Upto 50.80 OD(UPTO SS321 Grade))	INDIA
6	PRAKASH STEELAGE LIMITED (114.3mm OD, thickness upto 6mm)	INDIA
7	QUALITY STAINLESS PVT. LTD (Upto 4"OD(upto 4.0mm thk)upto Grade SS316L))	INDIA
8	REMI EDELSTAHL TUBULARS LTD. (RAJENDRA MECHANICAL INDUSTRIES(50.8mm OD))	INDIA
9	SCODA TUBES LTD. (9.52 mm OD to 50.8mm OD)	INDIA
10	SCORODITE STAINLESS (INDIA) PVT. LTD. (19.05 mm OD to 50.80mm OD, thk upto 3mm)	INDIA
11	STEAMLINE INDUSTRIES LTD. (6.00mm OD to 50.8mm OD)	INDIA
12	SUNRISE STAINLESS PVT. LTD (Upto 4" OD Thickness upto 6mm)	INDIA

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13	SURAJ LIMITED (SURAJ STAINLESS LIMITED)	INDIA
14	VENUS PIPES & TUBES PRIVATE LIMITED (upto 73.1 mm OD)	INDIA
15	WELSPUN SPECIALITY SOLUTIONS LIMITED (Upto 50.8mm OD)	INDIA
	FITTINGS: CS/AS/SS SEAMLESS & FORGED	
1	AMFORGE INDUSTRIES (Upto 24")	INDIA
2	ANIL METAL CORPORATION	INDIA
3	CHETAN STEELS (UPTO 6" SCH. 80)	INDIA
4	COMMERCIAL SUPPLYING AGENCY	INDIA
5	CSA FITTINGS (Forged ½" to 2"-(Upto 9000#) & Seamless: 2" to 8" (upto SCHXXS))	INDIA
6	EBY FASTENERS	INDIA
7	EBY INDUSTRIES	INDIA
8	FIT-TECH INDUSTRIES (Upto 24")	INDIA
9	FLASH FORGE (P) LTD. (Forged upto 4" (upto 9000#) & Seamless up to 42")	INDIA
10	GUJARAT INFRAPIPES PVT. LTD.	INDIA
11	JAY LAKSHMI STEELS & ENGINEERING CO.	INDIA
12	KALPESH TUBE(INDIA),(TRADER) (UPTO A MAX ORDER VALUE RS.25.0 LAKH)	INDIA
13	M.S FITTINGS MANUFACTURING CO. PVT LTD.	INDIA
14	MARDALE PIPES PLUS LTD.	INDIA
15	NAVKAR FORGINGS & FITTINGS PVT. LTD (Forged 3"(UPTO 6000#) & Seamless(Upto 16" SCH XXS))	INDIA
16	NEOSEAL ENGINEERING PRIVATE LIMITED (1.0 Fittings (Forged) CS, upto 1.5", ANSI Class-upto 3000#, 2.0 Fittings (SMLS) CS, upto 10", SCH-upto 40, 3.0 Fittings (SMLS) AS, upto 6", SCH-upto 40, 4.0 Fittings (SMLS) SS, upto 8")	INDIA
17	NL HAZRA (upto SCH80)	INDIA
18	P.K TUBES & FITTINGS PVT. LTD. (Forged upto 1 ½" & Seamless upto 24" (SCH160))	INDIA
19	P.K FORGE & FITTING INDUSTRIES	INDIA
20	PARAS FITTINGS PVT. LTD. (Forged: CS ½" to 2" & CS Seamless: 2" to 8"(upto SCHXXS))	INDIA
21	PARMAR TECHNO FORGE (Elbow- ½" to 12"; Tee- ½" to 8"; Reducer (conc & eccn)- ½" to 12" , Cap ½" to 18" (CS & SS))	INDIA
22	PERFECT MARKETTING PVT. LTD.	INDIA
23	PETROCHEM INDUSTRIES (Seamless: Upto 16" (All Fittings) & upto 36" (Only caps) SCH : XXS /80S, Forged: upto 3"-6000#)	INDIA
24	RAJENDRA FORGE INDUSTRIES (CS: UPTO 12" SCH 40 & SS: 6" SCH 40S)	INDIA

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25	S & G ENGINEERS (P) LTD.	INDIA
26	SAGAR STEEL CORPORATION (TRADER)	INDIA
27	SANGHVI METALS (TRADER)	INDIA
28	SAWAN ENGINEERS PVT LTD (Upto 36" (SCH160))	INDIA
29	SHIVANANDA PIPE FITTINGS LTD.,	INDIA
30	STEWARTS AND LLOYDS OF INDIA LIMITED	INDIA
31	TEEKAY TUBES PRIVATE LIMITED	INDIA
32	THE BENGAL MILL STORES SUPPLY CO.(TRADER)	INDIA
33	TOPAZ PIPING INDUSTRIES (2" to 36" (SCH 10 to Sch160))	INDIA
34	TUBE BEND (CALCUTTA) PVT. LTD. (CS FITTINGS ONLY)	INDIA
35	TUBE PRODUCTS INCORPORATE	INDIA
36	ZOLOTO INDUSTRIES (15mm to 150mm (only CS Galv.))	INDIA
37	PETROL RACCORD S.P.A. (Seamless: 1" to 42" (Elbows) & 1" to 56" Tee/Reducer/Caps))	ITALY
38	ETS TROUVAY & CAUVIN	FRANCE
39	PHOCEENNE	FRANCE
40	VALLOUREC	FRANCE
41	HORST KURVERS GMBH	GERMANY
42	MANNESMANN HANDEL AG	GERMANY
43	SEIKMANN ANLAGEN-TECHNIK GMBH.	GERMANY
44	TPS-TECHNITUBE ROHRENWERKE GMBH	GERMANY
45	DALMINE SPA	ITALY
46	GAM RACCORDI S.P.A	ITALY
47	IBF SEAMLESS PIPES SPA	ITALY
48	IND MECCANICA BASSI LUIGI & C. SPA	ITALY
49	MANTOVANI SPA	ITALY
50	RACCORTUBI SRL	ITALY
51	TECHNO FORGE SPA	ITALY
52	MARUBENI ITOCHU STEEL	JAPAN
53	NIPPON KOKAN	JAPAN
54	NISHITANI & CO. LTD.	JAPAN
55	NISSHO IWAI CORPORATION	JAPAN
56	OKURA & CO. LTD.	JAPAN
57	SOJITZ CORPORATION	JAPAN
58	SUMITOMO METAL INDUSTRIES LTD.	JAPAN
59	HAITIMA CORPORATION	TAIWAN
60	BRITISH STEEL CORPORATION	U.K.

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61	CORUS TUBES LIMITED	U.K.
62	EUROTUBE LIMITED	U.K.
63	VOMAL INTERNATIONAL LIMITED	U.K.
64	BONNEY FORGE	U.S.A.
	FITTINGS: SS UREA GRADE	
1	KEY-TECH ENGINEERING COMPANY (Upto 8")	INDIA
2	PETROL RACCORD S.P.A (Size upto 14")	ITALY
3	BHDT GMBH	AUSTRIA
4	ETS TROUVAY & CAUVIN	FRANCE
5	PHOCEENNE	FRANCE
6	VALLOUREC	FRANCE
7	HORST KURVERS GmbH	GERMANY
8	MANNESMANN HANDEL AG	GERMANY
9	SEIKMANN ANLAGEN-TECHNIK GMPH	GERMANY
10	TPS-TECHNITUBE ROHRENWERKE GMBH	GERMANY
11	DALMINE SPA	ITALY
12	IBF SEAMLESS PIPES Spa	ITALY
13	IND MECCANICA BASSI LUIGI & C.SPA	ITALY
14	RACCORTUBI SRL	ITALY
15	TECHNO FORGE SPA	ITALY
16	MARUBENI ITOCHU STEEL	JAPAN
17	NIPPON KOKAN	JAPAN
18	NISHITANI & CO. LTD	JAPAN
19	NISSHO IWAI CORPORATION	JAPAN
20	OKURA & CO. LTD	JAPAN
21	SOJITZ CORPORATION	JAPAN
22	SUMITOMO METAL INDUSTRIES LTD.	JAPAN
23	AVESTA CANDVITE TUBE AD	SWEDEN
24	HELENS ENERGY	SWEDEN
25	BRITISH STEEL CORPORATION	U.K
26	CORUS TUBES LTD	U.K
27	EUROTUBE LTD	U.K
28	VOMAL INTERNATIONAL LTD	U.K
	FRP/PVC PIPE AND PIPE FITTINGS	
1	ASTRAL POLYTECHNIK PVT. LTD. (1/2" to 12" Size)	INDIA
2	GANDHI AND ASSOCIATES	INDIA

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3	SONAL ENGG. PLASTIC FABRICATOR	INDIA
	CAST IRON FITTINGS & PIPES	
1	CRAWLEY & RAY (F&E) PVT. LTD	INDIA
2	IISCO LTD	INDIA
3	KESORAM SPUN PIPES & FOUNDRIES	INDIA
4	SAYAJI IRON & ENGG. CO (P) LIMITED	INDIA
5	SHAKTI CAST (P) LTD	INDIA
6	SHALIMAR WORKS LTD	INDIA
7	SHIVA ENGINEERING WORKS	INDIA
8	VISVESARAYA IRON & STEEL LTD.	INDIA
	FORGED FLANGES	
1	AJAY FORGING PVT. LTD	INDIA
2	AMFORGE INDUSTRIES(Upto 24"(upto1500#) & Upto 12"(FOR 2500#)	INDIA
3	ANANDMAYEE FORGINGS PVT. LTD.	INDIA
4	C D ENGINEERING	INDIA
5	CHANDAN STEELS LIMITED (ONLY SS Flanges- Upto36"-150#, Upto24"-300#, Upto20"-600#, Upto16"-900#, Upto12"-1500#, Upto8"-2500#)	INDIA
6	CHETAN STEELS (UPTO 6", 150#)	INDIA
7	CHW FORGE PVT. LTD. (FORMELY CHAUDHARY HAMMER WORKS)	INDIA
8	ECHJAY INDUSTRIES LTD	INDIA
9	FERROUS ALLOYS FORGING PVT. LTD	INDIA
10	GOLDEN IRON & STEEL WORKS	INDIA
11	GOOD LUCK ENGINEERING CO. (½"-12" (UPTO 2500#), 14"-16" (UPTO 900#), 18"-32" (UPTO 600#), 34"-48" (UPTO 300#)	INDIA
12	J.K FORGINGS (1/2" to 60" ANSI B 16.5, Class 150 to 2500)	INDIA
13	KUNJ FORGINGS PVT. LTD. (upto 60" (upto 300#) & upto 12" (upto 2500#))	INDIA
14	MAHESH INDUSTRIES (1/2" to 8"NB,Rating-150#,SWRF,SORF & BLRF material: ASTM A105 only; 2"NB to 4"NB, Rating- 150# WNRF FLANGES, Material-A105 only)	INDIA
15	METAL FORGINGS PVT. LTD. (Upto86"-150#; 60"-300# TO 600#; 48"-900# ; 24"-1500#; 12"-2500#)	INDIA
16	NEOSEAL ENGINEERING PRIVATE LIMITED (1.0 Flange (Blind/WN) CS, upto 36", ANSI Class-upto 150#, 2.0 Flange (Blind/WN) CS, upto 24", ANSI Class-upto 2500#, 3.0 Flange (Blind/WN) AS, upto 24", ANSI Class-upto 1500#, 4.0 Flange (Blind/WN) SS)	INDIA
17	P.K TUBES & FITTINGS PVT. LTD. (Upto 24"(upto1500#) & Upto	INDIA

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	12"(upto 2500#) Spectacle Blind and Spacer & Blinds only)	
18	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#))	INDIA
19	PERFECT MARKETING (P) LTD.	INDIA
20	PUNJAB STEEL	INDIA
21	R D FORGE (A UNIT OF R D CHEMICALS PVT LTD) (1/2" to 54" (150#), ½" to 40"-300#, ½" to 42"- 600#,1/2" to 20"-900#, 1/2" to 20"-1500#, ½" to 12" -2500# (CS, AS & SS))	INDIA
22	RAJENDRA FORGE INDUSTRIES (CS & SS : UPTO 12", 300#)	INDIA
23	S & G ENGINEERS (P) LTD.	INDIA
24	SANGHVI FORGINGS & ENGINEERING LTD (Upto 42" (upto 300#), 36" (600#), 24" (upto 1500#) & 12" (2500#))	INDIA
25	SANGHVI METALS (TRADER)	INDIA
26	SAWAN ENGINEERS PVT LIMITED	INDIA
27	TECHNO FORGE LTD. (UPTO 42" (UPTO 300#), UPTO 24" (600#), UPTO 20" (900#), UPTO 16" (1500#), upto 12" (2500#))	INDIA
28	TUBE BEND (CALCUTTA) PVT LTD	INDIA
29	ETS TROUVAY & CAUVIN	FRANCE
30	PHOCEENNE	FRANCE
31	HORST KURVERS GMBH	GERMANY
32	I.S. INTERNATIONAL	ITALY
33	MANTOVANI SPA	ITALY
34	OFFICINE NICOLA GALPERTI & FIGLIO S.P.A	ITALY
35	RACCORTUBI SRL	ITALY
36	NICHINAN SANGYO CO. LTD.,	JAPAN
37	NISHITANI & CO. LTD.	JAPAN
38	SOJITZ CORPORATION	JAPAN
39	VOMAL INTERNATIONAL LIMITED	U.K.
	PLATE RING FLANGES	
1	FABWELL ENGINEERS	INDIA
2	MAHESH INDUSTRIES (1/2" TO 16"NB -150# &300# SWRF, SORF & BLRF, Material: MS Plate Flanges of IS 2062 Grade)	INDIA
3	MOD FABRICATORS	INDIA
4	P K TUBES & FITTINGS PVT. LTD (Upto 48"- (Spectacle Blinds and Spacer & Blind only))	INDIA
5	PARAMOUNT FORGE (CS & SS: ½" to 84")	INDIA
6	PERFECT MARKETING (P) LTD	INDIA
7	R SQUARE ENGINEERS	INDIA
8	SANGHVI METALS (TRADER)	INDIA

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	FITTINGS: CS/AS/SS WELDED	
1	PARAS ENGINEERING WORKS (8" to 36" NB- SCH 5 to SCH XXS- (CS&SS))	INDIA
2	CHETAN STEELS (Upto 10" SCH80)	INDIA
3	FIT- TECH INDUSTRIES (Upto 48")	INDIA
4	FLASH FORGE (P) LTD. (Upto 42")	INDIA
5	NAVKAR FORGING & FITTINGS PVT. LTD (Upto24"- (SCH XXS, Material: CS only))	INDIA
6	NEOSEAL ENGINEERING PRIVATE LIMITED (1.0 Fittings (Welded) CS, upto 14", SCH-upto 40, 2.0 Fittings (Welded) SS, upto 14", SCH-upto 10S)	INDIA
7	P K TUBES & FITTINGS PVT. LTD (Upto 48"- (SCH160))	INDIA
8	PETROCHEM INDUSTRIES (6" to 36" (all Fittings) & 6" to 56" (Only Conc/Ecc. Reducers) SCH :XXS/80S)	INDIA
9	RAJENDRA FORGE INDUSTRIES (CS & SS: Upto 12", SCH40)	INDIA
10	SAWAN ENGINEERS PVT. LIMITED (Upto 52" (SCH160))	INDIA
11	TOPAZ PIPING INDUSTRIES (8" to 48" (SCH 10 to SCH160))	INDIA
12	PETROL RACCORD S.P.A (4"-56" (Tees/Reducers/Elbows))	ITALY
13	TK CORPORATION	KOREA
	PIPE COATINGS	
1	PRATIBHA INDUSTRIES LTD, (External Coating 4" to 24" Pipe OD)	INDIA
2	WELSPUN GUJARAT STAHL ROHREN LIMITED (DAHEJ) (4" to 64" for external coating & 16" to 64" for internal coating)	INDIA
	GATE/ GLOBE/ CHECK VALVES CS/SS/AS < 900 LBS	
1	AV VALVES LTD. (CAST UPTO 42"(150#), 28" (300#), 24" (600#) & FORGE UPTO 2" (800#))	INDIA
2	ADVANCE VALVES (2"-80" (Upto 600#) Dual Plate Check Valves only))	INDIA
3	ASSOCIATED TOOLINGS (I) PVT. LTD. (1/2" to 2", upto 800#)	INDIA
4	AUDCO INDIA LIMITED (L&T VALVES DIVN.)	INDIA
5	AUTOCAP INDUSTRIES (1/2" to 2", 800# (only CS & SS))	INDIA
6	BELL-O-SEAL VALVES LTD. (FOR ZERO LEAKAGE, HAZARDOUS FLUIDS)	INDIA
7	BHEL (VALVES DIVISION)	INDIA
8	BRIGHTCH VALVES AND CONTROLS PVT. LTD. (Upto 8" x 300# for CS, AS & SS Material)	INDIA
9	CHEMTECH INDUSTRIAL VALVES PVT. LTD.	INDIA
10	CHEMTROLS SAMIL (INDIA) PVT. LTD (Upto 12"-150# -Dual Plate Check Valve only)	INDIA
11	CRAWLEY & RAY (FOUNDERS & ENGINEERS) PVT. LTD. (<=300#,	INDIA

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	(only CS))	
12	DATRE CORPORATION LTD. (Upto 300#, 2"-8" (Gate), 2"- 6" (Globe & Check))	INDIA
13	DEWRANCE MACNEILL & CO. LTD.	INDIA
14	ECONO VALVES PVT. LTD.	INDIA
15	EXPERT ENGINEERING ENTERPRISES (Forged upto 2"-800#, Gate & Globe Valve: upto 12"-150# & 300#, Check Valve upto 32"-150# & 300#)	INDIA
16	FLOCON SYSTEMS PVT. LTD. (CS upto 6" 150#)	INDIA
17	FLOTEK INDUSTRIES (1.0 Gate (CAST)-CS, Upto 30", ANSI Class-upto 300#, 2.0 Gate (CAST)-AS/SS, Upto 16", ANSI Class-upto 600#, 3.0 Globe (CAST)-CS, Upto 14", ANSI Class-upto 600#, 4.0 Check (SWING)-CS/AS, Upto 12", ANSI Class-upto 600#)	INDIA
18	FLOVEL VALVES PVT. LTD.(SINGLE DISC, DUAL PLATE & NOZZLE CHECK VALVES ONLY: UPTO 48"(150#) & 24 (UPTO 600#))	INDIA
19	FLUIDTECH EQUIPMENT PVT. LTD. (CAST # (CS & SS): 2" to 12" 150# & 2" to 8" 300# AND FORGED (CS AND SS) ½" TO 2" (800#)	INDIA
20	FORWARD ALLOYS & CASTINGS (UPTO 14")	INDIA
21	GURU INDUSTRIAL VALVES PVT. LTD. (Cast CS only: upto 24"(150#), 20"(300#), 10" (600#) & Forged : upto 2" (800#)	INDIA
22	HAWA ENGINEERS LTD. (Gate Valves: upto 40"(150#), upto 26" (300#), upto 24" (600#), upto 2" (800#); Globe Valves: upto 20"(150#), upto 16" (300#), upto 12" (600#), upto 2" (800#), Check Valves: upto 36"(150#), upto 24" (300#), upto 16" (600#), upto 2" (800#) (Dual Plate: 36" (150#)	INDIA
23	HAWA VALVES INDIA PVT. LTD. (CS upto 6", 150#)	INDIA
24	HI-TECH VALVES PVT. LTD. (CS,<=800#, SIZE ½"-2", <=300# FOR SIZE 2"-6")	INDIA
25	INTERVALVE POONAWALLA LTD. (CAST UPTO 24" (UPTO 300#) & UPTO 12" 600# , FORGED UPTO 2" (800#))	INDIA
26	JC VALVES & CONTROLS INDIA PVT. LTD. (CAST UPTO 48" (150#) & 24"(UPTO 600#) & FORGED UPTO 2" (800#))	INDIA
27	KIRLOSKAR BROTHERS LTD.(CS UPTO 12" size, 300#)	INDIA
28	KSB PUMPS LIMITED (VALVES DIVN)	INDIA
29	LARSEN & TOUBRO LIMITED (1/2" TO 24")	INDIA
30	LEADER VALVES LTD. (Casting<=20" upto 600#, & 30"-150#, Forging<=2" upto 800#)	INDIA
31	M.H. VALVES PVT. LTD. (1/2" to 1 1/2"-800#, 2" to 6"-600#)	INDIA
32	MICON ENGINEERS (HUBLI) [PVT. LTD.(Cast: Upto 12" (150# & 300#), 6" (600#) & Forged: upto 2" (800#))	INDIA
33	MICROFINISH VALVES LTD.	INDIA

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34	NEOSEAL ENGINEERING PRIVATE LTD (Upto 24" rating upto 600#)	INDIA
35	NITON VALVES INDUSTRIES PVT. LTD. (Forging upto 800#, <=1.5" size)	INDIA
36	NSSL LTD. (Cast: UPTO 80" (150#), 56" (UPTO 600#) & FORGED UPTO 2" (800 #))	INDIA
37	NUTECH CONTROLS (Gate/Check Valve (CS) Upto 12", ANSI Class-up to 300#, Globe Valve (CS), Upto 10", ANSI Class-up to 300#, Gate/Globe/Check Valve (AS/SS) Upto 8", ANSI Class-up to 300# & Gate/Globe/Check Valve (CS/AS/SS) Upto 2")	INDIA
38	OSWAL INDUSTRIES LTD. (UPTO 48" (150#), 32" (300#) & 24" (600#)	INDIA
39	S & M INDUSTRIAL VALVES LTD. (CS Gate & Globe Valves 2" – 24" <=300#)	INDIA
40	SAKHI ENGINEERS PVT. LTD. (1.0 CS/AS/SS, upto 16", ANSI Class-up to 150#, 2.0 CS/AS/SS, upto 12", ANSI Class-up to 300#)	INDIA
41	SAP INDUSTRIES LIMITED (UPTO 14")	INDIA
42	SHALIMAR VALVES PVT. LTD. (Cast Upto 24" (Upto 600#), Forged: 1½" to 1 ½" (800#))	INDIA
43	SHREERAJ INDUSTRIES (CS upto 150#)	INDIA
44	STEEL STRONG VALVES (I) PVT. LTD. (Upto 42")	INDIA
45	VALVE TECH INDUSTRIES (<900LBS (upto 24" 600# for CS, upto 12" 300# for AS/SS)	INDIA
46	VENUS PUMP & ENGINEERING WORKS.	INDIA
47	VIBA FLUID CONTROL	INDIA
48	WEIR BDK VALVES (A UNIT OF WEIR INDIA PVT. LTD.) (Cast UPTO 36" (150#); 24" (300#); 12" (600#) & Forged: Upto 2" (800#))	INDIA
49	ZED VALVES CO. PVT. LTD. (Upto 14" (600#))	INDIA
50	ZOLOTO INDUSTRIES. (40 MM TO 200 MM(ONLY CS & SS))	INDIA
51	VELAN INC. (UPTO 48" , Rating upto 600#)	CANADA
52	BOTELI VALVE GROUP CO. LTD.(Cast Upto 56" (150#), 36" (300#), 24" (600#) & Forged: Upto 2" (800#))	CHINA
53	ZHEJIANG JIEHUA VALVE CO. LTD.	CHINA
54	PEMTO VALVE	GERMANY
55	CESARE BONETTI SPA (Cast Upto 42" (Upto 300#), 24" (600#) Forged: upto 1 ½" (800#))	ITALY
56	FASANI S.P.A.	ITALY
57	FRIULCO SPA (UPTO 48" (150#), 32" (Upto 600#)	ITALY
58	GTC ITALIA, S.R.L.	ITALY
59	MANTOVANI SpA	ITALY
60	OMB S.P.A.	ITALY

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61	PETROL VALVES S.R.L.	ITALY
62	MATSURA H. P MACHINE WORKS CO.LTD.	JAPAN
63	NISHITANI & CO. LTD.	JAPAN
64	SOJITZ CORPORATION	JAPAN
65	REDPOINT ALLOYS BV	NETHERLAND
66	BABCOCK BORSIG ESPANA , S.A	SPAIN
67	POYAM VALVES (AMPO S.CCP.) (Size upto 60" (Rating upto 800#)	SPAIN
68	WALTHAN & WEIR	SPAIN
69	SUFA LIMITED	U.A.E.
70	BEL VALVES	U.K.
	GATE/ GLOBE/ CHECK VALVES CS/SS/AS >=900 LBS	
1	A V VALVES LIMITED (Cast Upto 24" (900# & 1500#), 8" (2500#) Forged: Upto 2" (2500#))	INDIA
2	ADVANCE VALVES (2"-36" (900#) 2"-24" (1500#), 2"-12(2500#) DUAL PLATE CHECK VALVES ONLY)	INDIA
3	ASSOCIATED TOOLINGS (I) PVT. LTD. (½" TO 2" (RATING :900# & 1500#))	INDIA
4	AUDCO INDIA LIMITED (L&T VALVES DIVN.)	INDIA
5	BHEL (VALVES DIVISION)	INDIA
6	FLOTEK INDUSTRIES (1.0 Gate (CAST)-CS/AS, Upto 6", ANSI Class-upto 2500#, 2.0 Globe (CAST)-CS/AS, Upto 4", ANSI Class-upto 1500#, 3.0 Check (SWING)-CS/AS, Upto 10", ANSI Class-upto 2500#, 4.0 Gate/Globe/Check Valves (Forged)-CS/AS/SS, upto 0.75")	INDIA
7	FLOVEL VALVES PVT. LTD. (Dual Plate Check Valves only: Upto 24" (900#))	INDIA
8	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#)	INDIA
9	INTERVALVE POONAWALLA LTD.(Forged: Upto 2" (1500#))	INDIA
10	JC VALVES & CONTROLS INDIA PVT. LTD. (CAST UPTO 12" (1500#),10" (2500#) & FORGED UPTO 2" (2500#))	INDIA
11	KSB PUMPS LIMITED (VALVES DIVN)	INDIA
12	LARSEN & TOUBRO LIMITED (1/2" TO 2")	INDIA
13	LEADER VALVES LIMITED (Casting<=12" upto2500#, Forging <=2" upto 2500#)	INDIA
14	METROPOLITAN INDUSTRIES (SIZE=200mm, rating=2500 lb)	INDIA
15	MICON ENGINEERS (HUBLI) PVT. LTD. (FORGED: UPTO 2" (1500#))	INDIA
16	NEOSEAL ENGINEERING PVT. LTD. (Upto24"- rating upto 2500#)	INDIA

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17	NSSL LIMITED (CAST: Upto 36"(900#), 24" (upto 2500#) & FORGED: Upto 2" (Upto 2500#))	INDIA
18	NUTECH CONTROLS (Gate/Globe/Check Valve (CS/AS) Upto 2", ANSI Class-upto 2500#)	INDIA
19	OSWAL INDUSTRIES LTD. (Upto 12" (900# & 1500#))	INDIA
20	SAKHI ENGINEERS PVT. LTD. (CS/AS/SS, upto 4", ANSI Class-upto 1500#)	INDIA
21	SHALIMAR VALVES PVT.LTD.(CAST: UPTO 20"(900#), FORGED: ½" TO 1 ½" (1500#))	INDIA
22	VALVE TECH INDUSTRIES (>=900LBS (upto 8" 2500# for CS, upto 8" 1500# for AS/SS)	INDIA
23	WEIR BDK VALVES (A UNIT OF WEIR INDIA PVT. LTD.) (Cast UPTO 12" (upto 2500#) & Forged: Upto 2" (1500#), 1" (2500#))	INDIA
24	VELAN INC. (UPTO 24" (Rating upto 2500#))	CANADA
25	BOTELI VALVE GROUP CO. LTD.(Cast Upto 16" (Upto 1500#), 12" (2500#) & Forged: Upto 2" (1500# & 2500#))	CHINA
26	ZHEJIANG JIEHUA VALVE CO. LTD.	CHINA
27	BFE BONNEY FORGE VALVE LICENSEE	ITALY
28	CESARE BONETTI SPA (Upto 24" (Upto 2500#)	ITALY
29	FASANI S.P.A.	ITALY
30	FRIULCO SPA (UPTO 32" (900#); 24" (1500#); 14" (2500#))	ITALY
31	GTC ITALIA S.R.L.	ITALY
32	OMB S.P.A.	ITALY
33	PETROL VALVES S.R.L.	ITALY
34	VALVITALIA SPA	ITALY
35	MATSURA H. P MACHINE WORKS CO.LTD.	JAPAN
36	NISHITANI & CO. LTD.	JAPAN
37	BABCOCK BORSIG ESPANA, S.A.	SPAIN
38	POYAM VALVES, (AMPO S. COOP.) (SIZE UPTO 30" (RATING UPTO 2500#))	SPAIN
39	SUFA LIMITED	U.A.E.
40	BEL VALVES	U.K.
	BALL VALVES (SOFT SEATED)	
1	A V VALVES LIMITED (Upto 12" (Upto 600#))	INDIA
2	AIRA EURO AUTOMATION PVT. LTD. (Upto 6", Rating 150# & 300#)	INDIA
3	AQUA VALVES PVT. LTD.	INDIA
4	BRIGHTCH VALVES & CONTROLS PVT. LTD. (4" x 150# for CS, AS & SS material)	INDIA
5	CHEMTECH INDUSTRIAL VALVES PVT. LTD.	INDIA

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6	CRAWLEY & RAY (FOUNDER & ENGINEERS) PVT. LTD. (DN25)	INDIA
7	DELVAL FLOW CONTROLS PVT. LTD. (Upto 12" (Upto 900#))	INDIA
8	FLOCON SYSTEMS PVT. LTD. (CS upto 6", 150#)	INDIA
9	FLOW CONTROL	INDIA
10	FLOWCHEM INDUSTRIES (UPTO 300# and upto 10")	INDIA
11	FLUIDTECH EQUIPMENT PVT. LTD(UPTO 4" (300#))	INDIA
12	FORWARD ALLOYS AND CASTINGS (Upto 900#)	INDIA
13	GURU INDUSTRIAL VALVES PVT. LTD. (Cast CS only: Upto 12" (Upto 300#), 4" (Upto 900#) & Forged: Upto 2" (800#))	INDIA
14	HAWA ENGINEERS LTD. (Upto 16" (150# & 300#), Upto 12" (600# & 900#))	INDIA
15	INTERVALVE POONAWALLA LTD. (Forged: Upto 2" (800#), Cast: Upto 12" (Upto 300#))	INDIA
16	JC VALVES & CONTROLS INDIA PVT. LTD. (CAST UPTO 28" (upto 600#), 12" (900#, 1500#) & 10"(2500#))	INDIA
17	KSB PUMPS LTD. (VALVES DIVN.) (CS upto 100DN, 20 bar)	INDIA
18	LEADER VALVES LTD. (Casting <=6" upto 600# & forging <=2" upto 800#)	INDIA
19	MEVADA ENGINEERING WORKS PVT. LTD., MUMBAI (Upto 2"(800#), (Forged), UPTO 14"(300#), Material: CS/AS/SS)	INDIA
20	MICON ENGINEERS (HUBLI) PVT. LTD. (Cast: Upto 6" (150# & 300#) & Forged: Upto 2" (800#)	INDIA
21	MICROFINISH VALVES (P) LTD.	INDIA
22	NEOSEAL ENGINEERING PVT. LTD (Upto 12" rating upto 600# and Upto 8" upto 2500#)	INDIA
23	NSSL LTD. (Upto 12" (150# & 300#))	INDIA
24	NUTECH CONTROLS (Ball Valve (CS) Upto 10", ANSI Class-upto 150#; upto 2", ANSI Class-upto 900#)	INDIA
25	OSWAL INDUSTRIES LTD. (Upto 24" (150#, 300# & 600#))	INDIA
26	SAKHI ENGINEERS PVT. LTD. (1.0 (soft seated) CS, upto 10", ANSI Class upto-300#, 2.0 (soft seated) SS, upto 3", ANSI Class upto-150#)	INDIA
27	SAP INDUSTRIES LIMITED (UPTO 16", rating 600#)	INDIA
28	SHALIMAR VALVES PVT. LTD. (Upto 18" (600#) Material: CS/AS/SS)	INDIA
29	VALVE TECH INDUSTRIES (upto 24", 600#)	INDIA
30	VIBA FLUID CONTROL (Upto 300#)	INDIA
31	VIRGO ENGINEERS LTD. (Upto 16" (upto 600#))	INDIA
32	WEIR BDK VALVES (A UNIT OF WEIR INDIA PVT. LTD.) (Cast: Upto 30" (150# & 300#), 20" (600#), 16" (900#), 12" (1500#) & Forged: Upto 2" (800#))	INDIA

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33	XOMOX SANMAR LTD. (FISHER XOMOX)	INDIA
34	BHDT GMBH	AUSTRIA
35	VELAN INC. (UPTO 16", 600#)	CANADA
36	BOTELI VALVE GROUP CO. LTD. (Upto 32" (150# & 300#), 30" (600#), 24" (900#)	CHINA
37	ZHEJIANG JIEHUA VALVE CO. LTD.	CHINA
38	ETS TROUVAY & CAUVIN	FRANCE
39	PERRIN GMBH (SIZE UPTO 24", RATING UPTO 2500#)	GERMANY
40	CESARE BONETTI SPA (Cast: Upto 4" (150#) & Forged: Upto 1" (800#) Floating only)	ITALY
41	FRIULCO SPA (UPTO 48" (150# & 300#); 20" (upto 1500#); 12" (2500#))	ITALY
42	GTC ITALIA S.R.L	ITALY
43	MANTOVANUI SPA	ITALY
44	PETROL VALVES S.R.L	ITALY
45	PIBIVESSE SRL (UPTO 48" , 600#)	ITALY
46	METSO AUTOMATION	SINGAPORE
47	POYAM VALVES (AMPO S. COOP.) (Size upto 42" (Rating upto 2500#))	SPAIN
48	HATIMA CORPORATION	TAIWAN
	BALL VALVES (METAL SEATED)	
1	AIRA EURO AUTOMATION PVT. LTD. (Upto 6", Rating 150# & 300#)	INDIA
2	BRIGHTCH VALVES & CONTROLS PVT. LTD. (4" x 150# for CS, AS & SS material)	INDIA
3	DELVAL FLOW CONTROLS PVT. LTD. (Upto 12" (Upto 900#))	INDIA
4	GURU INDUSTRIAL VALVES PVT. LTD. (Cast CS only: Upto 12" (Upto 300#), 4" (Upto 900#) & Forged: Upto 2" (800#))	INDIA
5	HAWA ENGINEERS LTD. (Upto 16" (150# & 300#), Upto 12" (600# & 900#))	INDIA
6	INTERVALVE POONAWALLA LTD.(UPTO 12" , 150#)	INDIA
7	JC VALVES & CONTROLS INDIA PVT. LTD. (UPTO 28" (upto 600#),12" (upto 1500#), 10" (2500#))	INDIA
8	MICON ENGINEERS (HUBLI) PVT. LTD. (Cast: Upto 6" (150# & 300#) & Forged: Upto 2" (800#)	INDIA
9	MICROFINISH VALVES PVT LTD.	INDIA
10	NEOSEAL ENGINEERING PVT. LTD (Upto 12" rating upto 600#)	
11	NSSL LIMITED (Upto 12" NB, (150# & 300#))	INDIA
12	OSWAL INDUSTRIES LTD. (UPTO 24" (150#, 300#, & 600#))	INDIA
13	VALVE TECH INDUSTRIES (upto 16", 300#)	INDIA

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14	VIRGO ENGINEERS LTD. (UPTO16" (UPTO 600#))	INDIA
15	WEIR BDK VALVES (A UNIT OF WEIR INDIA PVT. LTD.) (Cast: Upto 30" (150# & 300#); 20" (600#), 16" (900#), 12" (1500#) & Forged: Upto 2" (800#)	INDIA
16	VELAN INC. (SIZE UPTO 16" (Rating Upto 600#))	CANADA
17	BOTELI VALVE GROUP CO. LTD. (Upto 32" (150# & 300#), 30" (600#), 24" (900#)	CHINA
18	PERRIN GMBH (SIZE UPTO 24" (RATING UPTO 2500#))	GERMANY
19	ALFA VALVOLE SRL	ITALY
20	CESARE BONETTI SPA (UPTO 24" (150#) & 4" (UPTO 1500#) TRUNNION MOUNTED ONLY)	ITALY
21	FRIULCO SPA (UPTO 48" (150# & 300#); 20" (UPTO 1500#); 12" (2500#))	ITALY
22	GE POWER (NUOVO PIGNONE SPA)	ITALY
23	GTC ITALIA, S.R.L.	ITALY
24	PETROL VALVES S.R.L	ITALY
25	PIBIVIESSE SRL(UPTO 48", 600#)	ITALY
26	VALVITALIA SPA	ITALY
27	RED POINT ALLOYS BV	NETHERLAND
28	METSO AUTOMATION	SINGAPORE
29	ORBIT VALVES PLC	SINGAPORE
30	POYAM VALVES, (AMPO S. COOP.) (SIZE UPTO 42" (RATING UPTO 2500#))	SPAIN
	BUTTERFLY VALVES	
1	A V VALVES LIMITED (UPTO 48" (150#))	INDIA
2	ADVANCE VALVES (2"-120"(UPTO150#), 2"-80"(UPTO 900#))	INDIA
3	AIRA EURO AUTOMATION PVT. LTD. (Upto 48", Rating: upto 300#)	INDIA
4	AUDCO INDIA LIMITED (L&T VALVES DIVN.)	INDIA
5	BDK PROCESS CONTROL PVT LTD. (UPTO 1600MM)	INDIA
6	CHEMTECH INDUSTRIAL VALVES PVT LTD	INDIA
7	CRAWLEY & RAY (FOUNDER & ENGINEERS) PVT. LTD. (40mm-1000mm)	INDIA
8	DELVAL FLOW CONTROLS PVT. LTD. (Upto 24" (Upto 300#))	INDIA
9	FLOCON SYSTEMS PVT. LTD. (CS upto 12", 150#)	INDIA
10	FLOTEK INDUSTRIES (1.0 Triple offset, CS/AS, Upto 18", ANSI Class-upto 300#, 2.0 Double offset & concentric-CS, Upto 36", ANSI Class-upto 150#)	INDIA
11	FLUIDTECH EQUIPMENT PVT. LTD. (CS upto 12" (300#))	INDIA
12	FOURESS ENGINEERING (I) LTD.	INDIA

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13	HAWA ENGINEERS LTD. (2" to 48"(PN10/PN16/150#/300#))	INDIA
14	HAWA VALVES INDIA PVT. LTD. (CS UPTO 6", 150#)	INDIA
15	HI-TECH BUTTERFLY VALVES INDIA PVT. LTD (<300#,<30"(TEFLON/RUBBER) ,<72"(METAL))	INDIA
16	INSTRUMENTATION LTD. (PALAKKAD)	INDIA
17	INTERVALVE POONAWALLA LTD. (Upto 72" (150#) & Upto 16" (300#))	INDIA
18	JC VALVES & CONTROLS INDIA PVT. LTD. (Upto 20" (150#) & 10" (300#))	INDIA
19	L&T LTD (1/2" TO 24")	INDIA
20	LEADER VALVES LTD.(upto 16"- 150#)	INDIA
21	MATHER & PLATT (INDIA) LTD. A SUBSIDIARY OF WILO SE GERMAN (UPTO DN1600,PN10, Double flange type)	INDIA
22	METROPOLITAN INDUSTRIES (SIZE=2000mm)	INDIA
23	MICON ENGINEERS (HUBLI) PVT. LTD.(Upto 24" (PN10 & PN16))	INDIA
24	SAKHI ENGINEERS PVT. LTD. (upto 6", ANSI Class upto-150#)	INDIA
25	SAP INDUSTRIES LIMITED (upto 32", rating PN10; upto 18", rating 150#)	INDIA
26	VALVE TECH INDUSTRIES (upto 48", 300# & upto 24", 600#)	INDIA
27	VENUS PUMP & ENGINEERING WORKS (upto 600NB, 150#)	INDIA
28	VIRGO ENGINEERS LTD. ((Triple offset only): 3" to 24", Upto 600# (CS/SS))	INDIA
29	WEIR BDK VALVES (A UNIT OF WEIR INDIA PVT. LTD.) (Upto 56" (Upto 150#), 24" (300#))	INDIA
30	XOMOX SANMAR LIMITED (FISHER XOMOX)	INDIA
31	TOMOE VALVE CO. LTD. (Upto 48"(150# & 300#), Upto 24"(600#, 900# & 1500#))	JAPAN
32	BHDT GMBH	AUSTRIA
33	VELAN INC. (Size upto 48"(Rating upto 600#)	CANADA
34	BOTELI VALVE GROUP CO. LTD. (Upto 36" (150# & 300#)	CHINA
35	ZHEJIANG JIEHUA VALVE CO. LTD.	CHINA
36	GRISS SAPAG INDUSTRIAL VALVES	FRANCE
37	ADAMS ARMATUREN	GERMANY
38	GTC ITALIA, S.R.L.	ITALY
39	HAITIMA CORPORATION	TAIWAN
40	LEEDS VALVE LTD	U.K
41	WEIR VALVES & CONTROLS DIVISION.	U.K
42	CURTIS WRIGHT FLOW CONTROL CORPOARATION	U.S.A.
43	EMERSON PROCESS MGT	U.S.A.

<div> पी डी आई एल PDIL</div>	IMPLEMENTATION OF ZERO LIQUID DISCHARGE (ZLD) UNIT AT RFCL, RAMAGUNDAM PLANT VENDOR LIST	PC211/E/001/P-II/Sec-11.0	0	<div> रामगुंडम रॉफ़िनरी एवं पीट्रोल रिफ़ाइनरी लिमिटेड</div>
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44	LEAR SIEGLER MEAS. CTRLS. CORP	U.S.A.
45	SPX VALVES & CONTROLS (COPES-VULCAN LTD)	U.S.A.
46	TYCO INTERNATIONAL INC.,U.S.A.	U.S.A.
47	XOMOS (CRANE CO.)	U.S.A.
	BLOWDOWN VALVES	
1	VELAN INC.(SIZE UPTO 2"(RATING UPTO 1500#)	CANADA
2	GESTRA AG	GERMANY
3	CEASRE BONETTI SPA(UPTO 3"(UPTO 2500#))	ITALY
4	TYCO INTERNATIONAL INC, U.S.A.	U.S.A.
	SAMPLING VALVES/ NEEDLE VALVES	
1	ASSOCIATED TOOLINGS (I) PVT. LTD. (1/2" to 1 1/2", Rating: 800#)	INDIA
2	CHEMTECH INDUSTRIAL VALVES PVT LTD	INDIA
3	EXCELSIOR ENGG WORKS	INDIA
4	EXPERT ENGINEERING ENTERPRISES(UPTO 12"-150# & 300#)	INDIA
5	FLOTEK INDUSTRIES (Needle Valve, SS, upto 0.5-0.75", ANSI Class upto 800-2500#)	INDIA
6	LEADER VALVES LIMITED(SIZE<=1 1/2"-800#)	INDIA
7	TECNOMATIC (INDIA) PVT LTD.	INDIA
8	WEIR BDK VALVES (A UNIT OF WEIR INDIA PVT. LTD.) (UPTO 50MM SIZE (upto 2500#))	INDIA
	PLUG VALVES (NON LUBRICATED)	
1	A V VALVES LIMITED (UPTO 20"(150#)(CS&SS))	INDIA
2	AUDCO INDIA LTD (L&T VALVES DIVN.)	INDIA
3	AZ ARMATUREN GMBH (1/2" TO 20"(150#, 300# & 600#), Matl. CS, AS &SS)	INDIA
4	BDK PROCESS CONTROL PVT LTD.	INDIA
5	CHEMTECH INDUSTRIAL VALVES PVT LTD	INDIA
6	CHEMTROLS SAMIL (INDIA) PVT LTD (Upto 12"-150# & 300#))	INDIA
7	CRAWLEY & RAY (FOUNDERS & ENGINEERS) PVT. LTD (DN 200)	INDIA
8	FLUIDTECH EQUIPMENT PVT. LTD. (Upto 4" (300#))	INDIA
9	GURU INDUSTRIAL VALVES PVT. LTD. (Cast CS only: Upto 12" (Upto 300#), Upto 4" (Upto 900#)) & Forged: Upto 2" (800#))	INDIA
10	HAWA ENGINEERS LTD. (1/2" TO 8" (150#))	INDIA
11	JC VALVES & CONTROLS INDIA PVT. LTD. (Upto 12" (Upto 300#))	INDIA
12	LARSON & TOUBRO LTD (1/2" TO 24")	INDIA
13	LEADER VALVES LIMITED (Upto 6" (Upto 300#))	INDIA
14	SAP INDUSTRIES LIMITED (upto 12", rating 150#)	INDIA
15	WEIR BDK VALVES (A UNIT OF WEIR INDIA PVT. LTD.) (UPTO	INDIA

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	16"(150#), 12" (300#), 3" (600#))	
16	XOMOX SANMAR LIMITED (FISHER XOMOX)	INDIA
17	ZHEJIANG JIEHUA VALVE CO. LTD.	CHINA
18	O.M.S. SALERI DI SALERI P & FIGLI S.M.C.	ITALY
19	POYAM VALVES, (AMPO S. COOP.) (UPTO 30" (UPTO 900#) FOR LIFT PLUG VALVES ONLY.)	SPAIN
	PLUG VALVES (LUBRICATED)	
1	A V VALVES LIMITED (Upto 20"-150# CS & SS)	INDIA
2	AUDCO INDIA LTD (L&T VALVES DIVISION)	INDIA
3	BDK PROCESS CONTROLS PVT. LTD	INDIA
4	ECONO VALVES PVT. LTD (<=8" (150 - 300#), <= 1 ½" (<=800#))	INDIA
5	FLUIDTECH EQUIPMENT PVT. LTD (Upto 4"-300#)	INDIA
6	GURU INDUSTRIAL VALVES PVT. LTD (Cast CS only: Upto 12"-300#, 4" Upto 900# & Forged: upto 2"-800#)	INDIA
7	HAWA ENGINEERS LTD. (1/2" TO 8" -150#)	INDIA
8	JC VALVES & CONTROLS INDIAN PVT. LTD (Upto 12"-300#)	INDIA
9	WEIR BDK VALVES (A UNIT OF WEIR INDIA PVT.LTD)Upto 8"-125#	INDIA
10	ZHEJIANG JIEHUA VALVES CO. LTD	CHINA
11	DELTA VALVES EUROPE	ITALY
12	O.M.S SALERI DI SALERI P & FIGLI S.M.C	ITALY
13	BABCOCK BORSIG ESPANA, S.A	SPAIN
	DIAPHRAGM VALVES/RUBBER LINED CHECK VALVES	
1	A V VALVES LIMITED (Upto 12"-125#)	INDIA
2	AKAY INDUSTRIES PVT LTD	INDIA
3	BDK PROCESS CONTROLS PVT. LTD. (Upto 150#, 6 mm to 350mm)	INDIA
4	CHEMTECH INDUSTRIAL VALVES PVT. LTD	INDIA
5	CRAWLEY & RAY (FOUNDERS & ENGINEERS) PVT. LTD (25NB to 200NB)	INDIA
6	HAWA ENGINEERS LTD (1/2" to 8" –PN10)	INDIA
7	WEIR BDK VALVES (A UNIT OF WEIR INDIA PVT LTD)(UPTO 14"(PN16))	INDIA
	CAST IRON VALVES	
1	A V VALVES LTD. (Upto 48" (125#))	INDIA
2	CRAWLEY & RAY (F&E) PVT. LTD. (BUTTERFLY)	INDIA
3	FLUIDTECH EQUIPMENT PVT. LTD. (Upto 24" (PN 1.0 & PN 1.6))	INDIA
4	GEETA ENGINEERING WORKS	INDIA
5	KIRLOSKAR BROTHERS LIMITED (Sluice, gate, butterfly valves	INDIA

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	PN1.0 & PN1.6)	
6	LEADER VALVES LTD. (size<=24" upto PN16 rating)	INDIA
7	S & M INDUSTRIAL VALVES LIMITED (ONLY GATE & GLOBE VALVES, 50mm-600mm, 125#)	INDIA
8	SAP INDUSTRIES LIMITED (upto 12", rating 150#)	INDIA
9	VENUS PUMPS & ENGINEERING WORKS (sluice<900mm, Diaphragm<300mm, stop<500mm)	INDIA
10	WEIR BDK VALVES (A UNIT OF WEIR INDIA PVT. LTD.) (Upto 12" (PN6))	INDIA
	PVC/CPVC VALVES	
1	ASTRAL POLYTECHNIK PVT. LTD (Size ½"-6", BUTTERFLY VALVE Upto 24")	INDIA
2	S & M INDUSTRIAL VALVES LTD. (32mm-80mm)	INDIA
	FLAT GASKETS/RUBBER GASKET	
1	FERROLITE JOININGS (P) LTD.	INDIA
2	GASKETS (INDIA) PVT. LTD	INDIA
3	GOODRICH GASKET PVT. LTD. (UPTO 24")	INDIA
4	HINDUSTAN ASBESTOS & ALLIED PRODUCTS	INDIA
5	HINDUSTAN COMPOSITE LTD.	INDIA
6	HINDUSTAN FERREDO LTD.	INDIA
7	IGP ENGINEERS LIMITED	INDIA
8	MADRAS INDUSTRIAL PRODUCTS (UPTO 48")	INDIA
9	MECHANICAL PACKING INDUSTRIES LTD.	INDIA
10	NEOSEAL ENGINEERING PVT. LTD (Upto 80" 150#- Only rubber gasket)	INDIA
11	PACKING & JOINTINGS (P) LTD.	INDIA
12	PERFECT MARKETING (P) LTD,	INDIA
13	PRASHANT ENGG STORES	INDIA
14	REINZ TALBROS PVT. LTD.	INDIA
15	SPIRALSEAL GASKETS PVT. LTD. (CAF & Teflon)	INDIA
16	STARFLEX SEALING INDIA PVT. LTD.	INDIA
17	THE BENGAL MILL STORES SUPPLY CO. (TRADER)	INDIA
18	UNIQUE INDUSTRIAL PACKINGS PVT. LTD.	INDIA
	SPIRALLY WOUND GASKETS	
1	GASKETS (INDIA) PVT. LTD	INDIA
2	GOODRICH GASKET PVT. LTD. (upto 24")	INDIA
3	IGP ENGINEERS LIMITED (10 TO 3550 MM, 150#-2500# FOR EXCH GSKT)	INDIA

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4	MADRAS INDUSTRIAL PRODUCTS (UPTO 52")	INDIA
5	NEOSEAL ENGINEERING PVT. LTD (Upto 84", 150# and 30", upto 600#)	INDIA
6	PACKINGS & JOINTINGS PVT. LTD	INDIA
7	PERFECT MARKETING (P) LTD,	INDIA
8	PRASHANT ENGG STORES	INDIA
9	SPIRASEAL GASKETS PVT. LTD.(SS UPTO 12" & 150#)	INDIA
10	STARFLEX SEALING INDIA PVT. LTD.	INDIA
11	THE BENGAL MILL STORES SUPPLY CO. (TRADER)	INDIA
12	UNIQUE INDUSTRIAL PACKINGS PVT.LTD. (UPTO 42"(600#) & UPTO 24" (2500#))	INDIA
13	ZHEJIANG JIEHUA VALVE CO. LTD.	CHINA
	LENS GASKETS & RING JOINT (METALLIC)	
1	GASKETS (INDIA) PVT. LTD	INDIA
2	GOODRICH GASKET PVT. LTD. (0.5" to 24")	INDIA
3	IGP ENGINEERS LTD. (150# to 2500#)	INDIA
4	MADRAS INDUSTRIAL PRODUCT	INDIA
5	METROPOLITAN INDUSTRIES (3mm thk, 300#)	INDIA
6	NEOSEAL ENGINEERING PVT. LTD. (Upto 30", Upto 900# AND Upto 20"- upto 2500#)	INDIA
7	PACKINGS & JOINTINGS PVT. LTD.	INDIA
8	PRASHANT ENGG STORES	INDIA
9	SPIRASEAL GASKET PVT. LTD	INDIA
10	STARFLEX SEALING INDIA PVT. LTD	INDIA
11	UNIQUE INDUSTRIAL PACKINGS PVT. LTD (Ring Joint Gasket only, Upto 16"-1500#)	INDIA
12	BHDT GMBH	AUSTRIA
13	MANTOVANI SPA	ITALY
	EXPANSION JOINTS & BELLOWS	
1	CORI ENGINEERS PVT. LTD. (For Rubber)	INDIA
2	D.WREN & CO. (For Rubber & Fabric)	INDIA
3	FLEXATHERM EXPANLLOW PVT. LTD. (Circular: Upto 240", Rectangular No bar for size, (Upto 600#))	INDIA
4	FLEXICAN BELLOWS & HOSES PVT. LTD	INDIA
5	FLUIDYNE ENGINEERS (I) PVT. LTD(METALLIC BELLOWS UPTO 800 mm DIA)	INDIA
6	KELD ELLENTOFT INDIA PVT. LTD (For Fabric)	INDIA
7	LONESTAR INDUSTRIES	INDIA

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8	MB METALLIC BELLOWS PVT. LTD	INDIA
9	PRASHANT ENGG. STORES	INDIA
10	STANDARD PRECISION BELLOWS	INDIA
11	TUBOFLEX	GERMANY
12	FLEXIDER S.P.A.	ITALY
	STRAINERS (PERMANENT INCLUDING Y-TYPE)	
1	CHEMTECH INDUSTRIAL VALVES PVT. LTD	INDIA
2	FLAIR STRAINERS & FILTERS (SIZE UPTO 42" (RATING UPTO 1500#))	INDIA
3	FLOTEK INDUSTRIES (Strainer (Y-Type) CS, upto 8", ANSI Class-upto 2500#)	INDIA
4	GRAND PRIX ENGINEERING PVT. LTD. (UPTO 60" PIPELINE, UPTO ANSI 1500#)	INDIA
5	GREAVES LIMITED	INDIA
6	GUJARAT OTOFILT	INDIA
7	HAWA ENGINEERS LTD. (1/2" to 24"(150# / 300# / PN10 / PN40))	INDIA
8	KWIKFLO FILTERS PVT. LTD.	INDIA
9	LEADER VALVES LTD. (upto 300# & upto 12" size)	INDIA
10	MOD FABRICATORS	INDIA
11	MULTITEX FILTRATION ENGINEERS LTD	INDIA
12	SAP INDUSTRIES LIMITED (upto 6")	INDIA
13	ZOLOTO INDUSTRIES (15MM TO 100MM)	INDIA
14	BOTELI VALVE GROUP CO. LTD. (Y - TYPE ONLY: 14" (150#) & 3" (300# & 600#))	CHINA
	STEAM TRAPS	
1	GREAVES LTD.	INDIA
2	MOD FABRICATORS (for Drip Rings)	INDIA
3	PENNANT ENGINEERING PVT. LTD.	INDIA
4	VIRGO ENGINEERS LTD. (1/2" to 4" (upto 600#) (CS/SS))	INDIA
5	YARWAY CORPORATION	INDIA
6	ZOLOTO INDUSTRIES (15 mm to 25 mm)	INDIA
7	GESTRA AG	GERMANY
8	ARMSTRONG INTERNATIONAL INC.	U.S.A
9	OGONTZ CORPORATION	U.S.A
10	TYCO INTERNATIONAL INC.,U.S.A.	U.S.A
	SPRING SUPPORTS	
1	PIPE SUPPORTS CO. (Upto 14MT)	INDIA
2	MYRICS PIPING SYSTEM PVT.LTD.	INDIA

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3	PIPE SUPPORTS INDIA PVT. LTD.	INDIA
4	PIPING & ENERGY PRODUCTS (P) LTD.	INDIA
5	SARATHI ENGG. ENTERPRISES PVT. LTD.	INDIA
6	SPRING SUPPORTS MFG. CO.	INDIA
7	FLEXIDER S.P.A.	ITALY
	FLAME ARRESTORS	
1	AIROIL FLAREGAS (INDIA) PVT. LIMITED	INDIA
2	EMFA INDUSTRIES	INDIA
3	M.H. VALVES PVT. LTD (1/2"-1.5": 800#, 2"-6": 600#)	INDIA
4	NIRMAL INDUSTRIAL CONTROLS PVT. LTD (1/2" TO 8", RATING:150#)	INDIA
5	PETROL SERVICE INDIA PVT. LTD.	INDIA
6	L & J TECHNOLOGIES	U.S.A.
	SPRAY NOZZLE ASSEMBLY	
1	CHEMTROLS SAMIL (INDIA) PVT. LTD.	INDIA
	FASTENERS	
1	AEP COMPANY	INDIA
2	CAPITAL INDUSTRIES	INDIA
3	CONSOLE ENGG. & FASTNERS INDUSTRIES	INDIA
4	EBY FASTNERS	INDIA
5	FIT TIGHT NUTS & BOLTS LTD.	INDIA
6	FIX FIT FASTENERS MFG. PVT. LTD.	INDIA
7	HEM INDUSTRIES (Upto 4")	INDIA
8	INDUSTRIAL ENGINEERING CORPORATION (SIZE UPTO 4" (M100))	INDIA
9	MEGA ENGINEERING PRIVATE LIMITED (½" TO 3" MATERIAL: CS/AS/SS)	INDIA
10	METRO MECHANICAL PVT.LTD.	INDIA
11	NAGBHUSHANAM INDUSTRIES	INDIA
12	NIREKA ENGG. CO. PVT. LTD.	INDIA
13	PACIFIC FORGING & FASTENERS PVT. LTD. (M 10 TO M125)	INDIA
14	PERFECT MARKETING (P) LTD,	INDIA
15	PIONEER NUTS & BOLTS PVT. LTD. (1/4" TO 4" DIA)	INDIA
16	PRECISION AUTO ENGINEERS	INDIA
17	PRECISION ENGINEERING INDUSTRIES	INDIA
18	PTD FASTNERS PVT. LTD.	INDIA
19	SANGHVI METALS (TRADER)	INDIA
20	SUNDARAM FASTENERS LIMITED	INDIA

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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
	FIRE WATER PUMPS	
1	BEST & CROMPTON ENGG. CO.	INDIA
2	GREAVES COTTON & CO. LTD.	INDIA
3	JAYANT ENGINEERING & MARKETING (P) LTD.	INDIA
4	KIRLOSKAR BROTHERS LIMITED	INDIA
5	MATHER & PLATT INDIA LTD. (A Subsidiary of WILO SE German)	INDIA
	PORTABLE FIRE EXTINGUISHERS & FIRE FIGHTING CHEMICALS	
1	CEASEFIRE INDUSTRIES LTD	INDIA
2	PYROTEK INDUSTRIES (INDIA) PVT. LTD.	INDIA
3	UNITECH MACHINES LTD.	INDIA
4	ZENITH FIRE SERVICES INDIA PVT. LTD	INDIA
	SMOKE / GAS DETECTOR	
1	CEASEFIRE INDUSTRIES LTD	INDIA
2	PYROTEK INDUSTRIES (INDIA) PVT. LTD.	INDIA
3	UNITECH MACHINES LTD.	INDIA
4	ZENITH FIRE SERVICES INDIA PVT. LTD	INDIA
	FIRE FIGHTING EQUIPMENTS	
1	DE'S TECHNICO PVT. LTD. (Deluge Valve and Sprinklers only.)	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. (Equipments for Fire Hydrant System)	INDIA
6	ZENITH FIRE SERVICES INDIA PVT. LTD	INDIA
	MARINE LOADING ARM	
1	LLOYDS STEELS INDUSTRIES LIMITED (8" TO 20")	INDIA
	TRUCK/WAGON LOADING ARM	
1	LLOYDS STEELS INDUSTRIES LIMITED (2" TO 4")	INDIA
2	WOODFIELD SYSTEMS INTERNATIONAL PVT LTD (upto SIZE: CORE-4"/ JACKET-6")	INDIA



NOTE(Piping vendor list):

1. Make of the items not indicated and any other make for the specified item shall be subject to owner's / consultant's approval.
2. Any item for which vendor list is not enclosed; bidder has to furnish a list of their proposed

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vendors along with their references for supply of similar type of items with their proven track record. Vendor for these items shall be finalized during execution/detail engineering stage.

3. Any addition to vendor list of listed item shall be reviewed and approved by Owner/PMC, subject to submission of proper justification/reason and back-up credentials with proven & reliable record of performance for similar items on case to case basis.
4. In case of trader/stockist, make of items shall be as per approved vendor list.



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7.0 INSTRUMENTATION



Sl.No	Vendor's Name	Country
Gas Analysers (IR, Thermal Conductivity, Paramagnetic)		
1.	ABB Ltd (BU – Analytical &Adv)	India
2.	Chemtrols Industries Limited (Maihak Make)	India
3.	Emerson Process Management (I) Pvt. Ltd	India
4.	Endress+ Hauser (India) pvt. Ltd.	India
5.	Yokagawa	India
6.	Ametek ,INC	U.S.A
7.	Emerson Process Mgt Singapore Ltd.	Singapore
8.	MaihakAktiengesellschaft	Germany
9.	M.S.A International	U.S.A
10.	Siemens AG	Germany
Sodium Analyser		
1.	ABB	India
2.	Hach	U.S.A.
3.	Thermofisher	U.S.A
4.	Waltron	U.S.A
Chlorine Analyser		
1.	ABB	India
2.	Hach	U.S.A.
3.	Krohne	U.K
4.	E&H	India
5.	Waltron	U.S.A
6.	Thermofisher	U.S.A
Turbidity Analyser		
1.	Hach	U.S.A.
2.	Yokogawa	JAPAN
SDI Analyser		
1.	Rodi	USA
Ph, conductivity & ORP Analyser		
1.	ABB India Limited	India
2.	BELA INSTRUMENTS (For Knick, GmbH make), Mumbai(For ConductivityAnalyser)	India
3.	Chemtrols Industries Limited	India
4.	Emerson Process Management (I) Pvt. Ltd	India
5.	Endress+ Hauser (India) pvt. Ltd. (Liquid Analyser)	India
6.	Forbes polymetron Pvt. Ltd.	India
7.	POTENCE CONTROLS (for GLI International make), Mumbai.(For ConductivityAnalyser)	India
8.	Yokogawa India Ltd.	India
9.	Emerson Process Mgt Singapore Ltd.	Singapore
10.	Foxbro Far East PTE Ltd.	Singapore
11.	Hach Company	U.S.A
12.	Yokogawa Electric Corporation	Japan
13.	Zellweger SA	France
Trace Analyser/ Ion Selective		
1.	ABB India Limited	India

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2	Chemtrols Industries Limited	India
3	Forbes Polymetron Pvt. Ltd	India
4	Bran & Luebbe Ltd	U.K
5	Hach company	U.S.A
6	Zellweger SA	France
PC / SERVERS		
1.	DELL	INDIA
SO_x/ NO_x Analyser		
1.	ABB India Ltd.	India
2.	Chemtrols Industries Limited	India
3.	Emerson Process Management (I) Pvt. Ltd	India
4.	Yokogawa India Ltd.	India
5.	Emerson Process Management Singapore Ltd	Singapore
6.	Horiba Ltd.	Japan
7.	Lear Siegler Meas. Controls Corp.	U.S.A
8.	M.S.A International	U.S.A
9.	Sick AG	Germany
10.	Siemens AG	Germany
11.	Thermo Environment Instruments Inc	U.S.A
12	Yokogawa Electric Corporation	Japan
Mass Spectrometer		
1.	ABB India Ltd.	India
2.	Orbital Science Corporation	U.S.A
3.	VG Gas Analysis Systems	U.K.
Gas Chromatograph		
1.	ABB India Limited	India
2.	Emerson Process Management (I) Pvt. Ltd.	India
3	Applied Automation Inc	Singapore
4	ABB Process Analytics	U.K
5.	Foxbaro Far East Pte Ltd	Singapore
6.	Siemens	Germany
7	Yokogawa India Ltd.	India
Flue Gas Analyser (ZrO₂ type)		
1.	ABB Ltd (BU – Analytical & Adv)	India
2.	Chemtrol (For MAIHAK Only)	India
3.	Emerson Process Management (I) Pvt. Ltd	India
4.	Endress+Hauser	India
5	Yokogawa India Ltd.	India
6	Ametek Inc	U.S.A
7.	GE Panametrics	Ireland
H₂S/ Total Sulphur Analysers		
1.	ABB India Ltd.	India
2.	Barton Instrument Systems Limited	U.K
System House Analysers		
1.	ABB Ltd (BU – Analytical & Adv)	India
2.	Adage Automation Pvt. Ltd.	India
3.	Analyser Instrument Co. Pvt. Ltd.	India
4.	Chemtrols Industries Limited	India
5.	Emerson Process Management (I) Pvt. Ltd	India

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6.	Yokogawa India Ltd.	India
7.	Intech	Italy
Density Analysers		
1.	Chemtrols Industries Limited	India
2.	Emerson Process Management (I) Pvt. Ltd (coriolis type)	India
3.	Bopp & Reuther MesstechnikGmbh (coriolis type)	Germany
4.	Solartron Mobrey	U.K
Moisture Analysers		
1.	Chemtrols Industries Limited	India
2.	AmetekInc	U.S.A
3.	GE Panametrics	Italy
Gas & Fire Detection System		
1.	Andrew Yule & Company Ltd. (Fire)	India
2.	Chemtrols Industries Limited	India
3.	Honeywell Automation India Limited (Gas)	India
4.	J B Boda And Brothers Pvt. Ltd. (Gas Make-International Sensor Technology)	India
5.	Pollution Protection System Mumbai Pvt Ltd (Gas)	India
6.	General Monitors (Gas)	U.K
7.	Teledyne Fluid Systems (Gas)	Thailand
Air Quality Monitoring System		
1	Chemtrol Industries Ltd.	India
Sample Handling System		
1.	Analyser Instrument Co.Pvt. Ltd.	India
Flow Element: Orifice/ Venturi/ Flow Nozzle		
1.	Baliga Lighting (only Orifice)	India
2.	Chemtrol Industries Ltd.	India
3.	Delta Engineering, Pune	India
4.	Eureka Industrial Equipments Pvt. Ltd.	India
5.	FORBES MARSHALL	India
6.	Flowtech Instruments (Orifice/Venturi)	India
7.	General Instruments Consortium	India
8.	Instrumentation Ltd.	India
9.	Micro Precision Products Private Ltd.	India
10.	Micro India Flow Elements Pvt. Ltd.	India
11.	Minco(India) Flow Instruments Pvt. Ltd.	India
12.	Unicontrols Instrument Pvt. Ltd.	India
13.	Bopp & Reuther Messtechnik GMBH	Germany
14.	Daniel Measurement & Control	USA
15.	ISA Controls Limited	U.K
16.	Technomatic SPA	Italy
Pitot Tube/ Annubar		
1.	ABB India Limited	India
2.	Control Engineers	India
3.	Emerson Process Management (I) Pvt. Ltd.	India
4.	Micro Precision Products Private Ltd.	India
5.	Unicontrols Instruments Pvt. Ltd.	India
6.	Daniel Measurement & Control	U.S.A
7.	ISA Controls Limited	U.K
8.	Technomatic Spa	Italy

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Rotameters		
1.	ABB india Ltd.	India
2.	Chemtrols Industries Ltd.	India
3.	Delta Control	India
4.	Eureka Industrial Equipments Pvt. Ltd.	India
5.	Flowtech Instruments services	India
6.	Instrumentation Engineers Pvt. Ltd.	India
7.	Krohne Marshall Pvt. Ltd.	India
8.	Placka Instruments & Controls Pvt. Ltd. (Purge Rotameter Only)	India
9.	Rota Instrumentation	India
10.	Yokogawa	India
11.	Rota Yokogawa Gmbh & Co. Kg	Germany
12.	Tokyo Keiso Co.Ltd.	Japan
13.	Azbil Corporation	Japan
14.	Emerson Process Mgt	U.S.A
15.	Krohne	Germany
Mass Flow Meter (Coriolis Type)		
1.	ABB India Limited	India
2.	Chemtrol Industries Ltd	India
3.	Emerson Process Management (I) Pvt. Ltd.	India
5.	Endress + Hauser	India
6.	SIEMENS Ltd.	India
7.	Yokogawa	India
8.	Bopp & Reuther Messtechnik GMBH	Germany
7.	Krohne	Germany
8.	Schlumberger resource management Ltd.	U.S.A
Turbine Flowmeter		
1.	ABB India Ltd.	India
2.	Chemtrol Industries Ltd	India
3.	Krohne	India
4.	Yokogawa	India
5.	Azbil Corporation	Japan
6.	Bopp & Reuther Messtechnik Gmbh	Germany
7.	Barton Instrument System Ltd.	U.K.
8.	Emerson Process Mgt	U.K.
9.	Emerson Process Mgt.	U.S.A
10.	Instromet International N.V.	Holland
11.	Itochu Corporation	Japan
12.	Oval Asea Pacific Pte Ltd.	Singapore
13.	Rockwell International Corporation	U.S.A
Vortex meter		
1.	ABB India Ltd.	India
2.	Emerson Process Management (I) Pvt. Ltd.	India
3.	Krohne Marshall Pvt. Ltd.	India
4.	Siemens Ltd.	India
5.	Yokogawa Limited	India
6.	Bopp & Reuther MesstechnikGmbh	Germany
7.	Endress + Hauser	Germany
8..	Itochu Corporation	Japan

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9.	Krohne	Germany
10.	Schlumberger resource management Ltd.	U.S.A
PD Meter		
1.	Chemtrols Industries Ltd.	India
2.	Rock Flow Meters (i) Pvt. Ltd.	India
3.	Bopp & Reuther MesstechnikGmbh	Germany
4.	Emerson Process Managment	U.S.A
5.	Oval Asea Pacific Pte Ltd.	Singapore
6.	Schlumberger resource management Ltd.	U.S.A
Magnetic Flow meter		
1.	ABB India Ltd.	India
2.	Chemtrol Industries Ltd	India
3.	Emerson Process Management (I) Pvt. Ltd.	India
4.	Endress + Hauser (India) Pvt. Ltd.	India
5.	Krohne Marshall Pvt. Ltd.	India
6.	Siemens Ltd.	India
7.	SBEM Pvt. Ltd.	India
8.	Yokogawa	India
9.	Azbil Corporation	Japan
10.	Bopp & Reuther MesstechnikGmbh	Germany
11.	Krohne	Germany
Insertion Type Flow Meter		
1	Emerson Process Management (I) Pvt. Ltd.	India
2	Siemens Ltd.	India
Ultrasonic Flow Meter		
1	Chemtrol Industries Ltd	India
2.	Endress + Hauser (India) Pvt. Ltd.	India
3.	Emerson Process Management	India
4	Siemens Ltd.	India
5	Yokogawa	India
6	EIP enviro level controls private limited	India
Orifice Meter		
1	Chemtrol Industries Ltd	India
Metering Skid		
1.	Chemtrol Industries Ltd.	India
Pressure Gauges		
1.	Ashcroft India(P) Ltd. (standard normal type)	India
2.	A.N. Instruments Pvt. Ltd.	India
3.	Baumer Technologies India Pvt . Ltd	India
4.	Forbes Marshall	India
5.	General Instruments Consortium,	India
6.	H.Guru Industries	India
7.	Peejee Engg. Works	India
8.	Precision Industries Ltd. (standard normal type)	India
9.	Premium Instrument & Controls Ltd.	India
10.	Manometer (India) Pvt. Ltd.	India
11.	Walchand Nagar Industries Ltd.	India
12.	Wika	India
13.	Budenberg Gauge Co. Ltd	U.K

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14.	Dresser Europe S.A	Germany
15.	Nagano keiki Seisakusho	Japan
16.	Rueger Sa	Switzerland
17.	Spriano Spa	Italy
18.	WikaAlexanderWiegardGmbh& Co.	Germany
Local D/P Indicators		
1.	Precision Mass Products Pvt. Ltd	India
2.	Switzer Instrument Co.	India
3.	Wika	India
4.	Barton Instrument Systems Limited	U.K
5.	Delta Controls Ltd.	U.K
Pressure & D/P Transmitters		
1.	ABB India Ltd.	India
2.	Emerson Process Management (I) Pvt. Ltd.	India
3.	Endress + Hauser (India) Pvt.Ltd.	India
4.	Honeywell Automation India Limited	India
5.	Siemens Ltd.	India
6.	Yokogawa Limited	India
7.	Azbil Corporation	Japan
8.	Emerson Process Mgt Singapore Ltd	Singapore
9.	Honeywell Inc.	U.S.A
10.	Moore Products Company	U.S.A
11.	Siemens Ag, Germany	Germany
12.	Smar Singapore Pte. Ltd.	Singapore
13.	VEGA Grieshaber KG	Germany
14.	Yokogawa Electric Corporation	Japan
Pressure & D/P Switches Including Vol. Seal		
1.	Endress + Hauser(India) Pvt. Ltd.	India
2.	Indfos Industries Ltd. (Except Vol.Seal)	India
3.	Kaustubha Udyog (Except Vol.Seal)	India
4.	Precision Mass Products Pvt. Ltd	India
5.	Switzer Instrument Co. (Except Vol.Seal)	India
6.	Azbil Corporation	Japan
7.	Delta Controls Ltd.	U.K
8.	Nagano Keiki Seisakusho	Japan
9.	SOR Inc.	U.S.A
10.	United Electric Controls Co.	U.S.A
Transparent/ Reflex / Bicolor Mag.Level Gauges		
1.	ABB India Ltd.	India
2.	Bliss Anand Private Ltd.	India
3.	Chemtrols Samil(India) Pvt Ltd.	India
4.	Flowtech Instruments services	India
5.	LEVCON INSTRUMENTS PVT. LTD.	INDIA
6.	Nisan Scientific Process Equipments Pvt. Ltd	India
7.	Pune Techtrol Pvt. Ltd. (= < 300#)	India
8.	Technomatic (India) Pvt. Ltd.	India
9.	V-Automat Instruments Pvt. Ltd. (upto 300#)	India
10.	Clark-Reliance Corp.	U.S.A
11.	CesareBonetti	Italy

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12	Jerugson Gauge & Valve Co.	U.S.A
13	Nihon Klingage Co. Ltd.	Japan
14	Richard Klinger Ag	Austria
15	Technomatic Spa	Italy
Level Switches (Float & Displacer Type)		
1.	ABB India Ltd.	India
2.	Bliss Anand Private Ltd.	India
3.	Chemtrols Samil(India) Pvt Ltd.	India
4.	Pune Techtrol Pvt. Ltd.	India
5.	SBEM Pvt. Ltd.	India
6.	Siemens Ltd.	India
7.	V.Automat & Instruments (P) Ltd.	India
8.	ISA Controls Limited	U.K.
9	KDG. MOBREY Ltd.	U.K.
10	Magnetrol International N.V	Belgium
11	SOR Inc.	U.S.A
12.	Vega Grieshaber KG	Germany
Displacer Type Level Transmitters		
1.	Chemtrols Industries Limited (Eckdard Make Electronics)	India
2.	Dresser Valve India Pvt Ltd (Rating <= 600#)	India
3.	Dresser Masoneilan	France
4.	Foxboro EckardtGmbh	Germany
5.	Magnetrol International N.V. (Lvdit)	Belgium
6.	Parcol Spa (Pneumatic Transmission Only)	Italy
Tank Level Instruments		
1.	ABB India Limited	India
2.	Emerson Process Management (i) Pvt. Ltd.	India
3.	Pune Techtrol Pvt. Ltd.	India
4.	Siemens Ltd. (Radar level Transmitter, guided wave Radar)	India
5.	SBEM Pvt. Ltd.	India
6	EnrafSingaporePte. Ltd.	Singapore
7.	Endress + Hauser Gmbh& Co., (Non-Contact & Servo)	Germany
8.	Krohne (Non-Contact Type)	Germany
9.	L& J Technologies	U.S.A
10.	Toyo Keiso Co. Ltd.	Japan
11	EIP enviro level controls private limited	India
Ultrasonic Level Transmitter		
1.	Forbes Marshall	India
2.	Siemens Ltd.	India
3	Vega Grieshaber KG	Germany
4	EIP Enviro level controls private limited	India
Tank Farm Management		
1.	Endress + Hauser (India) Pvt. Ltd. (Servo,Radar)	India
Guided wave Rdar		
1.	Endress + Hauser (India) Pvt. Ltd	India
2.	Forbes Marshall	India
3	Magnetrol	India
4	Vega Grieshaber KG	Germany
Temperature Elements (Thermocouple, Rtd)		

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1.	Altop Industries Ltd.	India
2.	ABB India Ltd.	India
3.	Detriv Instrumentation & Electronics Ltd.	India
4.	Electrical & Electronics Ltd.	India
5.	Eleind Engineering Pvt. Ltd.	India
6.	Endress + Hauser (India) Pvt. Ltd.	India
7..	Exotherms Instruments	India
8.	General Instruments Consortium	India
9.	Goa Instruments Industries Ltd.	India
10.	Industrial Instrumentation	India
11.	Precision Mass Products Pvt. Ltd.	India
12.	Pyro Electric Instruments Goa Pvt. Ltd.	India
13.	Tempsens Instruments (I) Pvt. Ltd.	India
14	Thermal Instruments India Pvt. Ltd.	India
15	Unicontrols Instruments Pvt. Ltd.	India
16	Azbil Corporation	Japan
17	Okazaki Manufacturing Co.	Japan
18	Sensycon	Germany
19	Thermo Electric Co.Ltd.	Holland
20	W.C.Heraeus GMBH	Germany
Bimetallic Thermometer		
1.	A N Instruments Pvt. Ltd.	India
2.	Ashcroft India(P) Ltd.	India
3.	Baumer Technologies India Pvt. Ltd.	India
4.	General Instruments Consortium	India
5.	Goa Instruments Industries Ltd	India
6.	H.Guru Industries	India
7	Krohne Marshall Pvt. Ltd.	India
8	Precision Mass Products Pvt. Ltd.	India
9	Nagano Keiki Seisakusho	Japan
10	Rueger SA	Switzerland
11	Technomatic SPA	Italy
12	Trend Instrument Inc.	U.S.A
Vibration Fork type Level Switches		
1.	ABB India Ltd.	India
2.	Protocontrol Instruments (I) Pvt. Ltd. (non-critical)	India
3.	Endress + Hauser	Germany
4.	SOR Inc.	U.S.A
5.	EIP Enviro level controls private limited	India
Dial Thermometer (Hg In Steel/Glass)		
1.	A N Instruments Pvt. Ltd.	India
2.	Ashcroft India(P) Ltd.	India
3.	Baumer Technologies India Pvt. Ltd.	India
4.	General Instruments Consortium,	India
5.	Goa Instruments Industries Ltd	India
6.	H.Guru Industries	India
7.	Precision Mass Products Pvt. Ltd	India
8.	Pejee Engg Works	India
9.	Walchand Nagar Industries Ltd.	India

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Radiation Pyrometer		
1.	Tempsens Instruments Pvt. Ltd.	India
2.	C.C.R Technico	Italy
3.	Chino Corpn.	Japan
4.	Land Infrared	U.K.
5.	Siemens AG	Germany
6.	Wahal Instruments	U.S.A
Temperature Transmitters		
1.	ABB India Limited	India
2.	Emerson Process	India
3.	Endress+ Hauser (India) Pvt. Ltd.	India
4.	Siemens Ltd.	India
5	Yokogawa	India
Gate/Plug Valves		
1.	Audco India Limited(L&T Valves Divn.)	India
2.	BHEL(Valves Division)	India
3.	Chemtrols Engineering Limited (Plug Valves)	India
4.	Flowserve India Control Pvt. Ltd.(Plug Valve upto 12"300# upto 6" 600#)	India
5.	Ksb Pumps Limited (Valves Divn)	India
6	NU Tech Controls (MOV Gate :1/2" to 8" 2500#, 10" to 14",300#)	India
7.	Samsons Contols Pvt. Ltd. (Upto 34", 300#)	India
8.	Valve Tech Industries (Mov -8" upto 2500#)	India
9.	Velan Inc.	Canada
10	Weir Bdk Vlaves	India
11	Bel Valves	Japan
12	CesareBonetti	Italy
13	Fasani S.P.A	Italy
14	MalbraqueS.A.	France
15	Matsura H. P Machine works co. Ltd.	Japan
16	Petrol Valves S.R.L	Italy
Globe / Angle Valves		
1.	AST S.P.A (Upto 8"900#)	India
2	Chemtrol Industries Ltd.	India
3	Circor Flow Technologies India Pvt. Ltd.	India
4	Dresser Valve India Pvt. Ltd.(Rating =<600#,size ¾" to 6")	India
	Emerson Process Management India Ltd	India
5	Emet Controls Pvt. Ltd.(Globe Valve up to 4",300# angle valve upto 1-1/2",2500#)	India
6	Flowserve india control pvt. Ltd. (globe valve upto 30" 600# upto 24" 900#, upto 16" 2500# upto 4" 4500#)	India
7	Koso fluids controls pvt. Ltd. (globe valves: upto 8" 2500# 10 to 18" 300# angle valves upto 8" 300#)	India
8	Instrumentation Ltd. (Palakkad)	India
9.	Mil Controls Limited	India
10.	NU Tech Controls	India
11	Pneucon valves Pvt. Ltd. (upto 6" 300#) noncritical)	India
12	Samson Control Pvt Ltd(upto 6" &=<600#)	India
13	Tecnik valves pvt Ltd. (air & water service upto 4" 150#)	India
14	Valve-Tech Inducstries (non-critical)	India

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15	Azbil Corporation (= < 2500#)	Japan
16	Arca Regler GMBH	Germany
17	Dresser Masoneilan	France
18	Flowserve (= < 2500#)	U.S.A
19.	Fisher Xomox (= < 2500#)	Singapore
20.	Parcol Spa	Italy
21	Nippon Fisher Co. Ltd. (= < 2500#)	Japan
22	Severn Glocon (1 to 12" 600#)	U.K.
Ball Valves		
1.	Tyco Valves & Controls (I) Ltd (= < 150 #)	India
2.	Virgo Engineers Ltd. (= < 600# With Maccair Actuators)	India
3.	Anand teknow aids engineering india limited (upto 6", 600# (ON-OFF)	India
4.	Bray Controls India Pvt. Ltd. (upto 4", 300#)	India
5.	Emerson	India
6	EMET controls pvt. Ltd. (upto 8", 150# for air service)	India
7	Fisher Xomox Sanmar	India
8	Flowserve India controls Pvt. Ltd. (upto 16" 600#)	India
9	Intervalve ponnawalla limited (uptp 10", 150#)	India
10	Koso Fluid Controls pvt. Ltd. (upto 8 " , 2500# , 10" to 18" 900#)	India
11	NU Tech Controls (14", 600# for non-critical purpose)	India
12	Pentair Valves and controls India Pvt. Ltd. (<= 150#)	India
13	Pneucon valves pvt. Ltd. (upto 6", 150# non-critical)	India
14	Samson Control Pvt Ltd (upto 24" & <= 1500#)	India
15	Valve tech industries ltd. (18", 150# non critical)	India
16	Weir Bdk Vlaves (upto 16", 150#)	India
17	G.T.C. Italia S.R.L (= < 300#)	Italy
18	Metso Automation (= < 2500#)	Singapore
19	Orbit Valves PLC (= < 2500#)	Singapore
20	Petrol Valves S.R.L	Italy
21	PERRIN GmbH (size ½" to 12", & rating 150# to 2500#, size 14" to 18", rating 150# to 1500# , size 20" to 24" rating 150# & 300#)	Germany
22	Pibiviesse S.P.A. (Rating Upto 2500 #)	Italy
23	Rotex manufacturers & Engineers Pvt. Ltd. (upto 6" 600#, 6" to 10" 150#)	India
24	Velan Inc. (ball valves on/off size: ¼" to 6" (rating upto 2500#) size 8" to 16" (rating upto 900#) size 18" to 30 " (rating upto 300#)	Canada
25	Ventil flowserve pvt. Ltd. (upto 1.5 to 12", 150#)	India
Butterfly Valves		
1	Advance valves pvt. Ltd. (size 2" to 24" upto 600#)	India
2	Bray controls india pvt. Ltd. (upto 300#)	India
3	Dresser Masonelian Valves	India
4	Emet controls pvt. Ltd. (upto 4", 900#, 6", 150# to 16", 150# double eccentric)	India
5	Flowserve india control pvt. Ltd. (upto 30", 300# upto 12" 600#)	India
6	Fisher	India
7	Intervalve ponnawaala ltd. (2" to 48", 150#)	India
8	Instrumentation Ltd. (Palakkad) (= < 300#)	India
9	Koso fluid controls (pvt.) ltd. (= < 150#)	India
10	Nu tech controls (16", 300# for non-critical services)	India
11.	Pneucon valves pvt. Ltd. (upto 8", 150# non critical)	India
12.	Samson controls pvt. Ltd.	India

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13	Tyco Valves & Controls (I) Ltd (= < 150 #)	India
14	Valve tech industries (non-critical services)	India
15	Virgo Engineers Ltd. (= < 300 #)	India
16	Weird BDK valves (upto 16", 300 #)	India
17	Bray Controls (= < 300 #)	U.S.A
18	Keystone (Upto 2500 #)	Singapore
19	Leeds valve ltd.	UK
20	Korea Unicom Valve Co. Ltd.	Korea
21	Parcol Spa (= < 2500 # Urea Service Also)	Italy
22	Pentair Valves and controls India Pvt. Ltd. (< = 150 #)	
23	Metso Automation (Upto 2500 #)	Singapore
24	Orton S.r.l. (upto 2500 #)	
PRDS & SPRAY NOZZLE, VENT VALVES upto 2500 #		
1.	ARCA (Forbes Marshal) (Mech. Spray nozzle type desuperheater only)	India
2.	Chemtrols Industries Ltd. (PRDS Combine & Split)	India
3.	Circor Flow Technologies India Pvt. Ltd. (1" to 20", upto 150 #, 1 to 10" upto 1500 #, 1" to 8", upto 2500 #)	India
4	Control components INC	India
5	Fisher Controls	India
6.	Samson Controls Pvt. Ltd. (upto 6", 150 #)	India
7.	CCI Valve Technology AB	Sweden
8	SPX Valves & Controls (COPES-VULCAN LTD.)	U.S.A
Electric Actuator		
1.	Biffi Italia S.R.L	Italy
2.	Limitorque, U.S.A	U.S.A
3.	Rotork Control (Deutschland) GmbH	Germany
4.	Auma, Usa	U.S.A
Air Filter cum Pressure Regulator		
1.	ABB India Limited	India
2.	Divya Control Elements Pvt. Ltd.	India
3.	Dresser	India
4.	Emerson Process Management	India
5.	Mil Controls Limited	India
6.	Placka Instruments & Controls Pvt. Ltd.	India
7.	Shavo Norgren (India) Pvt Ltd.	India
8.	Schrader Duncan Ltd. (1/4" to 2" port size)	India
Valve Actuator (Pneumatic/Rotary)		
1.	Bray Control India Pvt. Ltd.	India
2.	EL-O-Matic India Pvt. Ltd.	India
3	Rotex Manufacturers & Engineers Pvt Ltd	India
4	Schrader Duncan Ltd.	India
Self actuated pressure control valve		
1	Fisher Controls	India
2	Nirmal Industrial controls private limited (size 1/2" to 6" & rating : < = 300 #)	India
3	Nu tech Controls (upto 10", 600 #)	India
4	Pneucon Valves Pvt. Ltd. (upto 4", 150 #)	India
5	Samsons Controls Pvt. Ltd. (upto 2", 150 #)	India
Electropneumatic Positioner		
1.	Fisher Controls	India

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2	Siemens Ltd.	India
Desuperheaters		
1.	Circor Flow Technologies India Pvt. Ltd (upto 24",300# upto 28",150#, multinozzle 3" to 4",upto 2500#)	India
2.	Chemtrols	India
3	CCI	India
4	EMET Controls Pvt. Ltd.(Desuperheating Control Valves 1-1/2", 600# * 3",2500#)	India
5	Fisher	India
6	Tyco	India
Pressure reducing Station		
1.	Circor Flow Technologies India Pvt. Ltd (1" to 20",upto 150# ,1 "to 10", upto1500#,1"to 8 " upto 2500#))	India
Pressure Regulator		
1.	Chemtrol Industries Ltd.	India
2.	Ventil flowserve pvt. Ltd.	India
Safety Valves & Thermal Relief Valves Upto 2500#		
1.	AST S.P.A	India
2.	Bliss anand private limited (8" * 10" 300#, 6" * 8 " 600# ,4 * 6" 1500#)	India
3.	Fainger Leser Valves (P) Ltd. (Upto 600#, ½" To 6")	India
4.	Instrumentation Ltd. (Palakkad)	India
5.	Keystone	India
6	Pentair Sanmar Ltd.	India
7	Nu tech controls (upto 2",300# * 3",150#)	India
8	Valve Tech Industries	India
9	Weir Bdk Valves	India
10	BOPP & Reuther Messtechnik GMBH	Germany
11	Crossby valve & Engg. Company Ltd.	U.K
12	Dresser Industries Incorporated	U.S.A
13	Dresser Valve & Controls	Canada
14	Farris	U.K
15	Itochu Corporation	Japan
16	Parcol Spa (For Urea Service Also)	Italy
17	Sapag Gec Alsthom	France
18	Tai Milano S.P.A	Italy
19	Teledyne Fluid Systems	Thailand
20	Ventil flowserve pvt. Ltd. Upto ¼ to 1 ")	India
Vaccum Breakers		
1.	Fainger Engineering	India
2.	Potego India Pvt. Ltd.	India
3.	Braunschweiger Flammenfilter	
4.	Itochu Corporation	Japan
5.	Parcol Spa	Italy
6.	Safety Systems UK Ltd.	U.K
7.	Tai Milano S.P.A	Italy
8.	Whessoe Varec Limited	U.K
Rupture Discs		
1.	Bs&B Safety Systems (India) Limited	India
2.	Fainger Engineering	India
3.	Tyco Sanmar	India

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4.	Continental Controls Inc.	U.S.A
5.	Fike Europe	Belgium
6.	Sapag GEC Alsthom	France
7.	Teledyne Fluid Systems	Thailand
Pilot relief valves		
1.	AST S.P.A (inlet size upto 3", upto 1500#, outlet size upto 4", upto 300#,inlet size upto 4",upto 300# ,inlet size upto 6", upto 150#,outlet size upto 8", upto 150#)	India
2.	Bliss Anand Private Limited (Size 1" 2" 2500#)	India
Low pressure relief valve		
1.	Protego India Pvt. Ltd. (less than 1 BAR with flame arrestor)	India
Flame arrestor		
1.	Protego India Pvt. Ltd	India
Control Panel		
1.	Electronics corporation of india ltd.	India
2.	Ex protecta	India
3.	Hulasi metals pvt. Ltd.	India
4.	Industrial control appliances (p) ltd.	India
5.	Jaisun & hutchison control ltd.	India
6.	Prima automation (india) pvt. Ltd.	India
7.	Pyrotech electronics pvt. Ltd.	India
8.	Tan swa technologies INC	India
9.	United electric co (delhi) pvt. Ltd,	India
10.	Yokogawa india limited	India
11.	Instromet international N.V.	Holland
Programable Logic Controller		
1.	ABB India Limited	India
2.	GE Fanuc Systems Private Limited	India
3.	Honeywell Automation India Limited	India
4.	Siemens Ltd.,	India
5.	Schneider Electric	India
6.	Allen Bradley	India
Distributed Control System		
1.	ABB India Limited	India
2.	Emerson process management India Pvt. Ltd.	India
3.	Foxboro	India/Intl.
4.	Honeywell Automation India Limited	India
5.	Siemens Ltd.	India
6.	Yokogawa Limited	India
7.	Bailey controls company	U.S.A
8.	Emerson process management Singapore Ltd.	Singapore
9.	Honeywell Inc.	U.S.A
10.	Invensys	Holland
11.	Siemens AG	Germany
12.	Yokogawa Electric Corporation	Japan
Multiplexer / Remote I/O		
1.	Mtl Instrument Limited	India
2.	Pepperl + Fuch	India
3.	M.system Co. Ltd. (Remote I/O; Model No.R3)	Japan
4.	M.T.L., U.K.	U.K

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5	Pepperl + Fuchs Pte Ltd.	Singapore
6	Stahl-Und Apparatebau Hans LefferGmbh	Germany
7	Phoenix Contact India Pvt Ltd	India
Receiver Instruments (Indicator,Controller,Recorder)		
1.	ABB India Limited	India
2.	Chino-Laxsons (India) Limited (Only Recorder)	India
3.	Eurotherm Del India Limited	India
4.	Honeywell Automation India Limited	India
5.	Masibus Automation & Instrumenation Pvt.Ltd. (Receiver Instruments except recorder)	India
6.	Moore Controls Ltd.	India
7.	Yokogawa Limited	India
8	ChinoCorpn.	Japan
9.	Heraeus Electro-Nite International N.V.	Japan
10.	Honeywell Inc.	U.S.A
11	Siemens Ag, Germany	Germany
12	Yokogawa Electric Corporation	Japan
Alarm Annunciator		
1.	Industrial Instruments & Controls	India
2.	Shree Electronics	India
3.	M.T.L., U.K.	U.K
4.	Rochester Instrument Systems Ltd.	U.K
5.	Riley Panalarm	U.S.A
6.	Ronan Engg. Co.	U.S.A
Temperature Scanner		
1.	Industrial Instrumentation	India
2.	Protocontrol Instruments (I) Pvt. Ltd.	India
Cctv / Access System		
1.	Honeywell Automation India Limited	India
Miscellenous Items (Rtu / ScadaEtc)		
1	ABB India Limited	India
2.	Rockwell Automation India Pvt. Ltd.	India
3.	Siemens Ltd. (Simatic WINcc)	India
4.	Phoenix Contact India Pvt Ltd	India
Energy meter		
1.	M.system co. Ltd.(Model No. 53U)	India
Surge Protection Devices		
1.	Phoenix Contact (India) Pvt. Ltd.	India
Wiring Ducts		
1.	Trinity touch Pvt.Ltd.	India
DIN Rail		
1.	Trinity touch Pvt.Ltd.	India
Interface Module		
1.	Trinity touch Pvt.Ltd.	India
Cable connector		
1.	Phoenix contact (India) Pvt. Ltd.	India
Advance Process Control System		
1.	Yokogawa India Limited	India
Speed Indicator		

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1.	Bentley NevedaLlc	U.S.A
2.	Jacquet	Switzerland
3.	Pepperl + Fuch	Germany
4.	Pepperl + Fuchs Pte Ltd.	Singapore
5.	Shinkawa Electric Co.	Japan
Instrument Power & Control Cables		
1.	Associated Cables Ltd.	India
2.	Associated Flexibles & Wires Pvt. Ltd.	India
3.	Cords Cable Industries Ltd.	India
4.	Delton Cables Ltd	India
5.	Insucon Cables & Conductors (P) Ltd. (For Smaller Non-Critical Projects)	India
6.	J K Cables Limited	India
7.	Kei Industries Limited	India
8.	Leoni cable solutions	India
9.	Paramount Cable Corporation	India
10.	T C Communications Pvt Ltd	India
11.	Thermo Cables Limited	India
12.	Toshniwal Cables	India
13.	Udey Pyro Cables Pvt Ltd	India
14.	Centurion power cables pvt.ltd.	India
15.	Ramcro S.P.A	Italy
16.	TC Wire & Cables Pvt Ltd	India
Extension & Compensating Cables		
1.	Associated Cables Ltd.	India
2.	Associated Flexibles & Wires Pvt. Ltd.	India
3.	Cords Cable Industries Ltd.	India
4.	Delton Cables Ltd	India
5.	General Instruments Consortium,	India
6.	J K Cables Limited	India
7.	Kei Industries Limited	India
8.	Paramount Cable Corporation	India
9.	ThermopadsPvt. Ltd.	India
10.	Toshniwal Cables	India
11.	Centurion power cables pvt.ltd.	India
12.	Ramcro S.P.A	Italy
13.	TC Wire & Cables Pvt Ltd	India
Cable Trays & Accessories (Al./Gi/FRP)		
1.	D-Y Engineers	India
2.	Globe Electrical Industries	India
3.	HOPPES	India
4.	Indiana Engg Works Pvt Ltd	India
5.	Metalite Industries	India
6.	Parekh Engineering Company	India
7.	Sadhana Engineering Corporation	India
8.	Steelite Engineering Limited	India
9.	Sumip Composites pvt ltd	India
Multi Transit Inlet System		
1.	Hawke International	U.K
2.	MctBrattbergAktiebolag	Sweden

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1.	Eby industries	India
2.	Excel hydropneumatics pvt. Ltd.	India
3.	Micro precision products pvt. Ltd.	India
4.	Precision engineering industries	India
5.	Tecnomatic (india) pvt. Ltd.	India
6.	Wesmec engineering pvt. Ltd.	India
7.	Celleir	France
8.	Cesare bonetti SPA	Italy
9.	Dewrance & Co. Ltd.	U.K.
10.	Hopkinsons Ltd.	U.K.
11.	Siemens AG PGI	germany
12.	Sumitomo metal industries ltd.	Japan
13.	Thysen krupp stahlunion Gmbh	germany
14.	Tecnomatic SPA	Italy
15.	Global valves and fittings (india) pvt ltd	India
16.	Ventil flowserve pvt. Ltd.	India
Instrument Miniature Valves		
1.	Audco India Limited(L&T Valves Divn.)	India
2.	Aura Inc	India
3.	Bhel (valves division)	India
4.	Chemtrol Industries Ltd	India
5.	Chemtrols Samil(India) Pvt Ltd	India
6.	Comfit & Valves Pvt. Ltd.	India
7.	Excel Hydro-Pneumatics Pvt Ltd,	India
8.	Excelsior Engg Works	India
9.	Hyd- Air Engineering works Lonavla	India
10.	Ksb Pumps Limited (Valves Divn)	India
11.	Panam Engineers	India
12.	Tecnomatic (India) Pvt. Ltd.	India
13.	Anderson Greenwood & Co.	U.S.A
14.	BFE boneey forge valve License	Italy
15.	Celleir S.A.	France
16.	Crane Company International Sales	U.S.A
17.	Dewrance & Co. Ltd.	U.K.
18.	Euromisure Cremona	Italy
19.	Hopkinsons Ltd.	U.K.
20.	Kosei Sanyog Ltd.	Japan
21.	Swagelok company/creximco	U.S.A
22.	Sumitomo metal industries ltd.	Japan
23.	Technomatic SPA	Italy
24.	Velan engineering Co. Limited	U.K.
25.	Wesmec engineering pvt. Ltd	India
26.	Global valves and fittings (india) pvt ltd	India
26.	Ventil flowserve pvt. Ltd.	India
Purge rotameter		
1	Eureka industrial equipments Pvt. Ltd.	India
2	Instrumentation engineers pvt. Ltd.	India
3	Placka instruments & engineers pvt. ltd	India
AIR HEADER/ADPOT		



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1	Wesmec engineering pvt. Ltd.	India
Condensate pot		
1	HYDROPNEUMATICS	India
2	MICRO-PRECISION PRODUCTS	India
3	TECHNOMATIC (I) P. LTD.	India
4	Wesmec engineering pvt. Ltd.	India
Valve manifolds		
1	Comfit & Valves Pvt. Ltd.	India
2	EXCEL HYDROPNEUMATICS PVT. LTD.	India
3	HYDER	India
4	INSTRUMENTATION LTD.	India
5	MICRO PRECISION	India
6	NORDIVAL (SWAGELOC)	
7	PARKER	India
8	TECHNOMATIC	India
9	Wesmec engineering pvt. Ltd.	India
10	Global valves and fittings (india) pvt ltd	India
11	Ventil flowserve pvt. Ltd.	India
Calibration equipment & services		
1	Tempsens instruments (i) pvt. Ltd.	India
2	Fluke	Singapore
3	Omega Engineering	US
Enclosures		
1	Trinity touch pvt. Ltd. (weatherproof size 80 * 80 mm)	India
Instrument contractor for inst. Construction /erection works		
1	Blue star	India
2	Bells control ltd.	India
3	Godrej & Boyce mfg. co. ltd	India
4.	ICB Contractor Pvt. Ltd.	India
5.	Jasubhai Industries	India
6.	Koso india pvt. Ltd. (kent introl control valve divn.)	India
7.	L&T (construction contracts Divn.)	India
8.	Miraj instrumentation service (upto 0.5 crores)	India
9.	Narayan engineering (< Rs. 5 lacs (small project))	India
10.	Pace process control pvt. Ltd.	India
11	Peron engg. Construction ltd.	India
12.	Protect control pvt. Ltd.	India
13	Technimont ICB ltd.	India



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8.0 FIRE FIGHTING SYSTEM



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
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

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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
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 (INDIA) PVT. LTD.	INDIA
5	SAFEX FIRE	INDIA
6	SUPREMEX EQUIPMENTS	INDIA
7	UNITECH MACHINES LTD.	INDIA
8	ZENITH FIRE SERVICES INDIA PVT. LTD	INDIA
10.0	DELUGE VALVE	
1	DARLING MUESCO (I) PVT.LTD	INDIA
2	HD FIRE	INDIA

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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	
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	

	PROJECTS & DEVELOPMENT INDIA LTD.	PC211-102-P-II-SEC-12.0	0	 राष्ट्रीय फाइबर ऑप्टिकल लिमिटेड
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SECTION - 12.0 (TECHNICALPART)

SITE WORKING AND SAFETY CONDITIONS

**PROJECT: IMPLEMENTATION OF ZERO LIQUID DISCHARGE (ZLD) UNIT
AT
RFCL, RAMAGUNDAM PLANT**

0	10.08.23	ISSUED FOR TENDER	JKY	JKY	RRK
REV	REV ATE	PURPOSE	PREPD	REVWD	APPD





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1.0 SITE LOCATION

Ramagundam Fertilizer Unit is located about 240kms away from Hyderabad, the capital of Telangana State & in the district of Karimnagar.

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**

As given in commercial section.

2.13 **CONSTRUCTION WATER**

As given in commercial section.

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.

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.

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- 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 PPES(Safety helmet/safety shoes/gum boot, hand gloves, eye goggles reflective jackets, ear plug & face mask) 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, the entire 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 (handrail with toe guard), excavations etc.
 - Compliance with all electricity regulations.
 - Compliance with statutory requirements for inspection and test of all lifting appliances and auxiliary lifting gear.

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- 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 OWNER/PMC, 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 unsuitable 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.

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.

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7.10 While working at heights, safety belts, fall arrestor with wire rope sling 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 approval & in addition to class-I permit.

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/welding apron, leather hand gloves & welding goggles & fire blanket 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 -

- Satisfy the Owner that the appliance is in good working condition.
- Uses of matching sixes plug & does not uses bare wire to insert in socket.
- Inform the Owner of the maximum current rating, voltage and phase of appliance.
- Obtain permission of the Owner dealing the sockets to which the appliance may be connected.
- 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-

- The appliance is in good condition and is fitted with a suitable industrial plugs.

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- 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

- 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.
- Smoking is strictly prohibited inside factory areas.
- 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.
- 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.

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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.
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. Retractable fall arrestor, Safety belts, life line and other safety PPE,s shall be used wherever necessary.

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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

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.

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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. Retractable fall arrestor Safety belt with life line 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

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.

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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

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.

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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 violations; 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.

53. Penalty

The Contractor shall adhere consistently to all provisions of HSE requirements. In case of noncompliance's and also for repeated failure in implementation of any of the HSE provisions,

Consultant/Owner may impose stoppage of work without any cost & time implication to the Owner and/or impose a suitable penalty.

The amount of penalty shall be limited to 0.5 % (Zero decimal five percent) of the contract value for LSTK contract.

The amount of penalty applicable for the Contractor on different types of HSE violations is as below.



1. For not using personal protective equipment (Helmet, Shoes, Goggles, Gloves, Full body harness, Face shield, Boiler suit, etc.)

Rs 500/- per day/ Item / Person.

2. Working without Work Permit/Clearance Rs 20000/- per occasion.

- 3 Execution of work without deployment of requisite field engineer / supervisor at work spot Rs. 5000/- per violation per day.

4. Unsafe electrical practices (not installing ELCB, using poor joints of cables, using naked wire without top plug into socket, laying wire/cables on the roads, electrical jobs by incompetent person, etc.)

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Rs 10000/- per item per day.

5. Working at height without full body harness, using non-standard/ rejected scaffolding and not arranging fall protection arrangement as required, like handrails, life-lines, Safety Nets etc.

Rs. 10000/- per case per day.

6. Unsafe handling of compressed gas cylinders (No trolley, jubilee clips double gauge regulator, and not keeping cylinders vertical during storage/handling, not using safety cap of cylinder).

Rs 500/- per item per day.

7. Use of domestic LPG for cutting purpose / not using flash back arresters on both the hoses/tubes on both ends.

Rs. 3000/- per occasion.

8. No fencing/barricading of excavated areas /trenches.

Rs. 3000/- per occasion.

9. Not providing shoring/strutting/proper slope and not keeping the excavated earth at least 1.5M away from excavated area.

Rs.5, 000/- per occasion.

10. Non display of scaffold tags, caution boards, list of hospitals, emergency services available at work locations.

Rs.1000/- per occasion per day

11. Traffic rules violations like over speeding of vehicles, rash driving, talking on mobile phones during vehicle driving, wrong parking, not using seat

belts, vehicles not fitted with reverse horn / warning alarms / flicker lamps during foggy weather.

Rs. 2000/- per occasion per day



12. Absence of Contractor's RCM/SIC or his nominated representative (prior approval must be taken for each meeting for nomination) from site HSE meetings whenever called by Consultant/Owner & failure to nominate his immediate deputy (in the site organ gram) for such HSE meetings.

Rs10000/- per meeting.

13. Failure to maintain HSE records by Contractor

Safety personnel, in line with approved HSE Plan/Procedures/Contract specifications.

Rs 10000/- per month.

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14. Failure to conduct daily site safety inspection (by Contractor's safety engineers/safety officers), internal HSE meeting, internal HSE Awareness/Motivation Program, Site HSE Training and HSE audit at predefined frequencies (as approved in HSE Plan).

Rs.10000/- per occasion.

15. Failure to submit the monthly HSE report by 5th of subsequent month to Project's Engineer-in-Charge /Owner

Rs. 10000/- per occasion and Rs.1000/- per day of further delay.

16. Poor House Keeping Rs. 5000/- per occasion per subject

17. Failure to report & follow up accident (including Near Miss) reporting system within specific timeframe.

Rs. 20000/- per occasion

18. Degradation of environment (not confining toxic spills, spilling oil/lubricants onto ground).

Rs10000/- per occasion

19. Not medically examining the workers before allowing them to work at height / to work in confined space / to work in shot-blasting / to work for painting / to work in bitumen or asphalt works, not providing ear muffs while allowing them to work in noise polluted areas, made them to work in air polluted areas without respiratory protective devices,etc.

Rs 5000/- per occasion per worker

20. Violation of any other safety condition as per job HSE plan / work permit and HSE conditions of contract (e.g. using crowbar on cable trenches, improper welding booth, not keeping fire extinguisher ready at hot work site, unsafe rigging practices, non-availability of First-Aid box at site, not using hood with respiratory devices by blaster for shot//grit blasting, etc.)

Rs. 5000/- per occasion

21. Failure to carry-out Safety audit in time (internal & external), close-out of identified shortfalls of Observations of Safety Aspects(OSA),etc

Rs. 20,000/- per occasion



22. Carrying out sand blasting instead of grit/shot blasting

Rs. 50,000/- per day

23. Failure to deploy adequately qualified and competent Safety Officer

Rs. 10000/- per day per Officer

24. Utilization of hydra/ back-hoe loader for material shifting or any other unauthorized /unsafe lifting works

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Rs 25,000/- per occasion

25. Any violation not covered above to be decided by Consultant/Owner.

26. Any physical injury - maximum of Rs.2,00,000 per injury

27. Fatal accident - Rs. 25,00,000 per fatality

Note:- This penalty shall be in addition to all other penalties specified elsewhere in the contract. The decision of imposing stop-work instruction and imposition of work penalty shall rest with PDIL/Owner. The same shall be binding by the contractor. Imposition of penalty does not make the contractor eligible to continue the work in unsafe manner.