PART – II (TECHNICAL)

SECTION – 1.0

SCOPE OF WORK

INSTALLATION OF ULTRA-FILTRATION UNIT

AT

RCF, THAL

REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD
0	17.07.23	17.07.23	Issued for Tender	SNS	SNS	MN
P	06.04.23	06.04.23	Issued for Client Comments (DRAFT)	SNS	AC	MN

CONTENTS

1.0 INTRODUCTION:

Rashtriya Chemicals & Fertilizers limited (RCF) hereinafter also referred to as “OWNER” is a public sector undertaking involved in the manufacture and marketing of nitrogenous, phosphatic and potassic fertilizers as well as a variety of industrial chemical products. The company has presently two manufacturing units, one at Trombay and the other at Thal, both located in the state of Maharashtra.Thal unit is one of the first Fertilizer Complex established to utilise the Bombay High Off-shore Natural Gas. RCF Thal complex comprised of two trains of ammonia plant of 1750 MTPD capacity each i.e., Combined capacity of 3500 MTPD and three trains of urea plant of combined capacity of 6060 MTPD along with all necessary utilities and infrastructure facilities.

RCF intends to reduce the colloidal silica of DM water at RCF Thal complex by installing Ultra-Filtration unit and associated facilities. The Ultra-filtration unit is to be supplied by bidder on LSTK basis.The present ITB specifies the requirement of Ultra-Filtration unit for reducing colloidal silica of DM plant.

Projects & Development India Ltd. (PDIL) has been retained by RCF, Thalas Pre and Post Award Project Management Consultancy services for execution of the installation of Ultra filtration Unit for RCF Thalcomplex as detailed in subsequent sections of this NIT with single point responsibility.

2.0 PLANT LOCATION

The Thal Fertilizer Complex of RCF is located near the village Thal and Vaishet, about 25 km south of Mumbai across the sea.

3.0 GENERAL DESCRIPTION OF PACKAGE:

Ultra Filtration system shall comprise of following items:

1. UF Feed pump: 4Nos. (3W+1S).
2. Basket Strainers: 4Nos. (3W+1S).
3. UF Skid: 4Nos. (3W+1S), Net output of DM water production shall be 600 m3/hr.
4. UF Backwash pump: 3Nos. (2W+1S).
5. UF CEB Tank: 1 No.
6. UF CEB pumps: 2Nos. (1W+1S).
7. UF CIP Tank: 1 No.
8. UF CIP pumps: 2Nos. (1W+1S).
9. Acid Bulk storage Tank for UF: 2 No. (capacity:20 MT each)
10. Alkali Bulk storage Tank for UF: 2 No. (capacity:15 MT each)
11. Sodium Hypochlorite bulk storage Tank for UF: 2 No. (capacity:20 MT)
12. Acid Unloading/Transfer Pump: 2Nos. (1W+1S).
13. Alkali Unloading/Transfer Pump: 2Nos. (1W+1S).

14. Sodium Hypochlorite Unloading/Transfer Pump: 2Nos. (1W+1S).
15. Pumping & piping facilities from Neutralization pit up to B/L. (construction of Neutralization pit shall be in RCF scope).
16. UF Outlet DM buffer storage tank: 1 No. (capacity: 100 m3)
17. DM buffer storage tank to DM storage tank pump: 4 Nos. (3W+ 1S)
18. Static mixer
19. Pre filters for CIP, backwash (1W+1S, each)
20. MCC for all the pumps / motors
21. PLC for automatic control of UF service / CIP / CEB cycles

Note: The process flow diagrams given in NIT are tentative. However, nos. of equipment given in scope of work shall be final.

4.0 CONTRACTOR'S SCOPE OF WORK

The LSTK Bidder's scope of work shall include detailed design, engineering complete with all equipment & accessories, procurement of complete materials & bought-out items whatever deemed necessary for process, mechanical, electrical & instrumentation, analysers fabrication at shop/site as required, loading, transportation, unloading & storage at site, assembly, erection of mechanical, electrical & instrumentation system, inspection, testing, painting, statutory approvals, calibration commissioning, trial runs and demonstration of guarantees, & supply of complete package along with spares & maintenance works as a single point responsibility Vendor(SPRV) etc. In addition to this any items required shall be provided by the bidder for meeting the guaranteed parameters and for safe, reliable trouble-free continuous operation and maintenance required of the system. Training of owners personnel, trial runs after commissioning and performance guarantee test run, guaranteeing and handing over to the Client,all on turnkey basis, as per the Design Basis, Job Specifications, Standards, P&IDs, PFDs, Data Sheets, Equipment List, Drawings, Test Certificates of Equipment, Instruments & Machineries, Piping Materials, Vessels & others relevant items etc. as required & complete in all respect.

The scope of supply will include the following items but not limited to 4 Nos.(3W+1S) UF unit and associated facilities in line with NIT requirement items as listed belowincluding Interconnecting piping, all fittings, mechanical valves, control valves, motors,MCC,cables, supply of field and control room instrumentation etc. as required for completing the systemsas per enquiry specifications. **Any work not listed herein but is necessary for completion and smooth, safe &trouble-free continuous operation and maintenance of the plants as well**

as those required as part of good engineering practices shall be deemed to be included.

4.1 The Contractor's scope of services shall include but not be limited to the following: -

4.1.1 Design and Engineering comprising preparation of the following documents:-

- Residual basic engineering design,
- PFD with major controls, material & energy balance,
- P&ID, Interlock and logic diagram with full description.
- Equipment and line list with sizes.
- Functional loop schematics, etc.

4.1.2 Detailed Engineering comprising of: -

- Process flow diagram,
- Plot plan development,
- All Layouts,
- General arrangement Drawings,
- Fabrication and assembly drawings, etc
- Procurement of material and bought outs items.
- Shop/Site fabrication and testing.
- Assembly of sub-assemblies.
- Stage wise inspection at shop.
- Customs clearances, if any.
- All type of Insulation, cladding, and painting of the plant.
- Supply & Transportation to site.
- Shop/Site fabrication and testing.
- Assembly of sub-assemblies.
- Stage wise inspection at shop.
- Unloading, prolong storage/preservation and security at site.
- Movement of material equipment, consumables etc at site.
- erection, installation, assembly, hook ups and field testing.
- Filling of lubricants, Oils, consumables, chemicals etc. (for first filling and replacement as required before handing over to owner).
- Clear the work space of all construction aids debris etc. and provide a tidy work place from pre-commissioning stage.
- Pre commissioning and commissioning.
- Satisfactory performance guarantee tests at site.

- Handing over of plant to the owner as per PDIL/Owner's satisfaction.
- All statutory clearances and permits from local, statutory and other bodies such asStatic and mobile pressure vessel rules, Labour Inspector, Electrical inspectoretc.
- 4 hard copies & 2 soft copies in pen drive shall be submitted as final documents by bidder.
- Contractor shall prepare a comprehensive equipment List showing all items classified on the basis of each Process and utility unit. Equipment list shall also identify Equipment requiring: -
- Equipment list shall include the following against each item:-
  - ❖ Equipment/item tag numbers,
  - ❖ Description,
  - ❖ Drawing number,
  - ❖ Vendor,
  - ❖ Data sheet number,
  - ❖ Design flow, pressure and temperature,
  - ❖ Special features if any, etc.

4.2 Temporary Construction Facilities:

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

i. **Construction power supply facilities:** Construction power (3 phase, 415 Volt, AC) shall be provided by owner at single point free of cost. Any further distribution shall be in bidder's scope**.**

ii. **Construction Water Supply facilities:** Construction water shall be supplied at one point at site location free of cost, bidder to make arrangement for construction water supply from given location pointto bidder plant battery limit.

iii. Instrument Airshall be supplied at one point at sitelocation free of cost, bidder to make arrangement for further distribution.

iv. Construction sheds

v. Material storage

vi. Construction offices

vii. Temporary Communication facilities

viii. Office furniture

5.0 SCOPE OF SUPPLY

Contractor's scope of supply shall include but not be limited to the following on turnkey Basis: -

All equipment's as per (Equipment / Packages list) of this NIT.

However, Contractor shall supply all the required equipment/ items as per BEDP to complete the system in all respects.

a) All electrical, instrumentation and controls.
b) Isolation & Control valves (pneumatically operated)
c) All supports for equipment, piping, ducting, cable trays, etc.
d) Permanent shed for UF skids along with necessary provision of lifting.
e) Foundations and Foundation Bolts for all equipment and supports
f) First fill of all lubricants, chemicals(required for 15 days), hydraulic oils, and heat transfer mediaand subsequent filling before handing over to Owner. Any special tools and tackles required for operation and maintenance of the Plant and equipment.
g) Spares and consumables for start-up and commissioning.
h) Mandatory Spares
i) Spares list for 2 year's normal operation with itemized price with recommended Quantity to be furnished.

5.1 Scope of Services

a) Detailed process design including preparation of PFD, P&ID, mass balance diagram, control and logic diagram, interlock schemes, etc.
b) Detailed equipment layout, piping GAD & isometrics, battery limit hook ups and other works as required.
c) Documentation & approvals including approvals from statutory authorities including those required to be taken by Owner.
d) Procurement of raw materials, bought out components, fabrication and assembly at shop.
e) Inspection & testing, including third party inspection at shop, packing, forwarding & delivery to site.
f) All piping works as per piping specification. All isolation valve at battery limit shall be in bidder's scope.
g) Mechanical Completion.
h) Hydro testing, Pre-commissioning and reliability runs.
i) Commissioning and performance guarantee run and handing over.

j) Arrange all necessary instruments, tools/tackles required to aid pre-commissioning, commissioning and performance guarantee tests.

k) All documents/drawings shall be submitted by the bidders as per documentation schedule.

l) Undertake a HAZOP study for the systemfrom experience competent 3rd party.Bidders to incorporate all HAZOP study changes into their design and supply without any price and time implication.

m) All incoming and outgoing utilities shall be provided with isolation valve along with companion flanges gasket and bolting at the battery limit of the unit. All the utilities shall be supplied at battery limit of the plant at a single point.

n) Operation supervisors and maintenance personnel shall be arranged by the bidder during commissioning, trial and performance test runs.

5.2 MECHANICAL

5.2.1 STATIC

For Detailed Scope of work with respect of Static, refer attached
Document No.- PC-284/E-1/P-II/Sec-3.2, Rev. 0

5.2.2 ROTARY

For Detailed Scope of work with respect of Rotary, refer attached
Document No. - PC-284/E-1/P-II/Sec-3.3, Rev.0

5.2.3 PIPING

For Detailed Scope of work with respect of Piping,refer attached.
Document No.- PC-284/E-1/P-II/Sec-3.4, Rev.0

5.3 ELECTRICAL

For Detailed Scope of work with respect of Electrical, refer attached.
Document No. - PC-284/E-1/P-II/Sec-3.5, Rev.0

5.4 INSTRUMENTATION

For Detailed Scope of work with respect of Instrumentation, refer attached.
Document No. - PC-284/E-1/P-II/Sec-3.6, Rev.0

5.5 CIVIL

For Detailed Scope of work with respect of Civil, refer attached.

Document No. - PC-284/E-1/P-II/Sec-3.7, Rev.0

5.6 INSPECTION& TESTING REQUIREMENTS

For detail requirements of Inspection & Testing, please refer Technical Specifications of individual discipline attached.

5.7 PROGRESS REPORTING:

Bidder shall submit monthly progress report and detailed project schedule to Owner

5.8 INTERCONNECTING PIPING:

Bidder shall provide block valve with spectacle blind for all inlet & outlet lines at the battery limit for complete isolation.

PART – II (TECHNICAL)

SECTION –2.0

TECHNICAL SPECIFICATION

INSTALLATION OF ULTRAFILTRATION UNIT

AT

RCF, THAL

REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD
0	17.07.23	17.07.23	Issued for Tender	SNS	SNS	MN
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LIST OF ANNEXURE

1.0 GENERAL DESCRIPTION OF PACKAGE

Ultra Filtration system shall comprise of items as mentioned in PC-284/P-II/SEC-1.0 (Scope of Work):

UF OPERATIONAL PHILOSOPHY:

DM water shall be pumped from existing storage tank-1 (Dia- 18000 mm, height- 18000mm capacity- 4580 m3) through UF feed pumps for the removal of colloidal silica. DM water will first pass through basket strainers before feeding to UF skid. After basket strainers, DM water will be treated in UF modules for removal of colloidal silica. DM water after removal of colloidal silica shall be fed/ stored in another existing DM storage tank-2 (Dia- 18000 mm, height- 18000mm capacity- 4580 m3). The pipeline new nozzle fabrication and tapping To and Fro existing storage tanks-1 and 2 shall be in Contractor's scope. Contractor shall design pipelines, structural supports, isolation valves according to required guaranteed flow, NPSH, discharge head, minimum flow recirculation lines, etc.

Chemicals required for backwashing and CIP shall be unloaded in respective storage tanks from road tankers. Chemicals from storage tanks shall be pumped to respective day tanks/CIP tanks and subsequently in UF skid.

Backwash water shall be collected in underground neutralization pit. From pit, it will be pumped to required destination.

2.0 DESIGN BASIS:

2.1 DESIGN CAPACITY

DM Water

Design Capacity	600 M3/hr. (Net output)
No of Skids	4 nos. (3W+1S) Each of output capacity 200 M3/hr

2.2 Ultra-Filtration (U.F.) Module

No. of Skid	4 Nos. (3W+1S)
Feed flow rate	Bidder to decide
Permeate flow rate	200 m3/hr
Recovery	95 % (minimum)
Membrane Material	PVDF/PES
a) Molecular Wt. Cut off value	10000 MWCO Daltons
b) Pore Size	Bidder to furnish (micron)

Net flux Rate	60 LMH (minimum)
Membrane flow mode/configuration	from outside to inside/Inside to outside
Frontal pipes, valves, manifolds	SS 316L/CPVC/PP
Chlorine Resistance	Yes – pH 10.5

Feed water temperature range considered for the guaranteed outlet water quality 30 Deg C to 45 Deg C

Inlet Line of UF Shall Be Provided With PRV (Pressure Relief Valve)

2.3 Basket Strainers/Auto Backwash Filter

Numbers	4 Nos. (3W+1S)
Mesh Size	Bidder to decide
MOC	SS316L
Screen	SS316L

2.4 UF Feed Pump

Numbers	4 Nos. (3W+1S)
Type	Horizontal Centrifugal Pump
Capacity/Head	Bidder to decide (m3/hr/MWC) considering discharge point
Type of lubrication	Self-lubrication

Type of shaft sealing – Mechanical seal

Casing mounting type: Centerline mounting.

Material of Construction:

i) Casing	CF3M
ii) Impeller	CF3M
iii) Shaft	SS-316L

2.5A) UF Backwash Pump

Numbers	3 Nos. (2W+1S)
Capacity/Head	Bidder to decide (m3/hr/MWC)
Type	Horizontal Centrifugal Pump

Type of shaft sealing – Mechanical seal

MOC

i) Casing	CF3M
ii) Impeller	CF3M
iii) Shaft	SS-316L

2.5B) UF Fast Flushing Pump (If required)

Numbers	3 Nos. (2W+1S)

Capacity/Head	Bidder to decide (m3/hr/MWC)
Type	Horizontal Centrifugal Pump

Type of shaft sealing – Mechanical seal

MOC

i) Casing	CF3M
ii) Impeller	CF3M
iii) Shaft	SS-316L

2.6 UF-CEB Tank

Number	1 No.
MOC	FRP
Capacity	Bidder to decide

2.7 UF-CEB Pumps

Numbers	2 Nos. (1W+1S)
Head/Capacity	Bidder to furnish (MWC/m3/hr)
Type	Positive Displacement
MOC	Casing: PFA
	Diaphragm: PFA

2.8 CIP Tank

Number	1 No.
MOC	FRP
Capacity	Bidder to decide

2.9 CIP Pumps

Number	2 Nos. (1W+1S)
Head/Capacity	Bidder to furnish (MWC/m3/hr)
Type	Horizontal Centrifugal Pump

Type of shaft sealing – Mechanical seal

MOC	Casing: PFA
	Impeller: PFA
	Shaft: SS-316L

All dosing/day Tanks shall be provided with agitator at the top for mixing.

MOC of agitator shaft & blade shall be SS316L.

2.10 Acid Bulk Storage Tank for UF

Number	2 No.
MOC	FRP with UV protection
Capacity	20 MT each

ACID dosing tanks are provided with fume absorber. (MOC: FRP)

2.11 Alkali Bulk Storage Tank for UF

Number	2 No.
MOC	FRP with UV protection
Capacity	15 MT each

NaOH dosing tanks are provided with CO2 breather and seal pot. (MOC: FRP)

2.12 Acid Unloading/ transfer Pump

Number	2 Nos. (1W+1S)
Capacity	As per system requirement
Type:	Horizontal centrifugal type.
MOC	Casing: PFA lined
	Impeller: PFA
	Shaft: SS316L

Type of shaft sealing – Mechanical seal

2.13 Alkali Unloading/Transfer Pump

Number	2 Nos. (1W+1S)
Capacity	As per system requirement
Type:	Horizontal centrifugal type.
MOC	Casing: PFA lined
	Impeller: PFA
	Shaft: SS316L

Type of shaft sealing – Mechanical seal

2.14 Sodium Hypochlorite Bulk Storage Tank for UF

Number	2 No.
MOC	FRP with UV protection
Capacity	20 MT each

Tank shall be provided with fume absorber. (MOC: FRP)

2.15 Sodium Hypochlorite Unloading/Transfer Pump

Number	2 Nos. (1W+1S)
Capacity	As per system requirement
Type:	Horizontal centrifugal type.
MOC	Casing: PFA lined
	Impeller: PFA
	Shaft: SS316L

Type of shaft sealing – Mechanical seal

2.16 Neutralization pit transfer pump

Number	2 Nos. (1W+1S)
Capacity	As per system requirement
MOC	Casing: CF3M
	Impeller: CF3M
	Shaft: SS316L
Type:	Horizontal centrifugal type.

Type of shaft sealing – Mechanical seal

Suction head- Negative suction head-5m

Discharge head- 30m

2.17 DM Buffer storage Tank

Number	1 No.
MOC	SS316L
Capacity	100 m3

2.18 DM buffer storage tank to DM storage tank pump: 4 Nos. (3W+ 1S)

Number	4 Nos. (3W+1S)
Capacity	200 M3/hr
MOC	SS316
Head	Bidder to Decide.
Casing	CF3L
Impeller	CF3L
Shaft	SS316L
Type of Lubrication	Self Lubrication
Type of shaft sealing	Mechanical seal

2.19 A: Pre-Filter for CIP

Number	2 Nos. (1W+1S)
MOC	SS316L
Pore size:	(Bidder to decide)

B: Pre-Filter for Backwash

Number	2 Nos. (1W+1S)
MOC	SS316L
Pore size:	(Bidder to decide)

C: Pre-Filter for Fast flushing (If required)

Number	2 Nos. (1W+1S)
MOC	SS316L
Pore size:	(Bidder to decide)

All dosing/day Tanks shall be provided with agitator at the top for mixing.

MOC of agitator shaft & blade shall be SS316L.

2.20 Hazardous area classification

In general Area classification shall be in accordance with IS 5572 along with latest update. Ultra-Filtration Unit is located in SAFE AREA i.e. Non Hazardous area, however bidder to note that Area Classification class for instrumentation shall be as per NIT.

2.21 SITE METEOROLOGICAL DATA

Site Location

Country	India
State	Maharashtra
Place	Thal
Longitude	72° 52' 00" E
Latitude	18°41' 52" N

Weather Conditions

Mid-October to March	Mild cold (winter)
April to Mid-October	Hot & humid (summer)
June to Mid-October	Rainy (Monsoon)

Ambient conditions

Atmospheric Pressure, mbar

Maximum	1007
Minimum	995
Rainfall, mm	
Annual Rainfall	2500
Maximum Rainfall in 24 hrs	360
Design Rainfall Intensity for 1 hr duration, mm/hr	150
Temperature, ^{o}C	
max °C	40
min °C	9
Design / Humidity	
Winter % relative	Min 50
Summer % relative	Max100
Design Air Temperature (For electrical equipment)	
For heating & ventilation	45°C
For Electrical Equipment, Max./Min.	45°C/5°C
For Electric Motor	45°C
For Air Coolers, Wet/Dry Bulb Temp.	29°C/45°C
WIND	
Wind load design should be done as per IS: 875 (Part 3) -1987	
Max. Wind speed	120 km/hr
Design wind speed	160 km/hr.
Prevailing Wind Direction	: W & NW

2.22 UF Skid Feed Water Quality

Sr. No.	Parameters	Value
1.	pH	6-8
2.	Total Hardness	0
3.	Conductivity at 20 deg. C Micro-mho/cm	<0.2
4.	Total Suspended solid	NT
5.	M Alkanity as CaCO3 ppm by wt	NT
6.	Turbidity NTU	NT
7.	Total Iron as Fe ppm by wt (Max)	<0.01
8.	Sodium as Na ppm by wt(Max)	NT
9.	Chlorides ppm by wt	NT

12.	Colloidal Silica as SiO2 ppb	<50
13.	Total Silica as SiO2 ppb by wt (Max)	<100
14.	Total Copper, mg/kg	<0.003
15.	Total Dissolved Solids	<0.1

2.23 Utility System:

- Instrument Air shall be provided at the plant battery limit by client. Further distribution of instrument air to various distribution points shall be done by Contractor.
- Supply of drinking water for safety shower & Process water for miscellaneous job to be considered.

Contractor to specify any other utility required for UF Package.

3.0 CONTROL PHILOSOPHY

3.1 ULTRA FILTRATION UNIT

UF Unit shall be operated and controlled through a PLC based control system. The control system shall be provided in line with the engineering specifications / standards / drawings attached elsewhere in the tender document. Backwash sequence for the UF shall be automatic. The UF Unit will also have a provision for manual operation. The Instrumentation and Control Philosophy for the UF shall be as applicable to the smooth, safe & trouble-free operation of Unit and shall be defined in detail in Process specifications. Following online analyzers shall be installed for smooth, safe & trouble-free operation of UF Unit:

a) Silica, pH and Conductivity analyser at the common outlet of UF.
b) pH meter at out let of neutralization pit effluent transfer pump.
c) All Pumps shall be equipped with Pressure Transmitters.
d) All pumps suction line shall be equipped with strainers.
e) All strainers shall be equipped with differential pressure indication (DPI).
f) DPT shall be provided across all filters with local and DCS indication – alarms to be provided.
g) All tanks shall be equipped with Level Transmitters, local level gauges, vent with isolation valve and drain with isolation valve.
h) FT at the individual inlet of UF skid and at the common outlet of UF.

In addition to above mentioned instruments/analyzers, bidder to provide all necessary Instruments during detail engineering for smooth, safe & trouble-free operation without any cost & time implication.

4.0 SELECTION OF MATERIAL OF CONSTRUCTION:

4.1 Material of construction for pipes & valves carrying fluids shall be as below

1. MOC of all DM water pipe lines after UF feed tank shall be SS-316L.
2. MOC of all DM water valves after UF feed tank shall be CF3M.
3. MOC of Acid (Hydrochloric) and Sodium Hypochlorite Dilute/Strong pipe lines shall be CPVC.
4. MOC of Alkali (Sodium Hydroxide) Dilute/Strong pipe lines shall be SS316L.
5. MOC of Acid (Hydrochloric) and Sodium Hypochlorite Dilute/Strong valves shall be PP/PFA.
6. MOC of Alkali (Sodium Hydroxide) Dilute/Strong Valves shall be CF3M.
7. MOC of Instrument Air pipe lines shall be SS 304.
8. MOC of service water shall be Carbon Steel.

5.0 GUARANTEES:

5.1 Workmanship guarantee:

Bidder shall guarantee all components of package against faulty design, improper material of construction and poor workmanship in addition to performance guarantee. Approval by Principal for design calculation and detailed shop drawing, will not in any way absolve the bidder from his responsibility. Should any repair or replacement be necessary owing to any type of failure on account of design material and workmanship of the item, bidder shall in view of this guarantee be bound to replace the same either in part or whole without additional cost to purchaser. Repaired or replaced part shall also be covered by same guarantee as in case of main supply.

5.2 Performance guarantee and trial run:

The individual equipment shall be tested in accordance with standards prior to commissioning to establish the parameter and performance.

Trial run shall be performed for a period mutually agreed upon, without interruption prior to commissioning to establish the satisfactory working of the accessories, equipment. After the pre-commissioning and testing, each unit shall be commissioned separately to operate at the parameters specified and performance test run shall be conducted.

In the event of failure of performance test run, bidder shall carry out necessary modification at his own expense to meet the guarantees.

The Performance Test shall comprise a 24 hour performance test run. Vendor shall provide to owner (for approval) not later than 90 days prior to mechanical Completion, a proposed procedure including dates, arrangements and forms of tests, durations of tests, numbers of readings to be taken, instrument lists and numbers of observers required. The Performance Test must demonstrate the requirements outlined in clause **5.3(SEC-2.0)**. If the Performance Test is interrupted or terminated for any reason such test shall be restarted from the beginning. Performance Test to be carried within 3 months of commissioning. Bidders to make adequate allowance for these requirements in their tender.

5.3 Process Guarantees:

Performance Guarantee parameters for Ultra-filtration system:

1. Capacity of Ultra-filtration system 200 m3/hr (Net output) each unit
2. Turn down (50 % each unit)
3. Total Power consumption excluding plant lighting (as metered at the Energy meter for the unit).
4. Quality & parameters of DM water at UF common Outlet as specified below (Test shall be conducted at RCF laboratory).

Sr. No.	Parameters	Value
1.	Colloidal Silica as SiO2 ppm	BDL (< 0.008 ppm)

5. Operating cost:

Sr. No.	Utilities	Unit price in Rs.	Consumption per day for required capacity as per Specification	Cost Rs. Per day
1.	Power, kW	Rs. 10 per kW	…….kw/day	

Notes:

1. Operational cost for UF unit shall be calculated on the basis of total Power consumption required. The Power unit costs given above are firm. Loading towards operational cost (works cost) for techno-commercial suitable bidders shall be done considering Power cost.

2. LSTK BIDDER shall give guaranteed Power consumption figures as per format given in *Part-I of Commercial Bid* duly filled along with priced bid. Bidder shall submit acceptance sheet (Quoted or Not Quoted) along with unpriced Commercial Bid.
3. Performance guarantee test shall be conducted for Power consumption figures submitted by bidder along with price bid.
4. All Guaranteed Consumptions including power Cost shall be indicated in price schedule.

5.4 Conditions for Guarantees:

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

5.4.1 Raw materials and utilities excluding chemicals in sufficient quantities conforming to the range of specifications supplied to LSTK Contractor by Owner and used as the design basis for Ultra-filtration system.

5.4.2 Ultra-filtration unit shall be operated under the direction and supervision of LSTK Contractor as defined in operating manuals to be supplied by LSTK Contractor.

5.5 Measurement of feed water & Power:

Measurement of feed water and power shall be measured and calculated as per figures Indicated by various calibrated instruments. The guaranteed figures shall be inclusive of all instrument tolerances. All measurement instrumentation shall be part of the system/ unit installed by the LSTK Contractor and no special instrumentation for the purpose of guarantee tests shall be required.

5.7 PERFORMANCE TESTS:

5.7.1 <u>General:</u>

Performance tests which are part of commissioning shall consist mainly of two categories.

i) Functional test.

ii) Performance guarantee test.

i) Functional test.

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, 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.

ii) Performance guarantee test:

LSTK Contractor shall prove the performance guarantees tests of the UF unit as specified in this clause under the following headlines:

- Guarantee Test

5.7.2 Deviations from Specifications:

In the event that the DM water quality or any other conditions is not in accordance with conditions specified or referred to in Contract and are prejudicial to LSTK Contractor for establishing the performance guarantee parameters 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 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 & sound engineering principles and practice.

5.7.3 Guarantee Test Results:

Within a reasonable period of time but not later than 10 working days from the completion of the guarantee test Run, 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/ PMC for Owner's acceptance. The method of calculation for the Guarantee Test Run shall be mutually agreed by LSTK Contractor, Owner and PMC before starting of Guarantee Test Run. All data will be collected jointly in presence of LSTK contractor, Owner and PMC. Owner/PMC 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 10 working days of receipt of the report by Owner from the LSTK Contractor. In the event of rejection of Guarantee

test Run results by Owner, LSTK Contractor shall take immediate actions to set right as per the provisions of the contract and repeat guarantee test Run to the satisfaction of Owner.

5.7.4 Procedure for measurement of Colloidal Silica at RCF Laboratory:

RCF has well equipped NABL accredited laboratory. Silica measurement for UF outlet DM water will be done in RCF laboratory in presence of Contractor and Owner/PMC. Frequency for collection of outlet DM water sample for analysis will be mutually discussed before commencement of GTR.

The procedure for analysing Silica shall be as given below:

Procedure for measurement of Non-reactive (Colloidal) Silica

Ref: ***(IS: 3025 (Part 35) 1988) APHA 23 rd Edition 2017 4500-SiO2 D: 2017***

A} Measurement of Reactive Silica:

Reagents:

- Acid Ammonium molybdate:

10 gm Ammonium molybdate dissolved in silica free water with gentle warming. Adjust to pH 7 to 8 with silica free ammonia solution and make up to 100 ml silica free water.

- Hydrochloric Acid : 1:1 HCL
- Oxalic acid :

7.5 gm oxalic acid dissolved in silica free distilled water & make up to 100 ml silica free water

- Reducing agent:

500 mg of 1 amino -2 naphthol -4 sulphonic acid and 1 g of sodium sulphite in 50 ml of silica free distilled water with gentle warming, if necessary; add this to a solution of 30 g of sodium hyposulphite in 50 ml silica free distilled water. Filter and keep in a plastic bottle.

- Standard Silica Solution (1 ml = 0.1 mg SiO_2)

Dissolve 0.35357 g sodium Meta silicate (Na_2SiO_3, $5H_2O$) in one litre silica free distilled water. (1 ml = 0.1 mg SiO_2).

Preparation of Calibration Curve Procedure:

Prepare separate silica standard 0.01, 0.02, 0.04, 0.06, 0.08 ppm in 50 ml Nessler tube. Add in quick succession 1.0 ml 1: 1 Hydrochloric acid and 2.0 ml Ammonium molybdate mix well and let stand for 5 to 10 minutes. Add 2.0 ml oxalic acid and mix well after 2 minutes, add 2 ml reducing agent in each of the Nessler tube, light blue color will develop. See the absorbance on spectrophotometer at 815 nm wave length. Draw a calibration curve of absorbance against concentration of silica and named file.

Analysis procedure:

50 ml sample in Nessler add in quick succession 1.0 ml 1: 1 hydrochloric acid and 2.0 ml Ammonium molybdate, mix well and let stand for 5 to 10 minutes. Add 2.0 ml oxalic acid and mix well after 2 minutes, add 2 ml reducing agent in each of the Nessler tube, light blue color will develop. See the absorbance on spectrophotometer at 815 nm wave length. Take absorbance of sample against standard silica method file.

B} Measurement of Total Silica:

To detect the presence of non reactive (Colloidal) silica along with reactive silica , prepare a clear sample by filtration if necessary. Take 50 ml sample in a 100 ml platinum dish. Add 200 mg silica free $NaHCO_3$ and digest on a steam bath for 1 hour. Cool and add slowly, with stirring 2.4 ml 1 N H_2SO_4. Transfer quantitatively to a 50 ml nessler tube and make up to the mark with water. Prepare blank to compensate slight amount of silica introduced by the reagent and for the effect of salt on colour density. Proceed for photometric measurement as per analysis procedure.

C} Non Reactive (Colloidal) Silica:

Non Reactive (Colloidal) Silica = Total Silica - Reactive Silica

Note: *This Analysis method can measure Colloidal silica equal to or above 0.008 ppm or 8 ppb. Colloidal silica below 8 ppb is below detectable limit (BDL).*

6.0 Time Schedule:

a) Mechanical completion: 10 months from issue of LOI/WO

b) Commissioning and GTR: Within 2 months after mechanical completion.

PART – II (TECHNICAL)

SECTION –3.1

DESIGN SPECIFICATION – PROCESS

INSTALLATION OF ULTRAFILTRATION UNIT

AT

RCF, THAL

0	17.07.23	17.07.23	Issued for Tender	SNS	SNS	MN
P	06.04.23	06.04.23	Issued for Client Comments (DRAFT)	SNS	AC	MN
REV	**REV DATE**	**EFF DATE**	**PURPOSE**	**PREPD**	**REVWD**	**APPD**

CONTENTS

1.0 GENERAL:

The ultra filtration unit shall be designed to operate safely and satisfactorily at a capacity of 3W+1S x 200 m3/hr each. Accordingly Net output of DM water production shall be 600 m3/hr. Equipment and machinery shall be provided so that the plants can operate for at least two years without major overhaul or inspection. All design shall conform with the latest edition of the applicable sections of ASME, ASTM, IEEE, NFC, TEMA, AISI, NEMA, AISC, ACI, OSHA, UBE and other governing codes or standard practices. Any other equivalent and acceptable Code of Standard practice may be adopted with the approval of the PMC/Owner. In addition, the following state/local Codes/laws shall supplement:

a)	Pressure Vessels/ Formed ends	ASME, Section VIII, DIV.I
b)	Buildings & Structural	Relevant Indian Standard (BIS)
c)	Electricity	Indian Electricity Rules.
d)	Sanitary	Relevant Indian Standard (BIS)
e)	Safety	a) Manual of Chief Inspector of Explosives, Govt. of India.
f)	Water Pollution	Relevant Indian Standard (BIS) / Maharashtra Pollution Board limits

1.1 System of Measurements

The system of measurement shall be Metric as follows:

Parameter	Preferred Units	Alternative Units
Temperature	°C	
Pressure - absolute	kg/cm² abs	
Pressure - gauge	kg/cm² g	
Flow (liquid)	m³/hr	kg/hr
Length, Level	mm	M, Ft
Time	hr	sec, min
Heat	kcal	Gcal
Power	kW	

Fouling resistance	m^2 hr °C / kcal	
Pipe size / diameter	Inches (in)	mm
Mass	kg	
Liquid relative density	sp gr T°C/15.6°C	
Liquid density	kg/m^3	
Vapor flowing density	kg/m^3	
Storage tank pressure	mm of WC	
Vacuum	mm of Hg, mm WC	
Standard vapor	Nm^3/hr at 0°C & 1.033 kg/cm^2a	
Standard liquid	m^3/hr at 15.6°C	
Thermal conductivity	kcal/hr-m-°C	
Viscosity	cP	
Sound Pressure	dB(A)	
Sound Power	dB(A)	

2.0 DESIGN PRESSURE:

2.1 General Rule:

Design pressure of Process Static Equipment shall be based on the maximum Operating Pressure. Malfunction and Equipment failure shall be taken into consideration by safety devices. Design pressure shall be for process equipment shall be whichever is higher. Alternatively, LSTK Contractor shall select the design pressure as standard design.

a) For max operating pressure below 2 kg/cm^2 g use 3.5 kg/cm^2 g

b) For max operating pressure between 2 kg/cm^2g and 15 kg/cm^2g use Max. Operating Pressure + 1.5 kg/cm^2

c) For Max. Operating Pressure between 15 kg/cm^2 g and 100 kg/cm^2 g use Max. Operating pressure x 110 %

d) For Max. Operating Pressure equal and above 100 kg/cm^2 g use the Maximum Operating Pressure + 10 kg/cm^2 g.

2.2 Equipment under Vacuum:

Equipment normally operated under vacuum is designed for full vacuum and for the highest pressure it can experience in case of vacuum failure. Equipment containing a fluid with a vapour pressure at ambient temperature lower than atmospheric pressure which can be isolated shall be equipped with vacuum breaking device or else be designed for full vacuum. Equipment subject to vacuum due to mal-operation or failure shall be equipped with vacuum breaking devices or else be designed for full vacuum.

2.3 Complete Systems:

Several pieces of Equipment protected by the same relief valve shall have a design pressure of at least the set pressure of the relief valve.

2.4 Equipment on the Discharge of a Pump:

Equipment which may have to bear the shut-off pressure of a pump shall have a design pressure equal to or higher than the shut-off pressure. Pump shut-off pressure shall be estimated according to Clause 7.0.

2.5 Thin Walled Tanks And Vessels:

Atmospheric thin walled tanks and vessels shall have a design pressure equal to the highest pressure imposed upon discharge of the pressure relief device. The design pressure for vacuum shall be equal to the lowest pressure imposed upon suction of the vacuum relief device.

3.0 DESIGN TEMPERATURE:

Design temperature for process equipment shall be whichever is higher:

a) Maximum operating temperature + 15 °C (+25ºC for Feed/Effluent exchanger)

b) Boiling temperature at design pressure of process medium inside, if applicable.

c) Design temperature shall be rounded up to full 5°C steps.

d) Design minimum temperature shall be specified only if the minimum operating temperature is below 0 °C. Design minimum temperature shall be 5 °C less than the minimum operating temperature. Special attention shall be given to low boiling liquids.

e) For piping, design temperature shall be determined according to ASME B 31.3.

Alternatively, LSTK Contractor shall select the design temperature as standard design.

4.0 VELOCITY IN PIPES

Acceptable range velocity to be followed is as follows:

- Pump Suction & Gravity Flow lines: 0.5-0.8 m/s
- Liquid Pressure Lines: 1.2-1.8 m/s
- Air Velocity: Not more than 20 m/s

5.0 CORROSION ALLOWANCE:

Materials of construction and corrosion allowance for all Equipment and machinery shall be for a design life of 25 years (except for heat exchanger tubes). However, minimum corrosion allowance for carbon steel (including 0.5 Mo alloy steels) shall be if bidder requires higher corrosion allowance then same to be provided:

Pressure Vessels and other applicable Equipment	3 mm
Storage Tanks	1.5 mm
Piping	1.5 mm
Removable parts or internals (on each side in Contract with operating fluid)	0.75 mm
For stainless steel/titanium	0 mm
Carbon steel with epoxy resin coating	3 mm

6.0 HYDRAULIC RETENTION TIME:

Hydraulic retention time (Hold-up Requirements) is defined between low level (LL) and high level (LH).

Type of Service	Retention Time
Storage tanks	As per requirement of NIT
Acid storage tanks	2 nos. - 20 MT each
Alkali storage tank	2 nos. - 15 MT each
Naclo2 storage tank	2 nos. - 20 MT each

7.0 PUMPS:

Normally pumps shall be designed to 110 % of their maximum required flow rate in worst case of operation.

The shut-off pressure shall be estimated according to the following criteria whichever is higher:

a) Differential head at rated flow x 125 % (*) + Max suction static head + design pressure of suction side.

(*) Shall be corrected as per pump vendor data

Shut off pressure of pump shall not be more than 120% of rated head of the pumps

8.0 PRESSURE RELIEF VALVES:

Pressure relief valves shall be supplied with locked open isolating valves. Pressure relief valves for operational failure shall have installed spares. Also, PRV on fire case with Hydrocarbon service shall have installed spare. LSTK Contractor shall take care of any additional requirement as per guidelines. The set pressure of pressure relief valves shall be equal to the design pressure of the equipment. All safety valves will have bypass with exception of safety valves which are only for fire cases and if there is more than one safety valve.

All solenoid operated on-off valve 4” and above shall be butterfly valve.

9.0 COLUMNS AND VESSELS:

9.1 Nozzle:

a) Minimum size 3/4" (for S.S shall be 1 inch).

b) Nozzle rating according to once of connected piping for instrument min. Class 150 ANSI rating.

9.2 Manhole:

Manhole size 24” (*)

9.3 Hand hole or Inspection hole:

a) Preferable Size 8 inches

b) Minimum Size 6 inches

9.4 Vent and Drain:

Vent and drain for vessels will normally be provided at the minimum length on overhead or bottom line in accordance with the following table:

Volume or diameter of vessel (m^3 or mm)	Vent diameter (inches)	Drain diameter (inches)
V < 75 or D <= 4,500	2	2
75 < V <= 220 4,500 < D <= 6,000	3	3
220 < V <= 420 or D > 6,000	4	4
V > 420	6	4

Note: *Vent and drain connections are not necessarily located on vessels.*

Notes:

1. All pumps shall be with 10% margin over normal capacities of pumps and motor rating shall be suitable for end of curve operation of pump.
2. All strainers, filters vessels, shall have Differential Pressure Transfer (DPT) with local and PLC indication –Alarms to be provided.
3. Motors (5KW and above) shall have current status in PLC and all motors shall have running, stop & Trip status in the PLC.
4. All chemical dosing discharge lines shall have minimum Rotameter flow meter.
5. All dosing / bulk chemical storage tank shall have separate vent / overflow line with fume mitigation system.
6. All centrifugal pumps shall be provided with automatic minimum re-circulation line.
7. All reciprocating / diaphragm pump shall have pressure safety valve & diaphragm rupture alarm.
8. Sample points to be provided at various locations.
9. All lines at B/L shall be provided with lockable isolation valve along with drain and vent valve.
10. Tanks shall be provided with local level gauge, transmitters with indication & alarms in CCR, auto trip & auto start as applicable.
11. Pumps shall be provided with local pressure gauge at suction & discharge, transmitters with indication & alarms in CCR, auto trip & auto start as applicable.

12. Flow transmitters with pressure & temperature compensation shall be provide at inlets lines, All UF inlet, Final DM Water outlet B/W line, etc.
13. All required safety interlocks shall be provided for process safety.
14. Online pH & Conductivity Analyzers shall be provided at UF inlet & outlet.

These are the minimum instrumentation however, bidder to provide any other instrument required for trouble free, smooth, safe, continuous operation and maintenance of the plant

SECTION – 3.2 (TECHNICAL)

DESIGN PHILOSOPHY - STATIC EQUIPMENT

FOR

INSTALLATION OF ULTRAFILTRATION UNIT AT RCF, THAL

CLIENT : RCF-THAL

REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD
0	17.07.23	17.07.23	Issued for Tender	GS	BS	RRK
P	06.04.23	06.04.23	Issued for Client Comments (DRAFT)	GS	BS	RRK

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LIST OF ATTACHMENTS

1.0 DESIGN CRITERIA

1.1 This document defines the design philosophy to be applied for the complete design, detail engineering, Sizing (where applicable), supply, transportation, fabrication, assembly, painting, inspection & testing for all equipment covered under Scope of Supply along with final documentation for Static Equipment (i.e. Pressure Vessels, Internals, filters, Storage Tanks, etc) for Installation Of Ultra filtration Unit At RCF – Thal in accordance with this specification, standards specification, codes and other attachment etc. listed in NIT document.

1.2 The equipment shall be designed & constructed as per the latest edition (at the time of award of order) of the following codes and standards:

Code**	**Description**
ASME Section VIII Div 1	Rules for construction of Unfired Pressure Vessels
ASME X	Fiber-Reinforced Plastic Pressure Vessels
EN 13121	GRP Tanks And Vessels
API 650	Welded Steel Tanks for Oil Storage
API RP 2000	Venting Atmosphere And Low Pressure Storage Tank
ASME Section II A & B/ ASTM	Materials Specifications
ASME Section II PART C	Specification for welding rod, electrode & filler metal
ASME SEC II PART D	Material Properties
ASME Section V	Non-destructive Examination
ASME Section IX	Welding Qualification
ASME B 16.5	For Flanges
ASME B 16.47	For large diameter flanges
ASME B 16.20	For Metallic Gaskets for Pipe Flanges: Ring-Joint, Spiral Wound, and
ANSI	Pipes, Flanges, Fittings and Valves
IS: 875 / SITE DATA	For wind load consideration
IS: 1893 (Part 4) & IS: 1893 (Part 1) / SITE DATA	For seismic design consideration
Factory Act, 1948 BS CP 3003 (Part 1)	Factory Act & State Govt factory rules Code of Practice on lining of Vessels and equipment for Chemical Process.

** This list is not an exhaustive list. During the detailed engineering, bidders and suppliers will establish a list of standards and codes applied. In case of conflict between several codes, the bidder may propose the code applied, and/or the deviations required.

NOTES:

1. LSTK Contractor may select DIN, BS or any other well known international materials as substituted materials to ASTM/ASME ones, if they are equivalent or superior to ASTM / ASME ones. The chemical & mechanical properties of such equivalent or superior offered materials preferably comparison w.r.t. ASTM materials shall be furnished along the bid. LSTK Contractor shall also submit the references of past supplies of similar type of equipment w.r.t. the proposed materials offered by them in their bid.

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

1.3 Complete mechanical design of Equipment as per latest code /standard of construction shall be the responsibility of the LSTK Contractor. Strict compliance with the requirement of codes/equipment

specification & any other referred document shall be ensured. In addition, all statutory rules & regulations shall also be complied with.

1.4 Design conditions for all equipment shall be as per technical Specification and Material specification. Minimum required thickness is calculated based on design parameters considering different types of loadings including effect of static head of liquid column. Equipment shall also be designed for hydrostatic condition. Final thickness is decided giving due consideration for corrosion allowance, tolerance etc.

1.5 Design pressure shall be at the top of vertical vessel or at the highest point of horizontal vessel. The design pressure at any lower point shall be determined by adding the maximum operating liquid head and any pressure gradient within the vessel.

1.6 Wind analysis shall be performed as per IS-875 (Latest Edition).Design Wind speed 160 km/hr.Wind forces shall be increased by 20% (over & above design code requirement) to cater the effect of piping system, platforms and ladders etc. Vertical vessels with height/diameter ratio equal to or greater than 10 shall be analyzed for vibration due to vortex shedding when critical wind speed does not exceed 30m/s.

1.7 Seismic analysis shall be performed as per IS-1893 part-1 &IS-1893 Part 4 (Latest edition) by Response spectrum method (RSM) considering force factor =2, importance factor =2, percent damping as 2%, Seismic Zone as IV.

1.8 Minimum design pressure for all equipment shall be 3.5 kg/cm2g (except atmospheric storage tanks.)

1.9 All vessels / columns subject to internal pressure shall be designed to withstand a minimum external pressure of 0.175 kg/cm2 abs.

1.10 Design of supports and anchor bolts shall be performed for compressive and tensile loading. In no case shall diameter of anchor bolts be less than M24 for skirt support and M16 for other type of support.

1.11 Each Lifting lug shall be designed with shock factor 2.

1.12 Hydro testing of equipment shall be as per UG-99b of ASME Sec VIII Div-1. In order to safeguard against the risk of brittle fracture during hydrostatic test metal temperature during hydrostatic test be maintained at least 30°F (17°C) above the minimum design metal temperature, but need not exceed 120°F(48°C). Design pressure for each nozzle shall be sum of maximum allowable working pressure and static head of corresponding nozzles.

1.13 Maximum Allowable Working Pressure (MAWP) is the maximum gauge pressure at the top of a completed vessel, which is obtained from the calculations for every element of the vessel based on the actual thickness in the corroded condition. Supplier shall calculate the MAWP of each vessel, and the calculation shall be included in design calculations. MAWP shall not be assumed to be the same as the design pressure except for cases where MAWP cannot be determined by calculation to the applicable code. Accordingly calculate hydro test pressure as per UG-99b

1.14 Bolt of size M48 and above shall be designed and spaced so as to permit tightening with a hydraulic stud-tensioner. The bolts shall have an extra threaded length at one end of approximately 1 bolt diameter, and shall be provided with threaded protection caps. Hex nuts shall have suitable holes for manual tightening. The requisite no. of hydraulic stud-tensioner device with necessary adopters/insertions based on varying sizes of studs shall be supplied by bidder as per mechanical design of the equipment.

1.15 Orientation of longitudinal seams and position of circumferential seams shall be clearly marked in the fabrication drawing. Nozzles, support and other attachments shall be located clear of welded joints.

1.16 All process equipments shall be supplied with Nitrogen filled. In case of equipment assembled and welded at site, it shall be filled with N2 after testing at site. Dry Nitrogen shall be filled at a pressure of 0.5 Kg/cm2g and equipment shall be fitted with a pressure gauge and valve.

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

1.18 Bidder shall stand Performance Guarantee of equipment as per respective technical specifications/Process Data sheets.

1.19 Design conditions for all equipment shall be in accordance with the process data Sheets/specification .However, in any case design pressure shall not be lower than 10%over the maximum anticipated operating pressure and design temperature should be 25°C higher than the maximum anticipated operating temperature for all equipment unless otherwise specified.

1.20 Basic allowable stresses for shell, heads and other components etc. of vessels and shell, roof, etc. of tanks shall be the values specified in the design code.
Maximum allowable “tensile stress” and “compressive stress” shall be as per UG-23 of ASME Sec VIII Div - 1. These stresses may be increased by 20% for earthquake & wind combination case in line with UG-23 (d).

1.21 All blind flanges and man way covers weighing 35 kgs or more shall be fitted with handling Facilities such as davits.

1.22 As a General rule all nozzle attachment to shell/head shall be set in type.

1.23 As a minimum requirement, all vessels, Tanks, filters etc. shall be spot radiographed.

1.24 Forces and moments acting on nozzles shall be considered in the equipment design.

1.25 LSTK Contractor shall mark tangent lines, the position of the main axis and the centre of gravity for orientation in a clearly identifiable and permanent way on the vessel. Centre of gravity shall be clearly marked.

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

1.27 A proposed Welding Procedure Specification (WPS) shall be submitted to approved inspection agency for approval. On approval, a Procedure Qualification Test (PQT) shall be conducted which shall be witnessed by approved inspection agency. On acceptance of all tests as per ASME Section IX, a final WPS along with Procedure Qualification Record (PQR) shall be submitted. Production welding shall start only after approval of final WPS/PQR and qualification of welders as per ASME Section IX, approved inspection agency may accept previously qualified WPS/PQR at his sole discretion.

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

1.29 Gas or Carbon arc welding shall not be used.

1.30 Welding electrodes of composition similar to Internals material shall be used except austenitic electrodes of higher chromium and nickel content such as AWS A5.4, ASME SFA 5.4 class E309 and E310 may be used for 12-Cr stainless steel. For dissimilar material welding, electrode composition shall be similar to nobler material being welded. Following electrodes shall be used unless specified otherwise:

E 7018	for all CS materials
E 308	for all SS 304 to SS 304
E 308L	for all SS 304L to SS 304L
E 309 MoL	For SS 410S to SS 410S, SS to CS, SS 410S to SS 304, 304L, 316, 316L
E 316	For all SS 316

E 316L	For all SS 316L
E Ni – Cu7	For Monel to Monel and Monel to CS/SS

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

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

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

1.34 For equipment coming under the purview of Indian Boiler Regulations, it shall be LSTK Contractor responsibility to get approval from IBR authorities pertaining to design, drawings, material of construction, fabrication, inspection and testing etc.

1.35 Material test certificates shall comply to EN10204 Type 3.1 for pressure parts and EN10204 Type 2.2 for Non-pressure parts

.

1.36 Strength calculation shall be performed in latest version of PV elite software. Vendor shall send soft copy of PV-Elite (.pvdb file) along with document submission.

1.37 In case of conflict between this specification and other specification, codes and data sheets. It shall be referred to PMC/ Owner for clarification and the decision of PMC/ Owner shall be final & binding on contractor without any cost & delivery implications. However, it shall be resolved considering the most stringent in the following order.

- Statutory requirement
- Requirement specified in this specification
- Process data sheet/ P&ID
- Applicable codes & standards

1.4 REGULATIONS

Besides codes & standards, LSTK Contractor shall follow statutory requirements as applicable.

PUBLICATIONS:

NACE MR 0103	Materials Resistant to Sulphide Stress Cracking in Corrosive Petroleum Refining Environments
NACE MR 0175 / ISO 15156	Petroleum and natural gas industries - Materials for use in H2S containing environments in oil and gas production
NACE RP 0296	Guidelines for Detection, Repair and Mitigation of Cracking of Existing Petroleum Refinery Pressure Vessels in Wet H2S Environment
NACE TM 0284	Evaluation of Pipeline and Pressure Vessel Steel for Resistance to Hydrogen Induced Cracking
WRC Bulletin # 107	Local Stresses in Spherical Shells due to External Loadings.
WRC Bulletin # 297	Local Stresses in Cylindrical Shells due to External Loadings on Nozzles

1.5 CONSTRUCTION & ERECTION

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

1.5.2 LSTK Contractor shall perform the following:

i) Before installing the equipment, the foundations shall be checked and wherever Necessary, chipping shall be done by the LSTK Contractor. All grouting materials, packing plates/wedges required for the levelling and alignment of equipment, structures & pipelines etc. shall be provided.

ii) Top of the foundations shall be thoroughly cleaned to the satisfaction of Principal / LSTK Contractor before placing base plates.

iii) All equipment & structure etc. shall be checked and inspected for its proper levelling andgranting (grouting) shall be done with suitable grouting material as required.

iv) After tightening the foundation bolts, the final level / alignment shall be rechecked and redone, if required.

v) Installation of all supports and hangers, including concreting or welding as necessary.

vi) To check correctness of the piping, instruments and other connecting points in the equipment and piping installed.

vii) The welding joints shall be stress relieved wherever necessary as per applicable codes, Standards & specification.

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

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

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

i) Fabricate, erect and align the equipment & internals as per applicable codes, standards & specifications. All internals shall be inspected before and after installation.

ii) Carry out all NDT's required. The Personnel performing NDT's should have a minimum qualification as "NDT LEVEL-II" in the relevant Technique, certified by American Society for Non-destructive Testing.

iii) Perform non-operating field pressure tests and leak tests on field fabricated equipment in accordance with the applicable codes, standards and specifications, ensuring disposal of test media in accordance with instruction/recommendations

.

iv) Notify Owner / Third party of the test schedules for witness the tests by concerned inspector.

1.6 QUALITY ASSURANCE & CONTROL

1.6 1 The quality assurance shall be as per the approved procedures, test methods & facilities to be developed by the LSTK Contractor to ensure that the supplied equipment shall be of highest quality. The quality control shall mean that all the tests , measurements, checks & calibration which are to be carried out may be compared with the actual specified characteristics of the equipments/unit /system.

1.6.2 Quality Assurance (QA) shall mean the organizational set up, procedures as well as test methods and facilities developed by LSTK Contractor in order to assure that Equipment leaving LSTK Contractor's shop are of the highest possible quality i.e. either equal to or better than the requirement specified.

1.6.3 Quality Control (QC), shall mean all the tests, measurement, checks and calibration which are to be carried out in LSTK Contractor's shop in order to compare the actual characteristics of the equipment/unit/system with the specified ones, along with furnishing of the relevant documentation (certificates/records) containing the data or result of these activities.

1.6.4 LSTK Contractor shall submit a comprehensive description (manual) of QA/QC measures contemplated by him for implementation with regard to this specification. It is contractual obligation of the LSTK Contractor to develop and implement adequate QA/QC systems. QA/QC System shall cover all products and services required for the equipment as per scope of work including job sub contracted by the LSTK Contractor.

1.6.5 QA/QC system shall cover all products and services required for the equipment as per scope of work including job sub contracted by the LSTK Contractor.

2.0 Material of Construction

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

2.2 The Additional material requirements as indicated below shall be considered by Bidder.

2.2.1 All raw materials including bought -out items, whatsoever required, to complete the supplies shall be procured and supplied by LSTK Contractor with due identifiable mill material test certificates & inspection reports duly certified by third party inspection agency.

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

2.2.3 Carbon steel plates shall be procured in fully killed condition. CS plates shall be fully killed &normalized. All plates above 50mm thickness shall be vacuum-degassed and examined by Ultrasonic Testing (UT) as per applicable material specification code/standard.

2.2.4 All Stainless Steel (SS) plates shall be hot rolled & solution annealed and pickled as per SA-480.

2.2.5 All forgings except for flanges as per ANSI shall be UT tested as per ASTM A 388 for the thickness greater than 50 mm and shall be procured in normalized / annealed condition acceptance standards shall be as per AM 203.2 of ASME Section VIII Div. 2. In case any defect is found, no repair by welding shall be allowed.

2.2.6 All forgings including nozzle flanges shall be examined for surface defects by MP/PT testing after machining as per applicable material specification code & standard.

2.2.7 All external / internal attachments, pads/cleats for support directly welded to the equipment shall be of same materials (grade) as that of equipment, unless specified otherwise.

2.2.8 All nozzles up to DN 10" size shall be made of seamless pipe. For sizes above DN 10" nozzle connection shall be rolled from plates with full radiography of plates.

2.2.9 Unless otherwise specified girth flanges shall be of forged quality and ultrasonically tested.

2.2.10 Unless more restrictive prescription given by material specification the max. Content for carbon steel used for fabrication as shown by ladle analysis shall be 0.23% for plates, pipes & tubes 0.25% for forging.

2.2.11 Top portion of skirt (min. 500 mm height) welded to the bottom dished head shall be of same material (Grade) as that of shell /head for LAS & SS materials.

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

For Carbon Steel:

Cold formed dished ends or knuckles up to 16 mm nominal thickness shall be stress relieved.

b. Cold formed dished ends or knuckles above 16 mm nominal thickness shall be normalised.

c. For Low alloy Steel: - Cold Formed Dish ends and Knuckles shall be stress relieved.

d. Hot formed dished ends or similar parts, which have not been uniformly heated in the normalising range in the final stages of manufacture shall be normalised.

e. When the completed vessel involves post weld heat treatment, heat treatment recommended in (a) above shall not be applicable.

f. Vessels in caustic service, Amine or Sour gas service shall be stress relieved.

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

2.2.13 Pressure part plates having thickness 16 mm to 50 mm (both inclusive) shall be ultrasonically Tested (UST) as per ASTM A-435. Pressure part plates having thickness above 50 mm and all Plates to be used shall be UST as per ASTM A-578 Level B. No laminations or inclusions shall be permitted.

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

2.2.15 Unless otherwise specified Copper & Copper alloys shall not be used. Copper content up to 0.4% are acceptable in carbon steel & 0.6% in stainless steel.

2.2.16 PWHT of complete vessel shall be carried out in one go in a furnace. Local stress relieving of Weld joint in piece meal shall be avoided as far as possible.

2.2.17 When post weld heat treatment is required for pressure vessels, all material for pressure holding Components shall be simulation tested with minimum additional two (2) heat treatment cycles. Additional two heat treatments are; one for PWHT after shop repairing and the other for future PWHT at site.

2.2.18 All Carbon Steel (CS) and Low-Alloy Steel (LAS) pressure parts shall have 3 mm corrosion allowance unless specified otherwise. All internal CS & LAS parts shall have at least 1.5 mm Corrosion Allowance on either side. No corrosion allowance shall be considered for SS. In general, the recommendation of Process Licensor shall be adopted for construction if found more stringent.

2.2.19 Gaskets for all medium with flange rating ≤ 600 # shall be SS spiral wound type with external &internal guide rings shall be used unless otherwise specified. CAF gaskets are not acceptable.

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

2.2.21 Due provisions must be kept for venting out entrapped gases during welding of pads, flanges and liner plates etc.

2.2.22 In case of equipment involving site assembly/fabrication the entire site job including loading & unloading at site, fabrication, radiography, heat treatment, Inspection & testing etc. shall be carried out by the same vendor under the witness of owner approved TPIA .

2.2.23 Production Control coupons, when required as per code and specifications, shall be subjected to all tests like impact, inter granular corrosion test etc., in addition to mechanical test as required. In case of heat treated equipment test coupons shall be given similar heat treatment as for the equipment.

2.3 Rubber Lining

The type of rubber (i.e. Natural, Butyl, Nitrile, Ebonite, Hypalon etc.), its minimum Thickness & hardness shall be decided as per design code/specification.

a) For vacuum service, the Triplex lining shall be adopted. It shall consist of 3 layers :

1st layer: 60 ± 5 shore A
2nd layer :35 ± 5 shore B
3rd layer: 60 ± 5 shore C

b) In general for all other services the preferred hardness of rubber shall be 65 ± 5 shore A.

c) Lining up to 6 mm may be applied in single layer. Above this thickness it shall be applied in 2 or more layers. Except when the sheets shall be prepared by calendaring as follows:

Thickness of Lining (mm)	Minimum no. of Plies
up to 3	2
3 to 5	3
6	4

d) The surfaces which are to be covered with rubber shall be easily accessible & free from pitting or other physical imperfection.

e) Spark testing shall be done for Lining.

f) The internal surfaces requiring rubber lining shall be prepared by Fabricator to suit rubber lining. All welds shall be ground smooth and radiused to min. rubber lining thickness. All welds shall be free from pin holes, pits, pockets and nipples. Porous welds are to be peened until tight. Since the internal surface preparation of the equipment is to be done by the contractor/Fabricator the same surfaces will also be inspected and approved by the rubber lining contractor/TPIA during fabrication and/or on handing over of the equipment to him for rubber lining.

3.0 TECHNICAL REQUIREMENTS

3.1 Vessel/ Filter

3.1.1 Design, materials, fabrication and inspection of welded pressure vessels shall comply with ASME Code Section VIII, Division 1 (latest edition) and code and standard specified in the NIT.

3.1.2 Design of Vessels skirt shall be based on seismic/wind/thermal considerations and fire proofing/insulation requirements.

3.1.3. All nozzles above 24” NB shall comply with ASME B16.47 Series B (API 605).

3.1.4. Minimum nozzle thicknesses shall be Schedule Extra Strong above 2” NPS, and Schedule 160 for 2” NPS and below.

3.1.5 Stress calculations due to Local loads on vessel for external structural attachments, such as platform clips, pipe support clips and lifting lugs shall be performed.

3.1.6 For Vessels the minimum thickness of shell & heads, including corrosion allowance shall be as indicated below:

Sr. No	Shell Diameter (mm)	Thickness (Min.) mm	
		CS / LAS	HAS
1.	ID < 500	5	3
2.	501 < ID < 1200	5	4
3.	1201 < ID <2000	6	5
4.	2001 < ID < 2600	8	6
5.	ID > 2600	10	8
CS = Carbon Steel, LAS = Low-Alloy Steel, HAS = High-Alloy Steel			

3.1.7 Vessels skirts for carbon steel vessels shall be designed from the same material (Grade) as the shell or the head. Vessel skirts for other than carbon steel vessels shall be the same material (Grade) as the shell or the head for the top 500 mm.

3.1.8 Vessels with skirt support having eight or more anchor bolts shall be required to be supplied with an anchor bolt template. The template shall be an annulus 10 mm (minimum) thickness and 150 mm (minimum) wide, with boltholes equal to bolt diameter plus 3 mm, stacked drilled with skirt base plate.

3.1.9 Minimum man way size shall be equal to 24” nominal pipe size.

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

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

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

3.1.13 Local l stress calculations for external structural attachments, such as platform clips, pipe support clips and lifting lugs shall be performed.

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

3.1.15 For Vessels 24" manhole shall be used for all vessels with internal diameter more than 900 mm. Vessels of internal diameter below 900 mm shall be flanged at one head, however, a 6" hand hole shall be provided on the other end. Larger size manhole will be specified when required to accommodate internals or critical for vessel entry.

3.1.16 In vertical vessels with demister, manholes shall be provided on to access both sides of the demister.

3.1.16.1 In horizontal vessels, the manhole shall be located on one of the heads, which is away from internals such as displacers, baffles etc. The vent connection on the horizontal vessels shall be on the opposite end of the manhole. Large vessels with diameter of more than 3000 mm TI- TI, an additional 4" vent nozzle with blind shall be provided.

3.1.17 The extent of radiographic examination of the shell and head seams shall be spot examination, as minimum.

3.1.18 Vessels to be hydrostatically shop tested in the horizontal position shall be supported adequately to keep local stresses in the shell not exceeding 90% of the yield strength of the material. However compressive shall be as per applicable code.

3.1.19 The lifting lug, lifting trunion, tailing lug etc. shall be designed with shock factor 2.

3.1.20 Design of supports and anchor bolts considering soil & importance factors shall be performed for compressive & tensile loading. In no case, diameter of anchor bolts shall be less than M24 for skirt support & M16 for other type of support.

3.1.21 HEAD / DISHED ENDS

a) Dished ends shall be of seamless construction. However, dished ends with one chordal weld seam are acceptable. In such cases, the chordal seam shall preferably be in the middle one third of the blank. Intermediate heat treatment, if considered necessary, shall be carried out by the LSTK Contractor.

b) Whenever a dished end is made of more than two plates, it must have a crown plate. Whenever a nozzle or a manhole is positioned at the centre of the dished end, the crown plate should be larger than the nozzle /manhole reinforcing pad.

c) Torispherical heads shall be used for Pressures up to 6.86 bar (g). For torispherical heads, ratio of Knuckle to Inside Crown Radius shall not be less than 6 %.

d) Beyond 6.86 bar g, heads shall be of ellipsoidal type having a ratio of major axis to minor axis 2:1 or hemispherical type. Alternatively, Hemispherical Heads with minimum weld joints may also be used.

3.3 Storage Tanks

3.3.1 The following design codes shall be adopted for tank design as applicable:

i) API 650 Welded Steel Storage Tanks for Oil Storage

3.3.1.1 For fixing the nominal capacity of the cone roof tank, allowance for free board (minimum 500 mm), vapour space and dead liquid space at the bottom shall be taken in to account. Tank diameter and height shall be firmed up based on nominal capacity (Cylinder volume)

3.3.2 For Carbon Steel storage tanks the minimum thickness shall be based on stability considerations. Minimum thickness for roof & shell shall be 5 mm, and bottom plate 6 mm, excluding corrosion allowance

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3.3.3 Storage tanks up to 4meter in diameter shall be shop fabricated items. Tanks with diameters greater than 4 meter shall be field erected.

3.3.4 Tanks constructed of stainless steel shall comply with API 650, Appendix S.

3.3.5 Shell seams shall be located to clear openings to the maximum extent possible in accordance with API 650.

3.3.6 Bottom plates may be lap-welded with the lap toward the direction of drainage. Butt welded bottom plates shall be furnished when specified on the tank drawings or data sheets or when tanks are specified to have rubber lining.

3.3.7 For each surface in contact with product/vapour, the specified corrosion allowance shall be added to the required thickness of all load-carrying components including shell, roof, bottom and roof supports. & One-half the specified corrosion allowance shall be added to each surface of no-load-carrying internal components.

3.3.8 All walkways, stairways, and platforms shall be furnished with handrails on open or exposed sides.

3.3.9 Anchor bolts shall be provided based on design considering wind/seismic loads, uplift due to internal pressure etc. However, tanks having diameter ≤10 meter shall be provided with anchor Bolts and shall be spaced at approximately 1.8M of circumference.

3.3.10 Maximum height of unstiffened shell shall be calculated based on the corroded thickness of shell courses. Section modulus of wind girders shall also based on corroded thickness of shell courses.

3.3.11 All storage tanks shall be designed and hydro tested considering liquid height up to top curb angle of shell Using one foot method for tanks less than and equal to 60 meter. However for seismic design, operating liquid level may be considered. All design calculation shall be carried out in corroded condition.

3.3.12 Unless otherwise specified bottom plate slope shall be 1:100 from the centre of the tank towards shell.

3.3.13 Butt welded annular ring below shell (minimum 8 mm thick excluding corrosion allowance) shall be provided for all tanks of diameter 12 m and above.

3.3.14 Fabrication tolerance on shell, bottom, and foundation etc. shall be as per applicable code.

3.3.15 Anchor bolt shall be provided if required by calculation for uplift or stability for wind and Seismic load. Minimum anchor bolt size shall be M24 excluding any corrosion allowance on bolt diameter. Tanks with diameter ≤10 m shall be provided with anchor bolt at spacing of maximum 1.8 m, however minimum 4 nos of M24 shall be provided for all tanks with diameter ≤10 m.

3.3.16 All tanks shall be provided with under tank leak detection and sub grade protection system as per appendix-I of API-650 for applicable foundation Type.

3.3.17 Thickness of tank bottom shall be determined as per API-650 Appendix –I for tank bottom Supported by piers/grillage. Maximum deflection of Corroded bottom plate shall not be more than half of the thickness.

3.3.18 The roof plates shall be self supported or supported by structure. Column supported roof shall not be acceptable. The roof and its supporting structure shall be designed to carry the dead Load, internal and external pressure as specified in process data sheet and live load as per design code.

3.3.19 Inside/outside painting of tanks shall be carried out based on product stored and as per Process data sheet enclosed with NIT package.

3.3.20 The agitation (fixation and baffling) loadings shall be considered in the design calculation & fabrication Of the equipment.

3.3.21 Record of differential settlement on foundation during hydro testing shall be maintained & shall not exceed as per allowable limit of API-650.

3.3.22 All nozzle-reinforcing pads shall be tested pneumatically at 0.5 Kg/cm2g pressure with soap solution on attachment welds.

3.4 FRP/GRP TANKS

Codes

Construction

- ASME X Rule for Construction
- BS EN 13121

Materials and material testing

- ASTM C-581 Chemical resistance of Resins
- ASTM D-2150 Woven roving Laminated FRP
- ASTM D-2583 FRP hardness test
- ASTM D-2584 Ignition loss of cured FRP
- ASTM D-2990 Flexural creep and Creep-rupture
- ASTM D-2997 Machine made FRP pipe
- ASTM D-3299 Filament-wound reinforcing

- ASTM D-3892 Resin and FRP packaging
- ASTM D-4024 Machine made FRP flanges
- ASTM D-4097 Contact-molded FRP tanks
- ASTM D-5421 Contact-molded FRP flanges
- ASTM D-618 Plastics testing conditions
- ASTM D-638 Plastics tensile properties testing.
- ASTM D-695 Plastics compressive testing
- ASTM D-883 Plastics terminology
- ASTM F-412 Plastics piping terminology

Equipment testing

- ASME V Non-destructive examination

Flange Drilling and bolting

- ASME/ ANSI B 16.5 Flanges and flange fittings
- ASME/ANSI B 16.47 Large diameter steel flanges

3.4.1 Graphite powder/ Resin paste shall be applied behind all welds to provide a permanent earth Path for spark testing. Permanent metal foil strips shall not be permitted.

3.4.2 Flange face (Front & back) shall be smooth & flat. If the flange faces are machined, the full Chemical liner shall be reinstated.

3.4.3 The Barcol Hardness of FRP/GRP wall shall be tested according to ASTM D2583.

3.4.4 The difference in the glass content of FRP/GRP between the samples shall not be more than 5% wt.

3.4.5 All items shall be cured in accordance with the resin supplier's instruction s. wherever possible curing shall be done at Manufacturers works.

3.4.6 High frequency sparks testing

All production thermoplastic welds shall be examined visually & by high frequency spark test Equipment at the following stages:

- Completion of first weld run
- Completion of external run
- After pressure or static head test
- After any boil out test

3.4.7 Reinforcing materials used on the inner surface shall be in compliance with the latest edition of ASTM D3299.

3.4.8 For FRP/GRP tanks, thickness of Corrosion barrier of the thermoplastic lining shall not be included in the thickness calculation, to withstand design condition.

3.5 **Safety**

3.5.1 Safety standards and features which are inherent in the specific mechanical equipment design codes, standards and regulations are applicable.

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

i) Ladder cages
ii) Safety chain across platform access
iii) Step-off platforms where necessary
iv) Platform grating
v) Toe plates

3.6 OPERABILITY AND MAINTENANCE

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

3.7 DISPATCH

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

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

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

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

4.0 Fabrication

4.1 The Bidder shall comply in all respects with the provision of the applicable codes, standards and specification during fabrication with respect to tolerances, welding, fabrication, forming of heads, radiography, heat treatment, inspection, testing and quality control etc. unless & otherwise specified.

4.2 Plates of different thicknesses shall be made flush with the inner surfaces of equipment unless otherwise stated.

4.3 Larger heads which cannot be formed in one piece shall be fabricated as follows with prior approval from Principle.

a) In two pieces, with the welding seam included in the middle third and preferably on the centre line

b) In petal construction, with meridianal seams and a central cap of diameter not larger than 0.75 times the vessel outside diameter

4.4 Due provisions must be kept for venting out entrapped gases during welding of pads, flanges and liner plates etc.

4.5 All welding shall be carried out by qualified welders using approved procedures in compliance with the requirements of codes, standards & specifications and shall be duly certified by the concerned inspecting authority. All welding procedures must be got approved from authorised inspecting authority before starting any fabrication job. Welding of all parts must be completed before heat treatment.

4.6 All welds shall be full penetration welds with back chipping and re-welding from the second side. For those joints which are inaccessible for back chipping the root run shall be carried out with TIG process. Single side welding with backing strips shall are not permitted.

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

4.8 All sharp corners shall be rounded off with smooth radius. Inside edge of manhole and hand hole at the internal surface shall be rounded to minimum radius 5 mm.

4.9 All flange bolts & skirt-bolts shall straddle centre line unless otherwise stated.

4.10 In case of nozzle with butt-end construction, extra length shall be provided to facilitate hydraulic testing and subsequently cutting and edge preparation to suit piping welding at site.

4.11 All nozzles less than or equal to NB 65 mm shall be stiffened with three equispaced plate ribs of the same material as that of shell.

4.12 Flange facing and thread connection shall be protected against oxidation during HT.

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

4.14 Welding wherever specified, is to be done by qualified and approved welders using the suitable fillers and fluxes recommended for the materials in the fabrication drawings.

5.0 **Inspection & Testing**

5.1 Equipment shall be inspected and tested in accordance with the relevant codes, standards and specifications by TPIA (owner approved). Cost of TPIA shall be under LSTK contractor scope. The Inspection and testing shall be in accordance with the relevant codes, standards, specifications, including mandatory NDT requirements indicated under Inspection and Testing clause 5.3 & Inspection guidelines (Annexure-1). All equipment & bought -out items shall be inspected during various stages of manufacturing starting from identification of materials to final completion as per agreed QAP which shall be prepared by LSTK Contractor and shall duly approved by Owner/ It's authorised representative. In case of site fabricated/assembled equipment same inspection agency shall be responsible for inspection and testing at site. The guidelines for minimum inspection requirements are listed in Annexure-1 & also defined under Inspection & Testing clause of the design philosophy.

5.2. The equipment shall be inspected by Third party inspection agency (TPIA) ((owner approved) as defined elsewhere as inspection agency. It shall be the responsibility of the Bidder to make available to the inspector all the drawings, calculations and other documents. However the Principal shall have free access for inspection at vendor's/sub-vendor's shop and at site during project execution.

5.2.1 The equipment shall be considered acceptable for despatch only after final certification for acceptance is issued by concerned inspector.

5.2.2 All parent material (Primary& Secondary Components), welds and HAZ shall be impact tested at Minimum Design Metal Temperature (i.e. minimum service temperature or the temperature to be computed as per applicable codes, standards &specifications) by Bidder and shall have impact energy values as per the applicable codes, standards & specifications.

5.2.3 Production control coupons, when required as per codes & standards shall be subjected to impact test, corrosion test etc. in addition to mechanical tests as required. In case of heat treated equipment test coupons shall be given similar heat treatment as for the equipment.

5.2.4 Formed heads when fabricated in pieces shall be normalised and weld seams fully radio graphed after forming.

5.2.5 Vessel containing lethal, toxic and highly inflammable substance shall be fully radio graphed and stress relieved.

5.2.6 All nozzle reinforcing pads shall be tested pneumatically at 0.5 Kg/cm2g pressure with soap solution on attachment welds. Vent holes shall be plugged with non hardening mastic to prevent ingress of water.

5.2.7 All completed equipment shall be tested hydraulically as per the requirements of codes, standards & specifications in presence of the inspecting authority. Pneumatic test of completed equipment shall be carried out only when specially mentioned in the specification sheets. Chloride content in water used for testing shall not exceed 30 ppm for SS equipment and 40 ppm for CS and low alloy steel equipment. Duration of test shall be as minimum 1 hour. Hydrostatic test shall be done prior to painting at weld and/or coating on weld.

5.2.8 The temperature of test water shall comply with requirement of Fabrication code.

5.2.9 Unless otherwise stated gaskets used during testing shall be same as specified for operating conditions. However all joint gaskets shall be replaced by new gasket after Hydro testing.

5.3 The following NDT requirements are mandatory in addition to codes, standards & specification requirements:

A) UT examination

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

B) MP / PT examination

i) All edges of plates and opening in shell of CS having thickness equal to & above 40mm and LAS / SS having thickness more than 25mm .
ii) Root and final layer of all butt welds.
iii) Fillet welds of SS
iv) All weld surfaces after PWHT
v) Each layer of weld deposit in SS overlay
vi) Knuckle surfaces of dished ends, expansion bellows and pipe bends
vii) All forgings after machining
viii) Skirt to head joint
ix) All welds of SS and non ferrous materials and welds for vessels with design temp. (-)45 degree C and below after hydro testing.
x) All welds of SS over ¾ inch thk. after hydro testing.

C) Radiography:

i) All weld seams of formed head, if made in more than one segment shall be full radio graphed after forming.
ii) When spot radiography is specified, all T – Joints & minimum10% of total weld length excluding T joints shall be radio graphed.
iii) All nozzles fabricated from plates shall be 100% radio graphed.
iv) Radiography of welds in C - 1/2 Mo & Cr - Mo - Steel be carried out after heat treatment.
v) Vessel containing lethal, toxic and highly inflammable substance shall be full radio graphed

D) Hardness test on welds of Cr-Mo, Materials after final heat treatment. The value shall be as per applicable code .

Note: If a vessel is not 100% radio graphed and/or UT tested, then a minimum examination of butt, corner & T-joints shall be made.

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

6.0 **Pickling and Passivation**

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

6.1.1 Pickling

Aqueous pickling solution shall be as follows:

Nitric acid (Tech. grade) 10 to 25% plus Hydrofluoric acid 1 to 8% (to be used only for stabilised SS grades). Temperature 50 to 60° C for 10% Nitric acid and 20° C for 25% Nitric acid. When size and shape

of product permit, total immersion in the pickling solution is preferred. Where immersion is impractical, pickling may be accomplished by wetting the surface by

i) Swabbing or spraying
ii) Partial filling the item with pickling solution and rotating or rocking so that all the surface receives the required chemical treatment.

The maximum period for which the pickling solution shall be allowed to remain on the surface is 30 minute. During pickling removal of oxides may be hastened by brushing with a hard fibre or SS wire brush. Over pickling shall be avoided.
The pickling agent shall be washed off with plenty of water so as to leave no trace behind.

6.1.2 **Passivation**

After pickling and water rinsing, an aqueous caustic permanganate solution containing NaOH 10 weight % and KMnO4 4 weight % shall be used for neutralising pickling solution. This shall be followed by thorough water rinsing.

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

7.0 **Painting**

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

8.0 **Insulation & Fire Proofing**

8.1 The Equipment shall be insulated as Listed elsewhere in NIT document.
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8.2 Fire proofing, if required shall be considered as per Process Licensor's recommendations.

9.0 **Spares Parts (Erection & commissioning, Mandatory spares (for 2 years operation))**

For Spare parts refer Section - 7 (spare parts) of NIT.

10.0 Documentation Schedule

Documents shall be submitted as per "Documentation Schedule" in Section-6 of NIT.

11.0 **Vendor List**

For Vendor list refer Section – 10 of NIT.

12.0 Indicative QAP

The final Inspection & Test Plans (ITPs), based on the indicative ITP shall be developed by the LSTK CONTRACTOR as per contract specifications & codes and shall be submitted to PMC/Owner for approval. Inspection and Test Plan shall include detailed manufacturing/inspection activities including those of sub supplied/ bought out items. The indicative ITPs enclosed in the NIT are for guidance to the LSTK Contractor and may not cover some of the activities to be performed during execution of works under the scope of this contract. However Bidders to submit their proposed QAP/ITP in technical bid. For tentative QAP refer section-11.

13 **Guarantees**

13.1 **Mechanical Guarantee**

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

13.2 **Performance Guarantee**

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

ANNEXURE - 1

INSPECTION GUIDELINES

1.0 **GENERAL**

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

1.1 **VESSELS / FILTERS ETC.**

a) All carbon steel plates shall be identified against mill-test certificates at the VENDOR'S works before commencement of fabrication.

b) Establish that welding procedure and welders are qualified and welding electrodes are approved before commencement of fabrication.

c) Check fit-up and witness chipping-back of welded seams.

d) Wherever applicable, select spots for radiography, D.P and M.P Tests.

e) Witness any crack detection, hardness checks, ultrasonic tests etc. which may be specified. (1)

f) Review radiographs and in case it is unsatisfactory re-radiograph. (1)

g) Witness hydrostatic test.

h) Dimensionally check and carry out final internal and external inspection for quality of workmanship.

i) Check that all material test certificates and, where applicable, heat treatment charts are in order. Ensure that VENDOR is familiar with the requirements regarding data books and ensure that the documentation is submitted without any delay.

j) Check internal lining of reactors and vessels (if applicable) to specifications.

k) Witness any further test recommended by Process Licenser/Inspection agency and/or OWNER.

Note (1): X or Gamma rays

1.2 **VESSEL INTERNALS**

a) Leak testing & final inspection only is required.

b) Check one tray of each diameter and type, mock assembled in the shop.

c) Spot check for interchangeability of parts, where applicable.

d) Ensure that any uncommon down comers are fully assembled and offered along with their respective trays.

e) Where new designs and/or new VENDOR's are concerned, check that any applicable leakage tests have been carried out on prototype.

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

1.3 STORAGE TANKS

a) Shell plates to be dimensionally checked (including diagonals for square-ness) before rolling to curvature.

b) All shell plates to be inspected and dimensionally checked after rolling to curvature.

c) Check material test certificates and ensure that all shell plates are clearly stamped with the cast and plate number, so that they can be identified against the relevant test certificates.

d) Check material test certificates for roof and bottom plates.

e) Select the spot radiographs, D.P & M.P test as per codes.

f) Review the radiographs. (1)

g) On completion of inspection of shell plates ensure that VENDOR provides a chart giving all plate numbers, tier by tier.

g) Inspect fabrication of all fabricated fittings. This is to include checking of material test Certificates also.

i) Inspect tank gauging equipment.

j) For shop fabricated tanks, witness hydrostatic tests to applicable standards.

k) Check welding material electrodes

Note (1): X or Gamma rays

PART-II, TECHNICAL

SECTION – 3.3

DESIGN PHILOSOPHY – ROTATING EQUIPMENTS

REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD
0	30.06.23	30.06.23	Issued for Tender	VS	VS	RRK
P	05.04.23	05.04.23	Issued for Client Comments (DRAFT)	VS	VS	RRK

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LIST OF ATTACHMENTS

1.0 SCOPE

1.1 General

1.1.1 This Philosophy states that contractor's scope of work shall include basic & detailed engineering, procurement, supply, manufacturing, fabrication, Inspection & testing ,transportation, loading, unloading, insurance during transit, storage, construction, erection/installation of all Mechanical Rotating Equipment with allied electrical, instrumentation and civil works, testing, mechanical completion, pre-commissioning, commissioning, performance guarantee test runs including total project management and handing over of installation of ultra filtration unit at RCF, THAL

1.1.2 In addition, all statutory rules & regulations shall also be complied with.

2.0 DESIGN PHILOSOPHY FOR MACHINERY

2.1 Codes and Standards

The latest edition of codes and standards as listed below shall be followed for design and manufacturing of different machinery items. Generally the manufacturer will comply with these codes and standards as indicated therein with minor deviations that are normally adopted by manufacturer and are reasonably accepted as per good engineering practice.

A list of such Deviations/exceptions against Codes & Standards requirement/ guidelines, if any, furnished by successful bidder are subject to owner's review and approval during detail engineering contractor to note that OEM-standards are not acceptable. OEM standards should be based on respective national / international standards.

Contractor to also note that requirement mentioned in API & other relevant codes & standards regarding any optional requirement or any bulleted points mentioned in the applicable codes, owner's decision shall prevail. Owner may ask for the compliance or relaxation during detail engineering stage on suitable, valid submission/ technical justification from contractor.

Code	Description
API 610	Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industry
International Standard	Horizontal Centrifugal Pumps for Clear Cold Water
API 619	Reciprocating Compressors for Petroleum, Chemical and Gas Industry Services
API 671	Special Purpose Coupling for Refinery Services,

	Petrochemical and Gas Industry
API 673	Special Purpose Centrifugal Fans for General Refinery Service
API 674	Positive Displacement Pumps-Reciprocating
API 675	Positive Displacement Pumps-Controlled Volume
API 676	Positive Displacement Pumps-Rotary.
API 678	Accelerometer and Vibration Systems.
API 681	Liquid Ring Vacuum Pumps and Compressors for Petroleum, Chemical, and Gas Industry Services
API 682	Shaft sealing Systems for Centrifugal and Rotary Pumps.
API 685	Sealless Pump (Magnetic & Canned)
ISO / DIN	Centrifugal Pumps for smaller size & Non Critical Services.
International Standard, ASHRAE/ ISHRAE	HVAC
AHRI-560	Absorption Water Chilling & Water Heating Package
Performance Testing (ASME Codes)	
PTC 8.2	Centrifugal Pump
PTC 10	Centrifugal Compressors
PTC 11	Centrifugal Fans
AGMA Standard	
420	Practise for Enclosed Reducers or Increasers using Spur, Helical, Herringbone and Spiral Bevel Gears.
421	Practise for High Speed Helical Gear Units.

2.2 Design Life

All equipment shall be designed for a minimum service life of 25 years and at least 3 years of uninterrupted operation under normal operating conditions. This requirement excludes specialised components requiring periodic maintenance and replacement.

2.3 Essential Project Reference Documents

The following documents shall be observed, and relevant aspects incorporated into specifications and datasheets:

- Process Description, Specifications and Data Sheets from Licensor

- Hazardous Area Classification
- Electrical and Instrumentation Design Criteria

2.4 Regulations

Besides codes & standards, LSTK Contractor shall follow National Laws and Regulations together with Local by Laws for the state including statutory requirements as applicable.

2.5 Site Conditions

Site conditions shall be mentioned in process design philosophy/relevant potion of ITB.

2.6 Material of Construction

Generally Materials of construction shall be as per the process licensor's recommendation; However the API guideline may be adapted to the extent applicable.

Use of equivalent & superior material may be selected & shall be furnished with the offer along with chemical composition.

2.7 Quality Assurance & Control

2.7.1 The quality assurance shall be as per the approved procedures, test methods & facilities to be developed by the LSTK Contractor to ensure that the supplied equipment shall be of highest quality. The quality control shall mean that all the tests , measurements, checks & calibration which are to be carried out may be compared with the actual specified characteristics of the equipments/unit /system.

2.7.2 Quality Assurance (QA) shall mean the organizational set up, procedures as well as test methods and facilities developed by LSTK Contractor in order to assure that The Machines & Associated auxiliaries leaving LSTK Contractor's shop are of the highest possible quality i.e. either equal to or better than the requirement specified.

2.7.3 Quality Control (QC), shall mean all the tests, measurement, checks and calibration which are to be carried out in LSTK Contractor's shop in order to compare the actual characteristics of the equipment/unit/system with the specified ones, along with furnishing of the relevant documentation (certificates/records) containing the data or result of these activities.

2.7.4 LSTK Contractor shall submit a comprehensive description (manual) of QA/QC measures contemplated by him for implementation with regard to this specification. It is contractual obligation of the LSTK Contractor to develop and implement adequate QA/QC systems.

2.7.5 QA/QC system shall cover all products and services required for the complete machine unit as per scope of work including job sub contracted by the LSTK Contractor.

3.0 DESIGN REQUIREMENTS

3.1 GENERAL

3.1.1 All machines shall be preferably directly coupled to their prime movers; Gears/any other forms of transmission shall be avoided. If not, specifically mentioned, the drivers shall have rated output at least 10% greater than the power requirement at design operating condition of the driven equipment and also compliant to respective API whichever is more stringent.

3.1.2 Copper (Cu) or Cu-alloy shall not be used for any components for ammonia or similar services.

3.1.3 All process pumps shall have Mechanical Seals. Single seals will be used in most cases, however, for ignitable or hazardous fluids, double, or Inside Wet and Outside Dry running seals will be used. Seals shall be designed as per API 682 latest edition only.

3.1.4 Special tools and wrenches required for installation and maintenance shall be provided.

3.1.5 LSTK Contractors have to submit the reference list for similar equipment's models (minimum 2 nos.) supplied in past for similar duty conditions. Reference list must contain at least the following: Fluid handled Capacity, Suction Pressure, Discharge Pressure, Model No., Power consumption, Client Name, Address, and Year of supply.

3.1.6 Provision of Coast down tank shall be made in the Lube Oil System.

3.1.7 Dedicated oil clarifiers with all hose & piping connection to be provided for major/critical equipments.

3.1.8 Noise level for all rotating equipment shall be limited to 85 dBA measured at 1 meter distance from the equipment.

3.1.9 All machines must have the details related to lubricants used written e.g. name of the lubricants, tank capacity (where it is used), level measurement with high low marking, flow direction on the oil pipe line, trip values for oil pressure low, auto start pressure etc. marked at appropriate locations.

3.1.10 Lubricants storage section having minimum emergency stock of all lubricants to take care of any emergencies. It shall have lubrication drum loading / unloading facility, for transportation of oil drums with associated facilities like an electrical or hand operated oil pump (for transfer of lubricant to machines), with oil collection pits in case of any spillages with adequate illumination.

3.1.11 During detail engineering stage, all the rotating equipments datasheets shall be submitted as per relevant API standard format.

3.1.12 For all types of pumps working and standby philosophy, refer design chapter.

3.2 CENTRIFUGAL PUMPS

The process pumps except slurry pump shall be designed as per API 610, 11th edition. The pumps shall be of robust design to ensure long service life and minimum maintenance requirement. The pumps shall be designed for easy access for inspection and maintenance. All continuously running pumps shall have a spare pump installed. Slurry pumps shall be designed as per Manufacturer's standard/ISO/DIN standard.

In addition to codes & standards, following points shall also be applicable:

3.2.1 All pumps shall have continuously rising head curve from any specified operating point to shut off point. Pumps running in parallel shall have equal head rise to shut off point.

3.2.2 All pumps shall be designed for 20% overload.

3.2.3 The pumps should have stable operating characteristics. The pump head at shut off shall be approximately 110% of head at rated capacity and not exceeding 120%.

3.2.4 Best efficiency point shall be as close as possible to normal operating point.

3.2.5 Impellers of multistage pumps shall be secured positively against axial movement.

3.2.6 For multistage pumps, a lateral critical speed analysis shall be carried out.

3.2.7 Pumps with centre line support shall be provided for pumps handling fluids of operating temperature more than 177^0C.

3.2.8 The maximum calculated axial load shall not in any operating condition exceed 50% of bearing manufacturer's load rating.

3.2.9 Metastream type of coupling shall be provided. Coupling guard shall be non-sparking for pumps located in hazardous area.

3.2.10 Mechanical seal of Eagle Burgmann / John crane / Flowserve make only shall be provided based on pump manufacturer recommendation. Only cartridge type balanced mechanical seal shall be used.

For non API pumps in utility service, mechanical seals shall be as per applicable design standard suitable for the specified service.

3.2.11 For pumps with forced lubrication system, the lubrication system shall be designed as per API 610.

3.2.12 Pumps shall not be offered or supplied with minimum impeller diameter. Selected impeller diameter shall be with a margin of at least 5% from minimum impeller diameter.

3.2.13 Bearing Isolators of reputed make shall be provided for equipment & its driver motor & gear box.

3.2.15 NPSH test to be carried out in presence of TPIa where margin between NPSHA and NPSHR is less than 1 mtr. In case of margin is lesser than 0.5 m, offered pump shall be rejected.

3.2.16 For pumps working and standby philosophy, refer design chapter.

Filter Feed Pump (1 W+1 SB) shall be provided with variable speed drive for feeding reacted slurry from Digestion Tank to Belt Filter.

For all other pumps around the Belt Filter 2 pumps will be installed each of 50% of required capacity and both these pumps shall be in continuous operation. One spare pump of each size shall be supplied as a warehouse spare. Coupling guard shall be non-sparking for pumps located in hazardous area.

3.2.16 SEALLESS CENTRIFUGAL PUMPS (Canned Motor)

i. Pumps shall be designed for flammable or hazardous services or as per the process requirement based on API 685 latest edition.

ii. Pumps shall be capable of at least a 5% head increase at rated conditions by replacement of the impeller(s) with one(s) of larger diameter or different hydraulic design.

iii. Casings shall be designed to permit removal of the rotor or inner magnet ring without disconnecting the suction or discharge piping.

iv. Pumps shall be capable of operating at least up to the maximum continuous speed. The maximum continuous speed shall be:
   a) Equal to the speed corresponding to the synchronous speed at maximum supply frequency for electrical motors;
   b) At least 105% of rated speed for variable-speed pumps, and any fixed-speed pump sparing or spared by a pump whose driver is capable of exceeding rated speed.

v. Since seal less pumps use pumpage or other liquid to cool and lubricate the bearings, the circulating liquid must remain stable as it passes through the bearings. The pump manufacturer shall furnish the temperature and pressure profiles of the fluid recirculation flow path through the pump and rotor chamber. These profiles are to be shown at maximum specified operating temperature and are to be provided for minimum stable flow, design conditions, and maximum rated flow.

vi. Pumps shall use throat bushings, wear rings, impeller balance holes, auxiliary impeller, and/or flushing-line arrangements to maintain a rotor chamber pressure greater than the suction pressure.

vii. The pump design shall also ensure that the temperature and pressure in the rotor chamber prevent vaporization at all operating conditions, including minimum flow while providing continuous flow through the rotor chamber for cooling and bearing lubrication.

viii. All internal cavities shall be completely self-venting. When exception must be taken, the Vendor shall, as a minimum, include provision for manual venting

and provide a “caution” tag attached to the pump to indicate that manual venting is required before and after maintenance.

ix. Pumps shall be designed to prevent damage from reverse rotation on starting check-outs. The pump shall be supplied with the means to detect backward rotation.

3.3 RECIPROCATING PUMP / METERING PUMPS

Reciprocating pump shall be designed as per API 674 latest edition and metering pump shall be designed as per API 675 latest edition.

3.3.1 The metering pumps shall be suitable for continuous capacity variation from 0 to 100%. The capacity variation should be possible while the pumps are working.

3.3.2 For pumps working and standby philosophy, refer design chapter.

3.3.3 Pumps shall have SI dimensions and comply with applicable ISO Standards, except for piping connections which may be as per ANSI Standards.

3.3.4 All threads and fasteners shall preferably be of ISO metric sizes.

3.3.5 Maximum noise level shall not exceed 85 db (A) at one meter distance.

3.3.6 Arrangement of equipment including piping and auxiliaries shall be developed by the vendor and submitted to the purchaser for review.

3.3.7 Any water or steam jackets for liquid ends shall envelop liquid cylinders, stuffing boxes and preferably valve chambers.

3.3.8 NPSH(R) shall be indicated by the vendor taking into account acceleration head. For pumps handling volatile liquids, the NPSH required shall be determined and guaranteed after taking into account the heat generated in the glands.

33.9 Valves and sets shall have a minimum hardness of 150 BHN if constructed of carbon or low alloy steel and 225 BHN for 13% Cr steel. The difference in hardness between valves and seats shall be 50 BHN minimum.

3.3.10 Hollow plungers are prohibited. Repacking should be possible without removing plunger from the cylinder.

3.3.11 Enclosed crank cases, gear units and similar mechanisms shall be sealed. Removable covers shall be provided for inspection, cleaning and minor adjustments of parts.

3.3.12 For liquid end pressure containing parts like cylinders, valve chambers and suction and discharge manifolds, corrosion allowance shall not be less than 1.0 mm for carbon and low alloy steels.

3.3.13 The enclosure shall be suitable for mounting on base frame and shall be weatherproof and dust tight.

3.3.14 Welding of piping and pressure containing parts up to 40 kg/cm2 pressure shall be spot radio graphed. For pressure above 40 kg/cm2 100% radiography, magnetic particle test or dye penetrate test of welds is required.

3.3.15 All pumps shall be directly coupled with their motors. V-belt shall not be used.

3.3.16 Design code of offered pump to be specified in the bidders offer.

3.3.17 Mechanical seal of John crane / Flowserve / Eagle-Burgmann/ Equivalent reputed make only shall be provided. Only balanced mechanical seal shall be used.

3.3.18 For pumps with forced lubrication system, the lubrication system shall be designed as per API 614 latest edition.

3.4 ROTARY PUMPS

3.4.1 Rotary pump shall be designed as per API 676 latest edition.

3.4.2 Pumps shall be designed and selected to ensure that suction pressure casing zones can be subjected to discharge pressure side hydrostatic test pressure.

3.4.3 Installed standby pumps shall be suitable for running with equal load in parallel operation.

3.4.4 For pumps working and standby philosophy, refer design chapter

3.4.5 API Mechanical seal of John crane / Flowserve / Eagle-Burgmann/ Equivalent reputed make only shall be provided. Only balanced mechanical seal shall be used.

3.4.6 For pumps with forced lubrication system, the lubrication system shall be designed as per API 614 latest edition.

3.4.7 Unless indicated otherwise multi-pole type direct drive electric motor shall be the driver for the pump to eliminate the use of gears. Electric motor drivers shall be in accordance with electrical Specification.

3.4.8 Gear unit shall be provided in accordance with AGMA standard.

3.4.9 Selection of MOC of stator or any pump part shall be done as per manufacturer recommendation only.

4.0 INSPECTION & TESTING

Machines shall be inspected by Third Party Inspection Agency (Lloyds/BV/TUV/PDIL) or TPIA approved by RCF. The Inspection and testing shall be in accordance with the all relevant codes, standards, specifications, including the minimum guide line given in Annexure - I (attached).

4.1 All testing accessories, measuring instruments including NDT testing equipment, etc. shall be arranged by LSTK Contractor. DM water shall be used for hydro testing of the equipment which shall be supplied by client.

4.2 In general, following tests shall be conducted for all rotating equipments:

- Material test
- Non-destructive test
- Hydrostatic test for all the pressure containing parts

- Dynamic balancing of rotor
- Helium leak test of compressor casing (if required as per API Code)
- Mechanical running test
- NPSHR test for pumps
- Performance Test
- Disassembly Test
- Strip test in case of any abnormality found during testing

The tests required to be conducted and witnessed shall be specified in the equipment data sheet. Disassembly test for Fans, Blowers & small Pumps can be waived –off in case no problem occurs during mechanical / performance Test.

5.0 SPARES (Kindly refer spare parts section)

Scope of work for spares supply:

Bidders shall quote for the following spares:

A) Start-up & commissioning spares Special tools & tackles, if any: The prices of Start-up & commissioning spares, Special tools & tackles, if any shall be included in the basic price of supply portion of LSTK.

B) Mandatory spares (Consumption within 2 years): A list of mandatory spares is listed here under. Bidder shall quote price for each mandatory spares mentioned and the same shall be considered for the evaluation.

C) Recommended Spares, if any: The bidder may quote any critical recommended spares which may be the required during first 2 yrs. of plant operation along with the bid. This will not be considered for bid evaluation. The validity of the offered price for recommended spares shall be the same as bid validity. Owner will take decision for the procurement of same within the bid validity.

D) For all the above mentioned spares, bidder to indicate the itemized price for each spares.

6.0 PAINTING

6.1 All exterior non-stainless steel surfaces subject to atmospheric corrosion with the exception of machined surfaces shall be epoxy painted.

6.2 All exterior machined surfaces shall be coated with suitable rust preventives.

6.3 Bidder shall submit detailed painting procedure for review/approval.

7.0 VENDORS LIST

All equipment shall be procured/fabricated as per approved vendor list (Section - 14). Any equipment for which vendor list is not enclosed, the LSTK Contractor may furnish a list of proposed vendors along with their references for supply of

similar type of equipment along with bid. However all proposed additional sub-vendor shall have well proven track record and shall be subjected to consultant / owner's approval.

Bidder shall indicate make of various equipment offered by them in the bid.

8.0 LSTK CONTRACTOR/VENDOR DOCUMENTATION:

Drawings & Documents of machinery items shall be as per ITB.

ANNEXURE-1

INSPECTION & TESTING GUIDE LINES – ROTATING EQUIPMENT

1.0 SCOPE

This document covers the minimum guide lines for the Inspection & Testing for the rotating Equipments.

All rotating Equipments shall be inspected by Third Party Inspection Agency (Lloyds/BV/TUV/PDIL). The Inspection and testing shall be in accordance with the all relevant codes, standards, and specifications as specified in Specification sheet.

2.0 PUMPS AND DRIVERS

2.1 Pump casing to be identified against foundry test certificates and thickness checked to conform to approved drawings.

2.2 Witness hydrostatic test on casings.

2.3 Dynamic balancing of rotor

2.4 Witness running tests on pumps including N.P.S.H. where applicable.

2.5 Non- destructive test.

2.6 Strip inspection of pumps on completion of running tests. Wearing surfaces to be checked and recorded. As a general principle, mechanical seals will not be dismantled after running tests. This necessity will be discussed on a case to case basis if abnormal noise or temperature has need records during testing. All materials to be checked against test certificates or VENDOR'S bill of materials.

2.7 Final inspection and dimensional check of pump (including driver, when mounted on base plate).

2.8 Heat run or standard abbreviated tests, as specified, to be witnessed on electric motor drives.

2.9 Final inspection and dimensional check to be carried out on motor drivers.

2.10 Check all test certificates.

3.0 COMPRESSORS / BLOWERS AND DRIVERS

3.1 Material of casings or cylinders to be checked against test certificates.

3.2 For fabricated casings, inspection shall be as per API 617/API 618.

3.3 Hydrostatic test on casings or cylinders to be witnessed.

3.4 Dynamic balancing of rotor

3.5 Non- destructive test.

3.6 For fabricated impellers, welding procedure and welder's qualifications to be established and impellers to be inspected before assembly. Impellers overspeed, NDT after overspeed and dimensional inspection.

3.7 Ensure that overspeed tests on impellers have been carried out and related certificate for dynamic balancing of impellers and subsequently the complete rotating assembly shall be provided. The overspeed test shall be carried out to prove the impeller proper balancing and relevant certificate shall be provided.

3.8 Witness leakage test on lube oil tank and carry out internal and external inspection. Tank to be finally inspected after internal coating and /or painting.

3.9 Inspect prefabricated lube oil piping.

3.10 Witness performance tests shall be done and check all safety and alarm devices when contact instrumentation is fitted.

3.11 If spare rotating assembly is ordered, any running tests with spare fitted or the dropping of the spare into the casing, as may be specified, to be witnessed.

3.12 Strip inspection on completion of running tests. To include examination of all running surfaces, checking of critical clearances, and examination of lube oil filters in the tests.

3.13 Final inspection and dimensional check of compressors mounted on base plates.

3.14 Gearing, pinion forgings and main wheel forgings or castings to be inspected at forge shop or foundry (as per DIN 50029 3.1B).

3.15 Any dynamic balancing of gearing rotors to be witnessed.

3.16 Fabricated gear cases to be inspected at sub-supplier's works.

3.17 Light or full load running tests, as specified to be witnessed on gearing.

3.18 Final inspection and dimensional check of gearing to be done at manufacturer's works. Inspection of electric motor drivers as for pump drivers.

SECTION – 3.4

DESIGN SPECIFICATION – PIPING

INSTALLATION OF ULTRA-FILTRATION UNIT

AT
RCF, THAL

CONTENTS

LIST OF ATTACHMENTS

SL NO.	DOC.NO.	DESCRIPTION	NO.OF SHEETS
1	EM0000-PNMP-TS951	DESIGN PHILOSOPHY- PIPING	49
2	TFL-PDS-600	PIPING MATERIAL SPECIFICATION	40
3		PLOT LAYOUT	1

1.0 GENERAL PIPING SCOPE OF WORK

1.1 The detail scope of work includes such as, but not limited to, complete management, Design, Detailed Engineering, 3D modelling, Stress Analysis, to provide all the necessary data, drawings, documents required as per the project requirements, Procurement, Supply, Transportation of materials, shop & site Fabrication, Erection, Installation, Supporting, Non-Destructive Testing (NDT) & required Inspection, pre-heating, dye-penetrant test, Magnetic Particle Test, post weld heat treatment, radiography, Ultrasonic test, Testing, Flushing, Air drying, blowing, cardboard-blasting, seal/leak-testing, Pre-Commissioning, Trial run, Commissioning and Guarantee of all the associated works pertaining to complete piping system and related facilities for INSTALLATION OF ULTRA-FILTRATION UNITAT RCF, THAL

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1.2 Design, material, fabrication and erection shall be in accordance with latest edition of ASME B31.3 chemical plant and petroleum refinery piping code. The dimensions, manufacturing tolerances shall conform to applicable standards.

1.3 All works described in this package shall be performed in accordance with the design-basis, specifications, drawings, and other requirements of NIT and shall be subject to Owner's review and approval.

1.4 MATERIAL OF CONSTRUCTION

Materials as per internationally acceptable code shall be used for piping based on service requirement. All materials for piping Components shall conform to ASTM or API Specifications as per enclosed piping specifications. All piping materials and valves shall be procured from the approved suppliers/vendors.

1.5 Cost of piping job shall also include the cost of supervision, Labour, overheads / profits, materials, consumables, scaffolding and all other associated arrangements required to execute the related activities of this package.

1.6 PIPING INTER - CONNECTION

Piping lines as per P&ID shall be provided at battery limit which shall be indicated later by Owner. Bidder shall provide valve at battery limit for respective piping system of the package unit.

1.7 SPARES

Mandatory spares shall be quoted by bidder as per spares section of NIT.

2.0 DESIGN AND DETAILED ENGINEERING BY BIDDER

2.1 Collection of all data/ information furnished in the NIT and additionally collected/ generated by Bidder.

2.2 Finalization of design data/ basis for carrying out design, detailed Engineering for complete scope of work as per project specifications, contained in the NIT.

2.3 Performing design and detailed engineering of the following:

a) Complete piping system for the package unit.

b) Carry Out all necessary calculations in accordance with approved design basis, drawings / documents and requirements of the NIT.

c) Finalization of layouts for the unit and preparation of construction drawing, preparation of piping drawings, equipment layouts, piping general layout drawings (GAD's) , pipe supports, piping isometrics. Typical indicative sketches/drawings included in NIT document shall be taken as broad basis for developing the layouts. Since the availability of free space is limited, Bidder shall plan its piping layouts in such a way so as to minimize the area requirement while giving due importance to ease of access, operation

and maintenance of the facilities installed by the Bidder. The fabrication/erection & all other piping jobs shall be carried out as per drawings/documents approved by Owner.

d) Carrying out Material Take Off for the entire piping system for the package unit.

e) The detail design shall take into consideration of local Statutory Regulation, if any, for the package unit.

3.0 PROCUREMENT & SUPPLY BY BIDDER

3.1 Bidder shall procure and supply all materials whatsoever required for temporary/permanent installation of piping system in sequence and at appropriate time. All equipments, materials, components etc shall be suitable for the service and the design life of the system.

3.2 Bidder shall procure all materials, components, equipments, consumables etc required for successful completion of the piping system. Bidder shall also procure spares required for pre-commissioning and commissioning/start-up as recommended for all the items supplied by him as per specifications provided in the NIT. Where no specifications are available in the contract, the same shall be prepared by the Bidder, and shall be subject to Owner's approval.

3.3 Material take-off (linewise and consolidated) with complete description of size, rating, material, thickness and specifications.

3.4 Preparation and finalization of data sheets for all piping materials e.g. all valves etc. All data-sheets shall be subject to review and approval by Owner.

3.5 Preparation of Material requisitions, Request for Quotation & its evaluation and recommend Bidders for Owner's approval. Preparation of purchase requisitions, review of Bidder's drawings and calculations, approval of manufacturing procedures wherever necessary, and the party inspection at manufacturer's works of the materials by reputed agencies as required. Quality control and expediting of all procured items at Bidder's shop or at fabrication yard.

3.6 Bidder shall procure materials as per specifications and list of approved Vendors/Suppliers (for major Items) included in the bid document.

3.7 Carry out proper documentation of inspection and quality assurance programs for all equipment and bulk materials duly approved by Owner. Bidder shall maintain an accurate and traceable listing of procurement records for the location, quality and character of all permanent materials in the Project.

3.8 Bidder shall immediately report to the Owner of all changes which will affect material quality, and take necessary corrective actions. Purchase requisitions including Purchase Orders of all major items shall be approved by Owner. For balance items, records shall be furnished for information only.

3.9 Compliance with Bidders and supplier's instructions and recommendations for transportation, handling, installation and commissioning.

4.0 INSPECTION

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

4.2 The inspecting authority shall have the right to select random samples for check test and reject materials, if samples furnished as above and tested as per the specifications fail to meet the requirement specified.

4.3 All the items shall be inspected and tested in the presence of one or more representatives of the purchaser during various stages of manufacturing. Material shall be considered acceptable for dispatch only after final certificate of acceptance is issued by the Inspector.

4.4 Testing performed in the presence of the purchaser's representatives shall not relieve the supplier of their own responsibilities and guarantees and any other contractual obligations.

4.5 Quality Assurance plan (QAP) / Inspection Test Plan (ITP) shall be submitted by bidder for approval by Third Party Inspection Agency (TPIA).

4.6 Scope of Inspection by TPIA:

- Review of Chemical composition report, MTC (all batches)
- Positive Material Identification (PMI) for Alloy/Stainless steels (10% random witness)
- Hydrostatic test (10% random witness)
- Non Destructive Examination- Report review
- Dimensional check, Marking, Visual check for surfaces, external appearance (10% random witness)
- Packing: Report review

5.0 PAINTING

Painting shall be as per specification attached elsewhere in NIT.

6.0 CONSTRUCTION

All construction works be carried out as per "Approved for Construction" drawings, procedures, specifications and applicable codes and standards. Any changes at site shall also need prior approval from the Owner/PMC and revision of drawings.

Bidder shall procure and supply all materials whatsoever required for temporary/permanent installations of piping system in required and at appropriate time. All equipment, materials, components etc. shall be suitable for the intended service and the design life of the system. Wherever no specification is available in the contract, the same shall be prepared by the Bidder and shall be subject to Owner approval.

After completion of erection jobs, all piping system will be suitably hydraulically tested as per the test pressure indicated in the line list / relevant document approved by owner.

7.0 BIDDER'S RESPONSIBILITY

All works shall be carried out by Bidder in accordance with the drawings / documents / specifications indicated in the subsequent paragraphs.

7.1 Specifications

7.2 Standards

7.3 Piping Support Standards

7.4 Drawings

7.5 Design Review

7.6 Bidder shall submit all proposal designs, analysis, drawings, installation and testing procedure for review & approval by Owner as mentioned in the scope work. Bidder shall as a minimum, provide above deliverables for Owner's information / records & review / approval.

7.7 Typical Plot Plan drawing of package unit is attached in the NIT. This drawing is INDICATIVE only and is furnished for Bidder's information. Issued for construction (IFC) drawings shall be prepared by Bidder after detailed engineering being done by him and shall be subject to approval by the Owner.

7.8 The Bidder shall submit separately, the material take off for piping, valves, fittings and all other accessories as per requirements.

7.9 Bidder shall obtain statutory approval from various authorities having jurisdiction over the area, as necessary, for construction of the unit package.

8.0 DRAWINGS/ DOCUMENTATION SCHEDULE

Bidder shall furnish all the drawings/ documents to Owner for comments/ approval. He shall incorporate all comments/modification suggested by Owner. The drawings/documents should be properly organised, supplied & submitted as per documentation schedule of NIT.

Number of sets shall be as stipulated elsewhere in the tender document. Final documentation shall be supplied in hard copies (4nos.) as well as soft copies.

9.0 PACKAGING

9.1 Items shall be thoroughly dried, cleaned and shall be free from moisture, dirt & loose foreign materials, with ends protected from mechanical damage during transportation, shipment & storage.

9.2 For transportation overseas, protection and packing shall be adequate to prevent damage from sea atmosphere.

10.0 DOCUMENTATION WITH BID

Following drawings/documents must be submitted along with the bid.

i) Proposed equipment layout drawing.

DESIGN PHILOSOPHY – PIPING

INSTALLATION OF ULTRA-FILTRATION UNIT

AT
RCF, THAL

CONTENTS

LIST OF ATTACHMENTS

DOCUMENT/ANNEXURE NUMBER	DESCRIPTION
1	Table Of Basic Span
2	Accessibility For Valves & Instruments
3	Vertical And Horizontal Guides Spacing
4	Clearances
5	Design Philosophy For Stress Analysis
5A	Criteria for Identifying Extremely Critical Lines (Level I)
5B	Criteria for Identifying Moderately Critical Lines (Level II)
5C	Minimum allowable nozzle loadings: Vessels and S/T heat exchangers
6	Job Specific Requirements

1.0 SCOPE

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

1.1 APPLICABLE STANDARD & CODES

Standard No.	Title
ASME/ANSI B16.5	Steel Pipe Flanges and Flanged Fittings
ASME/ANSI B16.9	Steel Butt-Welding Fittings
ASME/ANSI B16.10	Face to Face and End to End Dimensions of Valves
ASME/ANSI B16.11	Forged Fittings Socket Welded and Threaded -
ASME/ANSI B16.20	Metallic Gaskets for Pipe Flanges – Ring Joint, Spiral Wound, and Jacketed.
ASME/ANSI B16.21	Non-Metallic Flat Gaskets for Pipe Flanges
ASME/ANSI B16.25	Butt-Welding Ends
ASME/ANSI B16.34	Valves – Flanged, Threaded Welding End.
ASME/ANSI B16.47	Large Diameter Steel Flanges
ASME/ANSI B31.1	Power Piping
ASME/ANSI B31.3	Process Piping
ASME/ANSI B31.5	Refrigeration Piping
ASME/ANSI B36.10M	Welded and Seamless Wrought Steel Pipe.
ASME/ANSI B36.19M	Stainless Steel Pipe
API 6D	Specification for Pipe Line Valves (Gate, Plug, Ball and Check Valves).
API 6FA	Fire Test for Valves
API 501	Specifications for Metallic Gaskets for Refinery Piping
API 594	Check Valves:, Wafer-Lug and double flanged type
API 598	Valve Inspections and Testing
API 599	Steel Plug Valves, Flanged and Butt-weld ends
API 600	Steel Gate Valves, Flanged and Butt-welding ends, Bolted Bonnets
API 602	Gate, Globe, and Check Valves for Sizes DN 100 (NPS 4) and Smaller for the Petroleum and Natural Gas Industries
API 603	Class 150 – Corrosion Resistant Flanged End gate valves.
API 604	Ductile Iron gate valves – flanged ends.
API 606	Compact C.S. Gate Valve extended body.
API 607	Fire Test for soft seated Ball Valve.
API-608	Metal Ball Valves, Flanged, Threaded & BW Ends.
API 609	Butterfly Valves, Lug type & Wafer type
API 623	Steel Globe Valves—Flanged and Butt-welding Ends, Bolted Bonnets
IBR	Indian Boiler Regulations
AWWA C207-D	Large Dia. Steel Flanges (Ring Type).
EJMA	Expansion Joints Manufacture Association
MSS SP 6	Standard Finishes for Contact Faces of Pipe Flanges and Connecting End Flanges of Valves and Fittings
MSS SP 25	Standard Marking System for Valves, Fittings, Flanges & Unions
MSS SP 43	Wrought Stainless Steel Butt-weld Fitting
MSS SP 45	By-pass and Drain Connection

NACE MR0175-94	Sulphide Stress Cracking resistant Metallic Material
NFPA	National Fire Protection Association
EN 10204	Metallic Products - Types of Inspection documents
ASTM D3035	Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM D3261	Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing

2.0 DESIGN PHILOSOPHY

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

ASME B31.1 Power Piping
ASME B31.3 Process Piping
Materials, design, construction, testing and inspection shall be fully in accordance with the selected specification.

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

i) General site layout taking into account the topographical geo-technical aspect of the site.
ii) Access for maintenance and fire appliances.
iii) The interdependency of units and buildings with each other within the complex.
iv) Safety escape routes for personnel based on emergency or disaster management plans in the event of environmental upset or fire.
v) Suitable drainage system of Project site.

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

3.0 CODES, STANDARDS AND SUPPLEMENTARY SPECIFICATIONS

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

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

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

3.3 Standards, Codes and Supplementary Specifications for piping design shall be applied as follows:

i) Process and utility piping to ASME B31.3 Process Piping

ii) Power Plant piping to ASME B 31.1
Fire protection system shall be designed and installed in accordance with applicable NFPA (National Fire Protections Associations) Codes.

4.0 GENERAL DESIGN

4.1 Flanges for process and utility piping shall be in accordance with ANSI B16.5 and ANSI B16.47.

4.2 Wherever possible all purchased equipment shall be supplied with flanges that comply with ANSI B16.5/B16.47.

4.3 The minimum size of piping to be used in pipe-racks shall be 2" NB.

4.4 With the exception of equipment connections the minimum size of piping shall be ½" NPS.

4.5 Pipe sizes 1 ¼", 2 ½", 3 ½" 5" and 22" NPS shall not be used except as connections to purchased equipment.

4.6 Threaded pipe nipples between headers and vent, drain and instrument isolation valves shall be Schedule 160 for CS and Schedule 80S for SS in the size range ½" to 2" NPS.

4.7 Piping 2" NPS and above shall be butt-welded. All weld joints in piping 1½" NPS and below shall be socket welded using socket weld fittings.

4.8 In Class 900 and higher pressure rating double block valves shall be used for systems open to atmosphere, such as vents and drains. Piping in hazardous service shall have vents, drains and bleeds routed to a safe location. Category 'M' substances shall be vented to the flare system.

4.9 When a line of one material specification is connected to a line of higher material specification, the connecting line shall be constructed of the higher material specification or pressure rating up to & including the first block valve.

4.10 As a minimum, piping systems shall have isolation facilities as follows:

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

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

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

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

5.0 DESIGN PHILOSOPHY / GENERAL CRITERIA

5.1 Equipment Layout

5.1.1 Basis of Equipment Layout

Equipment Layout shall be finalised based on the following data:

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

5.1.2 **Development of Equipment Layout**

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

a) Process Requirement -Proper interconnection between equipment as per P&I Ds to achieve the intended process parameters.

b) Economy of piping material- Minimize the quantity of costly piping.

c) Erection & Construction requirements:

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

d) Operation and Maintenance Requirement

- Overhead and side clearances for exchangers and pumps
- Horizontal & overhead clearances for easy movement of working personnel.
- Crane approaches for air coolers/fired heaters.
- Provision of monorail for pumps and exchangers

e) Similar equipment grouping - All columns, exchangers, pumps etc. should be grouped together for convenience of maintenance and safety wherever feasible.

f) The technological structures should be interconnected for easy movement of operational personnel.

g) U/G piping corridors for main headers should be marked in equipment layout for all under ground piping.

5.1.3 **Plant Layout & Design guidelines**

5.1.3.1 **General**

The plant layout shall be based on ensuring adequate access, to allow construction, inspection, maintenance and operation to be performed in a safe and efficient manner. The alignment of equipment and pipe shall offer an organised appearance. The layout shall be in accordance with, but not limited to the design practices described in this criteria.

Where dynamic loading, limited pressure drop or other severe service condition applies, particular care shall be taken in routing pipe lines.

Flushing connections shall be provided on all lines containing flammable or toxic material, slurries, and materials which solidify- when the line is dead. Sufficient Nitrogen purging points shall also be provided. Supply piping of fuel gas shall be arranged for equal flow distribution.

Trolley beams, pipe davits, shall be provided with appropriate removable hoists mechanism for charging and discharging catalysts, chemicals, packing rings etc.

Piping and all other services shall be arranged so as to permit ready access of Cranes for removal of Equipment for inspection and servicing.

All utility and process piping shall be located above ground, and major lines shall be located in overhead pipe ways.

Lines that must be run below grade, and must be periodically inspected or replaced, shall be identified on the P & ID's; these lines must be placed in covered concrete trenches. Sleeper-ways shall not be used in process areas where they may block access for personnel and equipment.

Drip legs and dead ends shall be avoided, especially for piping where solids or fluids may congeal from corrosive condensate.

Where sleeper ways are used the elevations shall be staggered to permit ease of crossing or change of direction at intersections. Flat turns may be used when entire sleeper ways change direction. Flat turns must not be used within pipe racks.

Spacing and routing of piping shall be such that expanding/contracting lines (including insulation) will not clash with adjacent lines, structures, instruments and electrical equipment during warm up and cool down.

Piping to be sloped shall be indicated on the P&I D's.

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

In general, equipment layout shall be prepared considering straight pipe rack, however other shapes like L / T / U / H / Z etc can also be considered based on area available.

The width of the rack shall be 4M, 6M, 8M, 10M or 12M for single bay having four (4) tiers maximum. In general, the spacing between pipe rack portals (span) shall be taken as 8 M for main rack. However it can be decreased to 6 M depending on the size/number of the pumps to be housed below pipe rack. Intermediate Beams between two portals shall be provided to support smaller pipes <= 2". 20% extra space shall be provided on the pipe rack and portals on each tier for future expansion/modifications.

-Clearance beneath pipe rack shall be 3.8 M minimum.

-Height between two pipe rack tiers shall be 2.0M minimum.

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

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

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

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

5.1.3.3 **Pumps**

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

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

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

All pumps not open to sky with motor rating >= 45 KW shall be provided with monorail. No monorail should normally be provided for pumps outside rack and sufficient space below rack shall be available for pump maintenance.

5.1.3.4 **Clearance and Accessibility**

5.1.3.4.1 **Access to Pumps**

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

5.1.3.4.2 **Access to lower items to grade (Lowering Area)**

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

5.1.3.4.3 **Layout & Access Requirements for Platforms ladders and Stairs**

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

- Two means of access (i.e. two ladders or one ladder and one stair case) shall be provided at any elevated platform which serves three or more vessels & for B/L valves operating platform.
- Platforms, ladders and stairways shall be the minimum, consistent with access and safety requirements.
- Stairway for tanks to be provided on upstream of predominant wind direction.

i) Platform at elevated structure

a) Dual access (i.e. one staircase and one ladder) shall be provided at large elevated structure if any part of platform has more than 22.65M (75 ft) of travel.

ii) Platforms with stair access shall be provided for:

a) Location at which normal monitoring (once a day or more) is required or where samples are taken.

b) Locations where vessels or equipment items need operator attention "such as compressors, heaters, boilers etc.

iii) Platforms with ladder access shall be provided for:

a) Points which require occasional operating access including valves, spectacle blind and motor operated valves, heater stack sampling points.

b) Man ways above grade on equipment.

iv) Ladder location

a) Wherever practicable, ladder shall be so arranged that users face equipment or platform rather than facing open space.

b) Landings shall be staggered. No ladder shall be more than 6 M in one flight.

5.1.3.5 **Clearances**

Minimum clearances shall be as indicated in Annexure.

5.2 **Unit Piping**

5.2.1 **Basis of Unit Piping**

- Piping & Instrument Diagram

- Equipment layout
- Equipment Data sheet & Setting plan
- Line list
- Instrument Data sheet
- Structural & building drawings
- Topography of the plant
- Piping material specification
- Overall plot plan
- Tie in point drawing.

The following objective shall be ascertained during piping layout.

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

5.2.2 **Pipe Ways/Rack piping**

5.2.2.1 Racks shall be designed to give the piping shortest possible run and to provide clear head rooms over main walkways, secondary walkways and platforms.

5.2.2.2 Predominantly process lines are to be kept at lower tier and, utility & hot process lines on upper tier.

5.2.2.3 Generally the top tier is to' be kept for Electrical (if not provided in underground trench as per electrical design basis) and Instrument cable trays. Cable tray laying to take care of necessary clearances for the fire proofing of structure.

5.2.2.4 Generally the hot lines and cold lines shall be kept apart in different groups on a tier. .

5.2.2.5 Generally the bigger size lines shall be kept nearer to the column.

5.2.2.6 Minimum spacing between adjacent lines shall be decided based on O.D of bigger size flange'(minimum rating 300# to be considered), O.D of the smaller pipe, individual insulation thickness and additional 25 mm clearance, preferably. Wherever even if flange is not appearing the minimum spacing shall be based on above basis only. '

5.2.2.7 Actual line spacing, especially at 'L' bend and loop locations, shall take care of thermal expansion / thermal contraction / non expansion of adjacent line. Non expansion / thermal contraction may stop the free expansion of the adjacent line at "L' bend location.

5.2.2.8 Anchors on the racks are to be provided on the anchor bay, if the concept of anchor bay is adopted. Otherwise anchors shall be distributed over two to three consecutive bays.

5.2.2.9 Anchors shall be provided within unit on all hot lines leaving the unit.

5.2.2.10 Process lines crossing units (within units or from unit to main pipe way) are normally provided with a block valve, spectacle blind and drain valve. Block valves are to be grouped and locations of block valves in vertical run of pipe are preferred. If the block valves have to be located in an overhead pipe way, staircase access to platform above the lines shall have to be provided.

5.2.2.11 Provision of block valves, blinds etc. shall be as per Process Design Basis and P & IDs.

5.2.2.12 All small bore piping shall be designed in a way so as to ensure adequate space for maintenance and operation. For small bore piping intermediate support shall be provided in between portals.

5.2.2.13 Stubs on saline water (if applicable) service shall be from top of main header.

Minimum branch size for tapping including for instruments e.g. PG/PTI TE etc. shall be of 3" NPD and 150 mm height on internal cement lined pipes.

5.2.2.14 Aboveground lines shall be grouped to run on pipe racks or sleepers in so far as practicable.

5.2.2.15 Hot lines on pipe racks or sleepers shall be grouped and expansion loops shall be nested together. The number of expansion loops shall be kept to a minimum.

5.2.2.16 Piping handling corrosive fluids shall be run under piping handling non corrosive fluids, and shall not, where possible, be run overhead across walkways or normal passages for personnel.

5.2.2.17 All process and utility piping will be located aboveground within the plant battery limit, except water mains.

5.2.2.18 All piping shall be arranged in horizontal banks, where possible, to facilitate supporting.

Banks running north-south shall be at different elevations from banks running east-west. Exceptions are permitted to avoid unnecessary change in elevation at change of direction or where essential to avoid pockets.

5.2.2.19 All piping shall be routed for the shortest possible run and have the minimum number of fittings consistent with provision for expansion and flexibility. All piping shall be arranged in a neat manner, providing free access around all operating equipment.

5.2.2.20 Vertical lines at vessels shall run close to the vessel shell to facilitate supporting. The line shall be arranged and grouped to allow the use of single support.

5.2.2.21 Lines carrying molten solids, slurries or highly viscous liquids shall have a sufficient

slope for each gravity flow.

5.2.2.22 The shortest and most direct layout possible shall be provided for gravity flow lines, especially when the fluid is subject to solidification and when the differential pressure is

small.

5.2.2.23 Piping shall be arranged to facilitate handling of equipment for inspection or maintenance.

5.2.2.24 Vapor collecting system shall be routed so that the vapor rises continuously from the vessel being vented to a higher point without pocketing.

5.2.2.25 Pockets shall be avoided in lines, particularly those carrying corrosive chemicals, slurries, vents, blow down lines, etc.

5.2.3 Column / Vessel Piping Control Valves

5.2.3.1 Piping shall be supported from cleats welded on the vessel as far as possible.

5.2.3.2 Proper guides at intervals shall be provided for long vertical lines.

5.2.3.3 Access platforms/ladders shall be provided along the column for valves and instruments.

5.2.3.4 For ease of operation and maintenance, column and vessels which are grouped together, shall have their platforms at the same elevation interconnected by walkways wherever feasible. However each column \ vessel shall have an independent access also. Column vessel platforms should be designed in such a way so that all the nozzles should be approachable from platforms.

5.2.3.5 Unless specifically indicated in P&ID's control valves shall preferably be kept at grade instead of platform.

5.2.3.6 Piping intended for vacuum services shall be routed as short as possible, with minimum bends and flanged joints.

5.2.3.7 Piping support cleats shall be designed for safety valves considering impact loading during popping off.

5.2.4 **Pump Piping**

5.2.4.1 Pump drives shall have clear access.

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

5.2.4.3 Reducers immediately connected to the pump suction shall be eccentric type flat side up to avoid the accumulation of gas pocket. For end suction pumps, elbows shall not be directly connected to the suction flange. A straight piece minimum 3 times the line size shall have to be provided at the suction nozzle.

5.2.4.4 Pump discharge check valve if installed in vertical lines shall be fitted with a drain connection as close as possible downstream of the valve.

When a suction vessel operates under vacuum, the vent connection of the pump has to be permanently connected to vapour space of the suction vessel to allow possible filling of the pump with liquid before it is started.

5.2.4.5 Unless otherwise specified T -type strainers shall be used on pump suction piping for sizes 2" and above.

5.2.4.6 Y-type strainers to be used for all sizes in steam services and for pump suction lines 1½ and below.

5.2.4.7 All small bore piping connected to pump (drain to OWS & CBD, seat and gland leak drain) shall have provision for break up flanges for removal of pumps.

5.2.4.8 Piping shall be so arranged that forces and moments imposed on the pump nozzle do not exceed the allowable values as per API 610.

5.2.4.9 Pump discharge should preferably be routed away from the pump rather than towards the motor side.

5.2.4.10 Pump cooling water connection shall be taken from the top of circulating cooling water header.

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

5.2.5.1 Steam piping shall be designed to have complete condensate removal. Drip legs shall be provided with steam traps at low points in the system.

5.2.5.2 All steam branch connections shall be taken from the top of the header.

5.2.5.3 Return exhaust steam / condensate lines shall connect to the top of the exhaust steam Condensate header.

5.2.5.4 Where block valves have been installed in the main steam header such that condensate can collect either side of the valve when closed, a safe means of draining the condensate prior to opening the valve shall be provided.

- Steam header shall be located generally on the upper tier and at one end of the rack adjacent to columns.
- Branch lines from horizontal steam header, except condensate collection points, shall be connected to the top of the pipe header.
- Isolation valves (if provided) on the branch line shall preferably be provided on the horizontal run and outside the pipe rack.
- All branch lines shall be drainable.
- Drip legs & steam traps shall be provided at all low points and dead ends of steam header. Drip legs at low points shall be closer to downstream riser and shall be provided to suit bidirectional flows, if applicable.
- All turbines on automatic control for startup shall be provided with a steam trap in the steam inlet line.
- All traps shall be provided with strainers if integral strainers are not provided.
- Steam traps discharging to atmosphere shall be connected to storm water drain/storm sewer, in case of open system. In case of condensate recovery, traps shall discharge into condensate header.
- Expansion loops are to be provided to take care of the expansions within units.
- Wherever condensate is to be drained, proper condensate draining facility shall be provided.

5.2.6. **Water Piping**

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

5.2.6.2 Water main headers may run underground to prevent freezing.

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

5.2.7 **Instrument Air Piping**

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

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

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

5.2.8 **Supports and Anchors**

5.2.8 1 Supports and/or anchors shall be provided close to changes in direction of lines, branch lines and, particularly, close to valves to prevent excessive sagging, vibration and strain.

5.2.8 2 Allowable spans between pipe supports shall be determined to keep the maximum deflection within 16 mm.

5.2.8 3 In cases where periodic maintenance requires removal of equipment, such as pumps and relief valves, and where lines must be dismantled for cleaning, piping shall be supported to minimize the necessity of temporary supports.

5.2.8.4 Spring-loaded hangers may be used on piping subject to thermal expansion or contraction. In cases where the movement is very large, or the limitation of reaction and

stress are very severe, constant support spring hangers shall be used.

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

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

5.2.8.7 All piping shall be properly supported to minimize vibration.

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

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

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

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

5.2.9 **Utility Stations**

Requisite number of utility stations shall be provided throughout the unit to cater for the utility requirement. Utility stations shall have four connections one for LP steam (SL), one for Plant Air (AP), one for Service Water (WS) and one for nitrogen each of 1.0" with isolation valves unless otherwise specified in P&ID.

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

Air and water lines shall have quick type hose connection and steam line shall have flanged type hose connection. All connections shall be directed downward. All connections shall have globe valve for isolation purpose. An inter connection with valve shall be provided between steam and service water lines shall be provided. Inert gas hose, when required, shall have built in non return valve in quick connection coupling of piping end.

Number of utility stations shall be such that all equipments shall be approachable from at least one utility station. The approach of utility station shall be considered 15 M all around the station location.

The Utility stations shall generally be located adjacent to pipe-rack column.

The utility stations shall also be provided on elevated structures like - technological structure, operating platforms of vertical equipments etc.

Operating platforms having manholes must have a utility station. Utility station locations shall be limited to a height of 35 M from H.P.P.

5.3 Offsite & Yard Piping

In general, offsite piping (except tank ages area), electrical cable and instrumentation cable shall also be laid either on pipe rack or pipe sleepers.

Wherever piping is laid on pipe sleepers, it shall have hard surfacing below it keeping a gap of 300 mm from the bottom of the pipes. Hard surfacing should be completed before start of pipe laying. Width of hard surfacing shall be about 1.0 meter more than the piping corridor. This extra hard surfacing shall be for movement of operating personnel along the piping corridor.

Pipes at road crossing shall be under culverts in general. Overhead pipe bridges may be used for areas where pipe racks are provided. Where culverts are not provided, pipe sleeves shall be used for underground road crossing. Culverts / overhead pipe bridges shall be adequately designed to take care of future requirements. Minimum 20% extra width shall be provided in all such structures.

Clearances between lines shall be minimum "C" as given below:

$C=(Do+D_f)/2$ + 25 mm + Insulation thickness(es) where,

Do - outside diameter of smaller pipe (mm)

D_f - outside diameter of flange of bigger pipe (mm)

However this 'C' spacing between the offsite piping on the rack/sleeper can be suitably increased so that the lines should not touch each other after insulation / lateral thermal expansion.

Adequate clearance shall be provided for every long & high temperature lines to avoid clashing at the bends. See 5.2.2 also for line spacing at 'L' bends and loops.

Expansion loops for all lines shall generally be kept at the same location.

Vents shall be provided on all high points & drains shall be provided at all low points. Drain valves at sleeper piping shall be kept outside the sleeper way if the same is not accessible and valves shall be put in horizontal only.

Places where piping is extended to make drain valves accessible - 2 nos. of stiffeners, irrespective of pipe rating, shall be provided as per 5.13.1. Spacing of guides on each line on a pipe bay shall not exceed the value given in clause 5.13.1

5.4 Flare Piping

Flare header shall be sloped towards flare knock-out drum. Only horizontal loop shall be provided as per requirement to accommodate thermal expansion. The desired slope shall be ensured throughout including flat loop. Flare header shall be supported on shoe of height ranging from 100mm to 300mm.

Proper thermal analysis temperature shall be established including the possibility of temperature gradient along the line before providing expansion loops. Efforts shall be made to minimize the number of loops. Flare line between knock out drum and water seal drum shall be designed for pressure fluctuations and adequately supported to avoid vibrations.

5.5 Underground Piping

5.5.1 Underground steel piping shall be protected from electric corrosion.

5.5.2 Underground piping passing under loaded areas, such as main roads in the plant, shall be protected from heavy traffic by casing pipes or covers extending at least 1 m on either side of the area or having the wall thickness sufficient to bear earth pressure.

5.5.3 Underground piping shall be sloped to all drain points with a downward slope of not less than 1 m in 150 m.

5.5.4 Expansion elbows or joints of underground piping for hot fluids, such as steam or heated heavy oil, shall be enclosed in a conduit from which they are separated to allow free longitudinal expansion.

5.5.5 Where it is impossible to run pipe aboveground or underground, trenches may be used.

5.5.6 Trenches for piping close to process equipment should be avoided, whenever possible.

5.5.7 All underground pipe work shall be provided with following protection:

a) At location where Underground Piping becomes above ground, INSULATING GASKET with material Glass Filled Teflon or equivalent shall be provided.

b) CATHODIC PROTECTION (CP) shall be provided to all underground piping. Specification shall be submitted by the CONTRACTOR & shall be approved by the OWNER.

c) Underground piping shall be wrapped & coated by “PYP KOTE” or equivalent tapes / sheets, 4.00 mm thick & shall be “HOLIDAY TESTED” before Hydro Test.

d) All underground pipes shall have Sand Bed, at least 150 MM all around the pipe.

e) All road crossings by Underground piping shall be through Hume Pipe Sleeves.

5.5.8 **Buried Pipes**

The following points to be considered in designing of buried pipes

i) All underground metallic piping shall be coated and wrapped and provided with cathodic protection system. If sacrificial metal is used, permanent testing arrangement shall be provided.

ii) All cooling water distribution headers 18" and higher shall be laid underground.

iii) All Sewage lines (oily and chemical) from catch basin to mains and manholes shall be laid underground.

iv) Underground pipe crossing roads, access ways and rails shall have casing pipe (R.C.C or C.S).

v) Valve chamber wherever required shall be made of brick or concrete. Valve chamber should be spacious to attend valves during operation/Maintenance.

vi) All U.G. headers shall clear equipment foundations as far as possible. Under special cases, the C.W. header may be laid over the footing of foundations.

vii) Provide break flange at + 500 MM from floor level connection with cathodic protection to isolate underground pipe from above ground piping with insulating gasket KIT.

viii) Pipes shall be laid below electrical cables if any.

ix) Top of underground piping shall be below grade level at least 1 meter deep in case of open areas and 1.5 meter deep for roads.

5.5.9 Piping in Trenches

The following points to be considered in designing of trench pipes

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

ii) Fire water lines/Process lines.

iii) Drain lines requiring gravity flow trenches.

iv) Sump for valves and trenches shall be provided.

v) Suitable draining scheme for trenches shall be provided.

5.6 Air Systems

5.6.1 Branch connections shall be taken from the top of the header.

5.6.2 Low points shall be fitted with drains.

5.7 In-Line Instruments

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

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

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

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

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

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

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

5.7.8 Orifice taps shall be located as follows:

i) Air, Gas and steam
Top vertical centreline (preferred)
45 degrees above horizontal centreline (alternate)

ii) Liquid
Horizontal centreline (preferred)
45 degrees below horizontal centreline (alternate)

iii) Tap orientation shall be shown on piping isometrics.

5.8 **Sample Connections**

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

5.9 **Vents and Drains**

5.9.1 The minimum size of vent and drain connections shall be as follows:

For process & utilities lines :

4" & Below	NPS ¾"
6" & 10"	NPS 1"
12" & above	NPS 11/2"

Vent & Drain shall be provided with the valve & blind flange. For all vents / drains of process lines / utilities lines, double valves shall be required for 600 # & more rating.

Process vents and drains shall be indicated on the P&ID's

5.9.2 Vent, drain and sampling valves on process lines, not connected to a piping system, shall be provided with appropriate end closures.

5.9.3 Vents shall be located at high points of pipelines when necessary.

5.9.4 Drains shall be located at low points to empty pipelines or equipment after testing or during maintenance (i.e for every loop).

5.9.5 All drains and vents shall be provided with valve, except that vents for test purpose for flare liens (header), may be plugged. Exposed threads shall generally be seal welded.

Low-point hydrostatic drains and high-point hydrostatic vents shall be added as required; locations to be determined during the design review.

5.9.6 Vent valves shall be the globe or gate type and drain valves the gate type.

5.9.7 Valved bleeds shall be provided at control valve stations, level switches, level controllers, and gauge glasses.

5.10 Line Strainers

5.10.1 Provide temporary conical type strainers in 2" NB and above butt weld pump suction lines for use during start-up. Arrange piping to facilitate removal.

5.10.2 Provide permanent Y-type strainers for pump suction piping below 2" NB Thd or SW.

5.10.3 Provide temporary basket type strainers located at the suction pulsation device inlet for start-up of reciprocating compressors. Arrange piping to facilitate removal of the filter.

5.10.4 Provide temporary basket type strainers and locate them as close as possible to the compressor inlet flange for start-up of centrifugal compressors. Arrange piping to facilitate removal of the filter.

5.10.5 Allowable pressure drop when specified shall be certified by vendor along with the offer. If asked specifically, vendor shall furnish pressure drop calculations

5.10.6 All 2" & higher sized Y type strainers shall be provided with 3/4" threaded, tap and solid threaded plug as drain connection. For less than 2", this shall be ½ " size.

5.10.7 Bottom flange of Y-type strainer shall not have tapped hole. Full length standard size studs shall be used for joining blind flange.

5.10.8 For fabricated strainers, all BW joints shall be fully radiographed and fillet welds shall be 100% DP/MP checked.

5.10.9 All the strainers shall be hydrostatically tested at twice the design pressure.

5.11 Spectacle Blinds

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

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

5.12 **Flexibility Analysis and Supporting**

5.12.1 **Pipe Supporting Criteria & General Guidelines.**

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

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

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

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

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

For lines which do not need any support otherwise but become unsupported by opening of flange, etc, during maintenance and thereby may transfer the total load on a small branch off, a permanent support shall be suitably provided which may be a spring support also. Bare

pipes of size 14" and above on elevated structures shall be supported with pad or shoe. While bare pipes of size 6" and' above, on sleepers, corrosion pads shall be provided.

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

Adequate stiffening shall be provided for the following:

a) Lines in above 600#,

b) Lines having two phase flow,

c) Lines having Pulsating flow such as discharge of reciprocating compressors & reciprocating pumps,

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

Wherever two phase flow in piping is expected, piping design shall be checked by dynamic analysis to prevent vibrations.

Pipe support design shall be such that deflection in piping systems due to sustained loads shall not exceed 15mm, in any case, between two adjacent supports.

As far as possible long trunnion types of supports (more than 0.5 metre) are to be avoided. In case long trunnion support is unavoidable in straight length of pipe, trunnion height to be restricted to 0.5 M and balance height to be made up by providing extended structure.

In the heaters where steam air decoking provision is there, the main lines and decoking lines should be supported in a way so that either of the lines should not be in the hanging position while connected to other one. Same philosophy shall be adopted for similar type of switch over arrangement.

Piping passing through the technology structure or passing near the concrete column etc. should have adequate annular space to avoid restriction of line movement during thermal expansion. The gap should take care the thermal expansion along with insulation thickness.

High density PUF blocks shall be considered for cold piping supports. Use of wood blocks shall be avoided.

All pipes supports shall be so designed that there is no undue tension on equipment flanges. Flange joints should not move away from each other in case of unbolting of the joint.

5.12.2 **Flexibility Analysis Criteria & General Guidelines**

5.12.2.1 Formal flexibility analysis by computer program of piping system shall be performed on latest version of CAESAR-II software as per Annexure 5, 5A & 5B.

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

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

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

5.12.2.5 API 610 Pumps

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

ASME or Manufacturer's Standard Pumps

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

Other Horizontal Centrifugal Pumps

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

Vertical Turbine, Can-Types Pumps

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

5.12.2.6 For piping design purposes, differential settlement between items of major equipment on separate foundations shall be taken as 10 mm.

5.12.2.7 Cold springing in piping shall not be permitted without written permission from the Owner. Cold springing of piping directly connected to rotating equipment is not permitted under any circumstances.

Piping shall be analyzed for expansion, contraction, differential settlement, relief, valve reaction and effects mentioned at CI. 5.12.1.

The design of piping systems shall take into account the different conditions expected during operation, start-up, shut-down, cold branch in case of standby pump, tracing, etc. Hydrocarbon lines shall be designed for steam-out conditions, if specified in line schedule. The use of expansion joints shall be considered only when space oar pressure drop

limitation does not permit pipe bends. Expansion joint of axial type shall be avoided.

Forces and moments due to weight, thermal loads and other imposed loads on the equipment nozzle must not exceed the allowed loads for the equipment.

Minimum analysis temperature shall be the design temperature of the line as per line list.

5.12.3 **Method of Analysis**

Formal computer analysis shall be performed on piping systems as per design philosophy for stress analysis

The package used shall be latest version of CEASER / AUTO PIPE / SIMPLEX / CAEPIPE. Only one of these packages shall be used for the project & not a combination of the above packages.

All lines shall be analyzed at design / analysis temperature. In the absence of analysis temperature lines shall be analyzed at design temperature.

However in case of wide difference in design and operating temperature, temperature for analysis shall be established in process documents. (e.g. flare line)

All non-critical lines may be analyzed using other methods.

Special analysis methods shall be followed for lines involving pulsating flow such as those connected to reciprocating pumps & compressors which require acoustical plus analog study by approved agencies and shall require entire system analysis along with piping / equipments.

Seismic analysis shall be done for line sizes 12" and above.

5.13 Personnel Protection

5.13.1 Eyewash and emergency safety showers shall be provided in areas where operating personnel are subject to hazardous sprays, emissions or spills.

5.13.2 Personnel protection shall be provided on un-insulated lines and equipment operating above 70 deg C when they constitute a hazard to the operators during normal operation of the facility.

5.13.3 Leakage indicating tape and spray impingement shrouds shall be provided at flanged joints in hazardous service.

5.14 Mechanical Handling

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

6.0 MATERIALS

6.1 General

6.1.1 Basic material selection of particular line depending on its service, temperature and corrosivity shall be spelt out in process package. Material specification shall follow the requirements as per process parameters & attached PMS / VMS.

6.1.2 Only piping materials listed in ASME B31.3 shall be used for Category 'M' and Normal Service piping. Unless otherwise specified in PMS, For Category 'D' utility piping, where scaling and impurities are to be avoided (such as instrument air, potable water and deluge water) hot dipped galvanised and threaded fittings may be used in sizes up to and including 4" NB. Galvanised piping shall not be used in environments containing acids or other corrosive commodities. In corrosive environments stainless steel piping material shall be used for such utility systems.

6.1.2 All items/parts of Austenitic Stainless Steel shall be supplied in solution annealed condition.

6.1.3 In absence of specific requirement, Natural Rubber shall be used for lining in rubber lined piping items, wherever applicable. The Vendor shall confirm the suitability of Rubber Material for specified service. Unless otherwise specified, rubber lining shall be in accordance with IS4682 Part-I.

6.1.4 Unless otherwise specified, HDPE pipes & fittings shall be in accordance to ASTM D3035/ ASTM D3261/ASTM D3350 or equivalent.

6.1.5 **Specification for FRP material**

6.1.5.1 Anticorrosion Barrier of Polymer veil having minimum thickness 2.5 mm shall be provided for chemical resistance. Mechanical resistance to be sustained by FRP.

6.1.5.2 The selected nominal pipe wall thickness will include manufacturers full under tolerance, and the specified corrosion and/or erosion allowance. The pipe thickness will be adequate to resist all external loads from thermal, mechanical and other sources in addition to the

process pressure-temperature requirements. However the pipe thickness will be according to vendor's norms and standard calculations but not be lower than indicated in DIN 16965 Part 4. External FRP layer shall be protected against ultra-violet light.

6.1.6 Cast Iron shall not be used as Material of Construction for any piping items like Pipes, fittings, flanges, valves, fasteners, gaskets, etc.

6.2 Pipe

6.2.1 Calculation of pipe thickness and branch reinforcement shall be based on requirements of ASME B31.3. Proper corrosion allowance and mill tolerance shall be considered to achieve the selected thickness.

6.2.2 Unless specifically exempted, welded pipes shall be acceptable only with longitudinal weld made employing automatic welding. 100% radiography for all welds except for pipes for category D service.

6.2.3 Double seam 180˚ apart is allowed for sizes 36" and larger only.

6.2.4 Galvanized Pipes shall be only Hot Dip galv. to ASTM A53.

6.2.5 Hydrostatic tests shall be applied to each length of pipe and be in accordance with the requirements of ASTM A530/A530M, unless otherwise specified.

6.3 **Fittings**

6.3.1 Type of fittings shall be equivalent to pipe type in construction.

6.3.2 Thickness of fittings at ends to match pipe thickness for BW fittings. For reducing BW fittings having different wall thicknesses at each end, the greater one shall be employed and the ends shall be matched to suit respective thickness.

6.3.3 Unless and otherwise specified in the requisition all socket weld and screwed fittings shall be in accordance with ANSI B16.11 to the extent covered in the specification except for unions which shall be in accordance with MSS-SP-83.

6.3.4 Special fittings like Weldolet, Sockolet, Sweepolet etc. which are not covered in ANSI , MSS-SP shall be as per Manufacturer's Std. Contours of these fittings shall meet the requirements of ANSI 31.3. Manufacturer shall submit drawings/catalogues of these items along with the offer & also shall be submitted for approval before manufacturing.

6.3.5 All pipes employed for manufacturing of fittings shall be required to have undergone Hydro test to ASTM A530.

6.3.6 All welded fittings shall be 100% Radio-graphed by X-Ray on all welds.

6.4 **Flanges**

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

6.4.2 All flange joints on piping system including flanges on the equipment, manholes, etc shall be tightened using Torque wrench / hydraulic bolt tensioner depending upon service criticality.

6.5 **Gaskets**

Gaskets shall be as per piping material specification/ applicable standard.

6.6 **Stud, Bolts, Nuts and Jack Screws**

6.6.1 All bolting shall be as per ASME/ANSI 818.2.1 for Studs, M/C Bolts and Jack screws, and ASME/ANSI B18.2.2 for nuts. Machine Bolts shall not be used in piping flange joint, except for Butterfly Valves, which shall be lug type, having UNC Threads in lugs facilitating opening of flanges from both sides.

6.6.2 Screw threads of bolting shall be unified coarse threads in accordance with ANSI / ASME B1.1 having Class 2A for bolts and Class2B for nuts. Screw threads in sizel-1/8 and larger shall be 8 threads per inch.

6.7 Valves

6.7.1 General

All flanged valves (except forged) shall have flanges integral with the valve body.

Yoke material shall be at least equal to body material.

Forgings are acceptable in place of Castings but not vice-versa.

No cast iron material valves to be used in any service.

Valves in saline water (if applicable) service shall be with non ferrous trims and all wetted parts other than trims shall be epoxy coated.

Valve body basic MOC shall be equivalent or above basic MOC of connecting pipe.

6.7.2 Ball/Plug/Butterfly Valves

Use of soft seated ball/plug/butterfly valves shall be suitably selected based on temperatures handled.

Butterfly valves shall be suitable for throttling application.

Lug type Butterfly valves shall be with threaded lugs only. Each butterfly valve shall be provided with the Bolts to be installed from both sides separately.

PN equivalent rating for Class150# valves shall be minimum PN16.

Ball valves may be used in place of gate or plug valves with the following limitations:

i) Operating conditions are within the permissible pressure - temperature range of seat materials.

ii) Fire safe type to be used for hydrocarbon services.

6.7.3 Valve Dimensions

Face-to-Face/End-to-End dimension shall be as per ANSI B16.10. In case the same is not covered under B16.10, the dimension shall be as per BS 2080/manufacturer standard.

Hand wheel diameter shall not exceed 750mm and lever length shall not exceed 500 mm on each side. Effort to operate shall not exceed 35 kgf at hand wheel periphery. However, failing to meet the above requirement, vendor shall offer gear operation.

Quarter-turn valves shall have "open" position indicators with limit stops.

6.7.4 Non Destructive Testing of Valves

6.7.4.1 Radiography procedure, areas of casting to be radiographed, and the acceptance criteria shall be as per ASME/ANSI B16.34.

All valve castings shall be of radiographic quality.

The minimum requirement of radiography shall be as under:

Class	Size	Qty
150	Up to 24”	5%
150	26” & above	100%
300	Up to 16”	10%
300	18” & above	100%
600 & above	All	100%

6.7.4.2 The welds of body-to-bonnet and body-to-end flange shall be subjected to 100% NDT; both radiographic and magnetic or liquid penetrant examinations.

6.7.4.3 Beveled ends on each butt welding end valve shall be subjected 100% magnetic particle or liquid penetrant examination.

6.7.4.4 Each valve shall be pressure tested in accordance with API 598.

6.7.5 **Criteria for Isolation Valves**

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

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

6.8 **Traps**

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

Parts subject to wear and tear shall be suitably hardened. Traps shall have integral strainers.

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

6.9 **Hoses**

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

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

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

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

Steam hoses shall be subject to steam resistance test.

6.10 **Expansion Joints (Metallic)**

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

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

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

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

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

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

Apart from the usual requirements, the vendor shall also furnish

a) Design calculations to justify stiffness and fatigue life.

b) Axial, lateral stiffness, angular stiffness, effective pressure thrust area.

c) Installation/maintenance manual.

6.11 Supports & Spring Assemblies

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

Testing of springs shall be as per BS1726.

6.12 Non Destructive Examination

10% radiography of butt welds and 10%DP/ MP test of fillet welds shall be done for pipe Classes in 150# & 300#.

100% radiography on butt weld joints and 100% DP/MP for fillet welds test shall be done for Pipe Classes in 600# & above.

7.0 PAINTING

Painting shall be as per attachment provided elsewhere in NIT.

8.0 WELDING

Welding shall be as per ASME BPV- Sec. IX

ANNEXURE – 1

TABLE OF BASIC SPAN

Pipe Size In.	SCH/Thk (in)	PIPE- VAPOR INSULATION			PIPE- LIQUID INSULATION			BARE PIPE EMPTY		BARE PIPE WATER FILLED		Pipe size in.
		BASIC SPAN (L)M			BASIC SPAN (L)M							
		UPTO 175^0 C	176^0 C TO 315^{0}C	316^{0}C TO 400^{0}C	UPTO 175^0 C	176^0 C TO 315^{0}C	316^{0}C TO 400^{0}C	SPAN(L) M	WEIGHT KG/M	SPAN(L) M	WEIGHT KG/M	
3/4"	SCH 40	3.5	3.5	2.5	3.5	3.0	2.0	4.5	1.68	4.0	2.04	*3/4"*
1"	SCH 40	4.5	4.0	3.0	4.5	3.5	3.0	5.0	2.52	4.5	'3.07	1"
1-1/2"	SCH 40	5.0	5.0	4.5	5.0	4.5	3.5	6.0	4.08	5.0	.5.4	*1-1/2"*
2"	SCH 40	5.5	5.0	4.5	5.0	4.5	3.5	8.5	5.47	5.5	7.65	2"
2-112"	SCH 40	6.5	6.0	5.0	6.0	5.5	4.5	7.5	8.7	6.5	11.79	*2-112"*
3"	SCH 40	7.5	6.5	5.5	6.5	6.0	5.0	8.0	11.35	6.5	16.15	3"
4"	SCH 40	8.0	7.5	6.5	7.5	7.0	6.0	9.0	16.2	7.5	24.45	4"
6"	SCH 40	10.0	9.5	8.5	9.0	8.0	7.5	10.5	28.3	9.0	46.7	6"
8"	SCH 40	12.0	11.0	10.0	10.0	10.0	9.0	12.0	42.84	10.0	75.22	8"
10"	SCH 40	13.5	13.0	12.0	11.5	10.5	10.5	14.0	60.74	11.5	111.9	10"
12"	*3/8"* w	14.5	13.5	13.0	12.0	11.5	11.0	15.0	74.40	12.0	147.5	12"
14"	*318"*w	15.0-	14.5	13.5	12.0	12.0	11.5	16.0	82.5	12.5	172.05	14"
16"	*318"*w	16.0	15.5	14.5	13.0	12.5	12.0	17.0	94.5	13.0	213.15	16"
18"	*3/8"* w	17.0	16.5	15.0	13..5	13.0	12.0	18.0	106.5	13.5	258.3	18"
20"	*318"* w	18.0	17.5	16.0	14.0	13.5	12.5	19.0	118.5	14.0	307.5	20"
24"	*3/8"*w	20.0	19.0	17.5	14.5	14.5	13.0	21.0	1425	15.0	418.2	24"
3/4"	SCH 80	3.5	3.5	2.5	3.5	3.0	2.0	4..5	2.20	4.0	2.49	*3/4"*
1"	SCH 80	4.5	4.0	3.0	4.5	3.5	3.0	5.0	3.25	4.5	3.72	1"
1-112"	SCH 80	5.0	5.0	4.5	5.0	4.5	4.0	6.0	5.45	5.0	6.60	*1-112"*
2"	SCH 80	6.0	5.0	4.5	5.5	5.0	4.0	6.5	7.53	6.0	9.45	2"
2-112"	SCH 80	6.5	6.0	5.5	6.0	6.0	5.0	7.5	11.49	6.5	14.25	*2-1/2"*
3"	SCH 80	7.5	6.5	6.0	6.5	6.5	6.0	8.0	15.37	7.0	19.66	3"
4"	SCH 80	8.0	8.0	7.0	7.5	7.5	6.5	9.0	22.47	8.0	29.94	4"
6"	SCH 80	10.5	10.0	9.0	9.5	9.0	8.5	10.5	42.90	9.5	59.85	6"
8"	**½" w**	12.0	11.5	10.5	10.5	10.0	10.0	12.0	65.10	11.0	94.8	8"
10"	**½" w**	13.5	13.0	12.0	11.5	11.5	10.5	14.0	82.20	12.0	130.69	10"
12"	**½" w**	14.5	13.5	./, 3.0	12.5	12.0	11.5	15.0	98.13	13.0	168.64	12"
14"	**½" w**	15.0	14.5	13.5	13.0	12.5	12.0	16.0	108.15	13.5	194.4	14"
16"	**½" w**	16.0	15.5	15.0	13.5	13.0	13.0	17.0	124.2	14.0	240.0	16"
18"	**½" w**	17.5	17.0	.16.0	14.5	14.0	13.5	18.0	140.25	14.5	286.64	18"
20"	**½" w**	18.0	17.5	..:.17.0.	15.0	14.5	14.0	19.0.	157.5	15.0	341.8	20"
24"	**½" w**	20.0	19.0	. 18.5	16.0	15.0	15.0	21.0	188.25	16.0	458.44	24"
1"	10S	4.0	3.5	3.0	4.0	3.0	2.5	4.5	2.08	4.0	2.7	1"

Pipe Size In.	SCH/Thk (in)	PIPE- VAPOR INSULATION			PIPE- LIQUID INSULATION			BARE PIPE EMPTY		BARE PIPE WATER FILLED		Pipe size in.
		BASIC SPAN (L)M			BASIC SPAN (L)M							
		UPTO 175^0 C	176^0 C TO 315^{0}C	316^{0}C TO 400^{0}C	UPTO 175^0 C	176^0 C TO 315^{0}C	316^{0}C TO 400^{0}C	SPAN(L) M	WEIGHT KG/M	SPAN(L) M	WEIGHT KG/M	
1-112"	10S	5.0	4.5	3.5	4.5	4.0	3.0	5.5	3.12	5.0	4.57	*1-112"*
2"	10S	5.0	4.5	3.5	4.5	4.0	3.0	6.0	3.94	5.5	6.33	2"
2-112"	10S	6.5	5.5	4.5	5.5	5.0	4.5	7.0	5.26	6.0	8.85	*2-1/2"*
3"	10S	7.0	6.0	5.0	6.0	5.5	5.0	7.5	6.45	6.0	11.91	3"
4"	10S	7.5	7.0	6.0	*6.p*	6.0	6.0	8.0	8.34	7.0	17.87	4"
6"	10S	9.5	9.0	8.0	8.0	7.5	7.5	10.0	13.82	8.5	34.54	6"
8"	10S	11.0	10.5	10.0	9.5	9.5	8.5	11.5	19.94	10.0	55.5	8"
10"	10S	12.5	12.0	11.0	10.5	10.0	9.5	13.0	27.S3	11.0	83.4	10"
12"	10S	14.0	13.0	12.0	11.0	11.0	10.0	14.5	36.00	11.5	114.6	12"
14"	105	14.5	14.0	13.0	11.5	11.0	11.0	15.5	41.18	11.5	132.6	14"
16"	10S	16.5	14.5	14.0	12.0	11.5	11.5	16.5	47.33	12.5	172.2	16"
IS"	10 S	16.5	15.5	14.5	12.5	12.5	11.5	17.5	53.18	13.0	212.1	18"
20"	10 S	17.5	16.5	15.5	13.0	13.0	12.0	18.5	68.50	13.0	264.5	20"
24"	10 S	19.0	18.0	17.0	14.0	13.5	12.5	20.5	94.37	14.0	376.8	24"

ANNEXURE – 2

ACCESSIBILITY FOR VALVES AND INSTRUMENTS

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

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

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

ANNEXURE-3

MAXIMUM SPACING OF GUIDES FOR VERTICAL & HORIZONTAL PIPES

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

NOTES:-

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

2. The guide spacings given in the above table are indicative only.

ANNEXURE – 4

CLEARANCES

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

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

Item	Description	
Platforms	Minimum clearance around any obstruction on the platform.	500 mm
	Headroom	2.2 M
	Maximum vertical distance between platforms	6 M
	Minimum toe clearance behind a ladder.	210 mm
	Minimum handrail clearance.	100 mm
Equipment	Minimum maintenance space required between flanges of exchangers or other equipment arranged in pairs.	500 mm
	Minimum maintenance space required for structural members or pipe.	300 mm
	Clearance from edge of road shoulder (the extreme projection)	1.5 M
Fired Equipment	Horizontal clearance from hydrocarbon equipment (shell to shell)	15 M
	Exception: Reactors or equipment in alloy systems shall be located for the most economical piping arrangement.	
	Clearance from edge of road to heater shell.	3 M
Valve Hand wheels	Clearance between the outside of the hand wheel and any obstruction.	25 mm*
Pipe (aboveground)	Clearance between the outside diameter of the flange and the outside diameter of pipe insulation.	25 mm*
	Clearance between the outside diameter of the pipe, flange or insulation and a structural member.	50 mm*
	Clearance between the outside diameter of the flange and the outside diameter of bare pipe.	25 mm*
	Minimum distance from underside of pipe to grade or platform.	300 mm
Control Valve Arrangement	Centreline of control valve above grade or platform.	450 mm
	Minimum centreline of control valve from face of column or wall.	600 mm
	Where process conditions require steam or hydrocarbon vapours to be discharged to atmosphere at a safe location,	

Item	Description	
	the tail pipe shall terminate as below:	
	Distance above nearest operating platform.	3 M
	Within radius of nearest operating platform.	7.5 M
** Verify conformance with local regulations. * With full consideration of thermal movements		

ANNEXURE – 5

DESIGN PHILOSOPHY FOR STRESS ANALYSIS

1.0 PURPOSE

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

Analysis with the extent of documentation required for flexibility analysis.

Purpose of piping stress analysis is to ensure:

Safety of piping and piping components

Safety of connected equipment and supporting structure

Piping deflections are within the limits

2.0 SCOPE

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

3.0 DEFINITIONS

3.1 Critical Lines / Critical Line List

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

3.2 Stress Analysis Temperature

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

3.3 Design Pressure

Design Pressure refers to the “Design Pressure” of the line under review as indicated on the Line List. Design Pressure is as defined in clause 301.2 of ASME B 31.3.

3.4 Temperature for Flexibility Analysis

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

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

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

1.0 SELECTION

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

4.1 Level I [Extensive Analysis]

Piping systems or lines that meet Annexure 5A criteria are deemed to be extremely critical. These lines are categorized as Level I and require careful study to ensure that the code compliance is met and the accurate determination of nozzle and support loads have been made. The routing of these lines is very important. They must be analyzed in the early stages of the project during routing studies so that the impact on the location of less critical lines is minimized. Normally, these systems require computer analysis. The general intent of the Level I analysis criteria is to study lines size DN 80 & larger that are affected by thermal expansion and / or a dynamic response, and that can't be evaluated by a weight-only analysis (as per the general intent of Level II analysis). Consideration has to be given to other special situations that augment the Level I general intent guidelines such as for lines that are excessively large and stiff.

4.2 Level II [Normal Analysis]

Piping systems or lines that meet Annexure 5B criteria are moderately critical lines and often do not require such rigorous study to ensure code compliance or accurate determination of nozzle and support loads. These lines are smaller in size and operate at lower temperatures (in general) than the lines to be analyzed using Level I Criteria. Normally, only manual calculations, by use of appropriate monographs are required for analysis of these systems.

4.3 Level III [Minimum Analysis]

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

4.4 Lines Deemed To Be Support Critical

Lines subjected to two-phase flow.

Cross country pipelines.

Lines with pipe thickness Sch 160 or greater.

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

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

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

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

Connecting to vent or flare systems or discharging to atmosphere

Liquid Blow down Lines.

Lined pipes

Non-metallic pipes

4.5 Lines Needing Dynamic Analysis

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

4.6 Special Piping

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

5.0 RELATED DOCUMENTATION

5.1 Critical Line List Format.

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

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

5.2 Lines Affecting the Flexibility of Critical Lines

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

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

6.0 PIPE STRESS ANALYSIS AND SUPPORTING

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

Piping stress analysis shall follow ASME B 31.3 and shall be complete to prevent overstressing of the pipe during operating conditions with wind and seismic loadings. During sustained, occasional (wind and seismic) & thermal expansion loading on piping,

The material allowable stresses shall be as per ASME B 31.3 for ASTM materials. For DIN material specifications the allowable stress values shall be calculated as per ASME

B 31.3 clause 302.3.2(d), wherein yield strength and ultimate strength values at temperature shall be taken from DIN material standards. For DIN material specifications, the other material properties viz. elastic modulus, density, coefficient of thermal expansion shall be taken from the respective DIN material standards.

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

6.3 Piping shall be designed in accordance with the Indian Standard criteria for earthquake resistance design for structures IS: 1893 for seismic zone-IV (refer project design basis). As a minimum, two (2) orthogonal horizontal components and a vertical component of ground

motion will be considered in the seismic analysis. For American standard, loading applied to piping would be in accordance with uniform building code (UBC).

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

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

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

Horizontal seismic coefficient (Ah) to be considered as 0.26 and Vertical (Av) to be considered as 0.173.

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

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

Both the horizontal directions shall be analyzed independently in two cases

+X, -X, +Z, -Z

Wind and seismic loading will not occur simultaneously.

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

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

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

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

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

1	WW+HP	HYD	
2	W+T1+P1	OPE	
3	W+T2+P1	OPE	
4	W+T1+P1+U1	OPE	
5	W+T1+P1+U2	OPE	
6	W+T1+P1+U3	OPE	
7	W+T1+P1-U1	OPE	
8	W+T1+P1-U2	OPE	
9	W+T1+P1-U3	OPE	
10	W+T1+P1+WIN1	OPE	
11	W+T1+P1+WIN2	OPE	
12	W+P1	SUS	
13	W+P2	SUS	
14	L2-L12	EXP	
15	L3-L12	EXP	
16	L4-L2	OCC	
17	L5-L2	OCC	
18	L6-L2	OCC	
19	L7-L2	OCC	
20	L8-L2	OCC	
21	L9-L2	OCC	
22	L10-L2	OCC	
23	L11-L2	OCC	
24	L12+L16	OCC	
25	L12+L17	OCC	
26	L12+L18	OCC	
27	L12+L19	OCC	
28	L12+L20	OCC	
29	L12+21	OCC	
30	L12+L22	OCC	
31	L12+L23	OCC	

P1- Maximum Operating Pressure W- Dead Weight

T1- Maximum Operating Temperature WW- Water Weight

P2- Design Pressure WIN- Wind Load

T2- Design Temperature U- Uniform Load

HP- Hydro test Pressure L2- Load case

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

7.0 CODES AND STANDARDS

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

Allowable Stress ASME B 31.3

Piping ASME B 31.3

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

Allowable Vendor

Wind Analysis ASCE 7 – 98

8.0 SOFTWARE USED

The package used shall be latest version of CEASER-II 5.2. Only one of these packages shall be used for the project & not a combination of the above packages.

9.0 DOCUMENT REQUIREMENT

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

Location and type of pipe supports with loads and movements.

Location of expansion joints and movements.

Vertical and horizontal loads including moments at all support points.

Vertical and horizontal loads including moments on all equipment and

Vessel connections.

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

Detailed nodal model used for the stress analysis

All assumptions and limitations applied to the analysis

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

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

1. Front sheet with Approval status
2. Isometrics with following information
   - Node numbers
   - Type of supports selected by stress engineer
   - Springs / Bellows data required for procurement like spring rate, loads, tide/untied information and SM (special material) identification.
   - Maximum Expansion and sustain stress values with node number
   - Nozzle/Anchors initial movements and piping imposed forces and moments on the same
   - Support loads (anchors, guides or rest) only they are above limit (The limit is defined in the beginning of the project in consultation with civil)

- Design and maximum operating conditions
- Coordinate axis system considered for inputs
- Dimensional details for piping designer to locate supports in piping model/layout.

3. Checklist as per Work instructions.
4. Following outputs
   - Load Cases
   - Restraint summary
   - Spring hanger report, if any
5. Stress critical line list extract for the lines analysed
6. Piping material specifications
7. Equipment drawings with allowable loads, if available
8. PID

ANNEXURE-5A

CRITERIA FOR IDENTIFING EXTREMELY CRITICAL LINES (LEVEL I)

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

NOTES:

1) Load sensitive equipment include fired heaters, reformers, lined vessels with lining of brittle material, non-ferrous equipments, graphite heat exchangers, plate & frame heat exchangers, etc.
2) This criterion is not to be applied to auxiliary piping such as seal flush; bearing cooling, etc. delta T refers to the differential temperature between the process piping and jacket.

ANNEXURE-5B

CRITERIA FOR IDENTIFYING MODERATELY CRITICAL LINES (LEVEL II)

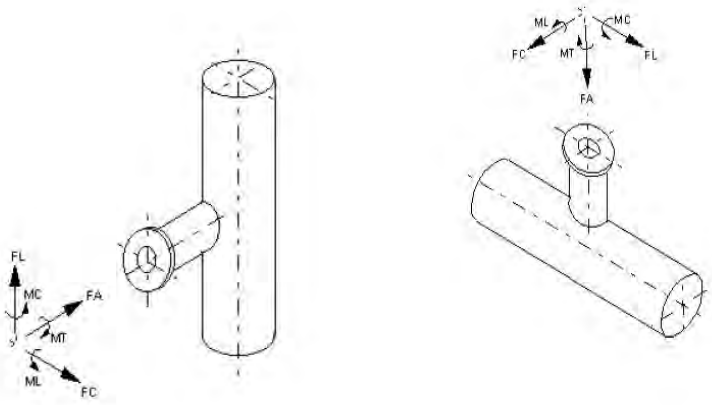
Temperature T, Degree C	Pipe Diameter DN (mm)	Piping Material	Service and Description
All	DN<80	All	Lethal fluid service.
T<-29	DN<80	Carbon Steel	All Services.
T<-46	DN<80	All	All Services
95<T<150	80<DN<200	All	All Services
T≥65	DN<80	Non-Metallic	All Services
T≥65	DN<80	All	All Services
T≥65	DN<80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

ANNEXURE-5C

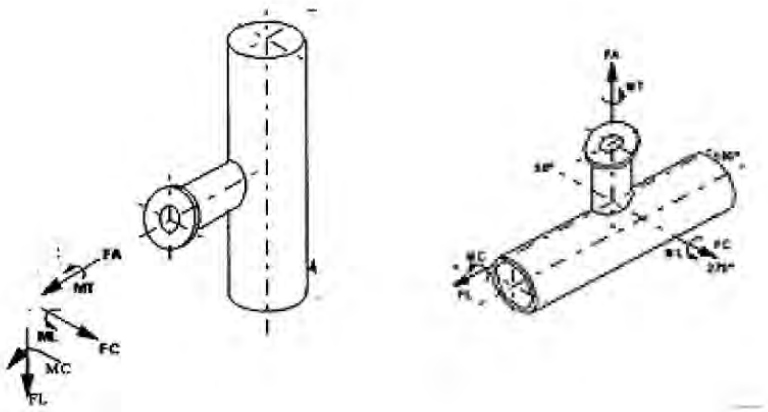
MINIMUM ALLOWABLE NOZZLE LOADINGS- VESSELS AND S/T HEAT EXCHANGERS

NOZZ. SIZE	FLANGE RATING	NOZZLE FORCES (N)				NOZZLE MOMENTS (Nm)			
(in)	(lbs)	FL	FA	FC	F	MT	ML	MC	M
1.5	150#	2250	2250	1688	2385	253	219	169	238
1.5	300#	2250	2250	1688	2385	253	219	169	238
1.5	600#	3750	3750	2813	3975	422	366	281	397
1.5	900#	4500	4500	3375	4770	506	439	338	476
1.5	1500#	6000	6000	4500	6360	675	585	450	635
2	150#	3000	3000	2250	3180	450	390	300	423
2	300#	3000	3000	2250	3180	450	390	300	423
2	600#	5000	5000	3750	5300	750	650	500	705
2	900#	6000	6000	4500	6360	900	780	600	846
2	1500#	8000	8000	6000	8480	1200	1040	800	1128
3	150#	4500	4500	3375	4770	1013	878	675	952
3	300#	4500	4500	3375	4770	1013	878	675	952
3	600#	7500	7500	5625	7950	1688	1463	1125	1586
3	900#	9000	9000	6750	9540	2025	1755	1350	1904
3	1500#	12000	12000	9000	12720	2700	2340	1800	2538
4	150#	6000	6000	4500	6360	1800	1560	1200	1692
4	300#	6000	6000	4500	6360	1800	1560	1200	1692
4	600#	10000	10000	7500	10600	3000	2600	2000	2820
4	900#	12000	12000	9000	12720	3600	3120	2400	3384
4	1500#	16000	16000	12000	16960	4800	4160	3200	4512
6	150#	9000	9000	6750	9540	4050	3510	2700	3807
6	300#	9000	9000	6750	9540	4050	3510	2700	3807
6	600#	15000	15000	11250	15900	6750	5850	4500	6345
6	900#	18000	18000	13500	19080	8100	7020	5400	7614
6	1500#	24000	24000	18000	25440	10800	9360	7200	10152
8	150#	12000	12000	9000	12720	7200	6240	4800	6768
8	300#	12000	12000	9000	12720	7200	6240	4800	6768
8	600#	20000	20000	15000	21200	12000	10400	8000	11280
8	900#	24000	24000	18000	25440	14400	12480	9600	13536
8	1500#	32000	32000	24000	33920	19200	16640	12800	18048
10	150#	15000	15000	11250	15900	11250	9750	7500	10575
10	300#	15000	15000	11250	15900	11250	9750	7500	10575
10	600#	25000	25000	18750	26500	18750	16250	12500	17625
10	900#	30000	30000	22500	31800	22500	19500	15000	21150
10	1500#	40000	40000	30000	42400	30000	26000	20000	28200
12	150#	18000	18000	13500	19080	16200	14040	10800	15228
12	300#	18000	18000	13500	19080	16200	14040	10800	15228
12	600#	30000	30000	22500	31800	27000	23400	18000	25380
12	900#	36000	36000	27000	38160	32400	28080	21600	30456
12	1500#	48000	48000	36000	50880	43200	37440	28800	40608
14	150#	21000	21000	15750	22260	22050	19110	14700	20727
14	300#	21000	21000	15750	22260	22050	19110	14700	20727
14	600#	35000	35000	26250	37100	36750	31850	24500	34545
14	900#	42000	42000	31500	44520	44100	38220	29400	41454
14	1500#	56000	56000	42000	59360	58800	50960	39200	55272

NOZZ. SIZE	FLANGE RATING	NOZZLE FORCES (N)				NOZZLE MOMENTS (Nm)			
(in)	(lbs)	FL	FA	FC	F	MT	ML	MC	M
16	150#	24000	24000	18000	25440	28800	24960	19200	27072
16	300#	24000	24000	18000	25440	28800	24960	19200	27072
16	600#	40000	40000	30000	42400	48000	41600	32000	45120
16	900#	48000	48000	36000	50880	57600	49920	38400	54144
16	1500#	64000	64000	48000	67840	76800	66560	51200	72192
18	150#	27000	27000	20250	28620	36450	31590	24300	34263
18	300#	27000	27000	20250	28620	36450	31590	24300	34263
18	600#	45000	45000	33750	47700	60750	52650	40500	57105
18	900#	54000	54000	40500	57240	72900	63180	48600	68526
18	1500#	72000	72000	54000	76320	97200	84240	64800	91368
20	150#	30000	30000	22500	31800	45000	39000	30000	42300
20	300#	30000	30000	22500	31800	45000	39000	30000	42300
20	600#	50000	50000	37500	53000	75000	65000	50000	70500
20	900#	60000	60000	45000	63600	90000	78000	60000	84600
20	1500#	80000	80000	60000	84800	120000	104000	80000	112800
22	150#	33000	33000	24750	34980	54450	47190	36300	51183
22	300#	33000	33000	24750	34980	54450	47190	36300	51183
22	600#	55000	55000	41250	58300	90750	78650	60500	85305
22	900#	66000	66000	49500	69960	108900	94380	72600	102366
22	1500#	88000	88000	66000	93280	145200	125840	96800	136488
24	150#	36000	36000	27000	38160	64800	56160	43200	60912
24	300#	36000	36000	27000	38160	64800	56160	43200	60912
24	600#	60000	60000	45000	63600	108000	93600	72000	101520
24	900#	72000	72000	54000	76320	129600	112320	86400	121824
24	1500#	96000	96000	72000	101760	172800	149760	115200	162432
26	150#	39000	39000	29250	41340	76050	65910	50700	71487
26	300#	39000	39000	29250	41340	76050	65910	50700	71487
26	600#	65000	65000	48750	68900	126750	109850	84500	119145
26	900#	78000	78000	58500	82680	152100	131820	101400	142974
26	1500#	104000	104000	78000	110240	202800	175760	135200	190632
28	150#	42000	42000	31500	44520	88200	76440	58800	82908
28	300#	42000	42000	31500	44520	88200	76440	58800	82908
28	600#	70000	70000	52500	74200	147000	127400	98000	138180
28	900#	84000	84000	63000	89040	176400	152880	117600	165816
28	1500#	112000	112000	84000	118720	235200	203840	156800	221088
30	150#	45000	45000	33750	47700	101250	87750	67500	95175
30	300#	45000	45000	33750	47700	101250	87750	67500	95175
30	600#	75000	75000	56250	79500	168750	146250	112500	158625
30	900#	90000	90000	67500	95400	202500	175500	135000	190350
30	1500#	120000	120000	90000	127200	270000	234000	180000	253800
32	150#	48000	48000	36000	50880	115200	99840	76800	108288
32	300#	48000	48000	36000	50880	115200	99840	76800	108288
32	600#	80000	80000	60000	84800	192000	166400	128000	180480
32	900#	96000	96000	72000	101760	230400	199680	153600	216576
32	1500#	128000	128000	96000	135680	307200	266240	204800	288768



ORIENTATION OF THE FORCES AND MOMENTS AS PER WRC BULETTIN107



ORIENTATION OF THE FORCES AND MOMENTS AS PER PD 5500

JOB SPECIFIC REQUIREMENTS

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

12	Electrical cable routing underground I Above ground: - ISBL - OSBL	Refer Electrical Design Basis.	
13	Any requirement of statutory approval.	All statutory requirements e.g. IBR/PCB/CCE and others	
14	Instrument cable routing ISBL & OSBL	Refer Instrumentation Design Basis.	
15	Safety shower / eye wash. (in case of chemical/catalyst handling system.)	Required. As Per PID	
16	Requirement of elevators.	Yes.	
17	Connectivity of all platforms at higher elevations for tall columns (ie. between columns &technological structure and between columns & rack).	Yes.	Adjacent columns/ technological Structures/ rack must be connected at minimum two locations.
18	Compressor/blower house for ISBL as well as OSBL a) location b) Maintenance requirement	a) Under Shed b) E.O.T.	With additional auxiliary hook for light wt handling maintain ace platt shall be provided across full width with cat ladder at each end
19	Instrument Air Drier Shed	Yes	
20	Insulation material a) Hot /Tracing/safety b) Electrical tracing c) Cold	As per process design basis.	
21	Painting System	Refer Std Specification (Civil)	
22	Method of surface preparation a) Mechanical tools b) Blast cleaning	Blast Cleaning	
23	Sand blasting! grit blasting	Grit Blasting	
24	Painting of SS pipes below insulation	****As Per Specification	Wherever painting is not specified, Aluminum/ SS foil as per piping design basis shall be used.

25	Specific colour coding requirements.	Client agreed	
26	Usage of IS grade material.	No	
27	Usage of asbestos gasket.	No	
28	Provision for high settlement in tank farm: a) Usage of dresser coupling in tank farms. b) Flexibility of piping.	Flexibility of Piping.	
29	Steam tracing type	Standard module for steam distribution and condensate collection manifolds with integral glandless piston valve & trap and carbon steel tracer pipe.	
30	Bulk Material	Client agreed vendor list.	
31	Engineering Drawing Mode	Electronic & Hard Copies also required	
32	Specific software package for engineering drawings -AutoCAD and AP-ISO -PDS/SP 3D with Isogen -Auto Plant Designer with Isogen or AP-ISO -PDMS with Isogen -AutoCAD	3-D Models, capable of model review and walk through.	
33	Material Control System		
34	Item Coding system		
35	Stress Analysis Package	CEASER II (Latest Version)	
36	Access to Nozzles of columns	Platforms for all Nozzles.	
37	Staircase / Ladders for tall column/reactors.	Ladders for columns/staircases "for reactors	

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

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

PIPING MATERIAL SPECIFICATION

CLIENT : RCF, THAL
PROJECT : INSTALLATION OF ULTRA-FILTRATION UNIT
LOCATION : THAL

DOC. PC00284-PDS-600
Rev.:0

Class: B50

PROJECTS AND DEVELOPMENT INDIA LIMITED

SERVICE	TEMPERATURE LIMITS (Deg.C)				
AF,AW,CD,DM,HZ,IA,MDA,PC,PH,VS,CH	Ref.SI	Ref.SI			
RATING ASME 150# RF	CORROSION ALLOWANCE NONE	MATERIAL SS 304			

ITEM	NOTES	SIZE (NPS)	SCH/ RAT	END	DESCRIPTION	COMM CODE	SPCL REV
PIPE							
PIPE		26 - 28	06.35 MM	BE	EFW,ASTM A358 GR.TP304 CL.1,ASME B36.10,	PPW911300	
PIPE		30 - 32	SCH 10	BE	EFW,ASTM A358 GR.TP304 CL.1,ASME B36.10,	PPW911300	
PIPE		34 - 36	SCH 10	BE	EFW,ASTM A358 GR.TP304 CL.1,ASME B36.10,	PPW911300	
PIPE		38 - 40	SCHSTD	BE	EFW,ASTM A358 GR.TP304 CL.1,ASME B36.10,	PPW911300	
PIPE		42 - 44	SCHSTD	BE	EFW,ASTM A358 GR.TP304 CL.1,ASME B36.10,	PPW911300	
PIPE		46 - 48	SCHSTD	BE	EFW,ASTM A358 GR.TP304 CL.1,ASME B36.10,	PPW911300	
PIPE		1/2 - 3/4	SCH40S	PE	SMLS,ASTM A312 TP304,ASME B36.19,	PPPE21400	
PIPE		1 - 11/4	SCH40S	PE	SMLS,ASTM A312 TP304,ASME B36.19,	PPPE21400	
PIPE		11/2 - 11/2	SCH40S	PE	SMLS,ASTM A312 TP304,ASME B36.19,	PPPE21400	
PIPE		2 - 4	SCH10S	BE	EFW,STR.WELD,ASTM A312 TP304,ASME B36.19,	PPZ111400	
PIPE		6 - 8	SCH10S	BE	EFW,STR.WELD,ASTM A312 TP304,ASME B36.19,	PPZ111400	
PIPE		10 - 12	SCH10S	BE	EFW,STR.WELD,ASTM A312 TP304,ASME B36.19,	PPZ111400	
PIPE		14 - 16	SCH10S	BE	EFW,STR.WELD,ASTM A312 TP304,ASME B36.19,	PPZ111400	
PIPE		18 - 20	SCH10S	BE	EFW,STR.WELD,ASTM A312 TP304,ASME B36.19,	PPZ111400	
PIPE		22 - 24	SCH10S	BE	EFW,STR.WELD,ASTM A312 TP304,ASME B36.19,	PPZ111400	
FLANGE							
W.N.FLANGE		26 - 48	150#	WN-RF 125 AARH	ASTM A182 F304,ASME B16.47 SR.B,WELD NECK	WN0670701	
W.N.FLANGE		1/2 - 24	150#	WN-RF 125 AARH	ASTM A182 F304,ASME B16.5,WELD NECK	WN0670801	
SPACER AND BLIND		14 - 24	150#	RF 125 AARH	ASTM A182 F304,ASME B16.48,	RS062PO01	
SPECL BLIND		1/2 - 12	150#	RF 125 AARH	ASTM A182 F304,ASME B16.48,	SP062PO01	
BLIND FLANGE							
BLIND FLANGE		26 - 48	150#	RF 125 AARH	ASTM A182 F304,ASME B16.47 SR.B,	BF0620701	
BLIND FLANGE		1/2 - 24	150#	RF 125 AARH	ASTM A182 F304,ASME B16.5,	BF0620801	
GASKET							
GASKET		1/2 - 24	150#	SPRL-WND RF	TP304 SS WDG; GPH FLR; TP304 SS INR RNG/ OTR RNG,ASME B16.20,	GSQL30301	
GASKET		26 - 48	150#	SPRL-WND RF	TP304 SS WDG; GPH FLR; TP304 SS INR RNG/ OTR RNG,ASME B16.20/B16.47 SR.B,	GSQL3QJ01	
STUD & NUTS							
STUD & 2NUTS HVY HEX		-			ASTM A193 GR.B8 CL.2/ASTM A194 GR.8,,	SNA600000	
DRIP RING							
DRIP RING		3 - 3	150#	RF 125 AARH	ASTM A182 F304,PDIL-PDS-600,	DR062QK01	
FITTING (BW)							
BRANCH WELD		2 - 48		BW	STAINLESS STEEL,ASME B31.3,	RWOK11200	
BRANCH WELD WITH RP		2 - 48		BW	STAINLESS STEEL,ASME B31.3,	WBOK11200	
CAP		2 - 48		BW	ASTM A403 WP304-SMLS,ASME B16.9,	CP7410900	
ELBOW		2 - 48		BW	ASTM A403 WP304-WLDD,ASME B16.9,	ELZ410900	
REDUCER CONC.		2 - 48		BW	ASTM A403 WP304-WLDD,ASME B16.9,	RCZ410900	
REDUCER ECC.		2 - 48		BW	ASTM A403 WP304-WLDD,ASME B16.9,	REZ410900	
TEE		2 - 48		BW	ASTM A403 WP304-WLDD,ASME B16.9,	TEZ410900	
WELDOLET		2 - 48		BW	ASTM A182 F304,MSS SP 97,	WL0613300	
FITTING (SW)							
CAP		1/2 - 11/2	3000#	SOCW	ASTM A182 F304,ASME B16.11,	CP0630207	W
COUPLING		1/2 - 11/2	3000#	SOCW	ASTM A182 F304,ASME B16.11,	CN0630207	
ELBOW		1/2 - 11/2	3000#	SOCW	ASTM A182 F304,ASME B16.11,	EL0630207	
HALF COUPLING		1/2 - 11/2	3000#	SOCW	ASTM A182 F304,ASME B16.11,	HF0630207	
SOCKOLET		1/2 - 48	3000#	SOCW	ASTM A182 F304,MSS SP 97,	SL0633307	
TEE		1/2 - 11/2	3000#	SOCW	ASTM A182 F304,ASME B16.11,	TE0630207	
FITTING (THD)							
CAP		1/2 - 11/2	3000#	THD	ASTM A182 F304,ASME B16.11,	CP0640207	T

PIPING MATERIAL SPECIFICATION

CLIENT : M/S..RCF
PROJECT : INSTALLATION OF ULTRA-FILTRATION UNIT
LOCATION : THAL

DOC. No. PC00284-PDS-600
Rev.: 0

Class: B50

PROJECTS AND DEVELOPMENT INDIA LIMITED

SERVICE	TEMPERATURE LIMITS (Deg.C)				
AF,AW,CD,DM,HZ,IA,MDA,PC,PH,VS,CH	Ref.SI	Ref.SI			
RATING ASME	CORROSION ALLOWANCE	MATERIAL			
150# RF	NONE	SS 304			

ITEM	NOTES	SIZE (NPS)	SCH/ RAT	END	DESCRIPTION	COMM CODE	SPCL REV
PLUG		1/2 - 11/2		THD	ASTM A182 F304,ASME B16.11,ROUND HEAD	PG0640200	
THREDOLET		1/2 - 48	3000#	THD	ASTM A182 F304,MSS SP 97,	TL0643307	
NIPPLE							
NIPPLE		1/2 - 11/2	SCH80S	PLN-PLN	SMLS,ASTM A312 TP304,ASME B36.19,	NPPE51413	1
NIPPLE		1/2 - 11/2	SCH80S	PLN-THD	SMLS,ASTM A312 TP304,ASME B36.19,NPT	NPPE61413	2
NIPPLE		1/2 - 11/2	SCH80S	THD	SMLS,ASTM A312 TP304,ASME B36.19,NPT	NPPE41413	3
SWAGE NIPPLE							
SWAGE (CONC)		1/2 - 11/2		PE	ASTM A403 WP304-SMLS,MSS SP 95,	NC74J4500	P
SWAGE (CONC)		1/2 - 11/2		PLN-THD	ASTM A403 WP304-SMLS,MSS SP 95,	NC7464500	T
SWAGE (ECC)		1/2 - 11/2		PE	ASTM A403 WP304-SMLS,MSS SP 95,	NE74J4500	P
SWAGE (ECC)		1/2 - 11/2		PLN-THD	ASTM A403 WP304-SMLS,MSS SP 95,	NE7464500	T
STRAINER							
T-TYPE STRAINER		2 - 24	150#	FLGD	SS ASTM A351 GR CF8,TTS510,	TTS510	
Y-TYPE STRAINER		2 - 24	150#	FLGD	SS ASTM A351 GR CF8,YTS510,	YTS510	
Y-TYPE STRAINER		1/2 - 11/2	600#	SOCW	ASTM A182 F304,YTS501,	YTS501	
VALVES							
GATE VALVE		1/2 - 11/2	800#	SOCW	SS BODY ASTM A182 GR F304,GAV501,	GAV501	
GATE VALVE		2 - 24	150#	FLG	SS BODY ASTM A351 GR CF8,GAV510,	GAV510	
GLOBE VALVE		1/2 - 11/2	800#	SOCW	SS BODY ASTM A182 GR F304,GLV501,	GLV501	
GLOBE VALVE		2 - 12	150#	FLG	SS BODY ASTM A351 GR CF8,GLV510,	GLV510	
CHECK VALVE		1/2 - 11/2	800#	SOCW	SS BODY ASTM A182 GR F304,CHV501,	CHV501	
CHECK VALVE		2 - 24	150#	FLG	SS BODY ASTM A351 GR CF8,CHV510,	CHV510	
CHECK VALVE		26 - 36	150#	FLG	SS BODY ASTM A351 GR CF8,CHV520,	CHV520	
BALL VALVE		1/2 - 11/2	800#	THRD	SS BODY AISI 316,BAV501,	BAV501	
BALL VALVE		2 - 6	150#	FLG	SS BODY ASTM A351 GR CF8M,BAV510,	BAV510	
BALL VALVE		8 - 24	150#	FLG	SS BODY ASTM A351 GR CF8M,BAV520,	BAV520	
BUTTERFLY VALVE		6 - 48	150#	RF	SS BODY ASTM A351 GR CF8,BUV510,WAFER TYPE	BUV510	
PLUG VALVE		1/2 - 1	600#	THRD	SS BODY AISI 316,PLV501,	PLV501	
PLUG VALVE		11/2 - 6	150#	FLG	SS BODY ASTM A351 GR CF8M,PLV510,	PLV510	

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PIPING MATERIAL SPECIFICATION

CLIENT : RCF, THAL
PROJECT : INSTALLATION OF ULTRA-FILTRATION UNIT .
LOCATION : THAL

DOC. No. PC00284-PDS-600
Rev.:0

Class: D50

PROJECTS AND DEVELOPMENT INDIA LIMITED

SERVICE	TEMPERATURE LIMITS (Deg.C)				
AW,PH,PC,AF,DM,MD,IA	Ref Sl	Ref Sl			
RATING ASME	CORROSION ALLOWANCE	MATERIAL			
300# RF	NONE	SS 304			

ITEM	NOTES	SIZE (NPS)	SCH/ RAT	END	DESCRIPTION	COMM CODE	SPCL REV
PIPE							
PIPE		14 - 14	SCHSTD	BE	EFW,STR.WELD,ASTM A312 TP304,ASME B36.10,	PPZ111300	
PIPE		16 - 18	SCH XS	BE	EFW,ASTM A358 GR.TP304 CL.1,ASME B36.10,	PPW911300	
PIPE		20 - 20	SCH XS	BE	EFW,ASTM A358 GR.TP304 CL.1,ASME B36.10,	PPW911300	
PIPE		24 - 24	SCH 40	BE	EFW,ASTM A358 GR.TP304 CL.1,ASME B36.10,	PPW911300	
PIPE		26 - 28	17.48 MM	BE	EFW,ASTM A358 GR.TP304 CL.1,ASME B36.10,	PPW911300	
PIPE		1/2 - 3/4	SCH40S	PE	SMLS,ASTM A312 TP304,ASME B36.19,	PPPE21400	
PIPE		1 - 11/4	SCH40S	PE	SMLS,ASTM A312 TP304,ASME B36.19,	PPPE21400	
PIPE		11/2 - 11/2	SCH40S	PE	SMLS,ASTM A312 TP304,ASME B36.19,	PPPE21400	
PIPE		2 - 4	SCH10S	BE	EFW,STR.WELD,ASTM A312 TP304,ASME B36.19,	PPZ111400	
PIPE		6 - 8	SCH40S	BE	EFW,STR.WELD,ASTM A312 TP304,ASME B36.19,	PPZ111400	
PIPE		10 - 12	SCH40S	BE	EFW,STR.WELD,ASTM A312 TP304,ASME B36.19,	PPZ111400	
FLANGE							
W.N.FLANGE		26 - 28	300#	WN-RF 125 AARH	ASTM A182 F304,ASME B16.47 SR.B,WELD NECK	WN0670702	
W.N.FLANGE		1/2 - 24	300#	WN-RF 125 AARH	ASTM A182 F304,ASME B16.5,WELD NECK	WN0670802	
SPACER AND BLIND		14 - 28	300#	RF 125 AARH	ASTM A182 F304,ASME B16.48,	RS062PO02	
SPECL BLIND		1/2 - 12	300#	RF 125 AARH	ASTM A182 F304,ASME B16.48,	SP062PO02	
BLIND FLANGE							
BLIND FLANGE		26 - 28	300#	RF 125 AARH	ASTM A182 F304,ASME B16.47 SR.B,	BF0620702	
BLIND FLANGE		1/2 - 28	300#	RF 125 AARH	ASTM A182 F304,ASME B16.5,	BF0620802	
GASKET							
GASKET		1/2 - 24	300#	SPRL-WND RF	TP304 SS WDG; GPH FLR; TP304 SS INR RNG/ OTR RNG,ASME B16.20,	GSQL30302	
GASKET		26 - 28	300#	SPRL-WND RF	TP304 SS WDG; GPH FLR; TP304 SS INR RNG/ OTR RNG,ASME B16.20/B16.47 SR.B,	GSQL3QJ02	
STUD & NUTS							
STUD & 2NUTS HVY HEX		-			ASTM A193 GR.B8T CL.2/ASTM A194 GR.8TA,,	SNQG00000	
DRIP RING							
DRIP RING		3 - 12	300#	RF 125 AARH	ASTM A182 F304,PDIL-PDS-600,	DR062QK02	
FITTING (BW)							
BRANCH WELD		2 - 28		BW	STAINLESS STEEL,ASME B31.3,	RWOK11200	
BRANCH WELD WITH RP		2 - 28		BW	STAINLESS STEEL,ASME B31.3,	WBOK11200	
CAP		2 - 24		BW	ASTM A403 WP304-SMLS,ASME B16.9,	CP7410900	
ELBOW		2 - 28		BW	ASTM A403 WP304-WLDD,ASME B16.9,	ELZ410900	L
ELBOW		2 - 28	19.05 MM	BW	ASTM A403 WP304-WLDD,PDIL-PDS-600,R=3D	ELZ41QK60	3
REDUCER CONC.		2 - 28		BW	ASTM A403 WP304-WLDD,ASME B16.9,	RCZ410900	
REDUCER ECC.		2 - 28		BW	ASTM A403 WP304-WLDD,ASME B16.9,	REZ410900	
TEE		2 - 28		BW	ASTM A403 WP304-WLDD,ASME B16.9,	TEZ410900	
WELDOLET		2 - 28		BW	ASTM A182 F304,MSS SP 97,	WL0613300	
FITTING (SW)							
CAP		1/2 - 11/2	3000#	SOCW	ASTM A182 F304,ASME B16.11,	CP0630207	W
COUPLING		1/2 - 11/2	3000#	SOCW	ASTM A182 F304,ASME B16.11,	CN0630207	
ELBOW		1/2 - 11/2	3000#	SOCW	ASTM A182 F304,ASME B16.11,	EL0630207	
HALF COUPLING		1/2 - 11/2	3000#	SOCW	ASTM A182 F304,ASME B16.11,	HF0630207	
SOCKOLET		1/2 - 28	3000#	SOCW	ASTM A182 F304,MSS SP 97,	SL0633307	
TEE		1/2 - 11/2	3000#	SOCW	ASTM A182 F304,ASME B16.11,	TE0630207	
FITTING (THD)							
CAP		1/2 - 11/2	3000#	THD	ASTM A182 F304,ASME B16.11,	CP0640207	T
PLUG		1/2 - 11/2		THD	ASTM A182 F304,ASME B16.11,ROUND HEAD	PG0640200	
THREDOLET		1/2 - 28	3000#	THD	ASTM A182 F304,MSS SP 97,	TL0643307	
NIPPLE							

PIPING MATERIAL SPECIFICATION

CLIENT : M/S..RCF THAL
PROJECT : INSTALLATION OF ULTRA-FILTRATION UNIT
LOCATION : THAL

DOC. No. PC00284-PDS-600
Rev.:0

Class: D50

PROJECTS AND DEVELOPMENT INDIA LIMITED

SERVICE	TEMPERATURE LIMITS (Deg.C)				
AW,PH,PC,AF,DM,MD,IA	Ref Sl	Ref Sl			
RATING ASME	CORROSION ALLOWANCE	MATERIAL			
300# RF	NONE	SS 304			

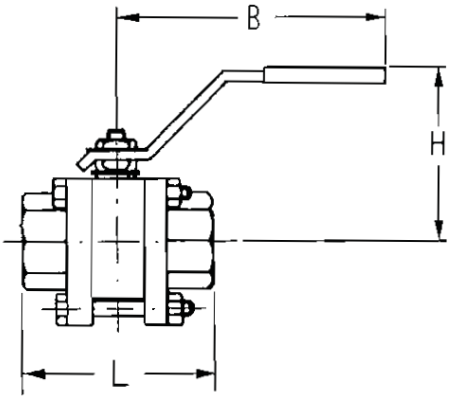
ITEM	NOTES	SIZE (NPS)	SCH/ RAT	END	DESCRIPTION	COMM CODE	SPCL REV
NIPPLE		1/2 - 11/2	SCH80S	PLN-PLN	SMLS,ASTM A312 TP304,ASME B36.19,	NPPE51413	1
NIPPLE		1/2 - 11/2	SCH80S	PLN-THD	SMLS,ASTM A312 TP304,ASME B36.19,NPT	NPPE61413	2
NIPPLE		1/2 - 11/2	SCH80S	THD	SMLS,ASTM A312 TP304,ASME B36.19,NPT	NPPE41413	3
SWAGE NIPPLE							
SWAGE (CONC)		1/2 - 11/2		PE	ASTM A403 WP304-SMLS,MSS SP 95,	NC74J4500	P
SWAGE (CONC)		1/2 - 11/2		PLN-THD	ASTM A403 WP304-SMLS,MSS SP 95,	NC7464500	T
SWAGE (ECC)		1/2 - 11/2		PE	ASTM A403 WP304-SMLS,MSS SP 95,	NE74J4500	P
SWAGE (ECC)		1/2 - 11/2		PLN-THD	ASTM A403 WP304-SMLS,MSS SP 95,	NE7464500	T
VALVES							
GATE VALVE		1/2 - 1	800#	SOCW	SS BODY ASTM A182 GR F304,GAV501,	GAV501	
GATE VALVE		11/2 - 11/2	800#	SOCW	SS BODY ASTM A182 GR F304,GAV501,	GAV501	W
GATE VALVE		11/2 - 11/2	300#	FLG	SS BODY ASTM A351 GR CF8M,GAV511,	GAV511	F
GATE VALVE		2 - 24	300#	FLG	SS BODY ASTM A351 GR CF8M,GAV511,	GAV511	
GLOBE VALVE		1/2 - 11/2	800#	SOCW	SS BODY ASTM A182 GR F304,GLV501,	GLV501	
GLOBE VALVE		2 - 12	300#	FLG	SS BODY ASTM A351 GR CF8M,GLV511,	GLV511	
CHECK VALVE		1/2 - 11/2	800#	SOCW	SS BODY ASTM A182 GR F304,CHV501,	CHV501	
CHECK VALVE		2 - 24	300#	FLG	SS BODY ASTM A351 GR CF8M,CHV511,	CHV511	
BALL VALVE		1/2 - 11/2	800#	THRD	SS BODY AISI 316,BAV501,	BAV501	
BALL VALVE		8 - 24	300#	FLG	SS BODY ASTM A351 GR CF8M,BAV521,	BAV521	
PLUG VALVE		1/2 - 1	600#	THRD	SS BODY AISI 316,PLV501,	PLV501	
PLUG VALVE		11/2 - 6	300#	FLG	SS BODY ASTM A351 GR CF8M,PLV511,	PLV511	

:

VALVE DATA SHEETS

PDIL

BALL VALVE



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	BAV 501
PRESSURE RATING CLASS	800
FACE	THREADED (NPT)
CONSTRUCTION	
BODY	THREE PIECES TYPE FULL BORE FLOATING BALL
EXTENDED STEM	NO
WRENCH OPERATED	YES
GEAR OPERATED	NO
FIRE SAFE	YES
NOMINAL SIZE	1/2" - 1 1/2"
MATERIALS	
BODY	AISI 316
BALL	AISI 316
BODY SEAT RING	PTFE
STEM PACKING	PTFE GRAPHITE
STEM	AISI 316
DESIGN CONDITIONS	
PRESSURE RATING	API 602

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED

2. IF NOT OTHERWISE STATED THE VALVES SHALL BE FULL BORE

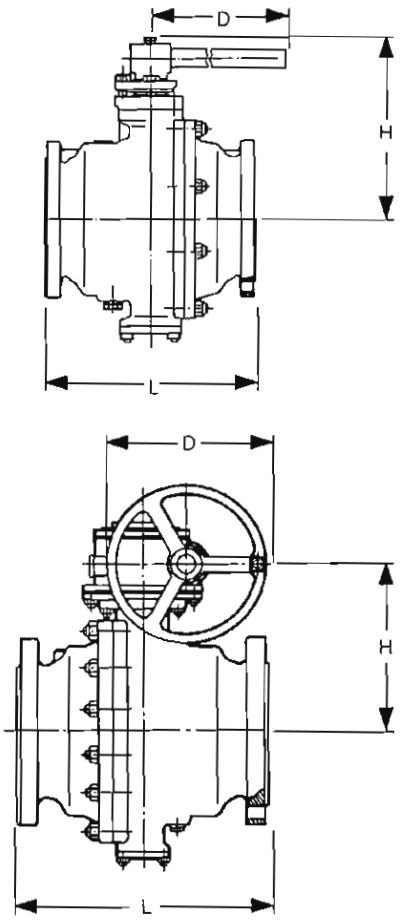
MANDATORY STANDARDS:

API 598, API 602, API 607, API 608, ANSI B16.11, ANSI B16.34

NOTES:

a) SEAT RATING ACC. TO MANUFACTURER'S STANDARD
b) BOTH ENDS FEMALE SCREWED

BALL VALVE



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	**BAV 510**
PRESSURE RATING CLASS	150
FACE	RF
CONSTRUCTION	
BODY	SPLIT BODY, FULL BORE, FLOATING BALL = <4" TRUN. MOUNT BALL >4" LONG PATTERN
EXTENDED STEM	NO
WRENCH OPERATED	2" - 6"
GEAR OPERATED	8" - 12"
FIRE SAFE	YES
NOMINAL SIZE	2" - 12"
MATERIALS	
BODY	A 351 Gr. CF 8M
BALL	AISI 316
BODY SEAT RING	PTFE
STEM PACKING	PTFE GRAPHITE
STEM	AISI 316
DESIGN CONDITIONS	
PRESSURE RATING	ANSI B16.34

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED

2. IF NOT OTHERWISE STATED THE VALVES SHALL BE FULL BORE

MANDATORY STANDARDS:

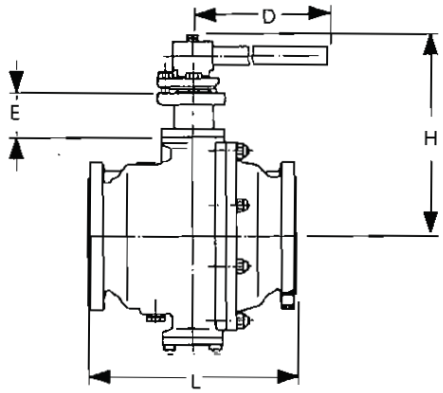
API 598, API 607, API 608, ANSI B16.10, ANSI B16.34, ANSI B16.5

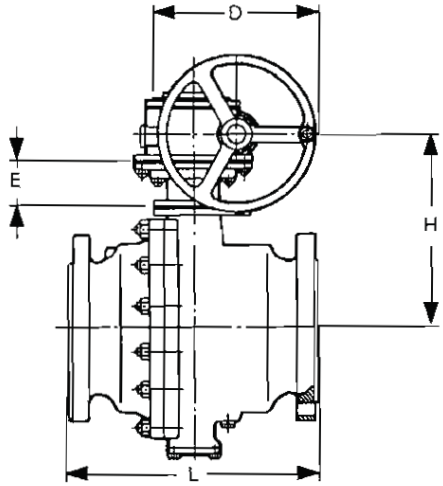
NOTES:

a) SEAT RATING ACC. TO MANUFACTURER'S STANDARD

PDIL

BALL VALVE





DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	BAV 520
PRESSURE RATING CLASS	150
FACE	RF
CONSTRUCTION	
BODY	SPLIT BODY FULL BORE TRUNNION MOUNTED BALL LONG PATTERN
EXTENDED STEM	NO
WRENCH OPERATED	NO
GEAR OPERATED	YES
FIRE SAFE	YES
NOMINAL SIZE	8" - 24"
MATERIALS	
BODY	A 351 Gr. CF 8M
BALL	A 351 Gr. CF 8M or CS Chromeplated
BODY SEAT RING	AISI 316 STELLITED
STEM PACKING	PTFE GRAPHITE
STEM	AISI 316
DESIGN CONDITIONS	
PRESSURE RATING	ANSI B16.34

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED

2. IF NOT OTHERWISE STATED THE VALVES SHALL BE FULL BORE

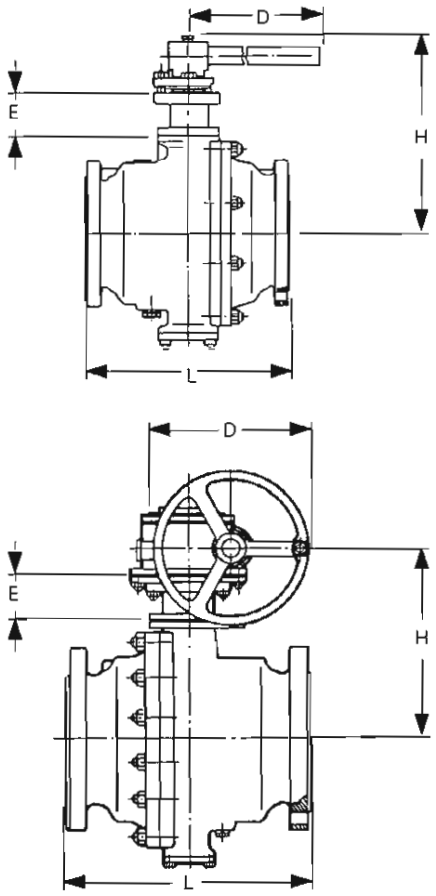
MANDATORY STANDARDS:

API 598, API 607, API 608, ANSI B16.10, ANSI B16.34, ANSI B16.5

NOTES:

a) SEAT RATING ACC. TO MANUFACTURER'S STANDARD
b) STEM EXTENSION E = 150mm

BALL VALVE



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	BAV 521	
PRESSURE RATING CLASS	300	
FACE	RF	
CONSTRUCTION		
BODY	SPLIT BODY FULL BORE TRUNNION MOUNTED BALL LONG PATTERN	
EXTENDED STEM	NO	
WRENCH OPERATED	NO	
GEAR OPERATED	YES	
FIRE SAFE	YES	
NOMINAL SIZE	8" - 24"	
MATERIALS		
BODY	A 351 Gr. CF 8M	
BALL	A 351 Gr. CF 8M CHROMEPLATED	
BODY SEAT RING	AISI 316 STELLITED	
STEM PACKING	PTFE GRAPHITE	
STEM	AISI 316	
DESIGN CONDITIONS		
PRESSURE RATING	ANSI B16.34	
FLUID	Kg/cm2g	°C
POTASSIUM CARBONATE SOL.	34	150

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED
2.
3. IF NOT OTHERWISE STATED THE VALVES SHALL BE FULL BORE

MANDATORY STANDARDS:

API 598, API 607, API 608, ANSI B16.10, ANSI B16.34, ANSI B16.5

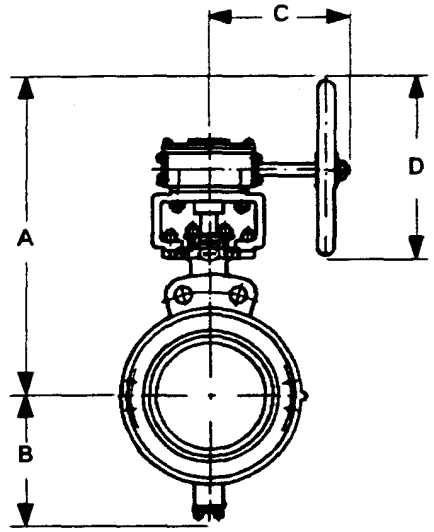
NOTES:

a) SEAT RATING ACC. TO MANUFACTURER'S STANDARD
b) STEM EXTENSION E = 150mm

NOM. DIA.	INCH	1 1/2	2	3	4	6	8	10	12	14	16	18	20	24			
LENGTH L	mm																
H	mm																
D	mm																
APPROX WT	Kg																

PDIL

BUTTERFLY VALVE



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	**BUV 510**
PRESSURE RATING CLASS	150
FACE	RF
CONSTRUCTION	
BODY	WAFER TYPE
	CATEGORY "B"
GEAR OPERATED	> = 8"
NOMINAL SIZE	6" - 48"
MATERIALS	
BODY	A 351 Gr. CF8
BODY SEAT	REINFORCED PTFE a)
DISC	STAINLESS TYPE 304
SHAFT	A 276 Gr. 304
SHAFT PACKING	PTFE
DESIGN CONDITIONS	
PRESSURE RATING	ANSI B16.34

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED
2. FASE-TO-FASE DIMENSIONS SHALL BE PER API 609

MANDATORY STANDARDS:

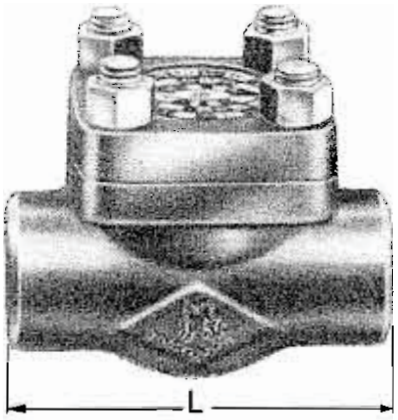
API 609, ANSI B16.34, ANSI B16.47, ANSI B16.5

NOTES:

a) MANUFACTURER MAY RECOMMEND ALTERNATIVE SEAT MATERIAL AND SEAT RATING SUBJECT TO PURCHASER APPROVAL
b) FLANGES > 24" ACC. TO ASME B16.47 SERIES B

PDIL

CHECK VALVE



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	**CHV 501**
PRESSURE RATING CLASS	800
FACE	SW
CONSTRUCTION	
BODY	FORGED
BONNET TO BODY CONNECTION	BOLTED
SEAT RING	RENEWABLE
TYPE OF DISC	BALL
NOMINAL SIZE	1/2" - 1 1/2"
MATERIALS	
BODY	A 182 Gr. F304
BODY SEAT RING	AISI 304
DISC	AISI 304
DESIGN CONDITIONS	
PRESSURE RATING	API 602

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED
2. IF NOT OTHERWISE STATED THE VALVE SHALL BE FULL BORE

MANDATORY STANDARDS:

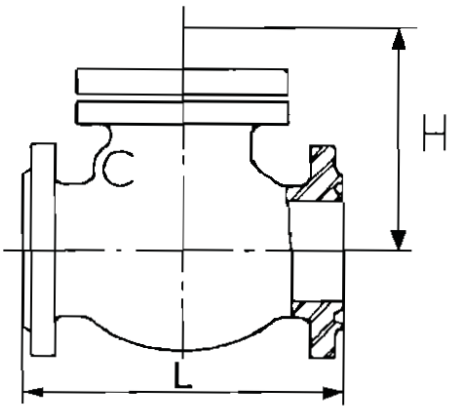
API 598, API 602, ANSI B16.11, ANSI B 16.34

NOTES:

a) VALVE DESIGN SHALL GENERALLY COMPLY WITH API 602

PDIL

CHECK VALVE



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	CHV 510
PRESSURE RATING CLASS	150
FACE	RF
CONSTRUCTION	
BODY	CAST
BONNET TO BODY CONNECTION	BOLTED
SEAT RING	INTEGRAL
TYPE OF DISC	SWING TYPE
ACCESSORIES	NO
BY-PASS	NO
NOMINAL SIZE	2" - 24"
MATERIALS	
BODY	A 351 Gr. CF8
BODY SEAT RING	A 182 Gr. F304 OR INTERGRAL
DISC	AISI 304
HINGE PIN	A 276 Gr. 304
DESIGN CONDITIONS	
PRESSURE RATING	ANSI B16.34

GENERAL

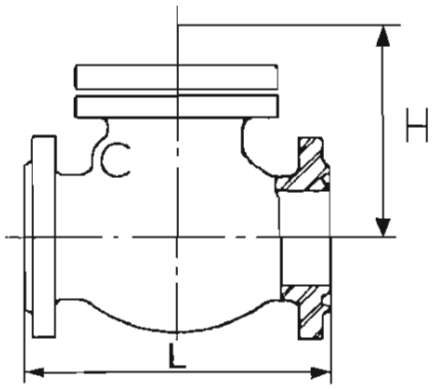
1. COPPER AND COPPER ALLOYS NOT PERMITTED

MANDATORY STANDARDS:

API 598, ANSI B16.10, ANSI B16.34, ANSI B16.5, MSS-SP 45

NOTES:

CHECK VALVE



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	CHV 511
PRESSURE RATING CLASS	300
FACE	RF
CONSTRUCTION	
BODY	CAST
BONNET TO BODY CONNECTION	BOLTED
SEAT RING	INTERGRAL
TYPE OF DISC	SWING TYPE
ACCESSORIES	NO
BY-PASS	NO
NOMINAL SIZE	2" - 24"
MATERIALS	
BODY	A 351 Gr. CF8M
BODY SEAT RING	INTEGRAL
DISC	AISI 316
HINGE PIN	A 276 Gr. 316

DESIGN CONDITIONS		
PRESSURE RATING	ANSI B16.34	
FLUID	Kg/cm2g	°C
PROCESS CONDENSATE	35	200
PROCESS GAS	35	200
POTASSIUM CARBONATE SOL.	34	150

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED

MANDATORY STANDARDS:

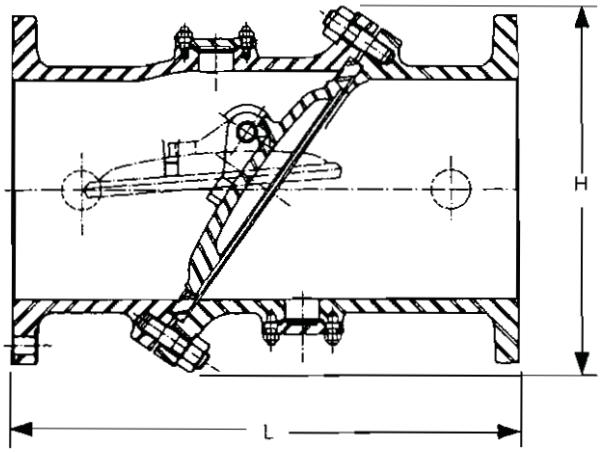
API 598, ANSI B16.10, ANSI B16.34, ANSI B16.5, MSS-SP 45

NOTES:

NOM. DIA. INCH	2	3	4	6	8	10	12	14	16	18	20	24	28	30	32	36
LENGTH L mm	267	318	356	445	533	622	711	838	864	978	1016	1346				
H mm																
APPROX WT Kg																

PDIL

CHECK VALVE



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	CHV 520
PRESSURE RATING CLASS	150
FACE	RF
CONSTRUCTION	
BODY	CAST
BODY CONNECTION	BOLTED
SEAT RING	RENEWABLE
TYPE OF DISC	TILTING DISC
ACCESSORIES	NO
BY-PASS	NO
NOMINAL SIZE	26" - 36"
MATERIALS	
BODY	A 351 Gr. CF8
BODY SEAT RING	A 182 Gr. F304
DISC	A 351 Gr. CF8
HINGE PIN	A 276 Gr. 304
DESIGN CONDITIONS	
PRESSURE RATING	ANSI B16.34

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED

MANDATORY STANDARDS:

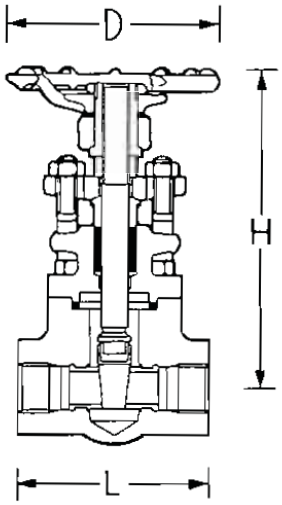
API 598, ANSI B16.10, ANSI B16.34, ASME B16.47 SERIES B

NOTES:

a) DIMENSIONS ACC. TO MANUFACTURERS STANDARD WITH REFERENCE TO ANSI B16.10

PDIL

GATE VALVE



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	GAV 501
PRESSURE RATING CLASS	800
FACE	SW
CONSTRUCTION	
BODY	FORGED
BONNET TO BODY CONNECTION	BOLTED
HANDWHEEL	NON-RISING
STEM	RISING
STEM AND YOKE TYPE	OS & Y
GATE TYPE	WSS
GEAR OPERATED	NO
BY-PASS VALVE	NO
NOMINAL SIZE	1/2" - 1 1/2"
MATERIALS	
BODY	A 182 Gr. F304
BODY SEAT RING	A 182 Gr. F304
GATE	A 182 Gr. F304
STEM	A 276 Gr. 304
STEM PACKING	GRAFOIL/GRAPHITE
TRIM NUMBER	2
DESIGN CONDITIONS	
PRESSURE RATING	API 602

GATE SYMBOLS	TYPE OF SEAT	TYPE OF GATE	TYPE OF BLOCKADE
WSS	WEDGE	SINGLE	SOLID WEB
WSF			FLEX. SOLID WEB
WDF		DOUBLE	SLIP ON OR SPLIT
PDF	PARALLEL		FLEXIBLE

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED
2. GLAND SHALL BE SUITABLE FOR REPACKING UNDER PRESSURE WHEN VALVE IS FULLY OPEN
3. IF NOT OTHERWISE STATED THE VALVES SHALL BE FULL BORE

MANDATORY STANDARDS:

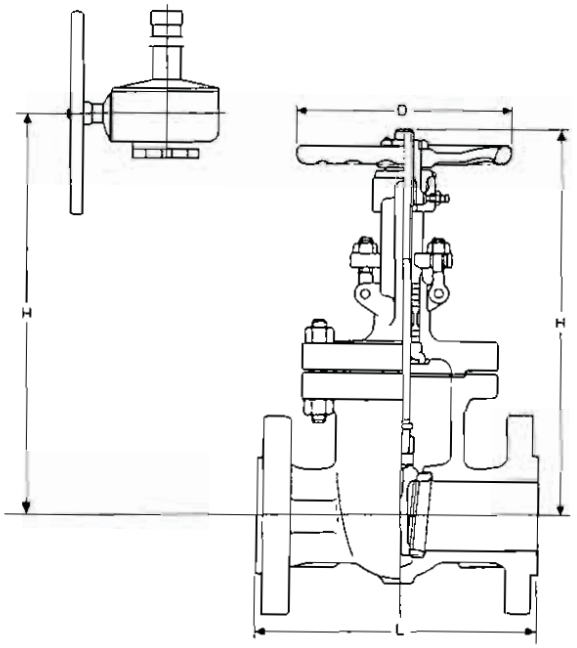
API 598, API 602, ANSI B16.11, ANSI B16.34

NOTES:

a) LENGTH TO BE VERIFIED BY MANUFACTURER

PDIL

GATE VALVE



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	GAV 510
PRESSURE RATING CLASS	150
FACE	RF
CONSTRUCTION	
BODY	CAST
BONNET TO BODY CONNECTION	BOLTED
HANDWHEEL	NON-RISING
STEM	RISING
STEM AND YOKE TYPE	OS & Y
GATE TYPE	WSF OR WDF
GEAR OPERATED	YES > = 14"
BY-PASS VALVE	NO
NOMINAL SIZE	2" - 24"
MATERIALS	
BODY	A 351 Gr. CF8
BODY SEAT RING	A 182 Gr. F304
GATE	AISI 304
STEM	A 276 Gr. 304
STEM PACKING	GRAFOIL /GRAPHITE
TRIM NUMBER	2
DESIGN CONDITIONS	
PRESSURE RATING	ANSI B16.34

GATE YMBOLS	TYPE OF SEAT	TYPE OF GATE	TYPE OF BLOCKADE
WSS	WEDGE	SINGLE	SOLID WEB
WSF			FLEX. SOLID WEB
WDF		DOUBLE	SLIP ON OR SPLIT
PDF	PARALLEL		FLEXIBLE

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED
2. GLAND SHALL BE SUITABLE FOR REPACKING UNDER PRESSURE WHEN VALVE IS FULLY OPEN
3. IF NOT OTHERWISE STATED THE VALVES SHALL BE FULL BORE
4. VALVES > = 10" AND > = 600" RATING SHALL HAVE BOSSES FOR BY-PASS CONNECTION ACC. TO API 600 AND MSS-SP 45, LOCATION E-F

MANDATORY STANDARDS:

API 598, API 600, ANSI B16.10, ANSI B16.34, ANSI B16.5, MSS-SP 45

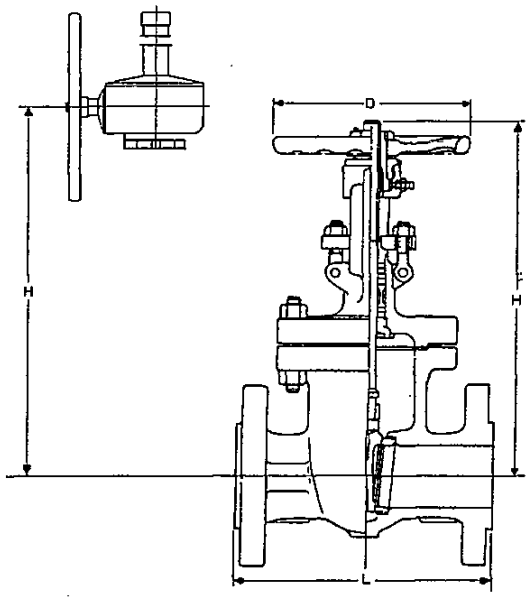
NOTES:

HALDOR TOPSØE A/S

GENERAL PIPING SPECIFICATION
VALVE DATA SHEET

NO. 4154021 | PAGE 03.04.-- | REV. 0

GATE VALVE



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	GAV 511
PRESSURE RATING CLASS	300
FACE	RF
CONSTRUCTION	
BODY	CAST
BONNET TO BODY CONNECTION	BOLTED
HANDWHEEL	NON-RISING
STEM	RISING
STEM AND YOKE TYPE	OS & Y
GATE TYPE	WSF OR WDF
GEAR OPERATED	YES > = 10"
BY-PASS VALVE	NO
NOMINAL SIZE	1 1/2" - 24"
MATERIALS	
BODY	A 351 Gr. CFBM
BODY SEAT RING	A 182 Gr. F316
GATE	AISI 316
STEM	A 276 Gr. 316
STEM PACKING	IMPREGNATED BRAIDED ASBESTOS
TRIM NUMBER	2

GATE SYMBOLS	TYPE OF SEAT	TYPE OF GATE	TYPE OF BLOCKADE
WSS	WEDGE	SINGLE	SOLID WEB
WSF			FLEX. SOLID WEB
WDF		DOUBLE	SLIP ON OR SPLIT
PDF	PARALLEL		FLEXIBLE

DESIGN CONDITIONS		
PRESSURE RATING	ANSI B16.34	
FLUID	Kg/cm2g	°C
PROCESS CONDENSATE	35	200
PROCESS GAS	35	200

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED
2. GLAND SHALL BE SUITABLE FOR REPACKING UNDER PRESSURE WHEN VALVE IS FULLY OPEN
3. IF NOT OTHERWISE STATED THE VALVES SHALL BE FULL BORE
4. VALVES > = 10" AND > = 600" RATING SHALL HAVE BOSSES FOR BY-PASS CONNECTION ACC. TO API 600 AND MSS-SP 45, LOCATION E-F

MANDATORY STANDARDS:

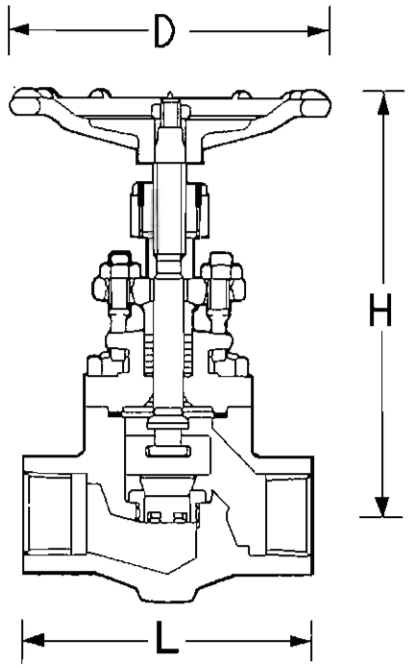
API 598, API 600, ANSI B16.10, ANSI B16.34, ANSI B16.5, MSS-SP 45

NOTES:

NOM. DIA. INCH	1 1/2	2	3	4	6	8	10	12	14	16	18	20	24	28	32	36
LENGTH L mm		216	283	305	403	419	457	502	762	838	914	991	1143			
H OPEN mm																
H CLOSED mm																
HANDWHEEL øD mm																
APPROX WT Kg																

PDIL

GLOBE VALVE



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	GLV 501
PRESSURE RATING CLASS	800
FACE	SW
CONSTRUCTION	
BODY	FORGED
BONNET TO BODY CONNECTION	BOLTED
HANDWHEEL	RISING
STEM	RISING
STEM AND YOKE TYPE	OS & Y
DISC TYPE	SWIVEL PLUG
GEAR OPERATED	NO
BY-PASS VALVE	NO
NOMINAL SIZE	1/2" - 1 1/2"
MATERIALS	
BODY	A 182 Gr. F304
BODY SEAT RING	A 182 Gr. F304
DISC	A 182 Gr. F304
STEM	A 276 Gr. 304
STEM PACKING	GRAFOIL
TRIM NUMBER	
DESIGN CONDITIONS	
PRESSURE RATING	API 602

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED
2. GLAND SHALL BE SUITABLE FOR REPACKING UNDER PRESSURE WHEN VALVE IS FULLY OPEN
3. IF NOT OTHERWISE STATED THE VALVES SHALL BE FULL BORE

MANDATORY STANDARDS:

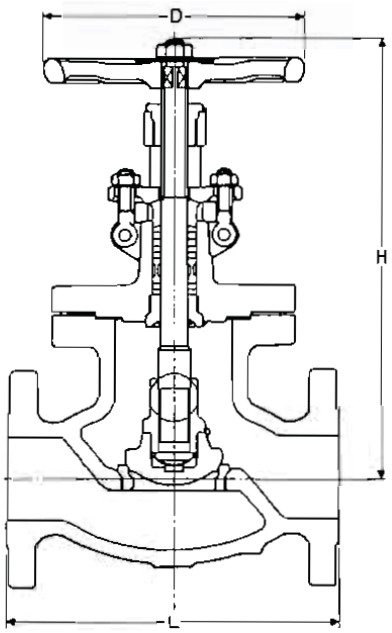
API 598, API 602, ANSI B16.11, ANSI B16.34

NOTES:

a) VALVE DESIGN SHALL GENERALLY COMPLY WITH API 602
b) LENGTH TO BE VERIFIED BY MANUFACTURER

PDIL

GLOBE VALVE



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	GLV 510
PRESSURE RATING CLASS	150
FACE	RF
CONSTRUCTION	
BODY	CAST
BONNET TO BODY CONNECTION	BOLTED
HANDWHEEL	RISING
STEM	RISING
STEM AND YOKE TYPE	OS & Y
DISC TYPE	PARABOLIC
GEAR OPERATED	NO
BY-PASS VALVE	NO
NOMINAL SIZE	2" - 8"
MATERIALS	
BODY	A 351 Gr. CF8
BODY SEAT RING	A 182 Gr. F304
DISC	AISI 304
STEM	A 276 Gr. 304
STEM PACKING	GRAFOIL
TRIM NUMBER	
DESIGN CONDITIONS	
PRESSURE RATING	ANSI B16.34

RATED Cv VALUES: (+-10%)

SIZE	2"	3"	4"	6"	8"	10"	12"		
Cv	50	120	220	490	900	1400	2100		

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED
2. GLAND SHALL BE SUITABLE FOR REPACKING UNDER PRESSURE WHEN VALVE IS FULLY OPEN
3. IF NOT OTHERWISE STATED THE VALVES SHALL BE FULL BORE
4. VALVES > = 10" AND > = 600" RATING SHALL HAVE BOSSES FOR BY-PASS CONNECTION ACC. TO ANSI B16.34 AND MSS-SP 45, LOCATION E-F

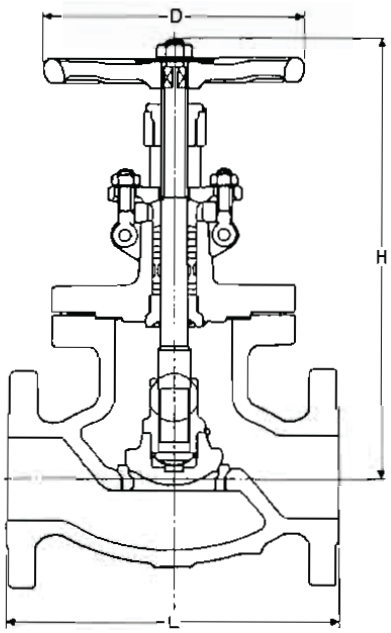
MANDATORY STANDARDS:

API 598, API 600, ANSI B16.10, ANSI B16.34, ANSI B16.5, MSS-SP 45

NOTES:

PDIL

GLOBE VALVE



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	GLV 511
PRESSURE RATING CLASS	300
FACE	RF
CONSTRUCTION	
BODY	CAST
BONNET TO BODY CONNECTION	BOLTED
HANDWHEEL	RISING
STEM	RISING
STEM AND YOKE TYPE	OS & Y
DISC TYPE	PARABOLIC
GEAR OPERATED	NO
BY-PASS VALVE	NO
NOMINAL SIZE	2" - 8"
MATERIALS	
BODY	A351 CF8M
BODY SEAT RING	A 182 Gr. F304
DISC	AISI 304
STEM	A 276 Gr. 304
STEM PACKING	GRAFOIL
TRIM NUMBER	
DESIGN CONDITIONS	
PRESSURE RATING	ANSI B16.34

RATED Cv VALUES: (+-10%)

SIZE	2"	3"	4"	6"	8"	10"	12"		
Cv	50	120	220	490	900	1400	2100		

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED
2. GLAND SHALL BE SUITABLE FOR REPACKING UNDER PRESSURE WHEN VALVE IS FULLY OPEN
3. IF NOT OTHERWISE STATED THE VALVES SHALL BE FULL BORE
4. VALVES > = 10" AND > = 600" RATING SHALL HAVE BOSSES FOR BY-PASS CONNECTION ACC. TO ANSI B16.34 AND MSS-SP 45, LOCATION E-F

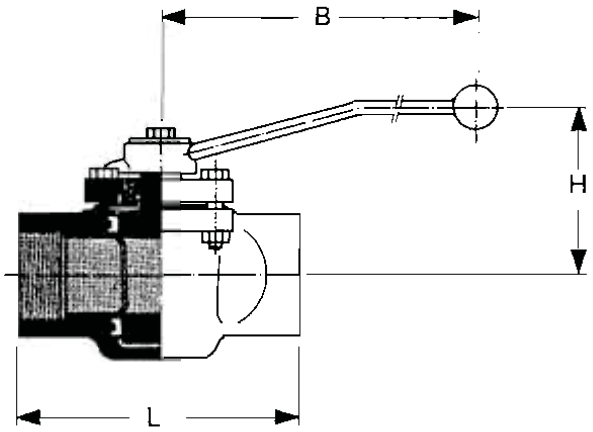
MANDATORY STANDARDS:

API 598, API 600, ANSI B16.10, ANSI B16.34, ANSI B16.5, MSS-SP 45

NOTES:

PDIL

PLUG VALVE



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	**PLV 501**
PRESSURE RATING CLASS	600
FACE	TREADED (NPT)
CONSTRUCTION	
BODY	FULL BORE NON-LUBRICATED
PLUG	TAPER PLUG
WRENCH OPERATED	YES
GEAR OPERATED	NO
FIRE SAFE	NO
NOMINAL SIZE	1/2" - 1"
MATERIALS	
BODY	AISI 316
PLUG	AISI 316
BODY SEAT RING	REINFORCED PTFE
STEM PACKING	PTFE
DESIGN CONDITIONS	
PRESSURE RATING	ANSI B16.34

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED

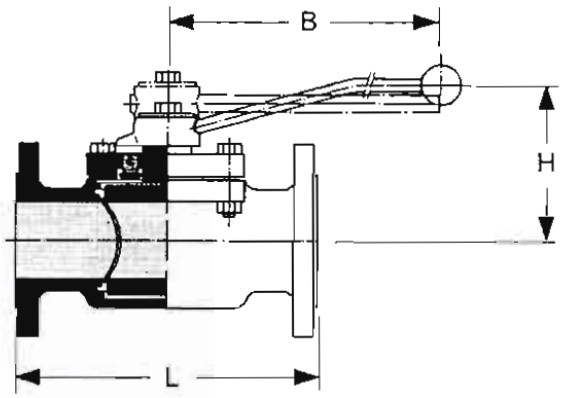
MANDATORY STANDARDS:

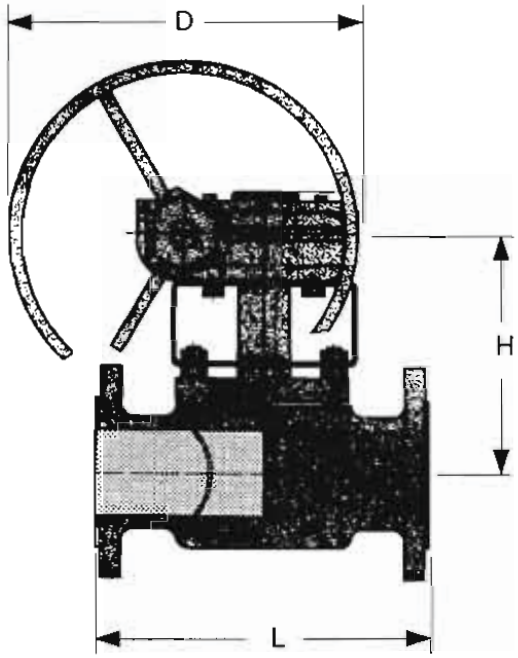
API 598, API 6D, ANSI B16.11, ANSI B16.34

NOTES:

PDIL

PLUG VALVE





DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	PLV 510
PRESSURE RATING CLASS	150
FACE	RF
CONSTRUCTION	
BODY	NON-LUBRICATED FULL BORE
PLUG	TAPER PLUG
WRENCH OPERATED	1 1/2" - 4"
GEAR OPERATED	6"
FIRE SAFE	NO
NOMINAL SIZE	1 1/2" - 6"
MATERIALS	
BODY	A 351 Gr. CF8M
PLUG	A 182 Gr. F316 a)
BODY SEAT RING	REINFORCED PTFE
STEM PACKING	PTFE
DESIGN CONDITIONS	
PRESSURE RATING	ANSI B16.34

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED

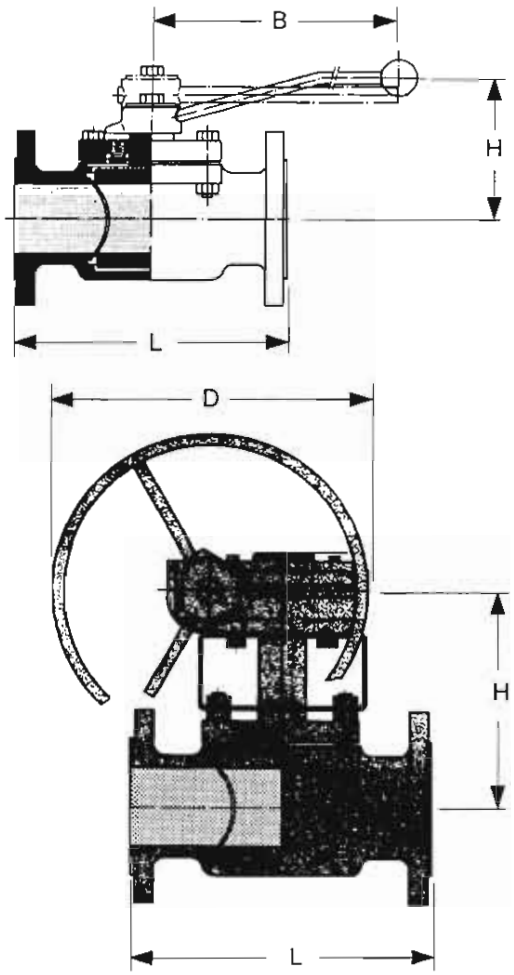
MANDATORY STANDARDS:

API 598, API 599, ANSI B16.10, ANSI B16.5

NOTES:

a) EQUIVALENT CAST MATERIAL IS ACCEPTABLE

PLUG VALVE



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	PLV 511	
PRESSURE RATING CLASS	300	
FACE	RF	
CONSTRUCTION		
BODY	NON-LUBRICATED FULL BORE	
PLUG	TAPER PLUG	
WRENCH OPERATED	1 1/2" - 4"	
GEAR OPERATED	6"	
FIRE SAFE	NO	
NOMINAL SIZE	1 1/2" - 6"	
MATERIALS		
BODY	A 351 Gr. CF8M	
PLUG	A 182 Gr. F316 a)	
BODY SEAT RING	REINFORCED PTFE	
STEM PACKING	PTFE	
DESIGN CONDITIONS		
PRESSURE RATING	ANSI B16.34	
FLUID	Kg/cm2g	°C
POTASSIUM CARBONATE SOL.	34	150

GENERAL

1. COPPER AND COPPER ALLOYS NOT PERMITTED

MANDATORY STANDARDS:

API 598, API 599, ANSI B16.10, ANSI B16.5

NOTES:

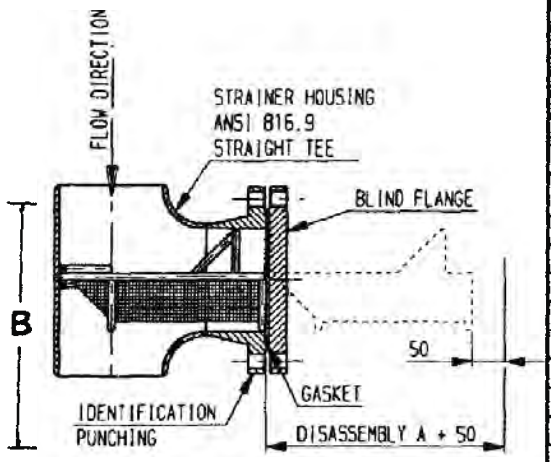
a) EQUIVALENT CAST MATERIAL IS ACCEPTABLE

NOM. DIA.	INCH	1/2	2	3	4	6											
LENGTH L	mm																
H	mm																
B	mm																
HANDWHEEL øD	mm																
APPROX WT	Kg																

STRAINER DATA SHEETS

PDIL

T-TYPE STRAINER



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	TTS 510	
PRESSURE RATING CLASS	150	
FACE	RF	
CONSTRUCTION		
BODY	CAST	
BODY TO BONNET CONNECTION	BOLTED	
STRAINER	PERFORATED PLATE	
STRAINER HOLES, SIZE	Ø 1,5 MM	
NOS STRAINER HOLES / SQ.CM	18	
BLOW OFF CONNECTION	NOTE 1	
NOMINAL SIZE	2" - 24"	
MATERIALS		
BODY	A 351 Gr. CF8	
STRAINER	AISI 304	
DESIGN CONDITIONS		
PRESSURE RATING	ASME B16.34	
FLUID	Kg/cm2g	°C

GENERAL

1. STRAINER MUST BE REMOVABLE
2. COPPER AND COPPER ALLOYS NOT PERMITTED

MANDATORY STANDARDS:

ASME B16.34, ASME B16.5, MSS-SP 45

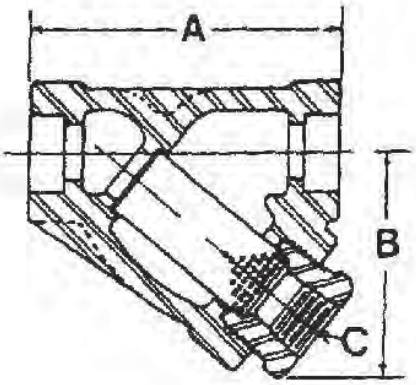
NOTES:

1.

STRAINER SIZE	-	BLOW OFF CONNECTION
2" - 4"		3/4" NPT PLUG
6" - 8"		1" NPT PLUG
10"		1 1/4" NPT PLUG
12" - 24"		1 1/2" NPT PLUG

PDIL

Y-TYPE STRAINER



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	YTS 501	
PRESSURE RATING CLASS	600	
FACE	SW	
CONSTRUCTION		
BODY	FORGED	
BODY TO BONNET CONNECTION	SCREWED	
STRAINER	PERFORATED PLATE	
STRAINER HOLES, SIZE	Ø 0,8 MM	
NOS STRAINER HOLES / SQ.CM	40	
BLOW OFF CONNECTION	NOTE 1	
NOMINAL SIZE	1/2" - 1 1/2"	
MATERIALS		
BODY	A 182 Gr. F304	
STRAINER	AISI 304	
DESIGN CONDITIONS		
PRESSURE RATING	ASME B16.34	
FLUID	Kg/cm2g	°C

GENERAL

1. STRAINER MUST BE REMOVABLE
2. COPPER AND COPPER ALLOYS NOT PERMITTED

MANDATORY STANDARDS:

ASME B16.11, ASME B16.34

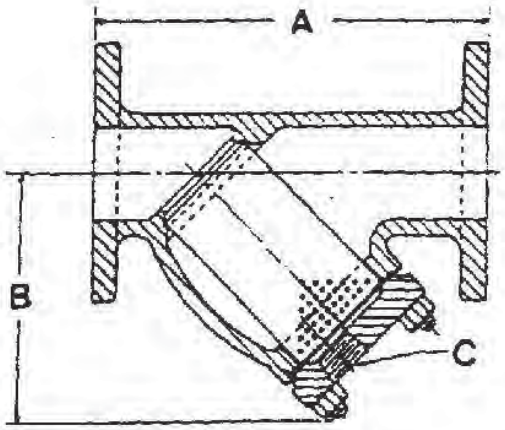
NOTES:

1.

STRAINER SIZE	BLOW OFF CONNECTION
1/2" - 3/4"	1/4" NPT PLUG
1" - 1 1/2"	3/4" NPT PLUG

PDIL

Y-TYPE STRAINER



DESIGN (ILLUSTRATIVE ONLY)

ITEM NO	YTS 510	
PRESSURE RATING CLASS	150	
FACE	RF	
CONSTRUCTION		
BODY	CAST	
BODY TO BONNET CONNECTION	BOLTED	
STRAINER	PERFORATED PLATE	
STRAINER HOLES, SIZE	Ø 1.5 MM	
NOS STRAINER HOLES / SQ.CM	18	
BLOW OFF CONNECTION	NOTE 1	
NOMINAL SIZE	2" - 24"	
MATERIALS		
BODY	A 351 Gr. CF8	
STRAINER	AISI 304	
DESIGN CONDITIONS		
PRESSURE RATING	ASME B16.34	
FLUID	Kg/cm2g	°C

GENERAL

1. STRAINER MUST BE REMOVABLE
2. COPPER AND COPPER ALLOYS NOT PERMITTED

MANDATORY STANDARDS:

ASME B16.34, ASME B16.5, MSS-SP 45

NOTES:

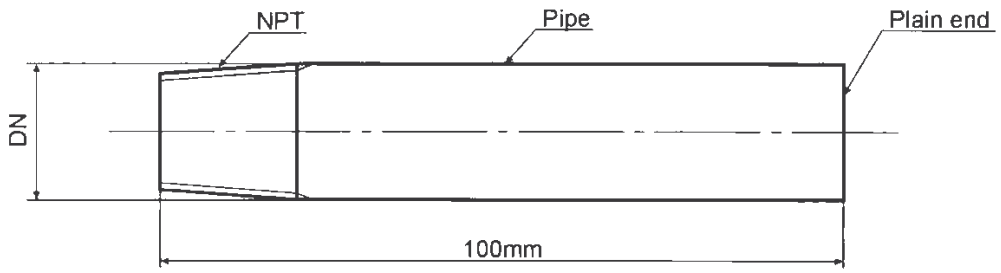
1.

STRAINER SIZE	BLOW OFF CONNECTION
2" - 4"	3/4" NPT PLUG
6" - 8"	1" NPT PLUG
10"	1 1/4" NPT PLUG
12" - 24"	1 1/2" NPT PLUG

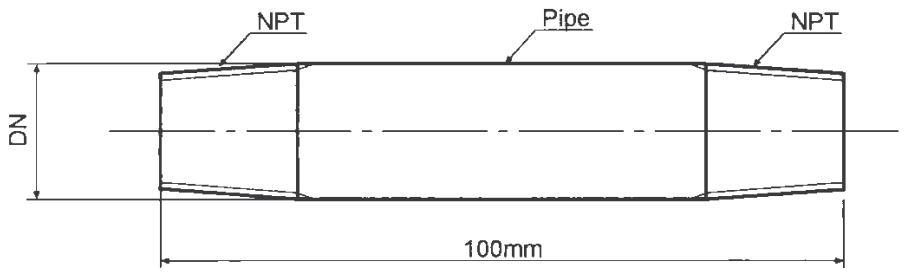
OTHER STANDARDS/DATASHEETS

NIPPLES

1) Half nipple (1/2-nipple)



2) Nipple

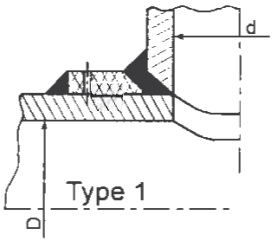


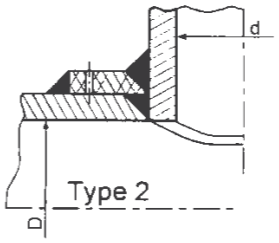
DN = 1/2", 3/4", 1" or 11/2"
Schedule and material of pipe acc. to
piping class specification

Threading acc. to ANSI B 1.20.1-1983

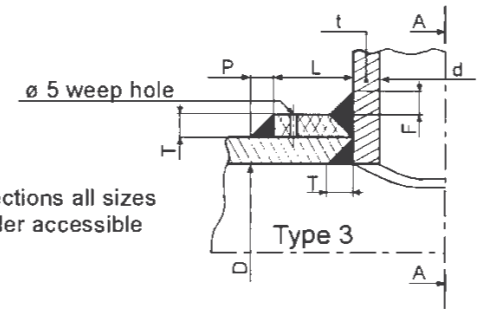
REINFORCING RINGS

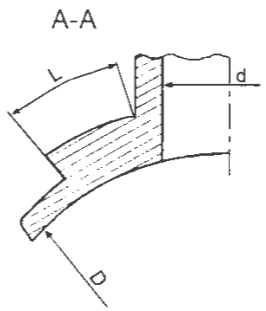
Branch connections-sizes under 24"
inside of header inaccessible





Branch connections all sizes
inside of header accessible





1. Reinforcing of branch connections shall be in accordance with limitations given in the General Piping Specification.
"Reinforcing rings" shall conform to the requirements of this specification.

2. All welds are to be continuous. Fillet welds to have concave contour.

3. Backchipping or gouging to sound metal before welding reverse side is required.

4. The periphery of the cut hole should be examined for laminations when using type 1.

5. Weld details for inclined nozzles are to be similar to the details shown for 90 degree nozzles.

6: The type must be determined by the frabricator.

Legend

T - Thickness of reinforcing ring, to be of the same thickness as header and of equal or better material. Preferably cut from header.

P - Fillet weld leg dimension, equal to T.

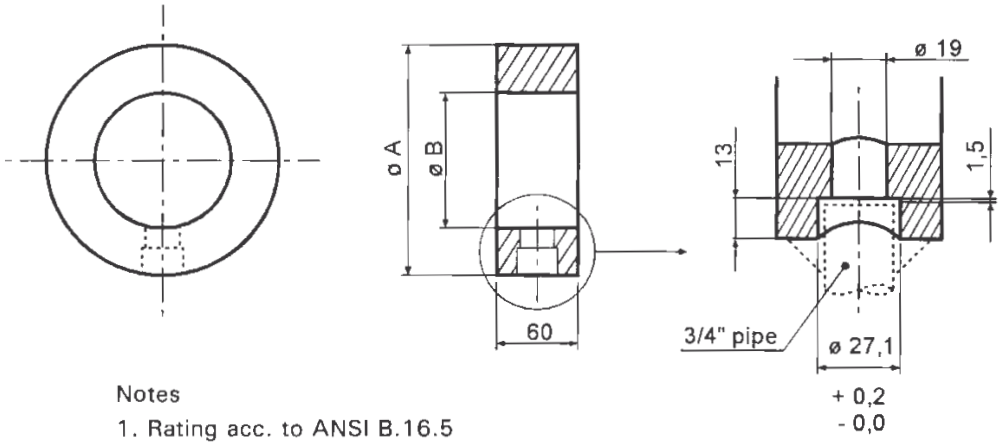
F - Fillet weld leg dimension equal to t.

L - Width of reinforcing ring, see table. For branch sizes > 36" L = d/2

Reinforcing ring table

Nom. Branch size "d" inch.	2"	3"	4"	6"	8"	10"	12"	14"	16"	18"	20"	24"	26"	28"	30"	32"	34"	36"
Ring width "L" mm	30	45	55	80	105	130	150	170	190	215	240	290	310	330	360	380	405	430

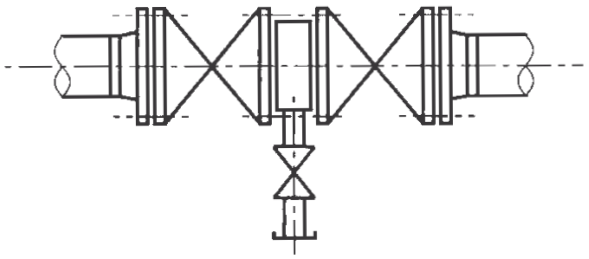
DRIP RING



Notes

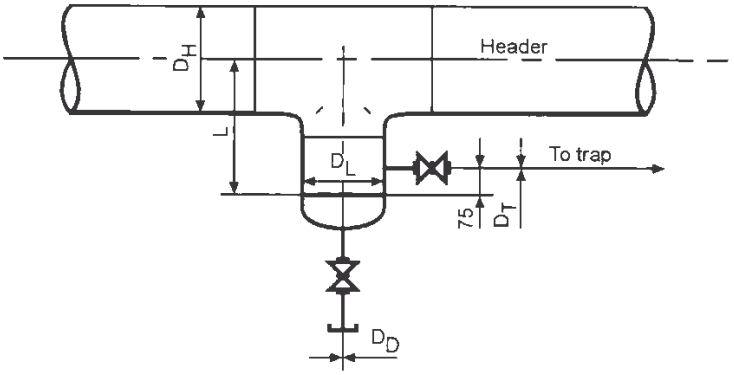
1. Rating acc. to ANSI B.16.5
2. Material in accordance with piping class
3. Faces to be machined parallel and finish to be in accordance with ANSI B.16.5
4. Nom. dia., rating and material to be engraved on edge in letters min. 5mm high e.g. 3"-CL. 600-A 182 Gr. F1

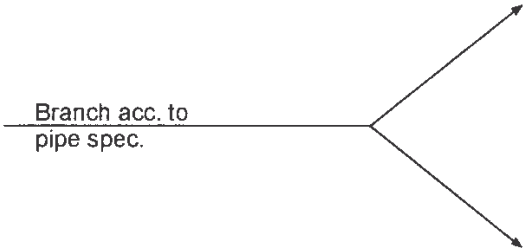
DN Inch.	Class 150 RF		Class 300 RF		Class 600 RF	
	A mm	B mm	A mm	B mm	A mm	B mm
2"	100	52	107	52	107	52
3"	132	78	145	78	145	78
4"	170	102	177	102	190	102
6"	220	154	247	154	263	154
8"	276	206	304	205	317	198
10"	336	260	358	254	396	247
12"	406	311	418	303	453	295
14"	447	343	480	334	487	317
16"	510	394	535	381	560	363
18"	545	445	592	429	608	409
20"	602	495	650	478	678	455
24"	713	590	770	575	786	547

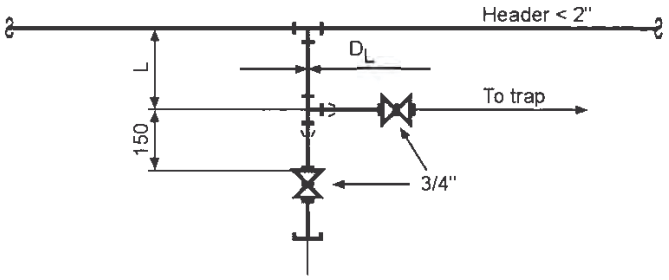


Only where no alternative installation is possible, driprings shall be used.

DRIP LEG ON STEAM HEADERS



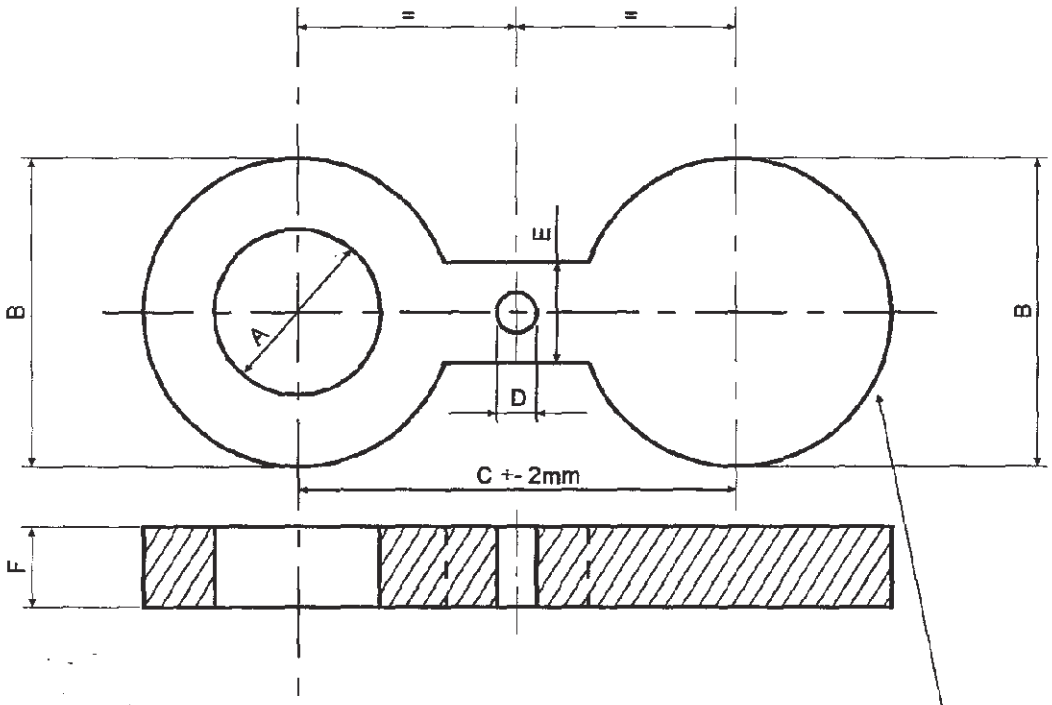




*) D_L = Header size

D_H	= < 2"	3"	4"	6"	8"	10"	12"	14"	16"	18"	20"	24"
D_L	*)	3"	4"	6"	6"	8"	8"	10"	12"	12"	12"	12"
L	250	300	300	350	350	400	400	450	500	525	550	600
D_D	3/4"	3/4"	3/4"	1"	1"	1"	1 1/2"	1 1/2"	1 1/2"	1 1/2"	1 1/2"	1 1/2"
D_T	3/4"	3/4"	3/4"	3/4"	3/4"	3/4"	1"	1"	1"	1"	1"	1"

SPECTACLE PLATE CLASS 150 RF

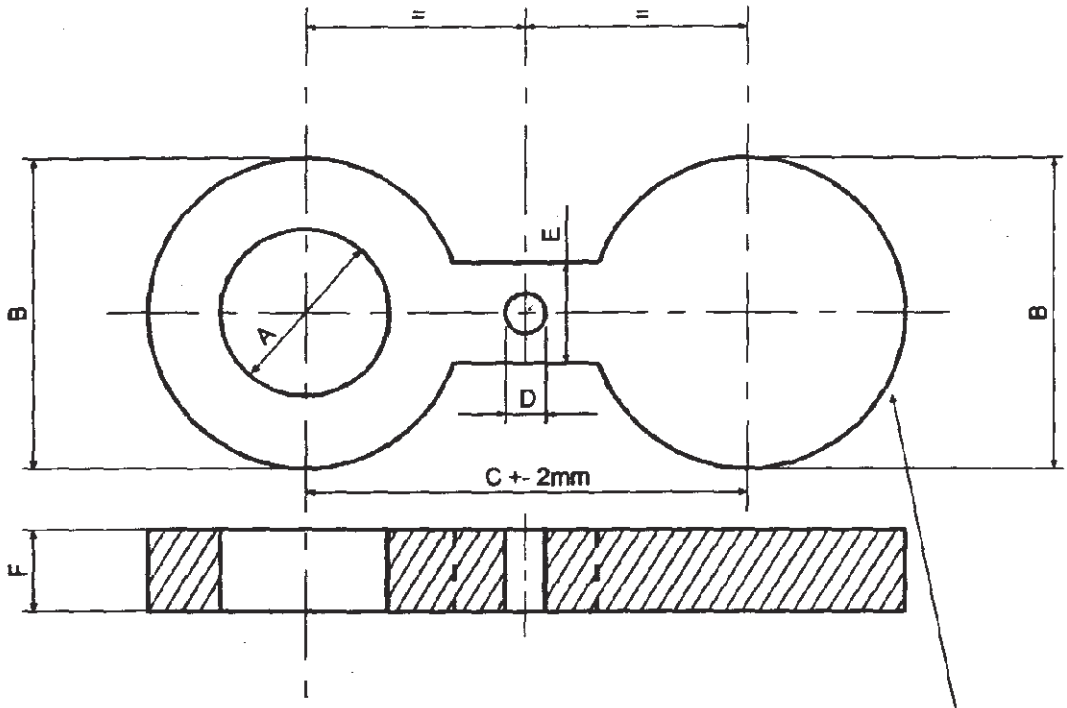


Spectacle plate suitable for flanges acc. to ANSI B16.5. Material as for flanges acc. to piping class.

Nom. dia., rating and material to be engraved on edge in letters min. 5 mm high for example thus: 3"-class 150 -A105

Nominal diameter inches	Min. reqd. overlength bolt	A	B	C	D	E	F
1"	8	33	64	79	16	38	6
1 1/2"	8	48	83	99	16	38	6
2"	8	60	102	121	20	51	6
3"	8	89	133	152	20	64	6
4"	8	114	171	191	20	64	6
6"	12	168	218	241	22	76	10
8"	15	219	277	299	22	76	13
10"	18	273	337	362	26	102	16
12"	24	324	407	432	26	102	22
14"	27	356	447	476	30	108	25
16"	27	406	511	540	30	108	25
18"	27	457	546	578	33	114	25
20"	31	508	603	635	33	121	29
24"	37	610	714	749	36	140	35

SPECTACLE PLATE CLASS 300 RF

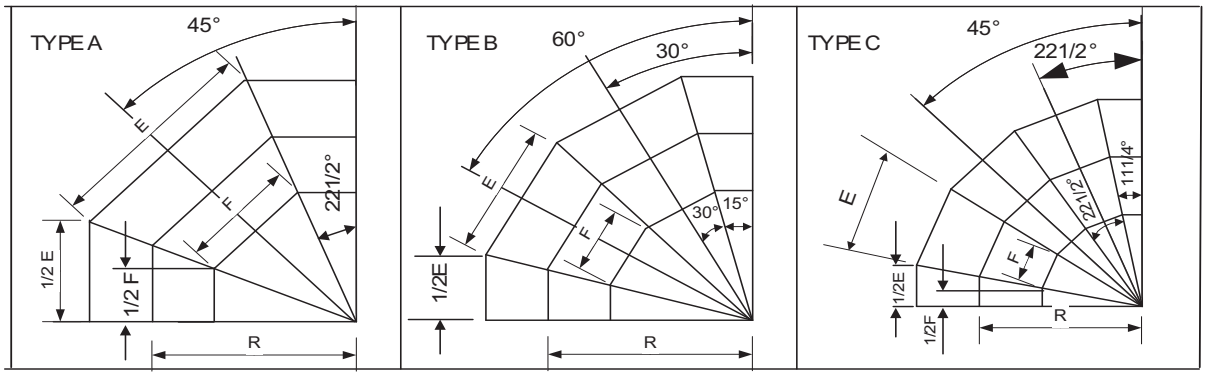


Spectacle plate suitable for flanges acc. to ANSI B16.5. Material as for flanges acc. to piping class.

Nom. dia., rating and material to be engraved on edge in letters min. 5 mm high for example thus: 3"-class 300 -A105

Nominal diameter inches	Min. reqd. overlength bolt	A	B	C	D	E	F
1"	8	33	70	89	20	3B	6
1 1/2"	8	48	92	114	22	51	6
2"	8	60	108	127	20	51	6
3"	12	89	146	168	22	64	10
4"	15	114	178	200	22	64	13
6"	18	168	248	270	22	76	16
8"	21	219	305	330	26	89	19
10"	27	273	358	387	30	102	25
12"	31	324	419	451	33	102	29
14"	34	356	482	514	33	121	32
16"	39	405	537	572	36	124	37
18"	43	457	594	629	36	114	41
20"	46	508	651	686	36	121	44
24"	56	610	772	813	42	140	54

MITRE BENDS

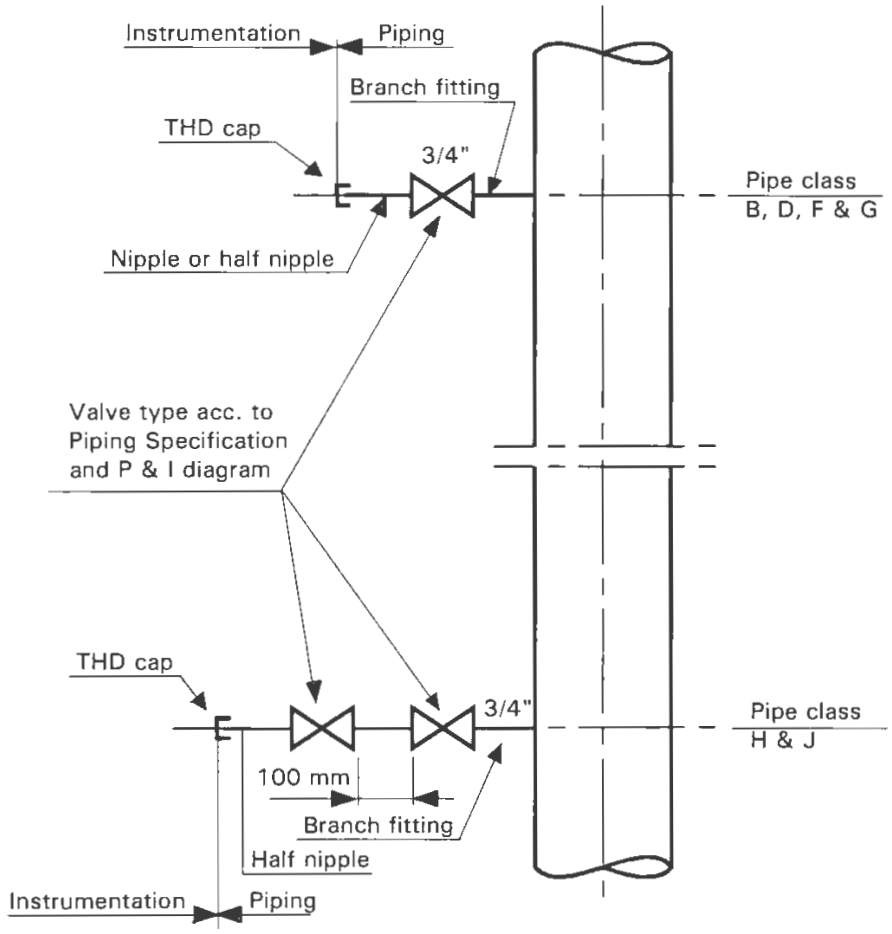


NOM SIZE INCH	OUTSIDE DIAM D mm	R =1.5D mm	30° 60°	45°	90°	$22^1/_2°$	DIMENSION					
							TYPE A		TYPE B		TYPE C	
							E mm	F mm	E mm	F mm	E mm	F mm
2	60.3	76	B	A	A	C	88	38	57	24	42	18
3	88.9	114	B	A	A	C	131	58	85	37	63	28
4	114.3	152	B	A	A	C	173	79	112	51	83	38
6	168.3	229	B	A	A	C	259	120	168	78	125	58
8	219.1	305	B	A	B	C	343	162	222	105	165	78
10	273.1	381	B	A	B	C	429	203	277	131	206	97
12	323.9	457	B	A	B	C	513	244	332	158	246	117
14	355.6	533	B	C	B	C			381	190	283	141
16	406.4	610	B	C	B	C			436	218	323	162
18	457	686	B	C	B	C			490	245	364	182
20	508	762	B	C	B	C			544	272	404	202
22	559	838	B	C	B	C			599	300	445	222
24	610	914	B	C	B	C			654	327	485	243
26	660	991	B	C	C	C			707	354	525	263
28	711	1,067	B	C	C	C			762	381	566	283
30	762	1,143	B	C	C	C			817	408	606	303
32	813	1,219	B	C	C	C			871	436	647	323
34	864	1,295	B	C	C	C			926	463	687	344
36	914	1,372	B	C	C	C			980	490	727	364
38	965	1,448	B	C	C	C			1,034	517	768	384
40	1,016	1,524	B	C	C	C			1,089	544	808	404
42	1,067	1,600	B	C	C	C			1,144	572	849	424
44	1,118	1,677	B	C	C	C			1,198	599	890	445
46	1,168	1,752	B	C	C	C			1,252	626	929	465
48	1,219	1,829	B	C	C	C			1,307	653	970	485
52	1,321	1,982	B	C	C	C			1,416	708	1,051	526
56	1,422	2,134	B	C	C	C			1,524	762	1,131	566
60	1,524	2,286	B	C	C	C			1,633	817	1,213	606
64	1,626	2,439	B	C	C	C			1,743	871	1,294	647
68	1,727	2,591	B	C	C	C			1,851	925	1,374	687
72	1,829	2,743	B	C	C	C			1,960	980	1,455	728
76	1,931	2,897	B	C	C	C			-	-	1536	768

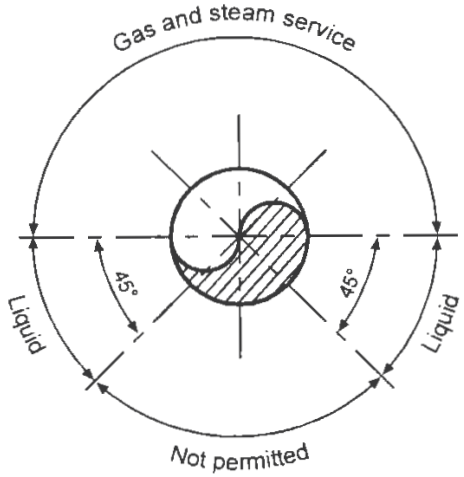
P1	27.12.2017		FOR REVIEW/COMMENT	NAZ	NS	GL/HOD
P	21.10.2017		FOR REVIEW/COMMENT	NAZ	NS	DM
REV	REV DATE	EFFDATE	PURPOSE	PREPD	REVWD	APPD

BRANCH FOR ANALYSIS - AND PRESSURE CONNECTIONS ON PIPING

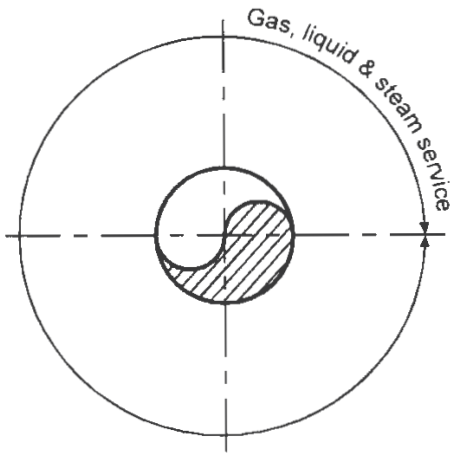
(FOR ANALYSIS CONNECTIONS WITH PROBE SEE SPECIAL DRAWINGS)



Location of branch in horizontal line

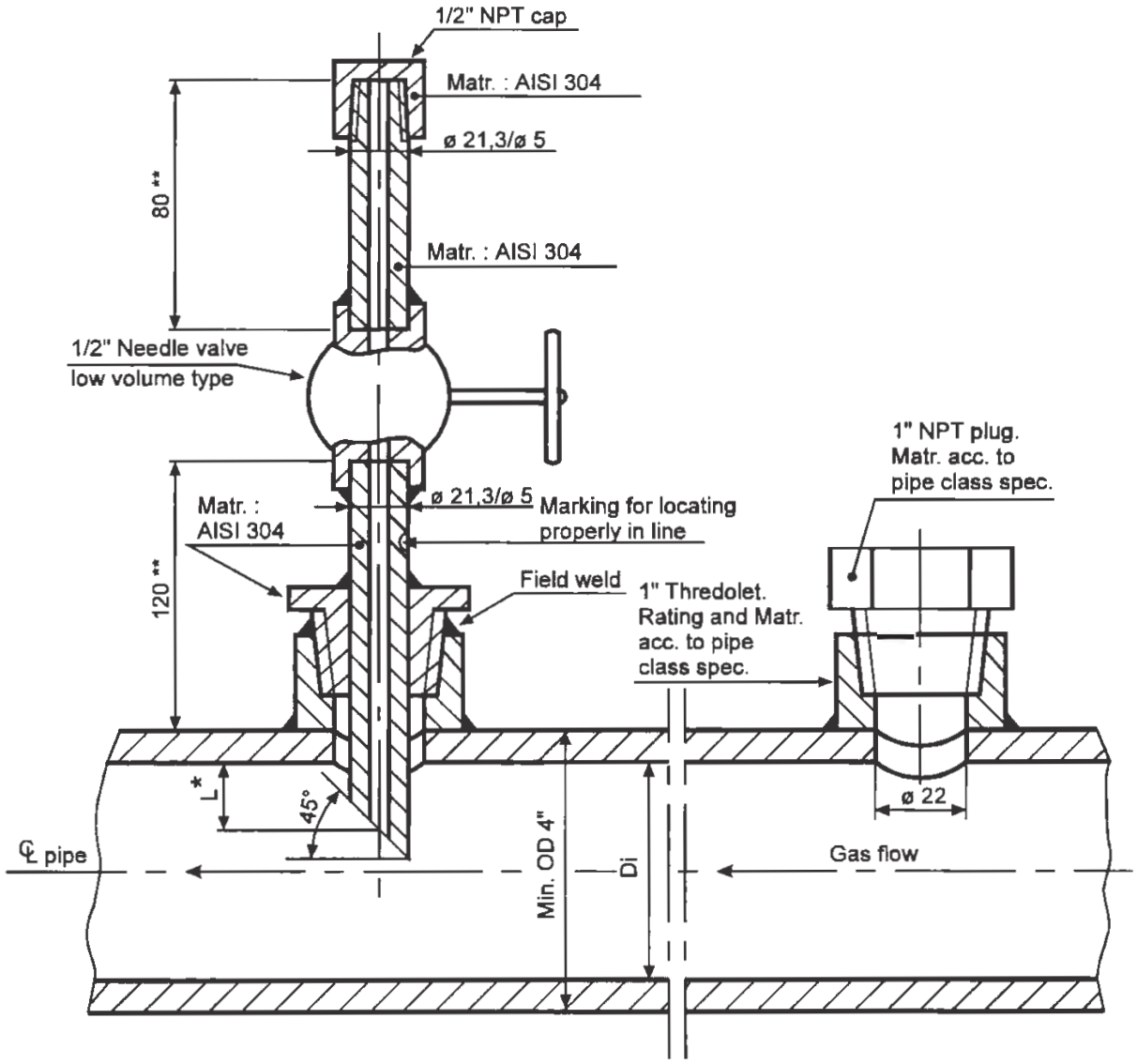


Location of branch in vertical line



All branch fittings and valves to be specified acc. to pipe class.

ANALYSIS CONNECTION WITH PROBE ON PIPE
FOR RATINGS < = CLASS 900

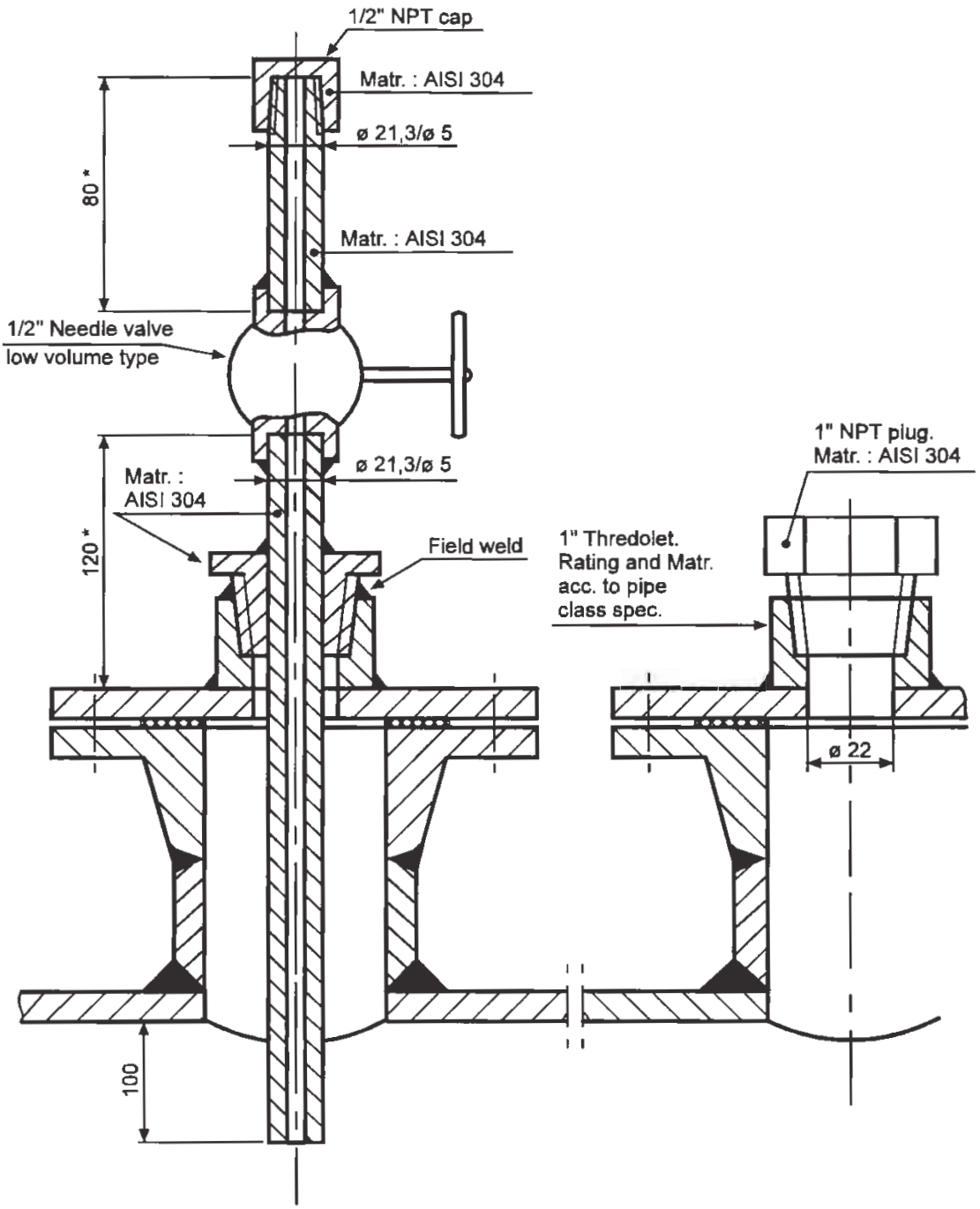


Final execution
Instrumentation supply

During pressure test and cleaning
Piping supply

* For Di > 6", L = 1/3 Di +- 1/6 Di
For Di < = 6", L = 1/2 Di +- 1/6 Di
** Shortest possible

ANALYSIS CONNECTION WITH PROBE ON EQUIPMENT
FOR RATINGS < = CLASS 900

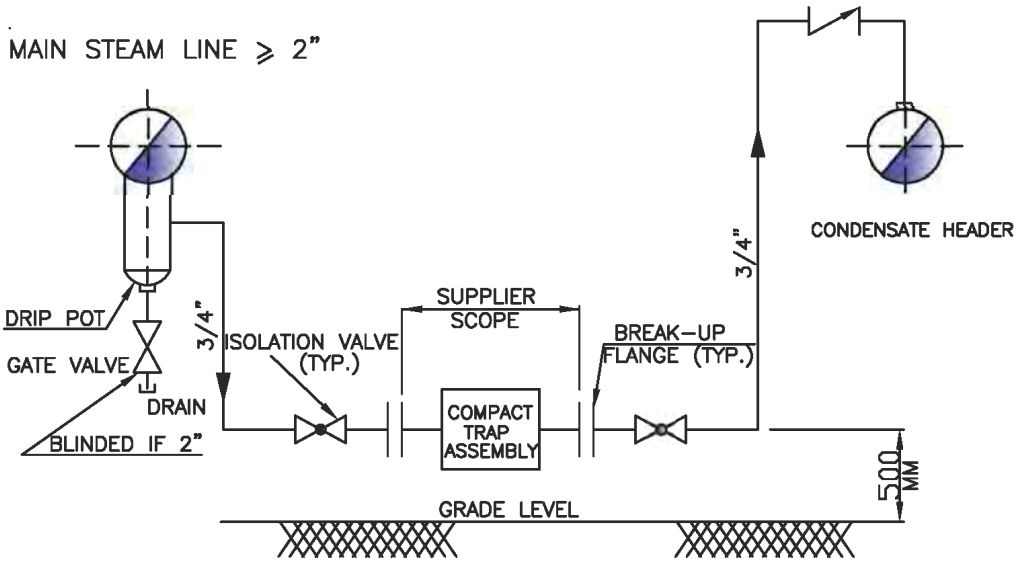


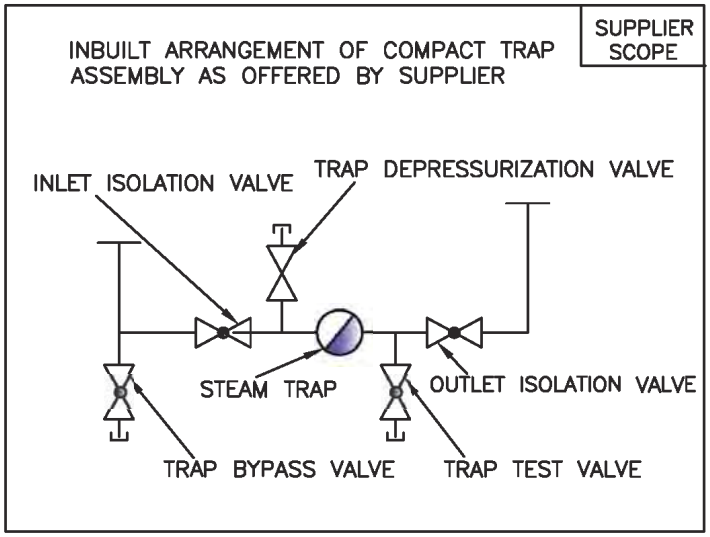
Final execution
Instrumentation supply

During pressure
test and cleaning
Piping supply

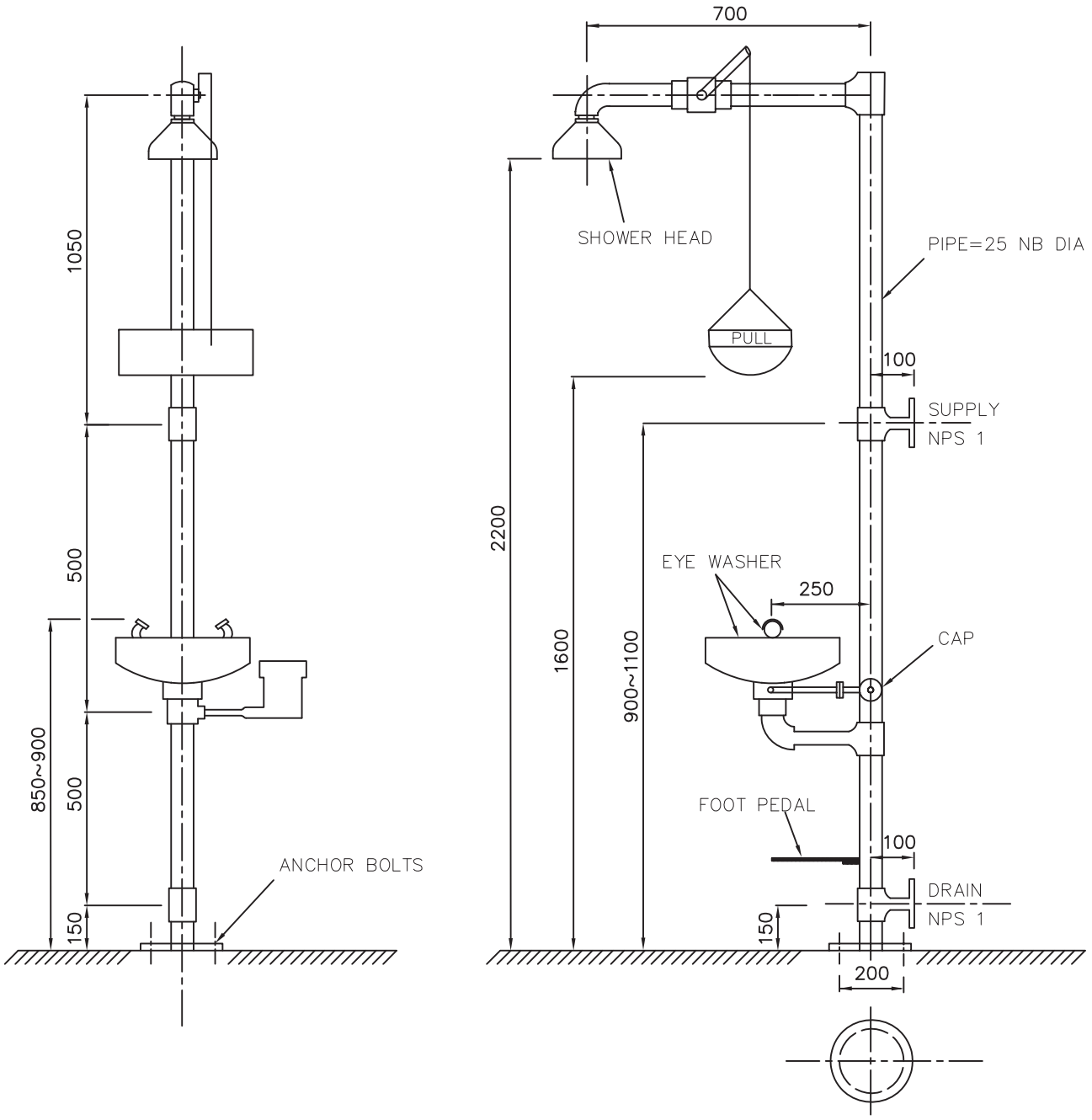
* Shortest possible

TYPICAL ARRANGEMENT OF DRAIN FOR STEAM LINES AND STEAM TRAP





DATASHEET FOR SAFETY SHOWER AND EYE WASH UNIT (COMBINED)



SUPPLY WATER CONDITIONS

1) SUPPLY WATER	: POTABLE WATER
2) DESIGN PRESS.	: 7 kg/cm2g
3) DESIGN TEMP.	: 70 °C
4) HYDRO. TEST PRESS.	: 1.5 times of Design Pr.
5) MINIMUM FLOW.	
a) SAFETY SHOWER	: 110 Lit/min.
b) EYE WASH	: 12 Lit/min.

MATERIAL

1) PIPE	: SS304
2) FITTING	: SS304
3) FLANGE	: SS304
4) VALVES/STRAINER	: SS304
5) BOWL FOR EYEWASH	: SS304
6) EYE WASH NOZZLE	: SS304
7) SHOWER HEAD	: SS304
8) PULL CHAIN	: SS304
9) FOOT PEDAL	: SS304
10) SPRING	: SS304
CODE/STANDARD	: IS 10592

NOTES:

1) THE GIVEN DIMENSIONS ARE ONLY FOR REFERENCE; THE MANUFACTURER'S STANDARD DIMENSIONS MAY BE APPLIED, SUBJECT TO APPROVAL .

2) THE COMBINED UNIT OF SAFETY SHOWER & EYE WASH SHALL BE PULL ROD AND FOOT PEDAL OPERATED AND PROVIDED WITH DUST COVER & FILTER.

3) ALL SAFETY SHOWER & EYE WASH UNIT SHALL BE PAINTED WITH FLOURESCENT PAINT SO THAT IT CAN BE VISIBLE IN NIGHT. NAME PLATE TO BE PROVIDED ON EACH SAFETY SHOWER & EYE WASH UNIT.

4) SAFETY SHOWER & EYE WASH UNIT SHOULD BE ISI MARKED.

5) THE COMBINED UNIT OF SAFETY & EYE WASH SHOULD BE CAPABLE TO PROVIDE A CUPIOUS FLOW OF WATER FOR ATLEAST 15 MINUTES.

6) ALL DIMENSIONS ARE IN MILLIMETERS.

7) OTHER SIZES BY VENDOR.

8) The spray nozzles shall be so designed as to deliver a spray of rinse water without harsh jets or misting. The water cone shall have vortex angle of 45^0.

DESIGN SPECIFICATION ELECTRICAL

FOR

PACKAGE EQUIPMENTS ULTRA FILTER PACKAGE

(TO BE PROCURED ALONG WITH DRIVEN MACHINE)

FOR

PLANT: RCF, THAL

JOB NO: EM- PC284

0	27.06.23	27.06.23	CLIENT'S COMMENTS INCORPORATED	BK	RKV	RKV
P	05.04.23	05.04.23	ISSUED FOR CLIENT'S REVIEW	BK	RKV	RKV
REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD

CONTENTS

LIST OF ATTACHMENTS

SERIAL NUMBER	DESCRIPTION	NO. OF SHEETS
1.0	Engineering Standard – Sheet Steel Distribution Board (ES-8080)	15
2.0	Engineering Standard – Cables (ES-8160)	8
3.0	Engineering Standard – Motor (ES -8102)	16
4.0	Engineering Standard – LCS (ES -8200)	10
5.0	Engineering Standard – Interlock switch socket (ES -8120)	8
6.0	Engineering Standard – JB(ES -8201)	8
7.0	Engineering Standard – Motor (ES -8083)	8

Electrical PDS No.	Description
PDS:E 203	Steel Tubular Lighting Pole
PDS:E 204	Installation of Electrical Poles

Electrical PDS No.	Description
PDS:E 206	Installation Arrangement Street Lighting Fixtures
PDS:E 207	Details of Bracket Arm for Street Lighting Pole
PDS:E 208	Installation Arrangement Area Lighting Fixtures
PDS:E 210	Junction Box for Street Lighting Pole
PDS:E 211	Installation of Junction Box for Street Lighting Pole
PDS:E 213	Typical Street Lighting Pole
PDS:E 402	Component rating for DOL starter
PDS:E 404	Component rating for AC feeders
PDS:E 412	Schematic Diagram AC Control Supply through Control Transformer for MCCs with bus coupler
PDS:E 464	Schematic Diagram Panic Light
PDS:E 510	Details of Concrete Cable Trench
PDS:E 511	Cable Rack Arrangement in Trenches
PDS:E 512	Fabrication Details of Cable Rack in Trench & Duct
PDS:E 516	Typical Arrangement of Cables burried in slit
PDS:E 525	Fixing Arrangement of Perforated Cable Tray (Horizontal Formation Ceiling Supported)
PDS:E 526	Fixing Arrangement of Perforated Cable Tray Horizontal Formation Wall / Structure Supported
PDS:E 527	Fixing Arrangement of Perforated Cable Tray Vertical Formation
PDS:E 531	Pre-Fabricated Cable Tray Horizontal Tee
PDS:E 532	Pre-Fabricated Cable Tray Horizontal Cross
PDS:E 533	Pre-Fabricated Cable Tray 90^0 Horizontal Bends
PDS:E 534	Pre-Fab. Cable Tray 90^0 Vertical Bend Bending Rad. 1000 mm
PDS:E 535	Pre-Fabricated Cable Tray 90^0 Vertical Bend Bending Radius 600 mm
PDS:E 536	Pre-Fabricated Cable Tray Coupling Arrangement
PDS:E 537	Pre-Fabricated Cable Tray Fixing Arrangement
PDS:E 538	Pre-Fabricated Cable Tray Reducing Coupler Plate
PDS:E 602	Earthing Conductor Details
PDS:E 603	Arrangement of Connections of Earth Conductors
PDS:E 604	Typical Details of Connection in Earth Pit
PDS:E 605	Earth Pit Details
PDS:E 606	Typical Arrangement of Earthing for Motor and Start Stop Push Button
PDS:E 610	3.8 M GI Electrode for Earthing
PDS:E 611	GI/Al Accessories for Earth Electrode
PDS:E 613	Earthing of storage tank & vessel
PDS:E 615	GI Earth Bus
PDS:E 617	Typical Arrangement for Neutral and Equipment Earthing
PC284-1221	LSDB-9Way
PC284-1210	LSDB-12Way
PC284-1211	DCDB
PC284-1205	DC Light ON scheme

Electrical PDS No.	Description

1.0 SCOPE & INSTRUCTION TO BIDDER

1.1 The scope shall include supply, design, detailed engineering, manufacture, erection, testing at works, delivery to site in well packed condition, complete electrical system required for Package Equipment at RCF Thal.

1.2 Supply, storage, handling, erection, testing & commissioning of all package items shall be in bidder's scope.

1.3 This specification shall be read in conjunction with all drawing, documents, data sheets and other relevant reference as specified herein.

1.4 The scope shall include but not limited to the following:

- Distribution board for Lighting / UPS supplies
- MCC panel
- Motors
- VFD (If required)
- Local Control Stations (LCS)
- Power & Control cables
- Cable Rack / trays with support
- Mounting structure / bracket for LCS / other items as required
- Earthing System
- Lighting system
- Electrical – Instrument Interface JB

1.5 Any other items not specified but required for the safe & reliable operation of the system are also included in bidder's scope of work.

1.6 All necessary drawings, calculations, test certificates and record of site tests etc. as required by the Inspector shall be furnished. Any modification/ rectification as required by Electrical Inspector shall be carried out free of cost by the contractor.

1.7 Two-point power supply to the bidder's distribution board (50%-50% load shall be shared by both the incomers with bus coupler open, if one incomer fails, bus coupler gets closed and 100% load shall be fed by other incomer) of the package shall be provided by the owner from owner's LV switchboard placed in existing substation. New MCC shall be provided with minimum two incoming feeders and one bus tie having auto/manual changeover facility.

1.8 Momentary paralleling of the system shall be possible for changeover without supply interruption in 415V panels.

1.9 The normal operation of the Motor Control Centre (MCC) shall be as under:
i) Bus coupler shall be provided between all the sources. Incomer and bus coupler rating shall be same.

ii) Each incoming feeder shall independently feed the loads on respective buses with full rated bus tie breaker open and the load on each bus balanced. However, each incoming feeder shall individually be capable to feed entire load of the switchboard i.e. combined load of both sections of switchboard. In order to ensure maximum degree of reliability and continuity, automatic transfer from one incoming feeder to other shall be possible through auto/manual closing of bus tie in case of sustained loss of power on any bus section.

iv) When one of the incoming feeder trips, the bus tie shall close automatically based on the philosophy described below and the total load shall be transferred to other healthy incoming

feeder which is capable of carrying the entire load. Sufficient switchgear capacity is to be provided. Time for changeover is suitably selected based on downstream system requirement of reacceleration of motors etc.

1.10 Supply, laying and terminations (at both ends) of incoming cables for bidder's distribution board, shall be in bidder's scope. All out going power, control & signalling etc. cables of appropriate voltage grades and sizes required from bidder's Distribution board to motor, space heater and motor RTDs and any other equipment etc. shall be supplied, terminated and laid by the bidder.

1.1 Bidder's distribution shall be placed in bidder's MCC Room in the shed / battery limit.

1.2 A clear space of 1.5meter is required in front of MCC for single front MCC and 1.5 M space is required on both the side of MCC for double front MCC.

1.3 A clear space of 2.5M on either side at entrance / exit.

1.4 Bidder shall also supply, fabricate and erect of the cable trays & support in the battery limit of Package Equipment, and from existing substation to new MCC room for laying of these incoming supply power cables and control cables.

1.5 Sufficient nos. of entrances (min. 2) shall be provided in MCC room.

1.6 Exhaust fans shall be provided in MCC room.

1.7 Bidder to furnish load list and Cable schedule with the offer.

1.8 Bidder to furnish complete operating scheme in respect to electrical.

1.9 Interfacing requirement between Instrument & electrical (I/O list) shall be furnished and the provision for the same shall be provided in electrical / Instrumentation. Separate Instrument & electrical interface junction box shall be provided and same shall be placed in electrical MCC room.

1.10 Bidder to provide Dedicated Energy meter to both incoming feeders with minimum accuracy class 1.0 or better. Kindly mote that the readings of this meters are to be use for performance guaranty test.

1.11 Bidder to prepare all DI/DO interconnection & termination details between different equipment's.

1.12 Cut-out & opening details for 415V MCC shall be furnished.

1.13 Interconnection between Local Control station and MCC / Distribution board ,VFD(if required) & PLC/DCS etc. to be done by the bidder.

1.14 VFD (where applicable) shall be placed inside MCC / DB. it shall also be with complete internal wiring with DB / MCC.

1.15 Bidder's VFD panel (wherever applicable) shall be kept inside MCC. LCS for motor shall be provided local /remote selector switch and provision for speed control in addition to start/ stop and other process requirement e.g. motor speed feedback etc. necessary internal control wiring shall be done in LCS & VFD up to terminals for easy connection of LCS to VFD (MCC/DB).

1.16 Supply of all control and signalling etc. cables of this package (From LCS/LCP/DCS to Motor, MCC to LCP/DCS,LCS, Motor etc.) shall also be in bidder's scope.

1.17 In case of any discrepancies between Design Philosophy & Electrical and Technical Specification of equipment / item / work in respect of description of equipment / item / work, the details indicated in the Design Philosophy – Electrical shall prevail. Also in case of any further discrepancy the job to be carried out as per IS/IEC/BS/IEEE standards whichever applicable or as per RCF standard practice after obtaining approval from RCF.

1.18 System study & Relay coordination (On latest version of ETAP) for this package with existing system, if required, shall be in vendor's scope.

1.19 This design philosophy contains specifications of the major equipment's to indicate the basic requirement and serve as a guideline. However, it shall be the responsibility of the bidder to offer a complete electrical system of superior quality for safe, proper, trouble free efficient operation and successful completion of the project, even if the specifications of certain items are not given.

1.20 This design philosophy contains documents / drawings to indicate the basic requirement and serve as a guideline. However, it shall be the responsibility of the contractor to offer a complete electrical system of superior quality, even if the specifications of certain items are not given.

1.21 LSTK contractor shall visit the site and collect all relevant information required for designing of complete system before quoting.

1.22 LSTK contractor shall assist in liaisoning and in all interface coordination with contractors of other units of project at construction, erection, testing & commissioning phase for any common facility. Contractor shall not be dependent on owner's manpower for the project. It shall be contractor's responsibility to coordinate to complete the project in time. Owner may inject their manpower at owner's discretion for training and smooth take over purpose.

2.0 BASIS OF DESIGN

2.1 **The electrical installation shall be designed to provide:**

- Necessary amount of power
- Flexibility
- Service reliability
- Ease of expansion
- Ease of operation and maintenance
- Safety of Personnel

3.0 CODES & STANDARDS

3.1 The design, manufacture and testing of the equipment shall comply with the latest issue of relevant Indian Standard Specification and codes of practices. In the absence of IS for any particular equipment or in case of imported equipment, relevant IEC shall be complied with.

3.2 The equipment shall also comply with the provisions of latest issue of Indian Electricity Rules, Other Statutory Acts and Regulations/ OISD The bidder shall obtain approvals of statutory authorities for electrical equipment and shall make, wherever necessary, suitable modification in the equipment, installation to comply with the above. Fee for obtaining statutory approval shall be borne by the owner.

3.3 Requirements of other statutory bodies like CEA / State Electrical Inspectorate, CCOE /PESO, as applicable shall be bidder scope.

4.0 SERVICE CONDITIONS

4.1 The equipment shall be designed for the site conditions as specified in various specification sheets attached.

5.0 SYSTEM DETAILS

5.1 The equipment shall be suitable for the system details as specified below-

Temp. Max./Min./Design Ref. : 40 ^{0}C /9 ^{0}C / 45^{0}C for all equipment except VFD(50^{0}C for VFD).

Relative Humidity : 100 %

Alt. above sea level : 5 Mtrs.

Atmospheric pollution : Urea dust, Corrosive due to presence of Ammonia vapours

Hazardous area classification : Safe Area

5.2 Utilization level

Motors up to 150KW : 415V AC

~~Motors above 150KW up to 1000KW~~ :~~3.3KV AC~~

~~Motors above 1000KW~~ :~~11KV AC~~

- Heaters : 415V AC
- Space heaters : 240V, 1Ph AC
- Lighting Network : 415V / 240V AC
- UPS Supply : 110V AC
- Power Sockets : 415V AC, 3Ph/240 V AC 1Ph
- DC voltage available : 110V DC
- Control circuits of contractors : 240V AC
- Instruments : 110V AC

5.3 **Fault Levels**

The fault levels shall be considered as 950 MVA (3 sec) at 11KV, 250MVA (3 sec.) at 3.3KV and 50 MVA (1 sec) at 415V.

5.4 System Earthing **--**

- The neutral of 415V supply system shall be solidly earthed.
- The D.C. System shall be unearthed.

6.0 MEETERING, CONTROL & MONITORING

6.1 METERING

6.1.1 Voltmeter with selector switch and separate ammeter for each phase (without selector switch) shall be provided for incoming supply for all switchboards.

6.1.2 All LT incomer and outgoing feeders shall strictly have analogue Ammeter and Voltmeters in addition to the multifunction meters.

6.1.3 Local Control Stations (LCS) of all motors rated 5KW and above shall have ammeter. Where required from process point of view, ammeters for motors below 5KW shall also be provided on Local Control Station. 32 x 32mm size ammeter with voltage (combine) meter shall be provided on all rating motor feeders in MCC panel.

6.1.4 Current drawn by the motors should appear on DCS as required from process point of view.

6.1.5 Multifunction meters including KWH, KW, I, PF, Voltage shall be provided for both incomer feeders. Bidder to provide Dedicated Energy meter to both incoming feeders with minimum accuracy class 1.0 or better. Kindly mote that the readings of this Energy meters are to be use for performance guaranty test.

6.1.6 LV incomers and lighting feeders in the incoming of all lighting boards and in feeders involving guaranteed power consumption and feeders going to other plants.

6.1.7 LV incomers shall be provided with annunciators.

6.2 CONTROL AND MONITORING

LT Motors Controlled Through Contactors:

- Ammeter in LCS for motors of 5.5 KW and above or as required from process point of view. 32 x 32mm size ammeter with voltage (combine) meter shall be provided on all rating motor feeders in MCC panel.
- Current monitoring of the motors, where required from process point of view. (4-20mA output & status output for monitoring) shall be provided in DCS.
- Process interlock in CCR, where required.
- Indication lamp for 'ON', 'OFF' and 'Fault' in switchgear.
- Indication lamp for 'ON', 'OFF' in remote (DCS/PLC etc.)
- Off-Auto-On switch, Analogue Ammeter, Indication lamp for ON, OFF, Space Heater ON (motor rated 30KW & above), Motor Ready to Start (for all critical motors) shall be provided on LCS.
- Motor feeder shall have test/run switch to bypass the process interlock for testing of motor. This shall be enabled only in 'Test' position of MCC module.

7.0 GENERAL DESIGN AND CONSTRUCTIONAL REQUIREMENTS

7.1 The electrical equipment shall be designed as per latest practice to provide maximum reliability, flexibility, safety to personnel and equipment and ease of operation and maintenance.

7.2 All equipment shall have adequate and standard ratings.

7.3 All outdoor equipment shall be weather proof and have IP55 protection and shall also be provided with canopy.

7.4 All live parts shall be adequately protected to prevent inadvertent or accidental contact.

7.5 All external hardware of diameter less than 8mm shall be of stainless steel and those of diameter 8mm and above shall be of mild steel cadmium plated or zinc passivated.

7.6 All equipment shall be provided with stainless steel nameplates containing the particulars along with the description and Code Nos. of equipment.

7.7 All detailed drawings, equipment sizing, make & type of equipment shall be subject to approval of owner/owner's authorized representative.

7.8 A clear space of 1.5meter is required in front of MCC for single front MCC and 1.5 M space is required on both the side of MCC for double front MCC.

7.9 A clear space of 2.5M on either side at entrance / exit.

8.0 EQUIPMENT SPECIFICATION:

8.1 DISTRIBUTION BOARD / MCC

8.1.1 Distribution Board shall confirm to Engineering Standard: ES: 8080 and specification sheet enclosed.

8.1.2 Filled in Specification Sheet and Technical Particulars for Distribution Board shall be furnished.

8.1.3 Bidder's Distribution Board shall be placed in MCC room in shed near Package in safe area.

8.1.4 Air circuit breakers (ACB) shall be provided in MCC (MV switchboards) for all feeders rated above 400A and switch fuse /MCCB/ACB shall be considered for feeder rated up to 400A.However in the feeders feeding power to small rated MCCs/ASBs, switch-fuse feeders shall not be used.

8.1.5 If breaker controlled motor is part of panel than incomer shall be of Air Circuit Breaker irrespective of ampere rating.

8.1.6 All relay shall be numerical type having IEC 61850 communication facility.

8.1.7 IP protection shall be minimum IP54 for sheet steel distribution board.

8.1.8 20% or minimum 1 no. of each type & rating, spare feeder shall be considered.

8.1.9 Medium voltage starter up to 75 kW shall be Contactor and MCCB with overload relay.

8.1.10 Medium voltage starter above 55 kW shall be Contactor and MCCB, overload relay with CBCT for earth fault protection. Overload Relay & ELR shall be compact microprocessor based communicable protection relay with earth leakage protection through CBCT.

8.1.11 Air circuit breaker with motor protection relay shall be considered above 75kW up to 160kW.

8.1.12 All MCC modules shall be designed for type 2 co-ordination.

8.1.13 For all other specifications, refer ES-8080.

8.2 MOTOR

8.2.1 Motor shall conform to Engineering Specification EM238-ESS-01 and Specification Sheet enclosed.

8.2.2 Filled in Specification Sheet and Technical Particulars for each type and rating of motors shall be furnished.

8.2.3 The rating of the motor shall be as per the sizes in the ISS. The margin between the installed power and absorbed power shall not be less than the following :

Motor Rating	Margin above Driven M/C Absorbed power
Less than 22 KW	25%
22KW to less than 55KW	15%
55KW and above	10%

8.2.4 The duty cycle of the motor shall meet the process and driven machine requirement.

8.2.5 The motor shall be of IE3 energy efficiency class as per latest edition of IS: 12615.

8.2.6 All motors shall be provided with on-line grease lubrication arrangement with grease for both DE and NDE side bearings except for motors of frame size less than 90.

8.2.7 Motors installed in the areas classified as hazardous shall be certified for such use by a recognized national \ international certifying & testing authority such as CIMFR,ERTL,PESO,BASEFA,PTB,FM,ATEX etc.

8.2.8 Noise level in db at rated speed, 1 mtr. away, at no load shall be 85 db ± 3 db.

8.2.9 Vibration level shall be as per relevant IEC60034-14 Code.

8.2.10 Starting current of LV Induction motor shall be as per IS12615-2011.

8.2.11 The motor shall also be provided with a rain protective hood.

8.2.12 All drawings & documents as specified in Cl. No. 12 of Engineering Specification EM238 - ESS-01 shall also be provided in soft copy.

8.2.13 Motor shall be suitable for VFD duty if running with VFD as well as for DOL starter also.

8.2.14 For all other specifications, refer ES-8102.

8.3 VARIABLE FREQUENCY DRIVE

8.3.1 As required VFD shall be separate for each motor.

8.3.2 Heavy duty VFD shall be provided to motor.

8.3.3 As VFD system shall be designed to run at 50 Deg. Celsius Ambient Temperature, necessary derating to be taken into account for this.

8.3.4 Input supply to the VFD shall be 3 Phase, 415V±10%, and 50Hz±5%.

8.3.5 Apart from self diagnostic features available with the VFD, following protections shall also be available :

- Motor Overload/Over Torque
- Instantaneous Over current
- Short circuit protection for converter/inverter
- Adjustable Current limit
- DC Bus Under & over voltage
- Control power supply failure
- Phase reversal Protection
- By Pass does not close
- By Pass does not open
- Ground Fault
- Over Voltage
- Under Voltage
- O/P Short Circuit
- Output Phase loss
- Input Phase loss
- Over Speed
- Heat Sink Over temperature
- Stall prevention (During acceleration, deceleration and constant speed operation).

8.3.6 VFD shall be suitable for distance from the motor.

8.3.7 The interconnecting cable between the drive & motor shall be joint free

8.3.8 Reliability in providing the critical “drive run signal” to the PLC is to be ensured & following measures are to be taken : -

- Both Drive run and Drive fault signal shall be independently given to PLC for monitoring the status and better diagnostics purpose.
- In order to prevent spurious tripping due to momentary loss of drive run signal (due to loose contact etc), feasibility of providing interlocks with the process parameters e.g. Furnace draft etc may be explored & implemented
- Analog 4-20 mA signals shall be provided through screened control cable.

8.4 LOCAL CONTROL STATIONS

8.4.1 The type and number of switchgear components such as push buttons, selector switches, Ammeters, lamps etc. shall be based on the functional requirements/process requirement of the control scheme and the type of equipment.

8.4.2 Auto/Manual or Local/Remote selector switch (if required).

8.4.3 Control stations shall be provided near each motor in the field.

8.4.4 Enclosure of the control station shall be suitable for site conditions such as weather proof, dust proof, corrosion resistant etc. All outdoor control stations shall be with canopy.

8.4.5 The motors shall be provided with appropriate Local Control Station (LCS) in the field. The enclosure shall be IP55. These LCS shall be hose proof.

8.4.6 Stop push button shall be of stay put type; however it can be of momentary type in case of drives such as lube oil pump etc which are critical.

8.4.7 Two numbers of stop push buttons shall be provided for the motors, which are installed at elevated platforms. One near the motor and one at the ground level.

8.4.8 Local control station shall be provided with ammeter for motors rated above 5.5 kW.

8.4.9 Local control station for aux. Lube oil pumps motors, heater shall be provided with ammeter irrespective of motor rating. LCS for all emergency / critical drives shall be provided with ammeters.

8.4.10 For all other specifications, refer ES-8200.

8.5 SWITCH SOCKETS

Sufficient number of FRP material inter-locked type 125A/63A, 415V, 3 Ph and 32A, 240V,

1 Ph switch sockets shall be provided in various plant locations at every 25 meter distance, as per hazardous area classification to facilitate the maintenance work. Supply to switch sockets shall be taken from MCC through suitably rated RCCB.
32/16A, 30mA, single phase switch sockets with RCCB shall be provided at the desired intervals as per the area of plant. Layout of the switch socket shall be approved by Owner/Consultant.

8.5.2 For all other specifications, refer ES-8120.

8.6 JUNCTION BOXES

8.6.1 Flameproof / Hose Proof Weather proof suitable for specified hazardous area classification heavy duty cast aluminium junction boxes with cable glands and terminals of suitable size shall be used for looping the cables wherever required. All unused cable entries shall be sealed with threaded plug which shall be fitted with endless neoprene rubber gasket**.**

8.6.2 For all other specifications, refer ES-8201.

8.7 LED LIGHTING FIXTURES & ACCESSORIES

8.7.1 The fixtures shall be complete with all accessories including the lamps, driver, heat sensor and all other accessories. The lighting fixtures shall also conform to the specification sheet for lighting fixture of this specification.

8.7.2 The fixtures shall be provided with cable glands and a terminal block suitable for termination of copper conductor up to 2.5 sq. mm size.

8.7.3 The fixture shall be so designed that it shall be possible to maintain or replace different accessories without difficulty, including replacement of lamps.

8.7.4 Unused holes in control gear box and junction box shall be packed with blanking plugs.

8.7.5 All lighting fixtures shall be provided with suitable double compression Al cable glands along with termination lugs and blanking plugs for unused entry.

8.7.6 All hardware used in lighting fitting, JBs shall be of Stainless Steel only.

8.7.8 LED Luminaries shall be suitable for single phase 240V±10%, 50Hz±5% AC input and ambient condition indicated elsewhere in the NIT.

8.7.9 Minimum Impact Resistance for outdoor fittings shall be IK-05.

8.7.10 The fixture shall be so designed that it shall be possible to maintain or replace the different

accessories without difficulty, including the replacement of the lamp. The vendor shall produce test certificate from central GOVT. LAB /NABL/ILAC accredited laboratory to prove conformity of specifications of LED fittings along with the offer. The model number on the test certificate shall be same as the offered model number.

8.7.11 Flameproof light fittings shall be certified for use in specified hazardous area and the Flameproof certificate shall be submitted along-with the offer. Explosion proof certificate from PESO shall be submitted before or along-with supply of such light fittings.

8.7(**I**) **LED CHIPS**

I. LED efficacy shall be greater than 140 Lumens/watt at 350mA driver current. In respect of higher power rating LED, driver current greater than 350 mA can be accepted if LED's LM 80 / IS: 16105 test reports are attached.

II. LED type can be SMD (surface mounted device) of COB (chip on board) type depending on the application. COB type to be considered only for applications such as Highbays, Flood Lights & Flameproof Light Fittings.

III. Test report/LM80 report for ambient temperature of 55/85/105 Deg. C at rated and maximum current shall be submitted.

IV. TM 21 life projection calculations along with LM80 for ambient temperature of 55/85/105 Deg. C as per applicable standard shall be submitted to substantiate life of LED. Reported Life span of LEDs shall be greater than 50000 Hrs at a soldering temperature of 85 Deg. C at rated driver current.

V. Colour temperature of white colour LED shall be from 5700K (5665K+/-355K) to 6500K as per ANSI standard C78.377A.

VI. Colour rendering Index for colour ranges from R1 to R15 shall be greater than 80.

VII. LED shall comply to Photo biological safety norms as per IEC 62471/EN62417/IS: 16108 and should fall in the exempt group for indoor luminaries and in exempt of low risk category for outdoor LED luminaries.

II. **LED DRIVER**

I. Minimum efficiency of LED driver shall be 85% for driver output rating of <= 40W and 87% for driver power output rating of > 40W.

II. Power factor of complete fitting shall be greater than 0.90.

III. In built high voltage cut-off for voltage above 290 Volt shall be provided.

IV. Short circuit protection and Open load protection shall be provided.

V. Surge protection device shall be provided for minimum of 2 KV in indoor luminaries and minimum of 10 KV for outdoor luminaries. SPD should be series type with fail safe.

VI. Total Harmonic distortion (THD) shall be less than 10%.

VII. Isolated LED driver should be used. The input (AC side) and output (LED side) are separated by power transformer for galvanic isolation.

VIII. Power supply of LED PCB should be through proper connectors.

IX. Driver shall comply EMI/EMC standards CISPR 15/ IS 6873 (CE, RE, CDN) and IS 61547.

X. Driver shall comply with safety standards IEC 61347-2-13/EN 61347-2-13/IS: 15885-2-13.

XI. Driver shall comply with performance standards IEC: 62384/IS: 16104.

III. **LUMINAIRE**

I. Circuit boards and electronic components rating/type should be suitable to provide reliable functioning.

II. Luminaire shall have LM-79/IS: 16106 test report from a NABL accredited laboratory.

III. Minimum system efficacy of luminaire shall be greater than 100 Lumens/watt.

IV. Potting of LED luminaire along with driver is mandatory.

V. Average Duty cycle to be 12 hours (Dusk to Dawn).

VI. Working temperature to be in the range of – 5 Deg. C to 60 Deg. C.

VII. Working humidity to be in the range of 10% to 100 % RH

VIII. Housing of indoor fixtures to be made of CRCA/PC/Aluminium Extrusion and for outdoor fixtures shall be pressure die cast LM6/ADC12/LM24.

IX. Lumen maintenance of fixtures shall be 50,000 Hrs at L70.

X. LED luminaires shall be completely glare free.

XI. View Angle should be typical 120 Deg.

XII. Cover type of indoor fixtures shall be UV stabilised poly carbonate type and outdoor type fixtures to be Toughened glass or UV stabilised poly carbonate type as applicable.

XIII. Temperature rise for driver at soldering point should not exceed 85 Deg. C. For Heat shrink temperature rise, maximum of 20 Deg. C over ambient temperature is allowable. Heat shrink to be designed accordingly.

XIV. Flameproof light fittings shall be certified for use of hazardous area as per area classification and flameproof certificate shall be submitted along with the offer. Explosion proof certificate from PESO shall be submitted before or along with supply of fittings.

XV. Luminaire should have BIS approval for surface mounted luminaire as applicable.

XVI. Housing ingress protection shall be as per table below:

Application Type	**Minimum Ingress Protection Required**
LED Street Light, Flood Light, Outdoor Industrial	IP66
Industrial Indoor (High Bay, Medium bay)	IP54
Toilet Fixtures	IP44
Domestic & Commercial Indoor type LED	IP20

XVII. Approve makes for different LED technologies to be as per table below :

LED Technology/type	**Approved make**
LED Chips SMD (Surface Mounted) type	Nichia, Osram, Lumileds, CREE
LED Chips COB (Chip on Board) type	Citizen, Bridgelux
Domestic/Decorative	Everlight Taiwan, Edison Taiwan,

	Samsung Korea
Luminaries	Osram, Nichia, Lumileds, CREE

IV. **OTHER CONDITIONS**

I. Type Test Report/Certificate from NABL accredited labs as per relevant standards on selected sample including endurance test as per IS10322 and safety test on drivers as per IS 15885.

II. Vendor shall carry out third party inspection from RCF approved TPI agency. TPI to be carried out on 10% material of each item on random basis as per scope of tender.

Vendor shall guarantee for full replacement of material (free of cost) due to any failure in 24 months from date of commissioning. Failures shall include failure/deterioration of LED's in terms of performance like guaranteed luminous efficiency as per LM80 report, abnormal lumen depreciation, failure of driver unit, etc.

9 CABLING SYSTEM

9.1 CABLES

9.1.1 All power, control, lighting & Interconnecting cable with cable gland & crimping lugs (for both end termination) for this package shall be supplied by the bidder. Supply of Cable trays & supporting structure for laying of these cables inside battery limit of this package shall also be in bidder's scope.

9.1.2 Bidder to provide the Cables and cable schedule for Power, Control, Safety & Signalling cables.

9.1.3 All Power & Control Cables shall be of Cu /Al Conductor, XLPE insulated, PVC inner sheathed (extruded type), GI wire/strip armoured, FRLS PVC (ST2 type) outer sheathed 1100V grade heavy duty cables as per IS:7098 (part-1).

9.1.4 Cable for vibration switch: Multi core, 2.5 mm2, stranded copper conductor XLPE insulated, PVC inner sheathed (extruded type), GI wire armoured, FRLS PVC outer sheathed 1100V grade heavy duty cables as per IS:7098 (Part-1).

9.1.5 All Cables shall also conform to Engineering Standard of Cables ES: 8160.

9.1.6 Cables shall be designed to carry the rated current after allowing the temperature and group de-rating factors.

9.1.7 All cables used shall be without any intermediate joints.

9.1.8 All cables shall be terminated at the equipment in safe area by means of double compression type Nickel brass cable glands and crimping lugs. All cable entries shall be from bottom only.

9.1.9 All cable up to 2.5 mm2 shall be copper cable. Cable size of 25 sq.mm & above shall be Al cable. All control cables shall be 2.5 mm2 (Cu).

9.1.10 All control cables shall have 10% spare cores subject to minimum of one spare core.

9.1.11 Cables shall be sized considering the following factors.

- Maximum continuous load current
- Voltage drop
- System voltage
- Laying conditions

- Derating due to ambient air temperature, ground temperature, grouping and proximity of cables with each other, thermal resistivity of soil etc. shall be taken into account
- Short circuits withstand criteria for HV cables.

9.1.12 The cable sizes shall be selected in accordance with current rating based on :-

a) Load Current.

b) Permissible voltage drops as specified below :-

	Max. voltage drop up to LV motors terminals during running condition	-	5 %
	Motor feeding cables referred to the starting current	-	10%
	Cable between LV MCC (415V) or auxiliary Switchboard/ any distribution board	-	2.5%

9.1.13 All cable terminations shall have crimping type lugs. Copper crimping lugs shall be supplied with copper and aluminium crimping lugs shall be supplied with aluminium cables.

9.2 CABLE RACKS / TRAYS

9.2.1 Supply of prefabricated Cable trays & supporting structure for laying of Power, Control, Safety & Interconnecting cables of this package in battery limit of this package and from existing substation to new MCC room for laying of these incoming supply power cables and control cables shall also be in bidder's scope. Bidder shall use existing supporting structure where ever available in the field. Where structure is not available bidder to provide.

9.2.2 The cable trays and risers shall generally be of G.I. prefabricated ladder type. G.I. prefabricated cable trays and its accessories such as coupler plates, risers, bends etc. shall be fabricated from 3.0 mm thick M.S. sheets. The rung spacing shall be 300 mm. The cable trays and their accessories shall be hot dip galvanized after fabrication. The galvanizing shall be uniform, clean, smooth, continuous and free from pores. The amount of zinc deposit at any point shall not be less than 610 gm per sq. m.

9.2.3 The cable trays shall be designed to avoid any sharp bend in the cables. The corners of the cable trays shall have a smooth circular radius, as required. In case of multi-tier trays, the minimum gap between the two tiers and between top tier and ceiling beam (bottom) shall be 300 mm.

10 MOUNTING STRUCTURES

LCS, switch sockets etc. shall be mounted on suitable structure fabricated out of standard section of mild steel.

11 EARTHING & LIGHTNING PROTECTION SYSTEM

11.1 Earthing system shall be carried out as per IS: 3043. Bidder to provide Earthing terminal/connection for all package equipments.

11.2 All structure shall be protected against lightning strokes by suitable lightning protection system to be designed and installed as per IS/IEC-62305.

11.3 All non-current carrying parts of various electrical equipment as well as cable armouring, metallic conduit, G.I. pipe, cable racks/trays, brackets, supporting structure etc. shall be effectively earthed by owner.

11.4 All non-electrical equipment such as equipment base plate, steel structures, pipe lines, vessels, tanks etc. shall be effectively earthed

11.5 All equipment shall be earthed through GI strip/ single core aluminium cable.

11.6 Installation, testing & commissioning of GI strip, single core cable and other accessories required for complete earthing in bidder's package shall be in bidder's scope.

11.7 The earth pit shall be of Chemical type and maintenance free earth electrode. Also the earth pit shall have name plate describing the function of earth pit i.e. BEP/NE, earth resistance and earth pit testing date and due date etc. as instructed by RCF.

11.8 All equipment rated 240V and above shall have two external earth connections and those rated below 240V shall have one external earth connection.

11.9 Minimum size of the earthing conductor for different equipment shall be provided as indicated below

11.10 Earthing terminal/connection/ earthing bolt etc.shall also be provided for below sizes :

i.	HV Motors	2 nos. 1Cx120 mm^2 Al, 1.1KV grade XLPE cable
ii.	LV Motors	
	75KW and above	2 nos. 1Cx120 mm^2 Al, 1.1KV grade XLPE cable
	Above 30KW & less than 75 KW	2 nos. 1Cx95 mm^2 Al, 1.1KV grade XLPE cable
	Above 5.5KW & up to 30 KW	2 nos. 1Cx25 mm^2 Al, 1.1KV grade XLPE cable
	5.5KW and below	2 nos. 1Cx10 mm^2 Al, 1.1KV grade XLPE cable
iii.	All minor equipment rated 250V or below	1 no. 1Cx10 mm^2 Al, 1.1KV grade XLPE cable
iv.	Non elect. Equip. such as vessels, structures etc.	2 no. 50x6 GI strip.
v.	DB/MCC	2 no. 50x6 GI strip.

11.11 All steel structures, tanks, vessels, pipes, pipe joints, valves etc. shall be earthed against static charge accumulation by 50x6 mm GI strip. The no. of earth connections shall be as follows:

Equipment having diameter	Hazardous area	Non hazardous area
30 M	2	2
More than 30 M	3	2

11.12 Wherever process equipment are mounted on steel structures, the structures shall be earthed instead of earthing the individual equipment.

11.13 The pipe structures shall be earthed at not more than 25M apart.

12 ILLUMINATION SYSTEM

12.1 AC Lighting power shall be tapped from owner's existing MLDB.

12.2 DC Lighting power shall be tapped from owner's existing DCDB.

In general, the lighting shall be provided by fixtures using LED lamps. The minimum illumination levels and type of fixtures in the various sections of the plants shall be as indicated below :

Sl. No.	AREA	LUX	TYPE OF FIXTURES

1.	**PLANTS**		
	i. Operating platforms		
	- Safe area	100	LED, Industrial
	- Hazardous areas	100	LED, Flameproof well glass.
	ii. Non-operating platform / general process areas & walk ways		
	- Safe areas	50	LED, Industrial well glass.
	- Hazardous area	50	LED, Industrial, Flameproof well glass.
	iv. Turbine Area		
	- Safe Area	150	LED, Industrial well glass.
2.	**SUBSTATION / MCC ROOM**		
	Switch room - Front of panel	100	2x18WLED Industrial Type
	- Back of panel	100	2x18WLED Industrial Type
	- Battery room	70	LED well glass Industrial Flameproof.
.	Panic lighting	-	18W LED well glass for out door lighting and 2x18W LED for indoor.

12.3 The specified illumination level shall be maintained after considering maintenance factor of 0.6 for plant and outdoor areas and utilization factors as per manufacturer's catalogues and type of fixtures.

12.4 Normally minimum mounting height of the fixtures shall be as follows:-

Type of Fixture	Wattage	Mounting Height
LED	40W	3.2 M / 4.0 M
	70W	5.0 M / 6.0 M

12.5 Panic lights (110V, DC) shall be provided at convenient locations in all plants for safe evacuation of operation personnel. Location of these lights shall be judiciously decided from safety considerations.These shall be switched 'ON' automatically on failure of power supply to main lighting board and shall switch 'OFF' automatically on resumption of mains or after 1 hour of power failure to avoid draining of the battery.

12.6 The outdoor lighting shall be photocell/timer controlled.

12.7 Aviation lights (LED type) shall be provided on tall structures and all isolated structures more than 45M high.

12.8 For lighting fixtures and 15 Amp plug socket circuits, 3 core 2.5 sq. mm (Cu) cable shall be used.

12.9 Normally the load on one lighting Sub-circuit of lighting Sub-Distribution Board and Junction Box shall be limited to 1000W approx

12.10 9Way/12way/18way6way type LSDB/DCDB shall be provided for feeding lighting fixtures.

12.11 The lighting Sub-Distribution Board for control of lighting shall be standardized as 18 ways, 12 ways, 9 way and 6way type.

12.12 All lighting / power socket shall be provided with RCBO in addition with MCCB/SFU at feeder end.

12.13 15A plug sockets shall be fed through separate circuit of indoor lighting Sub-Distribution Boards/Junction Box.

12.14 Normally 4Nos. of 15A plug sockets shall be connected to a circuit.

13 TESTING & INSPECTION

13.1 Testing of electrical equipment's shall be done in accordance with relevant IEC/BIS codes.

13.2 The bidder shall submit the certificates of type tests performed on identical equipment as evidence of the compliance of the equipment with the type tests.

13.3 The bidder shall submit the certificates of routine and acceptance tests conducted on the purchased equipment's.

13.4 All the routine/acceptance tests shall be performed at the manufacturer's works in the presence of owner's representative.

13.5 The owner or their representative shall be allowed to visit the manufacturing works for stage inspection during manufacturing stage.

13.6 The bidder shall intimate the owner 4 weeks in advance of the tests and submit the detailed schedule of tests.

14 INSTALLATION, TESTING AND COMMISSIONING

14.1 The Bidder shall undertake installation of electrical equipment in accordance with latest code of practices, in conformity with recommendation of the respective equipment manufacturers, drawings approved by the owner or owner's representative, direction of Engineer-in-Charge, statutory regulations and to the entire satisfaction of the owner.

14.2 The bidder shall arrange all the necessary erection tools and tackles, testing and measuring instruments and shall supply the required erection materials including structural steel.

14.3 Bidder shall furnish field inspection and test data sheets for all equipment's for owner's approval.

14.4 The bidder shall obtain the necessary certificate of compliance/completion certificate with test results from statutory authorities as required. All necessary drawings and test certificates as required by them shall be furnished by the vendor.

14.5 At least following tests shall be specifically conducted before commissioning in presence of owner's representative. All the test results shall be recorded and submitted to the owner.

a) Insulation Test

b) Continuity Test

c) High Voltage Test

d) Simulation Test

e) Earth Resistance Test

15 COORDINATION WITH OTHER CONTRACTORS

15.1 The successful vendor shall coordinate with Owner's other vendors and shall freely exchange all technical information required for this purpose.

15.2 All civil works connected with electrical installation shall be under the bidder's scope.

16 CONSTRUCTION POWER SUPPLY

16.1 The construction power supply shall be made available at 415V AC at 1 point. The Contractor shall make all provisions to tap this supply. LSTK contractor shall have to arrange adequately rated distribution and sub distribution boards/feeder pillars, power supply cables, earthing network and other associated equipment/materials for feeding loads to carry out construction and fabrication activities at his own cost. **Bidder to indicate the construction power requirement with the bid.**

16.2 All protection devices such as ELCB/ RCCB etc. shall also be provided by the bidder.

16.3 Contractor shall supply and install fire fighting equipment as per the regulations of the local electrical inspectorate / statutory bodies for the temporary electrical installation.

16.4 Contractor shall provide adequate area lighting at site of construction, fabrication yards and office etc. by means of suitable lighting fixture, lighting masts, flood lighting poles etc. which are to be supplied and maintained by the contractor as per safety aspect.

17 BILL OF QUANTITIES

17.1 The bidder shall furnish the Bill of quantities for all electrical items duly signed and stamped. Bill of quantities shall only be for our information. Actual quantities, as required, shall be supplied by the bidder.

18 DRAWINGS & DOCUMENTS

18.1 The bidder shall submit the documents for electrical equipment's as per the drawing and documentation schedule as given in this bid package.

18.2 A dedicated laptop PC with licensed copy of documentation software shall be included in the scope of bidder for documentation of Electrical Engineering.

18.3 The software shall be used for preparing and updating the various documents such as general arrangement drawings, cable schedules, single line diagrams, control system drawings and equipment specifications etc.

18.4 The documentation software shall be same which is used by the bidder for electrical documentation.

18.5 The details of the documentation software shall be furnished in the technical offer.

18.6 Native files (editable copy) of all the electrical equipment sizing calculations or any other calculations, Load List etc. shall be submitted for owner's review and as final documentation.

18.7 Native file (editable copy) of AutoCAD or any other software used for preparing Engineering drgs. & docs. of all Engineering drgs. & docs. shall be handed over as final documentation.

18.8 LSTK Contractor shall ensure that following shall be mentioned in each sheet of drawings/documents in the order mentioned below:

(a) Logo and Name of the client
(b) Logo and Name of the consultant
(c) Logo and Name of the contractor (LSTK Contractor)
(d) Logo and Name of the Manufacturer on the drawings prepared by manufacturer, if Applicable
(e) Name of the Project for which drawings are applicable
(f) Title of the drawing (Title shall indicate the details shown in the drawing)
(g) Drawing/ document number with sheet number and number of total sheets in the Drawing (Drawings having different title shall be assigned different drawing number)
(h) All sheets of each drawing shall bear same title, same document number and same revision number

18.9 ETAP Native file (editable copy) along with its base file & complete library or of any other software used for Electrical System Study & Relay coordination shall also be submitted for owner's review as well as with final documentation.

19 SPARES

19.1 Contractor shall supply mandatory spares for electrical equipment's for operation and maintenance as per the list attached with this bid package.

19.2 LSTK Contractor shall recommend 2 years Operational Spares for all the equipment (item-wise) with recommended quantity & unit price. The item-wise price shall be with validity of 2 years. The same shall not be part of LSTK price.

19.3 All spare parts shall be identical to the parts used in the equipment's.

19.4 Any other spare parts or special tools not specified, but required, shall also be quoted along with the offer.

20 MAKE OF ELECTRICAL ITEMS

20.1 Make of all electrical equipment shall be as per the vendor list attached with this bid package.

20.2 Any other vendor shall be subject to PDIL/owner's approval.

20.3 Bidder shall indicate the make of all equipment in their offer.

21 DEVIATIONS

21.1 Deviations, if any from this standard (clause wise) shall be clearly indicated in the offer with reasons thereof. Deviations from the data indicated in Specification Sheet shall be shown clearly by encircling it and indicating the revised data in Specification Sheet. In the absence of any such activities the compliance to the clauses shall be deemed automatically.

21.2 The bidder shall submit the duly signed & stamped copies of all the NIT documents as a token of compliance to NIT.

27.2 Successful Bidder shall also note that all those deviations mentioned in bid but not accepted by Owner/Consultant in writing shall be considered as withdrawn by bidder.

27.3 Any and all deviations mentioned anywhere else in the bid but not specifically and ambiguously mentioned under specific section 'List of deviations' shall not be considered.

SPECIFICATION SHEET INDUCTION MOTOR

CLIENT: M/S RCF	**PROJECT: ULTRA FILTERATION UNIT**		**PLANT: THAL**
ISSUED FOR : PROPOSAL ☐	**ENQUIRY** ☒	**ORDER** ☐	**FINAL** ☐
GENERAL			
Item No. :	Ref. Stds. : IS:12615, IS: 325, IS:5571,5572 & IEC : 60079-1		
Quantity :	Encl. Docs. : ES-8102		
Description:	Vendor :		
Code No. : **xxxx**	Vendor Ref. No. :		
TESTS TO BE WITNESSED : Routine ☒	Type ☐	Others ☐	
SERVICE CONDITIONS			
SYSTEM DETAILS	**AMBIENT CONDITION**		
Rated Voltage with ± % : 415V ± 10%	Temp. Max./Min./Design Ref. 40 ^{0}C /09 ^{0}C / 45^{0}C		
No. of phases : 3	Relative Humidity: 90% at 46^0 C	Alt. above sea : <1000 M	
Rated Frequency With ± % : 50Hz ± 5%	Atmospheric	Dusts : Dusty & corrosive	
Combined V & F variation : ±10%	Pollution	Vapours : Ammonia	
Fault Level : 50 kA for 1 second	Area	Safe ☒	Hazardous ☐
Space Heater Supply : 240V, 1-Ph, AC	Hazardous Area class: Safe Area		
Low Voltage Heating Supply :	**Location** : Indoor ☐	Outdoor ☒	
Instrument A.C. :	**COOLING WATER**		
Contact Rating D.C. :	Inlet Press: kg/sq.m.	Inlet Temp. ^{0}C	
Aux. Motor Supply :	Fouling Factor :	Outlet Temp. ^{0}C	
BASIC DATA			
RATING & DUTY	**DRIVEN M/C DATA**		
Rated Output :	Type :		
Syn. Speed :	Make :		
Duty : Continuous	Absorbed Power :		
Rotor Type : Squirrel Cage	Coupling :		
Starting Method : DOL	Torque-Starting / Max. :		
Max I Start/I Rated: Starting current of LV Induction motor shall be as per IS12615	GD^2 at Motor Speed :		
Min. Starting Voltage at Terminal (V_R) : 80% of rated voltage	Thrust - Radial / Axial :		
Min. Starting Torque at V_R :	Addl. Data :		
EXECUTION	**ACCESSORIES**		
Degree of Protection : IP- 55	Foundation Bolt ☒	Space Heater for Motor rated 3.7 kW & above ☒	
Addl. Degree of Protection : NA	Lifting Eye Bolt ☒	Drain Plug ☒	
Mounting Arrangement : ---	Cable Glands ☒	Cable Lugs ☒	
Direction of Rotation : Bidirectional	Diff. C.T.s ☐	C.W. Flow Indicator ☐	

Insulation Class : 'F 'with temp. rise limited to 'B '		RTDs for Wdg. ☐	Hot Air ☐	Bearings ☐
Cooling Method :		Thermometer For	Hot Air ☐	Bearings ☐
Stator Connection : ---		Earthing Terminals	On Body ☒	In T.B. ☒
CABLING DATA		Name Plate : ☒	Addl. name plate : ☐	
Power cable : 1.1 KV, Cu/Al Conductor, XLPE-A-FRLS PVC-		Rain Protecting Hood : ☒ IF INSTALLED IN OUTDOOR AREA		
Control cable : ---1.1 KV, Cu Conductor, XLPE-A-FRLS PVC X2.5mm^2		**MANDATORY SPARE PARTS**		
C.T. cable : ---		Required ☒		
R.T.D. cable : ---		Bearings (DE & NDE) ☒	Cooling Fan ☐	
Alarm cable :		Space Heater ☐		
Cable Gland	Type: Double compression	Grease Nipple & Plug (For only Online greasing motor) : ☐		
	Material : rolled Al type cable glands	Terminal stud with bushing & star link: ☐		
PAINTING	Epoxy Type & Shade 631 of IS:5	Inner & Outer covers for DE & NDE bearing: ☐		

☒- **Required or Applicable.**

Notes : i) The motor shall be energy efficient type having efficiency class of IE3 as per Latest Edition of IS 12615.
ii) This specification sheet shall be filled for Auxiliary motor, if any.
iii) Separate sheets shall be used for different services and ratings of motors.
iv) All unfilled data shall be filled by the bidder and submitted with bid.
v) Power and space heater cables shall be of 1.1KV grade XLPE-A-FRLS PVC.
vi) Cabling data , if required shall be provided during detail engineering.

TECHNICAL PARTICULARS INDUCTION MOTOR

CLIENT: M/S RCF	PROJECT: ULTRA FILTERATION UNIT	PLANT: THAL
ISSUED FOR : PROPOSAL ☐	ENQUIRY ☒	ORDER ☐

GENERAL		
Item No.		
Quantity		
Description		
Code No.		
Ref. Standard		
Make		
Maker's Type		
ELECTRICAL DATA		
Rated Output		
Rated Voltage		
No. of Starts - Hot / Cold		
Torque - Starting / Pull Up / Pull Out		
t Start at min. V Start		
Safe Stall Time at VR / I.IVR VR Hot / Cold		
Stator Time Constant		
Temp. Rise at Full Load - Wdg. / Hot Air / Brg.		
Temp. Rise of Stator / Rotor After	3 Starts From Cold	
	2 Starts From Hot	
Current at FL / 0.85 FL		
Efficiency at FL / 0.85 FL		
Speed at FL / 0.85 FL		
Power Factor at FL / 0.85 FL / Start		
Push Pull Voltage withstand Capacity		
Max. V dip for 1 sec. / 10 sec. / 60 sec.		
Losses - Fixed / Copper / Total		
Space Heater Rating		
Suitable for Low Voltage Heating		
C.T. Ratio & Accuracy Class		
C.T. VK & I Mag. at VK / 2		
MECHANICAL DATA		
Frame Size / Ref. Dimensional Drg.		
Weight - Stator / Rotor / Total		
Heaviest Weight to be Lifted		
Rotor GD^2 in Kgm^2		
Reaction at Supports for	S/C Condition	
	Starting Condition	
	Running Condition	
	Push Pull Condition	
Max. Vibration Limit		
Max. Noise Level		
Suitable for Outdoor Use		
Suitable for Bi-directional Rotation		
Material of Insulation		
Treatment of Insulation		
Winding Coils Replaceable at Site		
Type & Material of Fan		
Material & Thickness of Cooler Tube		
Cooling Water Required in M^3 / hr		
Lubrication Type		

Lubricant Specn.		
Interval of Lubrication		
Bearing Nos. & Type	DE	
	NDE	
	GUIDE	
On Line Lubrication		
Axial float / shaft end play of rotor shaft		
Type & Rating of Main Cable Box		
No. of Cable Glands in Control Cable Box		

Notes: i) All unfilled data shall be filled in by the bidder and submitted with their bid/ offer.

SPECIFICATION SHEET DISTRIBUTION BOARD

CLIENT: M/S RCF		**PROJECT: ULTRA FILTERATION UNIT**		**PLANT: THAL**	
ISSUED FOR : PROPOSAL ☐		**ENQUIRY** ☒		**ORDER** ☐	**FINAL** ☐
GENERAL			**AMBIENT CONDITION**		
Ref. Stds. : BIS & IEC			Temp. Max./Min./Design Ref. 40 ^{0}C /9 ^{0}C /45^{0}C		
Encl. Docs. : ES: 8080			Relative Humidity: 90% at 46^0 C		Alt. above sea : <1000 M
Bidder :		**Atmospheric Pollution**	Dusts :		Safe area
Bidder Ref. No. :			Vapours : Dusty & corrosive vapours of Ammonia		
		Location	Indoor ☒	Outdoor ☐	
			Gr. Floor ☒	1st Floor ☐	
Addl. Scope :	☐ Incoming Bus Duct	☐ Tie Bus Duct			
	☐ Testing & Commissioning	☒ Erection, Testing & Commissioning			
TESTS: Routine ☒	Type ☐	Others ☐			

BASIC DATA

TAG NO.	Item No.		1
	Description		415V Distribution Board
	Code No.		
REFERENCE DRAWINGS	Single Line Diagram		Shall be provided by bidder
	Feeder Details		As per Package requirements
	Auto Trip Alarm Scheme		--
	Non Trip Alarm Scheme		
	Trip Circuit Supervision Scheme		
	Auto C/O Scheme		
	P.T. Bus Arrangement		
SYSTEM DETAILS	Nominal Voltage with Variation		415V ± 10%
	Rated Frequency with Variation		50Hz ± 5%
	Combined V & F Variation		± 10%
	No. of Phases & Wires		3 Ph & 4W
	Insulation Level		2.5 KV
	Fault Level		50 kA for 1 sec
	Earthing Mode		Solidly Earthed
BUS BARS	**Rating**	Continuous	By bidder
		Short Time for 1 sec.	50kA
	Bare / Insulated		Insulated
	Type of Insulation		PVC sleeved
EXECUTION	**Breaker Feeders**	I/C & B/C : ST / DT	SINGLE TIER
		Others : ST/DT	SINGLE / DOUBLE TIER
	Other Feeders	Single front / Double front	Single Front/Double Front
		Fixed / Drawout	Drawout
	Cable Entry : Top / Bottom		Bottom

	Bus Duct Entry : Top / Bottom		--	--
	Accessibility : Front / Back		Front / Back	
CONTROL SUPPLY	Breaker Feeders	Closing & Indication	220V DC	
		Tripping	220V DC	
	Contactors		240 V AC	
	Space Heater		240 V AC	
MISC. DATA	Painting	Type	As per Tech Spec Attached	
		Shade		
	Period for which Spares required			

TECHNICAL PARTICULARS DISTRIBUTION BOARD

CLIENT: M/S RCF	**PROJECT: ULTRA FILTERATION UNIT**	**PLANT: THAL**
ISSUED FOR : PROPOSAL ☐	**ENQUIRY** ☒	**ORDER** ☐ **FINAL** ☐

GENERAL		
Manufacturer's Type		
Ref. Standards		
Rated Operational Voltage with ± %		
Rated Insulation Voltage		
Rated Voltage of Aux. Circuits with ± %		
Rated Current		
Short Circuit Rating		
Degree of Protection of Enclosure		
Service Conditions : Indoor / Outdoor		
DRAWOUT FACILITIES	Circuit Breakers	
	P.Ts.	
	Motor Starters	
	Protective Relays	
	Meters	
SINGLE FRONT / DOUBLE FRONT	C.B. Feeders	
	Other Feeders	
Cable Entry : Top / Bottom		
Accessibility : Front / Back		
MAXIMUM NOS. OF FEEDERS IN ONE PANEL	Circuit Breakers	
	Motor Starters	
	Switch Fuse	
SHEET STEEL TYPE & THICKNESS	Load Bearing member	
	Non Load Bearing member	
	Base Channel	
Material of Gaskets		
Material of External Hardware		
Operating Height : Max. / Min.		
Space Heater Rating of each Panel		
PAINTING	Method of Pre-treatment	
	Type	
	Thickness of Paint	
	Finishing Shade	
Dimensions : L X B X H / Dim. Drg. Ref. No.		
Shipping Dimensions of Largest Package		
Weight : Static / Dynamic		
BUS - BARS		
Material		
SIZE	HBB : Phase / Neutral	
	VBB : Phase / Neutral	
	Ground	
	Supporting Calculations	

	Attached	
MINIMUM CLEARANCE	Between Phases	
	Between Phase & Earth	
Minimum Creepage Distance		
Current Rating : Continuous / Short Time		
Temp. Rise for : Cont. Load / Short Time Current		
SUPPORT	Material	
	BIL	
	Arrangement :Separate/Common	
Material of Bus-bar Insulation		
Shrouding Material for Joints		
No. & Type of Bolts		
CLIENT: M/S RCF	**PROJECT: ULTRA FILTERATION UNIT**	**PLANT: THAL**
ISSUED FOR : PROPOSAL ☐	**ENQUIRY** ☒	**ORDER** ☐ **FINAL** ☐
CIRCUIT BREAKERS		
Make		
Maker's Type		
Ref. Standards		
Type of Circuit Breaker		
Short Circuit Category		
Maximum Operating Voltage		
No. of Poles		
CURRENT RATING	Continuous	
	1 second RMS	
	Momentary (kA Peak)	
BREAKING CURRENT	Symmetrical KA	
	Asymmetrical KA	
	Sym. MVA at Rated Voltage	
Making Current (Peak)		
INSULATION LEVEL	1 Min. PF withstand Voltage	
	Impulse withstand Voltage	
No. of Breaks per Pole		
TYPE AND MATERIAL OF	Main Contacts	
	Arcing Contacts	
Contact Pressure		
Type of Closing Mechanism		
Type of Tripping Mechanism		
Type of Arc Control Device		
Arc Pumping Features with Details		
Trip Free Features with Details		
Total Closing Time		
Interrupting Time at 10%, 50%, 100% of rated Interrupting Capacity	Total	
	Arcing Time	
SPRING CHARGING MOTOR	Rating	
	Voltage	
	Insulation	
	Duty	
Spring Charging Time		
CONTROL VOLTAGE WITH RANGE	Closing	
	Tripping	
	Alarm and Indication	
POWER/ CURRENT REQUIRED FOR	Closing	
	Tripping	
AUXILIARY CONTACTS	No. of Spare Contacts : NO / NC	
	Contact Rating : AC / DC	
	Convertible : Yes / No	
Net Weight of Breaker		
Type Testing Authority & Test Report Ref. No.		
CURRENT TRANSFORMERS		

Make / Maker's Type		
Ref. Standard		
Type of Primary Winding		
Ratio		
Rated Burden		
Accuracy Class		
ALF / ISF		
Insulation Class & Material		
Ref. Magnetisation Curve No.		
CLIENT: M/S RCF	**PROJECT: ULTRA FILTERATION UNIT**	**PLANT: THAL**
ISSUED FOR : PROPOSAL ☐	**ENQUIRY** ☒	**ORDER** ☐ **FINAL** ☐
POTENTIAL TRANSFORMERS		
Make / Maker's Type		
Ref. Standard		
Winding Connection		
Ratio		
Rated Burden		
Accuracy Class		
Insulation Class & Material		
SWITCHES		
Make / Maker's Type		
Ref. Standard		
Type of Switch		
Rated Operational Voltage		
Utilisation Category		
Rated Operational Current		
Short Time Withstand Current		
No. of Poles / Break		
Type Test Certificate Ref. No.		
FUSES		
Make / Maker's Type		
Ref. Standard		
Type of HRC Fuse		
Rated Voltage / Current		
Category of Duty		
Prospective Breaking Current		
CURRENT TIME CURVE SHOWING PRE-ARCING AND TOTAL I^2T VALUES	Ref. No.	
	Attached	
CONTACTORS		
Make / Maker's Type		
Ref. Standard		
Rated Operational Voltage		
Utilisation Category		
Rated Duty		
Rated Thermal Current		
OPERATING VOLTAGE OF COIL	Pick up Max./Min.	
	Drop off Max./Min.	
Coil Consumption Pick up / Hold on		
RELAYS		
Make / Maker's Type		
Ref. Standard		
Operating Principle		
Setting Range		
Type of Mounting		
Burden		
Reset : Hand or Self		
Flag Indication Type		
Ref. Characteristic Curve Type		
Ref. Descriptive catalogue		
INSTRUMENTS AND METERS		
Make / Maker's Type		
Ref. Standard		
Operating Principle		

Scale Range	
Accuracy	
Size	
Type of Mounting	

CLIENT: M/S RCF	PROJECT: ULTRA FILTERATION UNIT	PLANT: THAL
ISSUED FOR : PROPOSAL ☐	ENQUIRY ☒	ORDER ☐ FINAL ☐
CONTROL SWITCHES		
Make / Maker's Type		
Ref. Standard		
Contact Rating		
Utilisation Category		
PUSH BUTTONS		
Make / Maker's Type		
Ref. Standard		
Contact Rating		
Utilisation Category		
SIGNAL LAMPS		
Make / Maker's Type		
Ref. Standard		
Rated Voltage / Watts		
Type of Lamp Holder		
Type of Globe		
MINIATURE CIRCUIT BREAKER		
Make / Maker's Type :		
Ref. Standards		
Rated Current		
Breaking Capacity		
MOULDED CASE CIRCUIT BREAKERS		
Make / Maker's Type		
Ref. Standard		
Current Rating		
Breaking Capacity		
Setting Range of Thermal Release		
Setting Range of Magnetic Release		
CABLE GLANDS		
Material		
Type		
TERMINAL BLOCKS		
Make		
Type		
Current Rating		

Note: Bidder shall submit completely filled-in Technical Particulars.

SPECIFICATION SHEET
LOCAL CONTROL STATION

CLIENT: M/S RCF		**PROJECT: ULTRA FILTERATION UNIT**			**PLANT: THAL**
ISSUED FOR : PROPOSAL ☐		**ENQUIRY** ☒		**ORDER** ☐	**FINAL** ☐
GENERAL			**AMBIENT CONDITION**		
Ref. Stds.: IS/ IEC			Temp. Max./Min./Design Ref.: 40 ^{0}C /9 ^{0}C / 45^{0}C		
Encl. Docs. : Es:8200			Relative Humidity: 90%	Alt. above sea : <1000 M	
Vendor :			**Atmospheric Pollution**	Dusts: Humid & Dusty	
Vendor Ref. No. :				Vapour : : Corrosive vapours of Ammonia	
			Area	Safe : ☒	Hazardous : ☐
Sample : Regd. : ☐		Not Regd. : ☒	**Hazardous Area**	Zone :	
Tests : Routine : ☒		Type : ☐		Temp. Cl.:	
Others:			**Location** :	Indoor ☐	Outdoor ☒

BASIC DATA

Item No.		Type-1 (for LT motor rated 110 KW & above)	Type-2 (for LT motor rated 30 KW & below 110 KW)	Type-3 (for LT motor rated above 5.5 KW & below 30 KW)	Type-4 (for LT motor rated 5.5 KW & below)
Quantity		Equal to the no. of motors	Equal to the no. of motors	Equal to the no. of motors	Equal to the no. of motors
Rated Control Voltage with + %		240V ± 10%	240V ± 10%	240V ± 10%	240V ± 10%
Rated Frequency with +		50Hz ± 5%	50Hz ± 5%	50Hz ± 5%	50Hz ± 5%
Enclosure for Hazardous Area					
Provisions required in LCS					
PUSH BUTTON	Start	✔	✔	✔	✔
	Stop	✔	✔	✔	✔
	Speed Raise	--	--	--	--
	Speed low	--	--	--	--
	Reverse	--	--	--	--
	Forward	--	--	--	--
CONTROL SWITCH	TNC	--	--	--	--
	Lock / Service	--	--	--	--
	OFF / AUTO / ON	--	--	--	--
	Local/Remote	✔	✔	✔	✔
INDICATION LAMP	ON	--	--	--	--
	OFF	--	--	--	--
	Ready to Start/service	✔	--	--	--
	Space Heater ON	✔	✔	--	--
	C.B. tripped	✔	--	--	--
METERS	Ammeter	✔	✔	✔	--
	Range	--	--	--	--
	C.T. Sec. Current	1 Amp	1 Amp	1 Amp	1 Amp
	RPM Meter	--	--	--	--
RAIN HOOD	Regd.	✔	✔	✔	✔
	Not Regd.	--	--	--	--
Control Cable Size XL:PE-A-PVC (Cu)		14 x 2.5 mm^2	12 x 2.5 mm^2 (Cu)	10 x 2.5 mm^2	7 x 2.5 mm^2 (Cu)
Instrument Pair cable for speed raise & low push button & RPM meter (from VFD to LCS)		6Px1.5 Sq.mm (Cu) PVC insulated	6Px1.5 Sq.mm (Cu) PVC insulated	6Px1.5 Sq.mm (Cu) PVC insulated	6Px1.5 Sq.mm (Cu) PVC insulated
Painting Type & Shade		Epoxy, 631 as per IS: 5, Light grey	Epoxy, 631 as per IS: 5, Light grey	Epoxy, 631 as per IS: 5, Light grey	Epoxy, 631 as per IS: 5, Light grey
Period For which Spares Reqd.		2 Years	2 Years	2 Years	2 Years

MAKE OF COMPONENTS

Push Buttons	L & T / SIEMENS / TEKNIC / VAISHNAV
Ammeter	AEP / IMP / MECO / UNIVERSAL
Cable Gland	Baliga / FCG POWER / FEPL / FLEXPRO / FCG FCGPL / R STAHL
Terminal Block	ELEMEX / SIEMENS / L& T

Notes:

1. All incomplete data shall be furnished by the bidder.
2. Code no. of the drive suffixed with LCS shall be marked on each LCS
3. All filled data is tentative, bidder to fill actual data as per actual requirement/ process requirement.

TECHNICAL PARTICULARS
LOCAL CONTROL STATIONS

CLIENT: M/S RCF			PROJECT: ULTRA FILTERATION UNIT			PLANT: THAL
ISSUED FOR : PROPOSAL ☐			ENQUIRY ☒	ORDER ☐		FINAL ☐
			Details of Local Control Stations 🗐			
Sl.No.	ITEM NO.	CODE NO.	DESCRIPTION	IFL	C.T. Ratio	Remarks

Note:

1. - Data, marked as🗐, shall be furnished by the bidder.

TECHNICAL SPECIFICATION FOR WP WELLGLASS FITTINGS

Sr. No.	Description	RCF's Requirement	Bidder has to confirm
A	45W FITTINGS		
1	Make	Philips, Bajaj, Crompton, Havells, Anchor	
2	Lumens Efficiency	100 lm/W ± 5%	
3	Wattage	45 W ± 2W	
4	Operating Voltage continuous:	240V,1 phase 50HZ	
5	Frequency:	50 Hz	
6	Color of LED:	Cool white , No ultraviolet light	
7	Surge & spike protection	4kv AC	
8	Circuit protection:	Over voltage & Short circuit.	
9	Driver Type:	Constant current constant voltage.	
10	LED compliance:	As per LM 80 Confirms to: IS 10322. (copy of test certificate shall be submitted)	
11	Paint	Epoxy grade, grey colour, as per IS 5	
12	Light Color	Cool white 6000K	
13	Material of construction:	Cast Al LM 6 Alloy	
14	Ingress protection :	IP 65	
15	Terminal Box	Shall have Separate Terminal box for supply connection suitable for 3Cx2.5sqmm armored cable with Two nos. of cable entry for supply cable with Loop IN and OUT arrangement.	
16	Cable of entry - Side entry	- 2 nos 3/4" cable glands for connecting armored 3Cx2.5sqmm cable directly. - 2 nos of cable glands shall be supplied along with the fitting. - Extended cable will not be accepted	
17	Light Color:	Cool white 6000K	
18	Dome	Clear Glass/ Polycarbonate.	
19	Optics:	120 Degree Wide Beam	
20	Mounting	Eye-bolt or bracket.	
21	Supply Voltage :	230 V +/- 10%, 50 Hz.	
22	Product catalog	copy to be submitted along with technical bid	
23	Guarantee/Warrantee	36 Months from installation or 42 Months from supply of material	
24	General	Fittings shall have suitable TB for termination of 3C x 2.5 sqmm Armoured cable.	
25	Test certificate	The Vendor Shall Produce Test Certificate From Central Govt. Lab /NABL/ILAC Accredited Laboratory To Prove Conformity Of Specifications As Per NIT Along With The Offer. The Model Number On The Test Certificate Shall Be	

		Same As The Offered Model Number.	

TECHNICAL SPECIFICATION FOR LED STREET LIGHT FITTINGS

Sr. No.	Description	RCF's Requirement	Bidder has to confirm
A	120W STREET LIGHT	Code No. 300126136	
1	System Wattage	120Watt + /-2W	
2	Lumens Efficiency	100 lm/W ± 5%	
B	SPECIFICATIONS		
3	Make	Philips, Bajaj, Crompton, Havells, Anchor	
4	Operating Voltage continuous:	90V-270 VAC	
5	Voltage short time:	440V for 30 sec.	
6	Frequency:	47-53 Hz	
7	Color of LED:	Cool white , No ultraviolet light	
8	Surge & spike protection	4kv AC	
9	Circuit protection:	Over voltage & Short circuit.	
10	Driver Type:	Constant current constant voltage.	
11	LED compliance:	As per LM 80 Confirms to: IS 10322	
12	Material	Pressure die Cast Aluminum Housing	
13	Surface Finish	Light Grey/black	
14	Optics:	120 Degree Wide Beam	
15	Mounting -	external pole mounting on 45 to 60mm diameter pipe	
16	Cable Entry :	Through mounting pipe	
17	LED Make:	Nichia, Phillips, Cree, Osram or reputed make	
18	Ingress Protection	IP65	
19	Fasteners	All external fasteners should be of SS304.	
20	Efficacy of LED	minimum 100 lm/W ± 5%	
21	CRI of LED	>80	
22	Rated Life of LED	50,000 burning hours	
23	THD	<15%	
24	CCT	5600- 6500 K	
25	Starting	Flicker free & Instant Start	
26	Power Factor	>0.90	
27	Case Temp	<65 Degrees Cent. With heavy heat sink	
28	Operating temp	10 to 50 Degrees Cent.	
29	Terminal Box	Fittings shall have suitable TB for termination of 3C x 2.5 sqmm Armoured cable for supply connection with Two nos. of cable entry for supply cable with Loop IN and OUT arrangement.	
30	Guarantee / Warrantee	36 Months from installation or 42 Months	

		from supply of material	
31	Product catalogue	Copies shall be submitted along with technical bid.	
32	Test certificate	The Vendor Shall Produce Test Certificate From Central Govt. Lab /NABL/ILAC Accredited Laboratory To Prove Conformity Of Specifications As Per NIT Along With The Offer. The Model Number On The Test Certificate Shall Be Same As The Offered Model Number	

TECHNICAL SPECIFICATION OF LED FLOOD LIGHT FITTINGS

Sr. No.	Description	RCF's Requirement	Bidder has to confirm
A	200W WP FLOOD LIGHT	Code No. 300129403	
1	Minimum Lumens for200W	16000 Lumens	
2	System Wattage	Watt , tolerance as per BIS	
B	SPECIFICATIONS		
1	Make	BAJAJ,PHILIPS,ANCHOR,HAVELS	
2	OperatingVoltage continuous:	90V-270 VAC	
3	Voltage short time:	440V for 30 sec.	
4	Frequency:	47-53 Hz	
5	Color of LED:	Cool white , No ultraviolet light	
6	Surge & spike protection	4kv AC	
7	Circuit protection:	Over voltage & Short circuit.	
8	Driver Type:	Constant current constant voltage.	
9	LED compliance:	As per LM 80 Confirms to: IS 10322 (copy of test certificate shall be submitted)	
10	Material	LM 6 / Tempered Glass	
11	Surface Finish	Light Grey/black	
12	Optics:	120 Degree Wide Beam	
13	Mounting -	304 Stainless steel turning mounting bracket included	
14	Cable Entry :	Through 2 no's 3/4" ET glands for connecting armored 3Cx2.5sqmm cable directly. Extended cable without glands will not be accepted. 2 nos of cable glands shall be supplied along with the fitting.	
15	LED Make:	Nichia, Phillips, Cree, Osram or reputed make	
16	Ingress Protection	IP65	
17	Fasteners	All external fasteners should be of SS304.	
18	Efficacy of LED	minimum 90 lm/W	
19	CRI of LED	>80	
20	Rated Life of LED	50,000 burning hours	
21	THD	<15%	
22	CCT	5600- 6500 K	
23	Starting	Flicker free & Instant Start	
24	Power Factor	>0.90	
25	Case Temp	<65 Degrees Cent. With heavy heat sink	
26	Operating temp	10 to 50 Degrees Cent.	
27	Terminal Box	Fittings shall have suitable TB for termination of 3C x 2.5 sqmm Armoured cable for supply connection with Two nos. of cable entry for supply cable with Loop IN and OUT arrangement.	
28	Guarantee / Warrantee	36 Months from installation or 42 Months from supply of material	
29	Test certificate	The Vendor Shall Produce Test Certificate From Central Govt. Lab /NABL/ILAC Accredited Laboratory To Prove Conformity Of Specifications As Per NIT Along With The Offer. The Model Number On The Test Certificate Shall Be Same As The Offered Model Number	
30	Product catalogue	Copies shall be submitted along with technical bid.	

SPECIFICATION SHEET
LT POWER & CONTROL CABLES

CLIENT: M/S RCF		**PROJECT: ULTRA FILTERATION UNIT**			**PLANT: THAL**
ISSUED FOR : PROPOSAL ☐	ENQUIRY ☐	ORDER ☒	FINAL ☐		

GENERAL	**AMBIENT CONDITION**	
Encl. Docs. : ES:8160	Temp. Max./Min./Design Ref. 45 /11/ 45 °C	
Vendor :	Relative Humidity: 100 % Max.	Relative Humidity: 100 % Max.
Vendor Ref. No. :	**Atmospheric Pollution**	Dusts : Urea Dust, Sand Dust
		Vapours : Ammonia Vapour, Sea Chlorides

TESTS TO BE WITNESSED: Routine ☒ Type ☐ Acceptance ☒ Others ☐

Type Tests Certificate of Similar Cable : Required ☒ Not required ☐

BASIC DATA

Item No.		**1-10**	**11-16**	**17-19**
Ref. Stds.		IS:7098 (PART-1)	IS:7098 (PART-1)	IS:7098 (PART-1)
Voltage Grade		1.1 KV POWER CABLE	1.1 KV CONTROL CABLE	1.1 KV EARTHING CABLE
System Earthing		NEUTRAL SOLIDLY EARTHED	NEUTRAL SOLIDLY EARTHED	NEUTRAL SOLIDLY EARTHED
Type of Cable		POWER	CONTROL	EARTHING
CONDUCTOR	ALUMINIUM/ COPPER	ALUMINIUM / COPPER	COPPER	ALUMINIUM
	STRANDED	STRANDED	STRANDED	STRANDED
Insulation Type		XLPE EXTRUDED	XLPE EXTRUDED	XLPE EXTRUDED
Inner Sheath Type		EXTRUDED PVC (ST2)	EXTRUDED PVC (ST2)	--
CONDUCTOR SCREEN	Required	--	--	--
	Not Required	--	--	--
Material of Conductor Screen		--	--	--
Core Identification		**Individual cores shall be numbered (Alpha – Numeric) along the length for 7Core and above control cables.**		
ARMOURING	Required	YES	YES	--
	Material	GALVANISED STEEL WIRE	GALVANISED STEEL WIRE	--
	No.of Layer	SINGLE	SINGLE	--
Outer Sheath Type		EXTRUDED FRLS PVC TYPE-ST2	EXTRUDED FRLS PVC TYPE-ST2	EXTRUDED FRLS PVC TYPE-ST2
Special Requirements		--	--	--
Drum Material		Refer Remarks under Bill of Quantity		

BILL OF QUANTITY

Item No.	No. of Core & Cross-Sectional Area in Sq. mm.	Qty. in M.	Preferred Drum Length	Remarks
1.1 KV XLPE insulated, armoured, FRLS PVC outer sheathed, Power cable of following size:-				
1.1 KV XLPE insulated, armoured, FRLS PVC outer sheathed, Control cables of following size:-				
Single Core 1.1 KV XLPE insulated, unarmoured FRLS cable for earthing of following sizes:-				
1.				

TECHNICAL PARTICULAR
CABLES

CLIENT: M/S RCF	PROJECT: ULTRA FILTERATION UNIT	PLANT: THAL
ISSUED FOR : PROPOSAL ☐	ENQUIRY ☒	ORDER ☐ FINAL ☐

GENERAL		
Make		
Ref. Standard		
Item No.		
Voltage Grade		
Suitable For Earthed / Unearthed System		
No. of Cores & Size of Conductor		
CONSTRUCTIONAL DETAILS		
CONDUCTOR	Material	
	Construction	
	No. & Dia of wires per Core	
CONDUCTOR SCREEN	Material	
	Thickness	
INSULATION	Material	
	Thickness	
	Core Identification Method	
INSULATION SCREEN	Material	
	Thickness	
INNER SHEATH	Type & Material	
	Thickness	
ARMOURING	Type & Material	
	Dia of Wire / Strip Thickness	
OUTER SHEATH	Material	
	Thickness	
ELECTRICAL DATA		
CONTINUOUS CURRENT RATING WHEN LAID IN	Ground At 30^0 C	
	Air At 40^0 C	
Short Circuit Current For 1 sec.		
CONDUCTOR TEMP.	Continuous	
	Short Time	
Resistance At Operating Temp. (Ohm / KM)		
Reactance At 50 C/S (Ohm/KM)		
Capacitance (F/Km)		
Insulation Resistance		
Polarisation Index		
DERATING FACTOR CHART ATTACHED FOR	Temperature	
	Grouping	
	Exposure to Sun	
MECHANICAL DATA		
DIAMETER WITH TOLERANCE	Over Inner Sheath	
	Over Armour	
	Overall	
Weight Of Cables Per KM		
Minimum Bending Radius		
Maximum Pulling Tension		
Standard Drum Length		
Tolerance On Drum Length		

Notes: i) This Technical Particular shall be furnished separately for each type & size of cable and submitted for approval.

CLIENT: M/S RCF	PROJECT: ULTRA FILTERATION UNIT	PLANT: THAL
ISSUED FOR : PROPOSAL ☐	ENQUIRY ☒	ORDER ☐ FINAL ☐

GENERAL	
Item No.	VFD
Rated Output / Voltage	
Make	
Maker's Type	
Codes and Standards applicable	IEC60076. IEC61378, IS-2026
Enclosed Documents	ES8102(Engineering Standard of Motor)ES-8043 (Engineering Standard-Power Transformer)
TECHNICAL DATA	
Type of the drive, make & model	
Whether facility to hook up with DCS through auto controller.	Yes
Capacity in KW (Heavy Duty)	
Basic Load current	
IP Class	IP - 43
Starting current of motor through VFD	1X Full load current of motor
Standard Protection	To be provided as per specifications.
Reactor (Input & Output)	
Sine filter	Output sine filter to be provided
DC reactor	
Carrier frequency	
Output frequency stability	0.01 Hz
Provision to vary speed from control room through DCS	To be Provided
Whether VSDU is suitable for longer cable lengths	
Whether programming can be done for jumping over critical speeds	
Noise level during operation with all normal cooling Fans operating.	To be provided as per specifications.
Whether speed setting provision for low & high is provided.	Required
Speed control range	
Acceleration & deceleration time	Programmable at site (Party to provide range)
Output frequency range	
Input voltage of the drive	----- +/- 10%
Output voltage of the drive	Party to specify
Nominal drive output power	Party to specify
Nominal drive output current	Party to specify
Continuous overload ability	Party to specify
Short term overload ability	150% for 60 Seconds
Maximum heat loss	Party to specify
Accuracy of speed control	0.1%
Cooling method (if air then redundant air fan)	To be Provided
Ambient operating temperature range.	0 to 45 ^{o}C
Air conditioner requirement	Party to specify
Air flow requirement	Party to specify
Air filter requirement	Party to specify
Input Bridge (Pulse Configuration)	24 pulse
Dimensions	Party to specify
Weight	Party to specify
Total Harmonic distortion	As per IEEE 519 Standards / IEC 61800-4
Output waveform	Sine wave
Humidity limits	95% R.H.
Low harmonics	As per IEEE 519 standards
Higher harmonics	As per IEEE 519 standards
Drive de-rating factor per degree after design temperature of 40^{0}C	Party to specify
Two year recommended spare details	
Compatibility of variable speed drive with DCS	To be Provided
Efficiency of the drive	>97% as per specifications
Whether built in auto controller is provided?	Party to specify
Cabling Data — Power	
Cabling Data — Control	
Cabling Data — Instrument	

TECHNICAL DATA FOR TRANSFORMER		
GENERAL		
Quantity		1
Type		
Cooling method		
Installation		
Rated Apparent Power		
Rated Voltage MV Side		
Highest Voltage MV Side		
Rated Current MV Side		Later
Rated Frequency		50 Hz ± 5%
Combined Voltage & Frequency variation		± 10%
Fault MVA		
Number of secondary windings		
Rated Voltage LV Side		
Impedance Voltage HV-LV (U_{cc})		
Degree of Protection		IP 55
Sound Pressure Level		
Winding material		Copper
Efficiency		Later
INSULATION SYSTEMS		
Insulation level – HV side (Highest/ Power freq./ Impulse)		
Insulation level – LV side (Highest/ Power freq./ Impulse)		
Temperature Rise Oil		50 Degree Celsius
Temperature Rise Windings		55 Degree Celsius
Insulation Class		A
TAP CHANGERS		
Type		Off-Load
Tapping Range/ Number		-5% to +5% / 5 nos. @ 2.5%
Rating / Voltage Ratio		
Rated Current - Primary / Secondary		
Rated No Load Current		
Temp. Rise over Ambient - Oil / Winding		
Load Loss at Rated Current at 75°C		
No Load Loss at Rated Voltage / Copper Loss		
Full Load Efficiency at CosΦ - Unity / 0.8 Lag		
Maxm. Efficiency & Load at which it occurs		
Full Load Regulation at CosΦ - Unity / 0.8 Lag		
Short Circuit Withstand Capacity		
B max. at Rated V & F (Tesla)		
Excitation Loss per Kg. at B max.		
INSULATION GRADED / UNIFORM	Primary	
	Secondary	
Induced Over Voltage Withstand Capacity : Pri / Sec.		
OLTC : Rated Voltage / Rated Current		
Total Auxiliary Power Requirement : AC / DC		
CONTROL PANELS	Sheet Metal Thickness	
	Enclosure Type	
	Control Scheme Ref. No.	
Cooling Fans : Qty. / Rating		
MECHANICAL DATA OF TRANSFORMER		
Core : Material & Grade		
Winding Type : Pri. / Sec.		
INSULATING MATERIAL	Between Turns	
	Between Primary & Secondary	
	Between Core & Winding	
RADIATORS	Cooling Tubes / Separate Bank	
	Thickness	
	Vacuum Withstand Capacity	
TANK	Material	
	Thickness : Side / Bottom / Cover	
	Vacuum Withstand Capacity	
	Over Pressure Capacity	
DIMENSIONS	Overall (LXBXH)	
	Roller C/L	
	Largest Package (LXBXH)	

Minimum Height required to lift the Core		
WEIGHT	Core & Winding	
	Total	
	Heaviest Package	
Oil Quantity in Litres		
Noise Level		
BUSHING DATA (PRI. / SEC. / NEUTRAL)		
Type & Make		
Ref. Standard		
Rated Voltage		
Rated Current		
Creepage Distance		**Heavily Polluted (31MM/KV)**

Note: All unfilled data shall be filled by the vendor and submitted for approval.

ENGINEERING STANDARD

SHEET STEEL DISTRIBUTION BOARDS

REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD
2	20.01.07	01.02.07	ISSUED FOR IMPLEMENTATION	AV	BKC / SC	BB
1	16.01.06	30.01.06	ISSUED FOR IMPLEMENTATION	AV	BKC	BB
0	OCT. '97	--	ISSUED FOR IMPLEMENTATION	RNS/JKT/SC	JKT	HSW

CONTENTS

1.0 SCOPE

1.1 This standard covers the technical requirements of design, manufacture, testing at works and delivery in well-packed condition of Sheet Steel Distribution Boards.

1.2 This standard shall be read in conjunction with relevant Specification Sheets and Feeder details.

2.0 STANDARDS TO BE FOLLOWED

2.1 The design, manufacture and testing of the equipment shall comply with the latest issue of the following Indian Standards, unless otherwise specified. Equipment complying with equivalent IEC standards shall also be acceptable.

IS: 8623	-	Specification for low voltage switchgear and control gear assemblies.
IS: 13947	-	Specification for Low-voltage Switchgear and Control gear
IS: 5578	-	Guide for marking of insulated conductors.
IS: 11353	-	Guide for uniform system of marking and identification of conductors and apparatus terminals.
IS: 10118	-	Code of practice for selection, installation and maintenance of switchgear and control gear.

Various components housed in the distribution board shall conform to the Indian Standard Specification as mentioned against the component details.

2.2 The design and operational features of the equipment offered shall also comply with the provisions of the latest issue of the Indian Electricity Rules and other Statutory Acts and Regulations. The supplier shall, wherever necessary, make suitable modifications in the equipment to comply with the above.

2.3 Wherever any requirement, laid down in this standard, differs from that in Indian Standard Specification the requirement specified herein shall prevail.

3.0 SERVICE CONDITIONS

3.1 Ambient Conditions

These shall be as indicated in Specification Sheet.

3.2 System Details

These shall be as indicated in Specification Sheet.

4.0 OPERATING REQUIREMENTS

The distribution board shall be suitable for operating at the specified rating continuously with the specified voltage and frequency variations under the

ambient conditions indicated in Specification Sheet, without exceeding the permissible temperature rise and without any detrimental effect on any part.

5.0 DESIGN AND CONSTRUCTIONAL FEATURES

5.1 General

5.1.1 The distribution board shall consist of an assembly of a series of floor mounting, identical, metal clad, dead front type panels of unitized design. The panels shall be placed side by side to form a compact assembly and shall be extensible on either side.

5.1.2 The complete assembly shall be dust, damp and vermin proof having minimum degree of protection equivalent to IP-52 as per IS: 13947.

5.1.3 The frame work of the cubicles shall be of bolted/welded construction. The minimum thickness of steel shall be 2 mm for load bearing members, 1.6 mm for non-load bearing members and 3 mm for base channel. The doors and covers shall be fabricated from cold rolled sheet steel. Suitable reinforcement, wherever necessary, shall be provided.

5.1.4 The door hinges shall be concealed type.

5.1.5 All external hardware shall be cadmium plated/zinc passivated. The hardware for fixing the removable parts shall be provided with retaining devices.

5.1.6 The doors and the removable covers shall be provided with non-deteriorating neoprene gaskets. Gaskets without any discontinuity shall be preferred. Gaskets shall be held in position in groove of shaped sheet steel work or these shall be of U type. Adhesive cement, if used, shall be of good quality so that the gaskets do not come off during service.

5.1.7 All the components shall be accessible for inspection and maintenance without the necessity for removal of the adjacent ones. In case of single front design all components shall be accessible from the front for maintenance and back opening doors/ openable covers for maintenance shall not be acceptable.

5.1.8 The layout of the components inside a module shall be liberal to facilitate maintenance and the interconnection of wiring between the components shall not be subjected to any undue stress at the bends.

5.1.9 Mounting height of components requiring operation and observation shall not be lower than 300 mm and higher than 1800 mm.

5.1.10 Inter panel barriers shall be provided.

5.1.11 Adequate arrangement for earthing shall be provided to safeguard the operator or other personnel from electric hazards under all conditions of operation.

5.2 Panel Arrangement

5.2.1 The distribution board shall be drawout / non-drawout type in single front/double front configuration as specified in Specification Sheet.

5.2.2 Each Panel shall have its horizontal bus-bar chamber running on the top with multi-tier module units in the centre and having vertical bus-bar chamber and cable alley on either side.

5.2.3 The modules shall be enclosed on all sides and shall be so arranged that larger ones are placed at the bottom portion of the panel. Fixed type modules shall be at least 300 mm from the base channel.

5.2.4 The number of modules in the panel shall not exceed six for motor starter feeders and eight for switch fuse/MCB/MCCB feeders. The minimum size of module shall be 300 mm and 200 mm for starter and switch fuse feeders. The incomer and bus coupler module sizes for ratings up to 400 A shall be half the panel size. For higher ratings they shall be housed in single panel.

5.2.5 The module door shall be so interlocked that it shall not be possible to open the door with switch in closed position. Defeat interlock facility shall be provided.

5.2.6 The relay, meters, switches and lamps shall be flush mounted. All components of one module shall be mounted on the same module on a rigid sheet steel chassis. A 20 mm dia. rotating knob on the door shall be provided for closing and opening.

5.3 Bus Bars and Connections

5.3.1 The bus-bar shall be suitable for the supply system specified in the Specification Sheet. The bus-bar and connections shall be made of electrolytic copper or high conductivity aluminium alloy conforming to Grade E91E of IS: 5082.

5.3.2 The bus-bar shall be amply sized to carry the rated continuous current under the specified ambient temperature without exceeding the temperature of 90ºC. The bus-bars shall also be designed to withstand the system fault current for 1 second without exceeding the temperature of 200ºC for bare aluminium and 250ºC for bare copper. The minimum acceptable size of bus-bars shall be 250 sq. mm (Al). Calculation for the bus-bar sizing shall be furnished along with the offer.

5.3.3 In case of double front arrangement of distribution boards, different sets of vertical bus-bars shall be provided. The vertical bus-bars shall be PVC sleeved or shrouded by insulating barriers which shall have cut-outs to permit entry of power wires. It shall be possible to remove the shroud for inspection and maintenance. Neutral-bars shall be provided in this chamber.

5.3.4 Horizontal bus-bars shall be of same cross-section through out. Stepped bus-bars shall not be acceptable.

5.3.5 All bus-bars shall be arranged and colours coded according to IS: 5578/11353.

5.3.6 The horizontal bus-bar shall run in a separate bus chamber located at the top shall have separate screwed cover for inspection purpose.

5.3.7 The bus-bars shall be rigidly supported at equal intervals to withstand maximum short circuit stresses. The supports shall be of moulded construction with built in anti tracking barriers. The support material shall be of fibre glass reinforced thermosetting plastic.

5.3.8 All joints shall be suitably treated to avoid oxidation of contact surfaces and bimetallic corrosion. A minimum of two bolts with spring washers shall be used for horizontal bus-bar joints.

5.3.9 Horizontal bus bars shall be insulated with heat shrinkable PVC sleeves of reputed makes. Insulating shrouds shall be provided for all joints of insulated bus-bars.

5.4 Clearance and Creepage Distances

5.4.1 The clearance and creepage distances shall not be lower than the values specified below :

i)	Minimum clearance between two live conductors	--	20 mm
ii)	Minimum clearance between live part and accidentally dangerous part	--	20 mm
iii)	Minimum creepage distance	--	28 mm

5.4.2 The clearances and the creepage, as specified above, shall definitely be maintained in the bus-bar system. Provision of bus-bar insulations, separator or barriers shall not be considered to reduce the clearance from the values specified above.

5.4.3 At the termination points in the equipment, e.g. switches, contactors, thermal relays, etc. it is realized that above clearance shall not always be possible to be maintained. All such points where above clearance are not possible to be maintained shall, therefore, be insulated or taped.

5.5 Insulation

5.5.1 The insulation used shall be non-hygroscopic and shall be of porcelain, Epoxy-resins or fibre glass moulded with plastic. It shall be of adequate electrical and mechanical strength to give trouble free service during normal operation and short circuit conditions.

5.5.2 The insulation shall be treated suitably to withstand the tropical conditions and atmospheric pollution as specified in Specification Sheet.

5.6 Power Wiring

5.6.1 The connections from bus-bar including neutral to individual units on the modules shall consist of PVC insulated flexible copper cable or tapped copper strip.

5.6.2 The power wiring size shall be decided based on the rating of the switch, after using a rating factor of not more than 50% over the current rating in free air. In any case the minimum size of power wiring shall not be less than 4 sq. mm copper.

5.6.3 The size of connection from incomer to horizontal bus-bar and from horizontal bus-bar to bus coupler shall not be less than the size adopted for horizontal bus-bar.

5.7 Control Wiring

5.7.1 The switch board shall be completely factory wired and ready for external connections.

5.7.2 The wiring shall be carried out with flexible stranded PVC insulated copper conductor cables of 1100 Volt grade. The size of wires shall be as follows:

C.T. Circuit -- 2.5 sq. mm

V.T. and Control Circuits -- 1.5 sq. mm

5.7.3 All wiring shall be provided with dependent both end marking as per IS: 5578. Numbered ferrules, reading from the terminals outwards, shall be provided at both ends of all wiring for easy identification. These shall be interlocking type plastic ferrules.

5.7.4 Control wiring circuits, fed from a supply common to a number of feeders, shall be so protected that failure of a circuit in one feeder does not affect the operation of the other feeders.

5.7.5 The wiring to the equipment mounted on the doors shall be carried out with flexible multi strand copper conductor cable and supported so that opening of the door, there is no undue strain on wire leads.

5.7.6 The control cables shall be neatly arranged and properly supported.

5.8 External Cable Termination

5.8.1 All power and control cables shall enter the distribution board from the bottom unless otherwise specified in Specification Sheet. Sufficient space shall be provided for ease of connection and termination of cables.

5.8.2 All cables shall be of 1.1 KV grade PVC insulated armoured and PVC sheathed except for single core cable which shall be unarmoured. The number and sizes of cable shall be as indicated in Feeder details.

5.8.3 Compression type cable glands along with the cable lugs as required shall be provided for termination of cables.

5.8.4 The cable glands shall be of rolled Aluminium or Nickel/Cadmium plated brass heavy duty double compression type and shall be mounted on a removable gland plate, provided at a minimum height of 75 mm from the bottom of the distribution board. Two numbers spare knockouts of size 20 mm shall also be provided on the gland plates for future use.

5.8.5 For all power cables crimped type aluminium lugs for aluminium cables and tinned copper lugs for copper cables shall be provided.

5.8.6 The terminal blocks shall be pressure clamp type up to 35 sq. mm cable and bolted lug type for higher sizes of cables. These shall be protected type and rated for 1100 Volts service. The minimum current rating of terminal block shall be 16 Amp. The construction shall be such that after the connection of cables by means of lugs, necessary clearance and creepage distance are available.

5.8.7 Where more than two cables in parallel are required to be terminated, a system of bus links shall be provided with adequate clearance and spacing.

5.8.8 Suitable clamps to support the vertical run of cables shall be provided.

5.8.9 The terminal block shall be grouped according to circuit functions and suitably numbered. 20% extra terminals shall be provided in the terminal block.

5.8.10 For power connections, suitable marking on the terminals shall be provided to identify the phases.

5.9 **Feeder Details**

5.9.1 The requirements of incomer, bus coupler and outgoing feeders shall be as indicated in the single line diagram, feeder details and corresponding schematic diagram.

5.9.2 The bus coupler shall be so located that it is possible to maintain half of the bus-bars while the other half is still alive. Complete segregation of bus-bar connections to bus coupler shall be provided.

5.9.3 Castle key type mechanical interlocks shall be provided between incomers and bus section modules to avoid paralleling of incomers. In addition padlocking facilities shall be provided in OFF position.

5.9.4 Single phase loads shall be distributed as far as possible on all the three phases.

6.0 COMPONENT DETAILS

6.1 The make of the components shall be as specified in Specification Sheet and shall conform to type of co-ordination C as per IS: 13947.

6.2 **Moulded Case Circuit Breakers**

6.2.1 The circuit breaker shall conform to IS: 13947 (Part 2) and shall be of P2 category having rupturing capacity as specified in Specification Sheet.

6.2.2 The circuit breaker shall be provided with spring assisted quick make quick break type manually operated trip free mechanism, mechanical ON/OFF position indicators, thermal tripping devices of inverse characteristics, instantaneous short circuit tripping devices and necessary auxiliary and alarm switches. The MCCB cubicle shall be provided with service, test and isolated position and automatic safety shutter.

6.2.3 The thermal and short circuit tripping device shall be adjustable type.

6.2.4 When used for motor circuit shunt trip devices shall be provided and the let through power of controlling MCCB shall be lower than the respective contactor.

6.2.5 In addition, under voltage trip shall be provided, if specified.

6.3 **Switches**

6.3.1 The switches shall be Motor duty type AC23 category and shall comply with the requirements laid down in IS: 13947 (Part 3). Switches up to 63 Amps shall be rotary type and those of 100 Amp and above shall be link type.

6.3.2 ‘ON’ and ‘OFF’ positions of the switches shall be indicated on the panel. Provision shall be made to lock the switch in the ‘OFF’ position.

6.3.3 The fixed contacts shall be shrouded and the contacts shall be silver plated.

6.3.4 Two Pole switches shall also isolate the neutral circuit along with phase circuit. 4 Pole / 2 Pole switches shall be used for 3 Phase/1 Phase circuits respectively.

6.4 **Fuses**

The fuses shall be of non-deteriorating HRC cartridge link type and conform to IS: 13703. They shall be suitable for the load and the service required in the circuit.

6.5 **Air Break Contactors**

6.5.1 The Air Break Contactor shall be of AC3 category unless otherwise specified, conforming to IS: 13947 (Part-4) and flapper type. Gravity operated contactors are not acceptable.

6.5.2 The dropout voltage shall not exceed 65% of rated voltage.

6.5.3 Each contactor shall be provided with auxiliary contacts as required. The rating of the auxiliary contacts shall be 5 Amps. AC or 1 Amp DC at the specified control voltages. The spare auxiliary contacts shall also be wired terminal block.

6.6 **Bimetal Thermal Overload Relays**

6.6.1 The contactor shall be provided with three pole bimetal thermal overload relays unless otherwise specified. The bimetal relays shall be of suitable range, ambient temperature compensated and shall be separate mounting type. They shall be adjustable through graduated scale and shall be provided with changeover contact.

6.6.2 Bimetal relays shall conform to IS: 3231 and shall have built in single phasing preventor.

6.6.3 The bimetal relays shall be provided with a manual reset device resetable after opening the cubicle door. Auto reset thermal relays are not acceptable.

6.7 **Current Transformers**

6.7.1 The current transformers shall conform to IS: 2705.

6.7.2 Current Transformers shall be Class-F insulated and vacuum impregnated. The Current Transformers shall be rigidly mounted and shall be easily accessible for maintenance and testing.

6.7.3 The Current Transformers shall be of 7.5 VA output. The output shall be adequate for the instrument and metering duties involved with sufficient margin. The Current Transformers shall have the accuracy Class-1 for the metering duty.

6.7.4 All the Current Transformers shall be provided with terminals and shorting links. One of the terminals of C.T. shall be earthed. The polarity of the C.T. shall be clearly marked.

6.7.5 The C.T.s shall be capable of withstanding momentary open-circuit on the secondary side without injurious effects.

6.8 **Instruments and Meters**

6.8.1 All instruments shall be flush mounting type with square face and shall be tropicalized and dust tight.

6.8.2 The size of the instruments shall be 96 mm x 96 mm for full and half size modules and 72 mm x 72 mm for lower size modules.

6.8.3 Dials shall be parallax free with scale marked in black on white background and shall be suitable for direct reading.

6.8.4 Zero adjusters shall be provided for operation from the front of the cases.

6.8.5 All ammeters and voltmeters shall have 0 - 240º scale moving iron spring controlled type and of Class 1.5 accuracy as per IS: 1248. The scale range of the ammeter and voltmeter shall be as indicated in the feeder details.

6.8.6 In case of motor feeders, the ammeter shall be graduated uniformly upto C.T. primary current and with a compressed end scale upto 6 times the C.T. primary current. Red pointer shall be provided, which can be adjusted at site for indicating full load current.

6.8.7 KWH meter shall be 3 phase 4 wire type. These shall conform to the requirements of relevant IS and shall be C.T. operated. The current coil shall be rated for 5 Amp.

6.8.8 All kWh meters shall be provided with test blocks for current and voltage coils for testing them at site without interrupting their recording while in service.

6.9 Push Button and Control Switches

6.9.1 The switches and push buttons shall conform to utilization category AC 11/DC 11 as per IS: 13947 (Part-5). The contact shall be rated to make, break and carry inductive current of 5 Amp. at 415 V AC and 1 Amp at 220 V DC.

6.9.2 The control switches shall be spring return rotary type unless otherwise specified and provided with pistol grip type handle. The control switches for circuit breakers shall be additionally fitted with lost motion devices and sequencing devices.

6.9.3 The selector switches shall be stay-put rotary type and provided with oval shape handles.

6.9.4 The push buttons shall be of momentary contact spring loaded type with a set of normally close and open contacts. The push button for ‘Start’ shall be shrouded type and coloured green, stop push button shall be un-shrouded type and coloured red and other push buttons shall be un-shrouded type coloured black. The fixing ring shall be metallic white.

6.9.5 Emergency stop push buttons, if specified, shall be lockable in pushed position.

6.10 Miniature Circuit Breakers

6.10.1 The miniature circuit breakers shall conform to IS: 13032 and shall be of duty category M-9.

6.10.2 It shall be provided with overload and short circuit protective devices in a heat resistant housing.

6.10.3 A certificate of short circuit rating and current time tripping curve shall be furnished alongwith the offer.

6.11 **Signal Lamps**

6.11.1 Signal lamps shall be provided to indicate the various circuit conditions as shown in scheme drawings. The colour of the lamps for various functions shall be as follows:

Red	--	Switch/Contactor closed.
Green	--	Switch/Contactor open.

6.11.2 The lamps shall be LED type having lumen output 200 milli candela in axial direction.

6.11.3 It shall be possible to remove the globe from outside for replacement of lamps.

7.0 ACCESSORIES

7.1 The supplier shall include the following accessories.

-- Fuse Puller.

-- Test plug for kWh meters.

7.2 **Space Heater**

Each vertical section shall be provided with a thermostatically controlled space heater, rated for 240 V, 50 Hz and controlled through double pole miniature circuit breaker.

7.3 **Name Plates**

7.3.1 The distribution board shall have large name plate on the top to indicate its name and designation.

7.3.2 Each feeder shall be provided with name plate. Each single front panel shall have name plate both in front and back.

7.3.3 All control switches, push buttons, lamps etc. shall have functional identification labels.

7.3.4 Name plate shall be of black perspex with white engraving and of minimum 3 mm thick.

7.3.5 Any other accessories required, but not specified shall also be supplied to make the distribution board complete in all respects to ensure safe and proper operation.

8.0 PAINTING

8.1 The enclosure after degreasing, pickling in acid, cold rinsing phosphatising, passivating etc. shall be painted with two coats of anti-rust paint followed by two coats of anticorrosive paint.

8.2 Epoxy based paint shall be used, if indicated in Specification Sheet.

8.3 All paints shall be carefully selected to withstand tropical heat and extremes of weather. The paint shall not scale off, crinkle or be removed by abrasion due to normal handling.

8.4 Unless otherwise specified, the finishing shade shall be light grey Shade No.631 as per IS: 5.

8.5 One litre of paint shall be supplied along with each board for touch up at site.

9.0 TESTS AND INSPECTION

9.1 The distribution boards shall be subjected to routine test as per IS: 8623.

9.2 Additional tests, wherever specified, shall be carried out.

9.3 All the above tests shall be carried out in presence of purchaser's representative. In addition, the equipment shall be subjected to stage inspection during process of manufacture at works and site inspection.

9.4 These inspections shall however, not absolve the vendor from his responsibility for making good any defect which shall be noticed subsequently.

10.0 DRAWINGS AND DOCUMENTS

10.1 Drawings and documents as per Annexure-I shall be supplied unless otherwise specified.

10.2 All drawings and documents shall have the following description written boldly:

- Name of client
- Name of consultant
- Enquiry / Order Number with plant / project name
- Code No. and Description

11.0 SPARES

11.1 Spares for operation and maintenance

Item wise unit prices of spare parts with recommended quantity shall be quoted along with the equipments as listed in the Annexure-II for the period as stipulated in specification sheet.

11.2 Commissioning Spares

Commissioning spares, as required, shall be supplied with the main equipment. Item wise list of recommended commissioning spares shall be furnished for approval.

11.3 Any other spare parts not specified, but required, shall also be quoted along with the offer.

11.4 All spare parts shall be identical to the parts used in the equipments.

12.0 PACKING

12.1 The distribution board shall be properly packed before despatch to avoid damage during transport, storage and handling.

12.2 The packing box shall contain a copy of the installation, operation and maintenance manual.

12.3 A sign to indicate the upright position of the panels to be placed during transport and storage shall be clearly marked. Also proper arrangement shall be provided to handle the equipment.

13.0 DEVIATIONS

13.1 Deviations, if any, from this standard shall be clearly indicated in the offer with reasoning.

13.2 Deviations, if any, from the data furnished in specification sheet shall be indicated therein beside the data by encircling it.

ANNEXURE - I

DOCUMENTATION FOR SHEET STEEL DISTRIBUTION BOARDS

Sl.No.	Documents	Documents Required (Y / N)		
		With Bid	For Approval	Final
1.	Specification Sheet, duly completed	Y	Y	Y
2.	Technical Particulars, duly filled-in	Y	Y	Y
3.	Feeder Details	Y	Y	Y
4.	General Arrangement and Foundation Drawings	Y	Y	Y
5.	Schematic Diagrams with Terminal arrangement drawings	N	Y	Y
6.	Calculation for Bus-bar sizing	Y	Y	N
7.	Illustrative and Descriptive literature	Y	N	Y
8.	Catalogues for bought out accessories	Y	N	Y
9.	Installation, Operation and Maintenance Manual	N	N	Y
10.	Test Certificates			
	-- Type (for MCCB & MCB)	Y	N	N
	-- Routine	N	N	Y
11.	Guarantee Certificates	N	N	Y
12.	Spare Parts List	Y	N	Y

Note:

1. 4 hard copies & 1 soft copy shall be supplied with bid.
2. 4 hard copies & 1 soft copy shall be supplied for approval after order within 4 weeks from the date of LOI.
3. 8 hard copies & 2 soft copies in CD 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

ANNEXURE - II

LIST OF SPARES

The following spare parts shall be quoted along with the offer.

A **MOULDED CASE CIRCUIT BREAKER** (OF EACH RATING)
- i) Complete Breaker Assembly
- ii) Complete Breaker Assembly.

B **SWITCHES** (OF EACH RATING)
- i) Assembled switch in open execution
- ii) Single pole moving blade assembly
- iii) Single pole base assembly

C **FUSES** (OF EACH RATING)
- i) Assembled switch in open execution
- ii) Single pole moving blade assembly
- iii) Single pole base assembly

D **CONTROL SWITCHES**
- i) Trip-Neutral-Close Control Switch
- ii) Local-Remote Selector Switch
- iii) Heater Switch
- iv) Thermostat
- v) Ammeter Selector Switch
- vi) Voltmeter Selector Switch
- vii) Push Button
- viii) Push Button Element
- ix) Push Button Actuator of each type

E **CONTACTOR** (OF EACH RATING)
- i) Contactor with Auxiliary Contacts
- ii) Operating Coil
- iii) Auxiliary Contact Block

F **INDICATING LAMPS**
- i) Indicating lamps globes of each colour
- ii) Indicating lamp fittings
- iii) Indicating lamp bulbs

G **METERS**
- i) Ammeter
- ii) Voltmeter

H **PROTECTIVE RELAYS**
- i) Relays
- ii) Thermal overload relay of each type

NOTE: 1. All spare parts shall be identical to the parts used in the distribution boards**.**

ENGINEERING STANDARD

CABLES

2	20.01.07	01.02.07	ISSUED FOR IMPLEMENTATION	AV	BKC/SC	BB
1	16.01.06	30.01.06	ISSUED FOR IMPLEMENTATION	AV	BKC	BB
0	JAN'98	--	ISSUED FOR IMPLEMENTATION	RNS/ JKT/ SC	JKT	HSW
REV	**REV DATE**	**EFF DATE**	**PURPOSE**	**PREPD**	**REVWD**	**APPD**

CONTENTS

1.0 SCOPE

1.1 This standard covers the technical requirements of design, manufacture, testing at works and dispatch in well packed condition of power and control cables.

1.2 The standard shall be read in conjunction with relevant specification sheets and other relevant references as specified therein.

2.0 STANDARDS TO BE FOLLOWED

2.1 The design, manufacture and testing of cables covered by this standard shall comply with the latest issue of following Indian Standards, unless otherwise specified. Equipment complying with equivalent IEC standards shall also be acceptable.

IS: 1554 Part (I)	--	PVC insulated (heavy duty) electric cables for working voltages upto and including 1100 volts.
IS: 1554 Part (II)	--	PVC insulated (heavy duty) electric cables for working voltages from 3.3 KV upto and including 11 KV.
IS: 7098 Part (I)	--	Cross linked polyethylene insulated PVC sheathed cables for working voltages upto and including 1100 volts.
IS: 7098 Part (II)	--	Cross linked polyethylene insulated PVC sheathed cables for working voltages from 3.3 KV upto and including 33 KV
IS: 7098 Part (III)	--	Cross linked polyethylene insulated thermoplastic sheathed cables for working voltages from 66 KV upto and including 220 KV
IS: 692	--	Paper insulated lead sheathed cables for rated voltages upto and including 33KV
IS: 694	--	PVC insulated cables for working voltages upto and including 1100 volts
IS: 5831	--	PVC insulation and sheath of electric cables

2.2 The design and operational features of the cables offered shall also comply with the provisions of latest issue of the Indian Electricity Rules and other relevant Statutory Rules & Regulations. The supplier shall, whenever necessary, make suitable modification in the cables to comply with the above mentioned rules.

2.3 Wherever any requirement, laid down in this standard, differs from that in Indian Standard Specifications, the requirement specified herein shall prevail.

3.0 SERVICE CONDITIONS

3.1 Ambient Conditions

These shall be as indicated in specification sheet.

3.2 System Details

These shall be as indicated in specification sheet.

4.0 OPERATING REQUIREMENTS

The cables shall be suitable for operating continuously at the rated capacity as specified in relevant I.S. under the ambient conditions in specification sheet without exceeding the permissible temperature rise and without any detrimental effect on any part.

5.0 GENERAL DESIGN AND CONSTRUCTIONAL FEATURES

5.1 The design, manufacture and workmanship of cables shall be in accordance with the latest practice.

5.2 All materials to be used shall be new, unused and of the best quality.

5.3 Conductors

The power cables shall be of stranded Aluminium / copper round or shaped conductors and control cables shall be of annealed high conductivity stranded copper round conductors. The conductors shall comply with the requirements of IS: 8130.

5.4 Insulation

The conductor insulation shall be type A/C as indicated in specification sheet and shall comply with relevant IS.

5.5 Fillers

The cables shall have suitable fillers wherever required, laid up with conductors to provide substantially circular cross section before the inner sheath is applied.

5.6 Inner Sheath

Inner sheath, wherever applicable shall be ST1/ ST2 type compound applied by extrusion process except for paper cables for which it shall be of lead or lead alloy.

5.7 Armouring

All power and control cables shall be armoured as specified in specification sheet. The single core cables shall be armoured with hard drawn Aluminium

taps/ wires or any other suitable nonmagnetic material. All other cables shall have galvanized steel wire / strip armouring.

5.8 **Outer Sheath**

The outer sheath shall be ST1/ ST2 type compound applied by extrusion process and suitable to withstand atmospheric pollution, resistance to termites, fire retardant and coloured black.

5.9 **Screening**

Screening over conductor and insulation shall be provided as per relevant standard unless specified otherwise. The screening for control cables if specified shall be of aluminium, mylor or equivalent and provided with tinned drain wire which shall be continuous and permanently connected to the screen.

5.10 **Identification**

The individual cores of cables shall be coloured as per relevant IS. Where it is not possible to distinguish the cores by colour, coloured strip shall be applied on the cores or core nos. shall be marked on each core at regular intervals. All cables shall carry the manufacturer's name or trade mark, the cable size, voltage rating and year of manufacture at intervals not exceeding 100 meters. Running meter markings shall also be provided throughout the length of the cable.

5.11 **Dimension**

The overall dia. and dia. under armour of the cables shall be indicated by the vendor in the technical particulars. These shall be guaranteed with a tolerance of ± 5% but not exceeding 2 mm.

5.12 The cut ends of the cables shall be sealed by means of non-hygroscopic materials.

6.0 SPECIAL PURPOSE CABLES

6.1 **Flame Retardant Low Smoke Cables**

Flame retardant low smoke cables, where specified in specification sheet, shall have outer sheath of PVC having following values.

- Minimum oxygen index - 29%
- Minimum temperature index - 250ºC
- Maximum acid gas generation - 20%
- Maximum smoke density rating - 60%

6.2 **Heat Resistant Cables**

Heat resistant cables, where specified in specification sheet, shall be of silicon rubber insulated laid circular with asbestos worming and overall glass fibre

braided and varnished. Silicon rubber insulating compound shall conform to IS:6380 and the constructional features shall conform generally to IS:9968.

7.0 CABLE DRUM

7.1 The cables shall be supplied in non-returnable wooden drums (or steel drums if specified) of heavy construction. The wood used for construction of the drums shall be properly seasoned, sound and free from defects.

7.2 Cables shall be supplied in specified drum lengths. Where no such indication is given, standard drum lengths may be offered.

7.3 The tolerance on each drum of cable shall not exceed ± 2.5%. However, no negative tolerance on HV cables is acceptable.

7.4 All cable drums shall have stencilled data as per relevant IS as well as the purchaser's order no., item no. & drum no.

8.0 TESTS AND INSPECTION

8.1 The following tests shall be carried out on the cables as per relevant IS.

i) Routine Tests - On all cables

ii) Acceptance tests - On representative length of each size

iii) Type tests - Wherever specified on one cable drum of each size

8.2 In addition, the following tests shall be carried out on all fire retardant low smoke cables as per IS or as per the following standards:

i) Oxygen and temperature index test as per ASTM-D-2863

ii) Acid gas emission test as per IEC-754 Part-I

iii) Smoke density test as per ASTM-D-2843

iv) Flammability test as per IEC-332 Part-I or IS-10810

8.3 All the above mentioned tests shall be carried out in the presence of purchaser's representative. In addition, the cables shall be subjected to stage inspection at works and inspection at site for final acceptance.

8.4 These tests and inspections shall, however, not absolve the vendor from their responsibility for making good any defect which may be noticed subsequently.

9.0 DRAWINGS AND DOCUMENTS

9.1 Drawings and documents as per Annexure-I shall be supplied, unless otherwise specified.

9.2 All drawings and documents shall have the following descriptions written boldly.

- Name of client

- Name of consultant
- Enquiry / Order Number with plant / project name
- Code No. and Description

10.0 DEVIATIONS

10.1 Deviations, if any, from this standard shall be clearly indicated in the offer with reasoning.

10.2 Deviations, if any, from the data furnished in specification sheet shall be indicated therein beside the data by encircling it.

ANNEXURE - I

DOCUMENTATION FOR CABLES

Sl. No.	Document Description	Documents Required (Y / N)		
		With Bid	For Approval	Final
1.	Specification Sheet, duly completed	Y	Y	Y
2.	Technical Particulars, duly filled-in	Y	Y	Y
3.	Illustrative and Descriptive catalogues	Y	N	Y
4.	Installation, Termination and Jointing Instructions	N	N	Y
5.	Test certificates			
	a) Routine	N	N	Y
	b) Type	Y	N	Y
6.	Guarantee Certificates	N	N	Y

Note:

1. 4 hard copies & 1 soft copy shall be supplied with bid.
2. 4 hard copies & 1 soft copy shall be supplied for approval after order within 4 weeks from the date of LOI.
3. 8 hard copies & 2 soft copies in CD 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

ENGINEERING STANDARD

INDUCTION MOTOR

REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD
2	20.01.07	01.02.07	ISSUED FOR IMPLEMENTATION	AV	BKC / SC	BB
1	16.01.06	30.01.06	ISSUED FOR IMPLEMENTATION	AV	BKC	BB
0	SEP. '97	--	ISSUED FOR IMPLEMENTATION	RNS/JKT/SC	JKT	HSW

CONTENTS

1.0 SCOPE

1.1 This standard covers the technical requirements of design, manufacture, testing at works and delivery in well-packed condition of medium voltage and high voltage induction motors.

1.2 This standard shall be read in conjunction with relevant specification sheets and other relevant references as specified therein.

2.0 STANDARDS TO BE FOLLOWED

2.1 The design, manufacture and testing of the equipment covered by this standard shall comply with the latest issue of IS-325 and other relevant Indian Standards, unless otherwise specified. Equipment complying with equivalent IEC standards shall also be acceptable.

2.2 The design and operational features of the equipment offered shall also comply with the provisions of latest issue of the Indian Electricity Rules and other relevant Statutory Rules & Regulations. The supplier shall, whenever necessary, make suitable modification in the equipment to comply with the above mentioned rules.

2.3 Flame proof motors shall, in addition, comply with the requirements laid down in IS: 2148.

2.4 Increased safety motors shall, in addition, comply with the requirements laid down in IS: 6381.

2.5 Motors with type of protection “n” shall, in addition, comply with the requirements laid down in IS: 9628.

2.6 Wherever any requirement laid down in this standard differs from that in Indian Standard Specifications, the requirement specified herein shall prevail.

3.0 SERVICE CONDITIONS

3.1 Ambient Conditions

The ambient conditions shall be as indicated in the specification sheet.

3.2 System Details

3.2.1 The details of power system to which the motors will be connected shall be as indicated in the specification sheet.

3.2.2 The motors shall be suitable for connection to a power system where transient disturbances are very likely to occur. During the transient disturbances, voltage of the system may completely disappear and return in a short time with the motors still running and connected. Under this condition, the return of voltage may occur at such an instant that the induced e.m.f. in the motor is in phase with the applied voltage giving rise to current surges which may reach a value equal

to 1.6 times the starting current and also cause transient torques of large magnitudes.

4.0 GENERAL DESIGN FEATURES

4.1 Enclosure

4.1.1 The enclosure of motors for indoor and outdoor services shall be IP-54 and IPW-55 respectively as per IS: 4691, unless otherwise specified.

4.1.2 Motors for outdoor service shall be provided with special seals for the enclosure, joints, bearing housing, terminal boxes etc. so that no extra protective covering for ingress of water shall be required.

4.1.3 Vertical motors for outdoor installation shall be provided with a rain protective hood.

4.1.4 All external hard wares shall be zinc passivated or cadmium plated.

4.1.5 The enclosure shall be provided with threaded metallic plug to permit drainage of condensed water from the inside.

4.2 Cooling

4.2.1 All motors shall be totally enclosed fan cooled conforming to IC-0141 as per IS: 6362 unless otherwise specified.

4.2.2 In case of CACA construction, the same shall conform to IC-0161 as per IS: 6362.

4.2.3 In case of CACW construction, the same shall conform to ICW 37A 91 as per IS: 6362.

4.2.4 Wherever service conditions indicated in the specification sheet are such that corrosive agents are present in the surroundings, the following materials of construction for cooling tubes shall be adopted, unless otherwise specified.

For CACA motor - Aluminium tubes having minimum thickness of 1.6 mm

For CACW motor - Low carbon alloy steel

4.2.5 In case of CACW motors, the cooling tubes and flanges shall also be suitable for the cooling water analysis as indicated in the specification sheet. Trays shall be provided for collection of leaking water with arrangement for its drainage.

4.2.6 The cooling fans shall be suitable for bidirectional rotation of motors. These shall be fastened to the motor shaft by means of compensating rings or will be balanced independent of the motor. Guide key or reference points shall be supplied to prevent wrong assembly. The cooling air shall be sucked from the non-driving end.

4.2.7 The cooling fans shall be made of non-sparking materials such as cast Aluminium (LM-6 alloy) / cast iron.

4.3 **Direction of Rotation**

4.3.1 Motors shall be suitable for both directions of rotation. In case of any design limitation, the same shall be indicated in the offer.

4.3.2 In either case, a plate showing the direction of rotation corresponding to the phase terminal markings shall be fitted at the driving end shield of the motors.

4.4 **Stator**

4.4.1 The stator laminations shall be made from suitable magnetic sheet iron varnished on both sides. Where ventilation is required, these shall be arranged in suitable packs, each pack being separated by spacers to form ventilating ducts for circulation of air.

4.4.2 The slot shall be open type with coils so arranged that the coils can be easily removed for inspection and repair.

4.5 **Rotor**

4.5.1 The rotor shall be of squirrel cage construction, unless otherwise specified.

4.5.2 For small motors, the squirrel cage shall preferably be of pressure die-cast construction. For large motors, the rotor bars and the end rings shall be of copper or copper alloy. The bars shall be firmly placed in slots to prevent vibration during start up / locked rotor condition. Conductor ends shall be securely fixed to the end rings using the latest brazing techniques. Retaining rings shall be provided for high speed machines for the end rings. The rotor cage shall be designed for the required starting and duty cycles.

4.5.3 Wherever wound rotor is specified, the windings shall have the same features as detailed for the stator windings. The rotor voltage shall not exceed the stator voltage.

4.5.4 The rotor shall be dynamically balanced and shall rotate perfectly with no preferential stop points. The rotor shall be constructed such as to allow the removal or addition of material for balancing.

4.5.5 The rotor shaft shall be electrically and magnetically so balanced that the induced shaft voltage does not exceed 200 millivolt. Otherwise the bearing housing at non-driving end shall be insulated for 2 KV.

4.6 **Windings and Insulation**

4.6.1 The motor coils shall be made out of insulated electrolytic grade copper conductor. Successive coils shall be connected by accessible joints, well brazed and finished smooth to prevent damage to insulation.

4.6.2 The motors shall be insulated assuming the power system neutral as isolated.

4.6.3 All motors shall be insulated with class B or F insulation as indicated in the specification sheet with tropical and fungicidal treatments.

4.6.4 Wherever class F insulation is specified, the windings shall be easily replaceable type and the temperature rise shall not exceed that of class B insulation.

4.6.5 The winding coils shall be dried, properly impregnated with suitable varnishes to withstand the site conditions and properly baked. At least two additional impregnations and baking shall be applied to the assembled stator coil, making a total of three impregnations and baking. Finally the windings shall be painted with special anti-acid and anti-alkali paints to withstand the site conditions.

4.6.6 The windings shall be well brazed and capable of withstanding thermally and mechanically the transient disturbances specified under clause 3.2.2.

4.6.7 Lead-in wire between the windings and the outside terminals shall be made through bushings in H.V. motors. For M.V. motors, heat resistant insulated conductors shall be used as lead-in wire.

4.6.8 The windings shall be star connected for high voltage motors and delta connected for medium voltage motors.

4.7 Slip Rings and Brushes

4.7.1 Slip rings shall be located in the non-driving side. The material of construction shall be copper alloy. The slip rings and the brush gear shall be cooled by the motor cooling fan.

4.7.2 For explosion proof motors, the slip rings and brush gear shall be housed in a flameproof housing. In case this is not possible, the housing shall be pressurised type with flameproof pressure switch for interlocking with the motor. In either case, glass covers shall be provided for inspection.

4.7.3 The starting rheostats shall be designed for intermittent duty and rated for 10 minutes. Where speed regulation is required, the rheostats and the controllers shall be suitable for such duty and be continuously rated. Auxiliary contacts shall be provided on the controllers for connections to the motor supply controls to prevent wrong operations during starting.

4.8 Bearings

4.8.1 All motors shall be provided with bearings suitable for the application. The bearings must be guaranteed to ensure a smooth operation and a life not shorter than 30,000 hrs.

4.8.2 Where external thrusts are specified, the motors shall be fitted with special roller thrust bearings capable of withstanding the specified thrust. In such cases, the guaranteed life of the bearings shall not be less than 20,000 hours.

4.8.3 The bearing housing shall be effectively sealed against ingress of dust and water and creep age of lubricants along the shaft.

4.8.4 The bearing shall be suitable for both directions of rotation of the motor.

4.8.5 All motors shall be provided with on-line grease lubrication arrangement for both DE and NDE side bearings except for motors of frame size 112 and less and flange mounted M.V. motors. The arrangement shall be complete with grease nipple and drain plug located at convenient locations.

4.8.6 All oil lubricated bearings shall be fitted with oil level indicator and resistance temperature detector/dial type thermometer with alarm and trip contacts.

4.8.7 Self cooled bearing system shall be preferred.

4.8.8 The manufacturer shall specify the type of lubricant and the time interval of lubrication for the bearings of each motor.

4.8.9 The bearing temperature shall not exceed 90ºC for grease lubricated bearings and 70ºC for oil lubricated bearings.

4.8.10 Wherever shaft end-play has been specified, the bearings shall be capable of providing the specified end-play.

4.9 **Terminal Box**

4.9.1 All the terminal boxes shall have identical degree of protection as that of the motor.

4.9.2 The power terminal box shall be mounted on the right hand side of the motor as viewed from the coupling end. For M.V. Motors, design of terminal boxes shall be such that it may be possible to arrange top/bottom/side entry of cables at site.

4.9.3 The power terminal boxes shall be as follows:

a) For H.V. motors - Phase segregated type capable of with standing the system fault level for 0.2 Sec. or more.

b) For M.V. motors - Manufacturer's standard box with epoxy or SRBF moulded terminal board.

4.9.4 The mounting arrangement of power and neutral side terminal boxes for HV motors shall be identical so that it shall be possible to interchange the boxes at site.

4.9.5 In case of H.V. motors, all the six leads of the motors shall be taken out, three on one side and three on the other side to separate terminal boxes. However, neutral shorting link shall be provided on the neutral box for star connection.

4.9.6 In case of M.V. motors, all the six leads of the motors shall be taken out to a common terminal box. Shorting links for delta connections shall be provided in the terminal box for motors 112 frame and above.

4.9.7 For increased safety motors and for motors with type of protection "n", the terminals shall be provided with positive locking device so that they do not become loose during normal operation.

4.9.8 The power terminal boxes shall have adequate clearances in between the terminals and also between the terminals and cable gland for proper termination of cables. Where more than one cable is required to be terminated in parallel, the spacing in the box shall be adequate for easy termination.

4.9.9 Separate terminal boxes shall be provided for connection of power, control and space heater cables.

4.9.10 All terminal boxes shall be complete with heavy duty double compression type cable glands and lugs/connectors to receive the external cables.

4.9.11 Where cross linked polyethylene cables are specified, the terminal box shall be suitably designed for proper termination of such cables.

4.9.12 The cable lugs shall be of tinned copper and suitable for crimping.

4.10 **Geared Motors**

Where geared motors are specified, the gears shall be oil lubricated, heavy duty as per AGMA class III and capable of transmitting the rated motor power continuously. They shall be capable of withstanding moderate shock loads having a service factor of 2 and the starting duties. They shall be silent and smooth in operation. Inspection glass shall be provided to indicate the oil level in the gear box.

5.0 PERFORMANCE

5.1 **Starting**

5.1.1 The motors shall be capable of being started direct-on-line, unless otherwise specified.

5.1.2 The starting torque of each motor shall be higher than the initial resisting torque of the driven load through out the starting period even at a feeding voltage of 85% of the rated voltage for normal purpose motor and 80% of the rated voltage for special purpose motor as indicated in the specification sheet.

5.1.3 The starting current shall not be greater than 6 times the rated current when the motors are started at full voltage including tolerances, unless otherwise specified.

5.1.4 The motors shall be suitable for the following starting cycle:

a) With the motor at ambient temperature - 2 successive starts and 3rd start after 5 minutes.

b) With the motor at steady state load temperature - 1 immediate start and 2nd start after 5 minutes. This sequence shall be repeated in the next hour.

5.1.5 Speed switch shall be provided, wherever required, to fulfil the starting conditions.

5.2 Locked Rotor Condition

5.2.1 The locked rotor withstand time (t_E), under hot condition at 110% of rated voltage shall be more than the starting time of the motor coupled to the load even at the lowest stipulated starting voltage by 2 secs. for motors, having starting time up to 10 secs. and by 5 secs. for motors, having starting time more than 10 secs.

5.2.2 For increased safety motors, t_E under hot condition shall not be less than 10 secs. The value of t_E shall be determined in the presence of purchaser's representative unless test certificate from an independent testing authority is submitted for similar motors. The time t_E and the locked rotor current shall be stamped on the name plate as well as indicated in the test certificates.

5.2.3 For deciding the time t_E in all cases, the temperature of the insulated stator and rotor shall not exceed the value stipulated under clause no. 5.4.3.

5.3 Running

5.3.1 All motors shall be continuous maximum rated (S1 duty as per IS: 325), unless otherwise specified.

5.3.2 The motors shall be capable of delivering the rated output without exceeding the specified temperature rise under the system voltage and frequency variation conditions as specified in the Specification Sheet.

5.3.3 The motors shall be suitable for running at the rated load for 5 minutes duration at 80% voltage and for 1 Sec. duration at 70% voltage, without exceeding the specified temperature rise.

5.4 Temperature Rise

5.4.1 The total temperature of the stator winding under full load running condition shall not exceed the values permissible for the specified insulation class. For increased safety motors, the total temperature shall be 10ºC less than for normal motors.

5.4.2 For explosion proof motors, the maximum surface temperature shall not exceed the values applicable for temperature class of the hazardous gases / vapours present in the surrounding area. However for type 'n' motors, the maximum allowable temperature shall not exceed 200ºC.

5.4.3 In case of starting and locked rotor conditions stipulated under clause nos. 5.1.4 and 5.2.1 respectively, the maximum temperature in the rotor shall not exceed the following values:

For squirrel cage rotor	-	300ºC
For wound rotor	-	As applicable to the insulation class
For explosion proof motor	-	As per temperature class of the hazardous gases / vapours, without exceeding the above temperature as applicable

6.0 COUPLING DETAILS

6.1 Unless otherwise specified, all motors shall be coupled to the driven equipment through flexible coupling.

6.2 Normally the coupling half for the motor shaft shall be supplied by the driven equipment supplier. The coupling half shall be keyed on the shaft with a tapered joint or shrunk with a straight joint. For this purpose, the motor manufacturer shall coordinate all details of the coupling system with the driven equipment manufacturer, wherever required.

6.3 Where rigid coupling is specified, the motor shaft shall have the desired class of accuracy.

6.4 For all vertical flange mounted motors, the limitations on shaft extension, run out, perpendicularity and eccentricity, as required by the driven machine supplier shall be complied with by the motor supplier.

6.5 i) If the motor is to be coupled to a reciprocating pump or compressor requiring fluctuating torque, the motor supplier shall ensure that the inertia of the driving and driven machine assembly shall be such that the variation in the armature current shall not exceed ±66% of the rated current while delivering full load.

ii) The measurement of armature current shall be done with the oscillograph.

iii) The additional fly wheel, if any, shall be assembled at such a distance from the motor so as to allow easy inspection of the windings.

iv) All necessary coordination with driven equipment manufacturer shall be carried out by the motor manufacturer.

6.6 i) Wherever belt drive is specified, the motor supplier shall ensure that the shaft extension and the bearings are suitable for the duty specified.

ii) Unless otherwise specified, the slide rails for all belt driven motors shall be supplied by the motor manufacturer.

7.0 ACCESSORIES

The motors shall be complete with the accessories as indicated in the specification sheet.

7.1 Space Heaters

7.1.1 Space heaters rated for 240 V A.C. shall be provided to keep the winding dry for all high and medium voltage motors, except for motors rated below 30 KW which shall be suitable for space heating by connecting 24 V A.C to any of the two motor winding terminals.

7.1.2 The location of the space heaters shall be such as to allow easy access for inspection, maintenance and replacement.

7.2 **Name Plates**

7.2.1 The name plates shall be of stainless steel with letters embossed on them.

7.2.2 The name plate shall contain all the relevant details as per IS: 325 and in addition shall indicate the following:

i) The description and code no. of motor

ii) Degree of protection of enclosure

iii) Temperature rise of windings under running condition

iv) Designation of bearings

v) Recommended type of lubricant and interval of lubrication

vi) Direction of rotation

vii) Mounting Arrangement

7.2.3 Flameproof motors shall have additional name plate containing relevant particulars as per IS: 2148.

7.2.4 Increased safety motors shall have additional name plate containing relevant particulars as per IS: 6381.

7.2.5 Motors with type of protection “n” shall have additional name plate containing relevant particulars as per IS: 9628.

7.3 **Embedded Temperature Detectors**

7.3.1 All high voltage motors shall be provided with 6 nos. of evenly distributed embedded resistance temperature detectors for measurement of winding temperature. These shall be located in positions at which the highest temperatures are likely to occur.

7.3.2 In addition, the high voltage motors shall be provided with

i) 1 no. RTD for hot air temperature measurement

ii) 2 nos. RTDs (1 on each side) for bearing temperature measurement of oil lubricated bearings. For grease lubricated bearings, RTD shall be provided only where specified

7.3.3 These RTDs shall be of platinum having 100 ohm resistance at 0ºC and temperature coefficient as 3.850×10^{-3}.

7.3.4 The RTDs shall be 3 lead type having power frequency insulation level of 2KV.

7.3.5 The RTDs shall comply with the requirements laid down in IS: 2848.

7.4 **Dial Type Thermometers**

7.4.1 In high voltage motors, the measurement of hot air and bearing temperature (of oil lubricated bearings) by dial type thermometers shall be provided wherever specified.

7.4.2 The arrangement shall consist of a dial type of mercury-in-steel thermometer so mounted that its stem shall be located in the maximum temperature region.

7.4.3 The thermometer shall have two potential free contacts for alarm and trip.

7.4.4 All contacts shall be rated for 2 Amps. at 110 V D.C.

7.4.5 For bearing temperature measurement, separate thermometers shall be provided for each bearing.

7.4.6 For grease lubricated bearings, temperature measurement arrangement shall be provided only where specified.

7.5 **Oil Supply System**

7.5.1 For large sized motors, where forced oil lubrication system is considered, a common oil supply system for the motor and the driven equipment shall be provided by the driven equipment manufacturer.

7.5.2 However, the motor supplier shall quote separate price for the complete oil system of the motor.

7.5.3 The system shall be suitable for location near the motor.

7.5.4 The oil supply system for each motor shall include:

i) 2 Nos. 100% rated motor driven pumps with motors

ii) 1 No. oil tank complete with oil level gauge and thermometer

iii) 1 No. oil cooler

iv) 1 No. oil filter

v) 1 No. differential pressure switch for filter

vi) 2 Nos. pressure switches

vii) Necessary piping

viii) Necessary control and interlocks

8.0 VIBRATIONS

The motor vibrations measured at the bearings must not exceed the limits specified in IS: 12075, unless otherwise stipulated in the specification sheet.

9.0 NOISE LEVEL

The motor noise level shall not exceed 85 dB measured at a distance of 1 metre from the motor.

10.0 PAINTING

10.1 Enclosures of the motor and its accessories shall be painted with two coats of anti-rust paint and two coats of anti-corrosive paint after suitable pre-treatment.

10.2 Epoxy paint, wherever specified, shall be used.

10.3 Unless otherwise specified, the finishing shade shall be light grey having shade No. 631 as per IS: 5.

11.0 TESTS AND INSPECTION

11.1 All motors shall be routine tested as per relevant standards.

11.2 Additional tests, wherever specified, shall be carried out on one motor of each rating.

11.3 For high voltage motors of each rating, polarization index test shall also be carried out.

11.4 All the above mentioned tests shall be carried out in the presence of purchaser's representative. In addition, the motor shall be subject to stage inspection at works and inspection at site for final acceptance.

11.5 These inspections shall, however, not absolve the vendor from their responsibility for making good any defects which may be noticed subsequently.

12.0 PACKING

12.1 The motors shall be properly packed to safeguard against weather conditions and handling during transit.

12.2 The shaft shall be properly clamped / supported.

12.3 Rust inhibiting agents shall be applied to fittings and sliding surfaces.

12.4 All flanges shall be closed with blanking plates to avoid entry of foreign materials.

12.5 The loose pieces of the motor / spare parts / Instruments shall be separately wrapped in moisture resistant paper and marked with identification marks and name plate of the corresponding motors.

12.6 The packing box / crate shall include a copy of installation, operation and maintenance manual.

13.0 DRAWINGS AND DOCUMENTS

13.1 Drawings and documents as per Annexure-I shall be supplied, unless otherwise specified.

13.2 All drawings and documents shall have the following descriptions written boldly:

- Name of client
- Name of consultant
- Enquiry / order number with plant / project name

- Motor Code No. and Description

14.0 SPARES

14.1 Spares for operation and maintenance

Item wise unit prices of spare parts with recommended quantity shall be quoted along with the motors as listed in the specification sheet.

14.2 Commissioning Spares

Commissioning spares, as required, shall be supplied with the main equipment. Item wise list of recommended commissioning spares shall be furnished for approval.

14.3 Any other spare parts not specified, but required, shall also be quoted along with the offer.

14.4 All spare parts shall be identical to the parts used in the motors.

15.0 DEVIATIONS

15.1 Deviations, if any, from this standard shall be clearly indicated in the offer with reasoning.

15.2 Deviations, if any, from the data furnished in specification sheet shall be indicated therein beside the data by encircling it.

ANNEXURE - I

DOCUMENTATION FOR INDUCTION MOTORS

Sl. No.	Document Description	Documents Required (Y / N)		
		With Bid	For Approval	Final
1.	Specification Sheet and Technical Particulars completely filled-in	Y	Y	Y
2.	Dimensional Drawings	Y	Y	Y
3.	Drawings and data for air / water heat exchangers, if necessary	N	Y	Y
4.	Drawings and data for oil system, if necessary	N	Y	Y
5.	Characteristic curves			
	a) Thermal withstand curve	N	Y	Y
	b) Load Vs FL current	N	Y	Y
	c) Load Vs Efficiency	N	Y	Y
	d) Load Vs Power factor	N	Y	Y
	e) Load Vs Speed	N	Y	Y
	f) Voltage Vs Thermal Withstand time	N	Y	Y
	g) Starting current Vs Time	N	Y	Y
6.	Connection diagram for RTDs, thermometer etc.	N	Y	Y
7.	Terminal Box drawings	Y	Y	Y
8.	Illustrative and Descriptive catalogues	Y	N	Y
9.	Catalogues of bought out accessories	Y	N	Y
10.	Spare parts list	Y	N	Y
11.	Installation, Operation and Maintenance manual	N	N	Y
12.	Test certificates			
	a) Routine	N	N	Y
	b) Type	N	N	Y
	c) For enclosure	Y	N	Y
13.	Guarantee Certificates	N	N	Y

Note:

1. 4 hard copies & 1 soft copy shall be supplied with bid.
2. 4 hard copies & 1 soft copy shall be supplied for approval after order within 4 weeks from the date of LOI.
3. 8 hard copies & 2 soft copies in CD 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

ENGINEERING STANDARD

LOCAL CONTROL STATION

REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD
2	20.01.07	01.02.07	ISSUED FOR IMPLEMENTATION	AV	BKC/SC	BB
1	16.01.06	30.01.06	ISSUED FOR IMPLEMENTATION	AV	BKC	BB
0	DEC'97	--	ISSUED FOR IMPLEMENTATION	RNS/ JKT/ SC	JKT	HSW

CONTENTS

1.0 SCOPE

1.1 This standard covers the technical requirements of design, manufacture, testing at works and delivery in well-packed condition of Local Control Stations.

1.2 This standard shall be read in conjunction with relevant specification sheets and other relevant references as specified therein.

2.0 STANDARDS TO BE FOLLOWED

2.1 The design, manufacture and testing of the equipment covered by this standard shall comply with the latest issue of IS: 13947 and other relevant Indian Standards, unless otherwise specified. Equipment complying with equivalent IEC standards shall also be acceptable.

2.2 The design and operational features of the equipment offered shall also comply with the provisions of latest issue of the Indian Electricity rules and other relevant statutory Acts and Regulations. The supplier shall, wherever necessary, make suitable modification in the equipment to comply with the above.

2.3 Wherever any requirement, laid down in this standard differs from that in Indian Standard Specifications, the requirement specified herein shall prevail.

3.0 SERVICE CONDITIONS

3.1 Ambient Conditions

These shall be as indicated in specification sheet.

3.2 System Details

These shall be as indicated in specification sheet.

4.0 OPERATIONAL REQUIREMENTS

This equipment and associated components shall be suitable for operating satisfactorily under the specified ambient and system conditions.

5.0 GENERAL DESIGN AND CONSTRUCTIONAL FEATURES

5.1 The Control Stations shall be suitable for control voltage not exceeding 500V, 50 Hz AC or 220V D.C.

5.2 The enclosure shall be of die cast Aluminium alloy LM-6. As an alternative to cast Aluminium, fibre glass enclosure is also acceptable.

5.3 The equipment shall have dust, hose and weather proof construction equivalent to IPW-55 as per IS: 13947. These shall be suitable for outdoor location without any additional protection or cover.

5.4 A rain-hood shall be offered as an additional item. It shall be made of 14 gauge Aluminium sheet bent to shape. In case of fibre glass enclosure, these can be made of fibre glass.

5.5 All external hardware of diameter less than 8 mm shall be of stainless steel and those of diameter 8 mm and above shall be of mild steel cadmium plated or zinc passivated. For fibre glass enclosure Nylon PVC bolts of diameter 8 mm may be used.

5.6 The control station shall preferably be with bolted cover. The bolts for retaining the cover in position shall be provided with 10 mm dia. stainless steel and these shall be so arranged that they do not pierce into the door gasket.

5.7 All the components shall be mounted on a base plate inside the enclosure. Necessary actuating system for control switch, push button, non yellowing acrylic/ glass cover for ammeter and indication lamps shall be provided on the front cover. No wiring shall be carried out on the front cover.

5.8 The layout of components in the control station shall be liberal and standardised.

5.9 All mating surfaces shall be smoothly machined and shall be of sufficient width of at least 6 mm. The covers shall be provided with continuous gasket made of neoprene or synthetic rubber to prevent ingress of dust and moisture. The gasket shall be held in position in groove provided in the enclosure and shall be pressed all around uniformly by suitably shaped projection of the door. Gaskets simply glued to the surface are not acceptable.

5.10 The enclosure shall be suitable for mounting on wall or on steel structure. 4 Nos. holes suitable for 12 mm bolts shall be provided outside the enclosure for fixing the control stations.

5.11 The internal wiring shall be carried by means of single core PVC insulated 1.5 sq. mm stranded copper conductor cable. All termination shall be made with crimping type proper size lugs and shall be properly ferruled.

5.12 The control stations shall be completely factory wired and ready for external cable connection.

5.13 For easy identification, numbering ferrules shall be provided on all wiring at both ends i.e. equipment end and terminal block end. Terminals for external wiring shall be numbered

5.14 The enclosure shall be provided with two earthing terminals with studs of 8 mm. dia. projecting outside the enclosure for connection to earth. These terminals shall not pierce through the enclosure and shall be marked with earthing symbol.

5.15 Each control station shall be provided with minimum 2 mm thick stainless steel name plates or consisting of black Perspex with white engraving indicating the code number and description of the equipment controlled by it as indicated in specification sheet. Similar labels shall be provided for all indication lamps, push buttons and control switches. The name plate and label shall be fixed with screws only.

6.0 SPECIAL FEATURES FOR FLAME PROOF LOCAL CONTROL STATION

6.1 The enclosure shall be in addition, of flameproof execution as per IS: 2148.

6.2 The control stations shall be suitable for hazardous area of enclosure group and temperature class as indicated in specification sheet.

6.3 Cables shall enter the terminal box through flame proof cable gland. From the terminal chamber to the main enclosure, the connections shall be made through proper bushings. Direct entry of external cables into the main enclosure shall not be accepted. All entries shall be provided with stainless steel inserts.

6.4 An additional earthing terminal inside the terminal chamber shall be provided.

6.5 Local control stations and cable gland must be certified by the Central Mining Research Institute, Dhanbad or any other statutory authority for use in the specified hazardous area.

7.0 COMPONENT DETAILS

7.1 Local control stations shall be provided with controlling and indicating elements as indicated in specification sheet.

The make of components shall be as indicated in specification sheet.

7.2 Trip-Neutral-Close Switch

TRIP-NEUTRAL-CLOSE switch shall be double pole, 3 position, pistol grip, rotary type having self spring return feature to neutral position. The contacts shall be of phosphor bronze and shall be provided with two breaks in series. Mechanical sequence device to prevent two successive movements to the same position shall be fitted. The switch shall be capable of being padlocked in the ‘TRIP’ position.

7.3 ‘Auto-Manual’ Switch

‘Auto-Manual’ switch shall be single pole stay put type having three positions “AUTO-OFF-MANUAL”. Provision shall be made to padlock the switch in the “OFF” position.

7.4 Selector Switch / Lock Service Switch

These shall be single pole stay put type having two position with a pistol grip handle and capable of being padlocked in one of the position.

7.5 All the switches shall be rotary type with snap or wiping action contact and having a set of normally open and closed contacts in each position. All switches shall be provided with pistol grip handle.

7.6 **'Off-Auto-On' Switch**

7.6.1 'OFF-AUTO-ON' switch shall be in minimum three stack configuration, each stack having three positions with spring return from 'ON' to 'Auto' position and lockable in 'OFF' position by means of padlock.

7.6.2 The switch shall have sliding contact between 'AUTO' and 'ON' position. In 'OFF' position the contact shall be completely broken from 'AUTO' position.

7.7 **Push Buttons**

These shall be spring loaded, with a set of normally closed and open contacts. The push buttons for 'start' shall be shrouded type and coloured green while 'stop' push buttons shall be unshrouded type and coloured red. Provision shall be made to padlock the 'stop' push button in 'OFF' position. The fixing ring shall be metallic white. An oil proof rubber cap shall preferably be provided.

7.8 The switches and push buttons shall conform to utilization category AC11/ DC11 as per IS: 13947. The contact shall be rated to make, break and carry inductive current of 5 Amp. at 415 V AC and 1 Amp of 220V DC. The contact arrangement shall be as shown in the terminal drawings. Built in locks instead of padlocking are not acceptable.

7.9 **Indication Lamps**

7.9.1 LED type indication lamps shall be provided to indicate the various circuit conditions as shown in the terminal drawings.

7.9.2 The LEDs shall provide good illumination through a viewing angle of 180º. The LEDs shall have lumen output of 200 milli Candella in the axial direction.

7.9.3 The colour of the LED indication for various functions shall be as follows:-

RED : For 'ON' Indication
GREEN : For 'OFF' Indication
WHITE : For "Ready for Service" Indication

7.10 **A.C. Ammeters**

The ammeter shall be flush mounting, moving iron spring controlled type, of accuracy class 1.5 as per IS:1248, with square face of minimum size 72 mm x 72 mm having scale range 0-240º. The ammeter shall be provided with uniform scale up to CT primary current and compressed end scale up to 6 times the CT primary current. Adjustable red pointer shall be provided to indicate the full load current of the motors. Zero adjusters shall be provided for operation from the front of the meter. All ammeters shall be operated through 1Amp. CTs only. The CT ratio and full load current shall be as indicated in specification sheet.

7.11 **D.C. Ammeters**

The D.C. ammeter shall be shunt operated. These shall be moving coil or moving iron type of accuracy class 1.5 as per IS: 1248.

7.12 **Terminal Blocks**

All control stations shall be provided with terminal blocks. Terminal blocks shall be located at a minimum distance of 50 mm from the bottom of the enclosure. The terminal blocks for the control station shall be suitable for conductor sizes of 2.5 mm^2. These shall be of pressure clamp type design mounted on the base channel. The minimum rating of terminal block shall be 16 Amp.

7.13 **Cable Glands**

The cables for the external connections, shall enter the terminal chamber through heavy duty double compression type rolled Aluminium cable glands suitable for 2.5 sq. mm PVC insulated, armoured, and PVC sheathed copper conductor 1.1 KV grade cables. The number and cores of control cables shall be as indicated in specification sheet. The cable gland shall be fitted in a threaded hole.

8.0 PAINTING

8.1 The enclosure after suitable pre-treatment shall be painted with two coats of anti-rust paint followed by two coats of anticorrosive paint.

8.2 Epoxy based paint shall be used, if indicated in specification sheet.

8.3 All paints shall be carefully selected to withstand tropical heat and extremes of weather. The paint shall not scale off, crinkle or be removed by abrasion due to normal handling.

8.4 Unless otherwise specified, the finishing shade shall be of light grey having shade no. 631 as per IS: 5.

9.0 TESTS AND INSPECTION

9.1 All equipment shall be routine tested as per relevant standards.

9.2 Additional tests, wherever specified, shall be carried out.

9.3 All the above mentioned tests shall be carried out in the presence of purchaser's representative. In addition, the equipment shall be subjected to stage inspection at works and inspection at site for final acceptance.

9.4 These inspections shall, however, not absolve the vendor from their responsibility for making good any defect which may be noticed subsequently.

10.0 DRAWINGS AND DOCUMENTS

10.1 Drawings and documents as per Annexure-I shall be supplied, unless otherwise specified.

10.2 All drawings and documents shall have the following descriptions written boldly.

- Name of client
- Name of consultant
- Enquiry / Order Number with plant / project name
- Code No. and Description

11.0 SPARES

11.1 Spares for operation and maintenance

Item wise unit prices of spare parts for the following items as applicable shall be offered along with the main equipment with recommended quantity for the period as indicated in specification sheet.

i) Trip-Neutral-Close switch

ii) Auto-Manual switch

iii) Selector switch

iv) OFF-Auto-ON switch

v) Ammeters of different ranges

vi) Push buttons of different types

vii) Indication lamps of different types

viii) Terminal blocks

ix) Terminal bushings

11.2 Commissioning Spares

Commissioning spares, as required, shall be supplied with the main equipment. Item wise list of recommended commissioning spares shall be furnished for approval.

11.3 Any other spare parts not specified, but required, shall also be quoted along with the offer.

11.4 All spare parts shall be identical to the parts used in the equipment.

12.0 PACKING

12.1 The local control stations shall be properly packed to safeguard against weather conditions and handling during transit. It shall be wrapped in polythene bags and an additional wrapping of bitumen paper shall also be provided to make it completely water proof before the equipment is packed in wooden crates.

12.2 The packing box shall contain a copy of the installation, operation and maintenance manual.

13.0 DEVIATIONS

13.1 Deviations, if any, from this standard shall be clearly indicated in the offer with reasoning.

13.2 Deviations, if any, from the data furnished in specification sheet shall be indicated therein beside the data by encircling it.

ANNEXURE - I

DOCUMENTATION FOR LOCAL CONTROL STATIONS

Sl. No.	Document Description	Documents Required (Y / N)		
		With Bid	For Approval	Final
1.	Specification Sheet, duly completed	Y	Y	Y
2.	Technical Particulars, duly filled-in	Y	Y	Y
3.	General Arrangement Drawings	Y	Y	Y
4.	Schematic Diagrams	N	Y	Y
5.	Illustrative and Descriptive catalogues	Y	N	Y
6.	Catalogues of bought out accessories	Y	N	Y
7.	Spare parts list	Y	N	Y
8.	Installation, Operation and Maintenance manual	N	N	Y
9.	Test certificates			
	a) Routine	N	N	Y
	b) Type (only for flameproof equipment)	N	N	Y
	c) For enclosure	Y	N	Y
10.	Guarantee Certificates	N	N	Y

Note:

1. 4 hard copies & 1 soft copy shall be supplied with bid.
2. 4 hard copies & 1 soft copy shall be supplied for approval after order within 4 weeks from the date of LOI.
3. 8 hard copies & 2 soft copies in CD 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

ENGINEERING STANDARD

INTERLOCKING SWITCH SOCKET AND PLUG

REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD
2	20.01.07	01.02.07	ISSUED FOR IMPLEMENTATION	AV	BKC / SC	BB
1	16.01.06	30.01.06	ISSUED FOR IMPLEMENTATION	AV	BKC	BB
0	MAR'98	--	ISSUED FOR IMPLEMENTATION	RNS/JKT/SC	JKT	HSW

CONTENTS

1.0 SCOPE

1.1 The standard covers the technical requirements of design, manufacture, testing at works and delivery in well packed condition of interlocking switch socket and plug.

1.2 The standard shall be read in conjunction with relevant specification sheet.

2.0 STANDARDS TO BE FOLLOWED

2.1 The design, manufacture and testing of the equipment covered by this standard shall comply with the latest issue of IS-4160/ IEC-309 and other relevant Indian Standards, unless otherwise specified. Equipment complying with equivalent IEC standards shall also be acceptable.

2.2 The design and operational features of the equipment offered shall also comply with the provisions of latest issue of Indian Electricity Rules and other statutory acts and regulations. The supplier shall, wherever necessary, make suitable modifications in the equipment to comply with the above.

2.3 Wherever any requirement, laid down in this standard differs from that in Indian Standard Specifications, the requirement specified herein shall prevail.

3.0 SERVICE CONDITIONS

3.1 Ambient conditions

These shall be as indicated in specification sheet.

3.2 System details

These shall be as indicated in specification sheet.

4.0 OPERATING REQUIREMENTS

The equipment shall be suitable for operating at the rated capacity continuously, under the ambient condition indicated in specification sheet, without exceeding the specified temperature rise and without any detrimental effect on any part.

5.0 GENERAL DESIGN AND CONSTRUCTIONAL FEATURES

5.1 The switch socket shall be heavy duty industrial type. The interlocking arrangement shall be such that it is not possible to insert or withdraw the plug with the switch in ‘ON’ position.

5.2 The switch sockets shall have dust, hose and weather proof construction conforming to IPW55 as per IS: 13947 and shall be suitable for outdoor use without any extra protection. All jointing surfaces shall be smoothly machined and of sufficient width to prevent ingress or dust. Further the covers shall be provided with continuous gaskets made of neoprene to prevent ingress of dust and moisture.

5.3 The enclosure of switch sockets and plugs shall be of cast aluminium alloy 4600 and suitable for fixing on wall / structure.

5.4 The enclosure shall be largely dimensioned in order to avoid temperature rise inside it which may damage the insulating materials and gaskets employed therein.

5.5 The insulating materials used shall be non-hygroscopic, mould proof and treated with suitable varnish to withstand the ambient conditions.

5.6 All external hardware of diameter less than 8 mm shall be of stainless steel and those of diameter 8 mm or above shall be of mild steel cadmium plated or zinc passivated.

5.7 Suitable arrangement for looping of cables from one switch socket to the other shall be provided. For switch sockets rated above 63A, looping shall be done from busbars and for switch sockets rated 63A and below, looping may be done from terminal block. Necessary terminals, cable glands and lugs for looping shall be provided. Also one no. The readed plug for each switch socket shall be supplied loose.

5.8 All the relevant information shall be provided on engraved name plate made of aluminium.

5.9 The enclosure shall be provided with two earthing terminals outside the body.

6.0 SPECIAL FEATURES FOR FLAME PROOF SWITCH SOCKET AND PLUGS

6.1 The enclosure shall be in addition of flame proof execution as per IS: 2148.

6.2 The enclosure group and temperature class shall be as indicated in specification sheet.

6.3 Cable shall enter the terminal chamber through flame proof compression type cable glands. From the terminal to the main enclosure, the connection shall be made through proper bushings. Direct entry of external cables into the main enclosure shall not be accepted.

6.4 An additional earthing terminal inside the terminal chamber shall be provided.

6.5 Switch socket, plug and cable glands must be certified by the Central Mining Research Institute, Dhanbad or any other statutory authority for use in the specified hazardous area.

6.6 Further interlocking shall be provided so that the contacts cannot be energised when the plug and socket are separated.

7.0 COMPONENT DETAILS

7.1 The rating of the components shall be as indicated in specification sheet.

7.2 **Air Break Switches**

7.2.1 The switches shall be quick make, quick break rotary type and of utilisation category AC-23 as per IS: 13947.

7.2.2 Switches shall be hand operated from outside the cover. The switch handle shall remain fixed to the front cover while removing the front cover.

7.3 **H.R.C. Fuses**

7.3.1 The sockets shall be provided with link type HRC fuses.

7.3.2 The fuses shall be capable of withstanding a short circuit current of 50 KA and shall be delayed action type conforming to IS: 13703. These shall be mounted on a shrouded base.

7.4 **Socket Outlets**

7.4.1 The socket outlet shall be located in the lower part of the enclosure and shall be provided with a threaded aluminium cover attached to the body with G.I. chain, to protect the socket after extraction of the plug. Spring loaded automatic shutter shall not be acceptable.

7.4.2 The socket contacts shall maintain satisfactory spring pressure and contact with the corresponding plug under normal service conditions.

7.4.3 The socket contacts shall be sunk well below the surface of the socket- outlets so as to make it impossible to be touched unintentionally.

7.4.4 An earthing contact shall be provided in the socket outlet which shall ensure making and breaking respectively of its contact with the earthing pin of the plug before and after making and breaking of the corresponding current carrying contacts.

7.5 **Plugs**

7.5.1 The plugs shall be so constructed so that these can be easily fitted in to the socket outlets.

7.5.2 These shall be provided with knurled knob arrangement for screwing on the body of the socket so that it can be securely fixed on the top.

7.5.3 The plug base and cover shall be firmly secured to each other and shall be sufficiently robust in construction to withstand normal usage.

7.5.4 The plug pins shall preferably be of single part. The earthing pin shall be slotted with a single slot and shall be larger in dimension than other pins.

7.5.5 The plug and socket contacts shall be self aligning type with best electrical continuity.

7.5.6 The plug shall be provided with dust proof cable entry suitable for receiving TRS flexible heavy duty copper conductor cable of specified size. The arrangement shall be such that the conductors are relieved from strain including twisting where they are connected to the terminals and that the outer surface of the cable at the place of entry is not damaged.

7.5.7 Insulating barriers forming an integral part of the plug shall ensure separation of metals and bare flexible conductors at different potentials.

7.6 **Cable Termination**

7.6.1 Switch socket shall have cable termination arrangement on the upper part of the housing and shall be provided with side entries, one on either side, through heavy duty double compression type rolled aluminium cable glands suitable for 1.1 KV grade PVC insulated armoured and PVC sheathed cables of size as indicated in specification sheet.

7.6.2 The terminal blocks shall be pressure clamp type for switch socket rated up to 63A and bolted lug type for higher ratings. The terminals shall be rated for at least 1.5 times the switch rating.

8.0 PAINTING

8.1 The enclosure after suitable pre-treatment shall be painted with two coats of anti-rust paint followed by two coats of anti-corrosive paint.

8.2 Epoxy based paint shall be used, if indicated in specification sheet.

8.3 All paints shall be carefully selected to withstand tropical heat and extremes of weather. The paint shall not scale off, crinkle or be removed by abrasion due to normal handling.

8.4 The finishing shade shall be light grey shade no.631 as per IS: 5, unless specified otherwise.

9.0 TESTS AND INSPECTION

9.1 The switch sockets and plugs shall be subjected to routine tests as per IS-4160 and other relevant standards.

9.2 Wherever specified, additional tests shall be carried out on one switch socket and plug of each rating.

9.3 The tests shall be carried out in the manufacturer's works in the presence of purchaser's representative. In addition to the above tests, the equipment shall be subject to stage inspection at works and inspection at site for final acceptance.

9.4 These inspections shall, however, not absolve the vendor from their responsibility for making good any defect which may be noticed subsequently.

10.0 DRAWING AND DOCUMENTS

10.1 Drawings and documents as per Annexure-I shall be supplied, unless otherwise specified.

10.2 All drawings and documents shall have the following descriptions written boldly.

- Name of client
- Name of consultant
- Enquiry / Order Number with plant / project name
- Code No. and Description

11.0 SPARES

11.1 Spares for operation and maintenance

Item wise unit prices of spare parts for the following items as applicable shall be offered along with the main equipment with recommended quantity for the period as indicated in specification sheet.

i) Switch

ii) Fuse base

iii) Fuse

iv) Terminal blocks

v) Terminal bushings

11.2 Commissioning Spares

Commissioning spares, as required, shall be supplied with the main equipment. Item wise list of recommended commissioning spares shall be furnished for approval.

11.3 Any other spare parts not specified, but required, shall also be quoted along with the offer.

11.4 All spare parts shall be identical to the parts used in the equipment.

12.0 PACKING

12.1 The switch socket and plug shall be properly packed to safeguard against weather conditions and handling during transit. It shall be wrapped in polythene bags and an additional wrapping of bitumen paper shall also be provided to make it completely water proof before the equipment is packed in wooden crates.

12.2 The packing box shall contain a copy of the installation, operation and maintenance manual.

13.0 DEVIATIONS

13.1 Deviations, if any, from this standard shall be clearly indicated in the offer with reasoning.

13.2 Deviations, if any, from the data furnished in specification sheet shall be indicated therein beside the data by encircling it.

ANNEXURE – I

DOCUMENTATION FOR INTERLOCKING SWITCH SOCKET AND PLUG

Sl.No.	Description	Documents Required (Y / N)		
		With Bid	For Approval	Final
1.	Specification Sheet	Y	Y	Y
2.	Technical Particulars	Y	Y	Y
3.	General arrangement and foundation drawing	Y	Y	Y
4.	Schematic / wiring diagram	N	Y	Y
5.	Illustrative and descriptive literature	Y	N	Y
6.	Catalogue for bought out accessories	Y	N	Y
7.	Installation operation and maintenance manual	N	N	Y
8.	Test Certificates			
	a) Type	N	N	Y
	b) Routine	N	N	Y
9.	Guarantee Certificate	N	N	Y
10.	Certificate of flameproofness from statutory testing authority wherever applicable.	Y	N	Y
11.	Spare parts list with identification marks	Y	N	Y

Note:

1. 4 hard copies & 1 soft copy shall be supplied with bid.
2. 4 hard copies & 1 soft copy shall be supplied for approval after order within 4 weeks from the date of LOI.
3. 8 hard copies & 2 soft copies in CD 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

ENGINEERING STANDARD

JUNCTION BOX

REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD
1	20.01.07	01.02.07	ISSUED FOR IMPLEMENTATION	AV	BKC / SC	BB
0	JAN'99	--	ISSUED FOR IMPLEMENTATION	SC/SC/RNS/JKT	JKT	HSW

CONTENTS

1.0 SCOPE

1.1 This standard covers the technical requirements of design, manufacture, testing and inspection at works and delivery in well packed condition of junction boxes.

1.2 This standard shall be read in conjunction with relevant specification sheet and other relevant references as specified their in.

2.0 STANDARDS TO BE FOLLOWED

2.1 The design, manufacture and testing of the equipment covered by this standard shall comply with the latest issue of relevant Indian standards unless otherwise specified. Equipment complying with equivalent IEC standards shall also be acceptable.

2.2 Flameproof & increased safety junction boxes shall in addition, comply with the requirement as laid down in IS: 2148 & IS: 6381 respectively.

2.3 The design and constructional features of the junction boxes offered shall also comply with the provision of latest issue of the Indian Electricity Rules and other relevant Statutory Rules & Regulations. The supplier shall, whenever necessary, make suitable modification in the equipment to comply with the above mentioned rules.

2.4 Wherever any requirement laid down in this standard differs from that in Indian Standard specifications, the requirement specified herein shall prevail.

3.0 SERVICE CONDITIONS

3.1 Ambient Conditions

These shall be as indicated in specification sheet.

3.2 System Details

The details of power supply system shall be as indicated in the specification sheet.

4.0 GENERAL DESIGN & CONSTRUCTIONAL FEATURES

4.1 The junction boxes shall be dust and weather proof and suitable for installation outdoors without extra protection. The degree of protection shall be IP-55 as per IS: 4691.

4.2 The junction boxes shall be of die cast aluminium alloy LM-6 with domed / suspension covers. As an alternative to cast aluminium, fibre glass enclosure is also acceptable if specified in specification sheet.

4.3 The casting of the junction boxes and their cover shall be pressure die cast. The casting shall be uniform and free from blow holes. All mechanical surfaces shall be free from burrs, dents and internal roughness.

4.4 All external hardware of diameter less than 8 mm shall be of stainless steel and those of diameter 8 mm and above shall be of mild steel cadmium plated or zinc

passivated. For fibre glass enclosure Nylon PVC bolts of diameter 8 mm may be used.

4.5 The clearances and creepage distances shall be maintained inside the junction boxes as per relevant Indian standard.

4.6 The junction boxes shall be suitable for wall / structure / ceiling mounting and necessary arrangement for mounting the same shall be provided.

4.7 The junction boxes shall be provided with continuous gasket made of neoprene or synthetic rubber to prevent ingress of dust. The gasket shall be held in position in groove provided in the enclosure and shall be pressed all around uniformly by suitably shaped projection of the door. Gaskets simply glued to the surface are not acceptable.

4.8 The junction boxes housing terminal block shall be moulded type made of DMC / Fibre glass. Threaded terminals shall be made of brass (nickel plated or tinned) and provided with two tightening threaded nuts and four washers all made of brass (nickel plated or tinned). The terminals shall have two shorting links each horizontally placed connecting three terminals.

4.9 The terminal block shall be fitted with junction boxes base by means of 2 nos. 1/2” long nickel plated brass screws.

4.10 The junction boxes shall be provided with two nos. external earthing terminals and 1 no. internal earthing terminal.

4.11 All live parts inside the junction boxes shall be insulated and shall withstand a test voltage of 2.5 KV for 1 minute.

4.12 The junction boxes shall be provided with heavy duty double compression type rolled Al cable glands to suit the cable entries.

4.13 Threaded blanking plugs shall be provided for junction boxes to plug out the entries not in use as indicated in bill of quantities enclosed.

4.14 The junction boxes shall be provided with a blank stainless steel tag plate fastened to the junction box top cover with two stainless steel screws. The plate shall be at least 25 mm wide, 100 mm long and 1 mm thick.

4.15 For flameproof / increased safety junction boxes, the manufacturer shall submit copies of test certificates from statutory authorities clearly stating that the junction boxes as well as cable glands / blanking plugs are suitable for hazardous area as indicated in the specification sheet.

4.16 **15 Amp. Junction Box**

4.16.1 The junction boxes shall be 4 way dome cover type.

4.16.2 The dimensions of the junction boxes with their cover and accessories shall be generally as per PDS: E-547.

4.16.3 The junction boxes housing terminal block shall be moulded type made of DMC / Fibre glass as per Drg. no. PDS: E-557.

4.17 **63 Amp. Junction Box**

4.17.1 The junction boxes shall be 3 / 4 way dome cover type.

4.17.2 The minimum internal diameter of the box shall be 240 mm.

5.0 SPECIAL FEATURES FOR JUNCTION BOXES FOR HAZARDOUS AREA

5.1 For increased safety junction boxes, the terminals shall be provided with positive locking device against loosening.

5.2 The enclosure shall be in addition, of increased safety execution, Exe, as per relevant standard and shall be suitable for installation specified in specification sheet.

5.3 The junction boxes shall be liberally dimensioned in order to avoid temperature rise inside the enclosure which may damage the insulating materials or gaskets employed therein.

5.4 Cables shall enter the terminal box through increased safety compression type cable glands. From the terminal chamber to the main enclosure, the connections shall be made through proper bushings.

5.5 An additional earthing terminal inside the terminal chamber shall be provided.

5.6 The junction boxes shall be provided with Brass-Nickel plated shorted links. The terminal block shall be made of non-hygroscopic compound. Bakelite / Hylam shall not acceptable.

5.7 All screws / bolts and nuts shall be of stainless steel.

5.8 Junction boxes and cable glands must be certified by Statutory Authorities for use in the specified hazardous area. Equipments certified by overseas authorities shall obtain certificate of compliance / letter of opinion from respective statutory authorities.

5.9 Duly wired prototype samples for junction boxes shall be submitted for scrutiny as and when called for.

5.10 Type Test certificates for increased safety type junction boxes and cable glands along with blanking plugs shall be supplied.

6.0 PAINTING

6.1 Epoxy based electrostatic powder coating paint shall be provided on exterior surface while the interior of junction boxes shall be painted with anti-condensate paint. The painting shall be able to withstand corrosive atmosphere as specified in specification sheet.

6.2 Unless otherwise specified, the finishing shade shall be grey having shade no. 632 as per IS-5.

6.3 The terminal block of junction boxes shall be painted with Red, Yellow, Blue & Black colour for phase indication.

7.0 TESTS AND INSPECTION

7.1 The junction boxes shall be routine tested as per relevant standards.

7.2 Additional tests, wherever specified, shall be carried out on one unit of each rating.

7.3 The procedure & extent of the physical checks, routine & type test shall be governed by Quality Assurance Plan mutually agreed and approved by Inspection Authority.

7.4 All the above mentioned tests shall be carried out in the presence of purchaser's representative. In addition, the equipment shall be subjected to stage inspection at works and inspection at site for final acceptance.

7.5 These inspections shall, however, not absolve the vendor from their responsibility for making good any defect which may be noticed subsequently.

8.0 PACKING

Each junction box and cable gland shall be suitably packed and protected from damage due to transportation, loading and unloading. Threaded fittings shall have plastic caps to protect the threading.

9.0 DRAWINGS AND DOCUMENTS

9.1 Drawings and documents as per Annexure-I shall be supplied, unless otherwise specified.

9.2 All drawings and documents shall have the following descriptions written boldly:

- Name of client
- Name of consultant
- Enquiry / order number with plant / project name
- Motor Code No. and Description

10.0 SPARES

10.1 Spares for operation and maintenance

Item wise unit prices of spare parts for the following items, as applicable, shall be offered along with the main equipment with recommended quantity for the period as indicated in specification sheet.

i) Cable glands

ii) Threaded Plug

iii) Terminal blocks

iv) Terminal bushings

10.2 Commissioning Spares

Commissioning spares, as required, shall be supplied with the main equipment. Item wise list of recommended commissioning spares shall be furnished for approval.

10.3 Any other spare parts not specified, but required, shall also be quoted along with the offer.

10.4 All spare parts shall be identical to the parts used in the equipment.

11.0 DEVIATIONS

11.1 Deviations, if any, from this standard shall be clearly indicated in the offer with reasoning.

11.2 Deviations, if any, from the data furnished in specification sheet shall be indicated therein beside the data by encircling it.

ANNEXURE - I

DOCUMENTATION FOR JUNCTION BOXES

Sl. No.	Document Description	Documents Required (Y / N)		
		With Bid	For Approval	Final
1.	Specification Sheet, duly completed	Y	Y	Y
2.	Technical Particulars, duly filled-in	Y	Y	Y
3.	Certified dimensional drawing, including mounting details	Y	Y	Y
4.	Drawing showing constructional details	Y	Y	Y
5.	Illustrative and Descriptive catalogues	Y	N	Y
6.	Spare parts list	Y	N	Y
7.	FLP/Exe certificates for junction boxes and terminals conforming to IEC/ISS (CMRI, CCE, DGFASLI and BARC for terminals)	Y	N	Y
8.	Certificate for weather proof construction for junction boxes as per IPW-55	Y	N	Y

Note:

1. 4 hard copies & 1 soft copy shall be supplied with bid.
2. 4 hard copies & 1 soft copy shall be supplied for approval after order within 4 weeks from the date of LOI.
3. 8 hard copies & 2 soft copies in CD 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

ENGINEERING STANDARD

LIGHTING SUB DISTRIBUTION BOARDS

REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD
2	20.01.07	01.02.07	ISSUED FOR IMPLEMENTATION	AV	BKC /SC	BB
1	16.01.06	30.01.06	ISSUED FOR IMPLEMENTATION	AV	BKC	BB
0	DEC. '97	--	ISSUED FOR IMPLEMENTATION	RNS/JKT/SC	JKT	HSW

CONTENTS

LIST OF ATTACHMENTS

1.0 SCOPE

1.1 This standard covers the technical requirements of design, manufacture, testing at works and delivery in well packed condition of lighting sub distribution boards.

1.2 This standard shall be read in conjunction with relevant specification sheets.

2.0 STANDARDS TO BE FOLLOWED

2.1 The design, manufacture and testing of the equipment covered by this standard shall comply with the latest issue of the following Indian Standards. Equipment complying with equivalent IEC standards shall also be acceptable

IS: 13947	-	Low voltage switchgear and control gear
IS: 8623	-	Specification for low voltage switchgear and control gear assemblies

2.2 The design and operational features of the equipment offered shall also comply with the provisions of latest issue of the Indian Electricity Rules and other relevant statutory acts and regulations. The supplier shall, wherever necessary, make suitable modification in the equipment to comply with the above.

2.3 Wherever any requirement, laid down in this standard, differs from that in Indian Standard Specifications, the requirement specified herein shall prevail.

3.0 SERVICE CONDITIONS

3.1 Ambient Conditions

These shall be as indicated in specification sheet.

3.2 System Details

These shall be as indicated in specification sheet.

4.0 OPERATING REQUIREMENTS

The lighting sub-distribution boards shall be suitable for operating continuously under the ambient conditions and with the voltage and frequency variations indicated in specification sheet, without exceeding the specified temperature rise and without any detrimental effect on any part.

5.0 GENERAL DESIGN AND CONSTRUCTIONAL FEATURES

5.1 The lighting sub distribution boards shall be fabricated out of 2.5 mm thick cold rolled sheet steel and shall be suitable for mounting on wall/structure. These shall have dust and vermin proof construction conforming to IP-54 as per IS: 13947. For outdoor installation, the enclosure shall conform to IPW-55. Where specified in specification sheet, suitable canopy made out of 2 mm thick Aluminium sheet shall be supplied along with the board.

5.2 The miniature circuit breakers shall be so mounted inside the enclosure that their operating knobs project outside for easy operation. The cut-out for the knobs on the enclosure shall be lined with gasket for dust proofness. For further protection against ingress of dust, the portion where the knobs have protruded out, shall be provided with another external front cover, internally hinged at the top, gravity operated and with a knurled knob at the bottom. The external cover shall be flushed with the main cover. Continuous neoprene gasket shall be provided to make the board completely dust and weather proof.

5.3 All external hard ware of diameter less than 8 mm shall be of stainless steel and those of diameter 8 mm and above shall be of mild steel cadmium plated or zinc passivated.

5.4 The sub-distribution boards to be located indoors shall have top entry arrangement for outgoing cables and bottom entry for incoming cable. However for outdoor locations, all cable entries shall be from the bottom only.

5.5 Three phase and neutral bus bar system of adequate size shall be provided to which all outgoing and incoming MCB's shall be connected.

5.6 The internal wiring shall be carried out by means of single core PVC insulated 2.5 sq. mm stranded copper conductor cables.

5.7 Two earthing terminals outside the board shall be provided.

5.8 Suitable label inscription consisting of black perspex with engraving for the board and circuit nos. of all outgoing feeders shall be provided. The label inscription of the board shall contain description and code no. as indicated in specification sheet. The circuit nos. of outgoing feeders shall be serially indicated as 1L, 2L.....17L, 18L.

5.9 The board shall be complete with terminal block, cable glands, cable lugs and other accessories as specified.

6.0 SPECIAL FEATURES FOR FLAME PROOF LIGHTING SUB DISTRIBUTION BOARDS

6.1 The enclosure shall be in addition of flame proof execution as per IS: 2148.

6.2 The enclosure group and temperature class shall be as indicated in specification sheet.

6.3 The enclosure shall be of cast iron/cast Aluminium alloy (4600 as per IS: 617).

6.4 Cables shall enter the terminal chamber through flame proof compression type cable glands. From terminal chamber to the main enclosure connection shall be made through bushings. Direct entry of external cables into the main enclosure shall not be accepted.

6.5 The sub-distribution board shall be of 6 way type.

6.6 Individual earth terminals shall be provided for the earth conductor of the outgoing cables beside the phase and neutral terminals.

6.7 The sub-distribution board must be certified by Central Mining Research Institute, Dhanbad or other statutory authority for use in specified hazardous area.

7.0 COMPONENT DETAILS

7.1 The lighting sub-distribution board shall be wired and have components as per SD-8083 (copy attached). The type of board shall be as indicated in specification sheet.

7.2 Miniature Circuit Breaker (MCB)

7.2.1 The MCB shall be of duty category M-9 and shall conform to IS-8828. It shall be provided with overload and short circuit protective devices.

7.2.2 The incoming MCB's or switches shall be of triple pole and switched neutral type and outgoing MCB's of single pole and switched neutral type, single phase earth leakage protection in each phase of the incomer shall be provided.

7.3 Terminal Block

Pressure clamp type terminal blocks shall be provided both for incoming and outgoing cables. The rating of the terminal block shall be at least 1.5 times the rating of the MCB.

7.4 Cable Glands

Heavy duty double compression type Aluminium cable glands suitable for PVC insulated, armoured and PVC sheathed 1.1 KV grade incoming and outgoing cables of sizes as indicated in specification sheet shall be provided.

8.0 PAINTING

8.1 The enclosure after suitable pre-treatment shall be painted with two coats of anti rust paint followed by two coats or anticorrosive paint.

8.2 Where indicated in specification sheet epoxy based paint shall be used.

8.3 All paints shall be carefully selected to withstand tropical heat and extremes of weather. The paint shall not scale off, crinkle or be removed by abrasion due to normal handling.

8.4 The finishing shade shall be light grey shade no.631 as per IS: 5, unless specified otherwise in specification sheet.

9.0 TESTS AND INSPECTION

9.1 All the lighting sub-distribution boards shall be subjected to routine tests as per IS: 8623.

9.2 Additional tests, wherever specified, shall be carried out on one lighting sub-distribution board of each type.

9.3 The above mentioned tests shall be carried out in the manufacturer's works in the presence of purchaser's representative. In addition, the equipment shall be subjected to stage inspection at works and inspection at site for final acceptance.

9.4 The purchaser's inspection shall, however, not absolve the vendor from his responsibility for making good any defects which may be noticed subsequently.

10.0 DRAWINGS AND DOCUMENTS

10.1 Drawings and documents as per Annexure-I shall be supplied, unless otherwise specified.

10.2 All drawings and documents shall have the following description written boldly.

- Name of client
- Name of consultant
- Enquiry / Order Number with plant / project name
- Code No. and Description

11.0 SPARES

11.1 Spares for operation and maintenance

Item wise unit prices for the following items, along with recommended quantity for the period as indicated in specification sheet, shall be quoted along with the main equipment.

i) MCB
ii) Terminal blocks
iii) Terminal bushings

11.2 Commissioning Spares

Commissioning spares, as required, shall be supplied with the main equipment. Item wise list of recommended commissioning spares shall be furnished for approval.

11.3 Any other spare parts not specified, but required, shall also be quoted along with the offer.

11.4 All spare parts shall be identical to the parts used in the equipment.

12.0 PACKING

12.1 The equipment shall be properly packed to safeguard against weather conditions and handling during transit. It shall be wrapped in polythene bags and an additional wrapping of bitumen paper shall also be provided to make it completely water proof before the equipment is packed in wooden crates.

12.2 The packing box shall contain a copy of the installation, operation and maintenance manual.

13.0 DEVIATIONS

13.1 Deviations, if any, from this standard shall be clearly indicated in the offer with reasoning.

13.2 Deviations, if any, from the data furnished in specification sheet shall be indicated therein beside the data by encircling it.

ANNEXURE - I

DOCUMENTATION FOR LIGHTING SUB DISTRIBUTION BOARDS

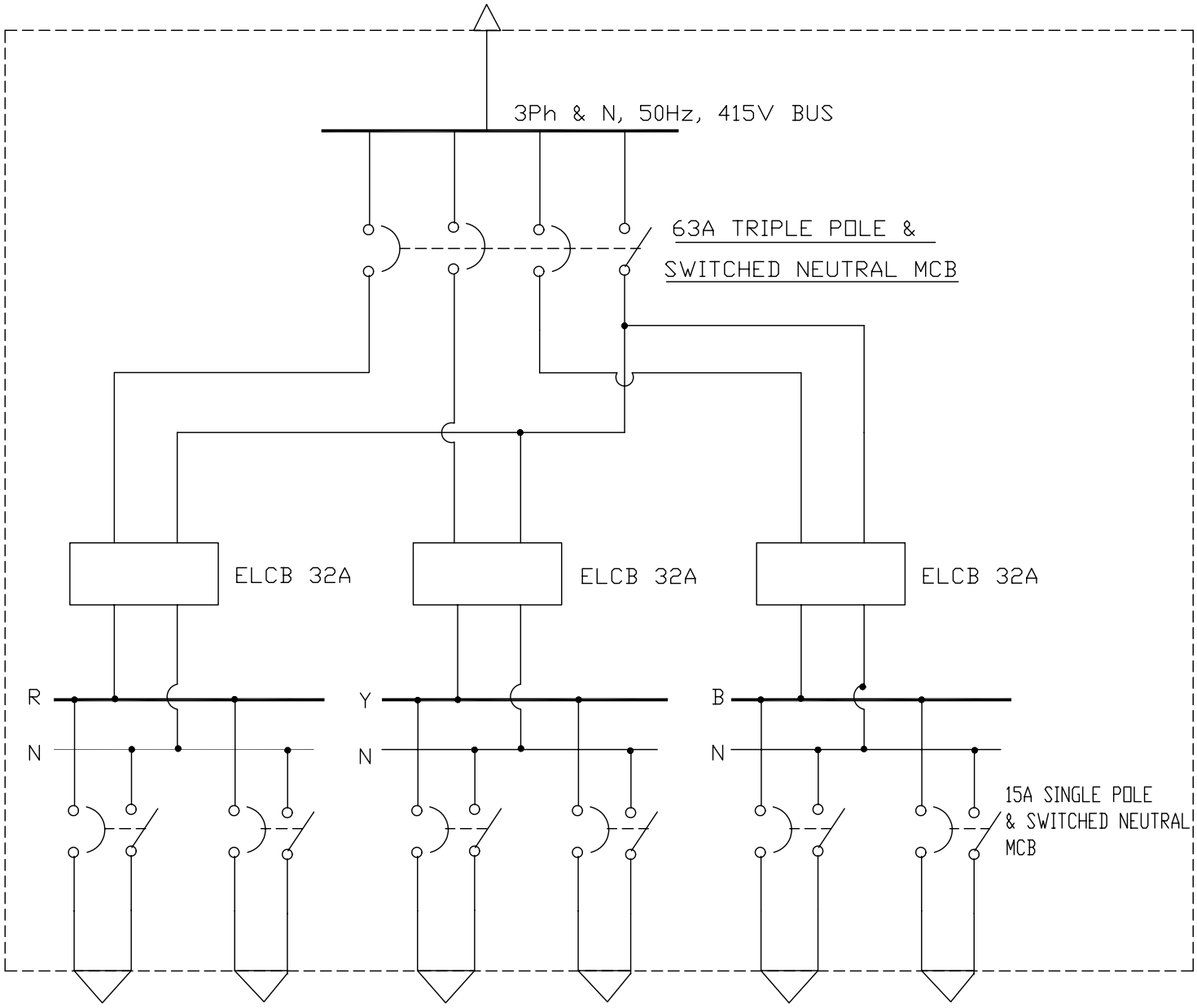
SL. NO.	Description	Documents Required (Y / N)		
		With Bid	For Approval	Final
1.	Specification Sheet, duly completed	Y	Y	Y
2.	Technical particulars, duly filled-in	Y	Y	Y
3.	General arrangement Drgs.	Y	Y	Y
4.	Certificate for flameproofness from statutory testing authority wherever applicable	Y	N	Y
5.	Schematic diagram	N	Y	Y
6.	Descriptive literature of Various equipment	Y	N	Y
7.	Guarantee certificate	N	N	Y
8.	Test certificate	N	N	Y

Note:

1. 4 hard copies & 1 soft copy shall be supplied with bid.
2. 4 hard copies & 1 soft copy shall be supplied for approval after order within 4 weeks from the date of LOI.
3. 8 hard copies & 2 soft copies in CD 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.

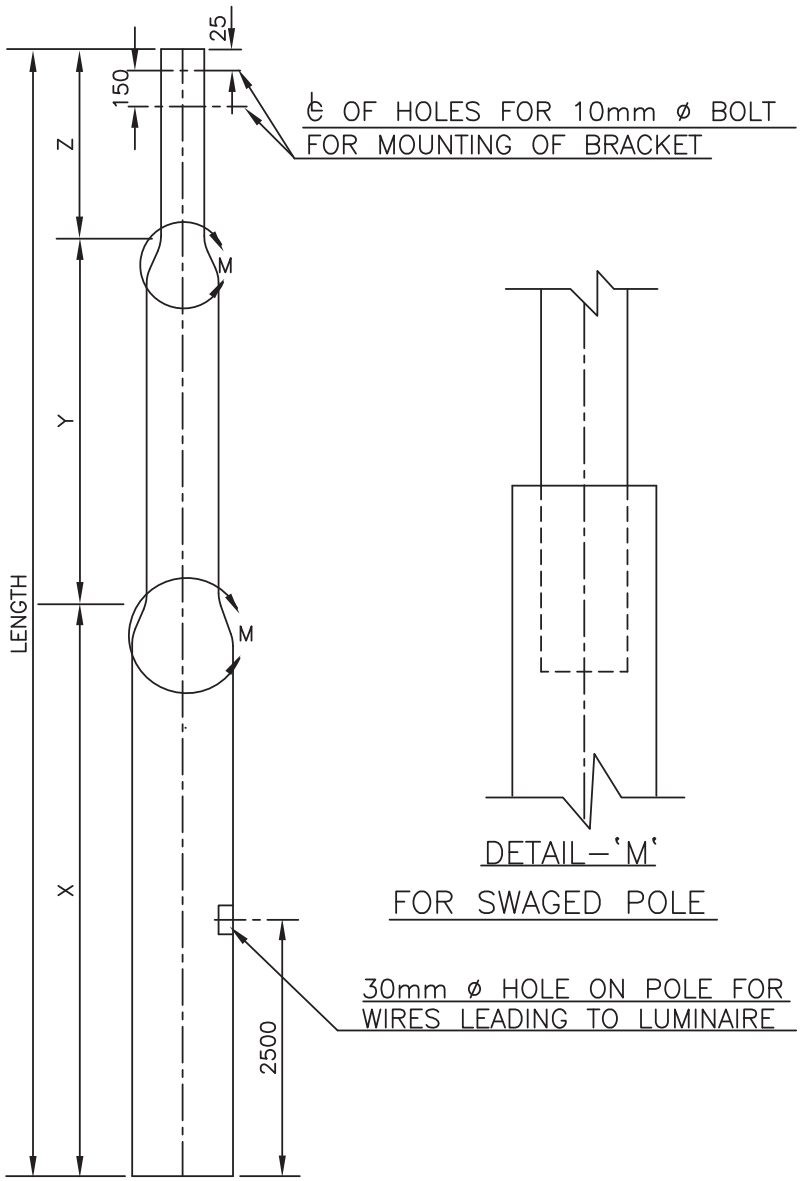
Y - Yes, N - No

PDIL	TYPICAL WIRING DIAGRAM FOR LIGHTING SUB–DISTRIBUTION BOARDS	SD : 8083	2
		DOCUMENT NO.	REV
		SHEET 1 OF 1	



SL. NO.	LIGHTING SUB-DIST. BOARD TYPE	NOS. OF OUTGOING FEEDERS
1.	A	6
2.	B	9
3.	C	12
4.	D	15
5.	E	18

2	20.01.07	01.02.07	ISSUED FOR IMPLEMENTATION	RUNDA	AV	BB
REV	REV.DATE	EFF.DATE	PURPOSE	PREPD	REVWD	APPD

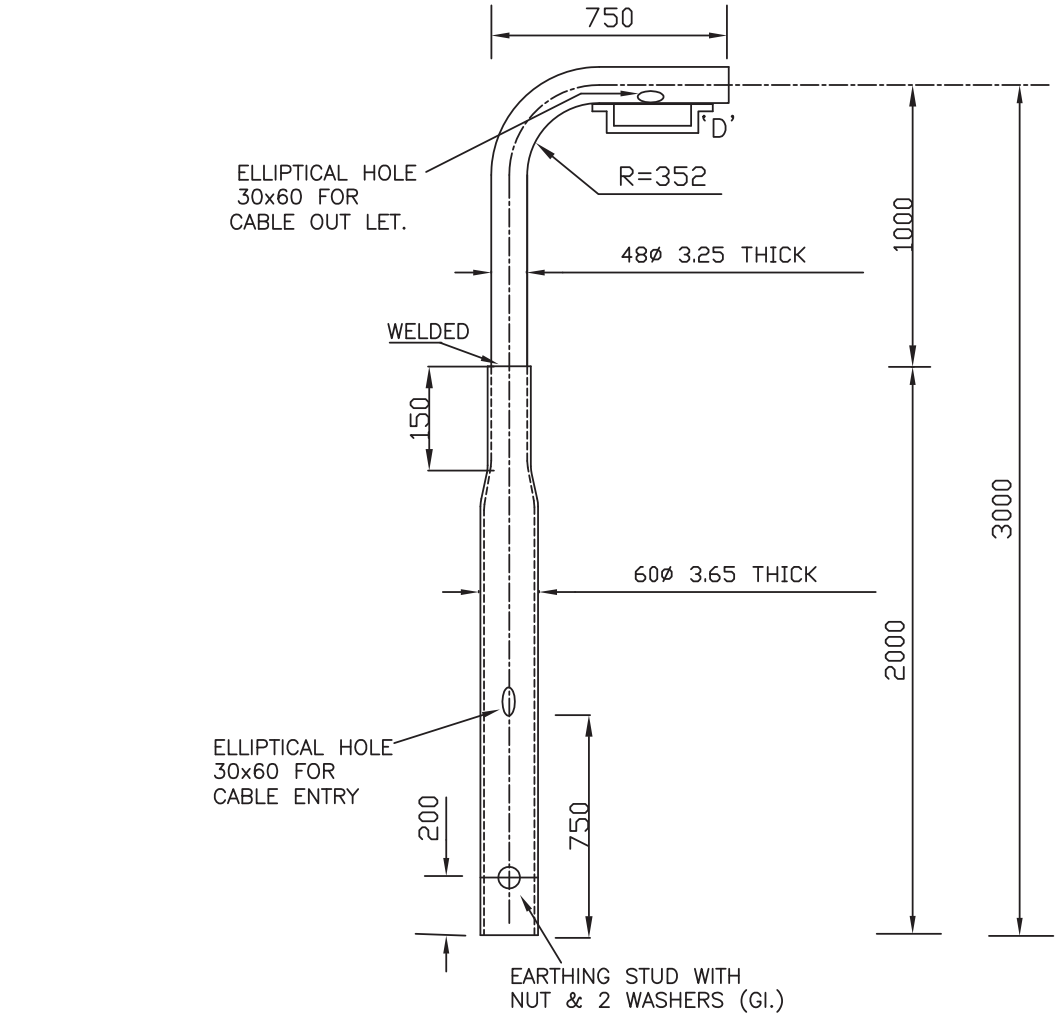


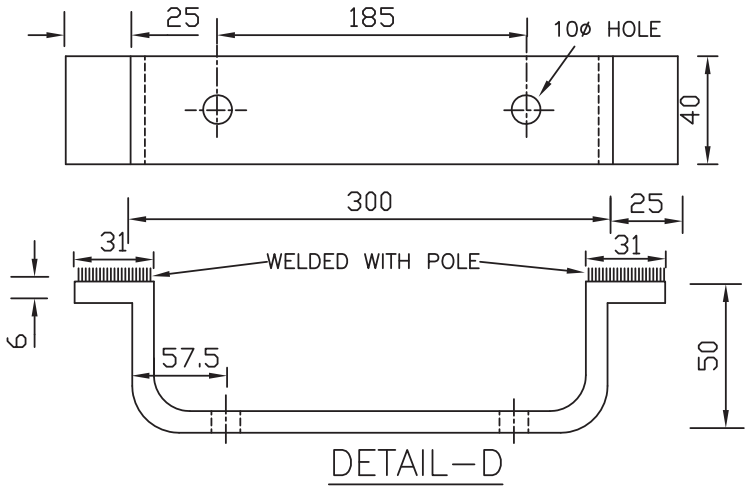
POLE DESIGNATION	LENGTH(M) X+Y+Z=L	PLANTING DEPTH(M)	DIAxTHICKNESS BOTTOM(mm)	DIA MIDDLE(mm)	DIA TOP(mm)	WEIGHT OF POLE (Kg)
410 TP3/SP3	X+Y+Z=7	1.25	114.3x4		78.1	87/85
410 TP12/SP12	X+Y+Z=8	1.5	114.3x4		78.1	101/97
410 TP13/SP13	X+Y+Z=8	1.5	139.7x4		88.9	125/119
410 TP27/SP27	X+Y+Z=9	1.5	114.3x4		76.1	113/108
410 TP30/SP30	X+Y+Z=9	1.5	139.7x4		88.9	140/133
410 TP33/SP33	X+Y+Z=9	1.5	165.1x4		114.3	170/184

NOTE:–

1. TP REFER TO STEPPED POLE.
2. SP REFER TO SWAGED POLE.
3. POLE DESIGNATION IS AS PER IS: 1239

SWAGED POLE TYPE 'B'



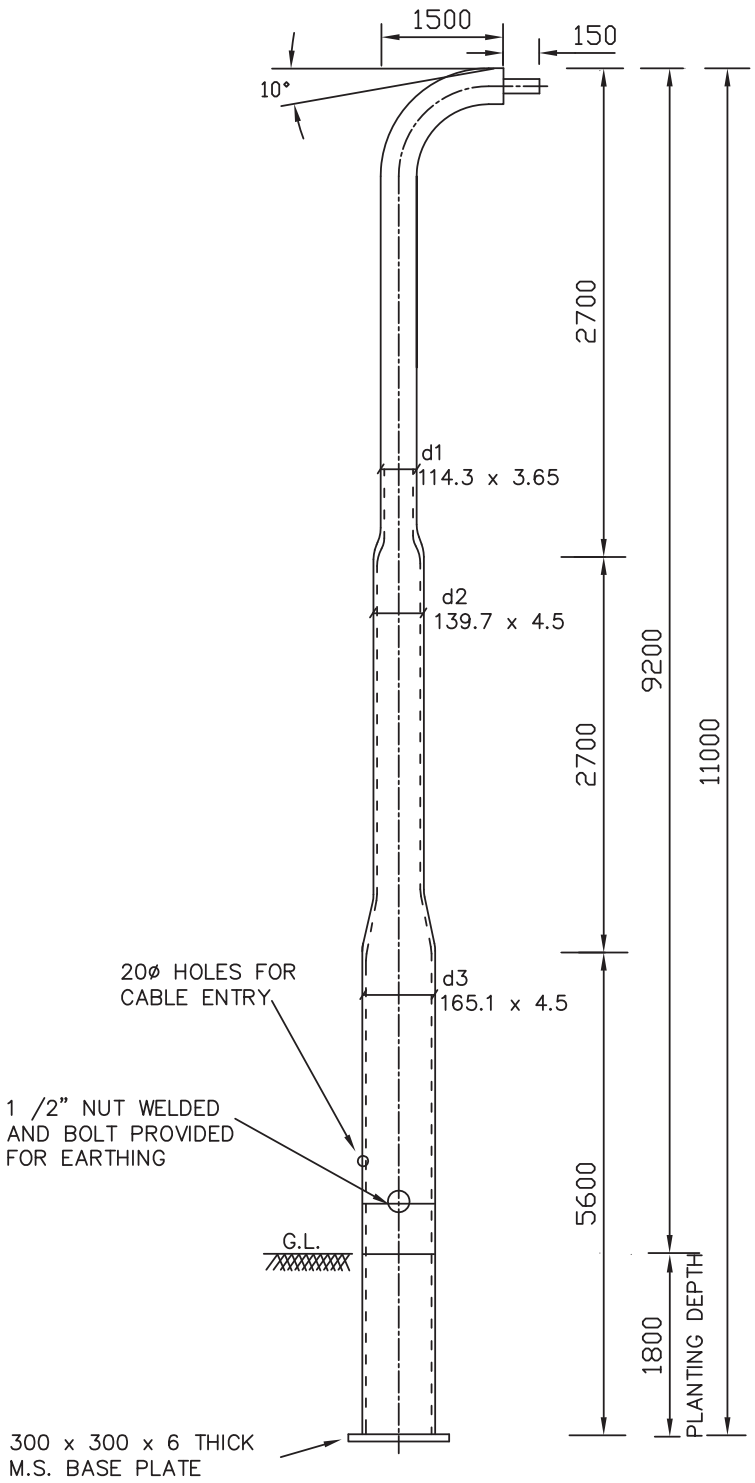


DETAIL–D

NOTE:–

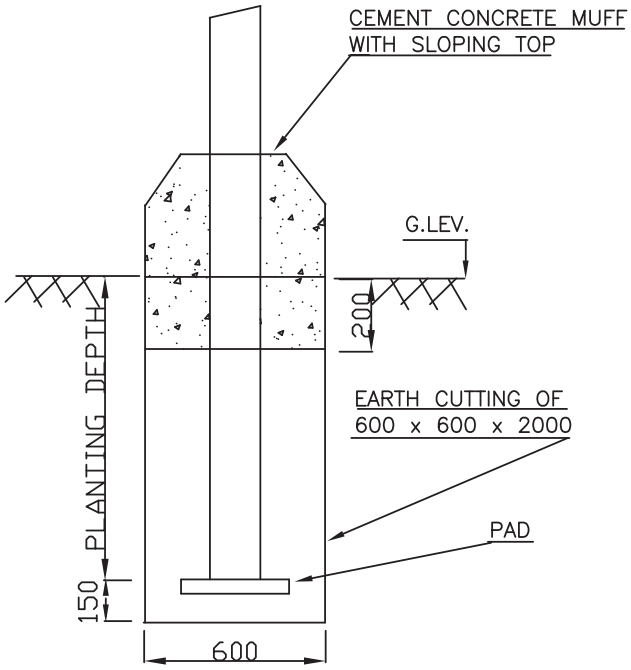
1. ALL DIMENSIONS ARE IN mm

SWAGED POLE TYPE 'C'
(FOR PLANT GROUND MOUNTING)



NOTES: –

1. NIPPLE OF DIA. 45 (NIPPLE TO BE PREPd. BY DIRECT REDUCTION OF DIA OF TOP PIPE WITHOUT USE OF ANY WASHER)
2. POLE MATERIAL MS AS PER IS 1239 ABOVE GROUND PORTION TO BE PAINTE 2 COATS OF RED OXIDE PRIMER,UNDER GROUND PORTION PAINTED BITUMINUS PAINT.
3. FOR FLOOD LIGHTING POLE THE TOP PORTION NOT TO BE TILTED BUT A 300 x 300 x 6mm THICK M.S. PLATE WELDED AT THE TOP SHALL BE PROVIDED TO MOUNT FLOOD LIGHT.
4. ALL DIMENSIONS ARE IN mm



1. FOR PAD USE:–

a) 400x400x70 CONCRETE BLOCK FOR POLES.

b) BASE PLATE AS SHOWN IN PDS:E 205 FOR STEEL TUBULAR POLES SHALL BE USED AS PAD

C) RCC / WOOD POLES DO NOT NEED ANY PAD.

2. MUFF IS MUST FOR STEEL TUBULAR POLES AND OPTIONAL FOR OTHERS POLES, MUFF SHALL BE PROVIDED AFTER UNDER GROUND CABLING FOR STREET LIGHTING IS COMPLETED.

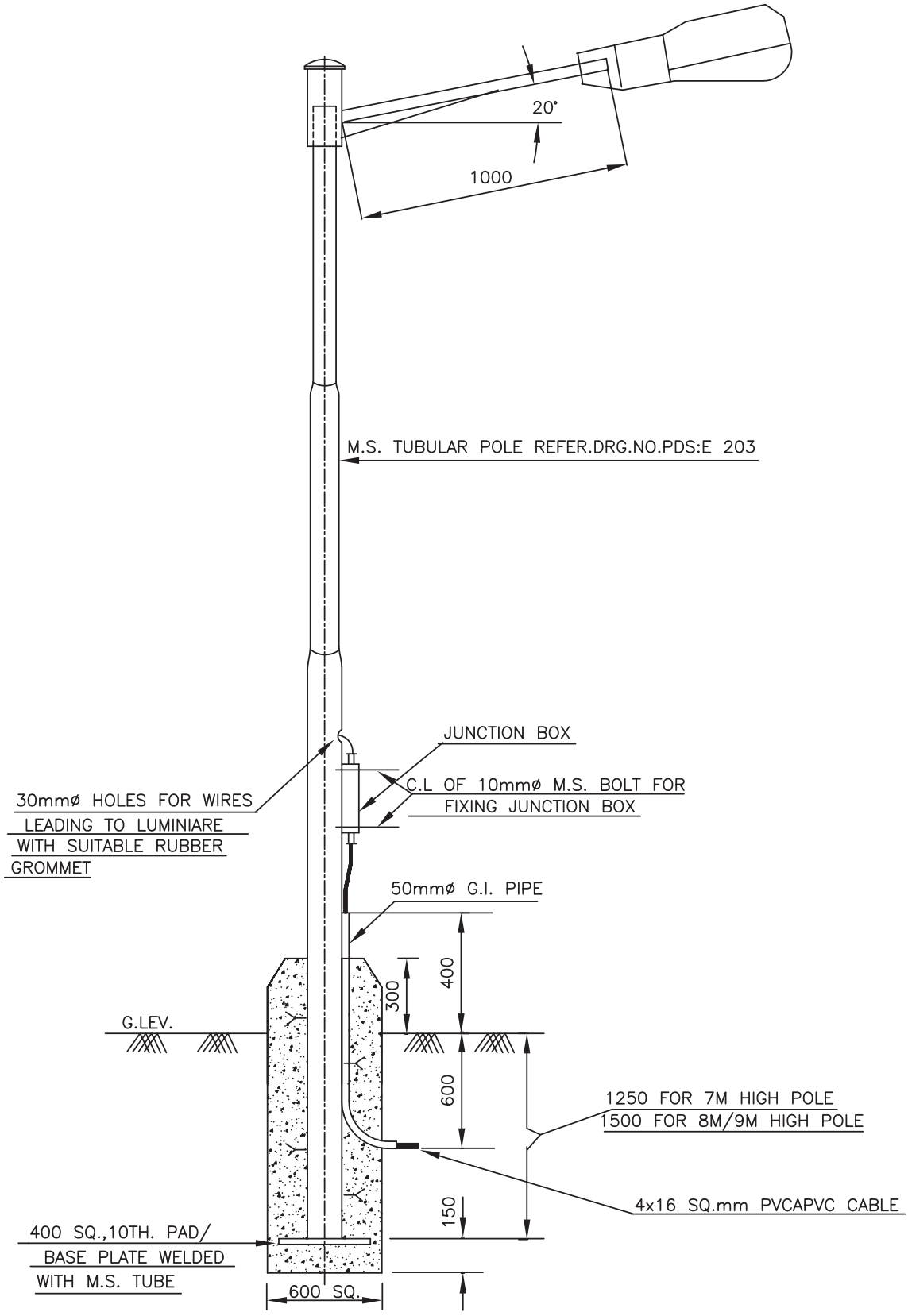
3. MUFF HEIGHT FROM GROUND LEVEL SHALL BE 300mm FOR ORDINARY POLES AND 457mm FOR STREET LIGHTING POLES HAVING J.B.LOCATED ON THE MUFF

4. FOR MOUNTING OF JBS' ON THE MUFF REFER PDS:E 209

5. FOR PLANTING DEPTH REFER RELEVANT ISS.

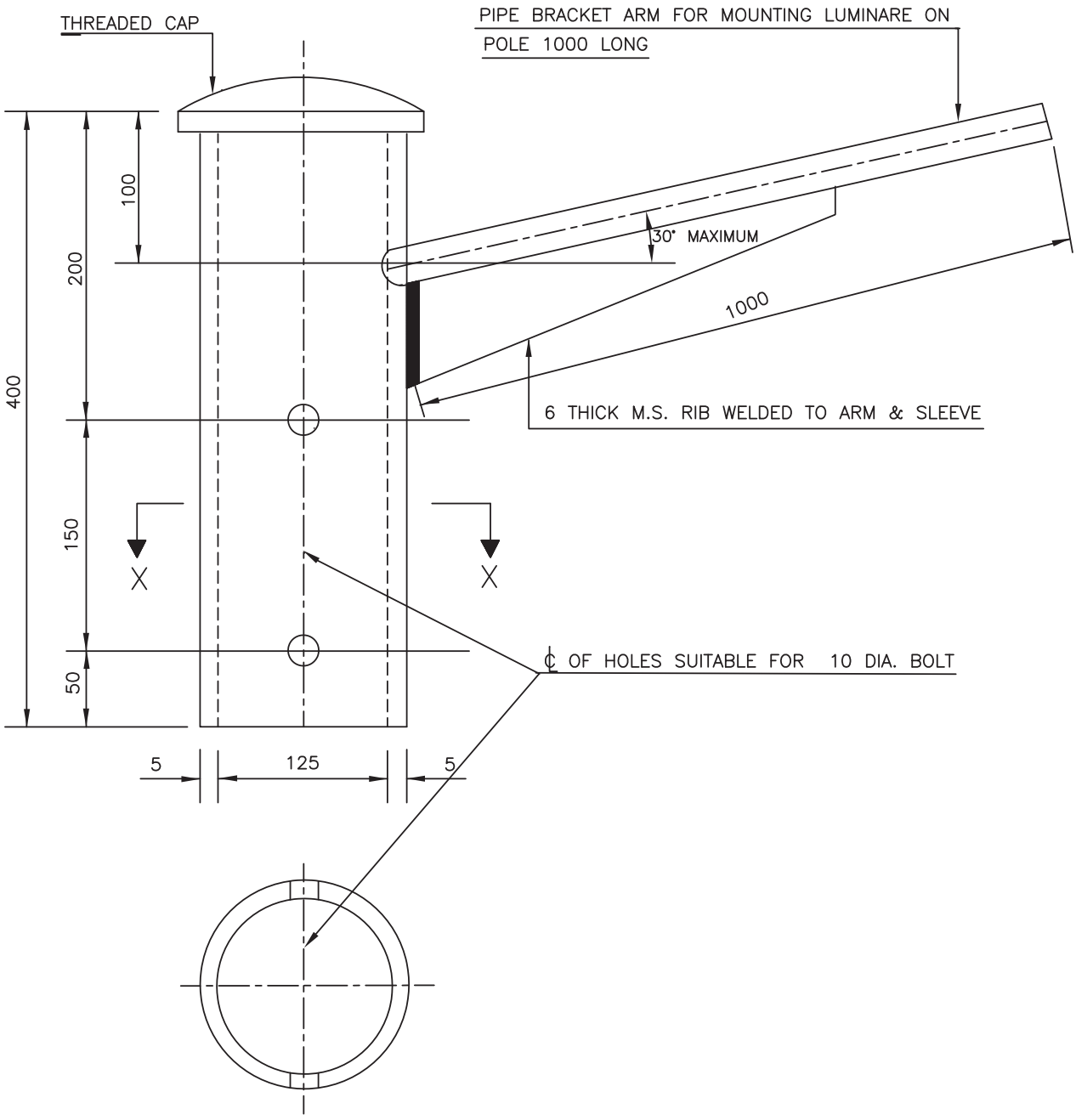
6. ALL DIMENSIONS ARE IN mm

पी डी आई एल PDIL	INSTALLATION ARRANGEMENT STREET LIGHTING FIXTURES	PDS: E 206	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	



NOTE :–
ALL DIMENSIONS ARE IN mm.

पी डी आई एल PDIL	DETAILS OF BRACKET ARM FOR STREET LIGHTING POLE	PDS: E 207	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	

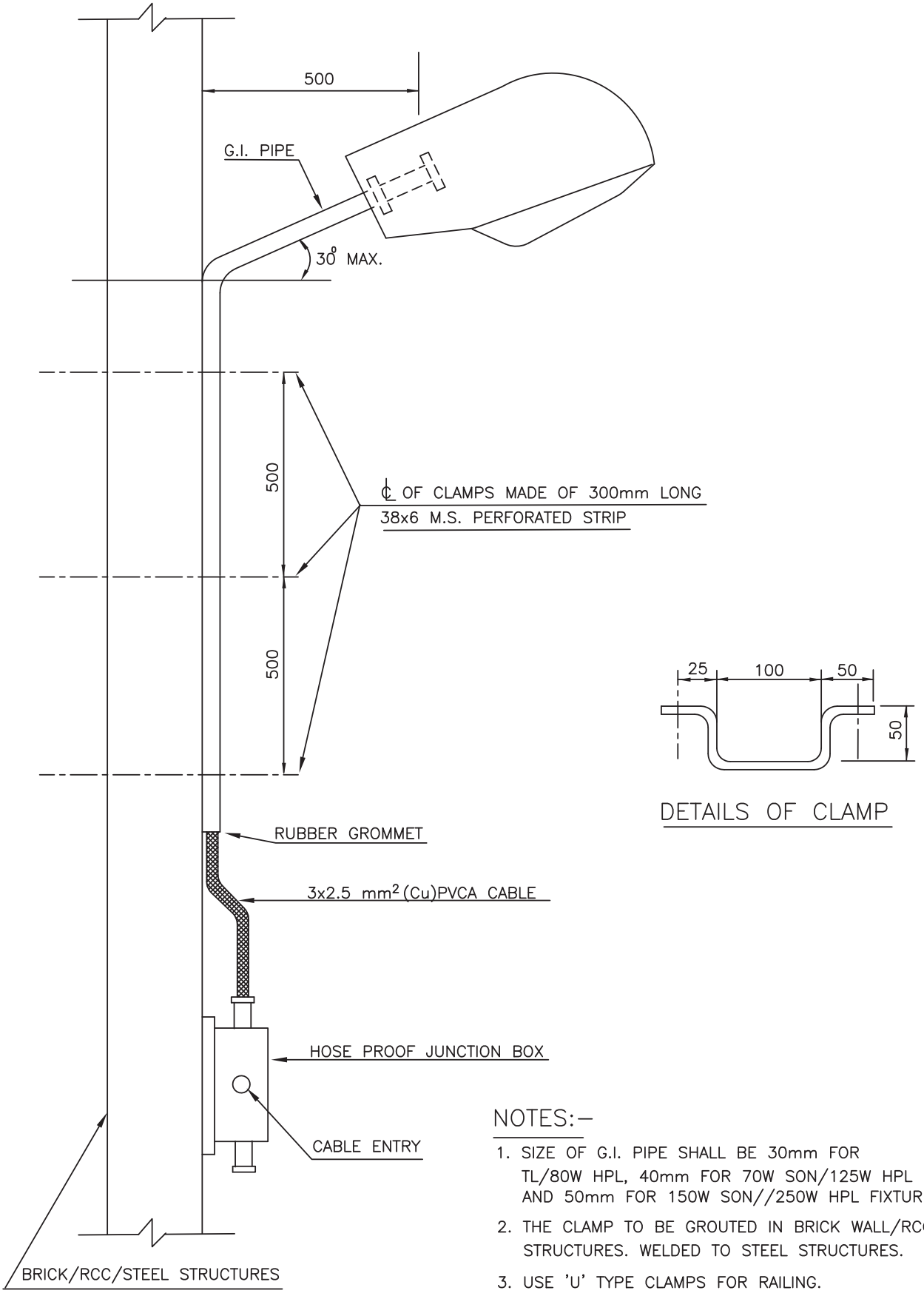


SECTION – XX

NOTES:–

1. SIZE OF PIPE SHALL BE 30mm FOR TL/80W HPL FIXTURES, 40mm FOR 70W SON/125W HPL FIXTURES AND 50mm FOR 150W SON/250W HPL FIXTURES.
2. ALL DIMENSIONS ARE IN mm.

पी डी आई एल PDIL	INSTALLATION ARRANGEMENT AREA LIGHTING FIXTURES	PDS: E 208	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	

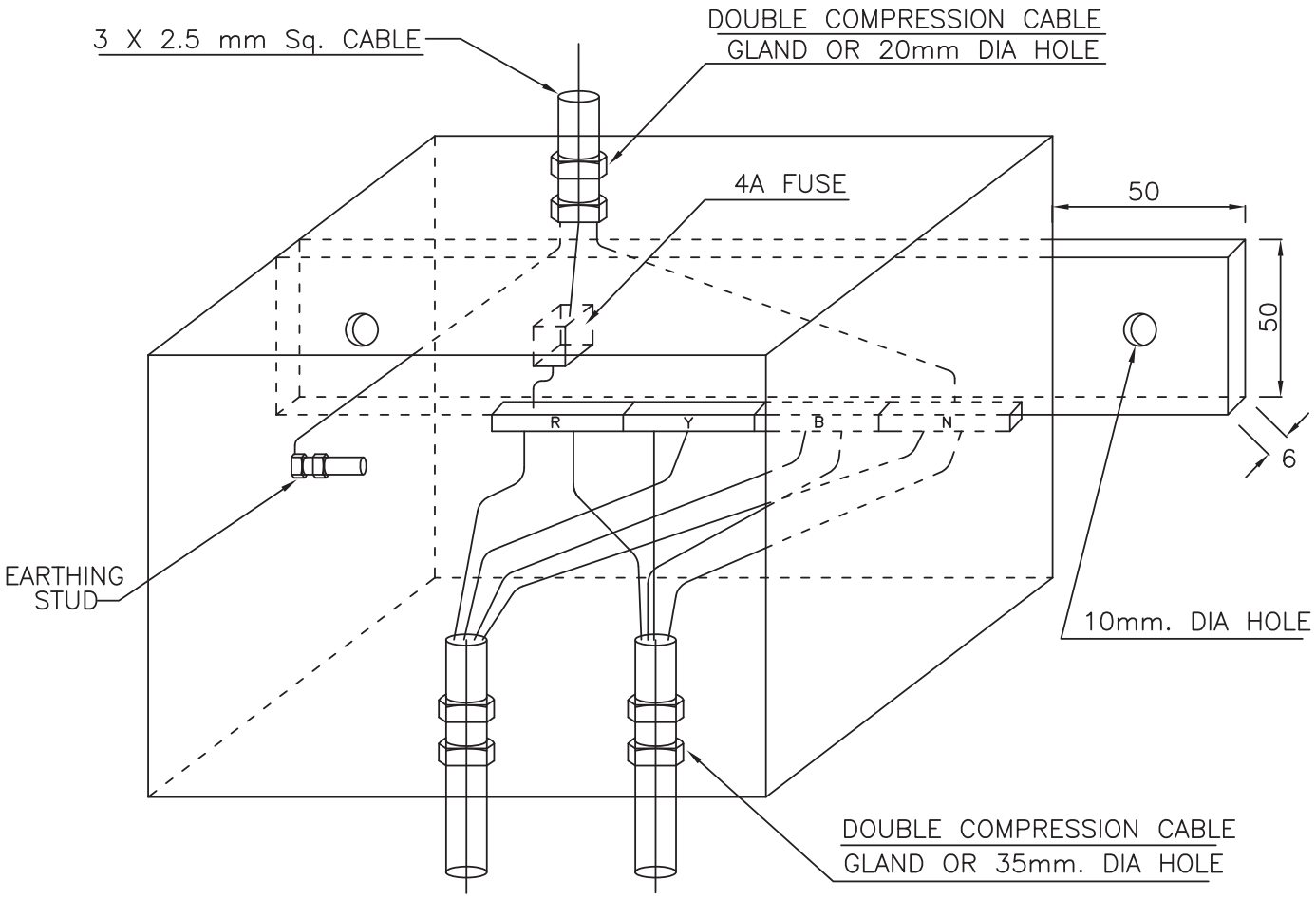


DETAILS OF CLAMP

NOTES:–

1. SIZE OF G.I. PIPE SHALL BE 30mm FOR TL/80W HPL, 40mm FOR 70W SON/125W HPL AND 50mm FOR 150W SON//250W HPL FIXTURES.
2. THE CLAMP TO BE GROUTED IN BRICK WALL/RCC STRUCTURES. WELDED TO STEEL STRUCTURES.
3. USE 'U' TYPE CLAMPS FOR RAILING.
4. ALL DIMENSIONS ARE IN mm.

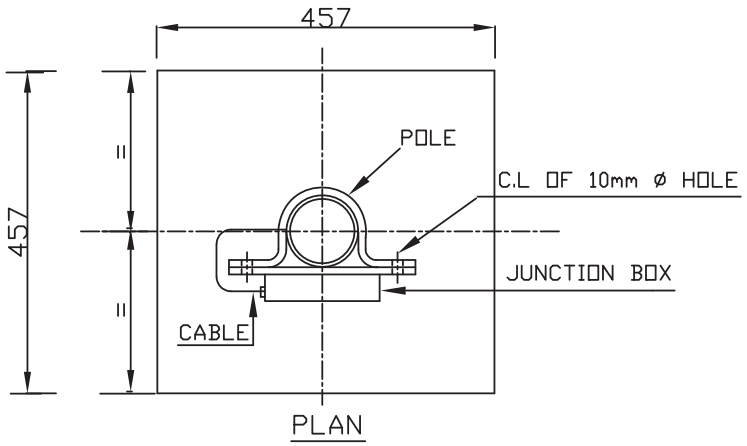
पी डी आई एल PDIL	JUNCTION BOX FOR STREET LIGHTING POLE	PDS: E 210	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	



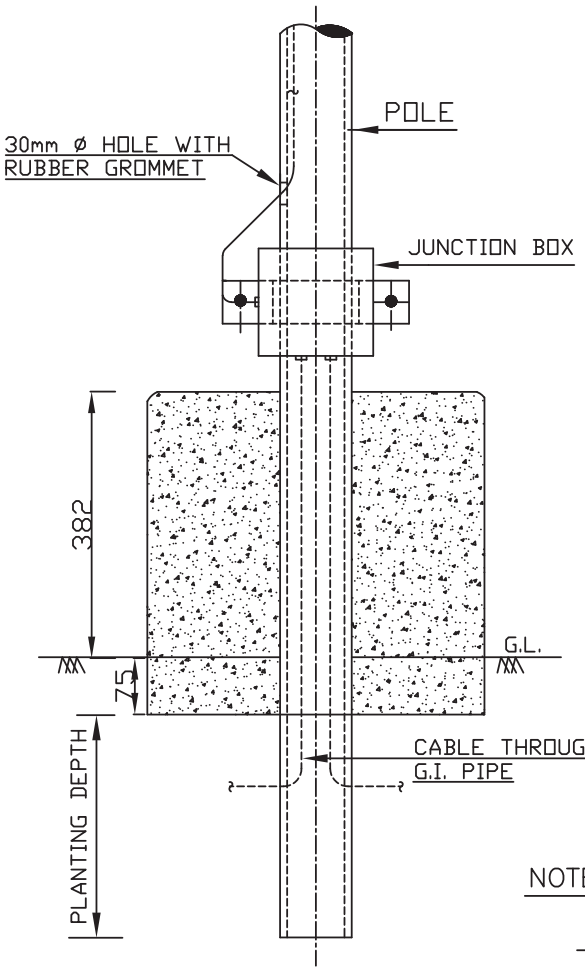
NOTE:–

1. THE MINIMUM INTERNAL DIMENSION OF THE J.B. SHALL BE 152 X 152 X 152.
2. THE FRONT DOOR SHALL BE HINGED & LOCKABLE TYPE.
3. THE CONNECTION OF FUSE TO THE PHASE 'R' IS TYPICAL ONE THE EXACT PHASE TO WHICH CONNECTION SHALL BE MADE SHALL BE DECIDED AT SITE.
4. FOR HAZARDOUS AREA'S THESE JUNCTION BOXES SHALL BE INCREASED SAFETY TYPE AND THE FUSE NEED NOT BE PROVIDED.
5. FOR POLE MOUNTED JUNCTION BOXED THE CABLE GLAND SHALL BE SIDE MOUNTED.
6. ALL DIMENSIONS ARE IN mm.

पी डी आई एल PDIL	INSTALLATION OF JUNCTION BOX IN THE POLE FOR STREET LIGHTING POLE	PDS: E 211	1
		DOCUMENT NO.	REV
		SHEET 1 OF 1	



PLAN

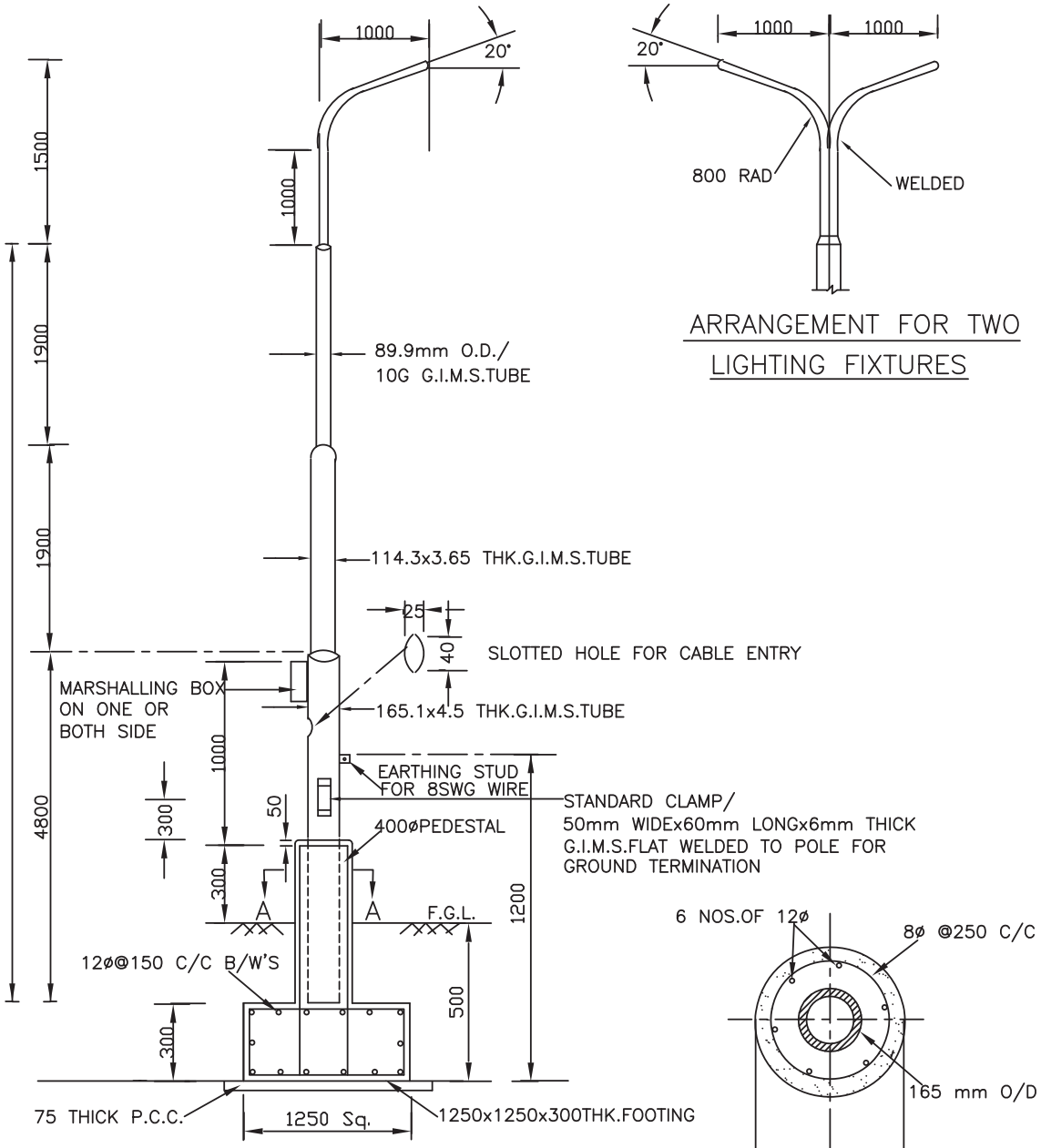


NOTE:–

ALL DIMENSIONS ARE IN mm

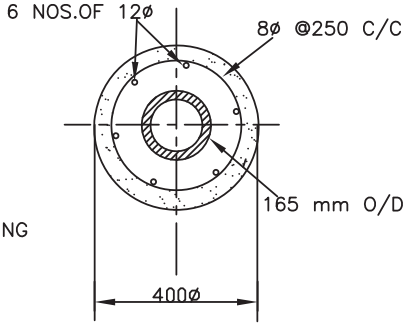
ELEVATION

पी डी आई एल PDIL	TYPICAL STREET LIGHTING POLE	PDS: E 213	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	



ARRANGEMENT FOR ONE LIGHTING FIXTURE

ARRANGEMENT FOR TWO LIGHTING FIXTURES



SECTION A–A

NOTE :–

1. CONCRETING AND APPROVED MOUNTING HARDWARE FOR LIGHTING FIXTURES ARE INCLUDING IN SCOPE OF SUPPLY.
2. CONCRETE FOUNDATION OF GRADE M15 SHALL BE PROVIDED.

ALL DIMENSIONS ARE IN mm.

पी डी आई एल PDIL	COMPONENT RATING FOR DOL STARTER	PDS: E 402	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	

In place of switch fuse, MCCB shall be used.

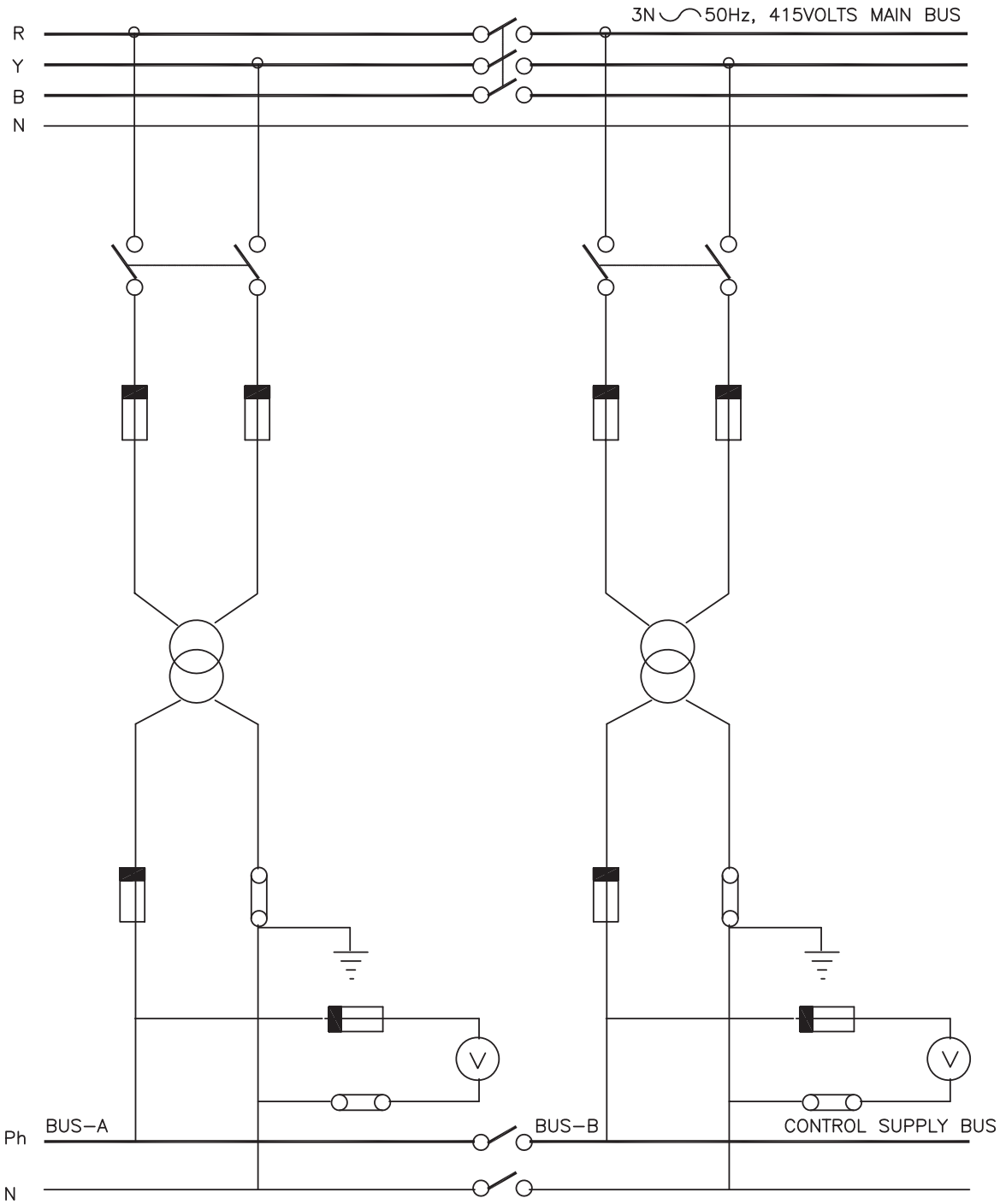
SL. NO.	MOTOR RATING IN KW	FULL LOAD CURRENT IN AMPS.	STARTING CURRENT IN AMPS.	MOTOR DUTY SWITCH RATING IN AMPS.	FUSE RATING IN AMPS.	CONTACTOR RATING IN AMPS.	THERMAL O/L RANGE IN AMPS.		C.T. RATIO	POWER CABLE SIZE sq. mm (PVCAPVC)
							L&T	SIEMENS		
1.	0.18	0.59	4.2	16	2	16	0.4–0.65	0.5–0.8	2/1	3x2.5(CU)
2.	0.25	0.88	6.3	16	4	16	0.6–1.0	0.8–1.2	2/1	3x2.5(CU)
3.	0.37	1.05	7.56	16	4	16	0.9–1.5	0.8–1.25	2/1	3x2.5(CU)
4.	0.55	1.50	10.8	16	6	16	1.4–2.3	1.0–1.6	2/1	3x2.5(CU)
5.	0.75	1.80	12.96	16	6	16	1.4–2.3	1.25–2.0	2/1	3x2.5(CU)
6.	1.10	2.50	18.0	16	10	16	2.3–3.0	2.0–3.2	5/1	3x2.5(CU)
7.	1.50	3.4	24.4	16	16	16	3.0–5.0	2.5–4.0	5/1	3x2.5(CU)
8.	2.20	4.60	33.1	16	16	16	4.5–7.5	3.2–5.0	5/1	3x2.5(CU)
9.	3.00	7.0	50.4	32	20	16	4.5–7.5	5.0–8.0	10/1	3x2.5(CU)
10.	3.70	7.3	52.5	32	20	16	6.0–10.0	5.0–8.0	10/1	3x2.5(CU)
11.	5.50	10.5	75.6	32	32	16	9.0–15.0	8.0–12.5	15/1	3x4(CU)
12.	7.50	14.0	100.8	63	32	16	9.0–15.0	10.0–16.0	20/1	3x6(CU)
13.	9.30	17.5	126.0	63	32	32	14.0–23.0	12.5–20.0	20/1	3x10(AL)
14.	11.0	20.6	148.3	63	63	32	14.0–23.0	16.0–25.0	25/1	3x10(AL)
15.	15.0	28.0	201.6	63	63	32	20.0–33.0	20.0–32.0	35/1	3x16(AL)
16.	18.5	33.0	237.6	100	80	40	30.0–50.0	25.0–36.0	40/1	3x25(AL)
17.	22.0	40.0	288.0	125	80	45	30.0–50.0	32.0–50.0	50/1	3x25(AL)
18.	30.0	52.0	374.4	125	100	70	45.0–75.0	40.0–57.0	60/1	3x35(AL)
19.	37.0	63.5	457.2	125	125	70	45.0–75.0	57.0–70.0	75/1	3x50(AL)
20.	45.0	76.0	557.2	200	160	110	66.0–110.0	70.0–95.0	100/1	3x70(AL)
21.	55.0	96.0	691.7	250	200	110	66.0–110.0	85.0–105.0	125/1	3x95(AL)
22.	67.5	119.0	858.0	250	200	200	90.0–150.0	85.0–135.0	125/1	3x150(AL)
23.	75.0	140.0	1008.0	A.C.B.	A.C.B.	A.C.B.	MICROPROCESSOR RELAY		150/1	3x185(AL)
24.	90.0	156.0	1123.2	A.C.B.	A.C.B.	A.C.B.	MICROPROCESSOR RELAY		175/1	3x240(AL)
25.	110.0	192.0	1382.4	A.C.B.	A.C.B.	A.C.B.	MICROPROCESSOR RELAY		225/1	3x300(AL)
26.	125.0	217.0	1627.5	A.C.B.	A.C.B.	A.C.B.	MICROPROCESSOR RELAY		250/1	3x400(AL)
27.	132.0	234.0	1684.8	A.C.B.	A.C.B.	A.C.B.	MICROPROCESSOR RELAY		250/1	3x400(AL)
28.	160.0	279.0	2008.8	A.C.B.	A.C.B.	A.C.B.	MICROPROCESSOR RELAY		300/1	2–3x185(AL)
29.	180.0	304.0	2188.8	A.C.B.	A.C.B.	A.C.B.	MICROPROCESSOR RELAY		350/1	2–3x240(AL)

NOTE:–

1. THE ABOVE DATA IS APPLICABLE FOR 415V, 4 POLE MOTORS.
2. AMMETERS SHALL HAVE UNIFORM SCALE UPTO C.T. PRIMARY CURRENT AND COMPRESSED END SCALE UPTO SIX TIMES THE C.T. PRIMERY CURRENT.
3. POWER CABLE SIZE SHALL BE SUBJECT TO VOLTAGE DROP CHECK.

SL. NO.	FEEDER RATING		SWITCH RATING AC–23	FUSE RATING (AMP)	C.T. RATIO	AMMETER SCALE RANGE	* POWER CABLE SIZE sq. mm (PVCAPVC)	REMARKS
	KVA	AMP						
1.	10	16	32	25	20/5	0–20	3/4x6(CU)	
2.	25	40	63	63	50/5	0–50	3/4x25(AL)	
3.	35	50	100	80	60/5	0–60	3/4x35(AL)	
4.	45	60	100	100	75/5	0–75	3/4x50(AL)	
5.	50	70	100	100	75/5	0–75	3/3.5x70(AL)	
6.	60	80	125	125	100/5	0–100	3/3.5x70(AL)	
7.	65	90	200	160	100/5	0–100	3/3.5x95(AL)	
8.	70	100	200	160	125/5	0–125	3/3.5x120(AL)	
9.	80	125	200	200	150/5	0–150	3/3.5x150(AL)	
10.	100	150	250	250	200/5	0–200	3/3.5x185(AL)	
11.	125	175	315	300	200/5	0–200	3/3.5x240(AL)	
12.	140	200	315	300	250/5	0–250	3/3.5x300(AL)	
13.	170	250	400	400	300/5	0–300	2–3/3.5x150(AL)	
14.	200	300	400	–	400/5	0–400	2–3/3.5x185(AL)	
15.	275	400	630	–	630/5	0–630	2–3/3.5x300(AL)	
16.	350	500	630	–	630/5	0–630	3–3/3.5x240(AL)	
17.	425	600	800	–	800/5	0–800	3–3/3.5x300(AL)	
18.	500	700	800	–	800/5	0–800	3–3/3.5x400(AL)	

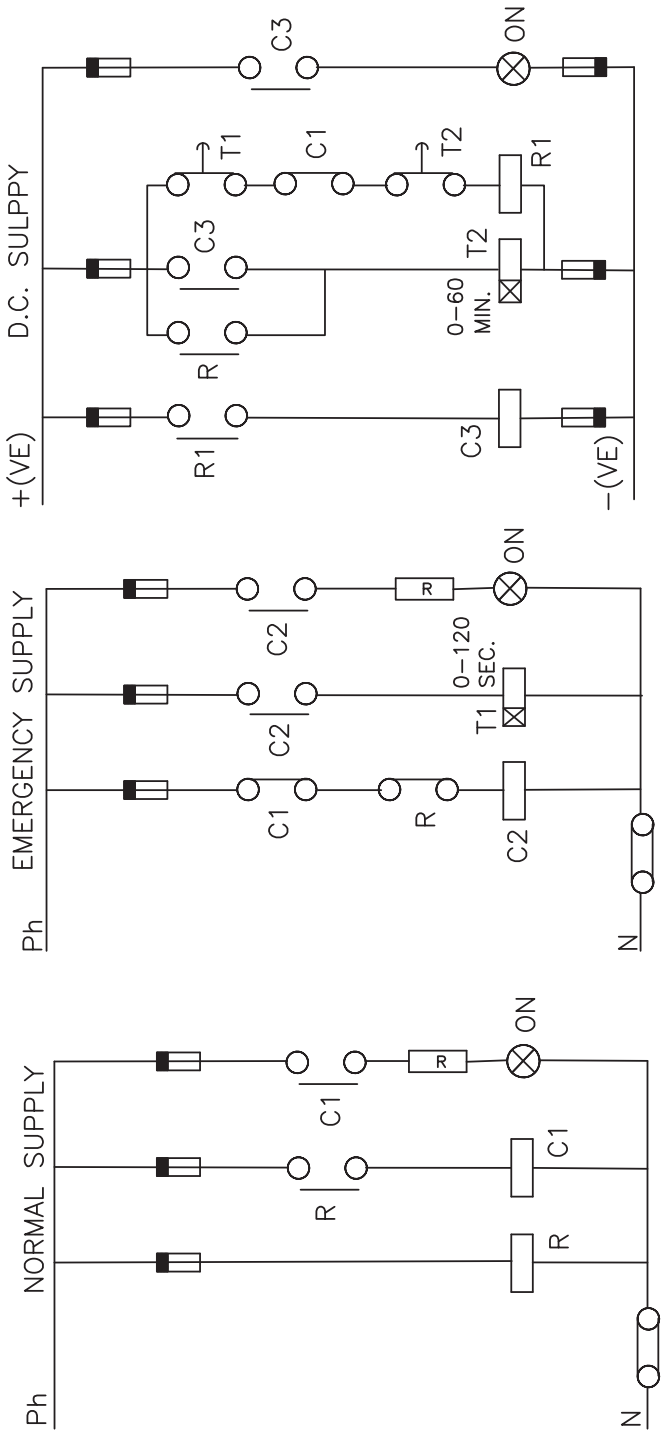
पी डी आई एल PDIL	SCHEMATIC DIAGRAM A.C.CONTROL SUPPLY THROUGH CONTROL TRANSFORMER FOR SWITCH BOARDS WITH BUS COUPLER	PDS: E 412	1
		DOCUMENT NO.	REV
		SHEET 1 OF 1	



NOTES:–

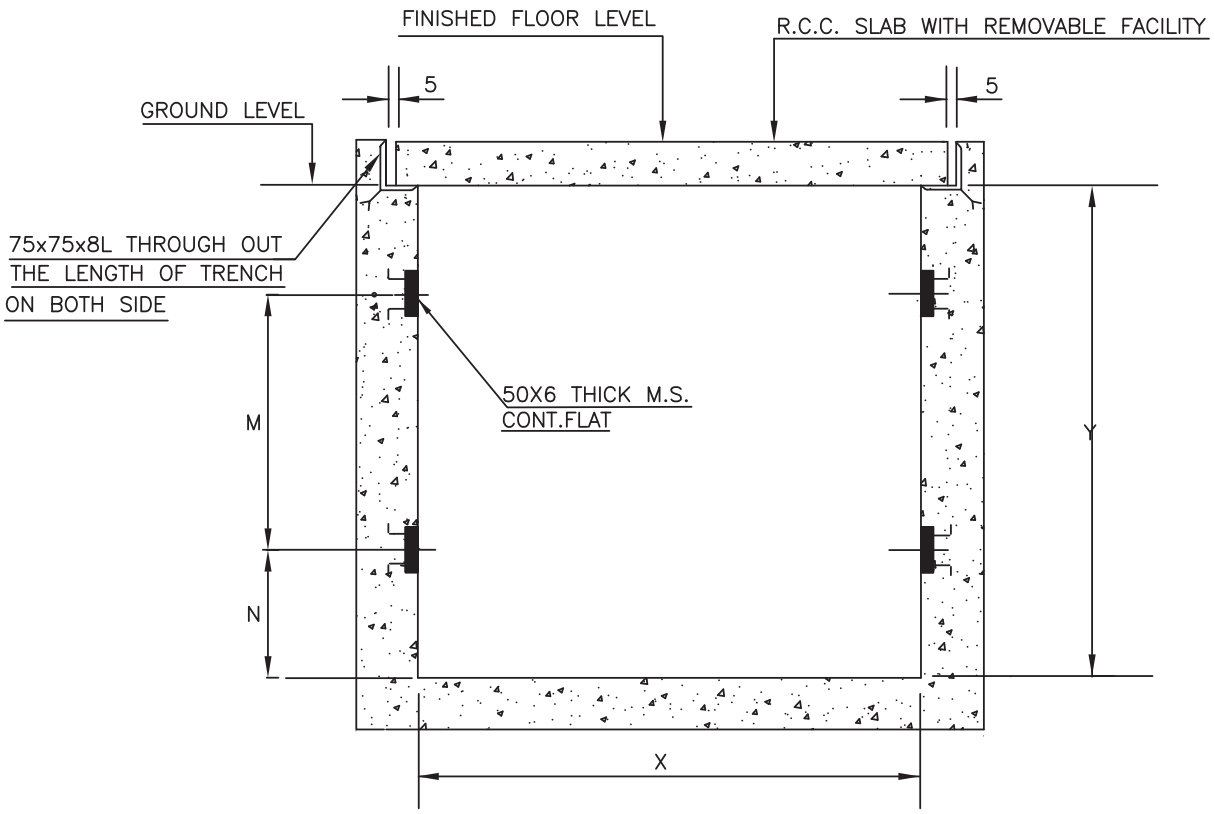
1. EACH TRANSFORMER SHALL BE RATED FOR 2.5 TIMES THE TOTAL CONTROL SUPPLY LOAD.
2. THE CONTROL BUS INTERCONNECTING SWITCH SHALL BE LOCKABLE IN OFF POSITION AND LOCATED IN BUS COUPLER PANEL.

पी डी आई एल PDIL	SCHEMATIC DIAGRAM PANIC LIGHT	PDS: E 464	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	



NOTE:–

CONTACTORS C1,C2 AND C3 CONTROLS THE LIGHTING FEEDERS FOR NORMAL,EMERGENCY AND D.C. SUPPLY RESPECTIVELY.



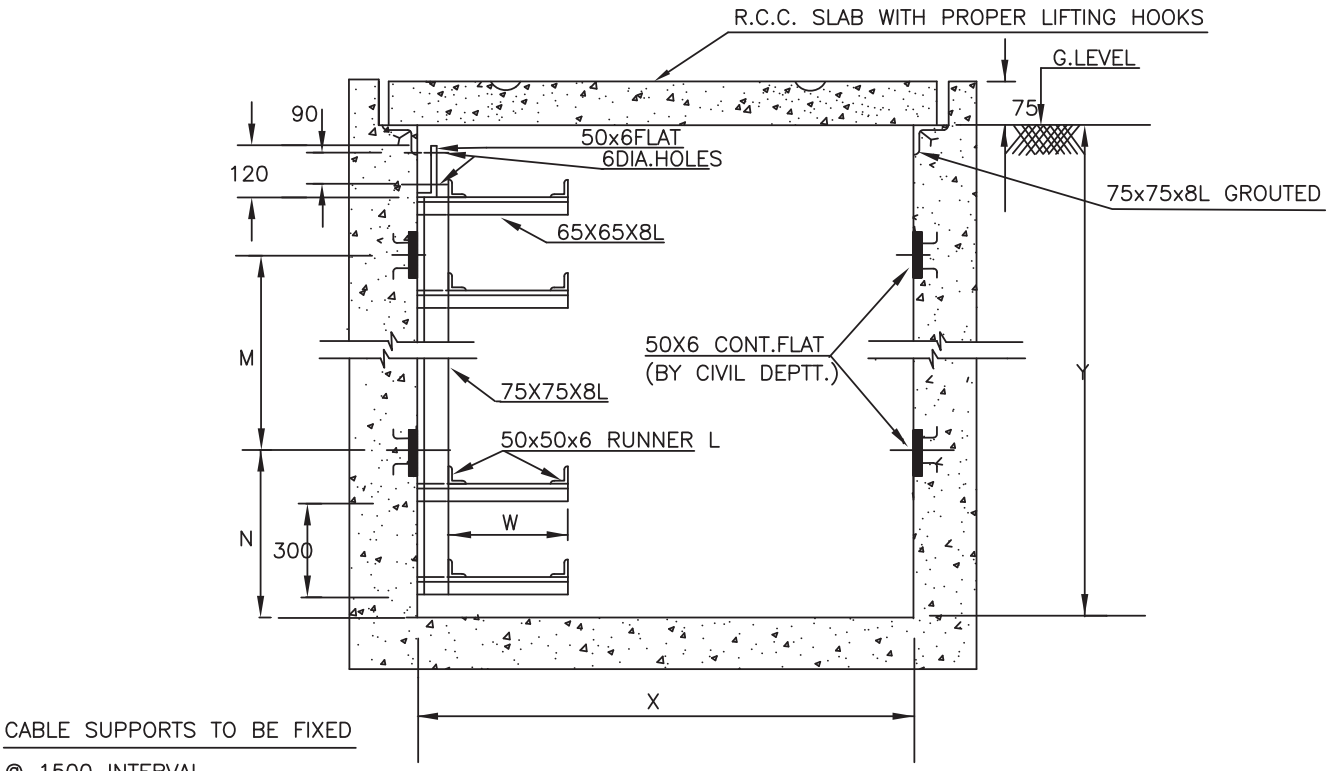
SECTION OF TRENCH

DESIGN TYPE	X	Y	N	M
5T 350DS.	1400	1500	400	650
4T 350DS.	1400	1200	250	650
3T 350DS.	1400	900	250	300
5T 350SS.	1000	1500	400	650
4T 350SS.	1000	1200	250	650
3T 350SS.	1000	900	250	300
5T 250DS.	1200	1500	400	650
4T 250DS.	1200	1200	250	650
3T 250DS.	1200	900	250	300
5T 250SS.	900	1500	400	650
4T 250SS.	900	1200	250	650
3T 250SS.	900	900	250	300

NOTES:–

1. THE TOP OF TRENCH SHALL MATCH THE FLOOR LEVEL IN PLANT AREA.
2. IN INDOORS INSTEAD OF RCC SLAB,20mm.THICK Al. EXTRUDED PLANK OR 10mm.THICK M.S.CHEQUERED PLATE SHALL BE USED AS PER PDS:E 507.
3. PROPER SLOPE TO BE GIVEN IN THE TRENCH FOR NATURAL DRAINAGE.
4. SS–SINGLE SIDE CABLE SUPPORTS.
5. DS–DOUBLE SIDE CABLE SUPPORTS.
6. ALL DIMENSIONS ARE IN mm.

पी डी आई एल PDIL	CABLE RACK ARRANGEMENT IN TRENCHES	PDS: E 511	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	



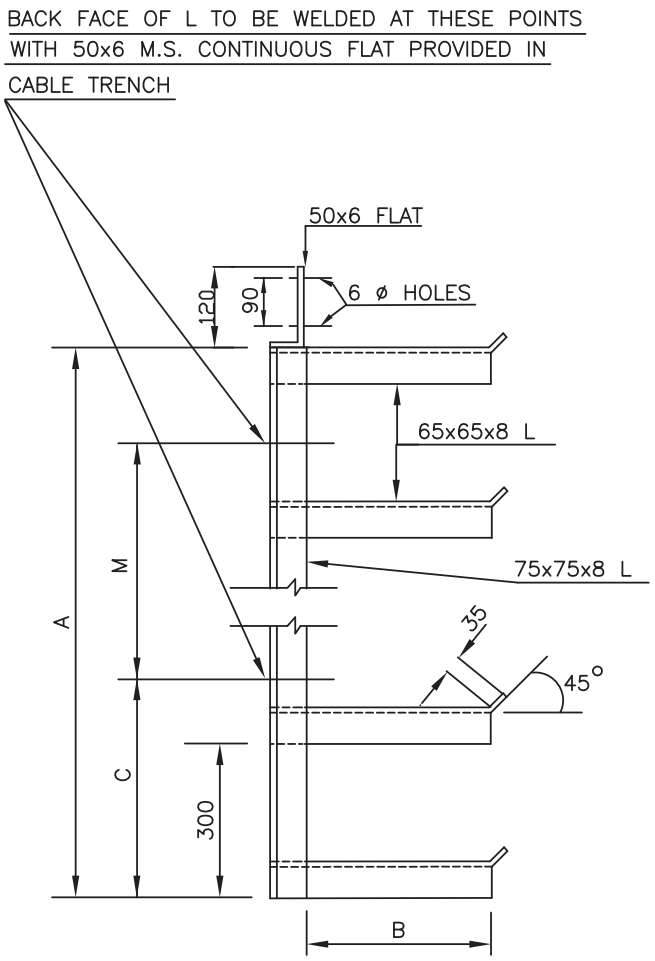
SECTION OF TRENCH

TYPICAL PLAN OF TRENCH

DESIGN TYPE	X	Y	N	M	W
5T–350–DS.	1400	1500	400	650	350
4T–350–DS.	1400	1200	250	650	350
3T–350–DS.	1400	900	250	300	350
5T–350–SS.	1000	1500	400	650	350
4T–350–SS.	1000	1200	250	650	350
3T–350–SS.	1000	900	250	300	350
5T–250–DS.	1200	1500	400	650	250
4T–250–DS.	1200	1200	250	650	250
3T–250–DS.	1200	900	250	300	250
5T–250–SS.	900	1500	400	650	250
4T–250–SS.	900	1200	250	650	250
3T–250–SS.	900	900	250	300	250

NOTES:–
1. SS–SINGLE SIDE CABLE SUPPORT.
2. DS–DOUBLE SIDE CABLE SUPPORT.
3. ALL DIMENSIONS ARE IN mm.

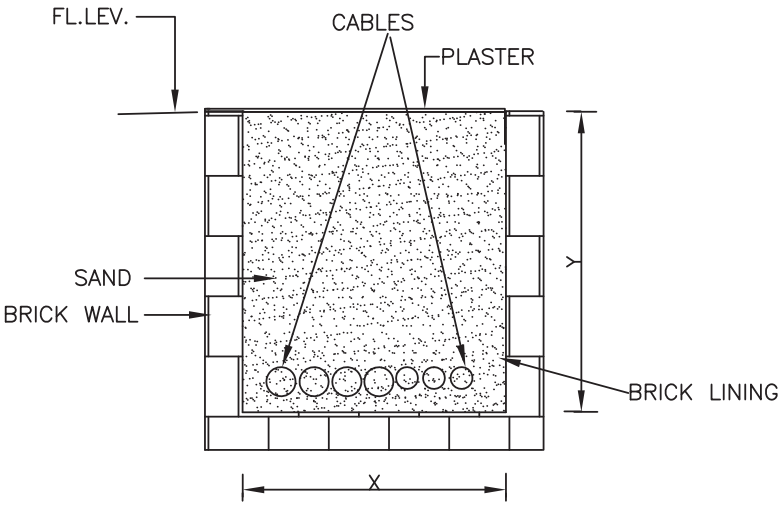
पी डी आई एल PDIL	FABRICATION DETAILS OF CABLE RACK IN TRENCH AND DUCT	PDS: E 512	1
		DOCUMENT NO.	REV
		SHEET 1 OF 1	



DESIGN TYPE	A	B	C	M	WT.OF STEEL PER UNIT(kg)
5T 350	1265	350	365	650	35
4T 350	965	350	215	650	28
3T 350	665	350	215	300	21
5T 250	1265	250	215	650	30
4T 250	965	250	215	650	25
3T 250	665	250	215	300	20

ALL DIMENSIONS ARE IN mm.

पी डी आई एल PDIL	TYPICAL ARRANGEMENT OF CABLES BURRIED IN SLITS	PDS: E 516	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	



SECTION OF SLIT

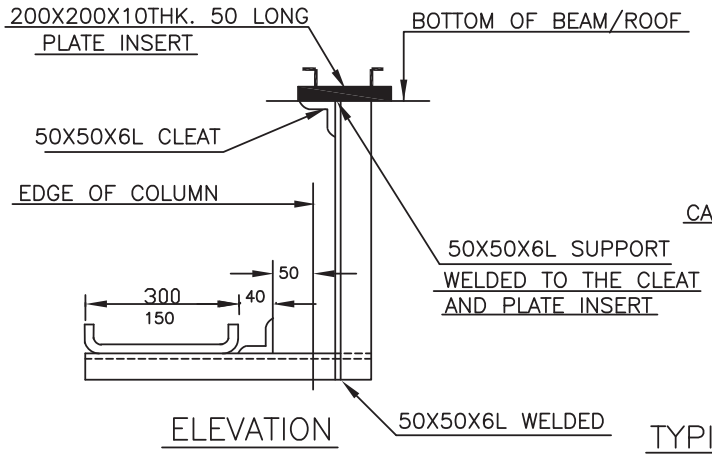
DESIGN TYPE	X	Y
S 300	300	300
S 200	200	200

NOTE:–

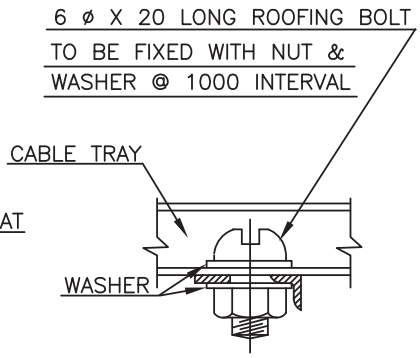
1. CABLE SLITS SHALL BE FILLED WITH SAND AND PROPERELY PLASTERED WITH LEAN CONCRETE AFTER LAYING OF CABLES.
2. WHEREVER CABLES ARE COMING OUT OF THE SLIT, SUITABLE MECH.PROTECTION TO BE PROVIDED.

पी डी आई एल PDIL	FIXING ARRANGEMENT OF PERFORATED CABLE TRAY (HORIZONTAL FORMATION CEILING SUPPORTED)	PDS: E 525	1
		DOCUMENT NO.	REV
		SHEET 1 OF 1	

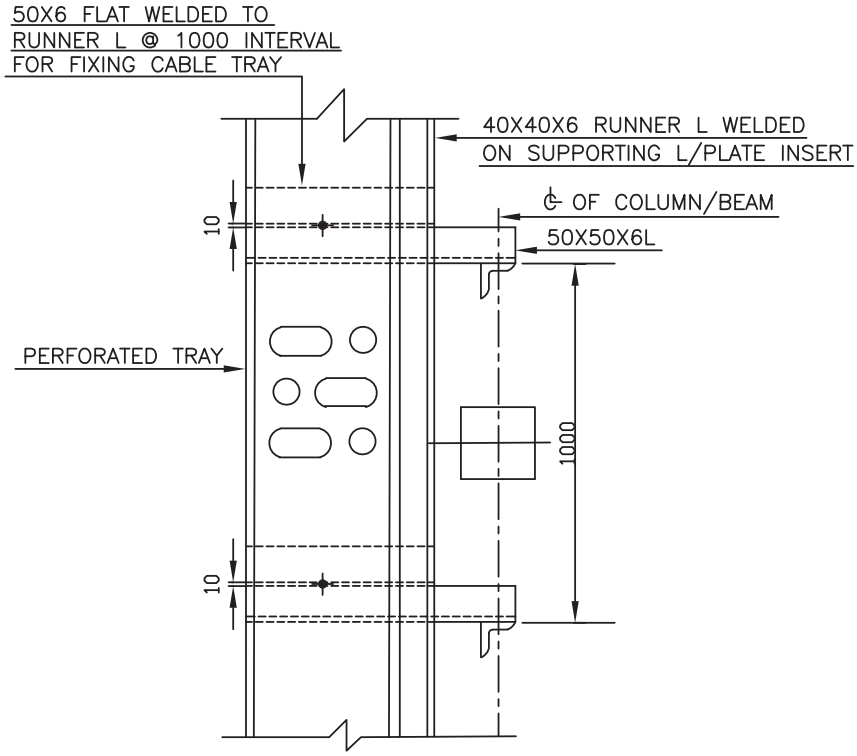
CEILING SUPPORTED RACK



ELEVATION



TYPICAL DETAIL OF TRAY FIXING



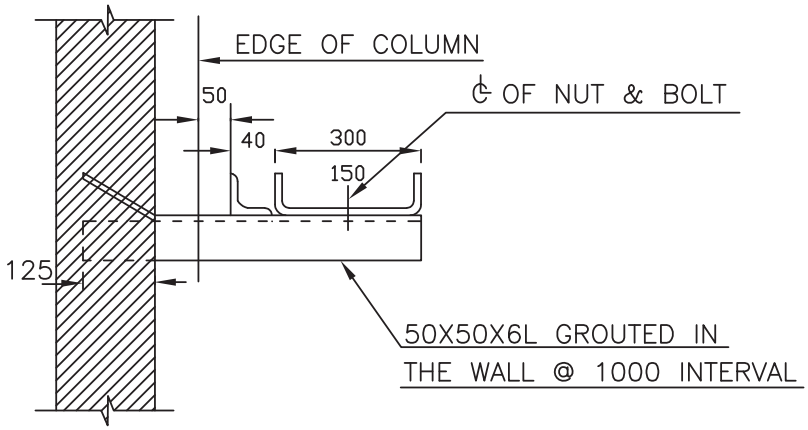
P L A N

NOTE:—

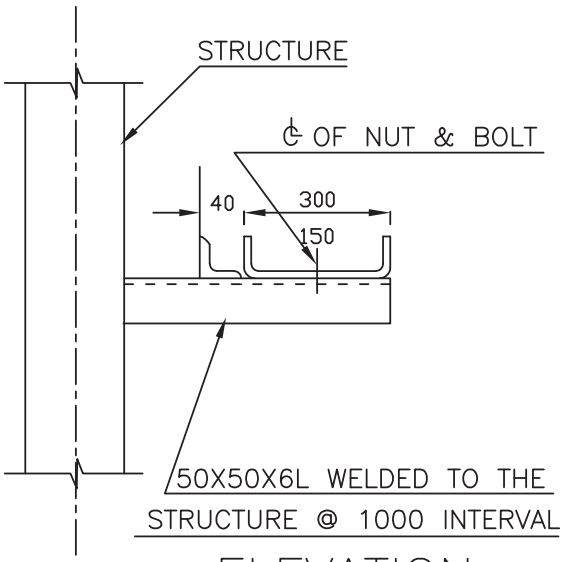
1. THE TRAY SHALL BE FIXED AT 1000 INTEREVAL BY 6 ø X 20 LONG ROOFING BOLT AND SHALL BE USED ONE NO. FOR 150 WIDE TRAYS & TWO NOS. FOR 300 WIDE TRAYS.
2. FOR MULTI TIERS RACK MINIMUM CLEARANCE BETWEEN THE TIER TO BE KEPT 300.
3. ALL DIMENSIONS ARE IN mm.

पी डी आई एल PDIL	FIXING ARRANGEMENT OF PERFORATED CABLE TRAY (HORIZONTAL FORMATION WALL / STRUCTURE SUPPORTED)	PDS: E 526	1
		DOCUMENT NO.	REV
		SHEET 1 OF 1	

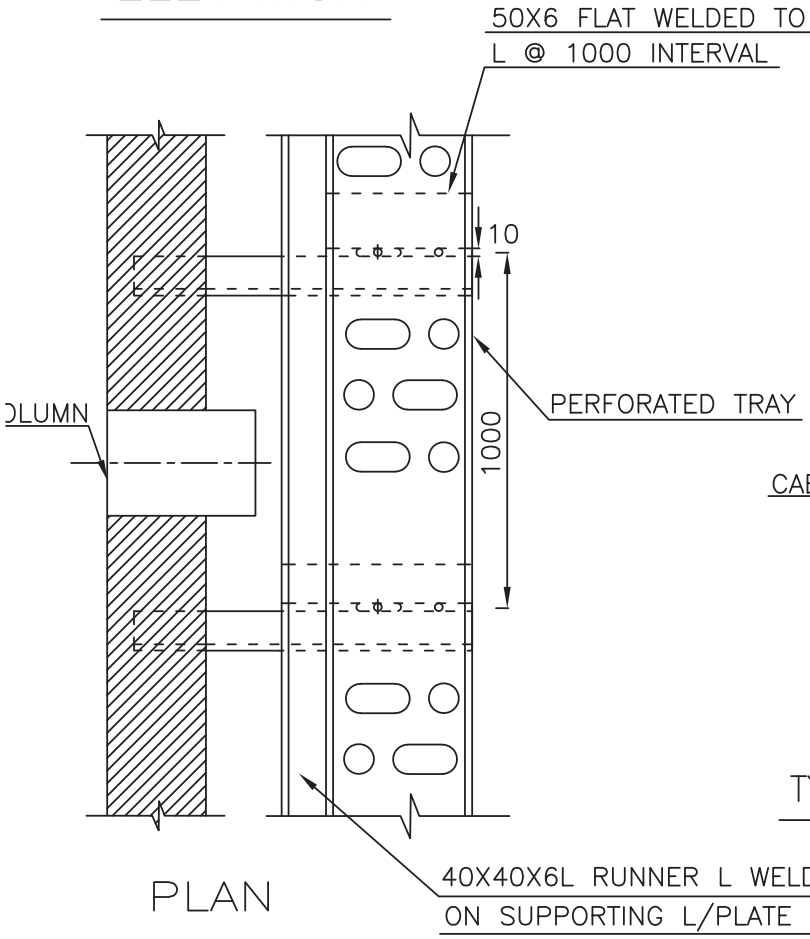
WALL / STRUCTURE SUPPORTED RACK



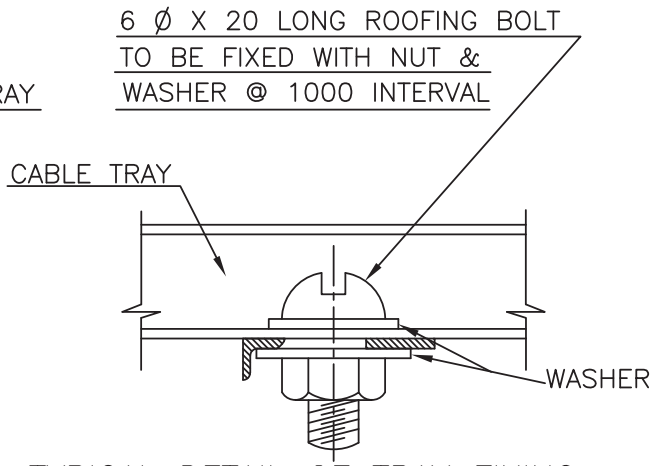
ELEVATION



ELEVATION



PLAN

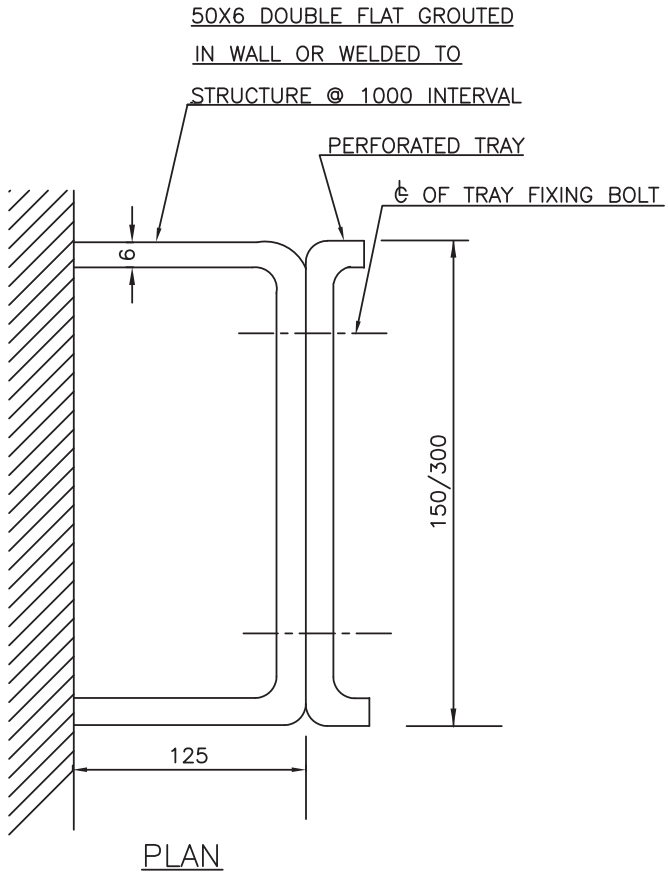


TYPICAL DETAIL OF TRAY FIXING

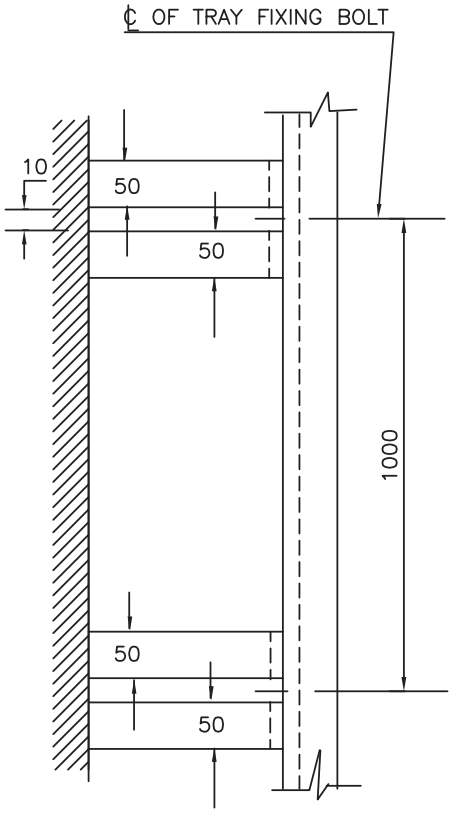
NOTES:–

1. THE TRAY SHALL BE FIXED AT 1000 INTERVAL BY 6 Ø X 20 LONG ROOFING BOLT. (ONE NO. FOR 150 & TWO NOS. FOR 300 WIDE TRAYS.)
2. FOR MULTI TIERS RACK MINIMUM CLEARANCE BETWEEN THE TIER TO BE KEPT 300.
3. ALL DIMENSION ARE IN mm.

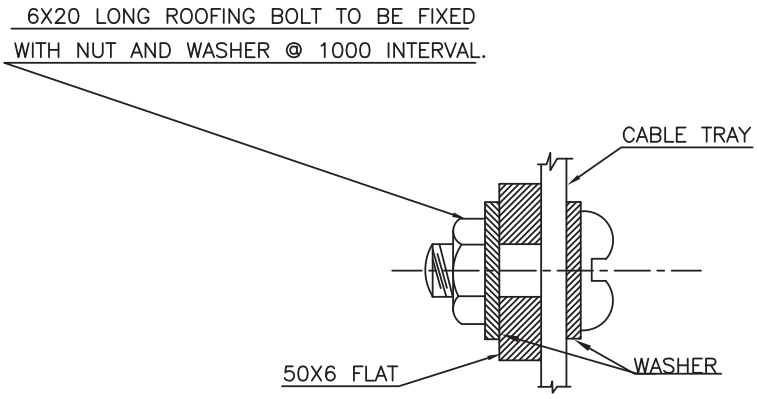
पी डी आई एल PDIL	FIXING ARRANGEMENT OF PERFORATED CABLE TRAY (VERTICAL FORMATION)	PDS: E 527	1
		DOCUMENT NO.	REV
		SHEET 1 OF 1	



PLAN



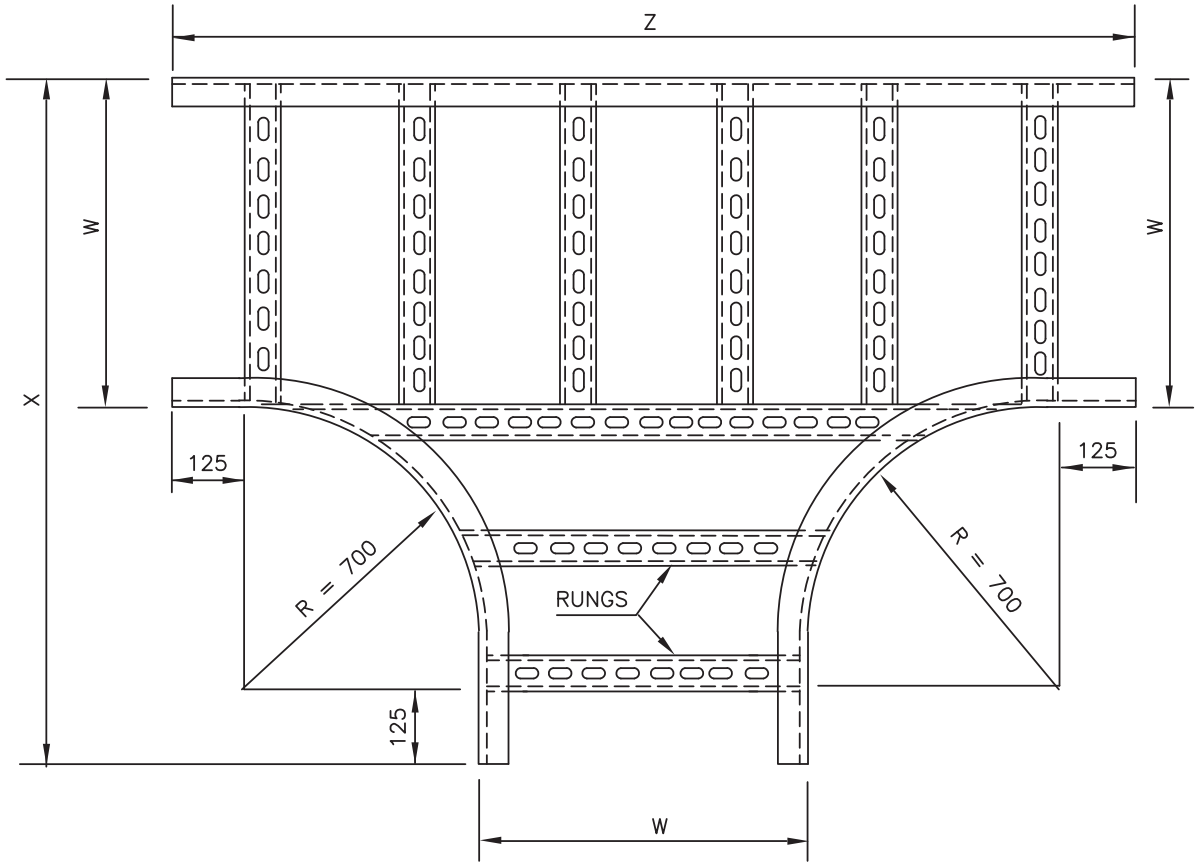
ELEVATION



TYPICAL DETAIL OF
TRAY FIXING

ALL DIMENSIONS ARE IN mm.

पी डी आई एल PDIL	PRE–FABRICATED CABLE TRAY HORIZONTAL TEE	PDS: E 531	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	



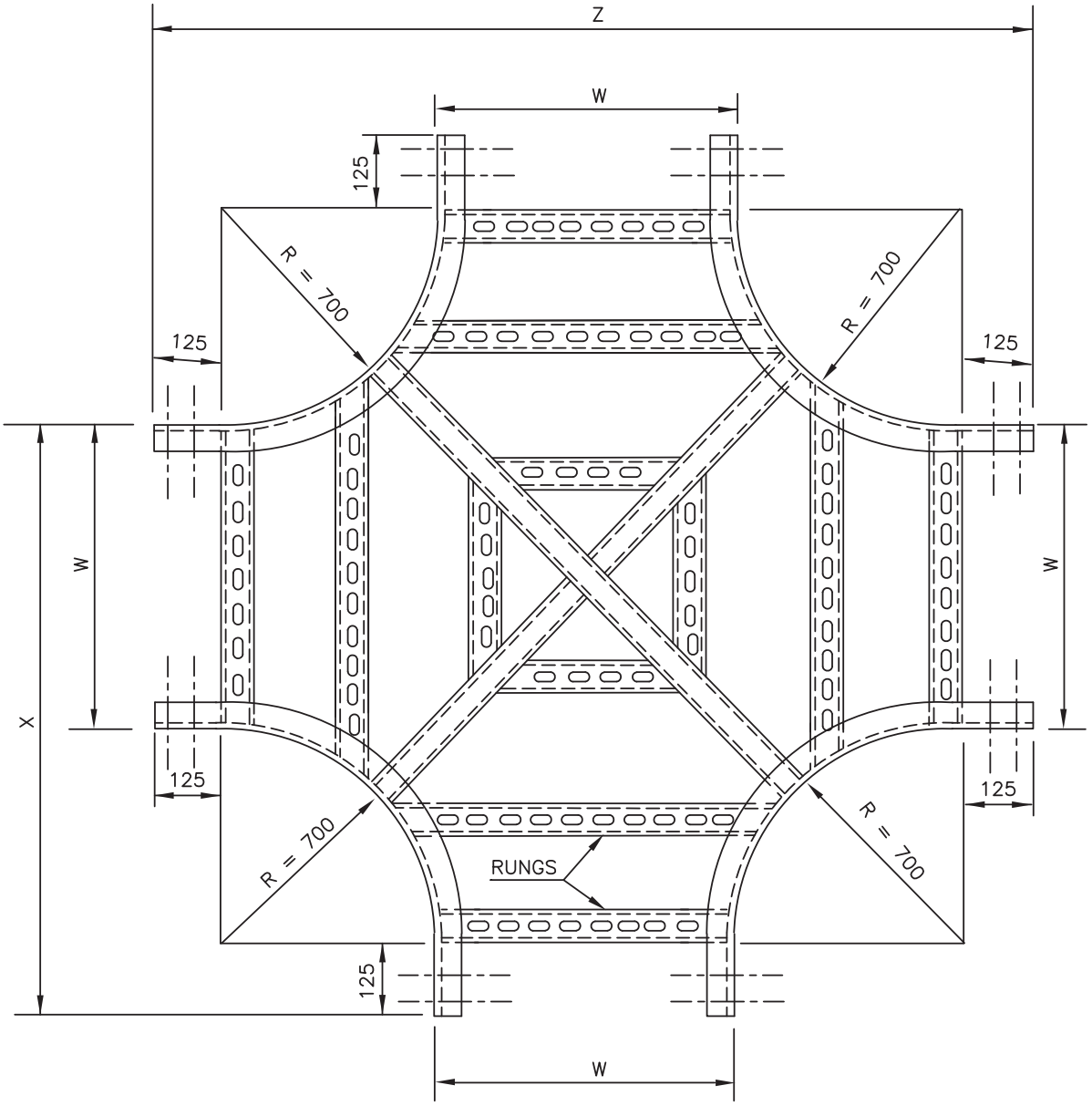
PLAN

DESIGN TYPE	W	X=R+W+125	Z=2R+W+250
HT 900	900	1725	2550
HT 600	600	1425	2250
HT 450	450	1275	2100
HT 300	300	1125	1950

NOTES :–

1. DISTANCE BETWEEN TWO RUNGS SHOULD BE APPROX. 300mm.
2. ALL DIMENSIONS ARE IN mm.

पी डी आई एल PDIL	PRE–FABRICATED CABLE TRAY HORIZONTAL CROSS	PDS: E 532	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	



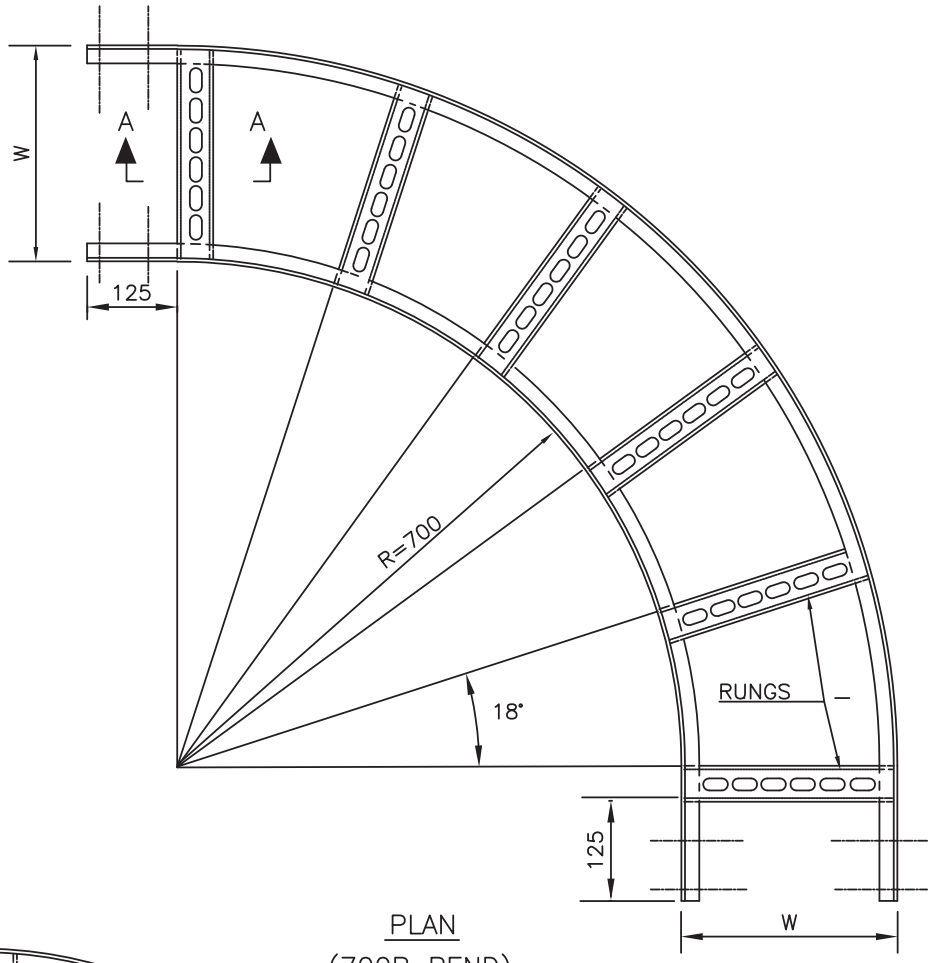
PLAN

DESIGN TYPE	W	X=R+W+125	Z=2R+W+250
HC 900	900	1725	2550
HC 600	600	1425	2250
HC 450	450	1275	2100
HC 300	300	1125	1950

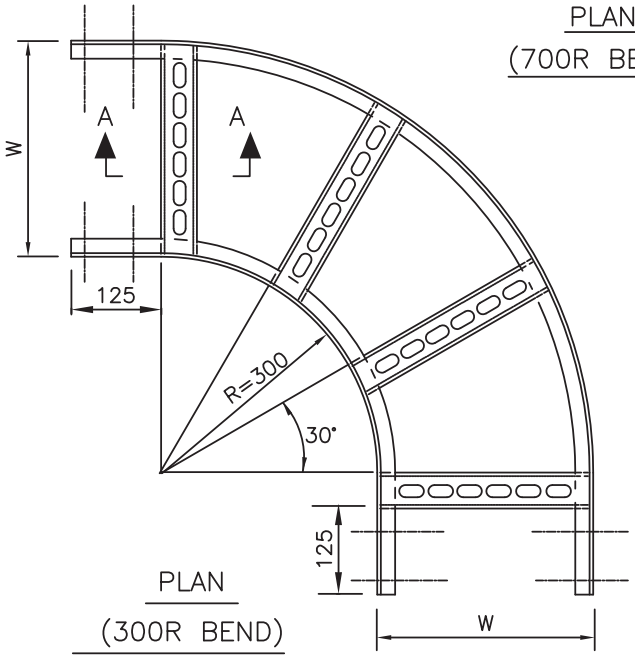
NOTES :–

1. DISTANCE BETWEEN TWO RUNGS SHOULD BE APPROX. 300mm.
2. ALL DIMENSIONS ARE IN mm.

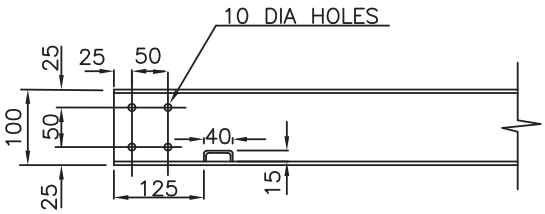
पी डी आई एल PDIL	PRE–FABRICATED CABLE TRAY 90° HORIZONTAL BENDS	PDS: E 533	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	



PLAN
(700R BEND)



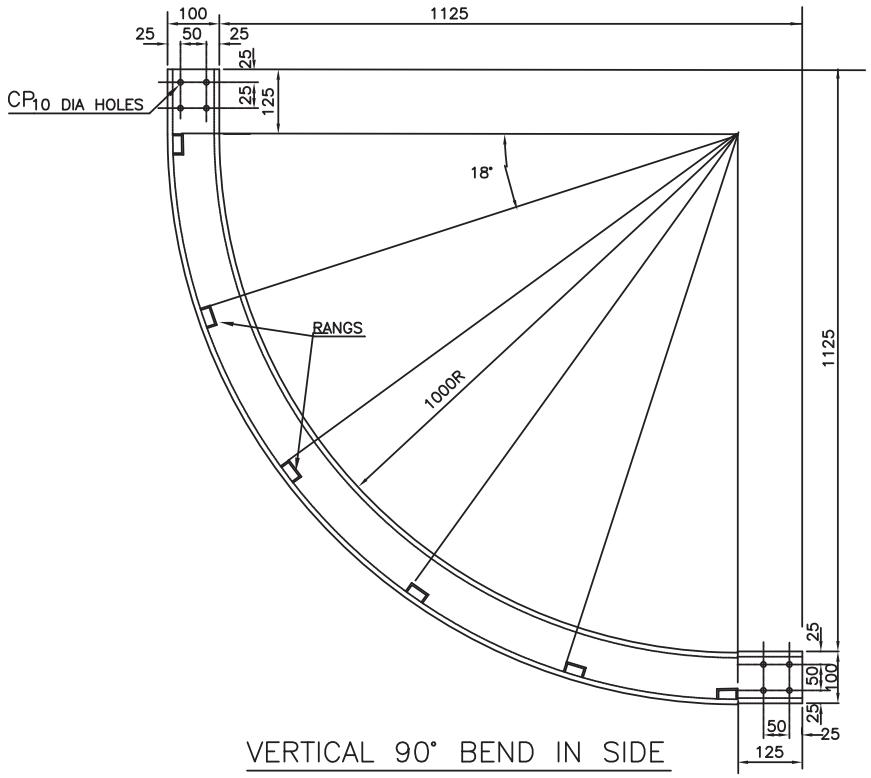
PLAN
(300R BEND)



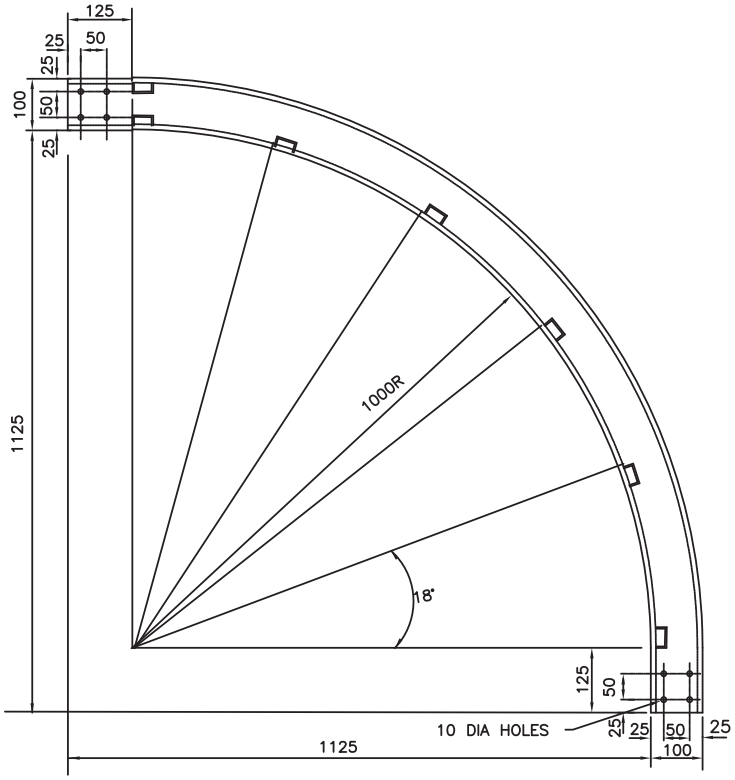
SECTION A–A

ALL DIMENSIONS ARE IN mm.

पी डी आई एल PDIL	PRE–FABRICATED CABLE TRAY 90° VERTICAL BEND BENDING RADIUS 1000 mm	PDS: E 534	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	



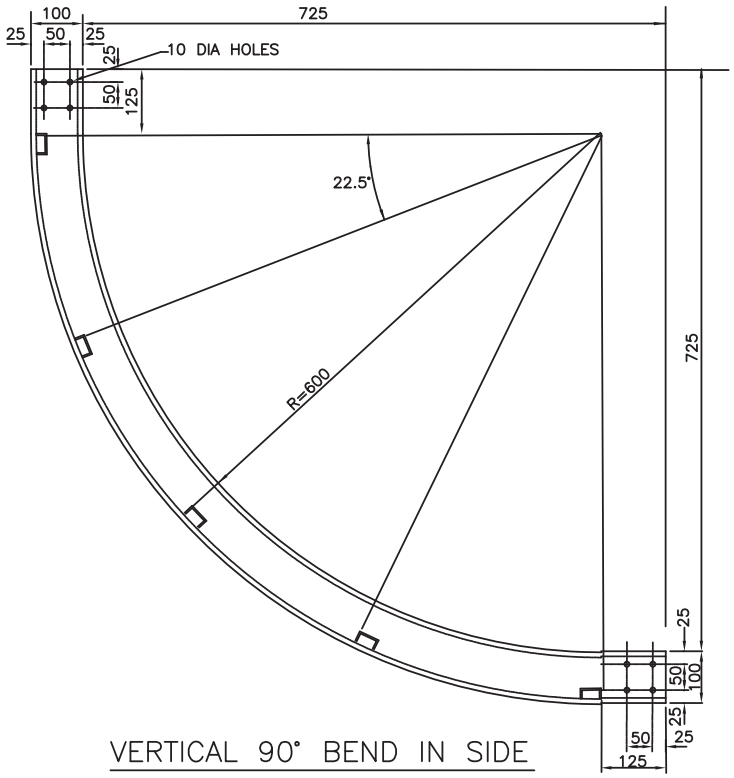
VERTICAL 90° BEND IN SIDE



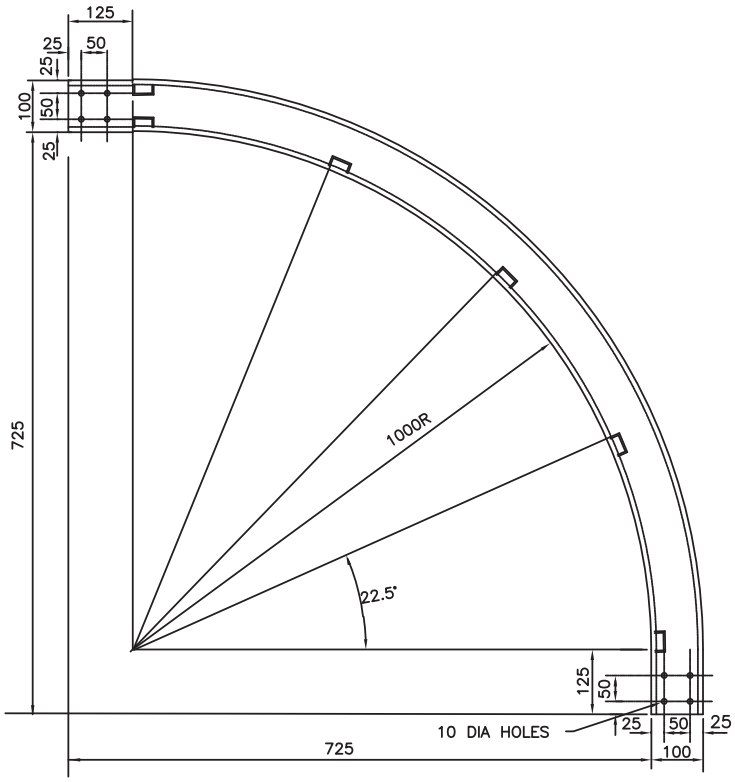
VERTICAL 90° BEND OUT SIDE

DIMENSIONS ARE IN mm.

पी डी आई एल PDIL	PRE–FABRICATED CABLE TRAY 90° VERTICAL BENDS BENDING RADIUS 600 mm	PDS: E 535	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	



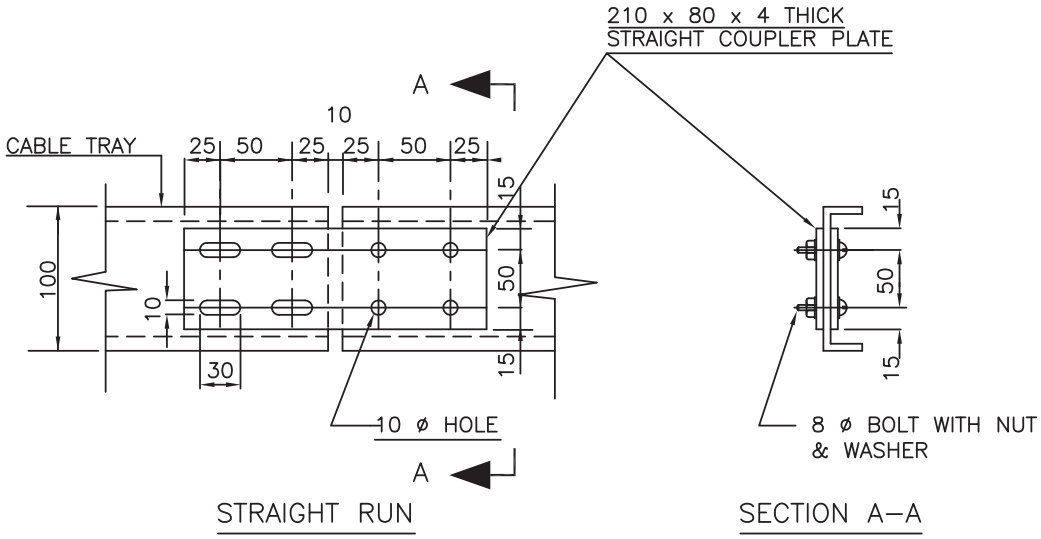
VERTICAL 90° BEND IN SIDE



VERTICAL 90° BEND OUT SIDE

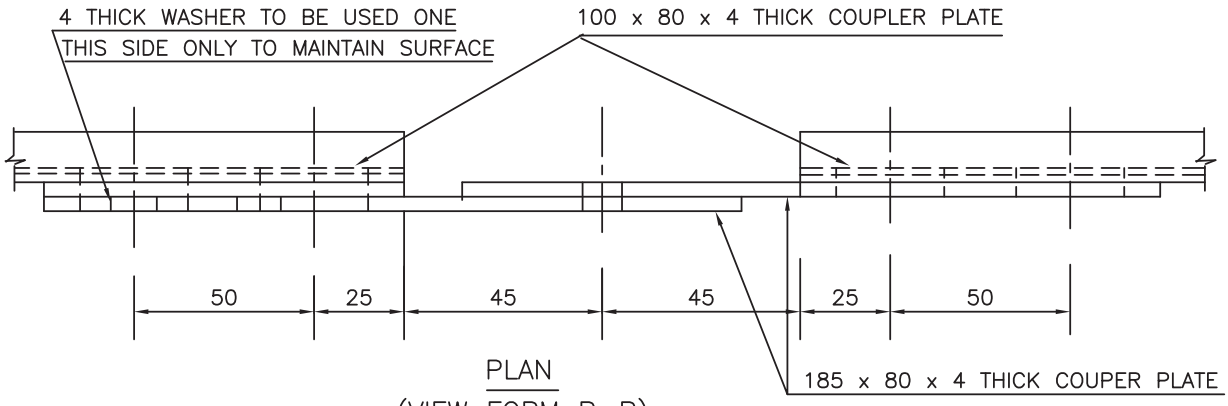
ALL DIMENSIONS ARE IN mm.

पी डी आई एल PDIL	PRE–FABRICATED CABLE TRAY COUPLING ARRANGEMENT	PDS: E 536	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	

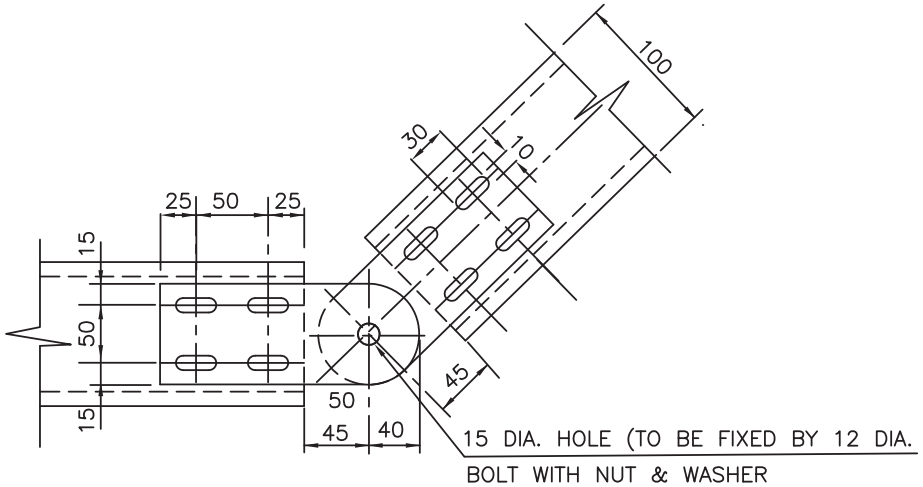


STRAIGHT RUN

SECTION A–A



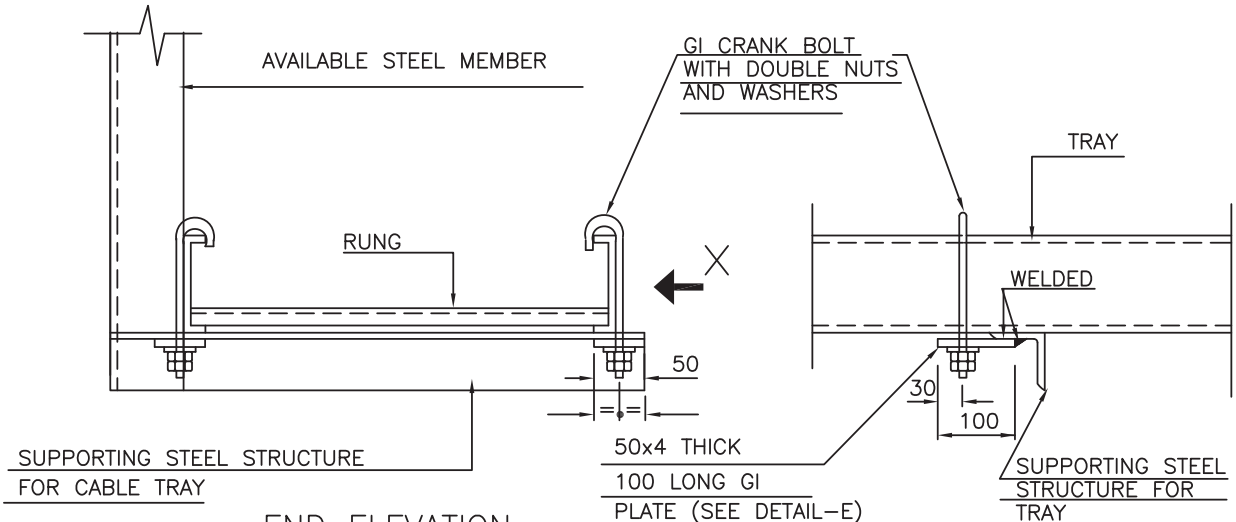
PLAN
(VIEW FORM B–B)



ELEVATION
(ADJUSTABLE BEND)

ALL DIMENSIONS ARE IN mm.

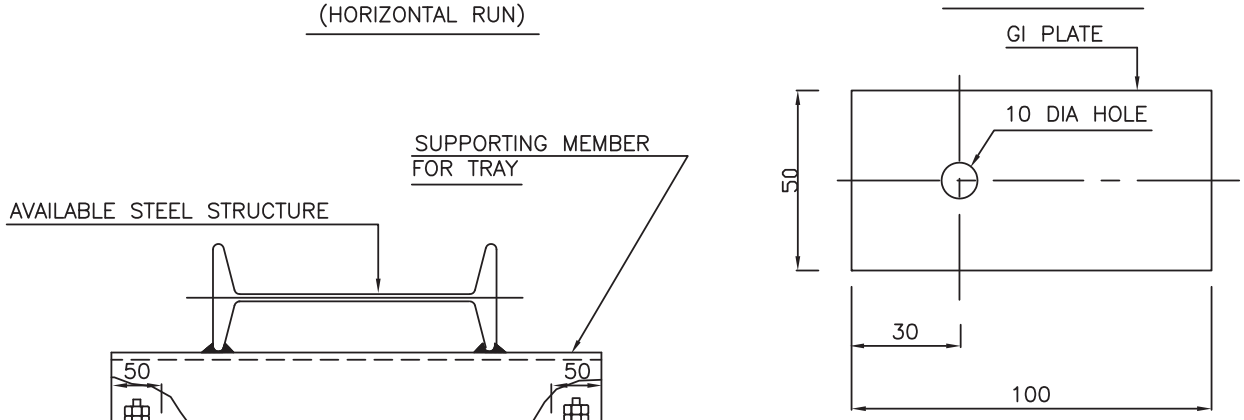
पी डी आई एल PDIL	PRE–FABRICATED CABLE TRAY FIXING ARRANGEMENT	PDS: E 537 / 0 DOCUMENT NO. / REV. SHEET 1 OF 1



END ELEVATION

(HORIZONTAL RUN)

VIEW AT –X

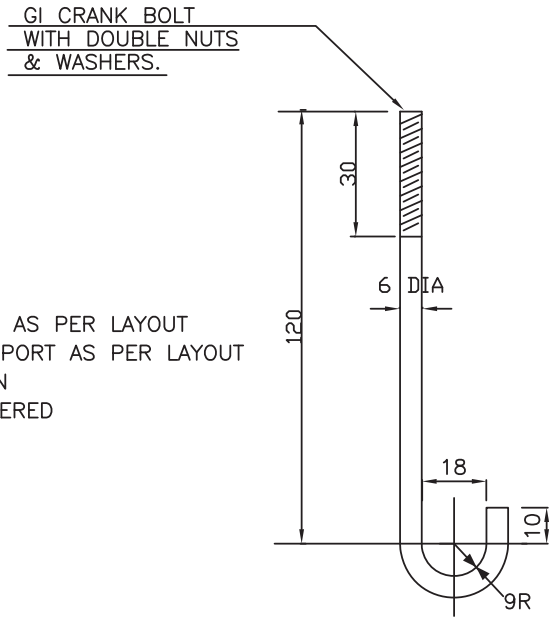


PLAN

VERTICAL RUN (RISER)

PLAN

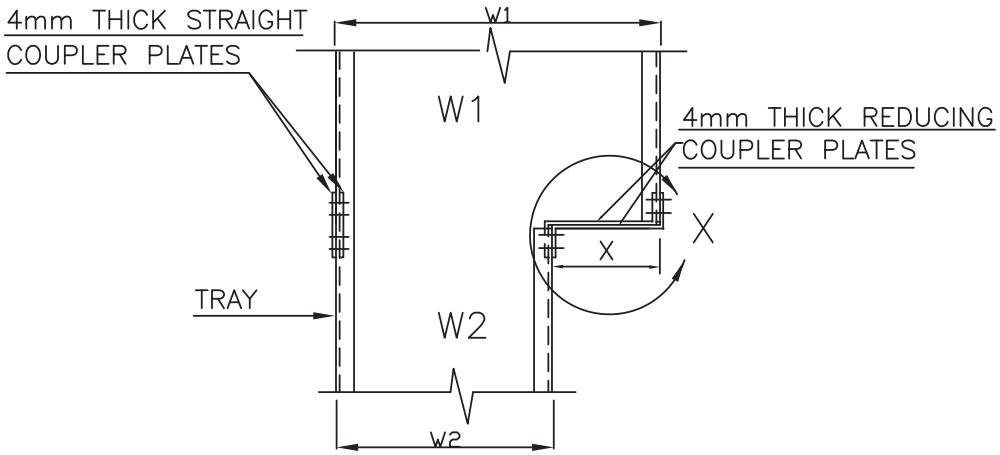
DETAIL–E



NOTES:–

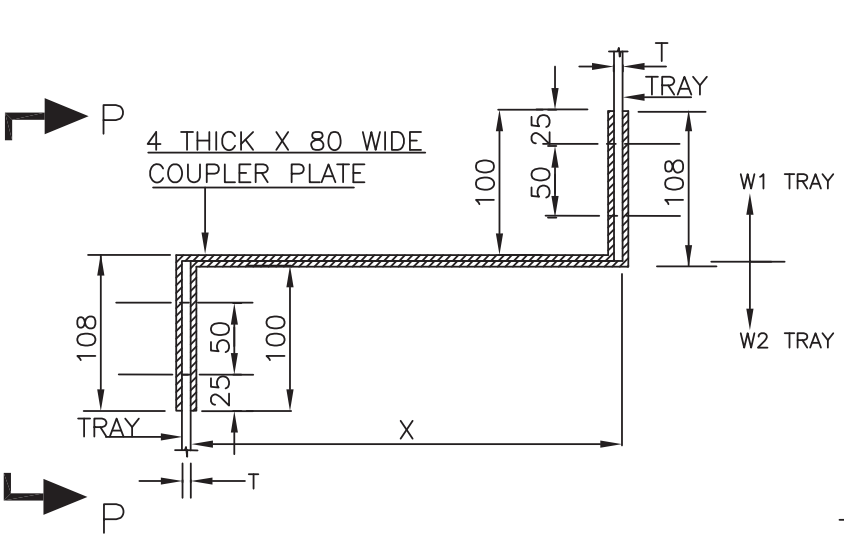
1. HORIZONTAL RUN TO BE CLAMPED WITH EVERY SUPPORT AS PER LAYOUT
2. VERTICAL RUN/ RISER TO BE CLAMPED WITH EVERY SUPPORT AS PER LAYOUT
3. EACH CRANK HOOK SHALL BE SUPPLIED WITH ONE PLAIN WASHER, ONE SPRING WASHER AND TWO DOUBLE CHAMFERED HEX NUTS. THESE SHAL BE GALVANISED ITEMS.
4. ALL DIMENSIONS ARE IN mm.

पी डी आई एल PDIL	PRE–FABRICATED CABLE TRAY REDUCING COUPLER PLATE	PDS: E 538	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	



PLAN

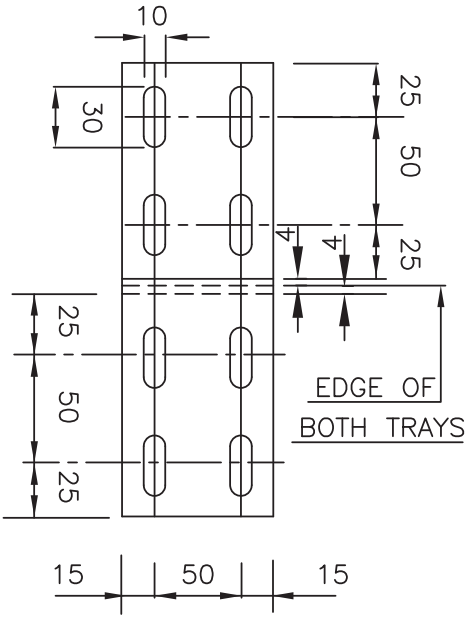
(REDUCING TRAY JOINT)



DETAIL– X

DETAIL OF REDUCING

COUPLER PLATE (4 THICK)



VIEW – P–P

ALL DIMENSIONS ARE IN mm.

SL. NO.	W1	W2	X
1	900	600 450 300	300 450 600
2	600	450 300	150 300
3	450	300 150	150 300

SL. No.	EQUIPMENT TO BE EARTHED	FAULT LEVEL (MVA)	G.I.STRIPS/WIRES			ALUMINIUM					REMARKS
			MIN.SIZE (mm^2)	SIZE TO BE USED (mm^2)	SYMBOL	MIN.SIZE (mm^2)	STRIPS/WIRES SIZE TO BE USED (mm^2)	STRIPS/WIRES SYMBOL	1.1kv PVC SINGLE CORE CABLE SIZE (mm^2)	1.1kv PVC SINGLE CORE CABLE SYMBOL	
1A.	FOR PLANTS HAVING SWITCHYARDS/ GENERATING STATION										
I.	SWITCH YARD EQUIPMENT,GENERATORS,H.T.SWITCH BOARDS,TRANSFORMERS,MAIN EARTHING GRID, CONNECTION FROM EARTH BUS TO EARTHING GRID.	750 AT 11KV	706	2-50x8	2 2	491	2-38.1x6.35=484	12 2	500	21	AS PER CLAUSE 17.3.2 OF IS:3043
II.	SWITCH YARD EQUIPMENT,GENERATORS,H.T.SWITCH BOARDS,TRANSFORMERS,MAIN EARTHING GRID, CONNECTION FROM EARTH BUS TO EARTHING GRID.	500 AT 11KV 300 AT 6.6KV 150 AT 3.3KV	471	60x8	1	328	50.8x6.35=323	11	400	22	-DO-
III.	SWITCH YARD EQUIPMENT,GENERATORS,H.T.SWITCH BOARDS,TRANSFORMERS,MAIN EARTHING GRID, CONNECTION FROM EARTH BUS TO EARTHING GRID.	250 AT 6.6KV 125 AT 3.3KV	392	50x8	2	272	50.8x6.35=323	11	300	23	-DO-
IV.	SWITCH YARD EQUIPMENT,GENERATORS,H.T.SWITCH BOARDS,TRANSFORMERS,MAIN EARTHING GRID, CONNECTION FROM EARTH BUS TO EARTHING GRID.	350 AT 11KV 200 AT 6.6KV 100 AT 3.3KV	330 314 314	50x8	2	229 218 218	38.1x6.35=242	12	240	24	-DO-
V.	SWITCH YARD EQUIPMENT,GENERATORS,H.T.SWITCH BOARDS,TRANSFORMERS,MAIN EARTHING GRID, CONNECTION FROM EARTH BUS TO EARTHING GRID.	250 AT 11KV 150 AT 6.6KV 75 AT 3.3KV	235	50x6	3	163	31.75x4.78=152	13	185	25	-DO-
1B	FOR PLANTS WITHOUT SW.YARD/GENERATING STN. H.T.SWITCH BOARDS,TRANSFORMERS,MAIN EARTHING GRID, CONNECTION FROM EARTH BUS TO EARTHING GRID.	ANY FAULT LEVEL AT ANY VOLTAGE	210	50x6	3	120	38.1x3.18=121	14	120	27	AS PER CLAUSE 12.3.2 OF IS:3043
1C	ALL M.V.SWITCH BOARDS		210	50x6	3	120	38.1x3.18=121	14	120	27	AS PER CLAUSE 12.3.2 OF IS:3043
2	H.V. MOTORS		210	50x6	3	120	38.1x3.18=121	14	120	27	-DO-
3	TRANSFOMER NEUTRALS		–	–	–	120	–		150	26	-
4	M.V. MOTORS RATED 75KW & ABOVE		210	50x6	3	120	38.1x3.18=121	14	120	27	AS PER CLAUSE 12.3.2 OF IS:3043
5	M.V. MOTORS ABOVE 30KW &LESS THAN 75KW		175	35x6	4	93	31.75x3.18=101	15	95	28	-DO-

पी डी आई एल
PDIL

EARTHING CONDUCTOR DETAILS

PDS: E 602

DOCUMENT NO.

REV. 0

SHEET 1 OF 2

SL. No.	EQUIPMENT TO BE EARTHED	FAULT LEVEL (MVA)	G.I.STRIPS/WIRES			ALUMINIUM					REMARKS
			MIN.SIZE (mm^2)	SIZE TO BE USED (mm^2)	SYMBOL	MIN.SIZE (mm^2)	STRIPS/WIRES SIZE TO BE USED (mm^2)	STRIPS/WIRES SYMBOL	1.1kv PVC SINGLE CORE CABLE SIZE (mm^2)	1.1kv PVC SINGLE CORE CABLE SYMBOL	
6	M.V.MOTORS ABOVE 5.5KW & LESS THAN 30KW 63A SW.SOCKETS,BATTERY CHARGERS,LIGHTING SUB–DIST.BDS.,D.C.BDS.		44	25x6	5	25	2 SWG=38.6	17	25	29	AS PER CLAUSE 12.3.2 OF IS:3043
7	M.V.MOTORS RATED 5.5KW & BELOW		7	8 SWG=13	6	5	10 SWG=8.3	18	6	30	–DO–
8	ALL MINOR EQUIPMENT RATED FOR 250V & BELOW		–	10 SWG=8.3	7	–	10 SWG=8.3	18	6	30	
9	NON ELECTRICAL EQUIPMENT,SUCH AS VESSELS STRUCTURES IN HAZARDOUS AREA & LIGHTNING PROTECTION CONDUCTORS		32x6	35x6	4	–	25.4x3.18=81	16	–	–	AS PER IS:2309

NOTE :–EARTHING CODUCTOR SIZES FOR ITEMS AT SL.No.4,5,6 & 7 SHOULD BE CHOSEN AS HALF THE POWER CABLE SIZES ACTUALLY USED.

पी डी आई एल
PDIL

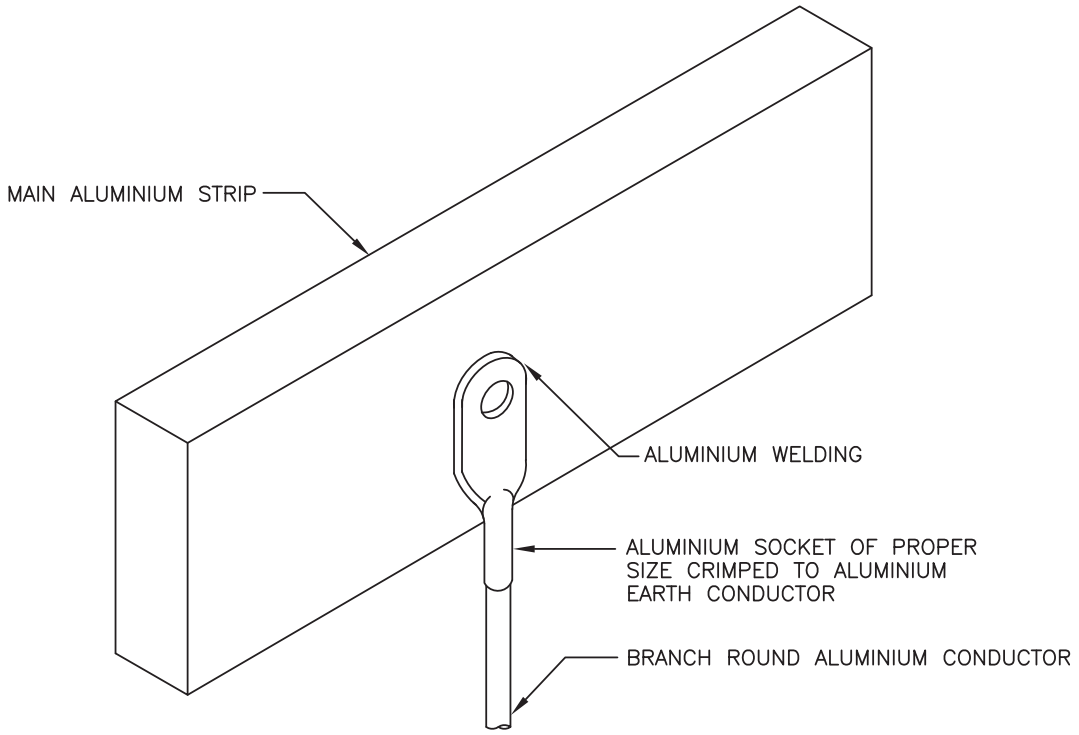
EARTHING CONDUCTOR DETAILS

PDS: E 602

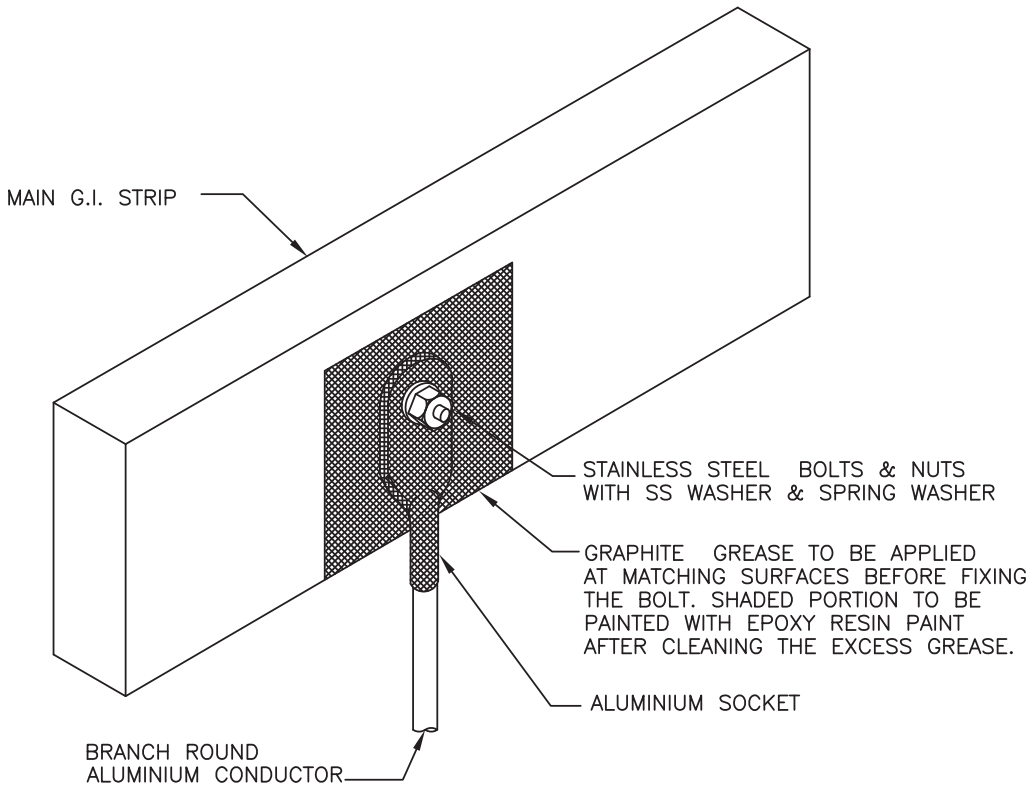
DOCUMENT NO.

REV. 0

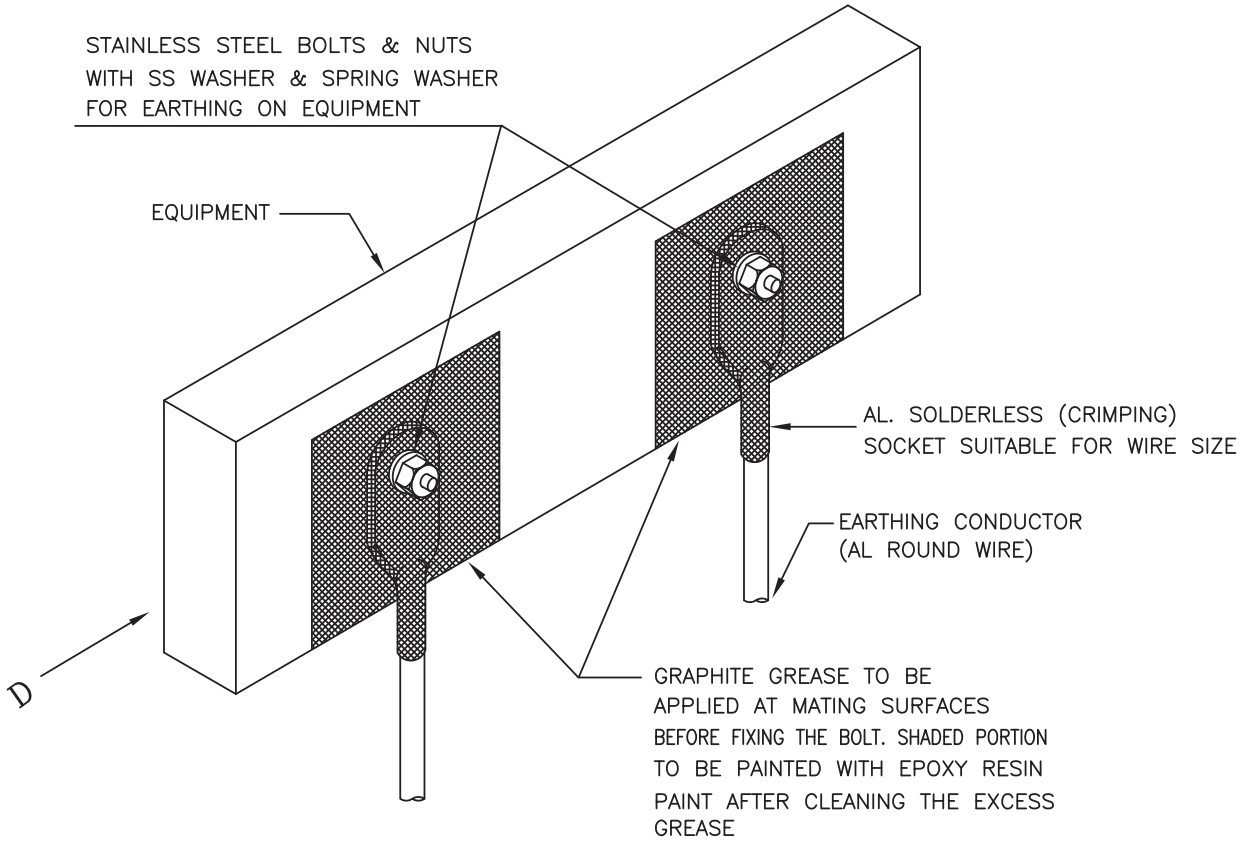
SHEET 2 OF 2



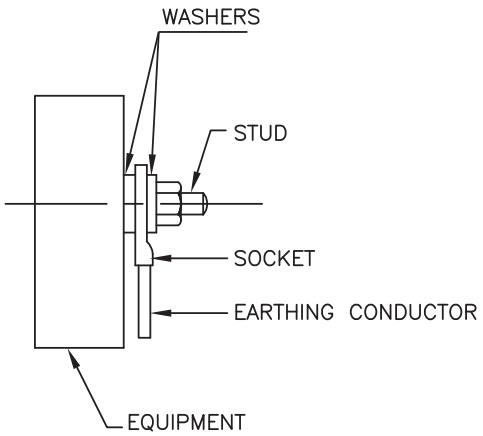
' T ' JOINT ALUMINIUM STRIP TO ROUND ALUMINIUM CONDUCTOR



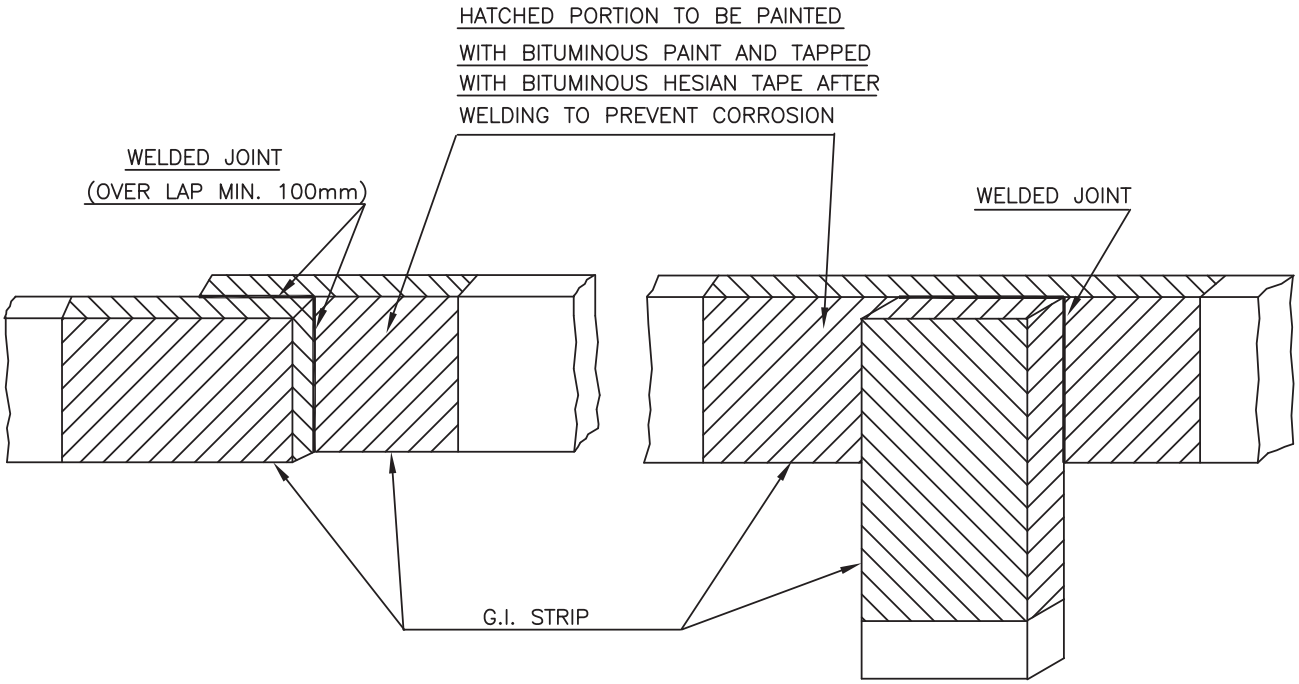
' T ' JOINT G.I. STRIP TO ROUND ALUMINIUM CONDUCTOR



ARRANGEMENT OF DOUBLE EARTH CONNECTIONS TO EQUIPMENT

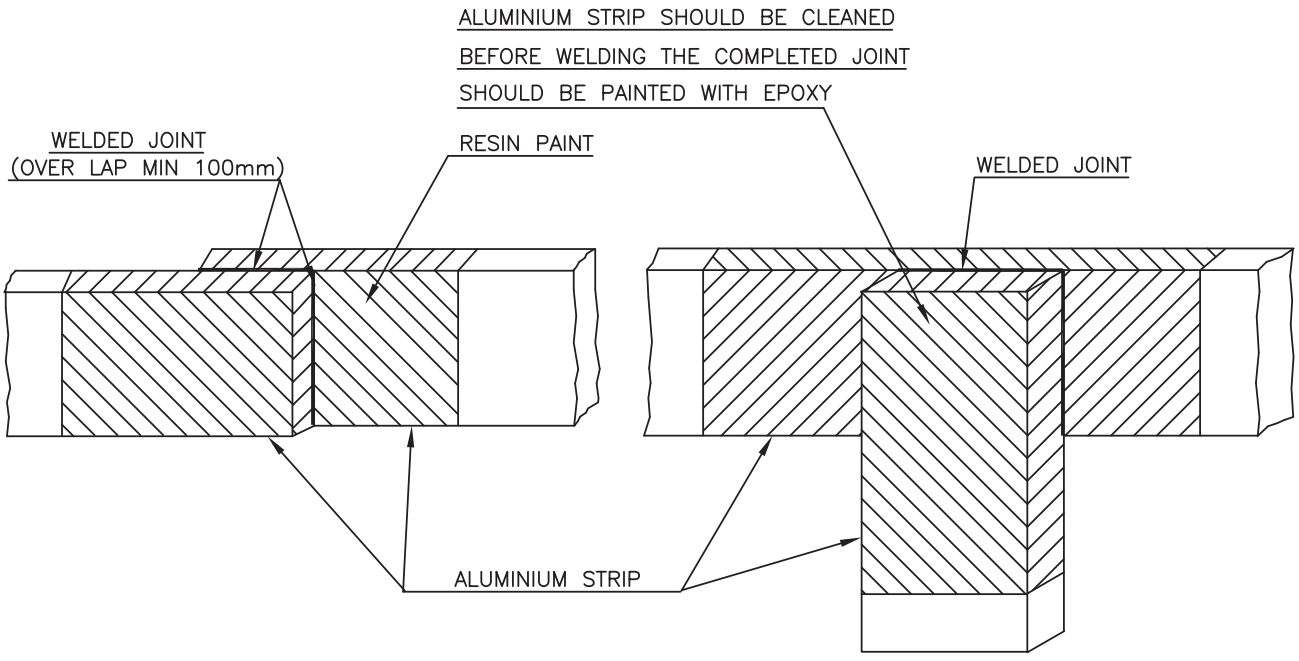


V I E W F R O M – D



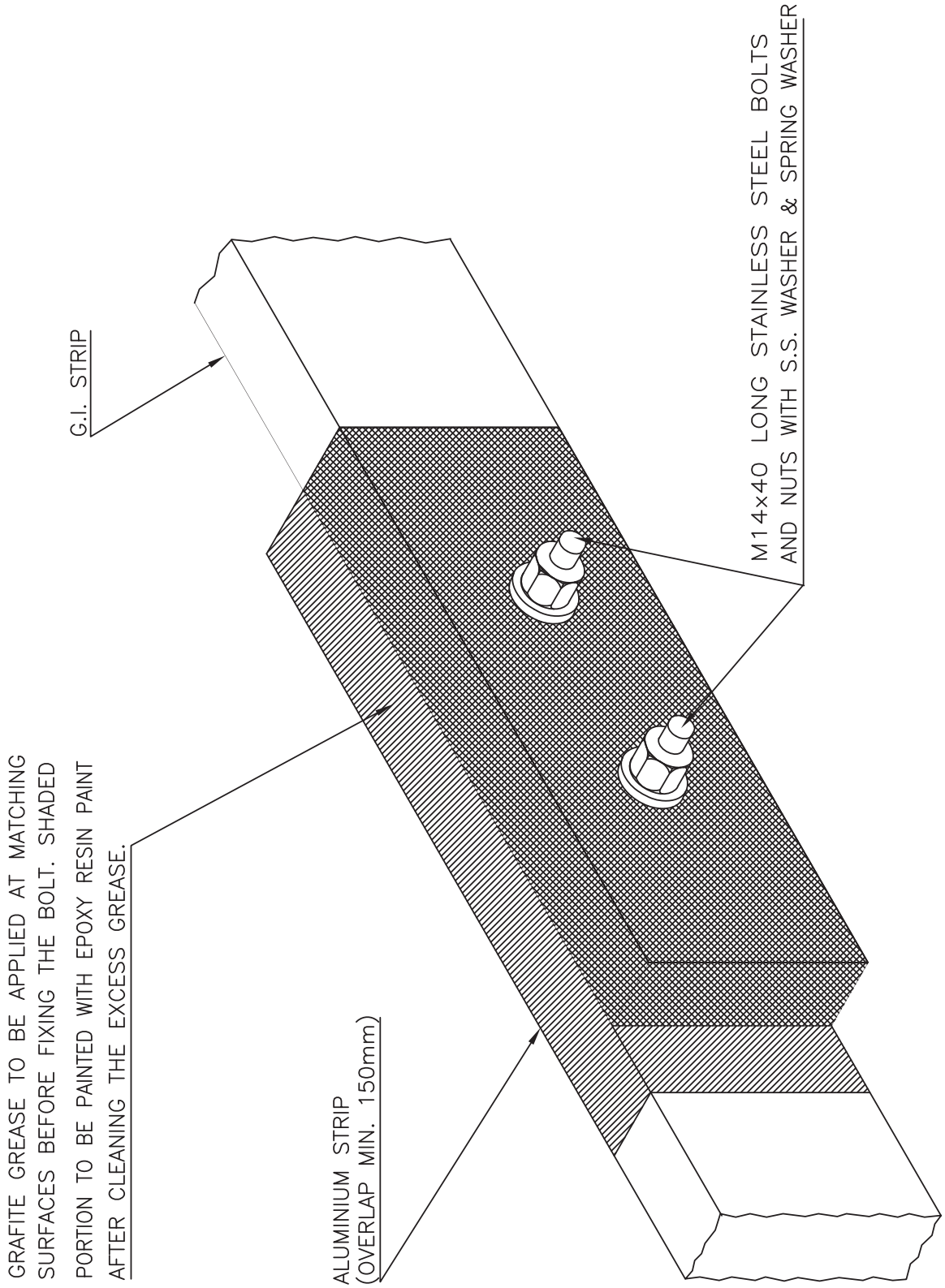
STRAIGHT JOINT G.I TO G.I. STRIP

" T " JOINT G.I. TO G.I. STRIP



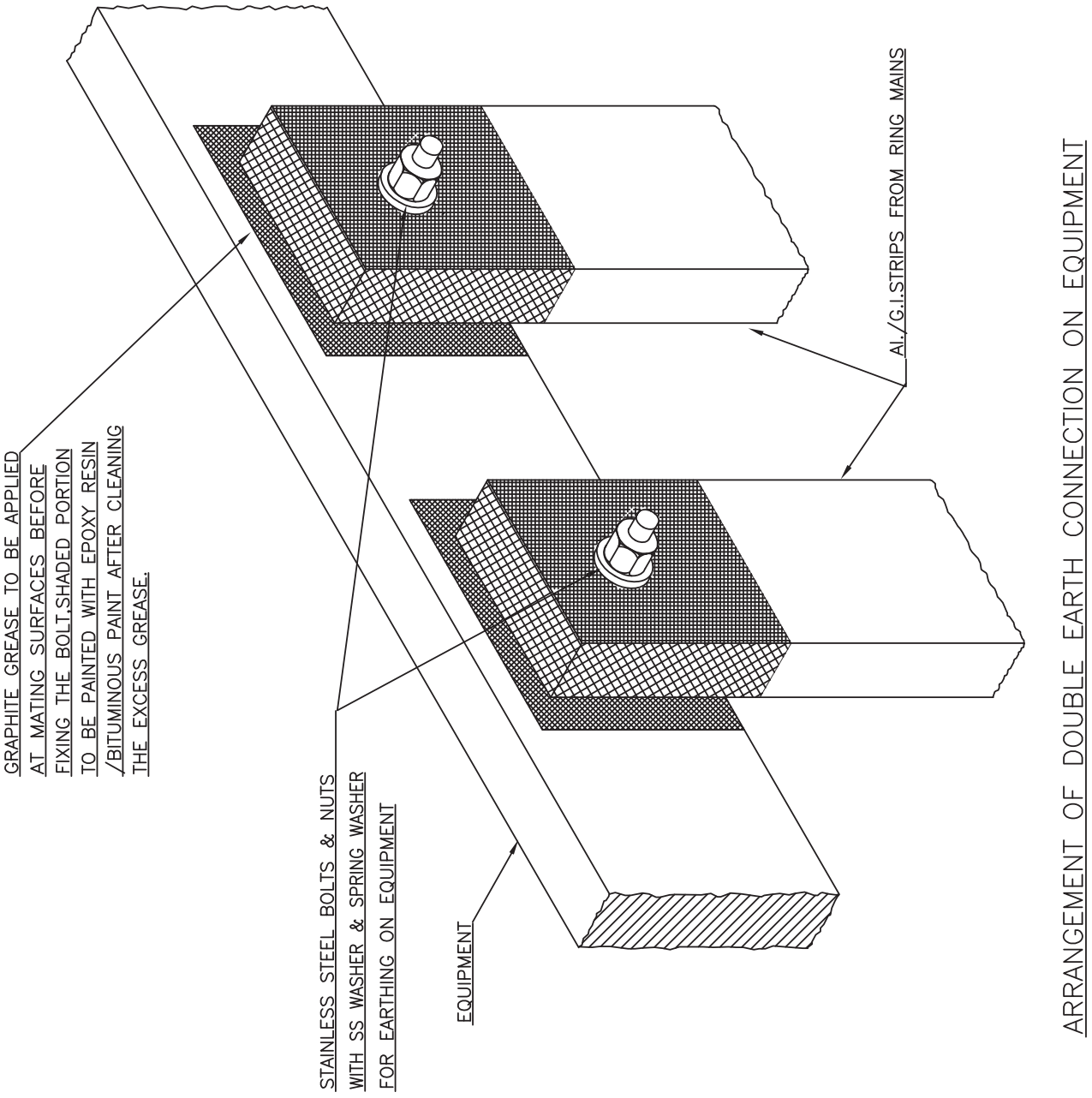
STRAIGHT JOINT AL. TO AL. STRIP

" T " JOINT AL TO AL STRIP



ARRANGEMENT OF LAP JOINT BETWEEN

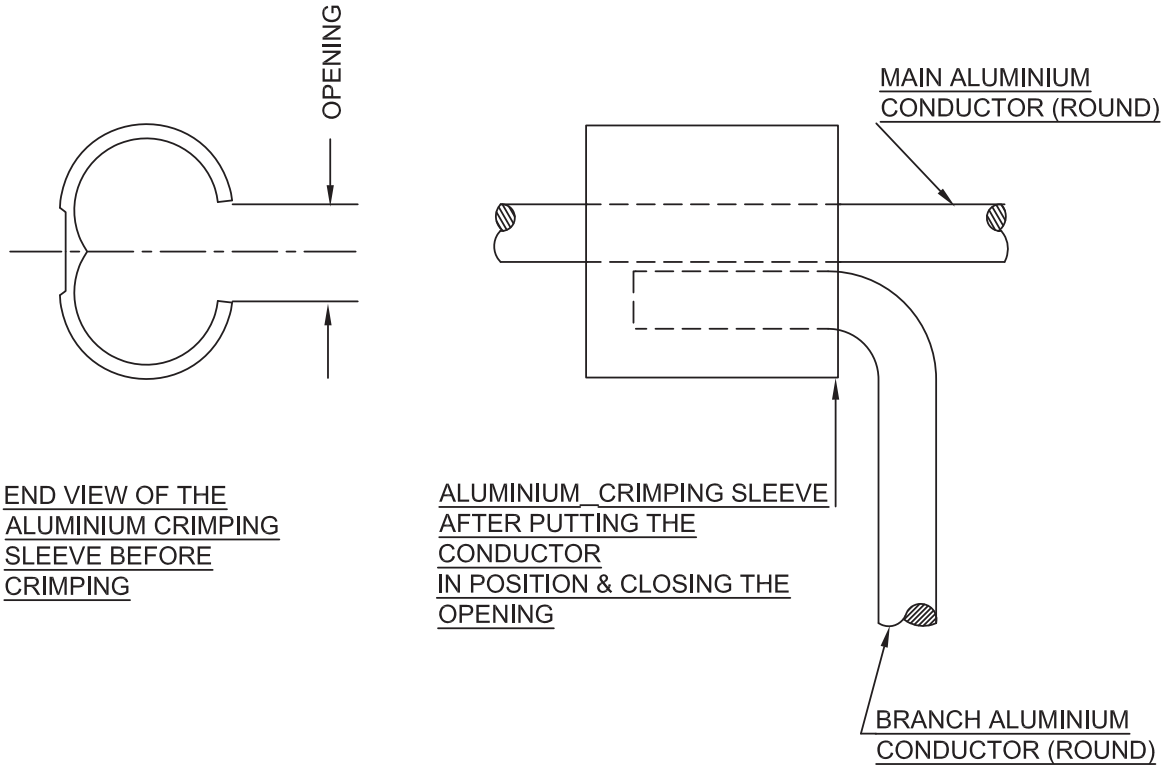
AI. EARTH STRIP TO G.I. EARTH STRIP



ARRANGEMENT OF DOUBLE EARTH CONNECTION ON EQUIPMENT

NOTE:–

EPOXY RESIN PAINT SHALL BE USED FOR AL STRIP AND BITUMINOUS PAINT FOR G.I.STRIP.

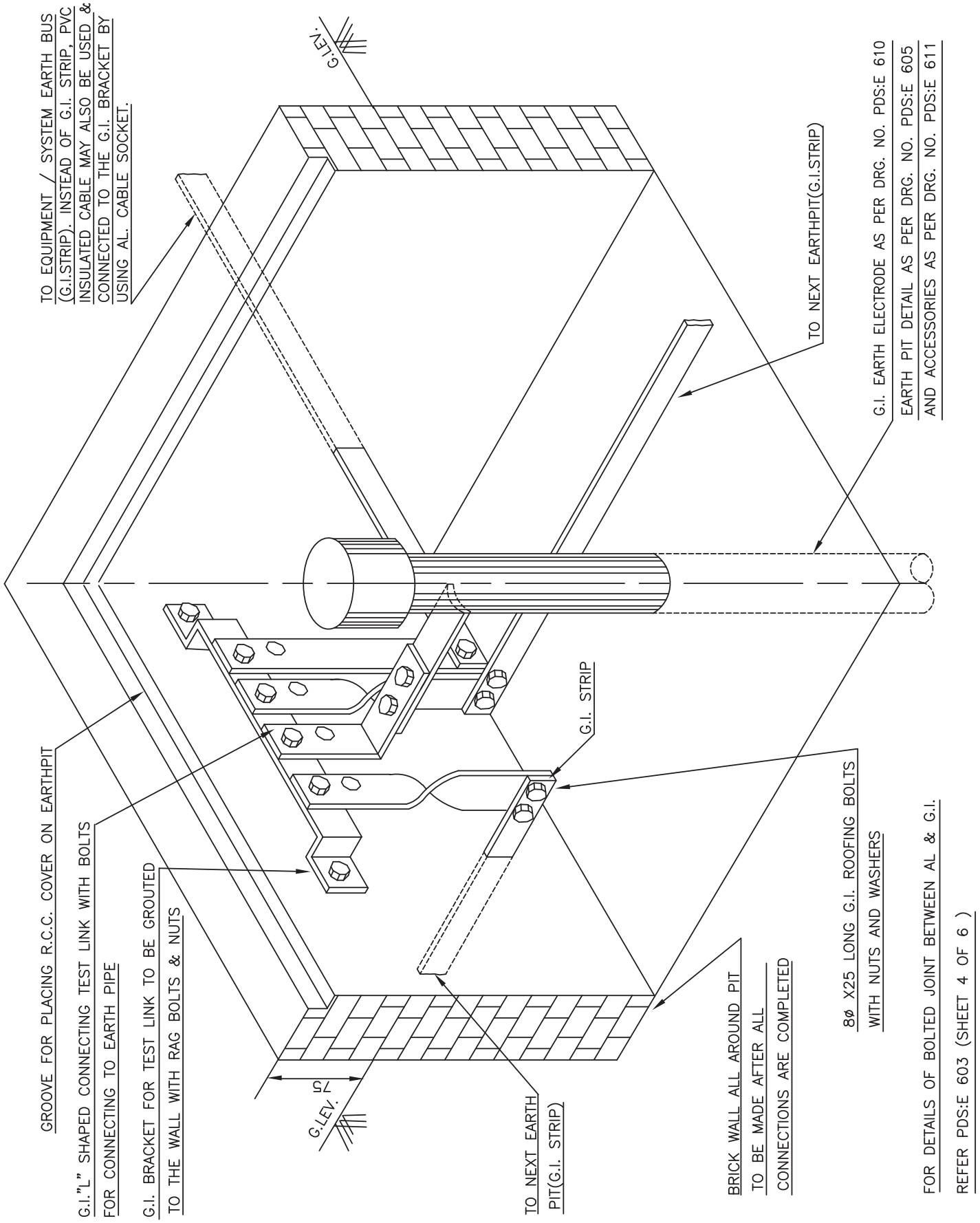


"T" JOINT ROUND ALUMINIUM CONDUCTOR TO ROUND ALUMINIUM CONDUCTOR (CRIMPING TYPE)

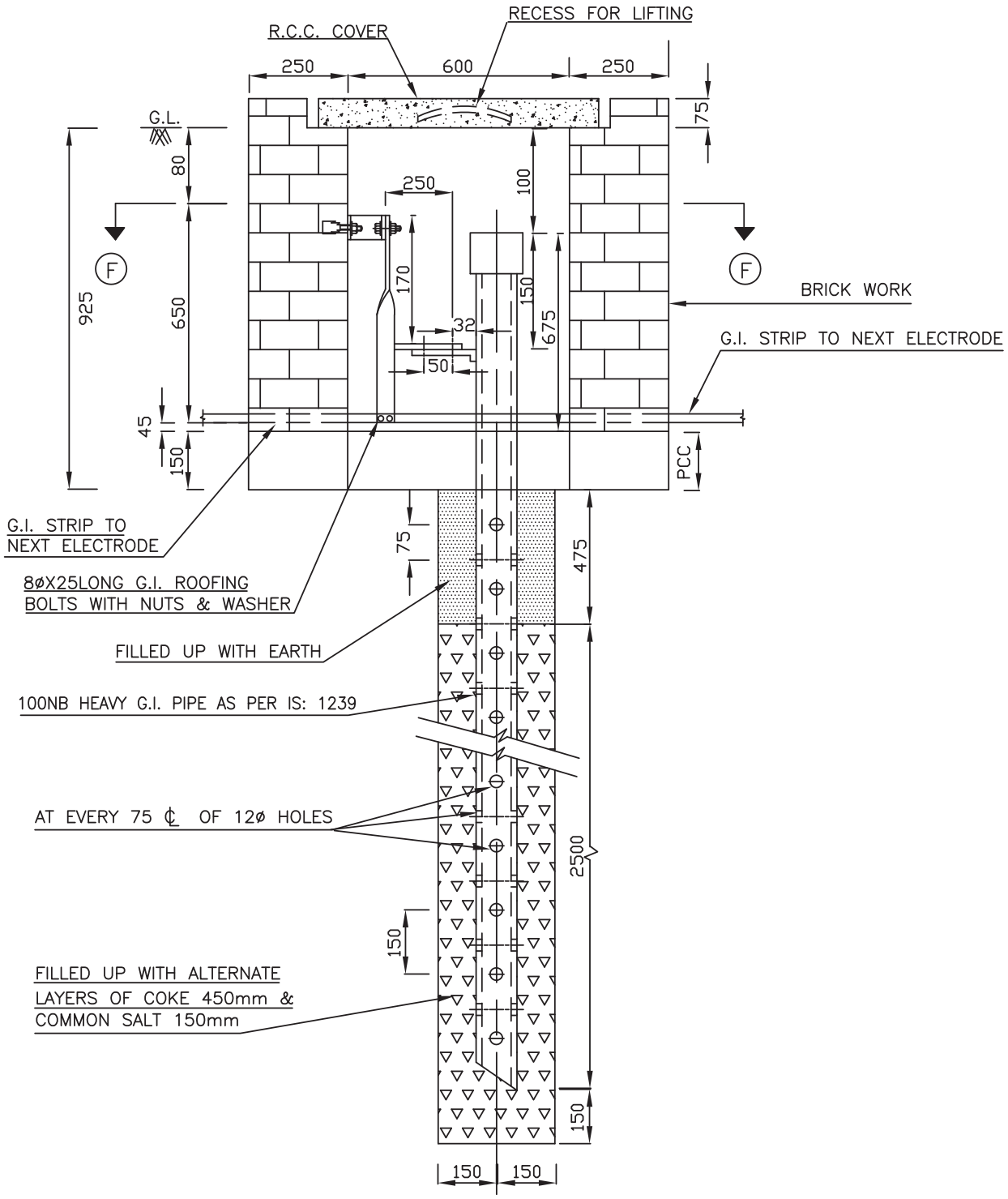
NOTE :–

USE CORRECT SIZE OF COMPRESSION DIES.

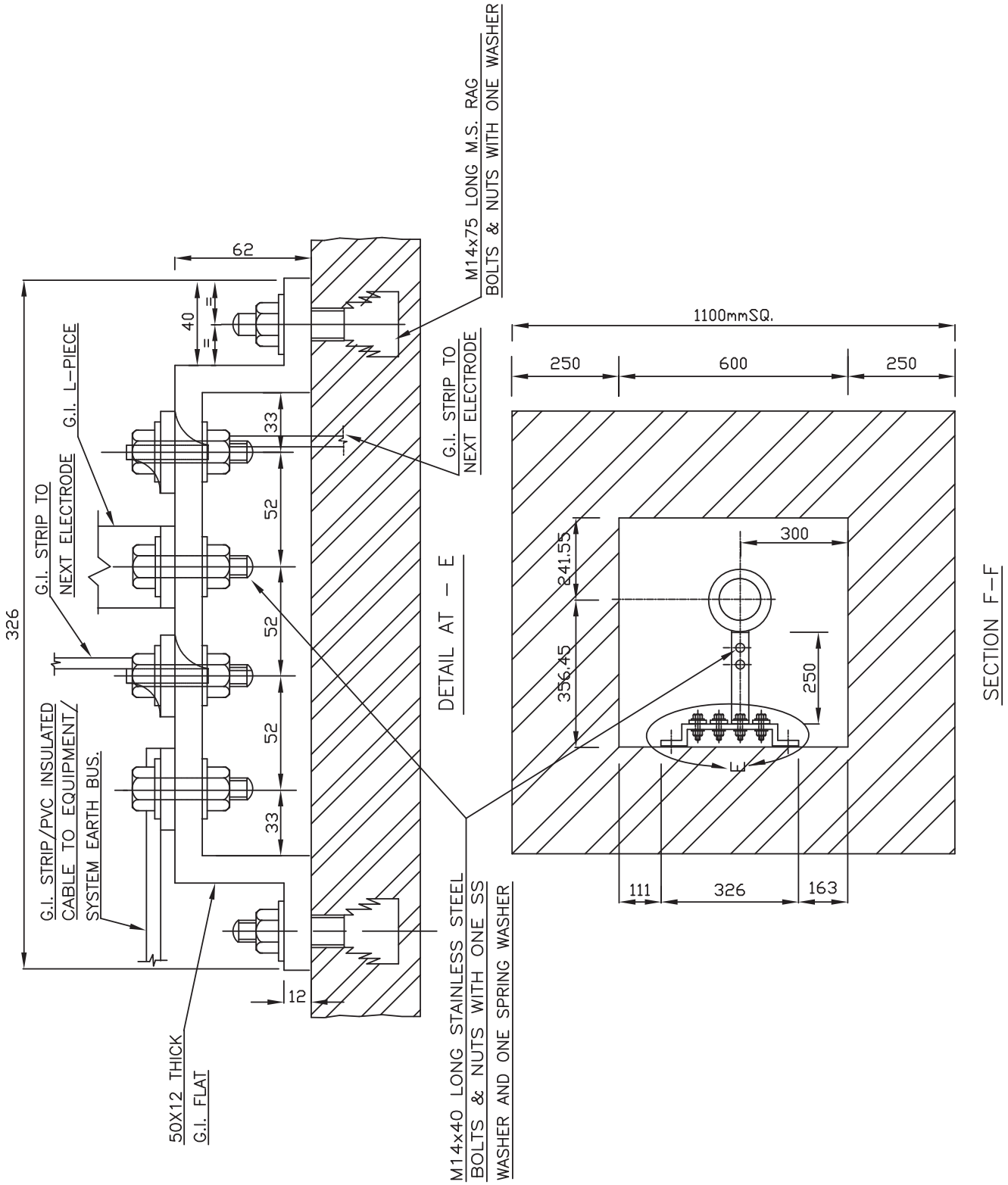
पी डी आई एल PDIL	TYPICAL DETAILS OF CONNECTIONS IN EARTH PIT	PDS: E 604 / 0 DOCUMENT NO. / REV. SHEET 1 OF 1



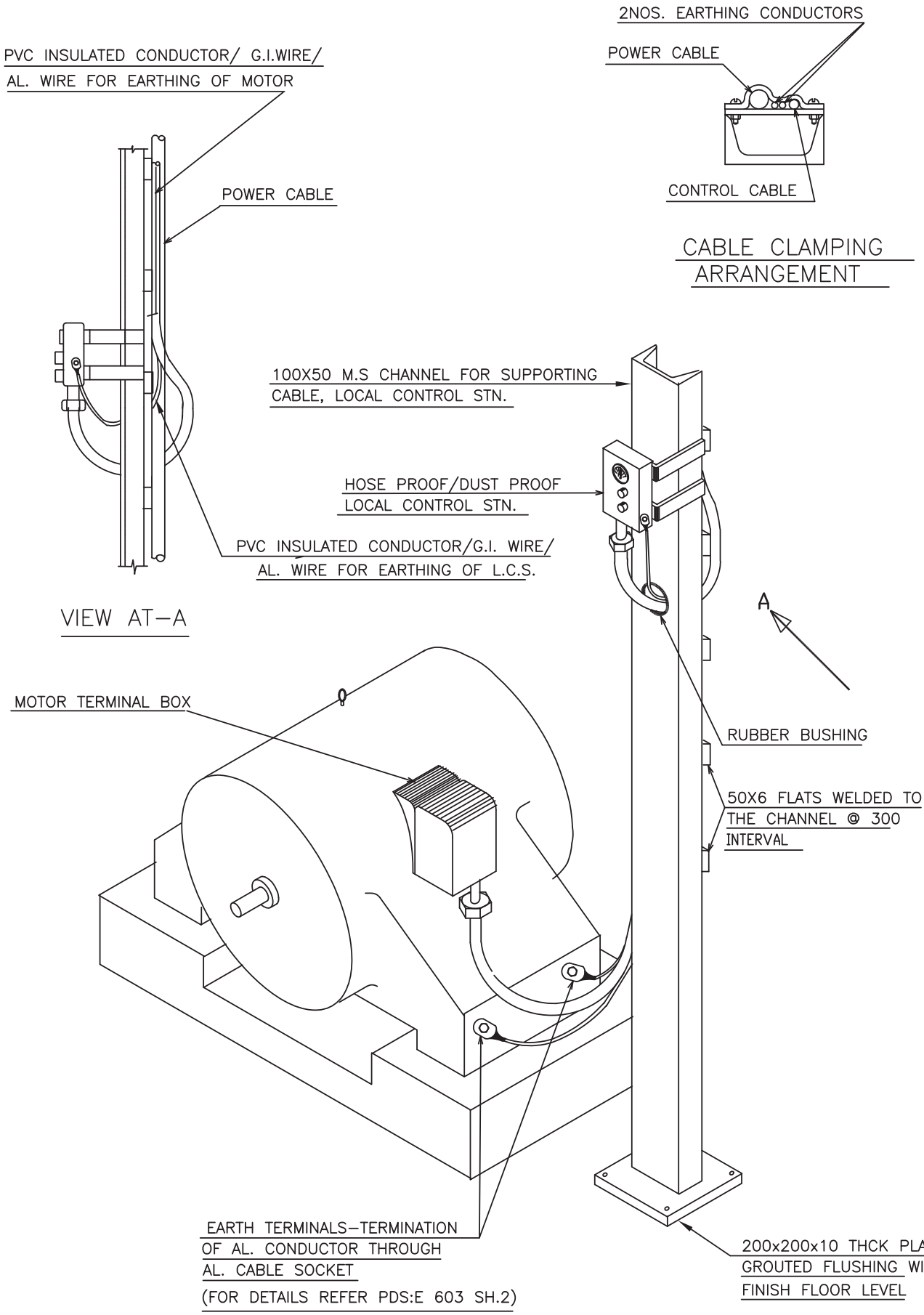
पी डी आई एल PDIL	EARTH PIT DETAILS	PDS: E 605	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 2	

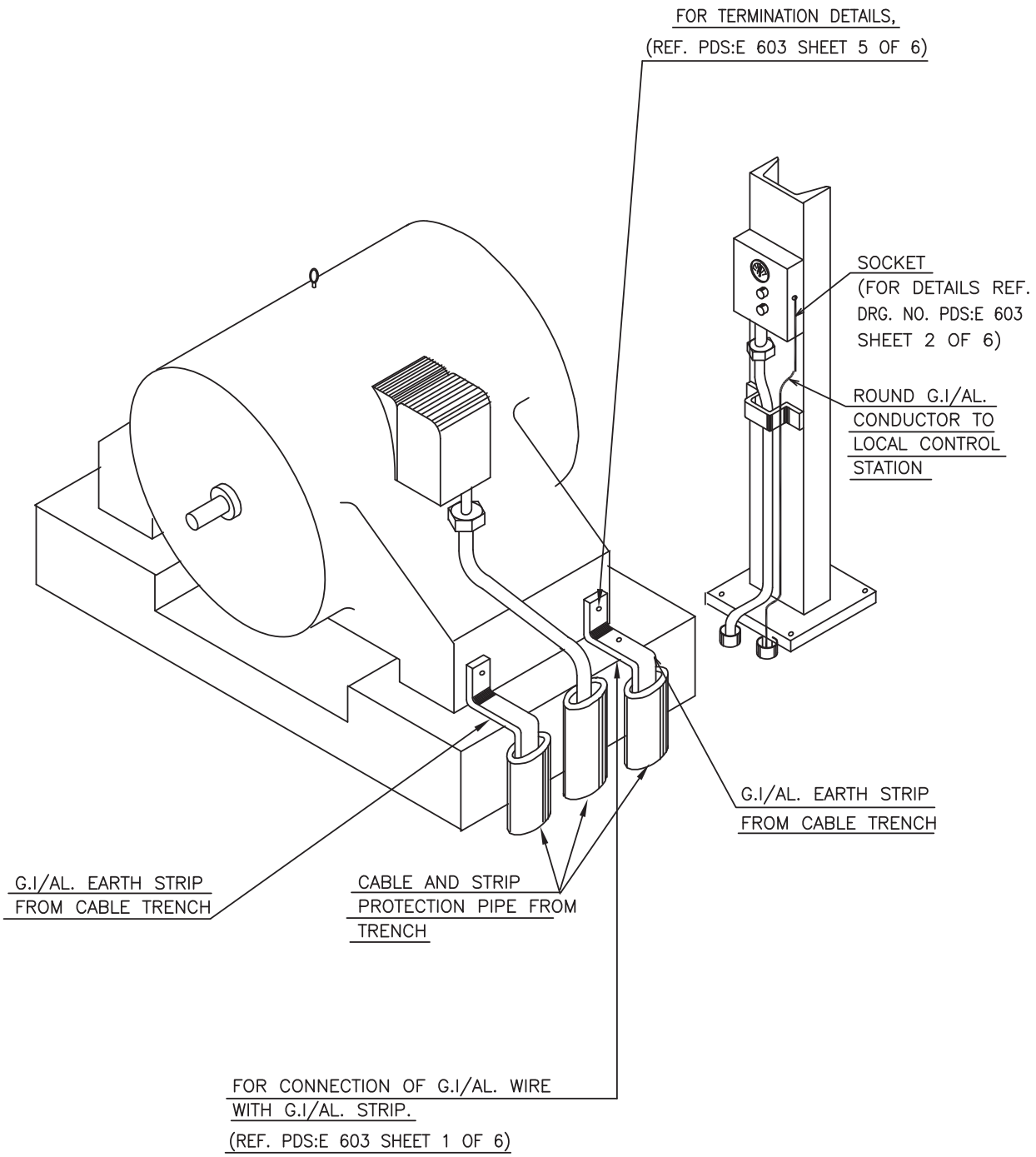


SECTIONAL ELEVATION OF EARTH PIT

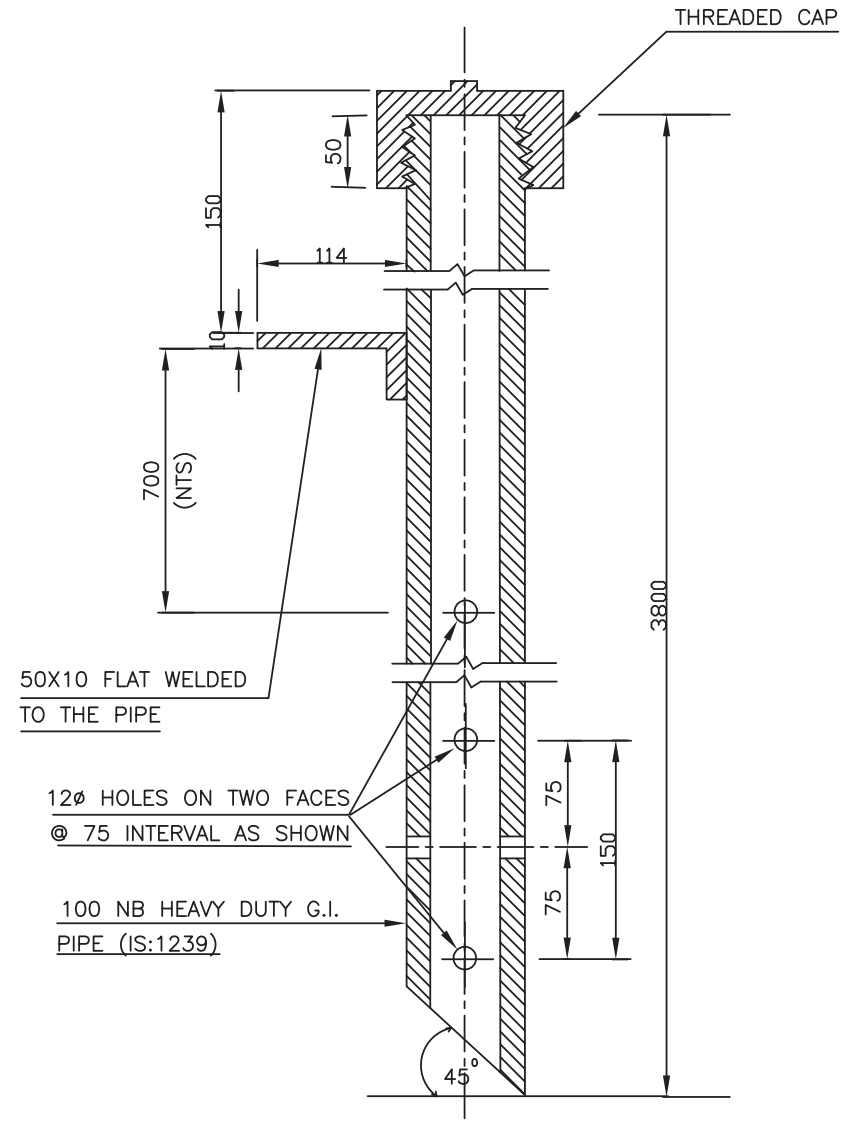

M14x75 LONG M.S. RAG BOLTS & NUTS WITH ONE WASHER
62
40
33
52
52
52
33
326
G.I. L-PIECE
G.I. STRIP TO NEXT ELECTRODE
G.I. STRIP/PVC INSULATED CABLE TO EQUIPMENT/ SYSTEM EARTH BUS.
G.I. STRIP TO NEXT ELECTRODE
12
50X12 THICK G.I. FLAT
M14x40 LONG STAINLESS STEEL BOLTS & NUTS WITH ONE SS WASHER AND ONE SPRING WASHER
DETAIL AT - E
1100mmSQ.
250
600
250
300
241.55
356.45
250
111
326
163
SECTION F-F

पी डी आई एल PDIL	TYPICAL ARRANGEMENT OF EARTHING FOR MOTOR AND START STOP PUSH BUTTON STATION	PDS: E 606	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 2	

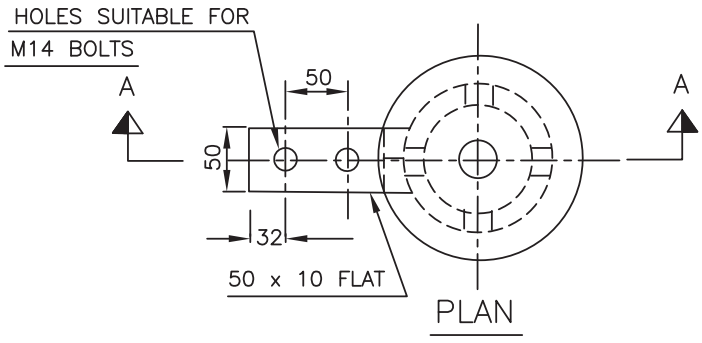



FOR TERMINATION DETAILS,
(REF. PDS:E 603 SHEET 5 OF 6)
SOCKET
(FOR DETAILS REF. DRG. NO. PDS:E 603 SHEET 2 OF 6)
ROUND G.I/AL. CONDUCTOR TO LOCAL CONTROL STATION
G.I/AL. EARTH STRIP FROM CABLE TRENCH
G.I/AL. EARTH STRIP FROM CABLE TRENCH
CABLE AND STRIP PROTECTION PIPE FROM TRENCH
FOR CONNECTION OF G.I/AL. WIRE WITH G.I/AL. STRIP.
(REF. PDS:E 603 SHEET 1 OF 6)

पी डी आई एल PDIL	3.8M G.I. ELECTRODE FOR EARTHING	PDS: E 610	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	



SECTION A–A

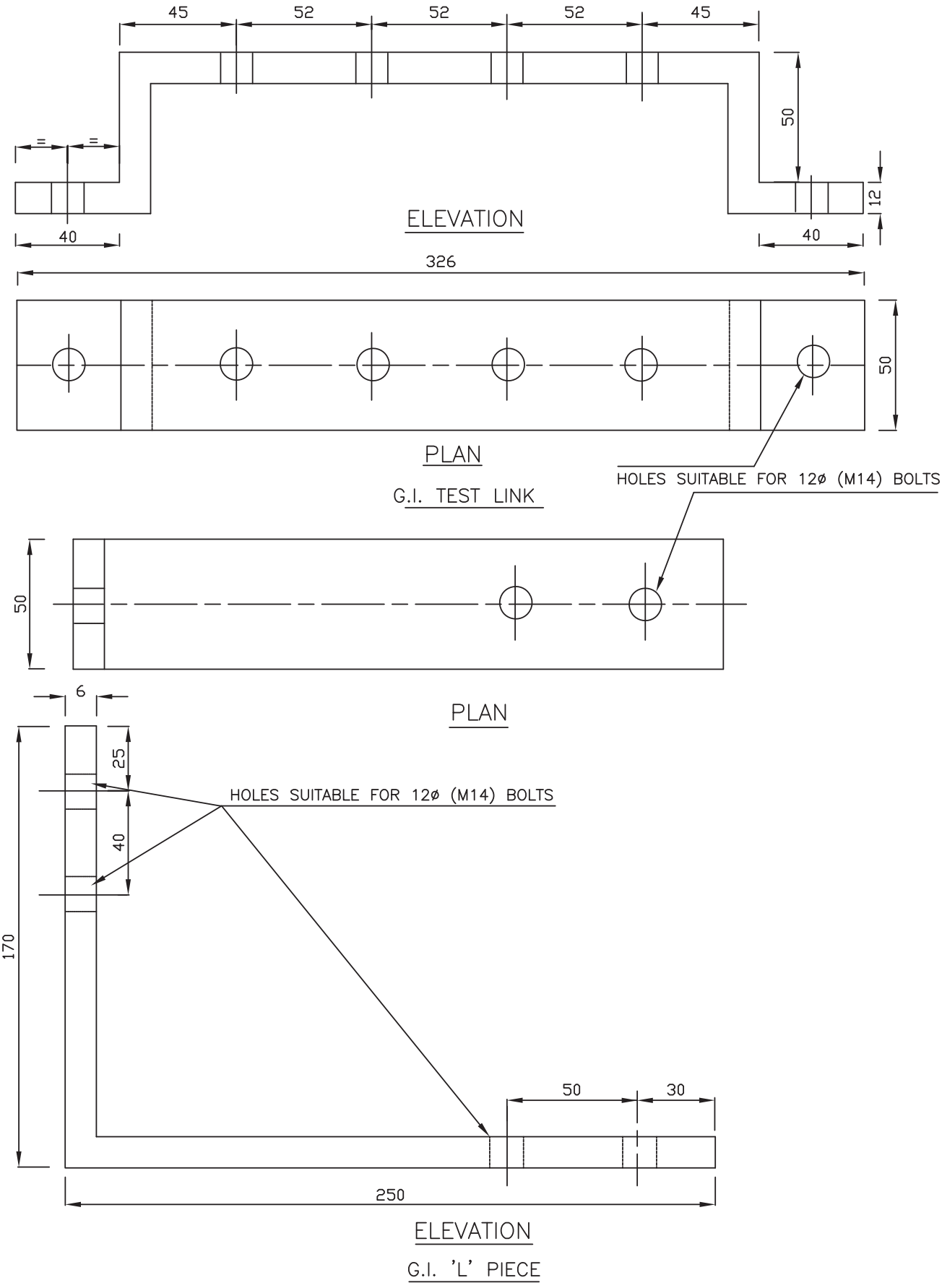


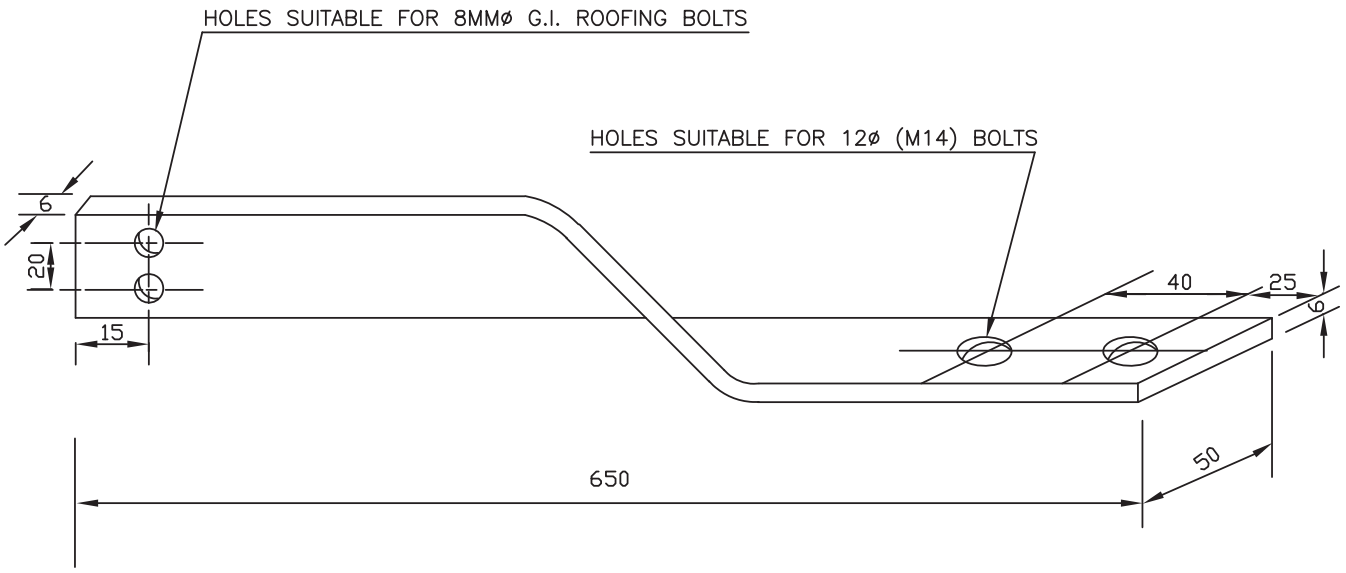
PLAN

NOTE:–

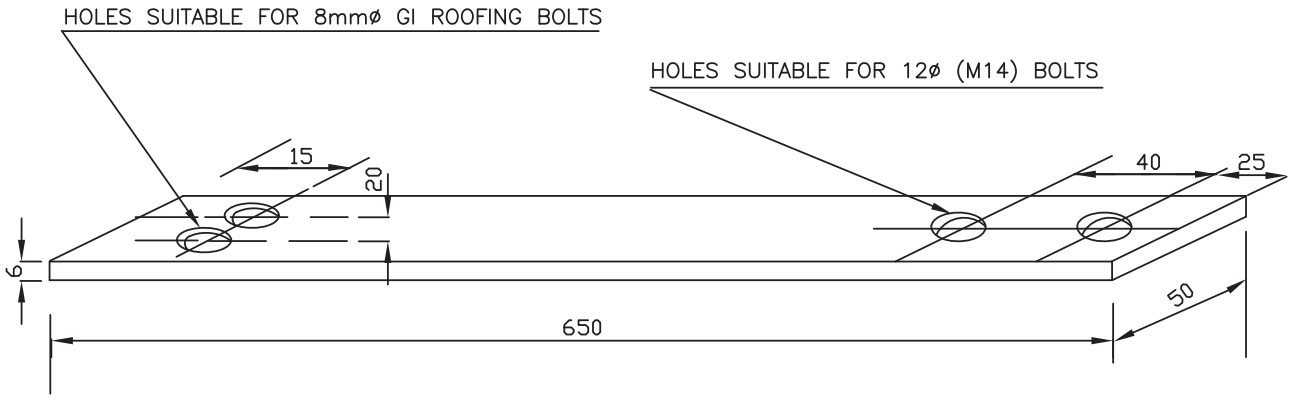
1. 12ø HOLES WILL BE PROVIDED AT 75mm INTERVAL ON TWO FACES THROUGHOUT THE LENGTH OF PIPE. THE FIRST ONE SHALL START 700mm BELOW THE WELDED FLAT.
2. ALL DIMENSIONS ARE IN mm.

पी डी आई एल PDIL	GI / AL ACCESSORIES FOR EARTH PIT	PDS: E 611	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 2	



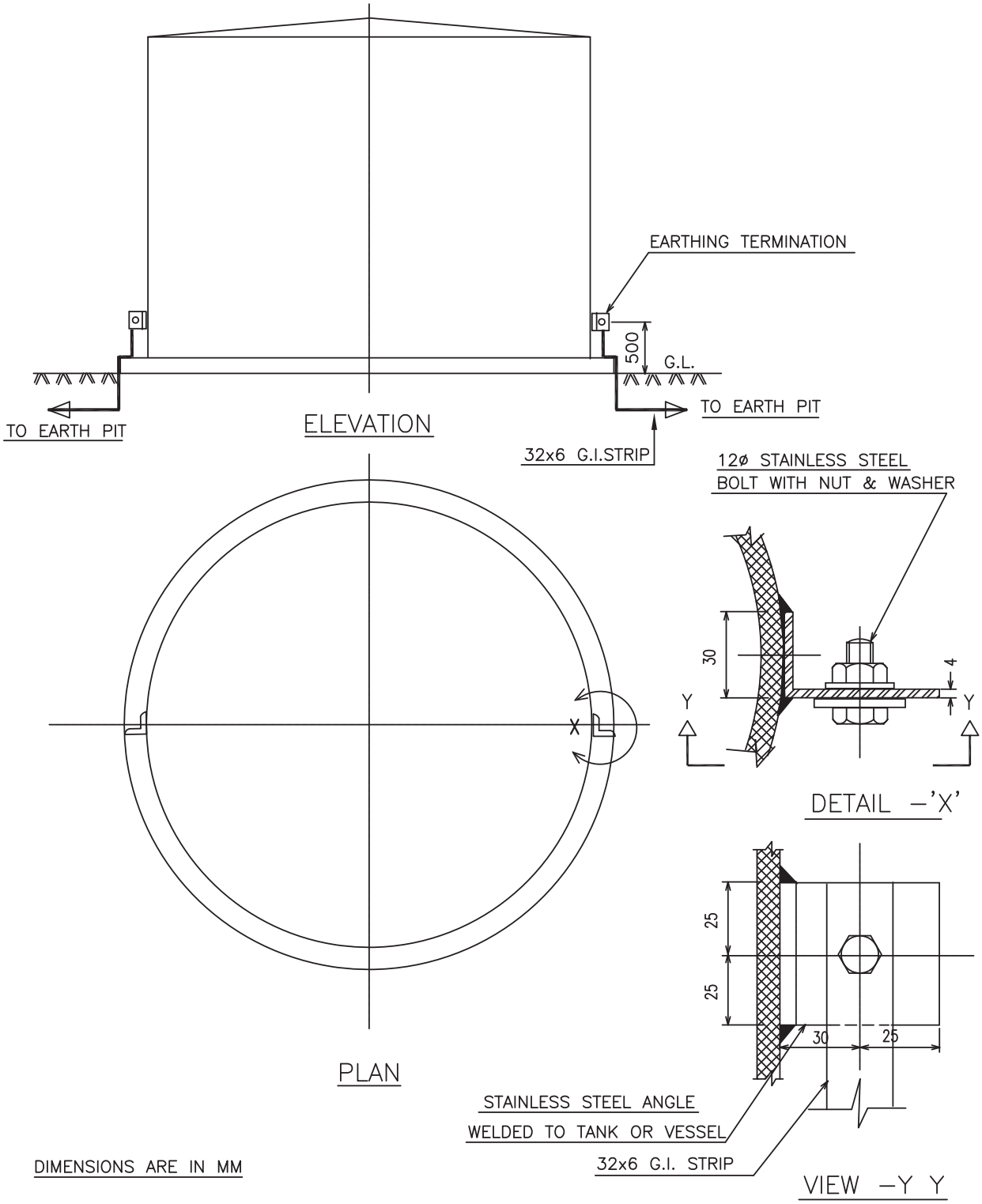


CONNECTING TWISTED ALUMINIUM FLAT PIECE



CONNECTING ALUMINIUM / G.I. FLAT PIECE

पी डी आई एल PDIL	EARTHING OF STORAGE TANK & VESSEL	PDS: E 613	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	

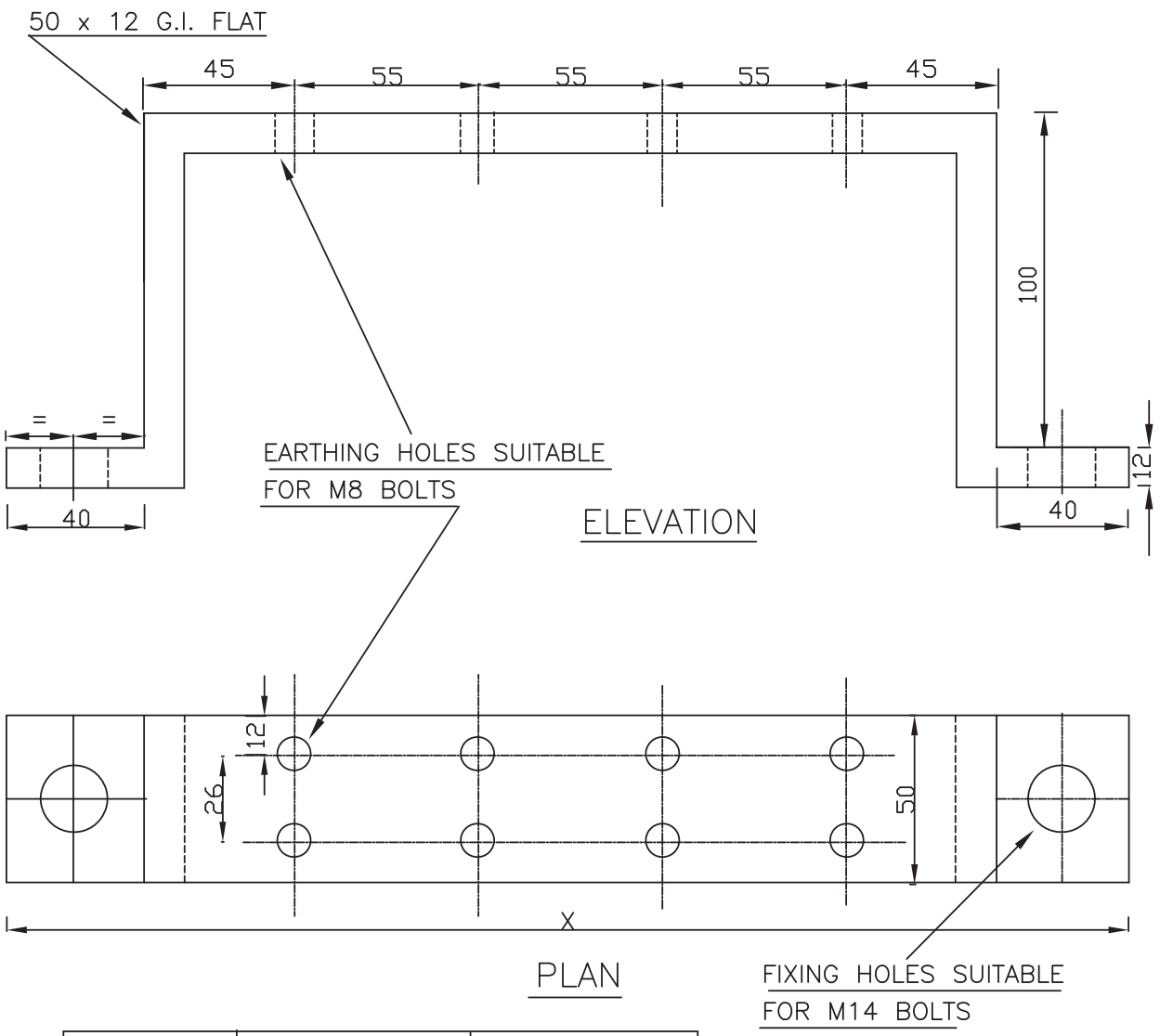


DIMENSIONS ARE IN MM

THE NO. OF EARTH CONDUCTOR SHALL BE AS FOLLOWS

EQUIPMENT WITH ANY DIMENSION	HAZARDOUS AREA	NON–HAZARDOUS AREA
≤ 3 Mts.	1	1
> 3 Mts. ≤ 30 Mts.	2	1
> 30 Mts.	3	2

पी डी आई एल PDIL	G.I. EARTH BUS	PDS: E 615	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	

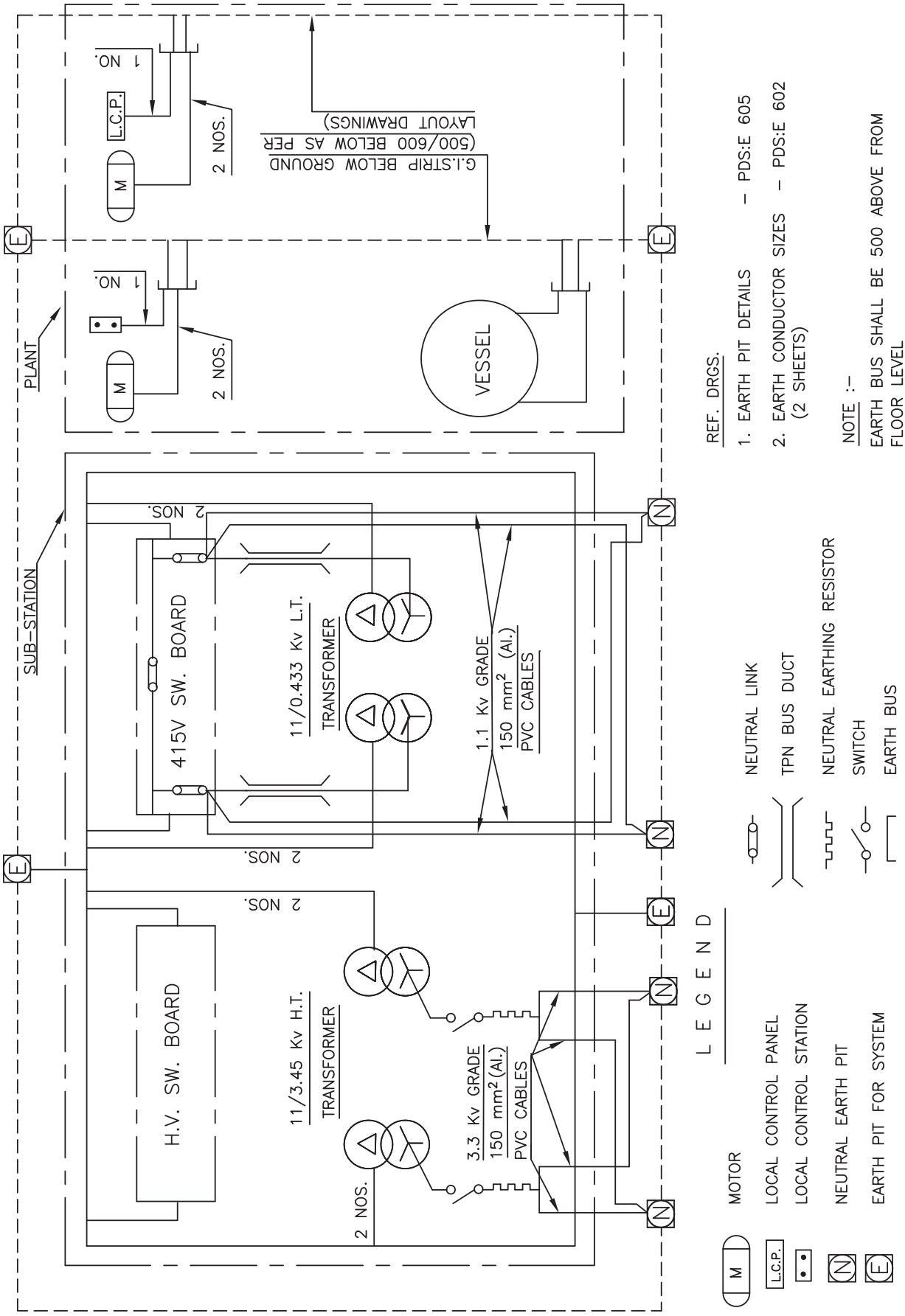


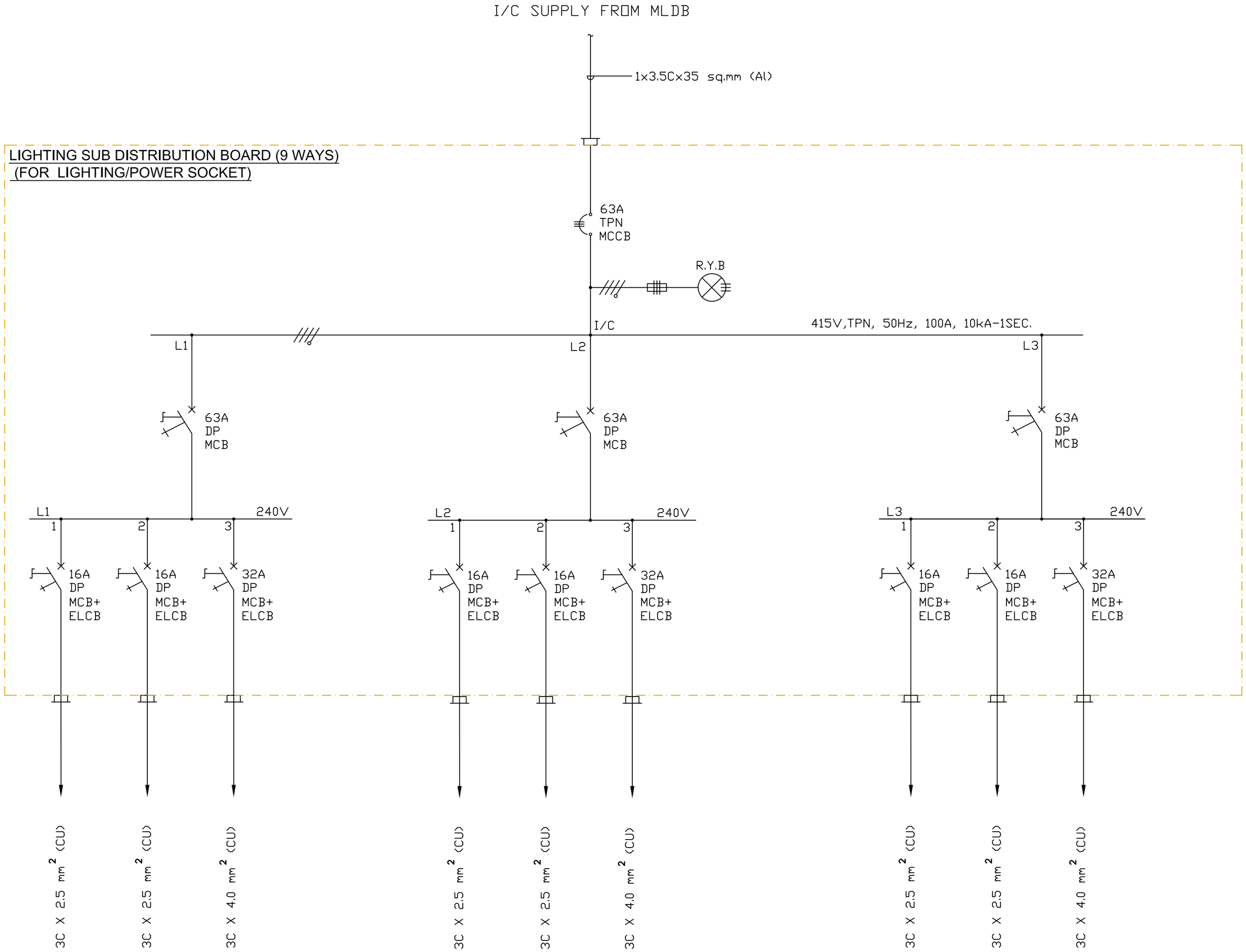
TYPE OF EARTH BUS	NO.OF EARTHING HOLES	OVERALL LENGTH x (mm)
1	8	335
2	10	390

NOTES:–

1. LOCATION OF EARTH BUS TO BE DECIDED AS PER EQUIPMENT POSITION AT SITE.
2. EARTH BUSES SHALL BE LOCATED ON STRUCTURES/COLUMNS WALLS/EQUIPMENT FOUNDATION ETC.
3. MOUNTING HEIGHT OF EARTH BUS SHALL NOT BE LESS THAN 500mm FROM FINISHED FLOOR LEVEL
4. ALL DIMENSIONS ARE IN mm

पी डी आई एल PDIL	TYPICAL ARRANGEMENT FOR NEUTRAL AND EQUIPMENT EARTHING	PDS: E 617	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	





Cable sizes indicated are tentative, sizes shall be finalized during detail engineering.

GENERAL NOTES:

1. BUSBAR MATERIAL - AL.
2. SYSTEM VOLTAGE - 415V, 3ϕ N, 50HZ
3. RATED SHORT CIRCUIT WITHSTAND - 10KA, 1 SEC
4. DEGREE OF PROTECTION (IEC 60529) - IP:55
5. PAINT SHADE - 631 OF IS:5.
6. CABLE ENTRY : INCOMER - BOTTOM
   OUTGOING - BOTTOM

LEGEND:-

- FUSE
- INDICATING LAMP
- MCB/MCCB WITH THERMAL ELECTROMAGNETIC PROTECTION
- CABLE GLAND
- MCCB

This drawing is tentative and for tender purpose only.There may be changes in drawing as per actual requirement.

FOR TENDER PURPOSE

REV.	DATE	DESCRIPTION	PPD.	CKD.	APPD.
P	26.10.18	FOR CLIENT'S REVIEW/COMMENTS	SS	SSM	RKV

CLIENT:– RCF, THAL

REV. P

SHEET 1 OF 1

SCALE: N.T.S.

PROJECT:– ULTRA FILTRATION PACKAGE

DRG. NO.– PC284 -1221

TITLE:– SINGLE LINE DIAGRAM OF LIGHTING SUB DISTRIBUTION BOARD

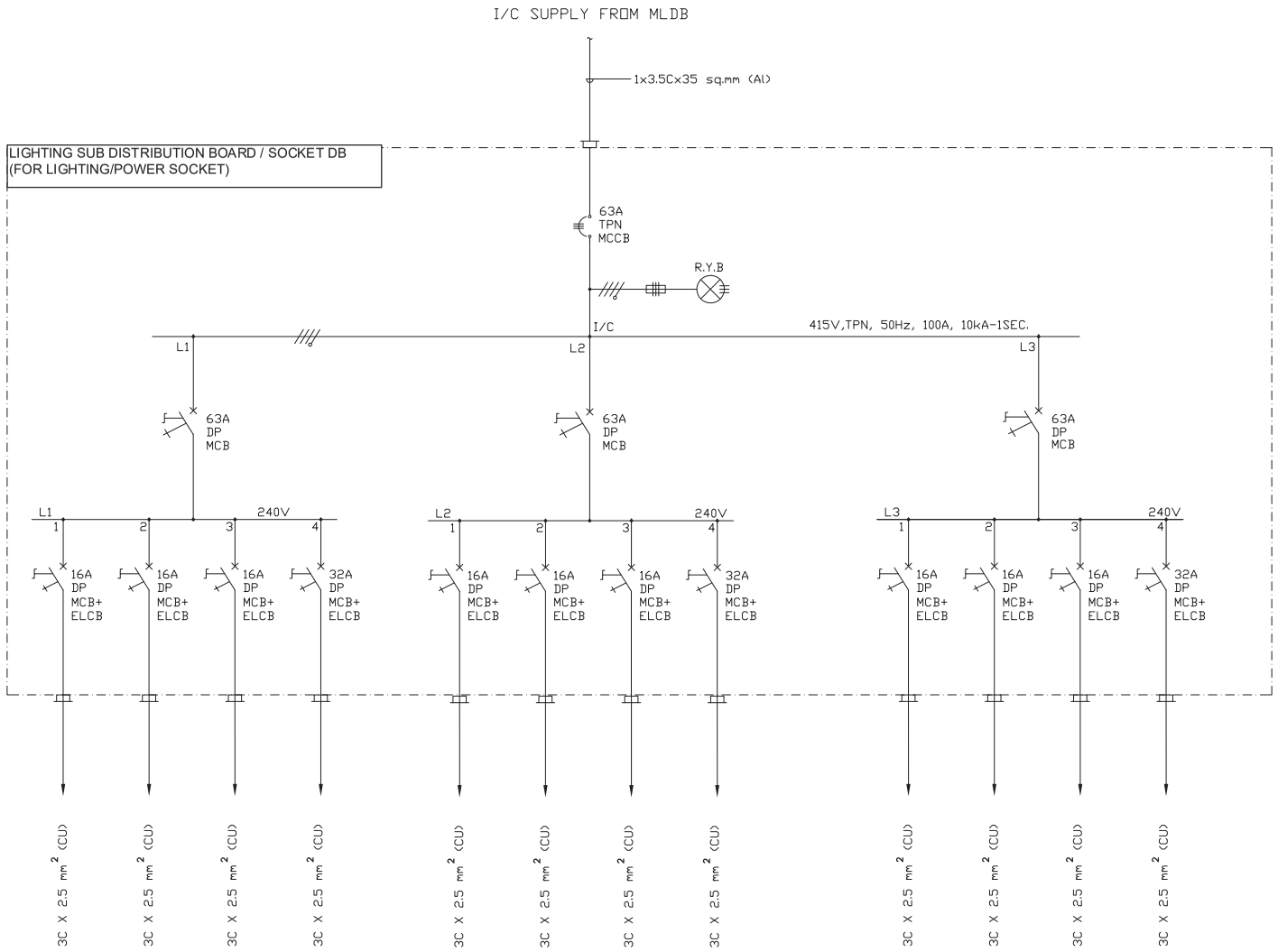
FILE:

पी डी आई एल PDIL
प्रोजेक्ट्स एंड डेवलपमेंट इंडिया लिमिटेड नोएडा
PROJECTS & DEVELOPMENT INDIA LTD.–NOIDA

ISO–A3

GENERAL NOTES:

1. BUSBAR MATERIAL - AL.
2. SYSTEM VOLTAGE - 415V, 3ϕ N, 50HZ
3. RATED SHORT CIRCUIT WITHSTAND - 10KA, 1 SEC
4. DEGREE OF PROTECTION (IEC 60529) - IP:55
5. PAINT SHADE - 631 OF IS:5.
6. CABLE ENTRY : INCOMER - BOTTOM
   OUTGOING - BOTTOM



LEGEND:-

- FUSE
- INDICATING LAMP
- MCB/MCCB WITH THERMAL ELECTROMAGNETIC PROTECTION
- CABLE GLAND
- MCCB

This drawing is tentative and for tender purpose only.There may be changes in drawing as per actual requirement.

Cable sizes indicated are tentative, sizes shall be finalized during detail engineering.

FOR TENDER PURPOSE

REV.	DATE	DESCRIPTION	PPD.	CKD.	APPD.
P	18.10.18	FOR CLIENT'S REVIEW/COMMENTS	SS	SSM	RKV

CLIENT:– RCF, THAL

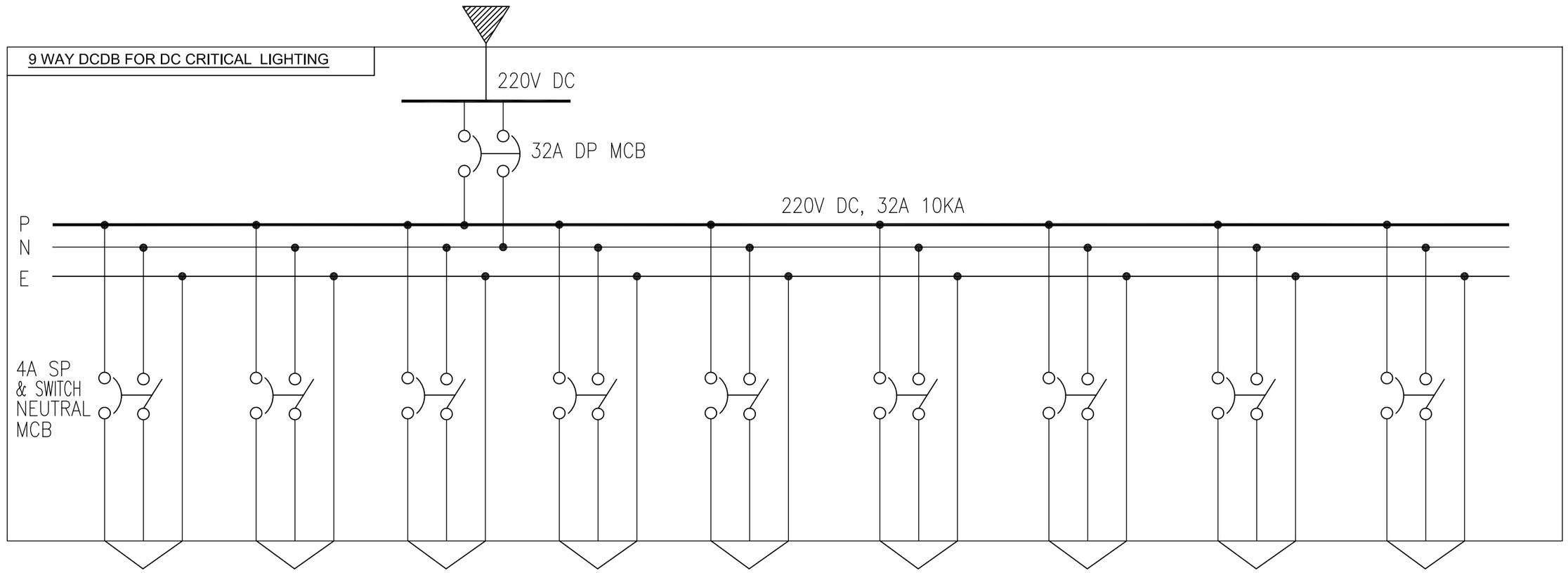
PROJECT:– ULTRA FILTRATION PACKAGE

TITLE:– SINGLE LINE DIAGRAM OF LIGHTING SUB DISTRIBUTION BOARD

REV. P | SHEET 1 OF 1 | SCALE: N.T.S. | DRG. NO.– PC284-1210 | FILE:

PDIL प्रोजेक्ट्स एंड डेवलपमेंट इंडिया लिमिटेड नोएडा
PROJECTS & DEVELOPMENT INDIA LTD.–NOIDA

ISO–A3



GENERAL NOTES:

1. BUSBAR MATERIAL - AL.
2. SYSTEM VOLTAGE - 220V, DC
3. RATED SHORT CIRCUIT WITHSTAND - 10KA, 1 SEC
4. DEGREE OF PROTECTION (IEC 60529) - IP:55
5. PAINT SHADE - 631 OF IS:5.
6. CABLE ENTRY : INCOMER - BOTTOM
   OUTGOING - BOTTOM

LEGEND:

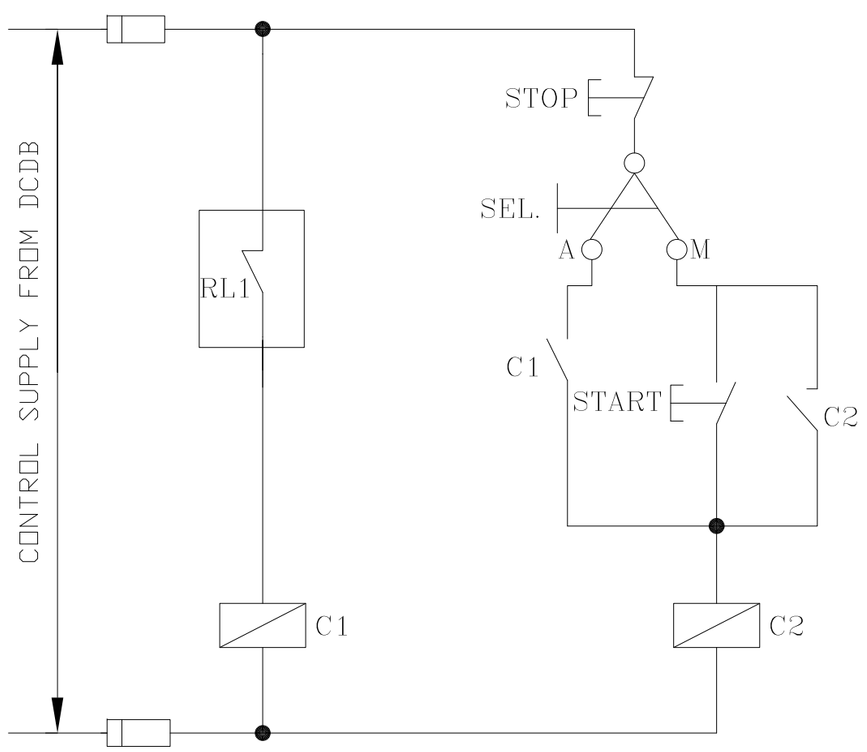
FUSE

INDICATING LAMP

DP MCB

VOLTMETER

DCDB	LOAD SCHEDULE								
LIGHTING SUB–DISTRIBUTION BOARD	R1	R2	R3	R4	R5	R6	R7	R8	R9
FIXTURE NOS.	–	–	–	–	–	–	–	–	–
LOAD IN WATTS	–	–	–	–	–	–	–	–	–



* NOTE:– RL1 RELAY CONTACT OF THREE PHASE FAILURE RELAY (RELAY CONTACT WILL BE ON AFTER FAILURE OF ALL THREE PHASES) RELAY RL1 IS SENSING LSDB1–INCOMING VOLTAGE IN CASE OF FAILURE OF INCOMING SUPPLY LSDB1 EMERGENCY DC LIGHT WILL BE ON THROUGH C2 CONTACTOR

THIS SCHEME IS FOR REFERENCE PURPOSE ONLY

This drawing is tentative and for tender purpose only.There may be changes in drawing as per actual requirement.

REV.	DATE	DESCRIPTION	PPD.	CKD.	APPD.
P	26.10.18	FOR CLIENT'S REVIEW/COMMENTS	SS	SSM	RKV

CLIENT:– RCF, THAL

REV. P

SHEET 1 OF 1

SCALE: N.T.S.

PROJECT:– ULTRA FILTRATION PACKAGE

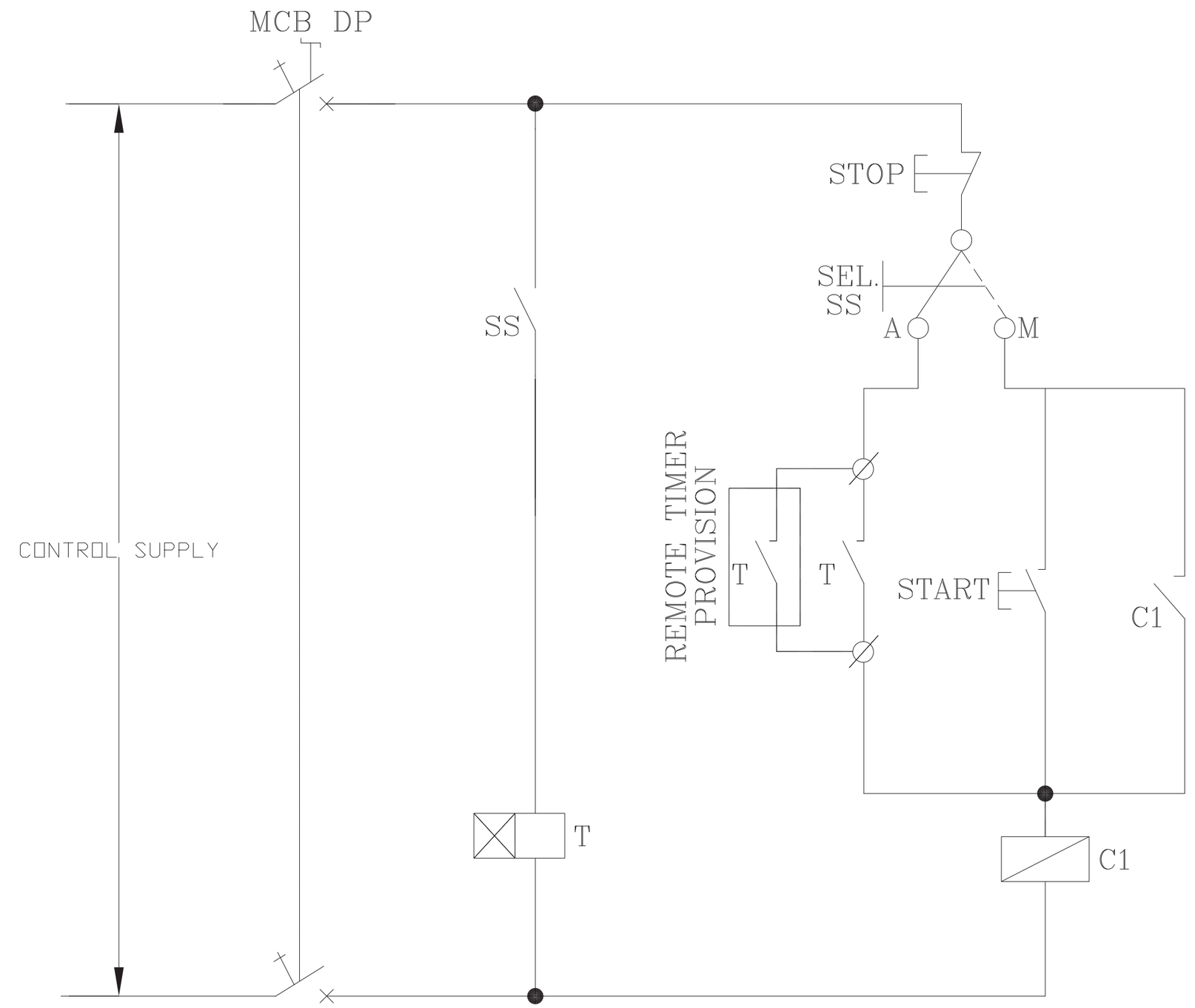
DRG. NO.– PC284 –1211

TITLE:– SINGLE LINE DIAGRAM OF DC DISTRIBUTION BOARD

FILE:

प्रोजेक्ट्स एंड डेवलपमेंट इंडिया लिमिटेड नोएडा
PROJECTS & DEVELOPMENT INDIA LTD.–NOIDA

ISO–A3



LEGEND:

- FUSE
- INDICATING LAMP
- MCB
- CABLE GLAND
- TIMER
- SELECTOR SW.

THIS SCHEME IS FOR REFERENCE PURPOSE ONLY

GENERAL NOTES:

1. BUSBAR MATERIAL - Al
2. CABLE ENTRY : INCOMER - BOTTOM
   OUTGOING - BOTTOM

NOTE:-

LDB SHALL HAVE CONTACTOR LOGIC SUITABLE FOR OPERATION IN AUTO-MANUAL MODE, THE PROVISION FOR EXTERNAL TIMER INPUT SHALL BE AVAILABLE IN THE LDB. THE LDB SHALL ALSO HAVE MANUAL ON & OFF PUSH BUTTONS WITH ON, OFF, R, Y, B LED INDICATION LAMPS. THE VENDOR SHALL PREPARE DETAIL DRAWING.

SS	S.S.	R.K.V.
SS	S.S.	R.K.V.
PPD.	CKD.	APPD.
REV.	P	0
SHEET 1 OF 1		
SCALE: N.T.S.		
DRG. NO.- PC284 -1205		
FILE: --		

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NOIDA

SECTION- 3.6

DESIGN PHILOSOPHY – INSTRUMENTATION

ULTRA FILTRATION UNIT
ATRCF, THAL

TABLE OF CONTENTS

LIST OF ATTACHMENTS

A. List of Annexure:

1.0 INSTRUMENTATION AND CONTROLS

2.0 SCOPE

2.1 This section outlines the general requirements and specifications for Instrumentation and Control System for the ultra-filtration unit. The Instrumentation and Control System shall consist of but not limited to the following:

a. Complete **PLC based control system** for monitoring & control for Ultra filtration unit. Monitoring &control for alarms, sequence control, permissive to start logic, valve logic,On-Off control& PID control etc. shall be performed by offered PLC system.

b. A local control panel(LCP)(preferably RITTAL make) shall be provided containing all modules, power distribution &marshalling. This panel shall have provision for essential start / stop / trip pushbuttons, selector switches, indicator lamps for motors, valves & Annunciator as per bidder standard operation philosophy.

c. In order to achieve peer-to-peer communication with existing Rockwell Control logix PLC system of Water Treatment Plant (WTP), bidder shall offer PLC system of **Rockwell automation make** having latest **1756 series** controller only.

d. A dedicated ethernet communication module (**1756-EN2T**) shall be offered for establishing communication with existing WTP PLC system. Supply of network switch, media converter, LIU, etc. at **UF PLC side only** required for FO communication between new & existing PLC systems shall be in bidder's scope. However supply, laying of FO cable & establishment of communication shall be in RCF's scope. List of parameters to be communicated shall be mutually decided during engineering stage. Facility for accepting remote start / stop commands of motors & valves from existing WTP PLC system shall be provided.

e. One no. of Operator cum Engineering station shall be considered for control, monitoring includingreal &historical time trend with one number Printer (Laser JetColor) which will be placed in local control room in front of LCP.This station shall be placed in lockable metallic operator console having cooling fans with 1 no. ergonomically designed full backrest revolving operator chair.

f. All Field Instruments including control valves, safety valves, etc. shall be in fully installed condition on skid.

g. Signal cables from field instruments shall be routed to LCP though cable trays.Construction, foundation & erection of structural supports for trays & Aluminium cable trays shall be in bidder's scope.

2.2 The Contractor's scope of supply for Instrumentation and Control by seller shall comprise the design, engineering, manufacturing, testing, supply of complete Field Instrumentation and control system required for fail-safe startup, operation, control and shutdown shall therefore be the responsibility of the contractor. Contractor scope of supply shall consist of the following as minimum.

a) Preparation of general specification for Instruments

b) Sizing of flow instruments, control valves, pressure relief valves etc., and preparation of Technical data sheets for all Instruments.

c) Preparation of engineering and construction documents like functional schematics, I/O list for PLC based System, logic diagrams for interlocks as per ISA5.2 with functional descriptions, configuration diagram, electrical load list, cable schedule, cable tray/trench layout, instrument air requirement, nameplate schedule, JB schedule, instrument location layout, electrical instrument signal interface, instrument index, layout drawings, loop diagrams, primary and secondary sketches and bill of materials.

d) Preparation of all engineering documents for PLC like graphic schemes, instrument loop data base, log formats and any other documents necessary to carry out the system engineering, implementation, software testing, supply and final commissioning and site acceptance tests.

e) Preparation of specification for erection materials like cables, cable trays, pipe & pipe fittings, air tubing, junction boxes, air distribution pots etc.

f) Site supervision of construction, erection, testing and commissioning activities of field instrumentation and control room instrumentation activities.

g) Supply of all instruments, cable, cable trays, structural items for mounting cable trays, Junction box, cable glands, branch cable trays.

In case of contradiction / conflict among documents, Bidder shall refer to Owner for clarification. However, most stringent specification shall be followed with Owner's approval. Owner decision shall be considered as final.

3.0 CONTROL PHILOSOPHY

3.1 Design and installation of instrumentation shall comply with codes and recommendations listed in item 5.0.

3.2 Complete PLC with Controller (CPU), power supply module, communication module, I/O module, system busetc. and barriers/isolators, relays etc. shall be installed in the local control panel.

3.3 One no. of Operator cum Engineering station with 27" or more LED display shall beused as an operator interface with following functionalities.

i) Control / monitoring of all PLC parameters through graphic displays, faceplates, pop ups, etc. All latest techniques like animation, linking, drag drop, scripting, etc. shall be used for developing user interface.

ii) Alarms, events, real time & historical trending, etc. for analysis.

iii)System hardware & communication diagnostic information in graphical representation.

3.4 i) All engineering functions of PLC hardware configuration, communication interface & operator interface.

ii) Control / monitoring of all PLC parameters through graphic displays, faceplates, pop ups, etc. All latest techniques like animation, linking, drag drop, scripting, etc. shall be used for developing user interface.

iii) Alarms, events, real time & historical trending, etc. for analysis.

iv)System hardware & communication diagnostic information in graphical representation.

v) Modbus communication server / client parameter configuration.

vi) SOE, alarm, daily, shift, totalizer, custom report configuration & printing.

3.5 Specification for operator cum engineering station shall be as per Annexure-I.Operator station console shall be lockable and have proper cooling arrangement. The furniture (chair, table etc.) required for stations & printers shall be provided by bidder.

3.6 Controller loading shall not exceed more than 50% (hardware and software load of controller) in any case, after implementation of complete project and running at peak load. In case more controllers are required to meet 50% loading criteria, bidder to include additional controllers without any cost implication.

3.7 SOE shall be integrated to the proposed PLC based system.

3.8 Local control panel shall be RITTAL make, with 100 mm black powder coated metal base frame and with colour shedding of RAL7032 (Siemens Grey) and removable gland plates at bottom only. This applies to all types of instrument panels to be used in the whole project like various PDB, Electrical / Instrument panels etc.

3.9 There shall be 20% installed spares minimum 1, installed and wired capacity for I/O cards of each category in PLC based system, including all peripheral termination modules, prefab cables, Relays, Safety barriers, etc. 20% extra I/O counts above normal shall be considered.

3.10 All marshalling and system panels shall have minimum 20 % wired spare capacity for future expansion (should be possible with the same wiring philosophy.)

3.11 There shall be some signal exchange between the new PLC based system with the existing PLC system of WTP.

4.0 BASIS OF DESIGN

General

Instrumentation for the proposed Ultra filtration unit is to provide a highly reliable and comprehensive controland monitoring system. To facilitate these well-proven techniques shall be adopted for measurement and control.

The following philosophy is to be adopted.

1. For all ON-OFF type valves, Open & Close position feedback shall be wired to the system.
2. All control valves shall be provided with SMART valve positioner with valve position signal feedback connected to PLC system by 4 to 20 mA analog signal. It shall be HART compatible.
3. Trip/Auto diversion solenoids shall be normally in energised condition and shall be de-energised to initiate trip.
4. Air fail to open, Close or Hold of any control valve shall be as per Licensors document, to take care of process, plant and human safety. For Piston actuators necessary air volume chambers and lock up relay shall be provided to achieve thefail safe condition.
5. Universal HART Protocol with Latest Revision shall be used in all cases.
6. Wago/weidmuller/Phoniex/Klippon make screw terminal shall be used with single tier only.
7. All limit switches shall be proximity sensor type.
8. Cable entry to local control room shall be through MCT blocks.
9. No head mounted temperature transmitters shall be used.
10. Turbine flow meter shall not be used.
11. All Contacts shall be Gold Plated 2 SPDT.
12. Transmitters shall be used preferably rather than switches.
13. No Direct Process Switches (Pressure / Level/ Flow / Temp.) shall be used. However, if it’s not possible to install transmitter for particular application online pressure/level switches (float type) may be used if the need arise.
14. All field transmitters for pressure, d/p, level and flow shall be microprocessor based (dual compartment) SMART transmitters with “UNIVERSAL HART” protocol with latest revision. The transmitter selection shall be such that the operating maximum upper limit shall be around 70% of the total measurement range of the transmitter.
15. Ultrasonic non-contact type level transmitters shall be preferably used for Acid, Alkali, Chemical service.
16. For ON-OFF control application involving line sizes of 3 “ & below, Saunders / weir type valves shall be used. For more than 3” size, Butterfly type valves shall be used. Actuator for butterfly valves shall be quarter

turn, rack & pinion type. For all ON-OFF control valves, end stroke restrictors shall be provided.

17. Online pH & conductivity transmitters shall be with IP67 protection & SS316 flow through chamber.
18. All equipment/materials supply shall include spares required for 2 years operation and consumable for commissioning.
19. Inputs from thermocouples shall be provided with cold junction compensation and downscale burns out feature for high temperature shut downs and vice versa for low. A passive alarms shall warn about the burn-out.
20. Hardwired signals from MCC / Switchgear to interposing relays shall be potential free contacts.Interface JB for MCC to PLC shall be provided in the MCC room.

5.0 INSTRUMENTATION CODE AND PRACTICES

IEC13	Diagrams, Charts and Tables, Preparation of LogicDiagrams
IEC 534	Industrial - Process Control Valves
IEC 584	Thermocouples
IEC 605	Equipment Reliability Testing elements
IEC 611-12	Part 12 Graphical Symbols for Diagrams.Binary Logic
IEC 654	Measurement and Control equipment
IEC 751	Industrial Platinum Resistance Thermometer Sensor
IEC 801	Electromagnetic Compatibility for Industrial Process measurement and Control Eqpt.
IEC 848	Preparation of Function Charts for Control Systems
IEC 902	Industrial Measurement and Control Terms and Definitions
ISA S-5 .1	Instrumentation Symbols and Identification
ISA S-5.2	Binary Logic Diagrams for Process Operation
ISA S-5 3	Graphic Symbols for Distributed Control/Shared Display Instrumentation,Logic and Computer Symbols
ISA-S20	Instrumentation specification formats
ANSI/ISA S 5.1	Process Instrumentation Terminology
ANSI/ ISA S71.04	Environmental conditions
ANSI/ ISA S75.01	Control Valve Equations
ANSI/ ISA S75.02	Control Valve Procedure Capacity Test
ANSI/ ISA S75.03	Face-to-Face Dimensions for Flanged Globe Style Control Valve Bodies

ANSI/ FCI 70.02	Quality Control Standard for Control Valve Seat Leakage
BS 6020	Instruments for the Detection of Combustible Gases
DIN 3582	Screwed Plugs, Tapped Holes, with Whitworth Part 2Pipe Threads: General Outlay of Types
DIN 43760	Measurement Standard for RTD.
DIN 19243	Measurement and Control Electrical Sensors, ElectricalPositionSensors and Signal Converters used for Intrinsically safe two-wire DC System.
EN-50-014/020	Electrical Apparatus for Potentially ExplosiveAtmospheres
EN 54 Part I	Components of Automatic Fire Detection System Introduction.
EN 54 Part 5	Heat sensitive Detectors - Point Detectors containing a Static Element.
ISO 3511.1	Process Measurement Control Functions and InstrumentationRepresentation Part I: Basic requirements.
ISO 3511.2	Process Measurement Control Functions and Instrumentation RepresentationPart 2:Extension of Basic Requirements.
ISO 3511.4	Process Measurement Control Functions and Instrumentation RepresentationPart 4: BasicSymbol for Process Computer, Interface and shared Display/Control Systems.
ISO 4200	Plain End Steel Tubes, Welded and Seamless - General Table ofDimensionsand Masses per Unit Length.
ISO 5167	Measurement of Fluid by Means of Orifice Plates,Nozzles and Venturi Tubes Inserted in Circular cross-section Conduits Running Full.
API RP 520	Sizing, selection and Installation of Pressure relieving devices in Refineries
API RP 521	Guide for Pressure Relieving and Depressuring System
API S 670	Vibration, Axial-Position and Bearing-Temperature Monitoring Systems
API RP 2000	Venting Atmospheric and low pressure storage tanks
API-Chapter 5.4 :	Accessory equipment forliquid meters Manual of
Chapter 6.2	Loading rack and tank truck metering system
Chapter 6.6:	Pipeline Metering SystemsMeasurement
Chapter 12:	Calculation of StandardsPetroleum Quantities
2.1 & 12.2	Part 1 and 2
API-RP-550	Manual on Installation of refinery Instruments Part Iand Control System

ANSI - B 16.104	Control Valve seat leakage
ISA-S 75.01	Control Valve sizing
ISA S 18.1	Specifications and guides for the use of general Annunciators.
IEC529	Environmental Protectionofequipment
ANSI B 2.1	Pipe threads
ANSIB 16.5	Steel pipe flanges, flanged valves and fittings
IEC 79.11/	Intrinsic safety code and practice
IEC-79.14	International Boiler Regulation
IS 2148	Flameproof enclosure of electrical apparatus
IEC 61508	Functional Safety of Electrical, Electronic, Programmable Electronic Safety Related Systems
IEC 61511	Functional Safety of Safety Instrumented Systems for the Process Sector

6.0 AREA CLASSIFICATION & ELECTRICAL EXECUTION

6.1 Area classification for all instruments and instrumentation systems is safe area.

Electrical / Electronic instruments	IP 67
Sensors; RTD, T/C, etc.	IP 65
Local Gauges; PG, etc.	IP 55
Pneumatic instruments	IP 54
Solenoid valves	IP 67
Local Panel / Skid Mounted Panels	IP 55

EMC compatibility and electrical safety as per latest IEC standard.

6.2 Electrical instrument equipment shall be designed for and supplied as intrinsic safe certified.

Analysers, solenoid valves and other equipment that cannot be classified intrinsic safe shall be ex-proof in accordance with the above mentioned electrical specification.

Certification for installation in hazardous areas in accordance with IEC 60079 series is shown below:

Separate trays shall be used for multi-conductor cables for thermocouple wiring, 4-20mA wiring and alarm system and power circuits, which also will ensure the required segregation between high and low energy level circuits.

Transmitters, positioners, I/P converters, etc.:	Ex ib IIC T3
Switches:	Ex de IIC T3
Analysers and Panels:	Ex p IIC T3
Solenoid Valves:	Ex d IIC T3(Ex md not allowed)
Junction Boxes and Cable Glands:	Ex d IIC T3

7.0 ELECTRICAL SUPPLY

The electrical supply will be as follows:

Distributed Control System, trip system, and Control Room Instruments	: 115V AC
Solenoid Valves	: 110V AC
Local Panels	: 115V AC/24 V D.C
Local Illumination, equipment forair conditioning,space heaters,ventilation of localpanels andsimilar purposes	: 240V AC
Field-mounted Transmitters and switches	: 24V D.C.intrinsic safe
Safety Circuits	: 115 V AC

The 115V AC supply will be an uninterrupted power supply (UPS) of 115V +/- 10%, 50Hz +/- 3%. The supply will be made available from two UPS sources. Individual clients from the redundant pairs utilizing 115V, AC shall be sourced from separated UPS sources. The system shall be configured / wired such that, any one UPS failure shall not affect operation of the Plant.

Where 24V DC is needed, it will be generated by ~~local~~redundant rectifier units having high MTBF, which are part of the instrumentation supply. The power supply to these redundant units shall be taken from separate UPS sources.

8.0 FIELD MOUNTED INSTRUMENTS

In general, all field mounted electronic instruments shall be provided with IP-66 weather-proof and dust proof enclosures in accordance with the IEC 529 notation.

8.1 ANALYSERS

Liquid analyser, sample conditioning unit and other accessories shall be mounted on rack.

Silica Analyser shall be of HACH 5500sc with 4 channelssample input & inbuilt sequencer. Separate sequencer shall not be acceptable.

8.2 FLOW INSTRUMENTS

8.2.1 Flow Transmitter

D/P cells shall have measuring methods on the floating differential capacitance/ inductance or piezoelectric principle or silicon resonator principle. Bodies shall normally be in stainless steel with AISI 316 internals. Pressure elements in austenitic stainless steel are a requirement in hydrogen service. The transmitter shall be furnished with an output meter or gauge with a sq. rt. scale. Smart type transmitters will be used with Hart Protocol. All flow transmitters shall have sq. root extraction function. Process connection size shall be 1/2" NPT through Oval flanges. Integral 3 valve manifold shall be used.

8.2.2 Rotameter Types

Rotameter types may be used in pipe sizes from 2" and smaller. The meter shall be selected for normal flow at 50 to 60 % of the span. In applications with toxic or inflammable fluids, glass tubes must not be used except for low-pressure analyser sample flows. They may be used for severe corrosive services and fluid of high viscosity. The metal tube meters shall be of stainless steel, PTFE lined or any other suitable lining for the service. The indicator assembly shall be magnetically coupled and mounted with rotameter body.

8.3 PRIMARY DIFFERENTIAL PRODUCERS

8.3.1 Orifice Plates

Orifice plates of the square edged concentric type shall be specified except where unsatisfactory for the application. Materials shall normally be AISI 316 SS unless special materials are required for the service.

Orifice Plates dimensions and calculations shall be in accordance with ISO 5167-1980.

8.3.2 Nozzles

ISA 1932 Nozzles may be used in high and medium pressure steam and BFW piping. Materials shall normally be AISI 316 Alloy steel unless special materials are required for the service. Dimensions and calculations shall be in accordance with ISO 5167-1980.

8.3.3 Venturi Tubes

Venturi Tubes or nozzles per ISO 5167-1980 or similar type elements may be used to measure the flow of low-pressure gases or liquids where loss of pressure is an important consideration.

8.3.4 Pitot Elements

Pitot elements of the annubar type may be used where high accuracy is not required or the pipe diameter is too large for acceptable orifice plate design. Use of annubar shall be limited to combustion air, flue gas raw water and

fresh water services unless specifically indicated. The connection size shall be 1 1/4" NPT. For rating 300# and above the process conn. Shall be 2" flanged.

8.3.5 Local Flow Indicator

Motion balance (Barton cell type) differential pressure indicator shall be used for local flow indication. Body and internal shall be of SS 316. Process conn. shall be 1/2" NPT(F).

8.3.6 Mass Flow Meter

Coriolis type mass flow meter with local digital display of flow shall be used with straight/U-tube, material 316-sensing element.

8.3.7 Electromagnetic Flow Meter

Electromagnetic flow meter with ceramic/teflon lining shall be used for the measurement of flow with high accuracy for highly viscous & corrosive services.

8.4 LEVEL INSTRUMENTS

8.4.1 For chemical tanks & open pits, non-contact ultrasonic type level transmitters shall be used. For closed water tanks, smart DP transmitters shall be used.

8.4.2 LEVEL GLASSES

8.4.2.1 Gauge Glasses

Glass type level gauges shall not be used. Magnetic type level gauges with hermetically sealed followers shall be used for level indications.

Level gauges shall be supplied with a pair of off-set shut off valves with ball check.

For cold services the temperature is below 0 deg C, a non-frosting extension will be used.

8.5 PRESSURE INSTRUMENTS

8.5.1 Pressure Transmitters

Pressure Transmitters and differential pressure transmitters shall be modern inherent motion-free type of the floating differential capacitance/piezoelectric/silicon measurement principle. Bodies shall normally be in stainless steel with pressure elements in AISI 316. Pressure elements in austenitic stainless steel is requirement in hydrogen service. Two valve integral manifold of 316 SS material in general shall be used with pressure transmitter. Smart type transmitters will be used HART protocol.

Overall accuracy for Smart Transmitter shall be ± 0.075 % or better. Process connection shall be 1/2" NPT.

8.5.2 PRESSURE GAUGES

8.5.2.1 Gauge

Gauges for process and utility service shall be the modern industrial S.S. Bourdon gauge type with the case in stainless steel. The gauge shall preferably be a safety type with solid front where pointer and glass are partitioned off from the bourdon type by a solid disc as per IS. Pulsation dampeners shall be installed with the gauges where pulsating pressure occurs. Process connection shall be 1/2" NPT (M). Blow out disc shall be provided for all gauges except for Instrument Air service. Accuracy shall be ± 1 % or better. Dial size:150 mm.Vendor shall also provide the gauge valves.

8.5.2.2 Pressure Elements

Pressure elements shall normally be of low carbon stainless steel. Special elements such as diaphragms and bellows can be selected who are more suitable for the service than bourdon tubes.

8.5.2.3 Pressure Switch

Pressure switches shall be used for alarm, interlock, sequence system and will have electric switches DPDT with Hermatically sealed contacts rated for 1 Amp, 24 V dc and contacts shall be gold plated. Process connection shall be 1/2" NPT(M). Sensor and all wetted parts material as a minimum shall be 316 SS. Casing material shall be Die cast aluminium.

8.5.2.4 Diaphragm Seal

Diaphragm seal of the filled type shall be used where plugging of the element may occur due to congealing and high viscous fluids or where suitable sensor material is not available in highly corrosive services.

8.6 TEMPERATURE INSTRUMENTS

8.6.1 Thermocouples

Thermocouples shall normally be the sheathed type with high purity magnesium oxide insulation. The hot junction shall be isolated from ground. Sheath diameter shall normally be 6 mm Inconel 600 sheath material shall be used for design temperature above 400 deg. C, whereas ordinary SS material can be used below 400 deg. C. The nominal wire diameter shall be approx. 0.19x sheath OD.

In general type K thermocouples shall be used. All temperature elements shall be duplex type. Skin thermocouples shall be provided for equipment like converter/ secondary reformer/ adiabatic pre reformer shell temperature measurement.

8.6.2 Resistance Temperature Probes

Resistance Temperature Probes shall be considered for applications where very narrow spans and high accuracy are required as well as low temperature service. They shall be 6 mm (1/4") stainless steel sheath type similar to the thermocouples and with a Pt 100 ohms (deg. C) element.

They shall be of vibration-proof element type.

8.6.3 Thermometers

Thermometers shall normally be bi-metallic, heavy duty, weatherproof (IP 65), any angle connected type with 150/100 mm dial as a minimum Case and stem shall be in stainless steel. Dials shall be of white, non-rusting metal with black figures.

8.6.4 Thermowells

Flanged thermowells shall be of 1 1/2" size. Screwed thermowells shall be of 1" NPT (M). Thermowell material in general shall be of AISI 316 SS.

8.7 CONTROL VALVES

Valve types shall be selected, pneumatic diagram/piston operated globe, ball or butterfly shall be selected taking into account such factors as piping, operating and design conditions, fluid being handled, range ability required, allowable leakage, noise and other special requirements. The valves shall have electro-pneumatic positioners.Valve seat leakage shall be in accordance with ANSI B16.104. Actuator shall be designed for Instrument air pressure of 3.5 Kg/cm2g. Volume Boosters (Fairchild / Fisher make) may be provided for ensuring faster response of the valve.

Actuator for rotary/butterfly valve shall be of Rack & Pinion type only.

Air - Piping and Fittings.

Air piping and fittings shall be in stainless steel with a min. tube size of ¼"OD. In case ¼" OD tube is not adequate, ½"OD tubes shall be used.

Seat Leakage shall be leakage class-IV or better.

Seat Leakage shall be chosen in accordance with process demands and safe operation of the plant and in accordance with ANSI B16.104-1976/FCI-70.2. Safety shut off valves must not be used in throttling service during normal operation.

8.8 PRESSURE RELIEVING DEVICES

8.8.1 Pressure Relieving Devices

All pressure Relieving Devices shall be sized in accordance with applicable local and national code requirements. Formulas shall be in accordance with API RP 520, 1990 and ASME Codes section VIII and I.

8.8.2 Nomenclature

Nomenclature used shall be in accordance with API RP 520.

8.8.3 Safety and Relief Valves

Safety and Relief Valves shall normally be direct spring loaded types. Balanced bellows valves shall normally be furnished for relief into closed flare and blow down systems, if the developed back-pressure exceeds 10% of the set pressure.

8.8.4 Rupture Discs

Rupture Discs may be used in lieu of or in combination with safety and relief valves, where applicable or required.

8.8.5 Pressure and Vacuum Relief Valves

Pressure and Vacuum Relief Valves for storage tanks shall normally be of the weight loaded or pilot operated type, and sized in accordance with API RP 2000 Tank Venting Code, or Local Codes if they govern.

8.8.6 Centre-to-Face

Centre-to-face dimensions shall be in accordance with API 526.

8.9 SWITCHES AND SOLENOID VALVES

8.9.1 Level Switches

Level switches shall normally be the external float cage type. Body material and rating shall conform to piping specifications. Internal trim shall be stainless steel unless other materials are required for service.

8.9.2 Pressure Switches

Pressure switches for direct connected process and utility service shall normally be diaphragm or bourdon tube type with materials suitable for the service. Connections shall normally be 1/2” NPT male. Micro switches shall be hermetically sealed.

8.9.3 Temperature Switches

Temperature switches mounted in the control room and in the locals panels shall be thermocouple actuated and be completely adjustable.

8.9.4 Flow Switches

Flow switches for direct operation by process fluids may be of the rotameter of paddle type for low accuracy requirements. Orifice plate and differential pressure type transmitter shall be used for high accuracy requirements and the switch shall be an electric analog switch. For alarm purpose, the switching shall be through DCS/PLC software.

8.9.5 Solenoid Valves

Solenoid valves shall normally be used as pilots to actuate other instruments/valves connected to the process. Protective enclosure shall be IP65. The coil insulation shall be of Class –H suitable for continuous operation in 85 deg. C ambient temperature (max. surface temperature in sun) for outdoor service. Body material shall normally be stainless steel& Orifice size shall be 9mm. Solenoid valves will be powered by 110V AC +/- 10%, 50 Hz +/- 3%

All switches and solenoid valves shall be ex-proof and shall meet the classification of the area in which they are installed and be fitted with 1/2" NPT (F) cable gland connection.

9.0 PNEUMATIC TRANSMISSION

9.1.1 Output Signal

Output signal from all pneumatic transmitters shall be 0.2-1.0 kg/cm2g.

9.1.2 Pneumatic Receiver Instruments

Pneumatic Receiver Instruments shall have receiver elements design for 0,2-1 kg/cm2g input signal.

9.1.3 Pneumatic Transmission Tubing

Pneumatic Transmission Tubing for local transmission shall be ¼" OD Stainless Steel tubing with stainless steel fittings.

9.1.4 Instrument Air

Instrument Air required is available at 6.5kg/cm2g and max. 70 degC. However, the air pressure can be down to 4.5 kg/cm2g for remote consumers. Design pressure is 10kg/cm2g.

Dew Point is - 40 deg. C at line pressure.

The air is oil and dust free.

Air distribution Headers shall be of SS 304.

10.0 ELECTRONIC INSTRUMENT SIGNAL WIRING

Electronic Instrument Signal Wiring shall be twisted pairs - 15 twists or more per meter. Conductors shall be 1.5mm2 for one and two pairs and 0.75 mm2 for multi-conductor cable and shall be stranded, tinned copper. Insulation shall have a minimum radial thickness of 0.25mm. Insulation of core to core shall withstand a r.m.s. AC test voltage of min. 2000V.

All cables shall be galvanised steel wire armoured under the PVC outer cover of a flame retardant, low smoke type (FRLS) in accordance with IEC 227.

Multi pairs shall be shielded with braided tinned copper wire. The temperature rating shall be min. 85 deg C. Each core shall be colour coded and/or numbered.

Cable and Multicore Cables for Solenoids etc.

Cables and multicore cables for such items as solenoid valves and flame detectors shall normally have a conductor size of 1.5mm2. However, conductor size for power cables shall be co-ordinated with the Electrical Group to avoid too many different cable types.

10.1 Thermocouple Extension Wires

Thermocouple Extension Wires shall be twisted pairs - 15 twists or more per meter. Conductors shall be 16 AWG for one 20 AWG for two pairs and multi-conductor cables. Conductors shall be solid and shall be galvanised steel wire armoured under the outer FRLS PVC cover. Individual pair cables and the individual pairs in multicore cables shall be shielded with braided tinned copper wire. Multicore cables shall also have a similar common shield.

Standard insulation is PVC with minimum temperature rating of 85 deg. C.

Each core shall be colour coded and numbered.

11.0 PROCESS CONNECTION(Refer Annexure- 3)

11.1 First tapping points for allpressure, d/p signals shall be 3/4” NPT. Mechanical piping scope shall be upto 1st isolation valve(s). Subsequent reduction to 1/2” size and impulse piping and connection shall be under the scope of instrumentation.

11.2 Wherever diaphragm seals have been used, the vessel or piping nozzle shall be 3” flanged. Flange rating shall conform to piping index.

11.3 All vessel or piping nozzles for temperature instruments shall be 1 1/2” flanged or 1” NPT(F) threaded.

ANNEXURE -1

SPECIFICATION FOR COMPUTER

Specification for computer DELL/IBM/HP make only.

These computers (latest configuration) should have as minimum, the following:

Dual Channel 10/100 Ethernet card.

DVD Rewriter Drive

Serial ports,keyboard,mouse, speakers for alarm annunciation, antivirus subscription , MS-office with life time validity

In addition to above, following requirements are also to be taken care,

CPU	:	Latest configuration (i7-10th Generation Or better)
Memory(RAM)	:	32 GB minimum
Cache	:	12 MB (min)
SSD capacity	:	>=1TB

Cooling Fans with dust filters : Yes

Mechanical & environmental specifications

Temperature	: 0-50 Deg C, operating
Humidity	: 60±5%,temp.27±3degC,noncondensing.
Vibration	: 5 to 17 Hz, 0.1" double amplitude displacement; 17to 500 Hz, 1.5G acceleration.
Shock (Operation)	: 10G acceleration peak (11 msec duration)
Safety	: UL approved
EMI	: FCC/VDE class A
CE compliant	: YES
Safety	: UL/CSA/TUV approved
Monitor	: Full color, Non-Interlaced,LED27” size

ANNEXURE -2

INSTRUMENT ACCURACIES

The instrument reference accuracies shall be as per the table below. Any deviation shall have prior approval of the Owner.

SR.NO.	DESCRIPTION	ACCURACY
1	Gas Monitors all types	5 %FS
2	Conductivity, pH meters	0.5 % value
3	Belt weighers	0.5 % range
4	Pressure, DP Transmitter	0.075 % of span (for 10:1 turndown)
5	Pressure, DP Transmitter rangeability	100:1
6	Pressure Gauges	1 % of span for Burdon type, 1.5 % of span for Diaphragm type.
7	Tank Gauging (Custody Transfer)	± 1 mm with ± 1 mm resolution
8	Other Tank Gauging	± 5 mm
9	Displacer Transmitter	± 10 mm
10	Temperature Gauge bimetallic	± 1 %
11	TT for Thermocouple, RTD	± 0.12°C
12	Orifice Plate: Normal Application	± 2 % of flow rate
13	Orifice Plate: Special Application	± 1.5 % of flow rate
14	Annubar, lines<10"	± 1 % of flow rate
15	Rotameters	± 2 % of flow rate
16	Vortex Meter	± 0.7 % of flow rate
17	Magnetic Flow Meter	± 0.5 % of flow rate
18	Positive Displacement Meter	± 0.25 % of flow rate
19	Ultrasonic Flow Meter	± 0.5 % of flow rate
20	Mass Flow Meter	± 0.25 % of rate
21	All Utility flows for guarantee runs	± 1 % or better

ANNEXURE-3

INSTRUMENT PROCESS CONNECTIONS

Instrument Devices	Vessel Or Tank	Piping Scrwd. Spec	Piping Flgd Or Sw	1st Block Valve	Instrument Connection	Vent And Drain Inst Connection	Remarks
Flow Instrument							
Flow dP Cells		1/2 Inch NPT	1/2 inch *	1/2 inch to Pipe Spec	1/2 inch NPT	1/2 inch NPT	* piping to provide ½"NPT M when valve is SW
dP Cells with remote chemical seals'	2 inch Flanged	2 inch Flanged	2 inch Flanged	2 inch Flanged	½" to 3" Flanged		
Variable Area Meter		Line Size	Line Size				
Averaging Pilot		1 ½ inch	1 1/2 inch	see Remarks			When hot tap is used use full sized ball valve
Flow Glasses		Line Size	Line Size				
Level Instrument							
Stand Pipes	2 inch Flanged			2 inch Flanged		3/4 inch NPT	Stand pipe size 2" or 3"
External Displaces / Guided Wave Radar	2 inch Flanged			2 inch Flanged	2 inch Flanged	3/4 inch NPT	
Internal Displacers	4 inch Flanged			4 inch Flanged	4 inch Flanged		
Internal Ball Floats	4 inch Flanged				4 inch Flanged		
Gauge Glasses	2 inch Flanged.			1 inch 2 inch*	1 inch 2 inch*	½ inch NPT	* For Magnetic type
Level Instrument with Remote Chemical seals	2 inch or 3 inch flanged	2 inch or 3 inch Flanged	2 inch or 3 inch Flanged	2 inch or 3 inch Flanged			
Pressure Instruments							
Pressure Gauges	2 inch Flanged	3/4 inch NPT	3/4 inch	3/4 inch	1/2 inch NPT	½ inch NPT	Except where 1" to Pipe Specification
Transmitters	2 inch Flanged	3/4 inch NPT	3/4 inch	3/4 inch to Pipe Spec	1/2 inch NPT	1/2 inch NPT	Except where 1"to Pipe Specification

Instrument Devices	Vessel or Tank	Piping Scr. Spec	Piping Fig or SW	1st Block Valve	Instrument Connection	Vent and Drain Inst connection	Remarks
dP Cells	2 inch Flanged	3/4 inch NPT	3/4 inch	3/4 inch to pipe Spec	1/2 inch NPT	1/2 inch NPT	Except where 1"to Pipe Specification
Pressure Instrument with Remote Chemical seals	2 inch or 3 inch flanged	2 inch or 3 inch Flanged	2 inch or 3 inch Flanged	2 inch or 3 inch Flanged			
Thermowell	2 inch flanged	1 ½ inch Flanged	1 ½ inch Flanged		1/2 inch NPT		
Analyzers	2 inch Flanged	2 inch Flanged	2 inch Flanged		Seller's std	Seller's std	

ANNEXURE-4

Units of Measurement and Accuracy of Instruments

The units of measurement, graduation of scales and charts shall be in accordance with the following table:

Measured variable	**Unit of measurement**	**Scale**
Temperature	deg Celsius	Direct reading
Pressure & Diff. Pressure	mm of WC, kg/cm2g,	Direct reading
Draft pressure	mm of H_2O	
Vacuum pressure	mm of Hg, mm of WC, kg/cm2a	-do-
Liquid flow Volume Mass	 M3/h Kg/hr, T/ D	 0-10 sq. root (DP cells) 0-100 linear
Gas flow Volume Mass	 NM3/hr, M^3/hr Kg/hr. T/ D	 - do -
Steam flow	Kg/hr, T/hr, T/ D	- do -
Level	% level, mm	0-100 linear / Direct
Vibration/Axial	mils	Direct
Analysers	%by volume or as specified	Direct
Density	Kg/m3,g/cm3	Direct
Conductivity	S/cm, u/cm	Direct
pH measurement	pH	Direct

SPECIAL NOTES:

1. **Bidder to note and understand the scope and technical requirement as specified in this document and as specified elsewhere in TENDER/NIT/ITB in totality.**
2. **For any clarification, bidder to raise queries before submission of BID, during Pre-BID meetings/queries, etc. and as per instructions given from time to time.**
3. **Documents are attached for reference purpose only, detailed and final documents shall be prepared and submitted by the bidder during detail engineering as well as approved PID and other related documents.**
4. **Bidder to note that the project has to be executed on LSTK basis with bidder being the single point responsibility for entire execution. It is responsibility of bidder to ascertained the quantum of Job involved and quote accordingly.**

PART II: TECHNICAL

SECTION – 3.7

DESIGN PHILOSOPHY – CIVIL & STRUCTURAL WORKS

INSTALLATION OF ULTRAFILTRATION UNIT AT RCF, THAL

REV	DATE	PURPOSE	PREPD	REVWD	APPD
0	14.07.2023	ISSUED FOR TENDER	AR	SA	RNS
P	26.06.2023	TENDER ISSUED FOR REVIEW	AR	SA	RNS

CONTENTS

CONTENTS

1.0 GENERAL SCOPE

1.1 The design considerations given here under establish the minimum basic requirements for civil-structural works for Lump-sum Turn-key (LSTK) contracts. This standard specification shall be read in conjunction with the Design philosophy documents from other department (Process, Mechanical & Electrical.etc) issued for the Job and Standard Specification for Material & Construction requirements.

1.2 This document defines the design philosophy & Brief scope of works under this Contract for Civil, Structural and Architectural Works for installation of ultrafiltration unit, RCF Thal and associated allied services within battery limit.

1.3 The scope of Civil, Structural and Architectural Works under this Contract shall include carrying out Micro-Grading & Leveling, Detailed Design, Drawings, Supply, Procurement of all materials, Construction, Demolitions, 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..

1.4 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.

1.5 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, abiding all relevant Indian Standards (Latest Revisions).

Water and Power for construction shall be made available by the Owner at single point within boundary.

1.6 SCOPE OF CIVIL STRUCTURAL AND OTHER ALLIED WORKS

The scope of work under this contract includes the complete civil and structural and other allied works associated with installation of ultrafiltration unit.

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

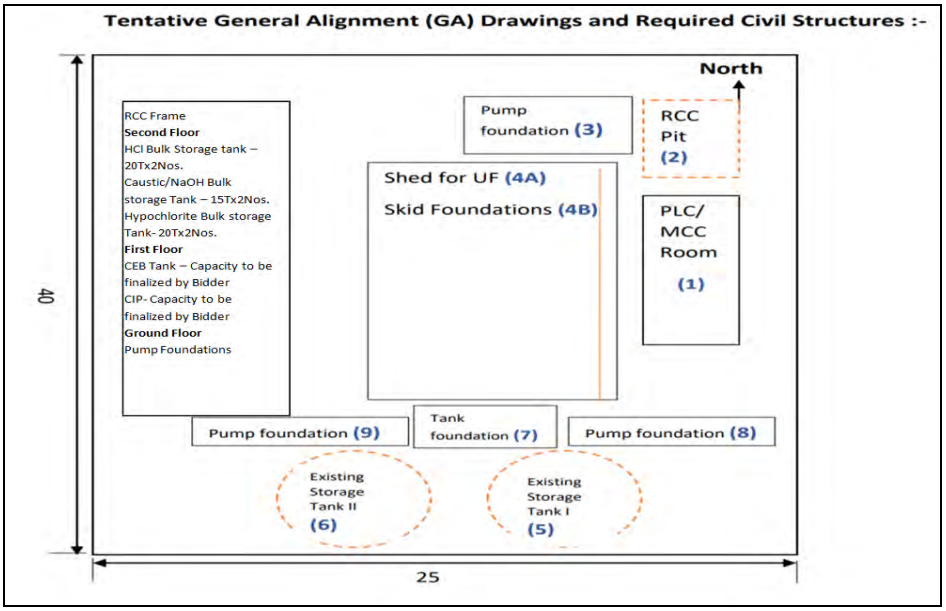
Consists of mainly but not limited to the followings:

1) Ultrafiltration skids to be covered under structural steel shed with Galvalume sheets (AZ-150 grade, TCT 0.7mm min.)and(Polycarbonate sheet-2mm thick)at intermediate

intervals. Structural steel members of Shed to be prefabricated, erected and fixed with bolted joint at site. The structural steel column fixed on RCC footings pedestal of (Required size as per structural design). Three sides of shed (West, South and North side) shall be covered with Galvalume sheets (AZ-150 grade, TCT 0.7mm min.) from top to bottom with1.0m clearance at bottom. East side UF Shed to be fully covered with Galvalume sheets (AZ-150 grade, TCT 0.7mm min.).

2) RCC structure (2 Floor) for chemical bulk storage tanks (For capacity, refer Process section) on second floor, Day tanks/measuring tanks (For capacity, refer Process section) on first floor and transfer, dosing pumps at ground floor.
3) New RCC single story Building for PLC/MCC.
4) RCC Foundation for all tanks, all pumps, UF skids within battery limit.
5) Dyke wall provision for Acid, Alkali and sodium hypochlorite tanks.
6) Storage Tanks, Neutralization Pit and MCC/PLC room to be located outside shed.
7) Acid Resistant Brick Lining for Acid proofing for UF & Drains.
8) Drains/trenches for within battery limit connected to neutralization pit. Drains to be covered with GI coated Gratings and Fixed between GI Coated Angle.
9) PCC flooring within battery limit.

Tentative General Alignment (GA) Drawings and Required Civil Structures :-



10) 1 no.- Existing RCC Pit(Owners scope).
11) 2 Nos. Pump Foundation for Effluent Transfer Pump. (Acid Proof)

12) 1No Shed for UF skids

13) RCC Foundations for Skid as per no of Skids

14) Existing DM Storage Tanks (Owners scope)

15) 1 No RCC Foundation for 100Cum capacity tank/Vessel.

16) 4 Nos Pump Foundations for Discharge pump

17) 4 Nos Pump Foundations for UF Feed pump.

18) 1 No RCC structure for:

Second floor -6 Nos of Storage Tank (Capacity mention in GENERAL DESCRIPTION OF PACKAGE), First Floor -3 Nos of Day Tank & Ground Floor 6 Nos of Pump Foundation Acid Unloading

1.7 BROAD PLANT DESCRIPTION

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

a) Engineering related to site leveling, Micro-grading & preparation.

b) Preparation of concept notes for design, engineering & construction.

c) Structural Analysis and design calculations as per specifications laid down in Civil Engineering Design Basis, enclosed in the tender. for all Civil works including but not limited to pile, pile-cap, foundation, plinth beam, RC superstructure, steel super structure, trenches, drains, pits etc.

d) General Arrangement and detail drawings for pile, pile-cap, foundations, plinth beams etc, based on the soil investigation carried out by the bidder for the proposed site.

e) General Arrangement and structural drawings at grade level showing foundations, extent of paving, trenches, drains, pits etc.

f) General Arrangement drawings for superstructure (RCC and structural steel) at all levels.

g) RCC drawings showing all necessary details for all foundations and structures.

h) Structural steel detail drawings for all steel structures.

i) Bar Bending Schedules for all RCC works.

j) Fabrication drawings with all details for steel structures.

k) Coordination with OWNER / PMC for various activities including approvals of design basis, concept note, drawings, material samples, laboratory test results etc.

l) Procurement of all items necessary for completion of scope of work.

m) Construction of all units / structures, items of work included in scope of work.

n) As built drawings & final documentation.

o) Obtaining Statutory Approvals.

p) Adherence to Quality Assurance Plan.

2.0 DETAILED SCOPE OF WORK

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.

2.1 SOIL INVESTIGATION

2.1.1 Geo-technical Investigation work has been carried out by the owner. However Bidder shall make his own assessment for the type of foundations envisaged based on his site visit and data collected from site during the site visit.

2.1.2 In any case, the Bidder has to carryout detailed Soil investigation after the award of contract and submit Soil investigation report with recommendations for Owner's review and approval. The recommendation given in approved final report becomes binding on the contractor. The Bidder is not eligible to increase his cost or demand any extension of time because the final report is in variance from preliminary report furnished by Owner.

2.1.3 The CONTRACTOR shall design and construct all foundations as per requirements with no extra cost to OWNER / Project Management Consultant (PMC).

2.2 TOPOGRAPHICAL / CONTOUR SURVEY

2.2.1 Topographical Survey work of proposed plant area is carried out by the owner. Topography drawing is attached as an **Annexure**-G to this document.

2.2.2 Before commencement of work / Contour Survey, the CONTRACTOR shall clear the site from all the debris lying on the site.

2.2.3 The CONTRACTOR shall establish the finished grade levels 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.

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

2.3 SITE DETAILS

2.3.1 GENERAL LOCATION OF THE SITE

Project site is geographically located in Thal, Raigad District of Maharashtra state.

2.3.2 SITE CONDITIONS:

Weather Conditions-

Mid October to March	- Mild cold (winter)
April to Mid-October	- Hot & humid (summer)
June to Mid-October	- Rainy (Monsoon)

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.

Finished Grade Level	- 100.00 m EL (existing ground level)
Finished Paved Level (Lowest)	- 100.15 m EL
Plinth Level	- 100.600 m EL
Road Crown Level (Internal roads)	- 100.15 m EL

Note: 100.00 M EL means elevation of existing ground level at respective locations which shall be corrected and connected to the actual level based on GTS.

Ambient conditions-

Atmospheric Pressure

Maximum	- 1007 mbar
Minimum	- 995 mbar

Design - 1006 mbar

2.3.3 RAINFALL

- Mean annual Rainfall - 2500 mm
- Heaviest in a day - 360 mm
- Design (1 hour) - 150.0 mm/hr

2.3.4 Temperature

Max °C - 40

Min °C - 12

Design / Humidity

Winter % relative - Min 50

Summer % relative - Max100

2.4 GRADING

The entire plant area has been developed during initial stage of plant construction.

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 LSTK Contractor shall perform earthwork, excavation and filling to arrive at finished grade level. For the purpose of grading the Contractor's Scope is not limited only to the unit battery limit, but to be extended upto the adjacent roads around the unit.

2.5 DISPOSAL OF SURPLUS EARTH

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

2.6 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.

2.7 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 arising discharge arising out of either rain water or fire fighting water.

2.8 CONTAMINATED RAIN WATER SYSTEM AND OILY WATER SEWER 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 oily water shall be pumped to Owner's Guard Pond. Details of Tie-in points at battery limit shall be provided during detail design stage.

2.9 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. Also same shall be mentioned in respective architectural / civil drawings issued by the contractor.

2.10 ACID / ALKALI PROOF LINING

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

2.11 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.

2.12 ENGINEERING AND CONSTRUCTION

Preparation of detailed design, drawings, testing, supply and construction of all civil, structural, architectural and other allied Construction works shall be in the scope of contractors work.

2.13 TRANSFER OF BENCHMARK

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

2.14 SIZING OF VARIOUS FACILITIES

Sizing, nos., location etc. of various facilities related to additional cooling tower 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.

2.15 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.

3.0 DETAILED ENGINEERING

3.1 GENERAL

3.1.1 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.

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

3.1.3 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.

3.1.4 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.

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

3.1.6 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.

3.1.7 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.

3.1.8 Design drawings of additional cooling towers 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.

3.1.9 The CONTRACTOR shall keep the OWNER / PMC informed of any major design revisions simultaneously in progress.

3.2 DESIGN CALCULATIONS

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

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

3.2.3 For structures, analysis and design shall be done on latest version of **Staad Pro Software.**

3.2.4 For other miscellaneous works, latest software's as necessary shall be used. Design calculations shall be done on A4 size sheet only.

3.3 DRAWINGS

3.3.1 The CONTRACTOR shall prepare

- Drawings for statutory approvals.
- Civil & structural design & construction drawings, architectural drawings based on the standard accepted practice and guidelines from PMC / OWNER.
- Scaffolding drawings for critical works and longer retention period.
- Bar bending schedules.
- Insulation / refractory schedule & drawings.
- Fabrication drawings.
- As-built drawings.

3.3.2 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, paving plans and revised contour plans. A0 size drawings can be used if necessary.

4.0 CONSTRUCTION

i) Construction of all civil and structural works including all material, labour, supervision, tools and tackles etc. shall be carried out by the CONTRACTOR.

ii) Procurement and supply of all materials viz. cement, reinforcement, structural steel etc. shall be in the scope of CONTRACTOR.

iii) 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.

iv) All materials and construction shall confirm to the specification given elsewhere in this document.

v) 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.

vi) The CONTRACTOR shall be responsible for obtaining the statutory approval from local authorities such as Inspector of Factories, Development Authorities, Municipal Corporation and other concerned authorities before starting the work.

vii) The CONTRACTOR shall ensure that the facilities are constructed in accordance with the APPROVED FOR CONSTRUCTION drawings and specifications.

viii) 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.

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

x) 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.

5.0 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 Quality Assurance Plan is attached for reference as **Annexure – D** and the contractor is obliged to follow it.

6.0 COMPLETENESS OF WORK/CONTRACT

i) 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, operational and durable as per latest IS standards.

ii) 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.

iii) 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, and 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.

PART II: TECHNICAL

SECTION – 3.7

DESIGN PHILOSOPHY – CIVIL & STRUCTURAL WORKS

ANNEXURE- A: CIVIL ENGINEERING DESIGN BASIS

(GENERAL CIVIL WORKS)

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**

1.	CCE	Chief Controller of Explosives
2.	TAC	Tariff Advisory Committee
3.	NFPA	National Fire Protection Association
4.	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. Whenever any reference to Bureau of Indian Standards (BIS)/ other code is made, the same shall be taken as the latest revision (with all amendments issued there to) on the notified date of submission of tender.

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

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: 8835 Guidelines for design of surface drains

IS: 11134 Code of practice for setting out of buildings

IS: 8640 Recommendations for dimensional parameters for industrial building

IS: 2502 Code of practice for bending and fixing of bars for concrete reinforcement

IS: 4926 Code of practice for ready mixed concrete

IS: 9012 Recommended practice for shotcreting

IS: 10262 Guidelines for concrete mix proportioning

IS: 4971 Recommendations for selection of industrial floor finishes

IS: 3483 Code of practice for noise reduction in industrial buildings

IS: 2065 Code of practice for water supply in buildings

IS: 1641 Code of practice for fire safety of buildings (general): General principles of fire grading and classification

IS: 1642 Code of practice for fire safety of buildings (general): Details of construction

IS: 1644 Code of practice for fire safety of buildings (general): Exit requirements and personal hazard

IS: 12456 Code of practice for fire protection of electronic data processing installation

IS: 3935 Code of practice for composite construction

IS: 11384 Code of practice for composite construction in structural steel and concrete

IS: 15988 Seismic Evaluations and Strengthening of Existing Reinforced Concrete Buildings – Guidelines

IS: 1346 Code of practice for waterproofing of roofs with bitumen felts

IS: 9918 Code of practice for in-situ waterproofing and damp-proofing treatment with glass fibre tissue reinforced bitumen

IS: 1200 (Part 1 to 28) - Methods of measurement of building and civil engineering works.

IS: 13592 Unplasticized Polyvinyl Chloride (PVC-U) pipes for soil and waste discharge systems inside buildings including ventilation and rainwater system

IS: 14333 High density polyethylene pipe for sewerage.

IRC: 15 - Standard Specifications and Code of Practice for Construction of Concrete Roads.

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

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

1. Statutory regulations
2. Job specifications
3. Engineering design basis
4. Standard specification

2.0 DESIGN CRITERIA –GENERAL

2.1 Site Grading

2.1.1 The grading of the area shall be done by cutting and filling with the following:

1. Cutting Area : Thoroughly rolled and compacted.

2. Filling Area : Compacted in layers not exceeding 20cm to achieve minimum 95% of maximum dry density

2.1.2 **Slope in Graded Areas (Between various grades)**

1. General Site Grading : 1 in 500 to 1 in 1000
2. Micro grading, after completion of major construction (for road corridors) : 1 in 200

2.2 **Roads**

2.2.1 All roads surface shall be prepared in accordance with Section-16 of CPWD Specifications & designed in accordance with IRC 37 (Latest revision) for crossing of drains, pipes, cable trenches etc; suitable culverts shall be provided. The culverts shall be designed for class `AA' loading and also checked for class `A' loading in accordance with IRC.

2.2.2 Road Width

Category	Width	Carriageway Width
i. Road for crane movement	9.0m	7.0m
ii. Main road	7. 0m	5.0 m (two lane)
iii. Secondary road	6.0 m	4.0 m

2.2.3 Camber : 1 in 50

2.2.4 Pavement Type : RCC pavement at all roads to be used for crane movement (Requirement of crane movement route and its specification to be finalized in consultation with OWNER /PMC)

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

2.2.6 Clearance : Minimum 6.0 m underside of pipe racks.

2.2.7 **Crossings (As per Design)**

a. Pipe Ways under roads & rails	:	RCC Box Culverts
b. Storm Water Culverts Under road / rail	:	RCC Box Culverts
c. Electric / Instruments Cable road with PVC pipe Class –	:	RCC duct bank

1 (IS 4985)		

2.3 **Concrete Paving (Within Plant Areas)**

2.3.1 **General**

RCC paving shall be laid in cast-in-situ panels of 3.0 meter X 3.0 meter size with expansion joints, each panel being cast in a single pour.

Hard stands should be designed and provided by CONTRACTOR, based on required crane capacity. Here called for by OWNER, the same shall be demolished after erection, and surface made good.

Provision of trenches, drains, sealing of trench covers, inserts, thickening for pipe /equipment supports etc. shall be made while construction pavements, as detailed in drawings.

Acid / alkali / chemical resistant coating as required shall be applied in areas where such corrosive materials are likely to come in contact with concrete.

Suitable drainage arrangements will be provided within curbed areas around pumps, for drainage leaks. Similarly, suitable drainage arrangement shall be provided at streaming points also.

Finish of 50 thick concrete screed, with non metallic (Quartz based) hardener topping shall be provided on paving after erection and commissioning of equipment is over.

2.3.2 **Joints**

Expansion joints & Contraction joints shall be as per relevant IS Codes applicable

(Latest revision with all amendments issued there to).

2.3.3 **Slope : 1 in 100 (minimum)**

2.3.4 Minimum requirements of paving in various areas

1. Paving within Process & Utility areas for maintenance compatible to crane movements / dropout / Loading / Unloading areas /Vehicular movement areas : Type – I (150 mm thk. RCC)
2. Non vehicular movement areas
   a. Unit : Type –II (100 mm thick RCC)
   b. Utilities : Type –II (100 mm thick RCC)
3. Pipe rack : PCC 1:4:8 (75 thick)

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

2.4 **Storm Water Drainage**

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

Minimum width of drains: 300 mm (depth > 300mm)

Run off coefficient 'K'

			Run off coefficient 'K'
1.	Paved Area		
	– concrete	:	1.0
	– bituminous	:	0.9
2.	Unpaved Areas	:	0.7
3.	Unusable Areas Like Green Belt	:	0.4

2.4.2 **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 provided in floor paving. These drains shall be covered by gratings (galvanized M.S) and shall be generally connected to peripheral storm water drains. Drains shall be designed for the maximum of rainwater / firewater on same principles as storm water drains.

2.4.3 **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 wheel / track loads on the soil adjacent to wall on crossing shall be considered on the walls. Approval from the rail authorities on culvert design shall be in the scope of CONTRACTOR.

Drain 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.

2.4.4 **Disposal of Storm Water**

Storm water drains shall not be combined with oily waste sewer / contaminated effluent rain water system, etc.

First flush of run-off water shall be recovered in the Chemical effluent sumps. Volume shall correspond to the first 15 minutes of Max. rain fall flow. Last incoming water shall overflow to the outfall of storm water network. Clean rain water shall be drained by appropriate (RCC) Channel up to the Battery limit of plant.

2.5 **Water Supply**

Bidder should developed water supply network within plant with integration to existing overall system. Detailed drawings & layout for the same should be submitted.

2.6 **Sanitary Sewers**

2.6.1 **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.

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 0.75 m/s and velocity 2.4 m/s respectively. Velocity shall be calculated by Manning's formula with n=0.015

Minimum pipe size shall be 100 mm and all pipes shall preferably be PVC - U of SWR grade (Confirming to IS: 13592).

2.6.2 Sanitary sewer shall be led into waste water treatment plant (WWTP).

2.6.3 Cover for Sewer Line shall be minimum 600 mm wide.

Under road, sewer shall be protected by concrete encasement or minimum cushion shall be 1200 mm.

Under railway, the sewer shall be protected as per railway standards.

2.6.4 **Material of Construction**

a. Material of Construction for Manholes shall R.C.C. M30.

b. Material of Construction for Sewer

Sanitary Sewer

i.	Toilet block to inspection	:	PVC-U pipes (SWR grade) Conforming to IS:13592
ii.	Gravity main & lateral	:	PVC-U pipes (SWR grade) Conforming to IS: 13592
iii.	Pressure pipe	:	RCC pipe
v.	Manholes	:	R.C.C. M30

2.7 **Contaminated Effluent Sewers**

2.7.1 Process Unit

Contaminated effluent shall be collected through catch basins located in the contaminated areas of the process unit and shall be send to RCC catch pits or Contaminated effluent sewer header and finally to the RCC effluent pond where these shall be treated. Treated effluent should be collected in RCC pond for recycling.

Contaminated effluent sewer system shall be designed for contaminated water due to rain water or Fire water, whichever is more.

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.

The manholes shall be R.C.C.(M30) construction. For trapping of gas or prevention of spread of fire 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.

Contaminated effluent sewers in process units and hydrocarbon tankage areas shall be of mild steel /carbon steel conforming to IS: 3589

2.8 Storage Tank Foundation and Dyke Walls

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

Tanks less than 2.5m dia. may rest directly on a concrete pedestal with anti corrosive layer.

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

For tanks greater than 10m dia, Tank Pad Foundations shall be provided.

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

2.9 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 flushed 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.

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PART II: TECHNICAL

SECTION – 3.7

DESIGN PHILOSOPHY – CIVIL & STRUCTURAL WORKS

ANNEXURE-B: CIVIL ENGINEERING DESIGN BASIS (STRUCTURAL)

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 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

1.	CCE	Chief Controller of Explosives
2.	TAC	Tariff Advisory Committee
3.	NFPA	National Fire Protection Association
4.	IS	Indian Standards
5.	Owner	RCF
6.	Consultant	To be finalized
7.	LSTK contractor	Successful LSTK Bidder of The Tender

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.

The main codes and 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 & reinforced concrete

SP:34 Handbook on concrete reinforcement and detailing

IS:800 Code of practice for general construction in steel

IS 801 Code of practice for use of cold formed light gauge steel structural members in general building construction.

IS:802 Code of practice for use of structural steel in overhead transmission line towers

IS:806 Code of practice for use of steel tubes in general building construction

IS:816 Code of practice for use of metal arc welding for general construction

IS:875 Code of practice for design loads

IS:1080 Code of practice for design & construction of shallow foundations on soil

IS:1161 Specification for steel tubes for structural purpose

IS:1597 Code of practice for construction of stone masonry

IS:1838 Filters for expansion joints

IS:1893 Criteria for earth quake resistant design of structures

IS:1904 Code of practice for design and construction of foundations in soils, General requirements

IS:1905 Code of practice for structural use of un-reinforced masonry

IS:2185 Concrete masonry units

IS:2629 Recommended practice for hot dip galvanizing of iron and steel

IS:2633 Methods for testing uniformity of coating of zinc coated articles

IS:2911 Code of practice for design and construction of pile foundations

IS:2950 Code of practice for design & construction of raft foundations

IS:2974 Code of practice for design & construction of machine foundations

IS:3370 Code of practice for concrete structures for storage of liquids

IS:4091 Code of practice for design and construction of foundation for transmission line tower and poles

IS:4326 Code of practice for earthquake resistant design and construction of buildings

IS:4925 Specification for Concrete Batching and Mixing Plant

IS:4991 Criteria for blast resistant design of structures for explosions above ground

IS:5249 Determination of dynamic properties of soil

IS:6403 Code of practice for determination of bearing capacity of shallow foundations

IS:6745 Method for determination of mass of zinc coating

IS:8009 Code practice for calculation of settlements of foundations

IS:9595 Recommendations for metal arc welding of carbon and carbon manganese steel

IS:11089 Code of practice for design and construction of ring foundation

IS:12118 Two parts polysulphide based sealant

IS:13920 Code of practice for ductile detailing of reinforced concrete structures subjected to seismic forces.

National Building Code (Latest)

Factory Rules (Latest)

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

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 Specifications

1.5 MATERIALS OF CONSTRUCTION

Type of Structure	Materials of Construction
COOLING TOWER CELL	TIMBER
BASIN	RCC
FOUNDATION	RCC

2.0 Design Loads

The following design loadings shall be considered:

1. Dead loads including self weight
2. Live load
3. Wind load
4. Seismic load
5. Equipment load
6. Dynamic load
7. Load from lifting appliances
8. Erection loads / maintenance loads
9. Thermal load
10. Earth pressure / Hydrostatic Loads
11. Any other load not mentioned above, but applicable

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

2.1 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

Staircase (steel)	:	140 kg/m²
Ladder	:	40 kg/m²
False ceiling	:	60 kg/m²
Heavy duty tar felting	:	30 kg/m²

2.2 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.

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.

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.

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.

Special Considerations

1. Bundle Pull

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

a. Fixed type - Nil
b. Kettle type - 0.30 × Bundle weight
c. All other types - 0.86 × Bundle weight or 30 N/mm of diameter

Whichever is greater

Total Bundles Pull shall be considered on fixed pedestal alone

2. 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 taken 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

3. 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 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.

2.3.2 **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.

2.3 **Live Loads**

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.

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

Operating area	-	5.0 kN/m²
Maintenance area	-	7.5 kN/m²
Ground floor	-	10.0 kN/m²

2. Compressor House/TG House

Operating area	-	7.5 kN/m²
Maintenance area	-	7.5 kN/m²
Ground floor	-	10.0 kN/m²

3. Service Platform

Vessel / Tower	-	3.0 kN/m²
Isolated platform (for valve operation)	-	2.5 kN/m²
Access way	-	2.5 kN/m²
Cross over	-	2.0 kN/m²
Piperack walkways	-	2.5 kN/m²
Gantry girder walkway	-	3.0 kN/m²

4. Substation / Control Room

Panel floor	-	10.0 kN/m²
Miscellaneous partition	-	1.0 kN/m²
Other areas	-	5.0 kN/m²

5. Office building

Office area	-	3.0 kN/m²
Entrance lobby	-	5.0 kN/m²
Exit way	-	5.0 kN/m²
Miscellaneous partition	-	1.0 kN/m²
Document Storage area	-	10.0 kN/m²

6. Laboratory

Upper floors	-	4.0 kN/m²
Ground floor	-	5.0 kN/m²

7. Cooling Tower

Operating platform /cover Slab of hot water basin & Sump	-	3.0 kN/m²

8. GT Building / DM Plant /ETP

Operating platforms	-	3.0 kN/m²
Ground floor	-	5.0 kN/m²

9. Staircase

Process Building	-	5.0 kN/m²
Technological structure	-	5.0 kN/m²
Office	-	5.0 kN/m²
Substation/Control Room	-	3.0 kN/m²
Laboratory	-	4.0 kN/m²
Service platform	-	2.5 kN/m²

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, 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.

2.4 Wind Loads

Wind loads for structural design shall be as per IS-875 (Part-3) (Latest Revision).

2.5 **Seismic Loads**

Seismic loads shall be as per IS: 1893 (Latest Revision).

2.6 **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.

2.7 **Contingency Loads**

2.7.1 **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.

2.7.2 **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:

1. Platform Walkways 3 kN
2. Secondary Floor Trimmers 5 kN
3. Primary / Grid beams 10 kN

2.8 **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 and 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).

2.9 **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
	$DL + LL + EL_O$
	$DL + LL + EL_O \pm WL$

OPERATING	DL + EL_O ± WL
	0.6 X (DL + EL_O) ± WL
	DL + EL_O + LL ± SL
	DL + EL_O ± SL 0.6 X (DL + EL_O) ± SL
ERECTION	DL + EL_e ± WL
	0.6 X (DL + EL_e) ± WL
TESTING	DL +EL_t ± WL
	0.6 X (DL + EL_t) ± WL

B) FOR CONCRETE DESIGN

LOAD CONDITION	LOAD COMBINATION
OPERATING	1.5 X (DL + LL + EL_O)
	1.2 X (DL + LL + EL_O ± WL)
	1.5 X (DL + EL_O ± WL)
	0.9 X (DL + EL_O) ± 1.5 X WL
	1.2 X (DL + EL_O + LL ± SL)
	1.5 X (DL + EL_O ± SL)
	0.9 X (DL + EL_O) ± 1.5 X SL
ERECTION	1.5 X (DL + EL_e ± WL)
	0.9 X (DL + EL_e) ± 1.5 X WL
TESTING	1.5 X (DL + EL_t ± WL)
	0.9 X (DL + EL_t) ± 1.5 X WL

C) FOR STRUCTURAL STEEL DESIGN

LOAD CONDITION	LOAD COMBINATION
OPERATING	DL + LL + EL_O
	0.75 X (DL + LL + EL_O ± WL)
	0.75 X (DL + EL_O ± WL)
	0.75 X (DL + EL_O + LL ± SL)
	0.75 X (DL + EL_O ± SL)
ERECTION	0.75 X (DL + EL_e ± WL)
	0.8 X (DL + EL_e)
TESTING	0.75 X (DL + EL_t ± WL)
	0.8 X (DL + EL_t)

The design shall be governed by worst load combinations.

3.0 DESIGN CRITERIA FOR FOUNDATIONS

3.1 General

Foundation sizing shall be based on working loads without any factor.

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.

3.2 **Shallow Foundations**

3.2.1 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

3.2.2 For transient loadings, such as wind / seismic, allowable net bearing capacity based on shear criteria may be considered.

3.2.3 For load combinations including wind/Earthquake, the Safe Soil Bearing Pressure may be increased by 25%.

3.2.4 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

3.2.5 **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.

3.2.6 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	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
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.

3.3 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 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, behaviour 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.

3.4 Machine 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 1/100th 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.

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

a) Operating speed of the motor / turbine

b) Operating speed of the machine

c) 2 x Operating speed of the machine

d) 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 machine are sitting on building floors, approved damping pads shall be used with prior approval of 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.

3.5 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. Minimum grade of reinforced

concrete shall be M25. For underground & water retaining structures, such as, manholes, cooling tower etc. M30 grade reinforced concrete shall be used.

3.6 **Foundation Bolts**

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

3.6.2 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.

3.6.3 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.

3.6.4 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.

3.7 **Pedestal Heights**

Building plinth	:	450 mm above finished ground level
Pedestals for structural columns:		
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

3.8 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 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.

3.6 Design Criteria for Reinforced Concrete Structures

3.9 General

1) All buildings, structures 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.

2) Only limit state method as per IS:456 shall be followed for the design unless otherwise specified elsewhere in this document for special structures.

3) All skeletal structures shall be of frame type construction, and detailing shall be as per provision of IS:13920.

4) 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.

3.10 Liquid Retaining R.C.C. Structures and Basements

3.10.1 All liquid retaining / storage R.C.C. structures shall be leakpoof 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.

3.10.2 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.

3.10.3 The walls and base slabs of liquid retaining storage structures shall be provided with reinforcement on both faces for thicknesses greater than 150 mm.

3.10.4 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 riffed/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.

4.0 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 & water retaining structures, such as, cooling tower etc and except for grade slabs / paving for which M20 may be used 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 Condition
	Minimum cement content (kg/m³	Maximum water-cement ratio	Minimum cement content (kg/m³	Maximum water-cement ratio	
53 Grade-OPC	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 and to be coated with 3 mm thick bitumen emulsion.

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.

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 and to be coated with 3 mm thick bitumen emulsion.

4.1 **Reinforcement Bars**

High yield strength deformed TMT steel bars of grade Fe500D conforming to IS: 1786 shall be used. The Minimum dia. shall not be les than 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.

4.2 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
Raft thickness in raft foundations with beam & slab construction	:	300 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 Liquid retaining / Leak proof structures, Underground Pits	:	125 mm
Walls	:	150 mm
Base slab with beams	:	200 mm
Base slab without beams	:	300 mm

4.2.1 MINIMUM COVER TO REINFORCEMENT

Minimum clear cover shall be provided to all steel reinforcement as per IS:456 & IS:3370. The following minimum clear cover shall be provided to all steel reinforcement including links.

- Slab (roof & floors, canopy, cantilever, waist slab) : 30 mm
- 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 : 50 mm
  in contact with earth
  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

4.3 **Expansion Joints**

Concrete structures

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

4.4 **Deflections**

4.4.1 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 deflection due to all loads including the Effects of temperature creep and shrinkage : Span/250
- Crack width (for non-liquid retaining structure) : 0.3 mm
- Total horizontal deflection between two floors : Storey height/200

4.5 **Miscellaneous Applications**

4.5.1 **Admixtures**

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

4.5.2 **Plinth protection**

Each building shall be provided with 1.0 m wide concrete M15, 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 to be provided along-with plinth protection which shall be connected to the drainage system.

4.5.3 **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.

4.5.4 **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.

4.5.5 **Masonry Wall**

a) 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.

b) All brick masonry (M 7.5 grade) walls shall be considered as 230mm 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 (M7.5 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 half masonry wall shall be provided with reinforcement consisting of 2 Nos. of 8mm diameter bars at every fourth layer.

4.5.6 **CRITERIA FOR MASONRY WORKS**

4.5.6.1 **General**

All masonry works shall be designed in accordance with IS:1905, IS:1597, IS:2185, IS:4326 and other relevant IS Codes as applicable. All external brick, stone and hollow concrete block masonry walls shall be of minimum 230, 350 and 250 mm thickness respectively. ES 2516, enclosed with the tender may be referred for details. Masonry shall be plastered with CM 1:6, 12 mm thick on inside surfaces and 20 mm thick on outside surfaces.

4.5.6.2 **Cement Mortar**

All masonry work shall be constructed in 1:6 cement sand mortar except half brick partition walls which shall be constructed in 1:4 cement sand mortar with 2 nos.8mm dia. M.S bars provided at every fourth course properly anchored with cross walls or pillars.

5.0 DESIGN CRITERIA FOR STEEL STRUCTURES

5.1 General / Design Methods

5.1.1 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 200º 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 º C. The structures connected to column, heater vessels working at high temperatures shall not be rigidly connected with staircase and adjoining structures, which are on ambient temperatures.

5.1.2 Crane gantry girders shall generally be of welded construction and of single span length. Chequered plate shall be used for gantry girder walkway flooring.

5.1.3 Steel staircases shall have channels provided as stringers with minimum clear width of 1000 mm. The vertical height between successive landings shall not exceed 4.0 meters. Treads shall be minimum 250 m wide made of grating (with curved chequered plate nosing) spaced equally so as to restrict the rise to maximum 150 mm. If relevant local by-laws or applicable Factory Act Rules stipulates more stringent requirements in this regard, the same shall be adhered to.

5.1.4 Electro-forged galvanized MS gratings grating shall be minimum 30 mm deep. The maximum size of voids in the grating shall be limited to 34 mm x 65 mm. The minimum

thickness of galvanizing shall be 86 microns. Gratings shall be suitable for the operation and maintenance loads for the floors.

5.1.5 Bolted connections shall be adopted as far as practicable, except for cases where welded 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

5.1.6 Lock nuts shall be provided for anchor bolts of tall structures, tall process columns, vibrating equipment, etc.

5.1.7 Minimum two nuts shall used for all anchor bolts except for ladder, stair and hand rail.

5.2 **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.

5.3 **Steel Grade**

Structural steel shall be of yield stress of 250 Mpa conforming to grade B of IS:2062. Tubular steel shall conform to Yst 310 of IS:1161 & 4 IS: 4923.

5.4 **Limiting Permissible Stresses**

Permissible stresses in structural members shall be as specified in various codes.

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

5.5 **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	:	L/200
– Under (dead load + live load) or (dead load + wind Load) conditions	:	
– Other structural components	:	As specified in relevant IS, Where "L" represents the span
– The limiting permissible horizontal deflection for multistoried steel structure/ building including flare stack	:	Height/325

5.6 Minimum Thickness

5.6.1 Structural Components

The minimum thickness of various structural components (Hot rolled 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 : 3 mm.

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

6.3.1 Building Slabs on Grade

The specifications given in Table-1 shall be followed.

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

TYPE I: Plant 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.

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

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

6.3.2 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.

PART II: TECHNICAL

SECTION – 3.7

DESIGN PHILOSOPHY – CIVIL & STRUCTURAL WORKS

ANNEXURE- C: CIVIL ENGINEERING DESIGN BASIS (ARCHITECTURAL WORKS)

1.0 General

1.1 Scope

The design philosophy defines the minimum design requirements and procedures for carrying out architectural design, Interior design, Furniture 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

CCE	:	Chief Controller of Explosives
TAC	:	Tariff Advisory Committee
NFPA	:	National Fire Protection Association
IS	:	Bureau of Indian Standards
Owner	:	RCF
PMC	:	To be finalized

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:

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.
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:

1. Statutory Regulations
2. Job Specifications
3. Engineering Design Basis
4. 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.

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

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 :

1) Activities, group of activities and consequent work-flow pattern.
2) Site conditions i.e., dimensions, contours etc.
3) Climatic conditions vis-à-vis orientation.
4) Safety regulations.
5) Lighting and ventilation.
6) Acoustics.
7) Services
8) Security
9) Economy
10) Aesthetics
11) Any specific requirement pertaining to particular buildings
12) All other established architectural design parameters.

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 favourable working environment.

Some of the functional spaces are Control room, Plant Manager's Cabin, Training room, etc.

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.

1) Corridors & passages.
2) Staircases
3) Elevator
4) Entrance lobby / Foyer including Reception & waiting
5) Gangway / walkways
6) Equipment loading / unloading platforms
7) Emergency Exits

2.2.1.3 **Amenity Spaces**

Following spaces are classified as amenity spaces:

1. Toilet (Gents & Ladies)
2. Drinking Water Facility
3. Locker & Change Room
4. Bath room & wash room
5. Pantry

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. These spaces shall be provided as per required building services. Following are examples:

1) Air-conditioning plant room.
2) Air handling rooms.
3) Pressurization blower plant room.
4) Electrical distribution panels rooms.
5) Service ducts
6) Firefighting equipment room.
7) UPS room.
8) Battery room
9) Store Room - Process.

2.2.1.5 **Sizes of Spaces**

Sizes of various types 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:

1)	Minimum area of any habitable room	=	9.5 m^2 with minimum dimension restricted to 2.5 m
2)	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.
3)	Maximum ht of habitable rooms	=	As stipulated by the local bye-laws
4)	Scale of accommodation for industrial work spaces	=	@ 14 m^3 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:

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

Following architectural norms shall be adopted:

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

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

2.2.2.2 **Ventilation**

A. Natural Ventilation

Established level of ventilation in terms of air changes per hour shall be maintained for all spaces. Following references shall be adhered to for the purpose:

1) National Building Code of India, Part-III, Section-1
2) IS:3101 (industrial buildings), IS:3362 (residential buildings); IS:7662(Part-I)
3) State Factories Rules
4) Any other relevant rules / Codes etc.

Natural ventilation shall also be supplemented by mechanical or electrical means of ventilation in all areas of habitation. Sufficient no. of Glazed / Louvered windows / ventilators shall be provided and supplemented by exhaust fans. Non- electrical Turbo ventilator of S.S. make of required size shall be provided in sufficient numbers over roof of all sheds of the entire scope of work.

B. Mechanical Ventilation

In addition to natural ventilation, if required mechanical or electrical ventilation shall be provided depending on the type of building and its use. Other relevant design basis shall be referred for its requirement and applications.

2.2.3 **Acoustics and Sound Insulation**

Specified acceptable noise level and reverberation time shall be maintained inside a building / shed. Following references shall be referred to for the purpose:

1) National Building Code of India
2) State Factory Rules
3) Limitations on decibel level stated elsewhere, if any, in the bid document

Required noise level in any space shall be maintained by means of

1) Segregating noise sources by buffer zones
2) Dampening of noise levels by damping devices
3) Providing Acoustic treatment with acoustic material (on walls, ceilings, floors, as required).

2.2.4 **Safety Requirements**

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.

1) National Building Code of India, Part-IV
2) State Factories Rules
3) Any other relevant rules / codes

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:

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

Drinking water provisions, including one number water cooler per area 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.

2.3.2 **Electrical Services**

This service shall be provided as essential service for all buildings / 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 wiring should be concealed. 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 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 fulfilment 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:

1) Preliminary Drawings including perspective views indicating architectural treatment minimum three different alternative proposals shall be submitted for OWNER's approval.
2) 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 brick masonry, RCC work etc. required for such changes / modifications shall also be added.
   a) Building / shed shape and features
   b) Canopies, overhangs & shading devices
   c) Gutters
   d) Entrance / exit steps, door
   e) Window / Ventilator composition
   f) External wall location with respect to columns
   g) Colour scheme, grooves in plaster
   h) Spatial arrangement
   i) 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.

1) Sub Station Building
   – Cable cellar floor : Highest paving point+ 500 mm
2) Transformer bay : Highest paving point + 800 mm
3) False floor areas (Control Room) : Highest paving point + 450 mm + Height of false flooring (min 800 mm)
5) Other Buildings / Shed (Process Operator's Cabin) - Highest paving point +450 mm from surrounding ground level.

2.5.3 Steps / Ramps

Steps / ramps shall be provided for access to the buildings / sheds for pedestrian /vehicles movement, equipment entry, etc. Minimum 1250 mm wide platform shall be provided in between entrance door and steps / ramps. Following dimensions of the steps / ramps shall be adhered to:

1) Tread	:	300 mm minimum

2)	Riser	:	150 mm maximum
3)	Slope of ramp	:	Not steeper than 1:10 slope
4)	Ratio of tread & riser	:	2 Riser + Tread = 600 to 650 mm
5)	Landing width	:	1000 mm minimum
6)	Flight width	:	1000 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

a)	Rain water duct / shaft	:	Min. 230 mm thick Brick wall
b)	External walls	:	300 mm thick CC block wall
c)	Fire wall (Around transformers)	:	200 thick RCC or 355 mm thick (including plastering) brick wall as per Electrical requirements. (OISD/IER/TAC)
d)	Internal partition wall	:	230 mm thick brick wall depending on the overall length and height of the wall (refer notes below)

2.5.5 **Doors**

Doors shall be provided for access, security and safety to all rooms, functional areas in a building with all safety closures as per the requirement of OWNER. 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:

1)	Equipment, Panel area	:	Maximum size of equipment including packing
2)	Other areas	:	Volume of movement through door
3)	Minimum door size at entrance	:	1500 mm x 2500 mm (masonry opening size)
4)	W.C. bath Cubicle door	:	800 mm x 2100 mm (masonry opening size)
5)	Minimum size of other doors	:	1000 mm x 2100 mm (masonry opening size)

2.5.6 **Windows / Ventilators**

Windows / ventilators shall be provided in all areas for natural lighting, ventilation, and visibility of working level with all safety closures as per the requirement of OWNER. For the purpose of ventilation, total open able 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 shall be provided. Areas accommodating panels /

equipment shall be normally provided with ventilators at high level for uniformity distributed lighting.

2.5.7 **Canopy / Overhang**

RCC Canopy / Overhangs shall be provided at all entrances for rain / sun protection, accentuation of the entrances, and pedestrian movement as per the following schedule:

1) For all offices, control rooms, composite buildings / sheds accommodating offices, canopy shall be provided at all entrances. Size of the canopy shall be decided based on vehicle parking & pedestrian movement in addition to aesthetics of the building / shed. Bottom of canopy shall be minimum 2800 from top of drive way.
2) Overhangs shall be provided over all exits. Size of the overhang shall be decided on the aesthetics of the building / shed subjected to minimum of 1000 mm.

Control rooms shall not have any projections on outer face of its walls except with false treatment for aesthetics of the building.

2.5.8 **Shading Devices**

RCC Shading devices shall be provided over all windows, open able ventilators for rain & sun protection. These devices shall be in form of horizontal projections, vertical projected fins or combination of both as per building façade treatment. Minimum projection shall be 600 mm.

2.5.9 **Parapet**

Parapets shall be of RCC for all buildings with minimum 500 mm high for non-approachable roof and 1100 mm high for approachable roof.

2.5.10 **Roof Gutter**

Gutter with rainwater pipes shall be provided for inclinedroof buildings / sheds for roof water drainage. Sizing of the gutter shall be based on areas to be drained and number of outlets. Gutters shall be of PVC or FRP sheet for steel structures and RCC for Concrete structures.

2.5.11 **Rain Water Pipes, Spouts**

PVC 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. PVC spouts may be used for drainage of chajja / small canopies of ground floor. Diameter of rain water pipe shall be 150 minimum.

2.5.12 **Entrance Lobby**

Entrance lobby shall be Air lock and provided only for pressurized and air conditioned areas/buildings.

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. Stairway in a single run shall have the same slope. The vertical rise of the stairways shall not exceed 2.5 m for single flight. Following dimensions for staircases shall be adhered to:

a)	Stairs width	:	1500 mm minimum, (1000 mm minimum for emergency exit)
b)	Tread	:	270 mm minimum
c)	Riser	:	150 mm maximum
d)	Ratio of tread & riser	:	2 Riser + Tread = 600 to 650 mm
Number of risers for single flight shall be restricted preferably to 12 depending on occupancy.			

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.

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 / coloured type.

2.5.19 **Partitions**

Brick masonry partition wall shall be provided for control building. If required, partitions may be provided for flexible space arrangement in office spaces.

2.5.20 **False Ceiling**

1) Various types of ceiling Board/Tiles are available from various Manufacturers. Providing and fixing tiled false ceiling of 8 mm thick partially perforated calcium silicate board made with Calcareous & Siliceous materials reinforced with cellulose fibre manufactured through autoclaving process to give stable crystalline structure with minimum compressive strength 225 kg/ sq. cm, bending strength 100 kg/sq. cm , of size 595x595 mm, having perforation of dia. 10 mm with minimum perforated area 18 % with nonwoven tissue on the back side, having an NRC (Noise Reduction

Coefficient) of 0.85 of size 595x595 mm in true horizontal level, suspended on interlocking metal grid of hot dipped galvanized steel sections (galvanized @ 120 grams/ sqm, both side inclusive) consisting of main "T" runner with suitably spaced joints to get required length and of size 24x38 mm made from 0.30 mm thick (minimum) sheet, spaced at 1200 mm center to center and cross "T" of size 24x25 mm made of 0.30 mm thick (minimum) sheet, 1200 mm long spaced between main "T" at 600 mm center to center to form a grid of 1200x600 mm and secondary cross "T" of length 600 mm and size 24x25 mm made of 0.30 mm thick (minimum) sheet to be interlocked at middle of the 1200x600 mm panel to form grids of 600x600 mm and wall angle of size 24x24x0.3 mm and laying false ceiling tiles of approved texture in the grid including, required cutting/making, opening for services like diffusers, grills, light fittings, fixtures, smoke detectors etc. Main "T" runners to be suspended from ceiling using GI slotted cleats of size 27 x 37 x 25 x1.6 mm fixed to ceiling with 12.5 mm dia and 50 mm long dash fasteners, 4 mm GI adjustable rods with galvanized butterfly level clips of size 85 x 30 x 0.8 mm spaced at 1200 mm center to center along main T, bottom exposed width of 24 mm of all T-sections shall be pre-painted with polyester paint, all complete for all heights as per specifications, drawings and

As directed by Engineer-in-charge.

False ceilings shall be provided for following purposes:

2) To reduce room volume and hide ducting etc. for air conditioned spaces.
3) To maintain acoustic level inside any space.
4) To reduce habitable room, corridor, lobby, toilet heights located in high ceiling building / shed to a reasonable and satisfactory height of minimum 3000 mm.
5) 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.

2.5.21 Under deck Insulation

Underdeck insulation below RCC roof and over false ceiling (both locations) shall be provided for air-conditioned office / space.

2.5.22 False / Cavity flooring

False / cavity flooring, consisting of cement filled flooring sheets with antistatic lamination 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.

Providing and fixing of cavity flooring system constructed with 610 x 610 mm panels, consisting of zinc aluminium alloy dye cast jack heads, capable of taking specified load (1200 kg/sq.m.) with m.s. jack pedestals made of 25 mm dia. M.S. rods (hot dipped galvanised and galvanising thickness of 50 microns) of 800 mm high (maximum), having two nuts for level adjustment upto 50 mm, alongwith 150 mm x 150 mm x 6 mm thick base plates welded to them and fixed on RCC floor with 4 nos. 6 mm dia. anchor fasteners/ wedge bolts and araldite at bottom, and 40 mm x 40 mm x 3 mm cold rolled M.S. channels to be fixed on jack heads, floor top is made of 35

mm thick NOVATEAK or its equivalent super phenol formaldehyde bonded particle with edges of the floor panel being covered by 4 mm thick rigid black PVC edging/lipping and with floor surface finished with 2 mm thick MICLAM or its equivalent high pressure laminated rough textured matt finished, having fire-resistant, antistatic and high abrasion resistance and providing 26 gauge aluminium sheet on bottom of floor panel complete as per specifications and direction of Engineer-in-Charge. (Each board panel has to be marked with proper identification number for facilitating removal and refixing at subsequent dates).

2.5.23 **Waterproofing on roofs**

Waterproofing on roofs shall be of either by membrane / chemical compound, as directed by engineer in charge

3.0 Building Structure

The design considerations, type of buildings and specifications of various buildings shall be as generally defined under this clause, unless stated otherwise as per plant requirements:

Sl. No.	Building	Design Consideration	Type of Building
1	Operators & Maintenance building	Rack layout, occupancy	RCC structure as per relevant standard/ codal requirements including C.C. block masonry infill walls
2	Control building	Equipment layout, occupancy	RCC blast proof wall
3	Substation	Equipment layout, occupancy	RCC frame, C.C. block masonry infill walls
4	Compressor shed	Equipment layout, occupancy	RCC frame, C.C. block masonry infill walls with steel roof truss painted as per painting specification with non AC High Impact Polypropylene Reinforced cement corrugated sheets roofing with well designed turbo ventilators.

4.0 Architectural Finishes (To be finalised in consultation with the client)

All the buildings shall be provided with Architectural finishes such as floor finishes, plastering & painting on walls & ceilings, doors / windows / ventilators, roof treatment, plinth protection, etc. as per approved makes.

4.1 External Finishes

4.1.1 External Walls – (To be finalised in consultation with the client)

1) Substation Room, Operator & Maintenance building
2) Control Room

4.2 Internal Finishes (To be finalised in consultation with the client)

4.2.1 Floor Finishes

1) Office area, & Sub station

2) Toilet, Drinking Water area
3) Circulation area (Corridor / Passage etc. except Entrance Lobby) of Sub station
4) False Flooring
5) Switch Gear, Cable Cellar, A.C. Plant Room, storage area
6) Battery Room
7) Acid resistant epoxy coating over IPS-flooring & 2100 high dado.

Note:

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

4.2.2 **Internal Wall Finishes (To be finalized in consultation with the client)**

1) Entrance lobby, Corridor lobby:
2) Office areas of Buildings:
3) Circulation areas (Corridor / Passage etc. excepting Entrance lobby) of Buildings
4) Rack Room, Office Rooms, Operators Room
5) Switchgear Room / Electrical Room
6) Battery Room
7) Acid resistant epoxy coating over cement plaster up to 2100 height. Plastic emulsion paint above 2100 height.
8) Toilet, Drinking water area

a. Internal Ceiling Finishes: (To be finalized in consultation with the client)

1) Toilet Electric Operator, Rack room, MCC panel room, UPS
2) Aluminum tray panel false ceiling.
3) Other areas which do not have false ceiling

4.3 **Doors, Windows & Ventilators**

4.2.1 **Doors**

1) All doors in Toilet / WC / Bath
2) Pressed steel frame, block board flush shutter with lamination on the both sides.
3) All doors of Electrical Room, A.C. Plant Room, Battery Room
4) Pressed steel frame with pressed steel shutter
5) Inside Control Room / Satellite Rack Room
6) Fire check door with 2 hours rating as required in perfect partition wall separating various fire zones.
7) All other door of Control Room / Satellite Rack Room / Sub station
8) Glazed, powder coated Aluminum door with decorative etching.

4.2.2 **Windows & Ventilators**

1) Windows / ventilators
Glazed, powder coated aluminum window / ventilator.

5.0 Miscellaneous

5.1 **Drawing**

5.1.1 Plant datum shall always be 100.00 Metres and it's correspondence to the reduced level with respect to the mean sea level shall be indicated in the "NOTES" (Unless it is already established).

5.1.2 Location co-ordinates shall be indicated on grids.

5.1.3 Reference drawings, notes, holds list, schedule of finishes including painting, door and window schedules, area statement, notes on plastering, key plan, were necessary, shall appear in the first drawing sheet of a building. Subsequent sheets can cover them by a reference to the first sheet.

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

5.1.5 False ceiling area shall be shown by hatching suitably.

5.1.6 False flooring area shall be shown by hatching suitably.

5.1.7 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 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.

5.2.3 Tile drops shall be indicated were 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 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 Gaps in floor cut outs shall be sealed with fireproof material for fire safety.

5.2.12 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 **General 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 RCC Flooring shall be done in panels, preferably in 3000X3000 size.

5.3.8 Parapet walls shall be at least 1100 mm high.

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 brick wall including its sealing.

PART II: TECHNICAL

SECTION – 3.7

DESIGN PHILOSOPHY – CIVIL & STRUCTURAL WORKS

ANNEXURE-D: TECHNICAL SPECIFICATIONS

FOR CIVIL, STRUCTURAL AND OTHER ALLIED WORKS

(ES-2516)

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. **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.

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 -875	Code of practice for design loads
IS -1893	Criteria for earthquake resistant design of structures
IS -3370	Code of practice for concrete structures for the storage of liquids
IS 10262	Recommended guidelines for concrete mix design
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
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 Fiber 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 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 meters 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. **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.

3.1.10 **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, or by blasting using only explosives and / or pneumatic hammers. In case of blasting, control blasting should be adopted depending on site conditions. For using explosives **CONTRACTOR** shall follow all provisions of Indian Explosives Act / Rules 1983, corrected / revised up to date.

3.1.13 In case of hard rock excavation to be carried out using explosives, **CONTRACTOR** shall obtain the written approval in advance.

3.1.14 The measurements for excavations shall be restricted and limited to minimum excavation line as per drawing for payment purposes.

3.1.15 Adequate protective measures shall be taken to see that the excavation does not affect or damage adjoining structures. **CONTRACTOR** shall take all measures required for ensuring stability of the excavation and safety of property and people in the vicinity. **CONTRACTOR** shall erect and maintain during progress of work, temporary fences around dangerous excavations at no extra cost.

3.1.16 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 0.50m^3.

3.1.17 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 0.25m^3.

3.1.18 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 and blasting or non-explosive materials viz. Acconex manufactured by A.C.C. Ltd. Specifications and instructions for use shall be as per manufacturer.

3.1.19 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 CONTRACTOR and without appeal.

3.2 **Filling**

3.2.1 Back filling of excavations in trenches, foundations and elsewhere shall consist of one of the following materials approved by **Engineer-in-Charge.**

1) Soil
2) Crushed sand
3) Hard-core
4) Stone/gravel

For back filling excavated earth can be used or good earth shall be taken from source upto10km.

3.2.2 Soil filling - Soil material shall be free from rubbish, roots, hard lumps and any other foreign organic material. Filling shall be done in regular horizontal layers each not exceeding 20 cm. depth.

3.2.3 Back filling around completed foundations, structures, trenches and in plinth shall be done to the lines and levels shown on the drawings.

3.2.4 Back filling around pipes in the trench shall be done after hydro testing is done.

3.2.5 Back filling around liquid retaining structures shall be done only after leakage testing is completed and approval of **Engineer-in-Charge** is obtained.

3.2.6 Sand used for filling under foundation concrete, around foundation and in plinth etc. shall be fine/ coarse, strong, clean, free from dust, organic and deleterious matter. The sand filling under foundation shall be rammed with Mech. compactor. Sand material shall be approved by **Engineer-in-Charge**.

3.2.7 Hard-core shall be of broken stone of 90 mm to 10 mm size suitable for providing a dense and compact sub grade. Stones shall be sound, free from flakes, dust and other impurities. Hard core filling shall be spread and levelled in layers, 15 cm thick, watered and well compacted with ramming or with mechanical / hand compacts including hand packing wherever required.

3.2.8 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.

3.2.9 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.

3.2.10 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 density : Not less than 1600 kg/m³
3. Plasticity Index : Not more than 20

3.2.11 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 90% of laboratory maximum dry density. A minimum of one test per 250 sq. meters of compacted area shall be done.

3.2.12 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.

3.2.13 All clods, lumps etc. shall be broken before compaction.

3.2.14 In case of grading/banking successive layers of filling shall not be placed, until the layer 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 - 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.

4.6 **Grades of Concrete**

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

4.6.2 A sieve analysis test of aggregates shall be carried out as and when the source of supply is changed without extra charge not withstanding the mandatory test required to be carried out as per CPWD specification.

4.6.5 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 CONTRACTOR under his own arrangements and at his costs, but under the supervision of the **Engineer-in-Charge**.

4.7 **Design Mix Concrete**

4.7.1 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, 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.

4.8.2 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 **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**.

4.8.3 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

4.8.4 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.

4.8.5 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
M 25	400 kg/cu m

4.9 **Testing of Concrete**

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

4.10 **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.

4.11 **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.

Pre cast concrete units, when ready shall be transported to site by suitable means approved by **Engineer-in-Charge**. Care shall be taken to ensure that no damage occurs during transportation. All adjustments, levelling and plumbing shall be done as per the instructions of the **Engineer-in-Charge**. CONTRACTOR shall render all help with instruments, materials and staff to the **Engineer-in-Charge** for checking the proper erection of the pre cast units.

After erection and alignment the joints shall be filled with grout or concrete as directed by **Engineer-in-Charge**. If shuttering has to be used for supporting the pre cast unit they shall not be removed until the joints has attained sufficient strength and in no case before 14 (fourteen) days. The joint between pre cast roof planks shall be pointed with 1:2 (1 cement : 2 sand) mortar.

5.0 STEEL REINFORCEMENT

High yield strength deformed TMT steel bars of grade Fe500D conforming to IS:1786 shall be used.

5.2 All joints in reinforcement shall be lapped adequately to develop the full strength of the reinforcement as per provision of IS: 456 or as per instruction of **Engineer-in-Charge**.

6.0 Form Work

6.1 The shuttering or form work shall conform to the shape, lines and dimensions as shown on the drawings and be so constructed as to remain sufficiently rigid during placing and compacting of the concrete and shall be sufficiently tight to prevent loss of liquid from the concrete. The surface that becomes exposed on the removal of forms shall be examined by **Engineer-in-Charge** or his authorized representative before any defects are made good. Work that has sagged or bulged out, or contains honey combing, shall be rejected. All shuttering shall be plywood or steel shuttering.

6.2 **CONTRACTOR** shall be responsible for sufficiency and adequacy of all form work. Centering and form work shall be designed & detailed in accordance with IS 14687 and approved by the **Engineer-in-Charge**, before placing of reinforcement and concreting.

6.3 **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	7 days

	2. Spanning over 4.5 m	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 stripling 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 BRICK WORK

This specification covers the construction of brick masonry in foundations, arches, walls, etc. at all elevations. The provision of IS: 2212 shall be complied with unless permitted otherwise.

7.1 Bricks

All bricks shall be of best locally available make and approved by OWNER/PMC Minimum compressive strength shall be 75 Kg/cm2.

7.2 Mortar

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

7.2.2 Sand for masonry mortar shall be coarse sand 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.

7.2.3 Mix of mortar for building brick work shall be as specified in the item of work.

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

7.3 Brick Masonry

Brick work shall be built in English bond, unless otherwise specified. The thickness of joints shall be 10 mm $\pm$ 3 mm. Thickness of joints shall be kept uniform. In case of foundations and manholes etc. Joints up to 15 mm may be accepted.

7.4 Half Brick Masonry

All courses shall be laid with stretchers. Reinforcement comprising 2 Nos.8 mm dia MS bars shall be provided over the top of the first course and thereafter at every third course.

7.5 Fixtures

All iron fixtures, pipe 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.

7.6 Curing

Brick work shall be protected from rain by suitable covering when the 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.

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.

9.0 PAINTING ON STRUCTURAL STEEL

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

9.1 Surface Preparation

The surfaces to be painted shall be sand blasted to Sa - 2.5 as per Swedish Standard SIS 05-59-00. Air used for sand blasting must be dry and oil free. Sand used for sand blasting shall be good quality river sand suitable for achieving the required surface finish. For optimum results pressure of sand blasting gun should be maintained at around 7 kg/cm^2 and maximum height of profile should be kept around 50 microns. Sand blasted surfaces must be coated with primer within 4 hrs in dry climate. Moreover it is not advisable to carry out sand blasting when humidity exceeds 85% (RH).

9.1.2 Painting system :

For chlorinated rubber paint:

Primer P2 - 2 coats - finish paint FP2 - 2 coats. Where P2 is high chlorinated zinc phosphate primer having DFT of 50 microns per coat and FP2 is chlorinated rubber based paint having DFT of 50 microns per coat.

9.1.3 All the surfaces must be sand blasted and 2 coats of primer plus 1 coat of finish paint applied in the 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:

1. Washing with clean water (pressure 7 kg/cm^2) using suitable nozzles. During washing broom corn brushes shall be used to remove foreign matters.
2. Solvent washing if required to remove traces of oil grease etc.
3. 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 premiered surfaces caused during erection are done up.

   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.

   After touch up work is over as indicated above, all the surfaces shall be given one coat of finish paint to the required specification.

9.1.4 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.

   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.

   Painting materials must be used before the expiry date indicated on the containers.

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), **CONTRACTOR** shall be required to apply extra coat (s) to achieve the desired DFT without any extra cost to **Engineer-in-Charge**.

Colour shade for each coat of primer and finish paint must be different to identify the coats without any ambiguity.

Shade for the final finish coat shall be decided by **Engineer-in-Charge** at site.

All painting materials must be accompanied by manufacturers test certificates. However, **Engineer-in-Charge** has any doubt regarding quality of materials, he shall have the right to direct **CONTRACTOR** to get the doubtful material tested or and provided (by **CONTRACTOR**) testing agencies for which no extra payment shall be made to **CONTRACTOR** and the charges shall deemed to be covered in the unit rates quoted for fabrication and erection of structural work.

DFT for paint shall be measured at least 20 points and mean DFT shall not vary by more than 10% than specified in DFT.

Instrument for measurement of DFT shall be arranged and provided by **CONTRACTOR** at his cost.

Thickness of each coat shall also be checked regularly to ensure uniformity in DFT.

9.1.5 Sand blasting and painting works, being a specialized job must be carried out through the approved agencies only.

9.1.6 **Equivalent Chart for Various Paint Manufacturers for chlorinated rubber paint:**

	ASIAN	**G & N**	**SHALIMAR**	**J & N**	**BERGER**	**BOMBAY**
P2	ASIOCHLOR HB ZINC PHOSPHATE PRIMER	NEROLAC PHOSPHATE PRIMER	CHLOROKOTE ZINC PHOSPHATE PRIMER	JENSOLAC CR PRIMER	LINOSOL HB ZINC PHOSPHATE PRIMER	KANGAROO HB ZINC PHOSPHATE OR HEMPATEX PRIMER 1632
FP2	ASIOCHLOR CF 625	NEROLAC CR PAINT	CHLOROKOTE FINISH	JENSOLAC CHLORINATD. RUBR. PAINT	LINSOL CHLORINATED RUBR.PAINT	PENTACHLOR GP ENAMEL 5638

10.0 Steel / Aluminium Doors, Windows and Ventilators

10.1 The Steel doors, windows and ventilators shall be of the size and type as per IS-1361 and IS-1038. Fixing and glazing shall be done as per IS-1081 and as per manufacturer's instructions. The putty of approved make such as special gold size or equivalent conforming to IS-419 shall be used.

10.2 Aluminium doors, windows and ventilators shall be manufactured from wrought aluminium and aluminium alloy extruded round tube and / or hollow rectangular /

square sections conforming to IS: 1285 & IS : 6477 or equivalent as approved by **Engineer-in-Charge**.

11.0 **ROOFING & CLADDING**

For roofing & cladding Non-asbestos high impact Polypropylene reinforced cement 6mm thick corrugated sheets (as per IS:14871) roofing upto any pitch and fixing with polymer coated J or L hooks, bolts and nuts 8mm dia. G.I. plain and bitumen washers or with self drilling fastener and EPDM washer.

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 toping, the surface shall be soaked with water at least for 12 hours and surplus water mopped up immediately before the toping 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 toping, 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.

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.** Nothing extra shall be paid on this account.

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 GLAZING

14.1 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.

14.2 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.

15.0 PROTECTIVE COATING AND LINING SYSTEM

15.1 **ACID PROOF TILES:-**

A. 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:

- Al_2O_3 : 22-24%
- SiO_2 : 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 °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^{o}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.

15.2 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 polymer (Epoxy Phenolic) Thickness 60 micron per coat	Primer coat on Concrete surface
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

15.3 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 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^{o}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
5.	Bituminous Paint (Primer)	Concrete surface

SL. NO.	DESCRIPTION	ITEM OR AREA
6.	10mm Bitumastic Laying in two layers each shall not be more than 5 mm thick	Over Bituminous Paint
7.	One layer, 5mm Acid, K-based Silicate Type mortar	#
8.	One layer, 40mm 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

16.0 CULVERT WORK

16.1 Pipe Culverts

16.1.1 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.

16.1.2 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 pipes shall be tested hydraulically as per IS: 783. Refilling of trenches shall not be commenced until the entire length of the pipe has been tested and approved. The excavation of earth in trenches for laying the concrete pipes and refilling shall be done as per IS: 783.

16.2 Box Culverts

16.2.1 The box-culverts are to be provided across the roads joining the storm water drains on both sides of the road. These box-culverts shall be of either complete reinforced cement concrete construction or brick masonry and reinforced cement concrete construction as specified in the schedule of items. The box-culvert construction shall be carried out as per the approved drawings.

PART II: TECHNICAL

SECTION – 6.0

DESIGN PHILOSOPHY

FOR

CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

ANNEXURE-D1

TECHNICAL SPECIFICATIONS

FOR BORED CAST- IN- SITU CONCRETE PILES

(ES-2516)

TABLE OF CONTENTS

1.0 SCOPE

1.1 This specifications cover the installation of bored cast-in-situ reinforced concrete vertical piles. Installation of bored cast-in-situ concrete vertical piles shall also conform to IS: 2911 (Part-1/Section-2).

1.2 This specifications also covers the technical requirements for load test (Initial and Routine tests) on reinforced concrete single vertical piles of to assess their vertical, horizontal and pull-out load carrying capacity.

1.2.1 Load tests on piles shall conform to IS: 2911 (Part-4).

2.0 GENERAL REQUIREMENTS

2.1 The work shall include mobilization of all necessary equipments, providing necessary engineering supervision through qualified and technical personnel, skilled and unskilled labour, etc. as required to carry out the complete piling work, load tests and submission of records / reports as per schedule.

2.2 The Contractor shall guarantee the "Safe Load" capacity of piles for various modes i.e., vertical, lateral and pull-out loads for piles installed by him.

2.3 Consequent upon award of work and prior to installation of piles, the Contractor shall submit design of piles in terms of allowable capacity, length, diameter, termination criteria, reinforcement, etc. for Owner's/ Consultant's approval. Owner's/Consultant's approval on pile design in no way absolve the Contractor for his responsibility to carry out all the initial (vertical, lateral and pull-out) load test of piles prior to installation of the job piles. The pile capacity to be used in design shall be arrived at from the initial load test of piles.

2.4 The Contractor shall make his own arrangements for locating the co-ordinates and position of piles shown in approved drawings and for determining the Reduced Levels (R.L) of these locations with respect to the single bench mark indicated by the Engineer-in-Charge. Two established reference lines in mutually perpendicular direction shall be indicated to the Contractor. The Contractor shall provide at site all the required survey instruments to the satisfaction of the Engineer-in-Charge so that the work can be carried accurately according to specifications and drawings.

2.5 In case of working piles, if the pile rejected due to any reasons, attributable to contractor the Contractor shall install extra piles at no extra cost to the Owner / Consultant. Further, the extra cost due to the increase in the pile cap size, if any, on account of extra piles shall be borne by the bidder.

2.6 It is essential that all equipment and instruments are properly calibrated both at commencement and immediately after the tests so that they represent true values. Certificates to this effect from an approved institution shall be furnished to the Engineer-in-Charge. If the Engineer-in-Charge so desires the contractor shall arrange for having the instruments tested at an approved laboratory at his own cost and the test report shall be submitted to the Engineer-in-Charge. If the Engineer-in-Charge desires to witness such tests Contractor shall arrange to conduct the test in his presence.

2.7 The complete jacking system including the hydraulic jack, hydraulic pump and pressure gauge shall be calibrated as unit. The complete unit shall be calibrated over its complete range of travel for increasing and decreasing loads same as that of test loads. The calibration certificate shall be submitted to the Engineer-in-Charge.

2.8 The reaction load to be made available for the test shall be at least 25 % greater than the maximum jacking force. The reaction system as relevant shall be designed for the total reaction load. All reaction loads shall be stable and balanced during all operations of testing. During testing, stability of reaction system shall be ensured.

2.9 The load applied on the pile shall be measured by a calibrated pressure gauge mounted on the jack with a least count of not more than 10 % of the safe load.

2.10 The displacement of pile (In vertical, horizontal and uplift) shall be measured using dial gauges having a least count 0.01 mm.

2.11 Load test shall be conducted at pile cut off level (COL). If the water table is above the COL the test pit shall be kept dry through out the test period by suitable dewatering methods.

2.11.1 In case of initial vertical load test where the water table level is higher than the COL Contractor may use reaction piles for testing purposes in each case.

Engineer-in-Charge may at his discretion decide to rise the COL above water table.

2.12 Full details of the equipment proposed to be used and the test setup with detail sketches shall be submitted to the Engineer-in-Charge, before making arrangement to carry out the tests, for his approval. Approval of the Engineer shall also be obtained after the test set up is complete prior to commencement of loading.

2.13 All operations in connection with pile load test shall be carried out in a safe manner so as to prevent the exposure of people to hazard.

2.14 If any test has to be discontinued, which in the opinion of the Engineer-in-Charge interferes with the load test results, and he decides to abandon the test, the Contractor shall install another pile for the purpose and repeat the test after correcting the fault and the cost of all such operations, including the cost of test pile, shall be at the Contractor's expense.

2.15 After completion of piling work contractor shall submit four copies of the following documents for Owners record and future reference:

a. Initial load test data for all tests done along with the pile data and the analysis of the initial test results.

b. Pile data along with concrete mix design detail (note pile data shall contain details as per requirement of Annexure- A).

c. Routine load test data for all tests done.

d. A full record giving all details of test in the Performa shown in Annexure- B shall be submitted in triplicate to the engineer immediately on completion of each test. The record shall also include the plots of:

   i. Load VS. Settlement

   ii. Time VS. Settlement (for each increment of load)

   iii. Characteristic of the piles and the interpretation of the pile load test curve as per the criteria for safe loads as mentioned in the specification.

2.16 Before commencement of the work, the Contractor shall submit Quality Assurance Plan to the Owner/Consultant for their approval.

3.0 CODES AND STANDARDS

3.1 All standards and codes of practice referred to herein shall be the latest editions including all applicable Amendments issued.

3.2 All works shall be carried out as per the relevant Indian Standard Codes. In case of conflict between the specification and the IS codes referred to herein, the former shall prevail. Some of the applicable Indian Standards and codes are referred to here below:

IS: 432(Part I&II)	Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.
IS: 456	Code of Practice for plain and reinforced concrete.
IS: 1786	Code of practice for twisted steel high strength deformed bars for concrete reinforcement.
IS: 2911(Pr-I&II)	Code of practice for design and construction of pile foundations- Bored cast-in-situ concrete pile.
IS: 2911(Part-IV)	Code of practice for design and construction of pile foundation Load test on piles.
SP-34	Handbook on concrete reinforcement and detailing
IS: 5121	Safety code for piling and other deep foundations.
IS: 10262	Recommended guidelines for concrete mix design.
IS: 12330	Code of practice for Sulphate resistant Cement

4.0 MATERIALS

4.1 GENERAL

All materials vise cement, steel, aggregates, water etc., which are to be used for pile construction shall conform relevant IS codes specifications for properties, storage and handling of common building materials. However, aggregates more than 20 mm shall not be used.

5.0 CONCRETE

5.1 Enclosed Technical Specifications for cast-in-situ concrete and allied works along with IS: 2911 Part I/Sec.2 - Code of Practice for Design and construction of pile foundations (Bored cast-in-situ concrete pile) shall be applicable to concrete works for piles. Use of plasticizer to control the water cement ratio shall be permitted on specific approval from Engineer-in-Charge.

5.2 GRADE AND MINIMUM CEMENT CONTENT

5.2.1 Design Mix of Concrete grade specified in elsewhere in this document shall be used; the cement content shall be as per mix design conforming to IS: 10262. However, the minimum cement content shall be 400 Kg, per cubic metre of concrete. In case of piles subsequently exposed to free water or in case of piles where concreting is done under water or drilling mud using methods other than the tremie, 10 percent extra cement over that required for the design grade of concrete at the specified slump shall be used subject to minimum quantities of cement specified above.

5.2.2 For the concrete, water and aggregates specifications laid down in IS: 456 shall be followed in general. Natural rounded shingle of appropriate size may also be used as coarse aggregate. It helps to give high slump with less water cement ratio.

5.3 SLUMP OF CONCRETE

The slump of concrete shall vary between 150 mm to 180 mm for concreting in water- free unlined boreholes. For concreting by tremie, a slump of 150 mm to 200 mm shall be used.

6.0 REINFORCEMENT

6.1 The minimum area of longitudinal reinforcements shall be 0.4 percent of the sectional area calculated on the basis of outside area of casing or the pile shaft where casing is not used, whichever is more. The minimum number of longitudinal reinforcement shall be six (6) and its minimum diameter shall be 12 mm. The stipulated minimum reinforcement shall be provided for the full length of pile. Adequate reinforcement shall be provided to take full uplift loads.

6.2 The longitudinal reinforcement shall project up to development length as per requirements laid in IS: 456 in terms of multiple of bar diameter above cut off level unless otherwise indicated.

6.3 The minimum diameter of the links or spirals bar shall be 8 mm and the spacing of the links or spiral shall not be less than 150 mm. The laterals shall be lied to the longitudinal reinforcement to maintain its shape and spacing.

6.4 Reinforcement cage shall be sufficiently rigid to withstand handling and installation without any deformation and damage. As far as possible number of joints (laps) in longitudinal reinforcement shall be minimum. In case the reinforcement cage is made up of more than one segment these shall preferably be assembled before lowering into casing tube/pilebore by providing necessary laps as per IS: 456.

6.5 Laps shall be staggered as far as practicable and not more than 50% bars shall be lapped at a particular section. Lap joints shall be staggered by at least 1.3 times the lapped length (Centre to Centre).

6.6 Proper cover and central placement of the reinforcement cage in the pile bore shall be ensured by use of suitable concrete spacers or rollers cast specifically for the purpose.

6.7 Minimum clear cover to all main reinforcements in piles shall not be less than 50 mm unless otherwise specified.

7.0 PILE INSTALLATION

Installation of piles shall be carried out as per pile layout drawings, installation criteria and the direction of the Engineer-in-Charge.

7.1 EQUIPMENT AND ACCESSORIES

7.1.1 The equipment accessories for installation of bored cast-in-situ piles shall be selected giving due consideration to the sub-soil conditions, ground water conditions and the method of casting etc. These shall be of standard type and shall have the approval of the Engineer-in-Charge.

7.1.2 List of details of equipment and accessories proposed to be used for the job shall be submitted along with the bid.

7.1.3 The capacity of the rig shall be adequate so as to reach the specified founding level.

7.2 CONTROL OF POSITION AND ALIGNMENT

7.2.1 Piles shall be installed as accurately vertical as possible. The permissible limits for deviation with respect to position and alignment (inclination) shall conform to IS: 2911 (Part-1/Sec.-2), which is reproduced below for ready reference.

a. The maximum deviation of vertical piles shall not exceed 1.5 per cent in alignment.

b. Piles shall not deviate more than 75 mm or D/10 whichever is more from their designed position at cut off level.

In case of piles deviating beyond these limits, the piles shall be replaced or supplemented by one or more additional piles without any extra cost to the Owner.

7.3. BORING

7.3.1 Boring operations shall be done by rotary or percussion type drilling rigs using direct, reverse mud circulation (DMC or RMC) methods or grab method. In soft clays and loose sands, bailer method, if used, shall be used with caution to avoid the effect of suction. Boring operations by any of the above methods shall be done using drilling mud.

7.3.2 The Contractor shall satisfy himself about the suitability of the method to be adopted for site. If DMC or RMC is used bentonite slurry shall be pumped through drill rods by means of high pressure pumps. The cutting tool shall have suitable ports for the bentonite slurry to flow out at high pressure. If on mobilization, the Contractor fails to make a proper bore for any reason, the Contractor has to switchover to other boring methods as approved by the Engineer-in-Charge at no extra cost to the Owner.

7.3.3 Working level shall be above the cut off level. After the initial boring of about 1.0 to 2.0 m temporary guide casing shall be lowered in the pile bore. The diameter of guide casing shall be of such diameter to give the necessary finished diameter of concrete pile. The centre line of guide casing shall be checked before continuing further boring. Guide casing shall be minimum 1.0

m length. Additional length of casing may be used depending on the condition of strata, ground water level etc.

7.3.4 Use of drilling mud (bentonite suspension/slurry) for stabilizing the sides of the pile bore is necessary wherever is likely to collapse in the pile bore. Drilling mud to be used shall meet the following requirement.

a) Liquid limit of bentonite when tested in accordance with IS: 2720(Part-V) shall be more than 300 percent and less than 450 percent.

b) Sand content of the bentonite powder shall not be greater than 7 percent.

c) Bentonite solution should be made by mixing it with fresh water using pump for circulation. The density of the freshly prepared bentonite suspension shall be between 1.034 and 1.10 gm/ml depending upon the pile dimensions and type of soil in which the pile is to be cast. However the density of bentonite suspension after mixing with deleterious materials in the pile bore may be up to 1.25 gm/ml.

d) The Marsh viscosity when tested by a Marsh cone shall be between 30 to 60 seconds.

e) The differential free swell shall be more than 540 percent.

f) The pH value of the bentonite suspension shall be between 9 and 11.5

7.3.5 The bentonite slurry and the cuttings, which are carried to the surface by the rising flow of slurry shall pass through setting tanks of adequate size to remove the sand and spoils from the slurry, before the slurry is re-circulated to the boring. The bentonite slurry mixing and recirculation plant shall be suitably designed and installed.

7.3.6 The bentonite slurry shall be maintained at 1.5 m above the ground water level during boring operations and till the pile is concreted. When DMC and RMC method is used the bentonite slurry shall be under constant circulation till start of concreting.

7.3.7 The size of cutting tools shall not be less than the diameter of the pile by more than 75 mm. However, the pile bore shall be of the specified size.

7.3.8 Socketing shall be done as per Geo-technical Report/ pile design requirement point of view wherever required.

7.4. CHISELING

7.4.1 Chiseling may be restored to with the permission of the Engineer-in-Charge below the socketing horizon. The chiseling tool or bit shall be of adequate size and weight so as to reach the desire depth.

7.5 LENGTH OF PILE

The length of pile below cut off level shall be as per pile drawing.

7.6 CLEANING OF PILE BORE

7.6.1 After completion of the pile bore up to the required depth, the bottom of the pile bore shall be thoroughly cleaned. Cleaning shall ensure that the pile bore is completely free from sludge /bored material, debris of rock/boulder etc. Necessary checks shall be made for pile bore as described in the subsequent clauses to confirm the thorough cleaning of the pile bore.

7.6.2 Pile bore shall be cleaned by fresh drilling mud through tremie pipe before start of concreting and after placing reinforcement.

7.6.3 Pile bore spoil along with used drilling mud shall be disposed off from site as directed by the Engineer-in-Charge.

7.7 ADJACENT STRUCTURES

7.7.1 When working near existing structures care shall be taken to avoid any damage to such structures.

7.8 CONCRETING

7.8.1 Concreting shall not be done until the Engineer-in-Charge is satisfied that the pile termination level is reached and the pile bore is cleaned properly and thoroughly.

7.8.2 The time interval between the completion of boring and placing of concrete shall not exceed 6 hrs. In case the time interval exceeds 6 hrs. the pilebore shall be abandoned. However, the Engineer may allow concreting provided the Contractor extends the pile bore by 0.5 m beyond the proposed depth, and clean the pilebore. The entire cost of all operation and materials for this extra length shall be borne by the Contractor.

7.8.3 Pile bore bottom shall be thoroughly cleaned to make it free from sludge or any foreign matter before and after placing the reinforcement cage.

7.8.4 Proper placement of the reinforcement cage to its full length shall be ensured before concreting.

7.8.5 Concreting shall be done by tremie method. The operation of tremie concreting shall be governed by IS: 2911(Part-1/Sec.2). Drilling mud shall be maintained sufficiently above the ground water level.

7.8.6 Concreting operations shall not proceed if the contaminated drilling mud at the bottom of the pile bore posses density more than 1.25 T/Cu.m. or sand content more than 7%. The drilling mud sample shall be collected from the bottom of pilebore as mentioned in subsequent clause.

7.8.7 Consistency of the drilling mud suspension shall be controlled throughout concreting operations in order to keep the bore stabilized as well as to prevent concrete getting mixed up with the thicker suspension of the mud.

7.8.8 It shall be ensured that volume of concrete poured is at least equal to the theoretically computed volume of pile shaft being cast.

7.8.9 The temporary guide casing shall be withdrawn cautiously after concreting is done up to the required level. While withdrawing the casing concrete shall not be disturbed.

7.9 CUT OFF LEVEL (COL)

7.9.1 Cut off level of piles shall be as indicated in drawings released for construction or as indicated by the Engineer-in-Charge.

7.9.2 The top of concrete in pile shall be brought above the COL to remove all laitance and weak concrete and to ensure good concrete at COL for proper embedment in to pile cap.

7.9.3 Concrete shall be cast upto Ground level, to permit overflow of concrete for visual inspection.

7.9.4 In the circumstance where COL is below ground water level, the need to maintain a pressure on the unset concrete equal to or greater than water pressure shall be observed and accordingly length of extra concrete above

COL shall be determined by the Contractor with prior approval of Engineer-in-Charge.

7.10 SEQUENCE OF PILING

7.10.1 Each pile shall be identified with a reference number.

7.10.2 The convenience of installation may be taken into account while scheduling the sequence of piling in a group. This scheduling shall avoid piles being bored close to other recently constructed piles.

7.11 REJECTION AND REPLACEMENT OF DEFECTIVE PILES

7.11.1 The Engineer-in-Charge reserves the right to reject any pile which in his opinion is defective on account of load capacity structural integrity, position, alignment, concrete quality etc. Piles that are defective shall be pulled out or left in place as judged convenient by the Engineer-in-Charge, without affecting the performance of adjacent piles. The Contractor shall install additional piles to substitute the defective piles as per the directions of the Engineer-in-Charge, at no extra cost to the Owner.

7.12 RECORDING OF PILING DATA

7.12.1 The Contractor shall record all the information during installation of piles. Typical data sheet for recording pile data shall be as indicated in ANNEXURE-A of this document and the Pile Load Test Data shall also be recorded as per the details indicated in Annexure- B of this document. On completion of each pile installation, pile record in triplicate shall be submitted to Engineer-in-Charge within two days of completion of concreting of the pile.

8.0 SAMPLING, TESTING, AND QUALITY ASSURANCE

8.1 Facilities required for sampling and testing materials, concrete, etc. in field and in laboratories shall be provided by the contractor. The contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and this specification. Where no specific testing procedure is mentioned the test should be carried out as per the prevalent accepted engineering practice to the direction of Engineer-in-Charge. Test shall be done in presence of engineer of the engineer or his authorized representative. In case the Engineer requires additional tests, the contractor shall arrange to get these tests done

and submit to the Engineer the test results in triplicate within three days after completion of any test.

8.2 RECORDS

The contractor shall maintain records of all inspection and testing, which shall be made available to the Engineer. The Engineer at his discretion may waive some of the stipulations for small and unimportant concreting operations and other works.

8.3 UNSUITABLE MATERIALS

Materials found unsuitable for acceptance shall be removed and replaced by the contractor. The work shall be redone as per specification requirements and to the satisfaction of the Engineer at no extra cost to the Owner.

8.4 QUALITY ASSURANCE PROGRAM

8.4.1 The Contractor shall submit and finalize a detailed Field Quality Assurance program within 30 days from the date of award of contract, according to the requirements of this specification. This shall include setting up of a testing laboratory, arrangement of testing apparatus/equipment, deployment of qualified/ experienced manpower, preparation of field quality plan, etc. On finalized field quality plan, the Owner shall identify, customer hold points, beyond which the work shall not proceed without written approval from the Engineer. The testing apparatus/equipment installed in the field laboratory shall be calibrated / corrected by the qualified persons as frequently as possible to give accurate testing results.

8.4.2 Frequency of sampling and testing, etc. and acceptance Criteria are given in Table- 1. The testing shall be done at field laboratory or any other laboratory approved by the Engineer-in-Charge. However, the testing frequencies set forth are the desirable minimum and the Engineer shall have the full authority to call for tests as frequently as he may deem necessary to satisfy himself that the materials and works comply with the appropriate specifications. The materials shall be tested to all the specified requirements as per relevant IS codes before acceptance at manufacturers premises or at independent Government laboratory. Tests indicated in the Table- 1 are for cross checking at site the conformity of the materials to some of the specifications.

8.5 TESTING OF CONCRETE

8.5.1 Concrete and other materials shall be tested for quality and strength and other properties as per relevant IS codes.

8.5.2 One sample consisting of six test cubes shall be made from the concrete used in each test pile, three to be tested after 7 days and three after 28 days.

8.5.3 For working piles, minimum one sample consisting of six test cubes shall be made from the concrete for the first ten piles, three to be tested after 7 days and three after 28 days. Thereafter minimum one sample consisting of there test cubes for every 25 piles shall be tested for the 28 day cube strength.

8.5.4 In preparation of test cubes/specimens vibrators shall not be used.

8.5.5 Concrete shall be tested for slump at every one hour interval.

8.5.6 Other materials like aggregates, reinforcement, etc., shall be tested as per relevant IS codes.

8.6 TESTING FOR POSITION AND ALIGNMENT

8.6.1 Each pile shall be checked for its position with respect to specified location. Each pile bore shall be checked for its alignment.

8.6.2 Permissible limits for deviation shall be as specified elsewhere in this section of specification.

8.7. PROPERTIES OF DRILLING MUD

8.7.1 Properties of drilling mud shall be checked as per the requirements specified in clause no. 7.03.4 of this specification. Prior to use in piling work and there after minimum once in a week or as found necessary by the Engineer one sample consisting of 3 specimens shall be tested.

8.7.2 Density and sand content of the drilling mud shall be checked at least in each pile for first 10- piles before concreting. In case of satisfactory results the frequency of sampling shall not be less than one in 25 piles.

8.8 CHECK FOR PILE BORE

8.8.1 On completion of boring and cleaning the bottom of each pile bore shall be checked by the methods as approved by the Engineer-in-Charge to ensure

that it is free from pile bore spoil/debris and any other loose material, before concreting shall be done only after the approval of the Engineer-in-Charge.

8.8.2 For sampling of drilling mud from the pile bore the following method or any other suitable method shall be adopted.

A solid cone shall be lowered by a string to the bottom of pile bore. A sampler tube closed at top with a central hole (hollow cylinder) is lowered over the cone, then a top cover shall be lowered over the cylinder. Care shall be taken for proper fittings of assembly to minimize the leakage while lifting the cone assembly to the ground surface. The slurry collected in the sampler tube shall be tested for density and sand content.

9.0 LOAD TEST ON PILES

9.1 TYPE OF TESTS

9.1.1 The Contractor shall carry out two categories of load tests i.e. Initial Load and Routine Load Tests in accordance with IS: 2911 (Part-4).

9.1.2 Initial load test shall be conducted to assess the safe load carrying capacity of pile before start of installation of working piles. This shall include the following type of tests:

a) Cyclic compression load test to assess safe vertical load capacity.

b) Lateral load test to assess safe horizontal load capacity.

c) Tension load test to assess safe pull out load capacity.

9.1.3 The minimum number of Initial Load Test for each diameter of pile proposed shall be as under:

a) Vertical Compression : 2 No.

b) Lateral : 2 No.

c) Uplift /pullout : 1 No

9.1.4 Routine load tests of piles as per IS: 2911 (Part-4) shall be conducted to verify the load capacity of working piles. This shall include the following types:

a. Direct Compression load test for vertical load capacity.

b. Lateral load test for horizontal load capacity.

9.1.5 The minimum number of routine load test for each diameter and type shall be 1.5 percent of the total number of working piles. The number of tests may be increased up to 2 percent as decided by the Engineer -in-Charge in a particular case depending upon nature, type of structure and strata condition.

9.2 TEST PILE

9.2.1 The test piles for routine load test shall be identified by the Engineer-in-Charge.

9.2.2 A minimum time period of four weeks shall be allowed between the time of pile casting and testing Test pile head shall be prepared for testing purposes only one week after casting the pile.

9.2.3 The test piles shall be cut off at the proper level and provided with a proper cap so as to provide a plane bearing surface for the test plate and for proper arrangements for seating of the jack and dial gauges.

9.3 VERTICAL LOAD TEST

9.3.1 EQUIPMENT AND TEST SET UP

a) A steel plate of sufficient thickness not less than 50 mm shall be centred on the pile head to prevent it from crushing under applied load. The size of the plate shall neither be less than the pile size nor less than the area covered by the base of the hydraulic jack(s).

b) The datum bars shall be supported on immovable supports preferably of concrete pillars or steel sections placed sufficiently far away from the test pile. The distance shall not be less than 3 times the diameter of test pile and in no case less than 2 metres from the edge of test pile. These supports shall be placed at a sufficient depth below ground to be unaffected by ground movements.

9.3.2 LOADING SYSTEM

The test load on the pile shall be applied in one of the following ways as approved by the Engineer-in-Charge.

a) By means of hydraulic jack(s) which obtain reaction from kentledge heavier than the required test load. While using this method care shall be taken to

ensure that the centre of gravity of kentledge heavier than the required test load. While using this method care shall be taken to ensure that the centre of gravity of kentledgte is one the axis of the pile. The load applied by the jack(s) shall also be coaxial with the pile. The nearest edge of the crib supporting the kentledge stack shall not be closer than 1.5 metre to the edge of the test pile.

b) By means of hydraulic jack(s) which obtained reaction from anchor piles or/and suitable loading frame. While using this method all anchor piles shall be at a centre to centre distance of at least three times the test pile shaft diameter from the test pile and in no case less than 2 metres. Care shall be exercised to ensure that the datum bar supports are not affected by heaving up of the soil.

c) By means of hydraulic jack(s) which obtain reaction from suitable rock anchors. When this method is adopted, the anchor transferring the load to the ground shall not be closer than two times the test pile shaft diameter to the test pile and in no case less than 1.5 m.

d) By means of combination of kentledge, anchor pile, rock anchors.

9.3.3 MEASURING SYSTEM

Settlement of the pile shall be recorded by four dial gauges placed at diametrically opposite locations and suspended from the datum bar around the pile.

9.3.4 TEST PROCEDURE

The test shall be carried out by the Direct Loading Method in successive increments for routine load test and by the Cyclic Loading Method for initial load test as detailed below and as directed by the Engineer-in-Charge

a) DIRECT LOADING METHOD

The test shall be carried out as per the procedure outlined below:

i) The load shall be applied to the pile top in increments (steps) of about 20% of the rated capacity of the pile or as directed by Engineer. Each increment of load shall be applied as smoothly and expeditiously as possible. Settlement reading shall be taken before and immediately after the application of next increment and at 15, 30 minutes and thereafter at every half hour until application of the next load increment.

ii) Each stage of loading shall be maintained till the rate of movement of the pile top is not more than 0.2 mm/hr. or until two hours have elapsed whichever is earlier.

iii) The rate of movement of pile shall not be permitted to be extrapolated from period of test less than one hour.

iv) Loading on pile shall be continued till one of the following takes place:

v) In case of initial load test, applied load reaches three times the assumed safe load or the settlement of pile exceeds a value of 10 per cent of bulb diameter incase of under-reamed pile.

vi) In case of Routine load test, applied load reaches one and half time the safe load or the maximum settlement of test loading in position attains 12 mm.

vii) Where yielding of the soil does not occur, the full test load shall be maintained on the pile head for a minimum period of 24 hrs. after the last increment of load and settlement shall be recorded at 6 hours interval during this period.

viii) Unloading shall be carried out in the same steps as loading. A minimum period of 30 minutes shall be allowed to elapse between two successive stages of load decrement. The final rebound shall be recorded 6 hours after the entire test load has been removed.

b) CYCLIC LOADING TEST

The test shall be carried out to find out separately skin friction and point bearing capacity of single pile. However, this test is not applicable for under reamed piles. The test procedure shall be as given below:

i) In general this test shall be conducted on similar lines as mentioned in Direct Loading Method. In addition, alternate loading and unloading up to zero load shall be done in steps at each stage of loading. The load increment/decrement for each steps shall be 20% of the rated capacity. The readings of all the dial gauges shall be recorded at the end of each step and the total and net settlement for each stage shall be calculated.

ii) For each stage, the loading of each steps shall be maintained for 15 minutes before reaching the maximum load. The maximum load for each stage shall

be maintained for one hour. The full test load shall be maintained on the pile head for 24 hours.

iii) Each step of unloading shall be maintained for 15 minutes and the subsequent rebound in the pile shall be measured accurately.

iv) A period of 15 minutes shall be allowed to pass between the successive unloading and loading operations.

v) To find out separately skin friction and point bearing capacity of pile the procedure as given in Appendix- A of IS: 2911(Part-4) shall be followed.

9.3.5 ASSESSMENT OF SAFE LOAD

The safe vertical load on single pile from the load test shall be the least of following values:

a) 2/3 of the load at which the total settlement attains a value of 12 mm unless otherwise specified in tender documents.

b) 50% of the final load at which the total settlement equals 10 percent of the pile diameter in case of uniform diameter piles

9.4 HORIZONTAL LOAD TEST

9.4.1 EQUIPMENT AND TEST SET UP

a) The test plate shall be set in high strength grout to provide full bearing against the projected areas of the pile. The size of the test plate shall be adequate to accommodate the spherical bearing and transfer the load to the pile.

b) Sufficient clearance shall be allowed between the test pile and the datum bar for the anticipated lateral movement of the pile when datum bar (for fixing the dial gauge) is located on the opposite side to the point of load application.

9.4.2 LOADING SYSTEM

a) Loading shall be applied by a hydraulic jack of adequate capacity equipped with spherical bearing at the top of ram and bearing plate at the bottom side, abutting the pile horizontally and reacting against a suitable system.

b) The reaction may be provided by the wall of the excavated pit when the test is being conducted below ground level or by a neighboring pile, in which case thrust pieces shall be inserted on their end of the jack to make up the gap as approved by the Engineer.

c) Load shall be applied on the pile at or approximately at cut of level (COL).

9.4.3 MEASURING SYSTEM

a) The deflection shall be measured at a point diametrically opposite to the point of load application. In case such a measurements is not possible, the deflection shall be recorded using at least 2 dial gauges kept at a spacing of 30 cm. at a suitable height and the displacement interpolated at load point from similar triangles.

b) Deflection of the pile at the level of load application shall be measured by dial gauge fixed to datum bar. The datum bar shall rest on immoveable supports as described elsewhere in this specification.

9.4.4 TEST PROCEDURE

a) The test procedure shall be similar to that for vertical load test.

b) Loading on the pile shall be continued till one of the following takes place:

i. In case of Initial load test applied load reaches thrice the assumed safe lateral load capacity of deflection of pile at the loading point exceeds.

ii. In case of Routine load test, applied load reaches one and half times the assumed safe load capacity or a deflection at the loading point exceeds 5 mm

9.4.5 ASSESSMENT OF SAFE LOAD

a) The safe lateral load of single pile shall be the least of following:

i) 50 % of the load for which the total deflection is 12 mm.

ii) Load corresponding to 5 mm total deflection.

iii) Load corresponding to any other specified displacement as per performance requirement.

b) Pile groups shall be tested under conditions as per actual use in the structure as far as possible.

However, for routine test (i) above is not applicable.

NOTE: The deflection of pile is at the cut off level of the pile.

9.5 PULL OUT TEST

9.5.1 EQUIPMENTS AND TEST SET UP

Uplift force may be applied by means of hydraulic jack(s) using a suitable pullout set up as approved by the Engineer.

9.5.2 LOADING SYSTEM

a) Load shall be applied along the longitudinal axis of the pile using an approved reaction system. Uplift forces on the pile may be applied directly to the test pile or through a lever system.

b) The reaction may be provided by neighboring piles or blocks constructed for this purpose.

c) The reaction supports/blocks/piles shall be at least 2.5 times the test pile diameter.

9.5.3 MEASURING SYSTEM

a. Displacement of the pile shall be recorded using two dial gauges placed at diametrically opposite locations ad suspended from the datum bar around the pile. Datum bar shall be provided with immoveable supports as described elsewhere in this specification.

9.5.4 TEST PROCEDURE

a) The test procedure shall be similar to that for vertical load test.

b) The loading on pile shall be continued till one of the following takes place.

i. The loading on pile top equals three times the estimated safe load.

ii. The load- displacement curves shows a clear break (downward trend).

9.5.5 ASSESSMENT OF SAFE LOAD

a) The safe load of the pile shall be the least of the followings:

i. Two third of the load at which the total displacement is 12 mm.

ii. 50% of the load at which the load displacement curve shows a clear break (down work trend).

10.0 RECORDING OF DATA & PRESENTATION

10.1 The pile test data essentially concerns three variables, namely, load, displacement and time. These are to be recorded sequentially for the tests under consideration and shall be recorded in a suitable tabular form along with the information about the pile as per Annexure-A & B and Table-1 of this document.

10.2 The data may be suitably presented by curves drawn between the variables and safe loads shown on the graphs. Load displacement curve should be an assential part of presentation.

ANNEXURE- A

PILE DATA

1. Reference No. Location(Co-ordinates) _____Area.
2. Sequence of Piling
3. Pile diameter & Type
4. Working Level (Platform level)
5. Cut Off Level (COL)
6. Actual Length Below COL
7. Pile Termination Level
8. Top Of Finished Concrete Level
9. Date and Time of Start and Completion of Boring

10. Depth of Ground Water Table in the Vicinity

11. Type Of Soil at pile tip

12. Method of Boring Operation

13. Details of Drilling mud as used:

    a. Freshly Supplied Mud, Liquid Limit, Sand Content, Density, Marsh Viscosity, Swelling Index, pH value.

    b. Contaminated Mud Density, Sand Content.

14. SPT (N) values in soil (from the nearest bore hole) UCS value in rock (from the nearest bore hole)

15. Chiseling, if any From..... M. To..... M.

16. Date and Time of Start and Completion of concreting.

17. Method of placing concrete.

18. Concrete Quantity:

    Actual

    Theoretical

19. Ref. Number of Test Cubes

20. Grade and Slump of concrete

21. Results of Test Cubes

22. Reinforcement Details:

Main Reinforcement	Stirrups: Type
No.:_____	No.:_____
Dia.:_____	Dia.:_____

Depth:_____ Depth:_____

23. Any other information regarding obstructions, delay and other interruption to the sequence of work

ANNEXURE - B PILE LOAD TEST : VERTICAL / HORIZONTAL / UPLIFT	Type of Equipment and method of boring	Plan of Test arrangement showing position and distance of Kentiledge, Supports, tension or compression piles and reference frame to test pile, etc.
	Date of Cast	Commencement of Test Completion of Test Capacity of Jack Jack Constant Weight of Kentiledge Reaction pile details

Time	Pressure Gauge	Load MT	Dial Gauge Reading	Average Settlement	Net(mm)	Rebound

Submission of Test Results

i , Time vs. Settlement.

ii , Load vs. Settlement Indicating the Safe Load.

Pile No.

Type of Pile

Diameter

Capacity

Type of Test Initial /routine

Loading Method Direct / Cyclic

TABLE-1: FREQUENCY OF SAMPLING AND TESTING

Sl.No.		Type of Material / Work	Nature of Test / Characteristics	Method of Test	No. of Samples & Frequency of Test	Acceptance Criteria
1		Pilebore size		Physical measurement`	Each Pile	drawing. Length as established by initial load test
	a.	Diameter				
	b.	Length				
2		Bentonite (Mud)				
		properties				
	a.	Basic properties of Bentonite before use.	viscosity, Specific gravity, Sand content, Swelling index, pH value	In Laboratory	Minimum one sample consisting of 3 specimen once in a week.	As per clause No. 7.03.4.
	b.	Contaminated mud from pile bore bottom before concreting	Density, Sand content	In Laboratory	piles before concreting. In case of satisfactory results, the frequency of sampling may be reduced to one in 25	be more than 1.25 Te/Cu.M. ii). Sand content shall not be more than 7%
3		Position and Alignment		Physical or any approved method.	Each Pile.	As per specification.
4		Cleaning of pilebore	As per Cl.No. 8.08.0	Each	Pilebore should be free from bored material	

Date

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PART II: TECHNICAL

SECTION – 3.7

DESIGN PHILOSOPHY

FOR

CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

ANNEXURE-D

TECHNICAL SPECIFICATIONS

FOR BORED CAST- IN- SITU CONCRETE PILES

(ES-2516)

TABLE OF CONTENTS

1.0 SCOPE

1.1 This specifications cover the installation of bored cast-in-situ reinforced concrete vertical piles. Installation of bored cast-in-situ concrete vertical piles shall also conform to IS: 2911 (Part-1/Section-2).

1.2 This specifications also covers the technical requirements for load test (Initial and Routine tests) on reinforced concrete single vertical piles of to assess their vertical, horizontal and pull-out load carrying capacity.

1.2.1 Load tests on piles shall conform to IS: 2911 (Part-4).

2.0 GENERAL REQUIREMENTS

2.1 The work shall include mobilization of all necessary equipments, providing necessary engineering supervision through qualified and technical personnel, skilled and unskilled labour, etc. as required to carry out the complete piling work, load tests and submission of records / reports as per schedule.

2.2 The Contractor shall guarantee the "Safe Load" capacity of piles for various modes i.e., vertical, lateral and pull-out loads for piles installed by him.

2.3 Consequent upon award of work and prior to installation of piles, the Contractor shall submit design of piles in terms of allowable capacity, length, diameter, termination criteria, reinforcement, etc. for Owner's/ Consultant's approval. Owner's/Consultant's approval on pile design in no way absolve the Contractor for his responsibility to carry out all the initial (vertical, lateral and pull-out) load test of piles prior to installation of the job piles. The pile capacity to be used in design shall be arrived at from the initial load test of piles.

2.4 The Contractor shall make his own arrangements for locating the co-ordinates and position of piles shown in approved drawings and for determining the Reduced Levels (R.L) of these locations with respect to the single bench mark indicated by

the Engineer-in-Charge. Two established reference lines in mutually perpendicular direction shall be indicated to the Contractor. The Contractor shall provide at site all the required survey instruments to the satisfaction of the Engineer-in-Charge so that the work can be carried accurately according to specifications and drawings.

2.5 In case of working piles, if the pile rejected due to any reasons, attributable to contractor the Contractor shall install extra piles at no extra cost to the Owner / Consultant. Further, the extra cost due to the increase in the pile cap size, if any, on account of extra piles shall be borne by the bidder.

2.6 It is essential that all equipment and instruments are properly calibrated both at commencement and immediately after the tests so that they represent true values. Certificates to this effect from an approved institution shall be furnished to the Engineer-in-Charge. If the Engineer-in-Charge so desires the contractor shall arrange for having the instruments tested at an approved laboratory at his own cost and the test report shall be submitted to the Engineer-in-Charge. If the Engineer-in-Charge desires to witness such tests Contractor shall arrange to conduct the test in his presence.

2.7 The complete jacking system including the hydraulic jack, hydraulic pump and pressure gauge shall be calibrated as unit. The complete unit shall be calibrated over its complete range of travel for increasing and decreasing loads same as that of test loads. The calibration certificate shall be submitted to the Engineer-in-Charge.

2.8 The reaction load to be made available for the test shall be at least 25 % greater than the maximum jacking force. The reaction system as relevant shall be designed for the total reaction load. All reaction loads shall be stable and balanced during all operations of testing. During testing, stability of reaction system shall be ensured.

2.9 The load applied on the pile shall be measured by a calibrated pressure gauge mounted on the jack with a least count of not more than 10 % of the safe load.

2.10 The displacement of pile (In vertical, horizontal and uplift) shall be measured using dial gauges having a least count 0.01 mm.

2.11 Load test shall be conducted at pile cut off level (COL). If the water table is above the COL the test pit shall be kept dry through out the test period by suitable dewatering methods.

2.11.1 In case of initial vertical load test where the water table level is higher than the COL Contractor may use reaction piles for testing purposes in each case. Engineer-in-Charge may at his discretion decide to rise the COL above water table.

2.12 Full details of the equipment proposed to be used and the test setup with detail sketches shall be submitted to the Engineer-in-Charge, before making arrangement to carry out the tests, for his approval. Approval of the Engineer shall also be obtained after the test set up is complete prior to commencement of loading.

2.13 All operations in connection with pile load test shall be carried out in a safe manner so as to prevent the exposure of people to hazard.

2.14 If any test has to be discontinued, which in the opinion of the Engineer-in-Charge interferes with the load test results, and he decides to abandon the test, the Contractor shall install another pile for the purpose and repeat the test after correcting the fault and the cost of all such operations, including the cost of test pile, shall be at the Contractor's expense.

2.15 After completion of piling work contractor shall submit four copies of the following documents for Owners record and future reference:

a. Initial load test data for all tests done along with the pile data and the analysis of the initial test results.

b. Pile data along with concrete mix design detail (note pile data shall contain details as per requirement of Annexure- A).

c. Routine load test data for all tests done.

d. A full record giving all details of test in the Performa shown in Annexure- B shall be submitted in triplicate to the engineer immediately on completion of each test. The record shall also include the plots of:

   i. Load VS. Settlement

   ii. Time VS. Settlement (for each increment of load)

   iii. Characteristic of the piles and the interpretation of the pile load test curve as per the criteria for safe loads as mentioned in the specification.

2.16 Before commencement of the work, the Contractor shall submit Quality Assurance Plan to the Owner/Consultant for their approval.

3.0 CODES AND STANDARDS

3.1 All standards and codes of practice referred to herein shall be the latest editions including all applicable Amendments issued.

3.2 All works shall be carried out as per the relevant Indian Standard Codes. In case of conflict between the specification and the IS codes referred to herein, the former shall prevail. Some of the applicable Indian Standards and codes are referred to here below:

IS: 432(Part I&II)	Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.
IS: 456	Code of Practice for plain and reinforced concrete.

IS: 1786	Code of practice for twisted steel high strength deformed bars for concrete reinforcement.
IS: 2911(Pr-I&II)	Code of practice for design and construction of pile foundations- Bored cast-in-situ concrete pile.
IS: 2911(Part-IV)	Code of practice for design and construction of pile foundation Load test on piles.
SP-34	Handbook on concrete reinforcement and detailing
IS: 5121	Safety code for piling and other deep foundations.
IS: 10262	Recommended guidelines for concrete mix design.
IS: 12330	Code of practice for Sulphate resistant Cement

4.0 MATERIALS

4.1 GENERAL

All materials vise cement, steel, aggregates, water etc., which are to be used for pile construction shall conform relevant IS codes specifications for properties, storage and handling of common building materials. However, aggregates more than 20 mm shall not be used.

5.0 CONCRETE

5.1 Enclosed Technical Specifications for cast-in-situ concrete and allied works along with IS: 2911 Part I/Sec.2 - Code of Practice for Design and construction of pile foundations (Bored cast-in-situ concrete pile) shall be applicable to concrete works for piles. Use of plasticizer to control the water cement ratio shall be permitted on specific approval from Engineer-in-Charge.

5.2 GRADE AND MINIMUM CEMENT CONTENT

5.2.1 Design Mix of Concrete grade specified in elsewhere in this document shall be used; the cement content shall be as per mix design conforming to IS: 10262. However, the minimum cement content shall be 400 Kg, per cubic metre of concrete. In case of piles subsequently exposed to free water or in case of piles where concreting is done under water or drilling mud using methods other than the tremie, 10 percent extra cement over that required for the design grade of concrete at the specified slump shall be used subject to minimum quantities of cement specified above.

5.2.2 For the concrete, water and aggregates specifications laid down in IS: 456 shall be followed in general. Natural rounded shingle of appropriate size may also be used as coarse aggregate. It helps to give high slump with less water cement ratio.

5.3 SLUMP OF CONCRETE

The slump of concrete shall vary between 150 mm to 180 mm for concreting in water- free unlined boreholes. For concreting by tremie, a slump of 150 mm to 200 mm shall be used.

6.0 REINFORCEMENT

6.1 The minimum area of longitudinal reinforcements shall be 0.4 percent of the sectional area calculated on the basis of outside area of casing or the pile shaft where casing is not used, whichever is more. The minimum number of longitudinal reinforcement shall be six (6) and its minimum diameter shall be 12 mm. The stipulated minimum reinforcement shall be provided for the full length of pile. Adequate reinforcement shall be provided to take full uplift loads.

6.2 The longitudinal reinforcement shall project up to development length as per requirements laid in IS: 456 in terms of multiple of bar diameter above cut off level unless otherwise indicated.

6.3 The minimum diameter of the links or spirals bar shall be 8 mm and the spacing of the links or spiral shall not be less than 150 mm. The laterals shall be lied to the longitudinal reinforcement to maintain its shape and spacing.

6.4 Reinforcement cage shall be sufficiently rigid to withstand handling and installation without any deformation and damage. As far as possible number of joints (laps) in longitudinal reinforcement shall be minimum. In case the reinforcement cage is made up of more than one segment these shall preferably be assembled before lowering into casing tube/pilebore by providing necessary laps as per IS: 456.

6.5 Laps shall be staggered as far as practicable and not more than 50% bars shall be lapped at a particular section. Lap joints shall be staggered by at least 1.3 times the lapped length (Centre to Centre).

6.6 Proper cover and central placement of the reinforcement cage in the pile bore shall be ensured by use of suitable concrete spacers or rollers cast specifically for the purpose.

6.7 Minimum clear cover to all main reinforcements in piles shall not be less than 50 mm unless otherwise specified.

7.0 PILE INSTALLATION

Installation of piles shall be carried out as per pile layout drawings, installation criteria and the direction of the Engineer-in-Charge.

7.1 EQUIPMENT AND ACCESSORIES

7.1.1 The equipment accessories for installation of bored cast-in-situ piles shall be selected giving due consideration to the sub-soil conditions, ground water conditions and the method of casting etc. These shall be of standard type and shall have the approval of the Engineer-in-Charge.

7.1.2 List of details of equipment and accessories proposed to be used for the job shall be submitted along with the bid.

7.1.3 The capacity of the rig shall be adequate so as to reach the specified founding level.

7.2 CONTROL OF POSITION AND ALIGNMENT

7.2.1 Piles shall be installed as accurately vertical as possible. The permissible limits for deviation with respect to position and alignment (inclination) shall conform to IS: 2911 (Part-1/Sec.-2), which is reproduced below for ready reference.

a. The maximum deviation of vertical piles shall not exceed 1.5 per cent in alignment.

b. Piles shall not deviate more than 75 mm or D/10 whichever is more from their designed position at cut off level.

In case of piles deviating beyond these limits, the piles shall be replaced or supplemented by one or more additional piles without any extra cost to the Owner.

7.3. BORING

7.3.1 Boring operations shall be done by rotary or percussion type drilling rigs using direct, reverse mud circulation (DMC or RMC) methods or grab method. In soft clays and loose sands, bailer method, if used, shall be used with caution to avoid the effect of suction. Boring operations by any of the above methods shall be done using drilling mud.

7.3.2 The Contractor shall satisfy himself about the suitability of the method to be adopted for site. If DMC or RMC is used bentonite slurry shall be pumped through drill rods by means of high pressure pumps. The cutting tool shall have suitable ports for the bentonite slurry to flow out at high pressure. If on mobilization, the Contractor fails to make a proper bore for any reason, the Contractor has to switchover to other boring methods as approved by the Engineer-in-Charge at no extra cost to the Owner.

7.3.3 Working level shall be above the cut off level. After the initial boring of about 1.0 to 2.0 m temporary guide casing shall be lowered in the pile bore. The diameter of guide casing shall be of such diameter to give the necessary finished diameter of concrete pile. The centre line of guide casing shall be checked before continuing further boring. Guide casing shall be minimum 1.0 m length. Additional length of casing may be used depending on the condition of strata, ground water level etc.

7.3.4 Use of drilling mud (bentonite suspension/slurry) for stabilizing the sides of the pile bore is necessary wherever is likely to collapse in the pile bore. Drilling mud to be used shall meet the following requirement.

a) Liquid limit of bentonite when tested in accordance with IS: 2720(Part-V) shall be more than 300 percent and less than 450 percent.

b) Sand content of the bentonite powder shall not be greater than 7 percent.

c) Bentonite solution should be made by mixing it with fresh water using pump for circulation. The density of the freshly prepared bentonite suspension shall be between 1.034 and 1.10 gm/ml depending upon the pile dimensions and type of soil in which the pile is to be cast. However the density of bentonite suspension after mixing with deleterious materials in the pile bore may be up to 1.25 gm/ml.

d) The Marsh viscosity when tested by a Marsh cone shall be between 30 to 60 seconds.

e) The differential free swell shall be more than 540 percent.

f) The pH value of the bentonite suspension shall be between 9 and 11.5

7.3.5 The bentonite slurry and the cuttings, which are carried to the surface by the rising flow of slurry shall pass through setting tanks of adequate size to remove the sand and spoils from the slurry, before the slurry is re-circulated to the boring. The bentonite slurry mixing and recirculation plant shall be suitably designed and installed.

7.3.6 The bentonite slurry shall be maintained at 1.5 m above the ground water level during boring operations and till the pile is concreted. When DMC and RMC method is used the bentonite slurry shall be under constant circulation till start of concreting.

7.3.7 The size of cutting tools shall not be less than the diameter of the pile by more than 75 mm. However, the pile bore shall be of the specified size.

7.3.8 Socketing shall be done as per Geo-technical Report/ pile design requirement point of view wherever required.

7.4. CHISELING

7.4.1 Chiseling may be restored to with the permission of the Engineer-in-Charge below the socketing horizon. The chiseling tool or bit shall be of adequate size and weight so as to reach the desire depth.

7.5 LENGTH OF PILE

The length of pile below cut off level shall be as per pile drawing.

7.6 CLEANING OF PILE BORE

7.6.1 After completion of the pile bore up to the required depth, the bottom of the pile bore shall be thoroughly cleaned. Cleaning shall ensure that the pile bore is completely free from sludge /bored material, debris of rock/boulder etc. Necessary checks shall be made for pile bore as described in the subsequent clauses to confirm the thorough cleaning of the pile bore.

7.6.2 Pile bore shall be cleaned by fresh drilling mud through tremie pipe before start of concreting and after placing reinforcement.

7.6.3 Pile bore spoil along with used drilling mud shall be disposed off from site as directed by the Engineer-in-Charge.

7.7 ADJACENT STRUCTURES

7.7.1 When working near existing structures care shall be taken to avoid any damage to such structures.

7.8 CONCRETING

7.8.1 Concreting shall not be done until the Engineer-in-Charge is satisfied that the pile termination level is reached and the pile bore is cleaned properly and thoroughly.

7.8.2 The time interval between the completion of boring and placing of concrete shall not exceed 6 hrs. In case the time interval exceeds 6 hrs. the pilebore shall be abandoned. However, the Engineer may allow concreting provided the Contractor extends the pile bore by 0.5 m beyond the proposed depth, and clean the pilebore. The entire cost of all operation and materials for this extra length shall be borne by the Contractor.

7.8.3 Pile bore bottom shall be thoroughly cleaned to make it free from sludge or any foreign matter before and after placing the reinforcement cage.

7.8.4 Proper placement of the reinforcement cage to its full length shall be ensured before concreting.

7.8.5 Concreting shall be done by tremie method. The operation of tremie concreting shall be governed by IS: 2911(Part-1/Sec.2). Drilling mud shall be maintained sufficiently above the ground water level.

7.8.6 Concreting operations shall not proceed if the contaminated drilling mud at the bottom of the pile bore posses density more than 1.25 T/Cu.m. or sand content more than 7%. The drilling mud sample shall be collected from the bottom of pilebore as mentioned in subsequent clause.

7.8.7 Consistency of the drilling mud suspension shall be controlled throughout concreting operations in order to keep the bore stabilized as well as to prevent concrete getting mixed up with the thicker suspension of the mud.

7.8.8 It shall be ensured that volume of concrete poured is at least equal to the theoretically computed volume of pile shaft being cast.

7.8.9 The temporary guide casing shall be withdrawn cautiously after concreting is done up to the required level. While withdrawing the casing concrete shall not be disturbed.

7.9 CUT OFF LEVEL (COL)

7.9.1 Cut off level of piles shall be as indicated in drawings released for construction or as indicated by the Engineer-in-Charge.

7.9.2 The top of concrete in pile shall be brought above the COL to remove all laitance and weak concrete and to ensure good concrete at COL for proper embedment in to pile cap.

7.9.3 Concrete shall be cast upto Ground level, to permit overflow of concrete for visual inspection.

7.9.4 In the circumstance where COL is below ground water level, the need to maintain a pressure on the unset concrete equal to or greater than water pressure shall be observed and accordingly length of extra concrete above COL shall be determined by the Contractor with prior approval of Engineer-in-Charge.

7.10 SEQUENCE OF PILING

7.10.1 Each pile shall be identified with a reference number.

7.10.2 The convenience of installation may be taken into account while scheduling the sequence of piling in a group. This scheduling shall avoid piles being bored close to other recently constructed piles.

7.11 REJECTION AND REPLACEMENT OF DEFECTIVE PILES

7.11.1 The Engineer-in-Charge reserves the right to reject any pile which in his opinion is defective on account of load capacity structural integrity, position, alignment,

concrete quality etc. Piles that are defective shall be pulled out or left in place as judged convenient by the Engineer-in-Charge, without affecting the performance of adjacent piles. The Contractor shall install additional piles to substitute the defective piles as per the directions of the Engineer-in-Charge, at no extra cost to the Owner.

7.12 RECORDING OF PILING DATA

7.12.1 The Contractor shall record all the information during installation of piles. Typical data sheet for recording pile data shall be as indicated in ANNEXURE- A of this document and the Pile Load Test Data shall also be recorded as per the details indicated in Annexure- B of this document. On completion of each pile installation, pile record in triplicate shall be submitted to Engineer-in-Charge within two days of completion of concreting of the pile.

8.0 SAMPLING, TESTING, AND QUALITY ASSURANCE

8.1 Facilities required for sampling and testing materials, concrete, etc. in field and in laboratories shall be provided by the contractor. The contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and this specification. Where no specific testing procedure is mentioned the test should be carried out as per the prevalent accepted engineering practice to the direction of Engineer-in-Charge. Test shall be done in presence of engineer of the engineer or his authorized representative. In case the Engineer requires additional tests, the contractor shall arrange to get these tests done and submit to the Engineer the test results in triplicate within three days after completion of any test.

8.2 RECORDS

The contractor shall maintain records of all inspection and testing, which shall be made available to the Engineer. The Engineer at his discretion may waive some of the stipulations for small and unimportant concreting operations and other works.

8.3 UNSUITABLE MATERIALS

Materials found unsuitable for acceptance shall be removed and replaced by the contractor. The work shall be redone as per specification requirements and to the satisfaction of the Engineer at no extra cost to the Owner.

8.4 QUALITY ASSURANCE PROGRAM

8.4.1 The Contractor shall submit and finalize a detailed Field Quality Assurance program within 30 days from the date of award of contract, according to the requirements of this specification. This shall include setting up of a testing laboratory, arrangement of testing apparatus/equipment, deployment of qualified/ experienced manpower, preparation of field quality plan, etc. On finalized field quality plan, the Owner shall identify, customer hold points, beyond which the work shall not proceed without written approval from the Engineer. The testing apparatus/equipment installed in the field laboratory shall be calibrated / corrected by the qualified persons as frequently as possible to give accurate testing results.

8.4.2 Frequency of sampling and testing, etc. and acceptance Criteria are given in Table- 1. The testing shall be done at field laboratory or any other laboratory approved by the Engineer-in-Charge. However, the testing frequencies set forth are the desirable minimum and the Engineer shall have the full authority to call for tests as frequently as he may deem necessary to satisfy himself that the materials and works comply with the appropriate specifications. The materials shall be tested to all the specified requirements as per relevant IS codes before acceptance at manufacturers premises or at independent Government laboratory. Tests indicated in the Table- 1 are for cross checking at site the conformity of the materials to some of the specifications.

8.5 TESTING OF CONCRETE

8.5.1 Concrete and other materials shall be tested for quality and strength and other properties as per relevant IS codes.

8.5.2 One sample consisting of six test cubes shall be made from the concrete used in each test pile, three to be tested after 7 days and three after 28 days.

8.5.3 For working piles, minimum one sample consisting of six test cubes shall be made from the concrete for the first ten piles, three to be tested after 7 days and three after 28 days. Thereafter minimum one sample consisting of there test cubes for every 25 piles shall be tested for the 28 day cube strength.

8.5.4 In preparation of test cubes/specimens vibrators shall not be used.

8.5.5 Concrete shall be tested for slump at every one hour interval.

8.5.6 Other materials like aggregates, reinforcement, etc., shall be tested as per relevant IS codes.

8.6 TESTING FOR POSITION AND ALIGNMENT

8.6.1 Each pile shall be checked for its position with respect to specified location. Each pile bore shall be checked for its alignment.

8.6.2 Permissible limits for deviation shall be as specified elsewhere in this section of specification.

8.7. PROPERTIES OF DRILLING MUD

8.7.1 Properties of drilling mud shall be checked as per the requirements specified in clause no. 7.03.4 of this specification. Prior to use in piling work and there after minimum once in a week or as found necessary by the Engineer one sample consisting of 3 specimens shall be tested.

8.7.2 Density and sand content of the drilling mud shall be checked at least in each pile for first 10- piles before concreting. In case of satisfactory results the frequency of sampling shall not be less than one in 25 piles.

8.8 CHECK FOR PILE BORE

8.8.1 On completion of boring and cleaning the bottom of each pile bore shall be checked by the methods as approved by the Engineer-in-Charge to ensure that it is free from pile bore spoil/debris and any other loose material, before concreting shall be done only after the approval of the Engineer-in-Charge.

8.8.2 For sampling of drilling mud from the pile bore the following method or any other suitable method shall be adopted.

A solid cone shall be lowered by a string to the bottom of pile bore. A sampler tube closed at top with a central hole (hollow cylinder) is lowered over the cone, then a top cover shall be lowered over the cylinder. Care shall be taken for proper fittings of assembly to minimize the leakage while lifting the cone assembly to the ground surface. The slurry collected in the sampler tube shall be tested for density and sand content.

9.0 LOAD TEST ON PILES

9.1 TYPE OF TESTS

9.1.1 The Contractor shall carry out two categories of load tests i.e. Initial Load and Routine Load Tests in accordance with IS: 2911 (Part-4).

9.1.2 Initial load test shall be conducted to assess the safe load carrying capacity of pile before start of installation of working piles. This shall include the following type of tests:

a) Cyclic compression load test to assess safe vertical load capacity.

b) Lateral load test to assess safe horizontal load capacity.

c) Tension load test to assess safe pull out load capacity.

9.1.3 The minimum number of Initial Load Test for each diameter of pile proposed shall be as under:

a) Vertical Compression : 2 No.

b) Lateral : 2 No.

c) Uplift /pullout : 1 No

9.1.4 Routine load tests of piles as per IS: 2911 (Part-4) shall be conducted to verify the load capacity of working piles. This shall include the following types:

a. Direct Compression load test for vertical load capacity.

b. Lateral load test for horizontal load capacity.

9.1.5 The minimum number of routine load test for each diameter and type shall be 1.5 percent of the total number of working piles. The number of tests may be increased up to 2 percent as decided by the Engineer -in-Charge in a particular case depending upon nature, type of structure and strata condition.

9.2 TEST PILE

9.2.1 The test piles for routine load test shall be identified by the Engineer-in-Charge.

9.2.2 A minimum time period of four weeks shall be allowed between the time of pile casting and testing Test pile head shall be prepared for testing purposes only one week after casting the pile.

9.2.3 The test piles shall be cut off at the proper level and provided with a proper cap so as to provide a plane bearing surface for the test plate and for proper arrangements for seating of the jack and dial gauges.

9.3 VERTICAL LOAD TEST

9.3.1 EQUIPMENT AND TEST SET UP

a) A steel plate of sufficient thickness not less than 50 mm shall be centred on the pile head to prevent it from crushing under applied load. The size of the plate shall

neither be less than the pile size nor less than the area covered by the base of the hydraulic jack(s).

b) The datum bars shall be supported on immovable supports preferably of concrete pillars or steel sections placed sufficiently far away from the test pile. The distance shall not be less than 3 times the diameter of test pile and in no case less than 2 metres from the edge of test pile. These supports shall be placed at a sufficient depth below ground to be unaffected by ground movements.

9.3.2 LOADING SYSTEM

The test load on the pile shall be applied in one of the following ways as approved by the Engineer-in-Charge.

a) By means of hydraulic jack(s) which obtain reaction from kentledge heavier than the required test load. While using this method care shall be taken to ensure that the centre of gravity of kentledge heavier than the required test load. While using this method care shall be taken to ensure that the centre of gravity of kentledgte is one the axis of the pile. The load applied by the jack(s) shall also be coaxial with the pile. The nearest edge of the crib supporting the kentledge stack shall not be closer than 1.5 metre to the edge of the test pile.

b) By means of hydraulic jack(s) which obtained reaction from anchor piles or/and suitable loading frame. While using this method all anchor piles shall be at a centre to centre distance of at least three times the test pile shaft diameter from the test pile and in no case less than 2 metres. Care shall be exercised to ensure that the datum bar supports are not affected by heaving up of the soil.

c) By means of hydraulic jack(s) which obtain reaction from suitable rock anchors. When this method is adopted, the anchor transferring the load to the ground shall not be closer than two times the test pile shaft diameter to the test pile and in no case less than 1.5 m.

d) By means of combination of kentledge, anchor pile, rock anchors.

9.3.3 MEASURING SYSTEM

Settlement of the pile shall be recorded by four dial gauges placed at diametrically opposite locations and suspended from the datum bar around the pile.

9.3.4 TEST PROCEDURE

The test shall be carried out by the Direct Loading Method in successive increments for routine load test and by the Cyclic Loading Method for initial load test as detailed below and as directed by the Engineer-in-Charge

a) DIRECT LOADING METHOD

The test shall be carried out as per the procedure outlined below:

i) The load shall be applied to the pile top in increments (steps) of about 20% of the rated capacity of the pile or as directed by Engineer. Each increment of load shall be applied as smoothly and expeditiously as possible. Settlement reading shall be taken before and immediately after the application of next increment and at 15, 30 minutes and thereafter at every half hour until application of the next load increment.

ii) Each stage of loading shall be maintained till the rate of movement of the pile top is not more than 0.2 mm/hr. or until two hours have elapsed whichever is earlier.

iii) The rate of movement of pile shall not be permitted to be extrapolated from period of test less than one hour.

iv) Loading on pile shall be continued till one of the following takes place:

v) In case of initial load test, applied load reaches three times the assumed safe load or the settlement of pile exceeds a value of 10 per cent of bulb diameter incase of under-reamed pile.

vi) In case of Routine load test, applied load reaches one and half time the safe load or the maximum settlement of test loading in position attains 12 mm.

vii) Where yielding of the soil does not occur, the full test load shall be maintained on the pile head for a minimum period of 24 hrs. after the last increment of load and settlement shall be recorded at 6 hours interval during this period.

viii) Unloading shall be carried out in the same steps as loading. A minimum period of 30 minutes shall be allowed to elapse between two successive stages of load decrement. The final rebound shall be recorded 6 hours after the entire test load has been removed.

b) CYCLIC LOADING TEST

The test shall be carried out to find out separately skin friction and point bearing capacity of single pile. However, this test is not applicable for under reamed piles. The test procedure shall be as given below:

i) In general this test shall be conducted on similar lines as mentioned in Direct Loading Method. In addition, alternate loading and unloading up to zero load shall be done in steps at each stage of loading. The load increment/decrement for each steps shall be 20% of the rated capacity. The readings of all the dial gauges shall be recorded at the end of each step and the total and net settlement for each stage shall be calculated.

ii) For each stage, the loading of each steps shall be maintained for 15 minutes before reaching the maximum load. The maximum load for each stage shall be maintained for one hour. The full test load shall be maintained on the pile head for 24 hours.

iii) Each step of unloading shall be maintained for 15 minutes and the subsequent rebound in the pile shall be measured accurately.

iv) A period of 15 minutes shall be allowed to pass between the successive unloading and loading operations.

v) To find out separately skin friction and point bearing capacity of pile the procedure as given in Appendix- A of IS: 2911(Part-4) shall be followed.

9.3.5 ASSESSMENT OF SAFE LOAD

The safe vertical load on single pile from the load test shall be the least of following values:

a) 2/3 of the load at which the total settlement attains a value of 12 mm unless otherwise specified in tender documents.

b) 50% of the final load at which the total settlement equals 10 percent of the pile diameter in case of uniform diameter piles

9.4 HORIZONTAL LOAD TEST

9.4.1 EQUIPMENT AND TEST SET UP

a) The test plate shall be set in high strength grout to provide full bearing against the projected areas of the pile. The size of the test plate shall be adequate to accommodate the spherical bearing and transfer the load to the pile.

b) Sufficient clearance shall be allowed between the test pile and the datum bar for the anticipated lateral movement of the pile when datum bar (for fixing the dial gauge) is located on the opposite side to the point of load application.

9.4.2 LOADING SYSTEM

a) Loading shall be applied by a hydraulic jack of adequate capacity equipped with spherical bearing at the top of ram and bearing plate at the bottom side, abutting the pile horizontally and reacting against a suitable system.

b) The reaction may be provided by the wall of the excavated pit when the test is being conducted below ground level or by a neighboring pile, in which case thrust pieces shall be inserted on their end of the jack to make up the gap as approved by the Engineer.

c) Load shall be applied on the pile at or approximately at cut of level (COL).

9.4.3 MEASURING SYSTEM

a) The deflection shall be measured at a point diametrically opposite to the point of load application. In case such a measurements is not possible, the deflection shall be recorded using at least 2 dial gauges kept at a spacing of 30 cm. at a suitable height and the displacement interpolated at load point from similar triangles.

b) Deflection of the pile at the level of load application shall be measured by dial gauge fixed to datum bar. The datum bar shall rest on immoveable supports as described elsewhere in this specification.

9.4.4 TEST PROCEDURE

a) The test procedure shall be similar to that for vertical load test.

b) Loading on the pile shall be continued till one of the following takes place:

i. In case of Initial load test applied load reaches thrice the assumed safe lateral load capacity of deflection of pile at the loading point exceeds.

ii. In case of Routine load test, applied load reaches one and half times the assumed safe load capacity or a deflection at the loading point exceeds 5 mm

9.4.5 ASSESSMENT OF SAFE LOAD

a) The safe lateral load of single pile shall be the least of following:

i) 50 % of the load for which the total deflection is 12 mm.

ii) Load corresponding to 5 mm total deflection.

iii) Load corresponding to any other specified displacement as per performance requirement.

b) Pile groups shall be tested under conditions as per actual use in the structure as far as possible.

However, for routine test (i) above is not applicable.

NOTE: The deflection of pile is at the cut off level of the pile.

9.5 PULL OUT TEST

9.5.1 EQUIPMENTS AND TEST SET UP

Uplift force may be applied by means of hydraulic jack(s) using a suitable pullout set up as approved by the Engineer.

9.5.2 LOADING SYSTEM

a) Load shall be applied along the longitudinal axis of the pile using an approved reaction system. Uplift forces on the pile may be applied directly to the test pile or through a lever system.

b) The reaction may be provided by neighboring piles or blocks constructed for this purpose.

c) The reaction supports/blocks/piles shall be at least 2.5 times the test pile diameter.

9.5.3 MEASURING SYSTEM

a. Displacement of the pile shall be recorded using two dial gauges placed at diametrically opposite locations ad suspended from the datum bar around the pile. Datum bar shall be provided with immoveable supports as described elsewhere in this specification.

9.5.4 TEST PROCEDURE

a) The test procedure shall be similar to that for vertical load test.

b) The loading on pile shall be continued till one of the following takes place.

i. The loading on pile top equals three times the estimated safe load.

ii. The load- displacement curves shows a clear break (downward trend).

9.5.5 ASSESSMENT OF SAFE LOAD

a) The safe load of the pile shall be the least of the followings:

i. Two third of the load at which the total displacement is 12 mm.

ii. 50% of the load at which the load displacement curve shows a clear break (down work trend).

10.0 RECORDING OF DATA & PRESENTATION

10.1 The pile test data essentially concerns three variables, namely, load, displacement and time. These are to be recorded sequentially for the tests under consideration and shall be recorded in a suitable tabular form along with the information about the pile as per Annexure-A & B and Table-1 of this document.

10.2 The data may be suitably presented by curves drawn between the variables and safe loads shown on the graphs. Load displacement curve should be an assential part of presentation.

A N N E X U R E - A

P I L E D A T A

1. Reference No. Location(Co-ordinates) _____Area.

2. Sequence of Piling

3. Pile diameter & Type

4. Working Level (Platform level)

5. Cut Off Level (COL)

6. Actual Length Below COL

7. Pile Termination Level

8. Top Of Finished Concrete Level

9. Date and Time of Start and Completion of Boring

10. Depth of Ground Water Table in the Vicinity

11. Type Of Soil at pile tip

12. Method of Boring Operation

13. Details of Drilling mud as used:

    a. Freshly Supplied Mud, Liquid Limit, Sand Content, Density, Marsh Viscosity, Swelling Index, pH value.

    b. Contaminated Mud Density, Sand Content.

14. SPT (N) values in soil (from the nearest bore hole) UCS value in rock (from the nearest bore hole)

15. Chiseling, if any From..... M. To..... M.

16. Date and Time of Start and Completion of concreting.

17. Method of placing concrete.

18. Concrete Quantity:

    Actual

    Theoretical

19. Ref. Number of Test Cubes

20. Grade and Slump of concrete

21. Results of Test Cubes

22. Reinforcement Details:

Main Reinforcement	Stirrups: Type
No.:_____	No.:_____
Dia.:_____	Dia.:_____
Depth:_____	Depth:_____

23. Any other information regarding obstructions, delay and other interruption to the sequence of work

ANNEXURE - B

PILE LOAD TEST : VERTICAL / HORIZONTAL / UPLIFT

Pile No.	Date of Cast
Type of Pile	Commencement of Test
Diameter	Completion of Test
Capacity	Capacity of Jack
Type of Test Initial /routine	Jack Constant Weight of Kentiledge
Loading Method Direct / Cyclic	Reaction pile details
Type of Equipment and method of boring	Plan of Test arrangement showing position and distance of Kentiledge, Supports, tension or compression piles and reference frame to test pile etc.

Date	Time	Pressure Gauge	Load MT	Dial Gauge Reading	Average Settlement	Net(mm)	Rebound

Submission of Test Results

i , Time vs. Settlement.

ii , Load vs. Settlement Indicating the Safe Load.

TABLE-1: FREQUENCY OF SAMPLING AND TESTING

Sl.No.		Type of Material / Work	Nature of Test / Characteristics	Method of Test	No. of Samples & Frequency of Test	Acceptance Criteria
1		Pilebore size		Physical measurement`	Each Pile	drawing. Length as established by initial load test
	a.	Diameter				
	b.	Length				
2		Bentonite (Mud)				
		properties				
	a.	Basic properties of Bentonite before use.	viscosity, Specific gravity, Sand content, Swelling index, pH value	In Laboratory	Minimum one sample consisting of 3 specimen once in a week.	As per clause No. 7.03.4.
	b.	Contaminated mud from pile bore bottom before concreting	Density, Sand content	In Laboratory	piles before concreting. In case of satisfactory results, the frequency of sampling may be reduced to one in 25	be more than 1.25 Te/Cu.M. ii). Sand content shall not be more than 7%
3		Position and Alignment		Physical or any approved method.	Each Pile.	As per specification.
4		Cleaning of pilebore	As per Cl.No. 8.08.0	Each	Pilebore should be free from bored material	

SECTION - 4.0 (TECHNICALPART)

CONSTRUCTION/ERECTION, PRE-COMMISSIONING,

COMMISSIONING AND START-UP

PROJECT: INSTALLATION OF ULTRAFILTRATION UNIT AT RCF, THAL

CLIENT: RASHTRIYA CHEMICALS AND FERTILIZERS THAL, MAHARASHTRA, INDIA

CONTENTS

LIST OF ANNEXURES

1 General scope of Work and services - Construction/Erection

LSTK CONTRACTOR shall be responsible for construction and erection of the Plant/ Unit including but not limited to the following:

1.1 Construction and erection of Plant/Unit and perform all other activities required to be performed for implementation of the WORK.

1.2 Provide and supply in due course all construction Equipment and Materials, tools, and temporary facilities necessary for implementation of the WORK.

1.3 Establish and operate adequate material control system in site for receipt, unloading, inspection, maintenance, handling, storage and utilization to ensure all Equipment and Materials are preserved and available as necessary for completion of the Plant/Unit.

1.4 Provide and supply all staff, tradesmen and labours for implementation of the WORK.

1.5 Establishment of overall construction policy and procedures for the Plant/Unit.

1.6 Provision of overall management and control of construction phase of the Plant/Unit.

1.7 Ensuring that all parts of the Plant/Unit are constructed and tested strictly in accordance with the specifications and applicable codes and standards set forth in the contract.

1.8 Ensuring that construction is accomplished in accordance with the schedules.

1.9 Provide transportation of all Equipment and Materials to be provided and supplied by LSTK CONTRACTOR under the CONTRACT either from inside or outside to Site.

1.10 Construct, operate and maintain all temporary facilities required for its personnel involved in the WORK.

1.11 Provide transportation in the area of the Site and between Site and temporary facilities for all its personnel involved in the implementation of the WORK, including field labour, administrative staff, etc.

1.12 LSTK CONTRACTOR manages and supervises its Sub Contractors and field labour for the WORK.

1.13 Provide liaison with OWNER/PMC, Sub Contractors, Licensors and Vendors to ensure that the Plant/Unit is constructed in accordance with the respective standard and specifications, set forth in the CONTRACT.

1.14 Establish with OWNER/PMC adequate procedures, control and reporting systems to provide close control of the progress of the WORK.

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.

LSTK CONTRACTOR shall also ensure that all special tools and test equipment required for pre-commissioning are to be arranged at its own cost.

LSTK CONTRACTOR shall provide adequate construction labour, construction tools and equipment for pre-commissioning.

Pre-commissioning which shall be performed by LSTK CONTRACTOR shall include, but not limited to the following:

2.1 Cleaning, flushing, draining blowing out, steaming out, drying and purging of Equipment and their linings and piping systems, including the installation and removal of temporary blinds, strainers, screens etc., and the replacement of all permanent items removed while the WORK is in progress.

2.2 Chemical cleaning wherever required, including but not limited to compressor suction piping and lube and seal oil piping, heaters, supply of chemical and disposal of wastes.

2.3. Chemical cleaning of feed water systems, and steam systems. Supply of chemical and disposal of wastes.

2.4 Chemical cleaning of any other parts, which have corroded to an extent, which, will detrimentally affect Plant/Unit performance or run length for such reasons as increased fouling due to rust. Supply of chemical and disposal of wastes.

2.5 Checking, Testing, calibration simulation test and adjustment of instruments, equipment and systems including control valves and safety devices, installation and checking of orifices plates and other sensor devices in so far as this can be done before actual operation of the item concerns of complete system and loops.

2.6 Function test and checking out of electrical systems including substations, transformers, cables and switchgear, checking of all interlocks and setting of all relays. This shall include drying out operations, filtering of oil if required.

2.7 For motor driven equipment, amperage checking of motors and removal of temporary safety screens.

2.8 Cleaning of screens and filters replacement and adjustment of packing and seals and tightening of flanges.

2.9 Introduction of fuels.

2.10 Introduction of lubricants and oil flushing for machinery.

2.11 Introduction of chemical into and initial operation of treatment plant.

2.12 Boiling out, bringing up to pressure and performing all required code tests on steam generation facilities and associated instrumentation.

2.13 Drying out of stacks and all refractory lined equipment.

2.14 For all piping systems, installation and removal of temporary blinds as required, circulation and commissioning of systems including process systems, services, effluent and drainage, utilities distribution, relief and blow down and interconnecting lines.

2.15 Test running of all other rotating equipment for 24 hours wherever possible.

2.16 Adjustment of all piping expansion and support devices.

2.17 Air-drying of Plant/Unit, which is required to be water-free.

2.18 Testing (including running, tightness and vacuum) of systems, as necessary to ensure that the sections and components of Plant/Unit are ready for operation.

2.19 All such further works which LSTK CONTRACTOR judges to be necessary or in the reasonable opinion of OWNER is necessary to bring the Plant/Unit to a state of readiness for the introduction of feedstock into Process Plant/Unit for processing requirements and for safe commencement of operation.

3.0 Basic Plan for Temporary Services

Temporary Construction Facilities

The 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) 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 **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

viii. Office furniture

3.1 Sewage & Refuse Disposal

All temporary building like site office, canteen etc. shall be provided with individual septic tanks and soak pits for treatment and disposal of sanitary sewers. Construction site shall be provided with a network of temporary drain for disposal of rain water.

4.0 Mechanical Completion

Mechanical Completion means the time when all construction, erection & installation work per finally approved P&ID after HAZOP study and pre-commissioning related to the Plant is completed in accordance with the Project drawings and specifications, and all mechanical and pressure tests, including but not limited to hydro-testing, non-operating adjustments, cold alignment checks, final cleanup, hot bolting, refractory drying, field calibration of safety valves, calibration of all instruments, instrument loop checking and testing, monitoring / control / safety systems checking and testing, and all pre-commissioning activities have been completed, all incoming & outgoing services and utilities have been connected to each unit of the PLANT, interconnections of process lines and interconnection are completed and the Plant/Unit is ready in every respect for commissioning and for the first introduction of feed materials.

When OWNER is satisfied that Mechanical Completion of the plant has been achieved, OWNER shall issue certificate of Mechanical Completion to LSTK CONTRACTOR in accordance with the CONTRACT for Owner's Approval.

In order to meet this, LSTK CONTRACTOR shall perform all necessary mechanical works, tests and checks.

5.0 COMMISSIONING

5.1 Schedule for Commissioning

LSTK CONTRACTOR shall prepare a schedule for commissioning, start-up, and performance testing and initial operation in conjunction with OWNER. This shall be issued at least three months before pre commissioning of the first facility.

This schedule shall include all activities as detailed herein and any other special activities, which require to be performed during commissioning.

5.2 Commissioning

LSTK CONTRACTOR shall be responsible to perform commissioning of the Plants and to provide necessary facilities during commissioning of the Plant including the Performance Tests. LSTK CONTRACTOR shall provide commissioning engineers and supporting staff and adequate commissioning labour. LSTK Contractor shall associate OWNER’s engineers and operating staff with the commissioning work.

6.0 START UP

LSTK CONTRACTOR shall be responsible to perform start-up of the Plant/Unit. LSTK CONTRACTOR shall provide necessary facilities and for Start Up of the PLANT.

NOTE:

Detail COTRACTOR'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.

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

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

b) Fabrication shops/yard

c) Workshop for maintenance of construction/testing equipment.

d) Field drawing office

e) Temporary warehouses, including open storage yards.

f) Construction offices (including facilities for photocopying, drawing reproduction, etc.)

g) First aid.

h) Lab facilities, including NDT, for testing calibration, etc.

i) All temporary or approach roads for carrying out the WORK including temporary approach roads for access to LSTK CONTRACTOR'S site office/workshop/camp, etc. ground preparation for heavy lifts including approaches to cranes for heavy lifts. OWNER does not take any responsibility for making temporary roads.

j) Canteen & catering facilities for all LSTK CONTRACTOR'S work force.

k) All drainage around the facilities created for his WORK, and sewage disposal arrangements for labour camps/officers camps, site offices, etc.

l) Necessary transport for movement of its personnel, construction Equipment and Materials, consumables, etc.

n) Watering of roads through water tankers for dust suppression.

o) All temporary lighting for working during night.

p)All temporary hutments, sanitary & potable water and domestic sewerage requirements of LSTK Contractor's work force.

11. Supply to OWNER complete survey report within three (3) working days after completion of any survey.

12. All excess soil shall be disposed of by LSTK CONTRACTOR outside the premises in a location designated by OWNER representative.

13. Perform all nondestructive, hydrostatic and pre commissioning testing required.

14. Supply to OWNER complete test records within three (3) days after completion of actual testing.

15. Perform all welding including radiography required.

16. Provide drawings and documents as required.

17. Provide mobilization and demobilization, temporary material and temporary facilities and utilities required for executing work.

18. Provide winterization during construction, if required.

19. Provide scheduling, planning and reporting as per CONTRACT.

20. Keep complete administration and control of work, specified in CONTRACT.

21. Provide maintenance on all construction and permanent plant material as required during the CONTRACT period.

22. Perform all material identifications as per CONTRACT.

23. Perform all transportations as required.

24. Perform quality assurance, control and supply quality control documentation.

25. Perform all pre-commissioning activities as defined in the CONTRACT.

26. Provide and supply all procedures for execution of the work in accordance with drawings specifications, and applicable codes and standards.

27. Perform all other works and activities and supply all other materials which are required for completeness of the Work either mentioned in the CONTRACT or they are necessary for completeness of the Work, in compliance with highest available standards and good quality.

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**)

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.

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.

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.

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.

- 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 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

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

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 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 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.

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.
- 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.

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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.

- 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.
- 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.

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.
- 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

2.12.1 Protective coating shall consist of a coating system employing Primer, Inner Wrap and Outer Wrap.

2.12.2 The coating system shall be mechanically applied by an approved type of wrapping machine utilizing constant tension brakes except at tie-in welds, repair patches and at other locations where mechanical application is not practicable..

2.12.3 Coating and wrapping materials shall be handled, transported, stored and applied strictly in accordance with the manufacturer's instruction.

2.12.4 Wrapping Coating material is Cold tape type from **Polyken/Denso/Atla** shall be used.

2.13 Flushing and Cleaning Of Piping Systems

i) Sections fabricated in LSTK CONTRACTOR'S workshop shall be fitted with plastic end caps to seal pipe ends, and jointing surfaces shall be suitably protected.

These caps shall not be removed until sections are in the course of erection after delivery at SITE and then shall be removed for refuse.

ii) During fabrication and erection the sections shall be inspected or internal cleanliness.

iii) The water which will be used for testing and flushing of the piping system shall be recollected per instruction given by OWNER.

v) Piping systems shall be flushed with suitable water as supplied by LSTK Contractor unless designated for nitrogen or air testing or otherwise specified by licensor. OWNER'S approval is required before start of flushing.

v) LSTK CONTRACTOR shall supply all equipment, pumps, gauges, etc. required for flushing and testing of the piping systems.

vi) For hydro testing and flushing the piping LSTK CONTRACTOR shall weld and caps and install drain plugs, remove end caps after successful hydro test.

3.0 HYDRO TESTING

3.1 Inspection and hydro testing of the piping systems shall be in accordance with the drawings and specifications and in strict witness by OWNER representatives.

3.2 Atmospheric pressure systems shall be:

- Visually inspected that all joints are properly made.
- Filled with water for a 24 hours leakage test under atmospheric conditions.

If any leakage occurs in the system during testing, repairs must be made without extra costs to OWNER.

3.3 LSTK CONTRACTOR shall test all piping systems as per the project test diagrams. Testing is to be witnessed and approved by OWNER.

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.

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.

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 ^{0}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**

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 tacks.

9.0 DRAWINGS AND DOCUMENTS

LSTK CONTRACTOR shall fill in checklists as required by OWNER.

10.0 MISCELLANEOUS

10.1 LSTK CONTRACTOR shall furnish all field engineering surveying layout, and checking to properly install all above ground piping to meet all requirements of the drawings and specification.

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 .

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.

- 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.

- 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.

- 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 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 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.

7.0 DRAWINGS AND DOCUMENTS

7.1 LSTK CONTRACTOR will carry out all construction and any required procurement activities directly from the AFC construction drawings and specifications and forming part of the CONTRACT. No additional design work or development e.g. completion of drawings will be required from LSTK CONTRACTOR.

However, the plan type drawings called out to be supplied by LSTK CONTRACTOR in previous subsections of this section are included in LSTK CONTRACTOR'S scope of WORK.

7.2 All of LSTK CONTRACTOR'S drawings, calculations, documents, test reports, and test certificates are to be submitted to OWNER for approval in 6-fold. After receiving approval LSTK CONTRACTOR to submit for final approval all of the above and one (1) soft copy in CF format. LSTK CONTRACTOR drawings receiving "Approved as Noted" stamp may be worked on provided all notes are incorporated.

7.3 LSTK CONTRACTOR'S drawings shall be clearly marked with titles, equipment numbers or other item identification.

7.4 Approval of drawings and calculations by OWNER in no way absolves LSTK CONTRACTOR from its responsibility for the accuracy or for the design, construction and timely performance of the WORK.

7.5 LSTK CONTRACTOR shall promptly submit reports of each and every test or inspection.

7.6 LSTK CONTRACTOR shall submit quality records of the materials, as specified in previous sections and the applicable engineering specifications.

7.7 LSTK CONTRACTOR shall furnish an equipment installation record indicating date of installation and tag number of each piece of equipment.

7.8 LSTK CONTRACTOR shall furnish an equipment maintenance record indicating date and type or maintenance of each piece of equipment during the LSTK CONTRACTOR period.

7.9 LSTK CONTRACTOR shall fill out checklists as required by OWNER.

8.0 LIFTING, LIFTING EQUIPMENT AND GEAR

8.1 Rigging and hoisting shall be executed in accordance with construction specification local and governmental requirements and safety manuals, as well as specific equipment manufacturer's instructions. If there are conflicts the more stringent shall prevail.

8.2 LSTK CONTRACTOR shall only perform the lifts and movements in accordance with approved LSTK CONTRACTOR submitted rigging studies and plans.

8.3 Preferably, equipment will be lifted in accordance with manufacturer's instructions, if include, using lifting trunnions, lifting lugs if provided, or by slings attached to or around the equipment, with adequate protective measures to prevent damage to equipment. No temporary lifting lugs shall be used without the written approval of OWNER.

8.4 **Testing And Certification**

All LSTK CONTRACTOR furnished cranes, lifting appliances and lifting gear must be properly tested, examined and /or inspected before being used on site and at the intervals specified in

the applicable regulations. Copies of the relevant certificates must always be available on site for inspection on request by OWNER or proper authorities.

8.5 **Operation**

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

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

9.0 **WELDING**

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

10.0 **EQUIPMENT PAINTING & INSULATION TOUCH**

Rotating and special equipment to be erected by LSTK CONTRACTOR will be delivered to SITE finished painted. LSTK CONTRACTOR is responsible to apply remedial */* touch up painting for any damages to paint, or protective coatings on equipment handled by it in connection. With any aspect of this operations such as unloading. Transport, handling and **erection as per Annexure mention in ITB Section.**

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

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.

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.**

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 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.

- 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.

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 consolation 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 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.

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.

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.

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.

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 be provide required nos. of earth pit. Earth pit shall be separate for electrical and instrument requirement.

7.0 **LIFTING**

7.1 Major instrument equipment shall be rigged from points designated or suitable to accept rigging. When available, LSTK CONTRACTOR shall utilize lugs on equipment.

7.2 When establishing hoisting loads, riggings plans and crane capacities, LSTK CONTRACTOR shall adhere to the requirements and instructions as defined in the specifications and as instructed by OWNER. Any equipment handling machine i.e Hydra, cranes etc. required at that time, same shall be provided by LSTK contractor.

8.0 **TESTING AND PRECOMMISSIONING (FUNCTION TEST)**

8.1 Testing and pre-commissioning consist of the complete testing and pre-commissioning prior to commissioning, including provision of required testing apparatus and testing documents, comprising, but not limited to:

8.1.1 Check for completion and conformance to specifications.

8.1.2 Check the accessibility of all instruments and components for field adjustments, routine maintenance and removal for overhaul, and relocate as necessary.

8.1.3 Perform pressure test on all air sub headers as required by the line specifications.

8.1.4 Clean all instrument air sub headers, transmission tubing and control tubing by blowing with dry, filtered air prior to connection of instrument components

8.1.5 Leak test pneumatic transmission and control tubing, using an approved method acceptable to OWNER

8.1.6 Perform hydrostatic or, where appropriate, pneumatic pressure tests on all instrument process piping, as required by the respective line specifications. Drain and below free of water, as necessary after test.

8.1.7 Check continuity and identification of transmission and control systems for each instrument to ensure proper hookup. Perform megger and continuity tests for instrument electrical wiring. Check correct source of power, polarity and earthing (take into account intrinsically safe technology of this procedure).

8.1.8 Check the bore of the orifice plates and flow direction during and after installation.

8.1.9 Check (on/off valve and) control valves for direction of flow and proper operation, e.g. travel, action with air failure, etc.

8.1.10 Calibrate all instruments (including the instruments in the fire and gas system) and synchronize transmitter and receiver readings for each instrument loop. Check the orifice plates and flow nozzles. Set air pressure regulators.

8.1.11 Install pressure and temperature gauges after line flushing.

8.2 Check fuses, perform voltage checks and energize all electrically powered instruments, alarm and shutdown system, etc. Maintain power supply.

8.3 Set pneumatic and electronic type switches and local control by simulation of input signals.

8.4 Check thermocouples and resistance thermometer circuits from element to measuring instrument by simulation.

8.5 Check and adjust calibration of all other field and panel mounted instruments.

8.6 Complete loop functional test of all instruments, including the instruments in all package units and in the fire and gas system. Functionally test complete control loops alarm and shutdown systems and partial process sequence, etc., to verify capability to measure, operate and stroke final control elements in the direction and manner required by the process application. All test results shall be recorded and submitted to OWNER. Each test record shall include date of test, ambient temperature, climatic conditions, instruments used with serial numbers, names of test personnel and witnesses, identification of equipment, ground electrode or circuit tested.

Testing shall be scheduled at least 24 hours in advance and OWNER is to be notified by LSTK CONTRACTOR. LSTK CONTRACTOR shall advise OWNER prior to testing, of make, type and accuracy of test equipment used for above-mentioned items. All required test certificates should be of a recent date not exceeding 6 months.

9.0 PAINTING

Surface preparation and application of all required paint layers shall be executed in accordance with paint specifications and related standards.

10.0 WELDING

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.**

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.

ASTMC921Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

ASTM C1029 Specification for Spray-Applied Rigid Cellular Polyurethane Thermal Insulation

ASTM C1696-16Standard Guide for Industrial Thermal Insulation Systems

ASTM C411Standard Test Method for Hot-Surface Performance of High -Temperature Thermal Insulation

ASTM C450 Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging

ASTM C871 Test Methods for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate, and Sodium Ions

ASTM C1338 Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.

ASTM C1055 Guide for Heated System Surface Conditions that Produce Contact Burn Injuries

ASTM C1139 Specification for Fibrous Glass Thermal Insulation and Sound Absorbing Blanket and Board.

ASTM D1622 Test Method for Apparent Density of Rigid Cellular Plastics

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.

1.4 LIMITATIONS

Temperature Limits.
This standard deals with insulation applied externally on piping equipments etc. as per the table below:-

Maximum Operating Temperature	Type of Insulation
600C to 7500C for C.S., A.S. & S.S.	HOT
- 1800C to 200C	COLD

1.5 THICKNESS DESIGN BASIS

Thickness calculation method as per procedure given in ASTM C-680

1. Hot Insulation
   - Design Ambient Temperature : 35ºC
   - Design Surface Temperature : 450C
   - 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 : 35ºC
   - Design Surface Temperature : 2 ºC 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).

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 551-600 deg.C,	1st layer insulation shall be 75mm 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 Hot Pipe Bends/Elbows	For Hot Pipe Bends/Elbows ceramic fibre rigid preformed pipe bend section desity 220 -250 Kg/m3 as per IS15402.

OR

For operating temperature Upto 400 deg.C,	hybrid insulation system (1st layer of 10 mm Aerogel 1Insulation + 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/m3 conforming to IS:8183.
For operating temperature 401-650 deg.C,	hybrid insulation system (1stlayer of Mineral1 wool + 2nd layer of 10 mm Aerogel 2 Insulation) Rockwool Mattress of density 150 kg/m3 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/m³	ASTM C303
Thermal Conductivity	0.021 W/(m.K) @ 24°C 0.022 W/(m.K) @ 38°C 0.023 W/(m.K) @ 93°C 0.025 W/(m.K) @ 149°C 0.029 W/(m.K) @ 204°C 0.032 W/(m.K) @ 260°C 0.036 W/(m.K) @ 316°C 0.043 W/(m.K) @ 371°C	ASTM C177
Maximum Service Temperature	650 °C	ASTM C477
Hot Surface Performance	Pass	ASTM C411
Water Vapour Sorption	≤ 5% by weight	ASTM C1104
Flexibility	Flexible	ASTM C1101
Surface Burning Characteristic	Flame Spread Index ≤5, Smoke Developed Index ≤10	ASTM E84
Linear Shrinkage	< 2% in width & length	ASTM C356
Water absorption	Max. 8% (before conditioning) Max. 16% (after conditioning)	ASTM C1763
Compressive strength	≥ 3 psi (20.7 kPa) @ 10% compression	ASTM C165
Sag resistance	≤ 5% thickness change	ASTM C411
Stress Corrosion Performance for Use on Austenitic Stainless Steel	Pass	ASTM C795
Corrosiveness to steel	MLCR < that of 5-ppm chloride solution	ASTM C1617
Fungal resistance	No growth	ASTM C1338
Hydrophobic	Yes	

Bands/Wires for securing insulation shall be of ASTM 8209 Alloy 3003 H16 or 18-737 designation 31000 (old NS3) condition H3 or 18/8 Stainless steel.

For securing cladding on insulation on piping, aluminium band 12mm (min) X 24 SWG thick shall

be used. For securing cladding on insulation on equipment, aluminium band 20mm wide X 24 SWG shall be used.

Other insulating materials may be used provided they have the same or better properties and durability aspects.

Insulation thickness of insulating materials shall be based on design calculation of thermal conductivity, insulation class, etc. Same shall be submitted to the Owner with necessary design calculations, drawings, test certificates and durability parameters.

For Valves, Turbines & Compressors Insulation

Prefabricated factory made Ceramic Fibre or Flexible Aerogel Insulation pad to be used made out of Ceramic Fibre Blanket of density 128 kg/m3 or Flexible Aerogel Insulations encased in high temperature resistant cloth. The minimum thickness of the pad shall be –

Option 1 (Ceramic Fibre):

0 Deg.C	to	300 Deg.C	= 25mm
301 Deg.C	to	400 Deg.C	= 50mm
401 Deg.C	to	500 Deg.C	= 75mm

Option 2 (Flexible Aerogel Insulation):

0 Deg.C	to	300 Deg.C	= 15 mm
301 Deg.C	to	400 Deg.C	= 30 mm
401 Deg.C	to	500 Deg.C	= 40 mm

Removable insulation for flanges and valves, like tailor made jackets or pre formed insulation boxes, shall be suitable for quick removal and reinstallation. All tailor made jackets shall fit the actual valve/flange/equipment and secure adequate overlap to incoming insulated pipes.

Technical data sheet of the Ceramic Fiber Pad is as below:

A.	Purpose/Application This Engineering specification is for Fabric jacketed supercera ceramic Fibre insulated flexible reusable covers/pad for application on pipes: pipe fittings, valves, flanges etc vessels & equipments, tubes etc in hot services.	
01	Dimension (mm)	As per drawing/sketch provided by OEM.
02	Thickness (mm)	25-100
Specification of Protective jacketed material		
I	Vest Cover	Liner Fibre Glass Fabric
Ii	External Top Cover Fabric (for cold face)	Polymer Coated Fibre Glass fabric Temp. resistance 300 Deg. C, oil & water resistant
Iii	External Bottom Cover fabric (for hot face)	High silica cloth for Temp Resistance up to 900 Deg C
2.	Specification of insulation Material	Ceramic Fibre Blanket (As per IS 15402)

I	Classification Temperature	1260 degree Celsius			
Ii	Thickness	25 – 100mm			
Iii	Bulk Density	128kg/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 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/m3
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.)

Polyisocynaurate

Temp. Limit : Up to (-) 180˚C and 125˚C (max.)

For Cold pipe Bends/Elbows: PUF/PIR Pre-formed Pipe bend section in two halves having 40-45 kg/m3 as per IS12436.

Flexible Elastomeric Foam (FEF), NBR Based

Flexible elastomeric foam pipes and sheets shall be made of synthetic NBR rubber and conform to EN 14304 - Factory made flexible elastomeric foam (FEF).

This material is suitable to be used for designated pipework with a design line temperature of -50°C to +110°C.

FEF material properties shall comply with the requirements provided in table below.

Table: Technical Specification for Industrial Grade FEF (LTI)

Properties	Requirements	Standard
Density	65 to 80 kg/m3	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)	EN 12086, EN 13469

	(0.019 Perm-inch)	(Eq. to ASTM E96)
Leachable chloride ions	Max. 90 mg/kg	ASTM C871
Fire performance & approvals	IMO Part 2 & Part 5 Class A, < 25 Flame Spread Index Class 1 DNV Approved	IMO 2010 FTP Code ASTM E84 BS 476 part 7
pH Value	6 to 8	ISO 10523

Flexible Aerogel Insulation Blanket

Flexible aerogel insulation blanket is made of non-woven fibre blanket infused with amorphous silica aerogel. The aerogel insulation blanket shall come with factory applied vapour barrier consisting of PET-Aluminium layers.

This material is suitable to be used for designated pipe work/equipment with cryogenic and dual-temperature temperatures from -196 to 250 °C.

Flexible aerogel insulation properties shall comply with the requirements provided in table below in accordance with ASTM C1728, Type IV, Grade 1A.

Table: Technical Specification for Flexible Aerogel Insulation

Material Properties	Value	Test Standard
Blanket Thickness	5, 10, 15, 20 mm	ASTM C303
Density	160 – 240 kg/m³	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	Pass	ASTM C795

Stainless Steel		
Corrosiveness to steel	MLCR < that of 5-ppm chloride solution	ASTM C1617
Fungal resistance	No growth	ASTM C1338
Hydrophobic	Yes	

Other insulating materials may be used provided they have the same or better properties and durability aspects.

Insulation material specification/ thickness/application mentioned in this document are the minimum requirements. Insulation specification/ thickness/ application shall be based on design calculation of thermal conductivity, insulation class, relevant IS/ ASTM codes etc. Same shall be submitted to the Owner with necessary design calculations, drawings, test certificates and durability parameters. CONTRACTOR shall submit detailed material specifications, durability parameters assured, test certificates and application procedure to OWNER/ PMC approval.

3.2 AUXILIARY MATERIALS FOR CLADDING

a) Aluminium Cladding

-Horizontal Vessels

Aluminium sheet as per IS-737 (designation 31000, condition H3 for flat sheet & 31500/51300, H4 for corrugated sheets)) shall be used for cladding. Insulation on overall piping, vessel and equipment, cladding will be coated on the side in contact with insulation with 3 mil thick polysurlyn film.

Specifications for aluminium Cladding material shall be as follows:

Material	Reference Code / Standard	Thickness	Application
Aluminium sheet with applied moisture barrier of 3 mil thick Polysurlyn coating	IS : 737 / ASTM C-653	22 SWG (0.71mm)	For all piping, tanks, vessels, heat exchanger, flanges, valves, equipments etc. upto 24" outside dia
		20 SWG (0.91mm)	For piping, tanks, vessels, heat exchanger, flanges, valves etc. above 24" 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 (0IdNS3)

condition H3. For securing aluminium foil on stainless steel surface 24 SWG thick x 20mm wide aluminium bands shall be used.

b) Screws
Screws used with aluminium sheeting shall be of self tapping type, A No.8x12mm long cadmium plated / SS of high quality at intervals of 150mm.

c) S-Clips.
Aluminium, 20x1.5mm or 25mm wide stainless steel banding bent to form a shape of "S" provide a minimum lap of 50mm.

d) Bands for securing cladding.
Aluminium of dimensions 12mm width x 0.56 mm thick (24 SWG) for pipes. Stainless Steel bands Type 304, 0.4mm thick x 13mm wide for large dia pipes (above 24") and cylindrical equipment up to outside dia 900mm, 0.5mm thick x 19mm wide for cylindrical equipment above 900mm outside dia meter.

e) Quick release clips for removable covers.
Suitable quick release clips will be made as shown in fig. 7 from 20Cm width x 20 SWG aluminium sheet and some fig.7 from 20mm width x 20 SWG aluminium sheet and some suitable rectangular ring.

f) Sealant for cladding joints with Foster 95-44 /TIKI F9544/ LOID SEAL 94.
g) The vapour barrier mastic shall be Foster 60-38/39 /TIKI M6038/39/ LB 135
h) Adhesive for cold insulation shall be Foster 81-33 /TIKI P8133/ LB 83
Vapour Stops at pipe support location shall be Foster 90-66 /TIKI F9066/ LOID SEAL 96
j) Rivets: Aluminium 'POP' blind eye type / Stainless Steel 9.5mm long x 5mm dia meter.
k) Filler material shall be PUF dust or mineral wool mixed with specified adhesive shall be placed lightly so as to fill irregular voids and sealant shall be Foster

Foam Seal Sealer 30-45. Glass cloth to be used for vapour barrier reinforcement shall be open weave 10 mesh having glass fibre thickness of 5 mils.
Galvanized steel sheets/ Annealed galvanised steel sheets/ Galvanised colour coated sheet are strictly PROHIBITED for use in cladding works. Other cladding materials (except G.I.) may be used provided they have the same or better properties and durability aspects, after prior approval from Owner/PMC.
Cladding material / auxiliary material specification/ thickness/ application mentioned in this document are the minimum requirements. Cladding material/ auxiliary material specification/ thickness/ application shall be based on design calculation of thermal conductivity, insulation class, corrosion aspects, durability, relevant IS/ ASTM codes, etc. Same shall be submitted to the Owner with necessary design calculations, drawings, test certificates and durability parameters.

CONTRACTOR shall submit material specifications, durability parameters assured, test certificates and application procedure to OWNER/PMC approval.

4.0 INSPECTION.

4.1 General

All insulation material shall be subject to inspection by owner before application. In case of doubt, Owner's representative will have the liberty to get the material tested by the contractor at any approved test laboratory. Any material not meeting specified requirement will be rejected and the rejected material shall have to be replaced by the contractor with material of specified type and quality. Insulation found to be improperly installed shall be removed and reinstalled properly by the contractor.

Contractor shall maintain detailed log of various insulation works and same shall be updated on daily basis. QA/QC checks of work done and materials shall be also registered in the daily logs. Owner will have the liberty to check the logs.

4.2 Inspection

Inspection of materials and / or installation by owner shall not relieve the contractor of his responsibility to ensure that finished insulation conform to specified requirements and is free from defects, contractor shall correct any defects due to poor workmanship. Contractor shall maintain test certificates and other relevant data from manufacturer.

4.3 Test for thickness

Test for thickness shall be carried out after application. Thickness at any point shall not be less than 2mm than the indicated designed thickness and excess thickness up to 115% of the designed thickness is permissible. .

4.4 Testing for bulk density

Testing of bulk density of the insulating materials shall be carried out before the application of insulation. This should be within ± 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.

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 0C 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 materiasl 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

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 ($1\text{-}^{1}/_{4}$ 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 curved 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.

2.1 Indian Standards:

IS-5: 1994	Colors for ready mixed paints and enamels.
IS-2379: 1990	Color codes for identification of pipe lines.
IS-2629: 1985	Recommended practice for hot-dip galvanizing on iron and steel.
IS-2633: 1986	Methods for testing uniformity of coating of zinc-coated articles.
IS-8629: 1977	Code of practice for protection of iron and steel structures from atmospheric corrosion.
IS:110	Specification for Ready Mixed Paint, Brushing, Grey Filler, for Enamels, for Over Primers
IS:101	Methods of test for ready mixed paints & enamels.

2.2 Other Standards:

2.2.1 Swedish Standard: SIS-05 5900-1967 / ISO-8501-1-1988
(Surface preparations standards for Painting Steel Surface).
This standard contains photographs of the various standards on four different degrees of rusted steel and as such is preferable for inspection purpose by the Engineer-in-charge.

2.2.1 DIN: 53151 Standards for Adhesion test.

2.3 The paint manufacturer's, instructions shall be followed as far as practicable at all times. Particular attention shall be paid to the following:

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

b) Surface preparation prior to painting.

c) Mixing and thinning.

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

3.0 SURFACE PREPARATION

3.1 Metal Surface Preparation

3.1.1 Safety

All work in adjacent areas, which may negatively affect the quality of blast cleaning, and/or impose safety hazards, must be completed or stopped before the blasting operation starts.

3.1.2 Pre-cleaning

Prior to surface preparation all weld spatter shall be removed from the surface, all sharp edges ground down and all surfaces cleaned free of contaminants including chalked paint, dust, grease, oil, chemicals and salt. All shop primed surfaces shall be water washed by means of suitable solvent, by steam cleaning, with an alkaline cleaning agent if necessary or by high-pressure water, to remove contaminants prior to top-coating

3.1.3 Surface Decontamination

Surface decontamination shall be performed prior to paint application when uncoated surface is exposed to a corrosive environment or existing paint work is to be repaired.

Existing coatings shall be removed by abrasive blast cleaning, and then high pressure potable water shall be used to clean steel surfaces.

Prior to application of coatings, the surface shall be chemically checked for the presence of contaminants.

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.

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.

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 5^0C (depending on local condition)
- The metal temperature is less than 3^0C 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

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.

4.6 Wash-Up

All surface of equipments/prefabricated piping etc. Primerised / painted at Vendor shop and received at site if required shall be washed up as follow:

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

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^{O} C (Steel structures, Piping support, uninsulated CS piping, flanges, valves, stairways, walkways etc. except grating).	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	P2 : ONE coat of two pack zinc rich epoxy Primer meeting SSPC Paint 20 level 1 F1 : One coat of two packs. Polyamide Cured Epoxy. F5 : One coat of two pack aliphatic acrylic polyurethane	P2 : 60 microns F1 : 120 – 200 microns F5 : 60 microns	Total dry film thickness of paint system: 240 microns as per C4 – High durability	Total dry film thickness of paint system: 320 microns as per C5 – High durability
02	Uninsulated CS piping, flanges, valves with operating temp. From Above 90^{O} C to 200^{O} C.	Blast cleaning to near white metal grade Sa-2½, of Swedish Standards SIS-05-5900 (Latest)	P1 : One coat of Ethyl Silicate zinc rich with solvent Primer meeting SSPC Paint 20 level 1 F3 : Two coats of single pack special Oleo resinous based heat resistant ready mixed Aluminium Paint.	P1 : 75 microns F3 : 2 x 25 microns for each coat Total - 125 microns.	Total dry film thickness of paint system: 125 microns.	

Ref No.	Application	Surface Preparation	Generic Coating System	Minimum DFT	Remarks	
03	Uninsulated CS piping, flanges, valves with operating temp. Over 200^{O} C.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	P1 : One coat of Ethyl Silicate zinc rich with solvent Primer meeting SSPC Paint 20 level 1 F4 : Two coats of Heat Resisting Silicon Aluminium Paint.	P1 : 75 microns F4 : 2 x 25 microns for each coat Total - 50 microns.	Total dry film thickness of paint system: 125 microns.	
04	Insulated CS piping flanges, valves with operating temp up to 90^{O} 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^{O} C to 200^{O} 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^{O} 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^{O} 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^{O} C to 200^{o}C, to be treated at	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900	P1 : One coat of Ethyl Silicate zinc rich with solvent Primer meeting SSPC Paint 20 level 1 F3 : Two coats of	P1 : 75 microns F3 : 2 x 25 microns for each	Total dry film thickness of paint system: 125 microns.	

Ref No.	Application	Surface Preparation	Generic Coating System	Minimum DFT	Remarks
	Manufacturer's shop.	(Latest).	single pack special Oleouresinous based heat resistant ready mixed Aluminium Paint.	coat	
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	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	P1 : 75 microns F3 : 2 x 25 microns for each coat	Total dry film thickness of paint system: 125 microns.

Ref No.	Application	Surface Preparation	Generic Coating System	Minimum DFT	Remarks	
	operating temp. Up to 200°C. (With exclusion of stair ways, walk ways etc.).		heat resistant ready mixed Aluminium Paint.			
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^{O}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				

Ref No.	Application	Surface Preparation	Generic Coating System	Minimum DFT	Remarks	
		site according to environmental and operating conditions.				
18	STORAGE TANKS					
a)	Acid / Alkali CS Storage Tank (External Surface including all stair ways)	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)	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-$^{1}/_{4}$ 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	Blast cleaning to near white metal grade 2 ½, of Swedish	P1 : One coat of Ethyl Silicate zinc rich with solvent Primer meeting SSPC Paint	P1 : 75 microns F6 : 2 x 25	Total dry film thickness of paint system: 125 microns.	

Ref No.	Application	Surface Preparation	Generic Coating System	Minimum DFT	Remarks	
	from 220°C to 240°C treated at Manufacturer's shop	Standards SIS-05-5900 (Latest).	20 level 1 F6 : Temperature indicating paint	microns for each coat Total - 50 microns.		
23	PACKAGE:					
a)	Surface(CS) with operating temperature upto 90°C treated at Manufacturer's shop	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	P2 : ONE coat of two pack zinc rich epoxy Primer meeting SSPC Paint 20 level 1 F1 : One coat of two packs. Polyamide Cured Epoxy. F5 : One coat of two pack aliphatic acrylic polyurethane	P2 : 60 microns F1 : 120 – 200 microns F5 : 60 microns	Total dry film thickness of paint system: 240 microns as per C4 – High Durability	Total dry film thickness of paint system: 320 microns as per C5 – High Durability
b)	Surfaces (CS) with operating temperature upto 91° C TO 200°C, treated at manufacturer's shop.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	P1 : One coat of Ethyl Silicate zinc rich with solvent Primer meeting SSPC Paint 20 level 1 F3 : Two coats of single pack special Oleouresinous based heat resistant ready mixed Aluminium Paint.	P1 : 75 microns F3 : 2 x 25 microns for each coat	Total dry film thickness of paint system: 125 microns.	
c)	Surface (CS) with operating temp. Over 200°C, treated at manufacturer's shop.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	P1 : One coat of Ethyl Silicate zinc rich with solvent Primer meeting SSPC Paint 20 level 1 F4 : Two coats of Heat Resisting Silicon Aluminium Paint.	P1 : 75 microns F4 : 2 x 25 microns for each coat Total - 50 microns.	Total dry film thickness of paint system: 125 microns.	
d)	Package in Carbon Steel and low Alloy Steel (1-$^1/_4$ Cr through 9 Cr) with cold insulated surface treated at manufacturer's	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.	

Ref No.	Application	Surface Preparation	Generic Coating System	Minimum DFT	Remarks
	shop (Upto 60 Deg. C)				
e)	Package in Cold Insulated high alloy Steel. (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
f)	DELETED				
24	For internal surface of shell, roof of CS tanks, with operating temp. Upto 110^{o}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
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
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%
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.

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 Carcenogic)

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

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	SMOOTH	ALUMINIUM	"

Description	Colour	Ra1	Correspond. Asian Paint colors to be defined – See Note-2
90°C			
- Cooling Water Piping	SEA GREEN		"
- Fire fighting Piping	Red	3002	"
- Structures	GREY	7010	"
- Stair cases – ladders	BLACK	9005	"
- Walkwais	GREY	7010	"
- Handrails assemblies	YELLOW	1004	"
- Equipment	GREY	7035	"
- Hot equipment	SMOOTH	ALUMINIUM	"
- Fire fighting equipment	RED	3002	"
- Valves in general	GREY	7035	"
- Hot valves	SMOOTH	ALUMINIUM	"
- Safety and Fire fighting valves	RED	3002	"
- Valves handwheels	BLACK	9005	
- Electric Rotary Machines	SKY BLUE	5012	
- Electric Static Machines	GREY	7035	
- Machinery (compressors & pumps) with operating temperature less than 90°C	GREY	7035	"
- Machinery (compressors & pumps) with operating temperature above 90°C	SMOOTH	ALUMINIUM	"
FURNACES			
- Cassing 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.

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)

a) Storage Tanks A – 60 mm
b) Equipments and piping with O.D. above 600 mm A– 40 mm and
c) Equipments and pipings with O.D. from 300 to 600 mm and for machinery of great dimensions A – 20 mm
d) Equipments and pipings with O.D. less than 300 mm and for machinery with small dimensions A – 10 mm

12.2 Inscription's Colours

Inscriptions shall be Black ENI 901 (RAL 9005) on light base

Inscriptions shall be White ENI 101 (RAL 9010) on dark base

12.3 Spaces and Interspaces

Spaces between words and assemblage of numbers shall have dimensions equal to 2A

Interspaces between letters or numbers shall have dimensions equal to A.

13.0 Colour Band for piping ;-

As a rule minimum width of colour band shall confirm to the following Table:-

Nominal pipe Size	Width L (mm)
3" & below	25
4" NB-6" NB	50
8" NB-12"NB	75
14" OD & above	100

14.0 LIST OF MANUFACTURERS :

1. M/s Berger Paints
2. M/s Jensons & Nickolson
3. M/s Jotun Paints
4. M/s Asian Paints
5. M/s Grauer & Weil (India) Limited
6. M/s Shalimar paints
7. M/s Garware Paints
8. M/s Goodlass Nerolac Paints Ltd

9. M/s.HEMPEL Paints

10. M/s International Paints (Akzo Nobel Brand)

11. M/s Carboline (India) Pvt. Ltd.

12.M/s Mohan Paints

15.0 The contractor shall obtain prior approval from Engineer-In-Charge for the brands of paint material proposed to be used. The contractor shall submit the following details of paint material either at the time of bidding or soon after award of work for approval of paints.

a. Technical data sheet
b. Material safety data sheet
c. Finger printing of paint products as per ISO 20340

16.0 Owner reserves the right to take random samples and get it tested through reputed labs. In case the supplied paint material do not meet the specified performance requirements then suitable action shall be taken against the paint supplier. The decision of Engineer-In Charge shall be final and binding on the Contractor in such cases

17.0 WARRANTY:

Contractor along with Paint Manufacturer jointly shall develop the paint schemes following the system specification.

They shall jointly provide a performance guarantee for a period 5 years as stipulated below,

After 1 years – Corrosion in 3% of total painted area accepted

After 2 years – Corrosion in 6% of total painted area accepted

After 3 years – Corrosion in 9% of total painted area accepted

After 4 years – Corrosion in 12% of total painted area accepted

After 5 years – Corrosion in 15% of total painted area accepted

where spontaneous visible corrosion has broken down the paint film to a degree exceeding “Ri 3” (as defined in ISO 4628/3-2003).

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 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 plan 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.

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.
- 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.

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

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 : ……

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 : ……

ANNEXURE-7-7

Deployment Schedule of Supervisory Personnel

SL. NO.	DESCRITPION	DEPLOYMENT SCHDULE																														
		1	2	3	4	5	6	7	8	9	10	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	35	36	37	TOTAL
1	**PROJECT MANAGEMENT**																															
1.1	PROJECT MANAGER																															
1.2	PLANNING MANAGER																															
1.3	PLANNING ENGINEERS																															
2	**RESIDUAL DESIGN AND DETAILED ENGINEERING**																															
2.1	PROJECT ENGINEERING MANAGER																															
2.2	ENGINEERING COORDINATOR																															
2.3	ENGG. PERSONNEL FOR VARIOUS DISCIPLINE																															
2.3.1	CIVIL STRUCTURAL																															
(i)	ENGINEERS																															
2.3.2	PRESSURE VESSELS																															
2.3.3	MECHANICAL EQPT/ ROTARY EQPT.																															
2.3.4	PIPING																															
(i)	ENGINEERS																															
2.3.5	ELECTRICAL																															
(i)	ENGINEERS																															

2.3.6	INSTRUMENTA-TION																													
(i)	ENGINEERS																													
2.3.7	MISCELL-ANEOUS																													
3	**PROCUREMENT**																													
3.1	PURCHASE																													
3.1.1	PURCHASE MANAGER																													
3.1.2	PURCHASE COORDINATOR																													
3.1.3	PURCHASE OFFICER																													
3.2	INSPECTION																													
3.2.1	INSPECTION MANAGER																													
3.2.2	INSPECTORS																													
3.3	EXPEDITING																													
3.3.1	EXPEDITING COORDINATOR																													
3.3.2	EXPEDITORS																													
3.4	CUSTOM CLEARANCE, IMPORT LICENCE, TRANSPORTA -TION PERSONNEL																													
4	**SITE CONSTRUCTION**																													
4.1	PROJECT MANAGER																													
4.2	CONSTRUC-TION MANAGER																													
4.3	CIVIL STRUCTURAL																													
4.3.I	LEAD ENGINEER																													
4.3.2	SITE ENGINEER																													
4.3.3	SUPERVISORS																													

4.4	MECHANICAL WORKS																												
4.4.1	LEAD ENGINEER																												
4.4.2	SITE ENGINEER																												
4.4.3	SUPERVISORS																												
4.5	PIPING WORK																												
4.5.1	LEAD ENGINEER																												
4.5.2	SITE ENGINEER																												
4.5.3	SUPERVISORS																												
4.6	ELECTRICAL WORK																												
4.6.1	LEAD ENGINEER																												
4.6.2	SITE ENGINEER																												
4.6.3	SUPERVISORS																												
4.7	INSTRUMENTA-TION WORK																												
4.7.1	LEAD ENGINEER																												
4.7.2	SITE ENGINEER																												
4.7.3	SUPERVISORS																												
4.8	QUALITY ASSURANCE/ QUALITY CONTROL																												
4.8.1	QC/QA MANAGER																												
4.8.2	INSPECTOR (CIVIL)																												
4.8.3	INSPECTOR (PIPING)																												
4.8.4	INSPECTOR (MECH EQPT)																												
4.9	SAFETY ENGINEER																												
4.10	SITE ENGINEERING WORKS																												

4.10.1	ENGINEERS																											
4.10.2	SUPERVISORS																											
4.11	COMPUTER ENGINEER																											
4.12	ADMINISTRA – TION MANAGER																											
4.13	MISCELLAN-EOUS																											
4.14	WAREHOUSE PERSONNEL																											
4.15	MATERIAL MANAGER																											
4.16	COMMISSION-ING																											
i)	COMMISSION-ING COORDINATOR																											
ii)	COMM ENGINEER (SHIFT- IN-CHARGE)																											
iii)	CONTROL ROOM COORDINATOR																											
iv)	FIELD SUPERVISOR																											
v)	TECHNICIAN																											

For and on behalf of ……

Stamp & Signature : ……

Name : ……

Designation : ……

Date : ……

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																							

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
4.3	WELDING TRANS FORMERS/RE C-TIFIERS																							
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																							

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
13.4	CONCRETE PUMP CAR																							
13.5	TRANSIT MIXER																							
13.6	MIXER																							
13.7	VIBRATORS																							
13.8	COMPACTORS																							
13.9	THEODOLITES																							
14.0	OTHERS																							
14.1	INSULATION TESTING EQUIPMENT																							
14.2	SECONDARY INJECTION TESTING KIT																							
14.3	METERS, TOOLS & TACKLES ETC.																							
14.4	CALIBRATION EQUIPMENT																							
14.5	OTHER TOOLS & TACKLES																							
14.6	MULTI METERS CALIBERAT-ORS ETC.																							
14.7	INDUCTION PIPE BENDING PLANTS																							
14.8	METALOGRAPHY																							
14.9	SPECTRO-METERS																							

For and on behalf of :…

Stamp & Signature : ……

Name : ……

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 : ……

SECTION – 5.0

PROJECT EXECUTION PLAN

CONTENTS

1.0 PURPOSE:

This procedure has been prepared with the objective of :

- Defining systematic and orderly administrative relationship amongst related parties during the execution and the operation of the plant.

- Progress reporting and review of progress of work

2.0 COMMUNICATION AND GENERAL CORRESPONDENCE:

Project Manager of RCF is the sole contract for all activities of the project. Therefore all the correspondence between RCF and LSTK Contractor shall be directly done with/ by Project Manager or by his authorized representative. The Name, Address, Telephone no, Fax, email id shall be intimated during the kick off meeting.

3.0 PROJECT MANAGEMENT & EXECUTION:

3.1 Kick-Off Meeting:

Immediately after the award of job, a kick-off meeting will be held to finalize and establish the modalities and procedures to be adopted for execution of the contract based on the enquiry document, commitments made by LSTK Contractor and subsequent agreements reached between RCF/PMC and LSTK Contractor during negotiations. The kick-off meeting will be attended by key members of RCF/PMC and LSTK Contractor. These will address the following details between RCF/PMC and LSTK Contractor:

i) Execution Methodology/ Philosophy, in the line with project requirement.

ii) Project execution schedule

iii) Progress Reporting

iv) Project Co-ordination Procedures.

v) Organization Chart

vi) Construction Site related issues.

3.2 Project Procedures and Methodology:

Detailed Technical Requirements along with the Detailed Scope of Work and overall proposed implementation schedule shall be prepared by LSTK Contractor. These will form the basis for formulation of the overall Project schedule of the plant by LSTK Contractor. LSTK Contractor is required to organize his services in a systematic manner to ensure execution and completion of the unit as per the schedule. LSTK Contractor is required to submit along with his bid the methodology/procedure proposed by him for this unit together with the organizational set up proposed and bio-data of Key-personnel.

In order to achieve uniformity in execution of various activities of the Project, LSTK Contractor shall develop Engineering Design Basis and Project Procedures/

Methodologies to be adopted by the executing agency. LSTK Contractor is required to carry-out his supply of Know-How, Process Package, detailed engineering, procurement, tendering, construction supervision and management, planning scheduling, monitoring, reviewing, reporting, and Overall Project Management activities in accordance with the job specifications / procedures developed by LSTK Contractor based on the methodologies / procedures. All activities to be performed/services to be rendered by LSTK Contractor under this contract shall be monitored by RCF/PMC and will be subject to periodic reviews by the PMC. LSTK Contractor shall facilitate such reviews/monitoring by RCF/ PMC.

3.2.1 LSTK Contractor's service for engineering, procurement, tendering, construction, supervision and management, planning, scheduling, monitoring, reporting, and overall project management shall meet the requirements given in this section.

3.2.2 English language and Metric Units shall be used in all documents, drawings, reports, correspondences etc. under this contract.

3.2.3 All the drawings/documents prepared by LSTK Contractor/Sub-bidders/Vendors shall be submitted to RCF/PMC for review/Information purpose. Such review by RCF/PMC shall, however, not relieve LSTK Contractor of his responsibilities.

3.2.4 For achieving the Project schedule it may be necessary in some cases to prepare the drawings in stages and release it for construction so as to take up simultaneous execution of detail engineering and construction. Any revisions involved for the above is included in the scope of work of LSTK Contractor. Also any change required to meet the site conditions/statutory requirements shall have to be carried by LSTK Contractor at no extra cost.

3.2.5 LSTK Contractor is required to organize a Task Force of dedicated specialists from each discipline under a Project Engineering Manager who will be assisted by Engineering Coordinator. An engineering schedule will be prepared and submitted to RCF/PMC for review. This schedule shall be used for all engineering activities. The engineering coordinator shall coordinate all design and engineering activities and interact with Purchase, Inspection, expediting, C&T, tendering, planning, construction and project groups. His responsibilities shall include.

3.3 Procurement:

3.3.1 The procurement services to be provided by LSTK Contractor shall cover the purchasing, inspection, expediting, Custom clearance and transportation activities & transportation activities and demurrage charges if any.

3.3.2 Purchase:

The Purchase activities will cover all equipments and materials required for completion of the Project.

3.3.3 Inspection and Expediting

LSTK Contractor is required to organize a proper inspection and expediting system so as to ensure timely delivery of all the items/equipment meeting the specified quality criteria.

This function has to be carried out by appropriate deployment of qualified personnel who have wide experience in their respective fields. RCF/PMC will reserve the right to inspect items deemed necessary by them without any additional cost to LSTK Contractor /Sub-bidder/ vendor.

3.3.4 Customs Clearance and Transportation:

LSTK Contractor is required to organize a custom clearance and transportation (C&T) system to ensure prompt clearance of imported equipments from customs and transportation of equipments/materials to project site from Ports/Vendors works.

4.0 PROJECT PLANNING, SCHEDULING & MONITORING SYSTEM:

LSTK Contractor is required to institute and maintain a proper planning; scheduling and monitoring system and employ professionally qualified and experienced planning Engineer(s) for the Project. The system shall have latest state-of-the-art technique; to this effect. LSTK Contractor shall implement this system through the Prima Vera Project Planner. The system developed should be capable to support and enforce proper control Mechanism in the project. It should be based on hierarchical breakdown of works with elaborate level of detailing and control. The levels of controls should be such that it supports and foster controls at activity level, function level and management level with greater emphasis on target, scope and commitment at various stages of contract for accountability and action planning. Such multi-level/multi-tier system of planning, scheduling and monitoring, supports, effective information generation, assimilation, summarization and reporting in proper and adequate manner. The system shall be predictive type and should constitute pre-warning mechanism to diagnose and anticipate the problem well in advance and provide preventive features/measures. It is required that work breakdown structure should consist of details of systems, work packages, functions, work items and activities from monitoring point of view at micro level and summarization at higher levels. It is expected that the work breakdown structure coding system / methodology to be followed shall be informed / discussed with the successful LSTK Contractor during the kick-off Meeting.

Following schedules documents/reports shall be prepared and submitted by LSTK Contractor for RCF/PMC review at various stages of the Project:

- List of critical drawings.
- Breakdown of work packages to work items level.
- Input requirements of each work item/activity. s
- Schedule start and finish dates of all milestone/activities in line with overall schedule of the project.
- Overall system-wise, discipline-wise weightages for each item/activity.
- 3 month front end schedule within a week of award.

In this kick-off meeting, it will be endeavored to reach complete understanding with LSTK Contractor on activities, inputs and logic to establish Planning Documents for

Monitoring. Venue of the Kick-off Meeting to be held between the successful LSTK Contractor, PMC & RCF, shall be either at PMC's Office or RCF's Office preferably at Noida / Thal and the same would be informed subsequently.

4.1 Overall Project Schedule:

LSTK Contractor shall submit within 30 days of Fax of Intent, the work breakdown structure showing Project work load i.e. preparation of Process Package, tenders, Material Requisitions, Construction Drawings equipments etc. along with a sufficiently detailed overall project schedule in the activity network form, clearly indicating the major milestones, inter relationship / interdependencies between various activities such as process, engineering, procurement tendering, manufacture / delivery, construction etc. together with a computer analysis of critical path and floats as well as quantum of work for major activities.

The schedule will be reviewed by RCF/PMC and the comments if any shall be incorporated in the network issued for implementation within 2 weeks from receipt of comments. The network thus finalized shall form part of the Contract and will become the basis for developing further detailed activity Network. This schedule shall not be revised without the prior permission from RCF/PMC during the entire period of contract. The changes made during revision of the contract shall be approved by RCF/PMC in writing.

4.2 Detailed Activity Network:

LSTK Contractor should develop detailed activity networks for various systems/plant/ unit of the Project, based on approved overall project schedule within 2 months of fax of intent. Such networks would be computerized for further monitoring and reporting.

4.3 Progress Measurement Methodology :

LSTK Contractor is required to submit during the Kick off Meeting, the detail methodology of progress measurement of Engineering, Procurement, Manufacturing / Delivery, computation of total service/physical progress at the unit-wise level and on the overall basis. The progress basis shall be physical realization of work such as in terms of deliverables and construction quantity/volume accomplished. The amalgamation of such output across the project to compute overall progress shall be suitably established with proper rational and norms and maintained throughout the project. RCF/PMC reserves the right to modify the methodology in part or in full.

4.4 Vendor Scheduling and Monitoring

LSTK Contractor shall establish schedules for pre-ordering and post ordering for follow up. The vendor monitoring preferably should be on logical networks and commitments at least on critical items in order to monitor them on regular basis for effective control. RCF/PMC may demand such follow up procedure and logical networks for the various critical equipment at any time during the course of order execution. The manufacturing schedule shall be established and agreed with the vendors and acceptance shall be brought to the notice of RCF/PMC in time.

4.5 Construction Network :

LSTK Contractor shall prepare and submit a detailed construction network with full consideration of logistics, construction studies and method for RCF/PMC. LSTK Contractor shall describe the resources required and special construction equipments, Tools & Tackles to be mobilized. The network shall be developed subsequent of substantial progress of engineering and ordering with fairly known construction workload and quantities.

4.6 As indicated elsewhere, Project Schedules as above shall be developed/evolved using the latest version of the Prima Vera Project Planner Software Package.

4.7 Progress Reporting:

LSTK Contractor shall submit the following progress reports on a regular basis for RCF/PMC information/review.

4.7.1 Monthly Progress Report:

This report shall be submitted on a monthly basis within 7 calendar days from cutoff date, or as agreed upon, covering overall scenario of the project. The report shall include, but not limited, to the following:

- Executive summary - Summary of major events/activities.

- Schedule v/s actual percentage progress and progress curves for detailed Engineering, sub-ordering, Manufacturing/Delivery, Contracting, construction commissioning and overall. Areas of concern/problem/hold-ups, impact and recovery action plans/catch-up plan. Activities executed achievements during the months and targets for the following month. Analysis of critical activities and impact on overall completion. Chronological achievements of key events indicating schedules and actual occurrence date. Annexure giving status summary for drawings material requisitions, equipment and materials delivery, contracting & construction, Resource requirement & deployment status.

5.0 PROJECT TIME CONTROL METHODOLOGY:

5.1 The time for completion of the complete scope of work shall be strictly as per the time Schedule given in the tender document.

5.2 LSTK Contractor shall furnish the following documents along with the bid.

5.2.1 An overall schedule in the form of Network, clearly indicating all important milestones in design, engineering, fabrication, procurement construction, testing and commissioning for the plant commensurate with the overall time schedule.

5.2.2 Resource deployment schedule indicating mobilization of all critical resources including manpower and machinery for the smooth execution of the job at engineering offices, fabrication shops & construction site. The resource schedule shall also contain various construction aids envisaged to be deployed for execution.

5.2.3 Organization structure for effective project management and control, clearly indicating the

responsibility center as well as bio-data of the key personnel, who are permanent employees of LSTK Contractor, shall be identified for the project.

5.3 Within 30 days of issue of Fax / letter of intent LSTK Contractor shall finalize with RCF/PMC the following as:

5.3.1 Overall Project Schedule:

Overall Project Schedule in line with the agreed milestone and detailed to adequate work breakdown structure level covering all phases of the work such as supply of Know-how, Process Package, design engineering, procurement manufacturing, shipment, tendering & field erection. This schedule shall also include the interface activities to be provided by RCF/PMC and the dates by which such facilities are needed. LSTK Contractor shall get the scheduled submitted & reviewed by RCF/PMC and the agreed schedule shall form part of the Contract monitoring document based on which performance would be reported and evaluated. This document shall be signed by both the parties. RCF/PMC shall also review the weightage allotted to various activities and method of reporting to be adopted by LSTK Contractor. During the progress of the contract if in the opinion of RCF/PMC, desired progress as physically/sequentially is not maintained, it would be obligatory on LSTK Contractor to re-programme the work schedule in order to accommodate the backlog and/or provide work front to other agency, without any obligation to RCF / PMC.

5.3.2 LSTK Contractor at any point of time of operating would be permitted to revise the accepted schedule/control documents with RCF/PMC without changing the contractual completion date, subject to prior approval by RCF/PMC in writing.

5.3.3 The review of the performance of work would be made at different levels of management and LSTK Contractor is expected to ensure proper participation for effective reviewing and action plan.

5.3.4 LSTK Contractor should ensure availability of professionally qualified planning Engineer both at H.O and site deemed adequate by RCF/PMC.

5.3.5 LSTK Contractor at his own cost should maintain a control room at site highlighting all the features, schedule and achievements of the project.

5.3.6 Weighted percentage of each discipline/group of work shall be mutually agreed to between LSTK Contractor and RCF/PMC after the award of contract to facilitate compilation of progress.

PART – II TECHNICAL

SECTION – 6.0

BIDDER/VENDOR DOCUMENTATION SCHEDULE

INSTALLATION OF ULTRA-FILTRATION UNIT

AT

RCF, THAL

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.

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	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. Review of documents / drawings shall be categorized as follows: i) Code-3: Not accepted. New Document / Drawing to be submitted ii) Code-2: Accepted with comments as marked iii) Code-1: Final approval

LIST OF DRAWINGS & DOCUMENTS

Sl.No.	Name of Documents	With Bid	Drawings/Documents Required After Award of Contract		
		Y/N	For review/ Approval	For Information	Final approved / As-built
	PROCESS				
1	Process Flow Diagram & Process Description	**Y**	**Y**		**Y**
2	Equipment List	**Y**	**Y**		**Y**
3	List of equipment and Data sheet of all equipment and machinery items	**Y**	**Y**		**Y**
4	Material Selection diagram		**Y**		**Y**
5	P&I Diagrams		**Y**		**Y**
6	Design calculations for sizing of equipments		**Y**		**Y**
7	Raw Material & Utility Balance Diagram along with specification of raw materials & utilities	**Y**	**-**	**Y**	**-**
8	List of Instrument with brief specifications, and Instrument Interlock Diagram	**Y**	**-**	**Y**	**-**
9	Logic diagrams		**Y**		**Y**
10	Safety valve Specifications		**Y**		**Y**
11	Control philosophy and Cause & Effect diagram	**-**	**-**	**Y**	**-**
12	HAZOP Study and Compliance report		**Y**		**Y**
13	Plot Plan		**Y**		**Y**
14	Operating Manuals and maintenance manuals	**-**	**Y**		**Y**
15	List of Motors indicating variable speed & emergency power requirement, continuous & intermittent use.	**Y**	**-**	**Y**	**-**

16	Performance Guarantees as per requirement of Tender	-	Y	-	-
17	Design Basis	Y		Y	Y

PART II: TECHNICAL

SECTION – 6

DRAWINGS & DOCUMENTS

PROJECT: INSTALLATION OF ULTRAFILTRATION UNIT

AT

RCF THAL

No.	Name of Document	With Bid	Drawings/Documents Required After Award of Contract		
			For review/ approval	For information	Final Approved/ As-built
1.0	**MECHANICAL STATIC EQUIPMENT**				
STORAGE TANK					
1.1	Outline sketches showing thickness of main parts, details of internal including weight (erection & operating) and anchorage details etc.	N	-	-	-
1.2	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
1.3	Bottom And Annular Ring Layout & Weld Detail	N	Y		Y
1.4	detail of sump for drain nozzles	N		Y	Y
1.5	Shell plate layout (showing location of nozzles and manhole)	N		Y	Y
1.6	Mechanical design calculations complying with the specifications and codes.	N	Y	-	Y
1.7	Detail of wind girder	N	Y	-	Y
1.8	Stairways, intermediate & top plate form	N	-	Y	Y
1.9	Roof plate layout & weld detail	N	Y	-	Y
1.10	Detail of nozzles on shell & roof	N	-	Y	Y
1.11	Details of internals like guide rollers, roof stoppers, still wells, dip pipe, heating coil e.t.c	N	-	Y	Y
1.12	Materials test certificates duly stamped by inspecting authority (**)	N	-	-	Y
1.13	QAP & inspection and test plan (**)	N	Y	-	Y
5.14	Welding procedure and qualification test reports (**)	N	-	Y	Y
1.15	Destructive and non destructive procedure & test reports (**)	N	-	Y	Y
1.16	Heat treatment. Hydrotest procedure and time temperature charts (**)	N	-	Y	Y
1.17	Records of vacuum box test, spark test for rubber lining, plumpness, roundness, peaking, banding etc. (**)	N	-	Y	Y
1.18	Radiographic examination reports & films (**)	N	-	-	Y

No.	Name of Document	With Bid	Drawings/Documents Required After Award of Contract		
			For review/ approval	For information	Final Approved/ As-built
1.19	All final as- built shop drgs. & design calculations	N	-	Y	Y
1.20	Completion certificates (including inspection certificates, hydrostatic test certificate , local code requirements) (**)	N	-	Y	Y
1.21	Inspector's final certificate (**)			Y	Y
1.22	1. Final civil load data including details of foundation/anchor bolts 2. Foundation settlement check record(**)	N	-	Y	Y
1.23	List of spare parts and details	N	Y	-	Y
VESSEL/ FILTER/etc					
1.1	Outline sketches showing thickness of main parts, MOC, details of internal including demister, weight (erection & operating) and anchorage details	N	-	-	-
1.2	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
1.3	Detail of nozzles, manholes, accessories etc.	N	-	Y	Y
1.4	Detail of internals such as tray, tray support ring, bolting bars etc.	N	-	Y	Y
1.5	Detail of demister	N	Y	-	Y
1.6	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
1.7	Detail of packing support, demister support, grating & grating support	N	Y	-	Y
1.8	Detail of internal distributor	N	Y	-	Y
1.9	Detail of external clips such as ladder, platform, pipe support	N	-	Y	Y
1.10	Detail of insulation ,fireproofing	N	-	Y	Y
1.11	Detail of pipe davit	N	-	Y	Y

No.	Name of Document	With Bid	Drawings/Documents Required After Award of Contract		
			For review/ approval	For information	Final Approved/ As-built
1.12	Detail of lifting lug, tailing lug & trunion etc. including design calculation	N	-	Y	Y
1.13	Shell development drawings incorporating all attachments and weld seams	N	-	Y	Y
1.15	All final as- built shop drgs. & design calculations	N	-	Y	Y
1.16	Data folder as per specification	N	-	Y	Y
1.17	Materials test certificates duly stamped by inspecting authority (**)	N	-	-	Y
1.18	QAP & inspection and test plan (**)	N	Y	-	Y
1.19	Welding procedure and qualification test reports (**)	N	-	Y	Y
1.20	Destructive and non destructive procedure & test reports (**)	N	-	-	Y
1.21	Heat treatment, Hydro test procedure and time temperature charts (**)	N	-	Y	Y
1.22	Radiographic examination reports & films (**)	N	-	-	Y
1.23	Records/ drawings, charts duly approved, signed and stamped by Statutory Authorities (**)	N	-	-	Y
1.24	Completion certificates (including inspection certificate, hydrostatic test certificate , local code requirements)	N	-	-	Y
1.25	Inspector's final certificate (**)	N	-	-	Y
1.26	Packing and forwarding instruction (**)	N	-	-	Y
1.27	Transportation drawing showing overall dimension, C.G. weight and handling instructions duly approved by appropriate authority	N	-	Y	Y
1.28	Final civil load data including details of foundation/anchor bolts	N	-	Y	Y
1.29	List of spare parts and details	N	Y	-	Y

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 copes 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.

DRAWINGS & DOCUMENTS – ROTATING EQUIPMENTS

SECTION – 6.0

INSTALLATION OF ULTRAFILTRATION UNIT

OWNER: RCF, THAL

JOB NO: PC-00284

REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD
0	30.06.23	30.06.23	Issued for Client Comments	VS	VS	RR
P	05.04.23	05.04.23	Issued for Client Comments	VS	VS	RR

CONTENTS

LIST OF ATTACHMENTS

Attachment Number	Description	Number of Sheets

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:

a. Size of Drawing.
b. Discipline of Engineering for which the drawing is issued.
c. Discipline wise segregation of numbering sequence for example:
   100 Series for Process. 200 Series for Mechanical etc.

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.

LSTK contractor shall furnish general details in their technical bid like quantity (W+S) of rotating equipments, tentative PFD/PID highlighting various major equipments, design code, recommended mandatory spare list etc.

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	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.

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.

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.

<u>As Built Drawings</u>:

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.

f. 10 complete sets of full size prints of the drawings and 4 sets of reduced size prints.

g. 10 complete bound sets of Manufacturer's specifications including design calculations.

h. 10 complete sets in hard binders of the Manufacturers data book including certified prints and data for all items including test reports. Data Books shall be complete with index as tag numbers associated with Manufacturer's data shown. Equipment data shall include as a minimum requirement the principal and description of operation, drawings and dimensions, spare parts lists and un-priced purchase orders and bill of material.

i. 10 bound copies each of the Spare Parts data books and the Lubricants inventory Schedule.

j. 10 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.

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.

4.0 LIST OF DRAWINGS & DOCUMENTS

S.No	Description	With Bid (Y/N)	For Review/ Approval	For Information	Final/ Approved/ As-built
A	**Pumps (All types)**				
1.0	List of drawings / documents including drawing number, revision number, description and approval status	N	Y	-	Y
2.0	Detailed manufacturing programme (Time bar chart)	N	Y	-	Y
3.0	Certified dimensional outline drawing	N	Y	-	Y
4.0	Cross sectional drawing and bill of material	N	Y	-	Y
5.0	Shaft seal recommendation by reputed API seal manufacture, drawing and bill of material	N	Y	-	Y
6.0	Shaft coupling assembly drawing and bill of materials including allowable misalignment clearances, shaft bores & key ways dimensions with tolerances and the style of coupling guard	N	Y	-	Y
7.0	Primary & auxiliary sealing schematic and bill of materials including seal fluid, fluid flows, pressure pipe and valve sizes, instrumentation, orifice sizes, and piping arrangement drawings	N	Y	-	Y
8.0	Cooling or heating schematic and bill of materials including cooling & heating media, fluid flows, pressure, pipe and valve sizes, instrumentation, orifice sizes and piping arrangement drawings	N	Y	-	Y
9.0	Lube oil schematic and bill of materials	N	Y	-	Y
10.0	Lube oil system arrangement drawing including sizes, rating and location of all customer connections	N	Y	-	Y
11.0	Lube oil component drawings data	N	Y	-	Y
12.0	Electrical and instrumentation schematics, wiring diagrams and bill of materials	N	Y	-	Y
13.0	Electrical and instrumentation arrangement drawing and list of components	N	Y	-	Y
14.0	Performance curves	N	Y	-	Y
15.0	Pump specification sheet with complete details in Performa enclosed with enquiry / order	N	Y	-	Y

S.No	Description	With Bid (Y/N)	For Review/ Approval	For Information	Final/ Approved/ As-built
16.0	Certified foundation assembly drawing of pump with driver & all accessories mounted on base plate with load diagram for foundation design (In case of motor being procured by purchaser, motor frame details will be supplied to vendor within 4 weeks.)	N	Y	-	Y
17.0	Engineering flow diagram showing: - Lubrication & sealing lines - Flushing / washing lines - Cooling / steam lines	N	Y	-	Y
18.0	Reference list for pumps supplied in past for similar duty conditions. Reference list shall contain complete address of user, user's purchase order number, brief specifications and date of commissioning	Y	-	-	Y
19.0	Lube oil schedule	N	-	-	Y
20.0	Automatic recirculation valve assembly drawing, sectional drawing with bill of material	N	Y	-	Y
21.0	Quality Assurance Plan.	N	Y	-	-
22.0	Material test certificates and Inspection & performance test report along with dispatch clearance certificates from inspector	N	-	-	Y
23.0	Instruction manuals describing installation, operation and maintenance procedures	N	-	-	Y
24.0	Spare parts recommendations and un-price list	Y	-	-	Y
25.0	Parts catalogue complete with reference drawing nos. and sketches etc.	N	-	-	Y

SECTION – 6.0

DRAWINGS & DOCUMENTS

INSTALLATION OF ULTRA-FILTRATION UNIT

AT
RCF, THAL

LIST OF DRAWINGS & DOCUMENTS:

Sl. No.	Description	With Bid (Y/N)	For Review/ Approval	For Information	Final/ Approved/ As-built
	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

ELECTRICAL BIDDER / VENDOR DOCUMENTATION SCHEDULE

Electrical Drawing and Documents Schedule

SL. No.	Description	For Review	For Information	Final / Approved / As built
1.	Specification Sheet of each electrical equipment duly completed of all items	Y	--	Y
2.	Technical Particulars of each electrical equipment duly filled in of all items	Y	--	Y
3.	Electrical Control Philosophy	--	Y	Y
4.	Load List (Absorb & rated Power)	--	Y	Y
5.	Single Line Diagram	Y	--	Y
6.	Data Sheet of MCC, LCP, LCS, Motor, VFD, Cables etc.	Y	--	Y
7.	GA Drawing of motor	--	Y	Y
8.	GA Drawing of LCS/ Local control Panel/MCC/ Distribution Board with position of mounting/placement arrangement.	--	Y	Y
9.	Cable schedule	--	Y	Y
10.	Cable sizing calculation	N	Y	Y
11.	Power Layout-cable details(No.) To & fro from Panel to motor , LCS , LCP, PLC as per cable schedule.	--	Y	Y
12.	Earthing and Cable Tray/Rack layout	N	Y	Y
13.	QAP of MCC, LCS, Motor, VFD, Cables and other items	--	Y	Y
14.	Block interconnection diagram	--	Y	Y
15.	Schematic diagram	--	Y	Y
16.	Terminal Interconnection Drawings to & fro from MCC Panel to motor , LCS , LCP, PLC and from PLC, LCS,LCP to motor etc.	--	Y	Y
17.	Installation, Operation & Maintenance manual	--	Y	Y
18.	Catalogue of brought out items	--	Y	Y
19.	List of spares	N	--	Y
20.	Test certificates	--	--	Y
21.	Guarantee Certificates	--	--	Y

Note: Y = Yes, N = No

PART-II TECHNICAL

SECTION – 6.0

DRAWINGS & DOCUMENTS

ULTRAFILTRATION UNIT

AT RCF, THAL

CONTENTS

Sl. No.	Document Description	Document to be submitted *		
		With Bid	After order for approval	Final
E)	**INSTRUMENTATION**			
1.	List of Instruments (tag wise) indicating type of Instrument, make, model no., quantity etc.	Yes	Yes	Yes
2.	Instrument mounting and connection details		Yes	Yes
3.	Instrument & JB location layout drawings		Yes	Yes
4.	Cable Tray layout		Yes	Yes
5.	Catalogue of Instruments & System		Yes	Yes
6.	All vendor drawing & documents		Yes	Yes
7.	List of spares (item wise and quantity) for Commissioning and 2 years of operation	Yes	Yes	Yes
8.	Specification & Data sheet of Instruments	No	Yes	Yes
9.	Detail wiring/ interconnection diagram		Yes	Yes
10.	P and I Diagram	Yes	Yes	Yes
11.	I/O list	No	Yes	Yes
12.	Loop Diagram & Wiring		Yes	Yes
13.	Logic Diagram for interlock & safety (if any)	No	Yes	Yes
14.	J.B. termination drawings		Yes	Yes
15.	Instrumentation, operating, maintenance manuals		Yes	Yes
16.	Instrument Test Certificate		Yes	Yes
17.	Vendor Inspection Plan	No	Yes	Yes
18.	List of alarms (Trip set point summary)	No	Yes	Yes
19.	Schematic drawings for control system	No	Yes	Yes
20.	Control Room Layout (conceptual) with Earthing layout with Earth Pit	Yes	Yes	Yes
21.	Overall System Architecture	Yes	Yes	Yes
22.	Vendor to indicate power requirement (if any) for the control system	Yes	Yes	Yes
23.	Instrument Air Consumption Requirement	No	No	No
24.	Hook-Ups Drawing & Bill of Material	Yes	Yes	Yes
25.	Other documents necessary to have a clear understanding of the system		Yes	Yes

26.	IRP/IRC panel requirement at MCC room	No	Yes	Yes
27	CONTROL VALVE Specifications and GA drawings		Yes	Yes
28	SAFETY VALVE Specifications and GA drawings		Yes	Yes
29	CABLE SCHEDULE		Yes	Yes
30	PNEUMATIC PIPING AND TUBING		Yes	Yes
31	WIRING DIAGRAM and GA drawing OF CONTROL PANELS.		Yes	Yes
32	WIRING DIAGRAM and GA drawing OF LOCAL CONTROL PANELS & AUX CABINETS		Yes	Yes

Note: * Indicates number of sets shall be as mentioned in the main NIT.

- Above list is indicative and minimum requirement. PMC/Client may ask any document / drawing post order which shall be absolutely essential to review/approval the instrumentation scope of work as per NIT / process requirements.

PART II: TECHNICAL

SECTION – 7.0

SPARE PARTS

PROJECT: INSTALLATION OF ULTRAFILTRATION UNIT

AT

RCF-THAL

Scope of work for spares supply:

Bidders shall quote for the following spares:

a) Start-up & commissioning spares: The prices of Start-up & commissioning spares shall be included in the basic price of supply portion of LSTK. The list of spares shall be furnished by the bidder along with technical bid.

b) Mandatory spares (Consumption within 2 years): A list of mandatory spares is listed here under. Bidder shall quote price for each mandatory spares mentioned and the same shall be considered for the evaluation.

c) Recommended Spares, if any: The bidder may quote any critical recommended spares which may be the required during first 2 yrs. of plant operation along with the bid. This will not be considered for bid evaluation. The validity of the offered price for recommended spares shall be the same as bid validity. Owner will take decision for the procurement of same within the bid validity.

d) Special tools & tackles, if any: Bidder shall quote lumpsum price for such special tools and tackles and the same shall be considered for evaluation.

e) For all the above mentioned spares, bidder to indicate the itemized price for each spares.

2.1 STATIC EQUIPMENT:

Sl.No	Spare Items	Quantities
1.0	**Pressure Vessel /Filter 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	**UF MEMBRANE**	
3.1	MEMBRANE ELEMENTS	200%

Notes:

1) Quantities shown are for each equipment.
2) The parts listed are the principal parts only. Other parts shall be considered for recommendation in quantities consistent with the above table.
3) All special tools and tackles required for maintenance for critical items shall be supplied along with equipment.
4) Above mentioned spare philosophy is also applicable for each Integral static equipment in a package item.

3.0 VENDOR'S RECOMMENDED SPARE PARTS:

Contractor shall submit list of recommended spare parts of specialised items not covered under mandatory spares (For 2 year's operation spares), along with itemised price. Owner will review and decide the recommended spares required for the project.

PART-II, TECHNICAL

SECTION – 7.0

SPARE PARTS – ROTATING EQUIPMENT

REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD
0	30.06.23	30.06.23	Issued for Client Comments	VS	VS	RR
P	05.04.23	05.04.23	Issued for Client Comments (Draft)	VS	VS	RR

CONTENTS

1.0 SCOPE OF WORK FOR SPARES SUPPLY:

Bidders shall quote for the following spares:

a) **Start-up & commissioning spares:** The prices of Start-up & commissioning spares shall be included in the basic price of supply portion of LSTK.

b) **Mandatory spares (Consumption within 2 years):** A list of mandatory spares is listed here under. Bidder shall quote price for each mandatory spares mentioned and the same shall be considered for the evaluation.

c) **Recommended Spares, if any:** The bidder may quote any critical recommended spares which may be the required during first 2 yrs. of plant operation along with the bid. This will not be considered for bid evaluation. The validity of the offered price for recommended spares shall be the same as bid validity. Owner will take decision for the procurement of same within the bid validity.

d) **Special tools & tackles, if any:** Bidder shall quote lumpsum price for such special tools and tackles and the same shall be considered for evaluation.

e) For all the above mentioned spares, bidder to indicate the itemized price for each spares.

2.0 MANDATORY SPARE PARTS & OPERATIONAL SPARES:

LSTK Contractor shall supply spare parts as per list of spares as detailed below:

i) Centrifugal Pump
ii) Seal less Canned Motor Pump
iii) Reciprocating Pump
iv) Metering Pump

2.1 CENTRIFUGAL PUMP:

Sl. No.	Description	Quantity (No. of Pumps installed)			
		1	2	3	4
1.	Impeller	1 set	1 set	1 set	1 set
2.	Impeller locking nut	2 sets	2 sets	2 sets	2 sets
3.	Wear Rings	1 set	2 sets	3 sets	4 sets
4.	Shaft with keys	1 No.	1 No.	1 No.	1 No.
5.	Shaft Sleeve	1 set	2 sets	3 sets	4 sets
6.	Interstage sleeves	1 set	2 sets	3 sets	4 sets
7.	Interstage Bushes	1 set	2 sets	3 sets	4 sets
8.	Mech. Seal where	1 no.	1 no.	2 nos.	2 nos.

	applicable				
9.	'O' Rings / Springs for Mech. Seal	1 set	2 sets	3 sets	4 sets
10.	Mechanical Seal Faces	1 set	2 sets	3 sets	4 sets
11	Constant level Oiler	2 sets	2 sets	2 sets	2 sets
12	Deflectors	2 sets	2 sets	3 sets	3 sets
13	Complete coupling	1 No.	1 No.	1 No.	1 No.
14	Flexible elements, Bushes, Pins for Coupling	1 set	1 set	2 sets	2 sets
15	Bearings (DE + NDE)	1 set	2 sets	2 sets	2 sets
16	Gaskets & 'O' Rings	2 sets	3 sets	4 sets	6 sets
17	Labyrinths	2 sets	3 sets	4 sets	5 sets
18	Throat Bushing	1 No.	2 Nos.	3 Nos.	4 Nos.
19	Throttle Bushing	1 No.	2 Nos.	3 Nos.	4 Nos.
20	Oil Seals	2 sets	3 sets	4 sets	6 sets
21	Balancing drum & sleeves	1 set	1 set	2 sets	2 sets
22	Leak-off valve-gaskets, 'O' Rings and springs	2 sets	3 sets	4 sets	5 sets
23	Spares for gear box (bearings, gears and seals)	1 set	1 set	1 set	1 set

2.2 SEALLESS CANNED MOTOR PUMP:

Sl. No.	Description	Quantity (No. of Pumps installed)			
		1	2	3	4
1.	Impeller	1 set	1 set	1 set	1 set
2.	Impeller locking nut	2 sets	2 sets	2 sets	2 sets
3.	Wear Rings	1 set	1 set	1 set	1 set
4.	Bearings Set	1 set	1 set	1 set	2 sets
5.	Gaskets, shims, O-rings (set)	1 set	1 set	1 set	2 sets
6.	Back pullout assembly	1 set	1 set	1 set	1 set
7.	Stator assembly	-	-	-	1 set
8.	Any other recommended spare as per Pump manufacturer design	Qty to be recommended by pump OEM			

2.3 RECIPROCATING PUMP:

Sl No.	Description	Quantity (No. of Pumps installed)			
		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
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 bolts complete with nuts	4 Nos.	4 Nos.	6 Nos.	6 Nos.
7.	Crank shaft	1 No.	1 No.	1 No.	1 No.
8.	Lube oil pump (w/o motor)	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.	Suction valve & seat	1 set	2 sets	3 sets	4 sets
6.	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)**				
1.	Oil seals	1 set	1 set	2 sets	2 sets
2.	Lube oil pump	1 No.	1 No.	1 No.	1 No.
3.	Spare parts for lube oil pump-gears, bushes, gaskets etc	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	**Torque Converter (If**				

	Applicable)				
1.	Oil seals	1 set	2 sets	3 sets	4 sets
2.	Piston rings	1 set	2 sets	3 sets	4 sets
3.	Special gaskets	2 sets	2 sets	4 sets	4 sets
4.	Set of V - belts	1 set	1 set	2 sets	2 sets
5.	Complete couplings	1 set	1 set	1 set	1 set

2.4 METERING PUMP:

Sl. No.	Description	Quantity (No. of Pumps installed)			
		1	2	3	4
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 bolts complete with nuts	4 Nos.	4 Nos.	6 Nos.	6 Nos.
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.	Suction valves & seats	1 set	2 sets	3 sets	4 sets
6.	Discharge valves & seats	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

In case any additional spares are recommended other than the above mentioned spares e.g. based upon the recommendation of OEMs, then LSTK contractor shall consider all such spares in their scope.

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, 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.
10. If any item is not mentioned above but supplied by the bidder. Bidder to consider 10% or minimum ONE for such items.

SECTION – 7

SPARE PARTS -PIPING

INSTALLATION OF ULTRA-FILTRATION UNIT

AT
RCF, THAL

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
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.

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 ≥900# and sizes ≥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.

PART-II, TECHNICAL

SECTION – 7.0

SPARE PARTS – ELECTRICAL

CONTENTS

1.0 SPARES PARTS FOR COMMISSIONING:

LSTK Contractor shall supply spare parts and Consumables (except raw materials and Utilities supplied by others) required during Pre-commissioning & Commissioning of the plants until the package is handed over to the Owner after Performance Test.

2.0 SPARE PARTS FOR TWO YEARS OPERATION (MANDATORY):

LSTK Contractor shall supply spare parts as per list of spares for 2 years operation of the plant as detailed below:

9.0(a)	**MCC Panel --- LOW VOLTAGE SWITCHGEAR (NON-BREAKER TYPE)**	
9.1	MCCB	One no. of each rating
9.2	Bus bar support insulators	10% of installed quantity of each rating
9.3	Aux switch assembly, limit position switches, Local/ Remote selector switch, breaker control switches & other switches	10% of each rating
9.4	Aux Relays of each type used	10% of each rating
9.5	Clustered type LED	10% of each rating
9.6	CTs. of each ratio & type	10% of each rating
9.7	VTs. of each ratio & type	10% of each rating
9.8	Meters. of each type	10% of each type
9.9	Thermal over Load Relay of each rating	10% of installed quantity of each rating
9.10	Contactors of each rating	10% of installed quantity of each rating
9.11	Numerical relay of each type	One no. of each type rating
9.12	ELCB & RCBO	10% of installed quantity of each type & rating

9.0(b)	**MCC Panel --- LOW VOLTAGE SWITCHGEAR (BREAKER TYPE)**	
	Closing Coil	2 Nos of each type and rating
	Shunt Trip Coil	2 Nos of each type and rating
	Spring Charging Motor	2 Nos of each type and rating
	Numerical relay of each type	One no. of each type rating
	Contactors of each rating	One no. of each type rating
	Aux switch assembly, limit position switches, Local/ Remote selector switch, breaker control switches & other switches	One no. of each type rating
	Aux Relays of each type used	One no. of each type rating
	Clustered type LED	One no. of each type rating
	CTs. of each ratio & type	One no. of each type rating
	VTs. of each ratio & type	One no. of each type rating
	Meters. of each type	One no. of each type rating
10.0	**415V MOTORS**	
10.1	Terminal Block	2 sets of each type
10.2	Cooling fan	2 Nos. of each type & rating
10.3	Grease Nipple & Plug	2 Nos for each rating
10.4	Fan Cover	2 Nos for each rating &Type
10.5	Bearings (Driving end)	1 set
10.6	Bearings (Non driving end)	1 set
11.0	LIGHT FITTINGS	10 Nos for each type & rating
12.0	JUNCTION BOX	10 Nos for each type & rating.

13.0	LCS	3 Nos for each type & rating.

14	**VFD Spares (If applicable)**	
1	One of each type of electronic circuit board (Control card / PCB)	1 No. of each type.

PART-II, TECHNICAL

SECTION – 7.0

SPARE PARTS – INSTRUMENTATION

REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD
0	30.06.23	30.06.23	Issued for Client Comments	AKS	AKS	RKR
P	05.04.23	05.04.23	Issued for Client Comments (Draft)	AKS	AKS	RKR

Spares for commissioning and Two Years Operation shall be as per following:

Sl.No.	Part Description	Quantity Requirement
1.0	**Field Instruments**	
1.1	Pressure Gauges, Differential pressure gauges, Temperature Gauges, Differential Pressure Gauges, Draft Gauge, Field Indicators,	10% subject to minimum 1 no. of each type.
	Level Gauge- Magnetic Type	1 set of Float, Magnet/ball follower-ring gaskets of each type.
	Level Gauge	20% subject to minimum 10 number of glass of each type, size along with pair of Gaskets (Cushion & Wet Gaskets), whichever is higher. For transparent gauges, 20% of illuminators with holder and reflector
	Servo Type Level Gauges	A) 10% or minimum one number of each type of -electronic card whichever is higher
		B) 10% or minimum two sets of float/displacer with rope and deadweight assembly whichever is higher
		C) 10% or minimum one number of local indicators
	RTD / Thermocouple (with Thermowell), Thermowells, Skin Thermocouple Sets,	10% subject to minimum 1 no. of each type.
	Variable Area Flow meter	10% or minimum one no. float & set of Packing for each type, size, rating and material, whichever is higher
	Averaging Pitot Tube	Set of Gasket, O-ring, Packing for Retract Mechanism and one no. Needle Valve with each Pitot Tube.
	Pressure Switches, DP Switches, Purge Rotameters.	10% subject to minimum 1 no. of each type.
	Float and micro switch assembly for level switch,	10% subject to minimum 1 no. of each type.
	Transmitters (SMART) – Pressure, Level & Flow (i.e.DP) including remote seals, Temperature transmitters .	10% subject to minimum 1 no. of each type.
	Displacer Type Level Transmitter	10% subject to minimum 1 no. of each type of complete Displacer transmitter head unit including torque tube assembly.
	Solenoid Valves	10% subject to minimum 1 no. of each type.
	ph& conductivity Transmitter	A) Electrode 10% (subject to minimum of 2 no.) B) PCB Transmitter (10% Subject to minimum of 2) C) PCB Power 10% (Subject of minimum of 2) D) Phpreampiffier card 10% (Subject of minimum of 1)

Sl.No.	Part Description	Quantity Requirement
	Ammonia Analyzer	IR Source : 1 No Chopper & Wheel Assembly : 1 No Power Supply Board : 1 No Display Board : 1 No Amplifier Board : 1 No Consumable : 1 Set
2.0	**Installation Material**	
2.1	Instrument valves and valve manifolds	10% subject to minimum 1 no. of each type.
2.2	Tube fittings	10% subject to minimum 1 no. of each type.
2.3	Tubes	10% of the total length
2.4	Cables	10% of the total length of each type
2.5	Junction boxes and cable glands	10% subject to minimum 1 no. of each type
3.0	**Local Panel & Hardwired Console**	
	All items like Push buttons, indicators, hand switches lamps, relays selector switches, IS type indicators / Annunciators, holders etc. mounted in the local panel.	Loose supply of 10% subject to minimum of each type.
4.0	Control valves / Special control valves / Self actuated PCVs/Saunders valve	
	a. Packing and bonnet Gasket	20% spare min qty 2.
	b. Gasket set, Packing Set, / O-rings etc	20% spare min qty 2
	c. Trim set consisting of Plug with stem, Seat ring, seal ring, cage (wherever applicable) and Diaphragm.	20% spare min qty 1
	d. Accessories like, Proximity type limit switches, air filter regulators, air lock relays, boosters, position transmitter, actuator diaphragm, Actuator Seal Ring Kit (wherever applicable) , Positioner & regulator output gauges,	10% or minimum 1 no. in each type. 10% or minimum 1 no. in each type
	e. 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
	I/P Convertor	10% subject to minimum 2 no. of each type.
	Smart Positioner	10% subject to minimum 2 no. of each type
5.0	On- off valve/ shut down valve (Ball valve, butterfly valve)	a) 20% (subject, to. minimum of 1) of Air filter regulators, whichever is higher.
		b)10 % (subject, to. minimum of 1) stem and Ball/plug for each size of valve.
		c) 100 % Seal kit consisting of O rings, gaskets, Seat ring, seat gasket etc. against each valve.
		d) 20% (subject to minimum of 2) of proximity switches, whichever is higher
		e) 20% (subject to minimum of 2) of solenoid valves of each type, whichever is higher.
		f) 20% (subject, to. minimum of 1) solenoid

Sl.No.	Part Description	Quantity Requirement
		valves of each type.
		g) 10% (subject to minimum of 1 of accessories like quick exhaust valves and temperature dependent fuses whichever is higher.
	Other Accessories like, air filter regulators, air lock relays, boosters, quick exhaust valve, Positioner & regulator output gauges ,	10% or minimum 1 no. in each type.
6.0	Pressure Relief Valves	Nozzle-1, Disc-1, Spring-1 for each type & size of Relief Valve
	Breather Valves	1 Set of seal kit for each valve
	Rupture Disc	3 Nos. of Gaskets & 2 Nos. of spare discs for each Tag
7.0	**PH / conductivity /Silica** a) Transmitter b) Sensor probe	10% subject to minimum 1 No. of each type. 2 numbers with delayed delivery to ensure shelf life.
	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.
	Sample Conditioning System (applicable for all analyzers) a) Complete sample kit for sample pumps inclusive of 'O'rings, Seal ring, Diaphragm etc. b) Consumables like filters, membranes, reagents, cal. Gas, carriers c) Sample handling system fitting, valves, pressure gauges, regulators, solenoid valves, flow meters / flow switches and other components, etc. d) Vaporization system if required, which includes vaporizer, thermostat, electrical, tracing cable and heater etc. e) Cooling system if required, which includes one cooler, flow conditioning system etc	1 set for each pump For 1 year of continuous operation 10% or minimum 1 no. of each type. - 1 set - 1 set.
8.0	System oriented items like contractor supplied i.e, PLC – I/O cards, FTA Cards, CPU, Communication card, Fault Tolerant Switch, Operator Keyboard, Power supply unit / card, hard disk BPS, Diode o-ring module, barriers, signal multiplier, relays, MCBs, TA, Converters, PB, Switches, Lamps, fused terminals, Fan assembly and including all hardwired instruments Cables like FTA Cables, Communication Bus cables, etc.	10% or minimum one of each type of module / card / unit. 10% or 1 cable assemblies, each type complete with connectors, Tees, Jacks etc.
9.0	MOVs Spares	

Sl.No.	Part Description	Quantity Requirement
	Torque limit switch	10% or minimum 1 no. of each type
	Position limit switch	10% or minimum 1 no. of each type
	GLAND PACKING SET	1 Set for each type
	BODY BONNET GASKET	10% or minimum 1 no. of each type
	STEM (COMPLETE SET)	10% or minimum 1 no. of each type
	STEM DRIVE BUSH	10% or minimum 1 no. of each type

PART –II: TECHNICAL

SECTION – 8.0

INFORMATION REQUIRED IN TECHNICAL PROPOSAL

INSTALLATION OF ULTRA-FILTRATION UNIT

AT

RCF, THAL

CONTENTS

17.0	List of Deviations
18.0	Time Schedule Network
19.0	List of Vendor's not covered under ITB Vendor List
20.0	Quality Assurance & Quality Control Procedure
21.0	List of Spare Part

INFORMATION REQUIRED IN THE TECHNICAL PROPOSAL:

The Technical proposal of the bid shall include, but not necessarily be limited to the following:

1.0 DESIGN BASIS:

Design basis for all Process, Mechanical, Electrical, Instrumentation, Civil & structural items (data as required by owner & mentioned in PC00284/P-II/Sec-1.0 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 equipments

5.0 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.

6.0 Piping & Instrument Diagram (P & ID) for plant and package items design case and normal case.

7.0 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.

8.0 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.

9.0 Normal & Emergency Power Requirement and the list of equipments connected to it.

10.0 Specifications of Chemicals and their estimated Initial and yearly requirement.

11.0 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.

12.0 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.

13.0 Detailed Technical Specifications of piping & valves with approximate tonnage/quantities in the form of Bill of Material.

14.0 Comprehensive Engineering Specification/Standards and Design Codes for all types of Equipments/items including Mechanical, Electrical, Instrumentation proposed to be adopted by the Contractor.

15.0 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.

16.0 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.

17.0 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.

18.0 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.

19.0 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.

20.0 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.

21.0 Quality Assurance & Quality Control procedure to be followed by Contractor for the implementation of this project.

22.0 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 Mechanical, Electrical, and Instrument items considered for this project.

SECTION - 9.0 (TECHNICALPART)

SITE WORKING AND SAFETY CONDITIONS

PROJECT: INSTALLATION OF ULTRAFILTRATION UNIT AT RCF, THAL

CLIENT: RASHTRIYA CHEMICALS AND FERTILIZERS THAL, MAHARASHTRA, INDIA

P	03.04.2023	Draft Tender Issued for Client Comments	JKY	JKY	RRK
REV	**REV ATE**	**PURPOSE**	**PREPD**	**REVWD**	**APPD**

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1.0 SITE LOCATION

Rashtriya Chemicals and Fertilizers Limited (RCF) a Government of India Undertaking is a leading fertilizer and chemical manufacturing company with about 75% of its equity held by the Government of India. It has two operating units, one at Trombay in Mumbai and the other at Thal, Raigad district, about 100 km from Mumbai.

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 coduct will be sufficient cause for removal of such person from the site.

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.

5.3 The hours of work on LSTK Contractors / Owner and contractor shall adhere to the same.

5.4 All Construction contractors employees shall wear safety helmet and such identification marks as may be provided by LSTK contractor on work site and duly approved by Owner.

5.5 All notices displayed on the site and any instructions issued by the Owner shall be strictly adhered to by the LSTK Contractors and/or his LSTK contractor employees.

5.6 It shall be the responsibility of LSTK contractor to provide suitable accommodation including necessary facilities for their labour and staff.

5.7 LSTK contractor will arrange ID-CARD and Permits for labour as per statutory provisions for its labour, as necessary.

5.8 The LSTK contractor shall be required to maintain employment records as covered in relevant Acts and produce documentary evidence to the effect that he has discharged his obligations under the Employees Provident Fund Act 1952 for the workmen working at site.

5.9 In case the Owner becomes liable to pay any wages or dues to the labour of the LSTK Contractors or his contractor or any Govt. agency under any of the provision of the Minimum Wages Act, Workmen Compensation Act or any other law due to act of omission of the contractor, the Owner may make such payment and shall recover the sum from Contractor's bills or any other dues.

6.0 COMPLETION OF WORK

Before finally leaving site, 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:

a) 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.
b) LSTK contractor shall fence his plant, platforms, excavations etc.
c) Compliance with all electricity regulations.
d) Compliance with statutory requirements for inspection and test of all lifting appliances and auxiliary lifting gear.
e) Safety belts proposed to be used, shall be got checked by Fire & Safety Department of LSTK Contractor / OWNER in written before use.
f) Before using the lifting or pulling equipment, LSTK contractor shall carryout load test which shall be witnessed by LSTK Contractor / OWNER.

7.3 Staircase, doors or gangways shall not be obstructed in any way that will interfere with means of access of escape.

7.4 No excavations will be started without the permission of the 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 un-suitable or unsafe. No claim arising there from shall be made by the LSTK Contractor.

The LSTK contractor or any one acting on his instructions will not bring on to the site any radio active substance or any apparatus using such substances or any X ray apparatus until written permission and direction regarding the use of such equipment has been received from the Owner.

The LSTK contractor shall be responsible for the safe storage of the radio graphic sources or those of his Construction contractors.

7.6 The LSTK contractor will meet all requirements, and act on the instructions of the Owner where it is necessary to operate a permit to work system.

7.7 Where it is necessary to provide and/or store petroleum products or petroleum mixtures and explosive, the LSTK contractor shall be responsible for carrying out such provision and/or storage in accordance with the rules and regulation laid down in Petroleum Act 1934, Explosive Act 1948 and Petroleum and Carbide of Calcium Manual Published by the Chief Inspector of Explosive of India. All such storage shall have prior approvals of the OWNER/PMC. In case any approval or clearance from Explosive or any statutory authorities is required, the contractor shall be responsible for obtaining the same.

7.8 The LSTK contractor shall have his own Fire Fighting Extinguishers and Equipment.

7.9 The LSTK contractor shall be responsible for the provision of all safety notices safety equipments including the safety gadgets for his workmen required by both the relevant legislation and such as the Owner may deem necessary.

7.10 While working at heights, safety belts with lifeline shall necessarily be used.

7.11 “LSTK contractor shall employ a safety officer for safe executing the construction activities of the project who will be responsible for implementing safety requirement contained in the documents.
The safety officer shall possess a recognised degree in engineering discipline preferably, F&S or (Any branch of engineering) and had a post qualification construction experience of minimum two years.

In addition, he/she shall also possess a recognised degree or diploma in industrial safety and preferably have adequate knowledge of the language spoken by majority of the workers at the construction sites.
Contractor shall ensure physical presence of safety personnel at each work location wherever Hot Work permit is required. No work shall be started at site until above safety personnel are physically present at site. The contractor shall submit a safety organogram clearly indicating the lines of responsibility and reporting system and elaborate the responsibilities of safety personnel in the HSE MAUAL/Program. The contractor should furnish Bio-Data/Resume of the safety personnel as above, at least 01 month before the mobilization for PMC/OWNER approval.

7.12 LSTK contractor shall use only steel planks and clamps executing scaffolding. Wooden planks and rope shall not be allowed for this purpose.

7.13 LSTK contractor shall use asbestos cloth to ensure falling of weld spatters down below during above ground welding to ensure safety of electrical cables and personnel and avoiding any fire hazards.

8.0 ELECTRICAL SAFETY REGULATIONS

8.1 In no circumstances will the LSTK contractor interfere with fuse and electrical equipment belonging to the owner or other contractors.

8.2 Before the LSTK contractor connects any electrical appliances to any plug or socket belonging to the other contractor or owner, he will -

i. Satisfy the Owner that the appliance is in good working condition.

ii. Uses of matching sixes plug & does not uses bare wire to insert in socket.

iii. Inform the Owner of the maximum current rating, voltage and phase of appliance.

iv. Obtain permission of the Owner dealing the sockets to which the appliance may be connected.

v. Use distribution board with ELCB for feeding power to hand held tools.

8.3 The Owner will not grant permission to plug in until he is satisfied that-

i. The appliance is in good condition and is fitted with a suitable plug.

ii. The appliance is fitted with a suitable cable having two earth conductors, one of which shall be earthed metal sheath surrounding the cores.

8.4 No electric cable in use by the other LSTK contractor/owner will be distributed without prior permission. No weight of any description be imposed on any such cable and no ladder or similar equipment will rest against or be attached to it. Cables / Wires used shall be in good condition without cuts & in insulation & joints.

8.5 The voltage for all portable equipment e.g. drilling machines, temporary lighting etc. will not exceed 240 volts.

8.6 No work must be carried out on any live equipment. The equipment must be made safe and a “permit to work” issued before any work is carried out.

8.7 LSTK contractor shall employ electrician to maintain his temporary electrical installation.

8.8 Take necessary clearance for working in hazardous area.

9.0 REPORTING

a) The LSTK contractor must report the following information to the Owner in writing daily. Number of men employed, trades-wise,

- Progress achieved;
- Concrete pour card, if any.

b) If during excavation any materials such as but not limited to precious materials or treasure troves etc are found, the same shall be reported to owner immediately and shall be the property of owner.

10.0 GENERAL SAFETY REQUIREMENTS TO BE OBSERVED DURING SITE FABRICATION AND ERECTION BY THE CONSTRUCTION CONTRACTOR

1. Before starting the work, **LSTK contractor** should get safety work permit and should strictly follow instructions written by the concerned authority in work permit. Permit is required for all types of job i.e. Hot, Cold Excavation, Chipping, Grinding etc.

2. Smoking is strictly prohibited inside factory areas.

3. Safety appraisal and equipments shall be provided to workmen as per the nature of work. Welders shall use gloves, goggles, shields etc. during welding, gas cutting etc. All technicians shall use gloves, goggles during grinding, chipping etc. If any unsafe practice is observed Fire & Safety Sections or the authority issuing the work permit is authorized to stop the work without any prior notice.

4. Temporary fire extinguishers, water hose shall be available near work place and in case of fire, Owner's Fire & Safety Section should be immediately informed by LSTK contractor from nearest available telephone. Project Manager should also be immediately informed.

5. LSTK contractor shall secure necessary insurance of his workmen for the entire duration of works under the contract. Owner is not responsible for any accident/injury caused whatsoever, to any person employed by the Construction Contractor. However, LSTK contractor has to inform Owner's Fire & Safety Section about accident, if any, immediately.

6. Temporary switch boards, cables, wires and electrical equipments should be installed in accordance with standard electrical practice with proper earthing etc. and should have prior approval of LSTK Contractor / Owner electrical engineer. Switch board shall be suitably protected against rainwater. The cable used for welding machine should have flexible tough rubber sheathing.

7. Temporary cables and wires including welding cables should be routed as not to cluster the work areas. Also any possibility of damage to live wires by falling objects should be avoided. Temporary electrical lines for power &

lighting shall run overhead or underground so that they should not hinder the movement of men, materials and vehicles.

8. Portable hand lamps being used by construction crew shall be preferably of 24 Volts supply bulb to be protected with safety shields.

9. Earthing for welding shall not be taken through existing structure or equipments due to the very explosive nature of the plant, raw materials, reaction during process and final product. There is every possibility of fire and explosion in the equipment due to electric spark caused by loose earthing connection etc.

10. LSTK contractor should be careful while excavating so that no underground cable or pipe line is damaged. As soon as any brick cover or under ground cables are exposed he should stop the work and inform Construction Manager immediately for necessary action.

11. LSTK contractor should not leave any welding machine etc. running after the work is stopped. Before leaving the work place, Contractor should ensure that welding sets are disconnected from welding socket outlet.

12. All work areas shall be kept reasonably clear and clean for easy movement of men & material. Also all approach roads shall be free from obstacles for easy movement of cranes, vehicles, fork-lifts, trollies etc. and all debris shall be periodically removed.

13. All temporary structure and supports for erection purpose such as scaffolding, ladders, walkways, platform, shuttering etc. shall be sufficiently strong for safe use and to prevent collapse & accidental fall of workman. Same shall be removed immediately after the work is completed.

14. All workmen working at unsafe elevation during the construction activity such as concreting, plastering, welding, erection work, painting, insulation etc. shall be safe and sufficient passage and should be properly instructed to take necessary safety precautions and observe safe practice to prevent accidental fall. Safety belts and helmets shall be used wherever necessary.

15. All supervisors, welders, electricians, technicians, riggers, engaged in the work shall be adequately skilled, experienced and acquainted with standard rules, regulation & practices of the work.

16. All open trenches, pits and other excavation carried shall be barricaded out by Construction Contractor, to avoid accident.

17. All lifting tools, tackles & accessories shall be in good working condition and of suitable capacity for the purpose for which they are used. All certificates/permits/licenses etc. required under any law or regulation for the same shall be available and valid during the entire period of the execution of the work under this Work Order/Contract.

18. LSTK contractor shall not use any structure or equipments erected or under erection for fastening, lifting or flying tackle guy-ropes etc. which may impose such loads for which structure or equipments are not designed to carry. However, LSTK contractor has to get prior approval from Construction Manager of Owner before using beams, permanent structure for the above purpose.

19. When work is carried out at high elevations, it is the responsibility of the LSTK contractor to ensure that tools and materials are not left in a position where they can fall on peoples moving /working below. Where necessary, places below should be cordoned off and caution boards be provided by contractor. Also, LSTK contractor should not cut existing hand railing/structure.

20. Contractor's men must not tamper with any machines, switches, valve or equipment not connected with their work. Welding holders should not be tested on running pipe lines.

21. Nylon rope should not be used for scaffolding where hot line is running near by, because there is every possibility of wire rope catching the fire. Also, no scaffolding is to be made on hot as well as insulated lines.

22. Necessary sign boards clearly indicating "RADIOGRAPHY HAZARDS" on all the four sides of the cordoned area surrounding radiography source will have to be displayed by Construction Contractor. Surrounding area will be cordoned with the help of manila rope and his personnel will be kept for watching/guard on all the four sides to prevent entry of personnel till the radiography work is completed. Construction Contractor's personnel should be able to communicate clearly/properly to stop entry of unauthorized personnel within the area cordoned for the radiography work.

Refuse Disposal

23. Refuse must be removed daily to prevent accumulation. Materials liable to cause persons to slip or trip and fall should be cleared immediately.

24. Refuse removal teams working after work hour should be organized where normal cleaning can not cope with the build up of waste materials.

25. Projecting nails should be removed or bent over.

Personal Protective Equipments

26. Helmets should be provided for all who are exposed to the dangers of falling material or structures they might strike against.

27. Suitable eye protection should be provided for all who are exposed to flying particles, harmful glare and dangerous substances.

28. In the handling of rough objects, gloves should be provided and used.

29. Safety footwear should be provided to all who are exposed to foot injury, should be good fitting and comfortable to wear.

30. Safety belts should be provided where other means are not practicable. Both the anchorage points and lifelines provided for attaching safety belts should be of adequate strength. The umbilical line should be fixed in such a way that user's freefall will not exceed 1 metre.

31. Catch net should be used where persons are liable to fall and these should be securely supported at a level as near as possible to the working level.

32. Noise defenders should be provided for work area where the noise level exceeds 85 dBA.

33. Respiratory protection should be provided by employers and used by workers where the dust level remains high and where control at source is not practicable.

Inspection & Record Keeping

34. Where defects render the scaffolds unsafe, they should be rectified immediately. Where this is not practicable, a sign should be put warning against using it.

Winches

35. Adequate foundations should be provided for winches.

Lifting Gear

36. All lifting gear and slinging should be tested before use and thereafter inspected regularly by competent engineers. Workers should also check the lifting gear visually before using them.

37. Each piece of lifting gear should bear its safe working load, its identification number and its last inspection date. It could in addition be colour coded according to due date of inspection.

38. Wire ropes should be preserved against rusting, kinking, fraying, birdcaging and heat damage. Defective wires should be destroyed to prevent recycling.

Concrete Mixers

39. Moving parts which are liable to become nip points, such as gears, chains and rollers should be guarded.

40. Where concrete mixers are driven by internal combustion engineers, 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.

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/ Monitory incentives.
A verbal warning shall be given to the workers during the first HSE violations. A written warning shall be issued on second violations and thereafter for the third volitions; the services of worker shall be terminated. For all these violations,

Penalties' shall be imposed, separately on the contractor. Records of warning for each worker shall be kept in the records**.**

SECTION – 10

VENDOR LIST- STATIC EQUIPMENT

FOR

PROJECT: INSTALLATION OF ULTRAFILTRATION UNIT

PLANT : ULTRAFILTRATION UNIT

CLIENT : RCF-THAL

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
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	HYOSUNG CORPORATION (CS/SS/LAS only)	KOREA
52	APPARATEBAU SCHWEISS TECHNIK GMBH	AUSTRIA
53	SCHOELLER-BLECKMANN NITEC GMBH	AUSTRIA
54	OLMI SPA	ITALY
55	JAPAN STEEL WORKS LTD	JAPAN
56	DOOSAN MECATEC CO. LTD.	KOREA
57	HANJUNG DCM CO. LTD.	KOREA
58	HUNDAI HEAVY INDUSTRIES	KOREA

59	KOREA HEAVY INDUSTRIES & CONSTN. CO. LTD	KOREA
60	CHEM PROCESS SYETEM PVT. LTD. (CS/SS ONLY)	INDIA
61	COPERION IDEAL PVT. LTD.(CS,SS ND LOW ALLOY STEEL ONLY)	INDIA
62	ESSAR HEAHY ENGINEERING SERVICES	INDIA
63	PHILS HEAVY ENGINEERIG PVT. LTD.	INDIA
64	PRAJ INDUSTRIES LIMITED	INDIA
65	SPETECH PLANT EQUIPMENT PVT. LTD. (CS ONLY)	INDIA
66	TECHNO PROCESS EQUIPMENT (I) LTD.	INDIA
67	UNIVERSAL HEAT EXCHANGER LIMITED (CS/SS/LTCS only)	INDIA
68	VIJAY TANKS & VESSELS LIMITED	INDIA
69	VIJAY TANKS & VESSELS LIMITED (KANDLA) (CS/ SS ONLY)	INDIA
70	CRYOSTAR TANKS & VESSEL PVT. LTD.(CS//AS/SS ONLY)	INDIA
71	BTL EPC LIMITED (CS ONLY)	INDIA
72	THE KCP LIMITED	INDIA
73	SUNGJIN GEOTECH CO. LTD. (CS and SS only)	KOREA
74	TECKSON STEEL INDUSTRIES (SS & CS ONLY)	INDIA
75	ATV PROJECTS INDIA LIMITED (CS ONLY)	INDIA
76	PRECEISION GASIFICATION SERVICES PRIVATE LIMITED (NON IBR)	INDIA
77	NUBERG ENGINEERING LIMITED	INDIA
78	NUBERG ENGINEERING LIMITED(CS-SS ONLY)	INDIA
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
26	PATELS AIRTEMP (INDIA LIMITED (CS & SS only)	INDIA
27	PRECISION EQUIPMENTS (CHENNAI) PVT. LTD (upto 44 Kg/cm2g)	INDIA
28	RAJ ENGG. CO. (up to 30kg/cm 2 (g) CS/SS/AS (P3 & P4 only)	INDIA
29	THE ANUP ENGINEERING LIMITED	INDIA
30	BTL EPC LIMITED (up to 36 kg/cm2 (CS Only))	INDIA
31	THE INDIAN SUGAR & GENERAL ENGG. CORPN. (ISGEC), DAHEJ (Except Urea Plant Critical Equipment)	INDIA
32	ISGEC HEAVY ENGINEERING LIMITED	INDIA
33	HYOSUNG CORPORATION (CS/SS/LAS only)	KOREA
34	SCHOELLER-BLECKMANN NITEC GMBH	AUSTRIA
35	BORSING GmbH	GERMANY
36	BELLELI S.P.A	ITALY
37	FBM HUDSON ITALIANA S.p.A	ITALY
38	GE POWER (NUOVO PIGNONE SPA)	ITALY
39	ROLLE S.P.A. (11 TO 60 kg/cm2 pr.)	ITALY
40	WALTER TOSTO SpA	ITALY
41	HITACHI ZOSEN	JAPAN

42	KOBE STEEL LIMITED	JAPAN
43	MITSUBISHI HEAVY INDUSTRIES LTD.	JAPAN
44	MITSUI ENGINEERING & SHIPBUILDING CO. LTD	JAPAN
45	DOOSAN MECATEC CO. LTD.	KOREA
46	HANJUNG DCM CO. LTD.	KOREA
47	HANTECH LIMITED	KOREA
48	KOREA HEAVY INDUSTRIES & CONSTN. CO. LTD	KOREA
49	MECANICA DE LA PENA S.A.	SPAIN
50	BEAIRD INDUSTERIES LOUISIANA	U.S.A
51	CHEM PROCESS SYSTEM PVT. LTD. (CS/SS upto 30 kg/cm^2g only)	INDIA
52	CICB-CHEMICON PVT. LTD. (upto 30 kg/cm^2 only (CS only))	INDIA
53	ESSAR HEAVY ENGINEERING SERVICES	INDIA
54	FAB-TECH WORKS & CONSTRUCTIONS PRIVATE LIMITED	INDIA
55	GMM PFAULER LIMITED (CS/SS only)	INDIA
56	INDCON PROJECTS & EQUIPMENT LIMITED (for CS/LTCS/SS only upto 30 kg/cm^2g)	INDIA
57	MEENAKSHI ASSOCIATED (P) LTD. (CS/LTCS/SS upto 30 kg/cm^2g)	INDIA
58	NUBERG ENGINEERING LIMITED (CS/SS upto 30 kg/cm^2g)	INDIA
59	PHILS HEAVY ENGINEERING PVT. LTD. (upto 30 kg/cm^2g)	INDIA
60	R.D. ENGINEERS (INDIA) PVT. LTD. (upto 30 kg/cm^2g)	INDIA
61	RELIANCE FABRICATIONS PVT. LTD. (CS/SS upto 30 kg/cm^2g)	INDIA
62	SPETECH PLANT EQUIPMENT PVT. LTD. (CS upto 30 kg/cm^2g)	INDIA
63	TECHNO PROCESS EQUIPMENTS (I) LTD.	INDIA
64	NEWTON ENGINEERING AND CHEMICAL LTD.(upto 36 kg/cm^2g) (CS/SS ONLY)	INDIA
65	UNIQUE CHEMOPLANT EQUIPMENTS (CS/SS only upto 30 kg/cm^2g)	INDIA
66	UNIVERSAL HEAT EXCHANGERS LIMITED (CS/SS/LTCS upto 30 kg/cm^2g)	INDIA
67	VIJYA TANKS & VESSELS LIMITED (Upto 37 kg/cm^2g only)	INDIA
68	VIJYA TANKS & VESSELS LIMITED (KANDLA)(CS/SS upto 30 kg/cm^2g only)	INDIA
69	AERO ENGINEERS (CS only)	INDIA
70	AVADH INDUSTRIES (Upto 34 kg/cm2g), CS only	INDIA

71	GEMINI ENGI-FAB PVT. LTD. (Upto 40 Kg/cm2g)	INDIA
72	JINDAL STEEL & POWER LTD. (MACHINERY DIVISION) (CS only)	INDIA
73	PRAJ INDUSTRIES LIMITED (CS/SS ONLY)	INDIA
74	TECHNOPROCESS EQUIPMENT INDIA PVT.LTD (NON IBR)	INDIA
75	THE KCP LIMITED	INDIA
76	ALPEC CO. LTD. (CS & AS only)	KOREA
77	SUNGJIN GEOTEC CO., LTD. (CS and SS only)	KOREA
78	CRYOSTAR TANKS & VESSEL PVT. LTD.(pressure 11 to 60 kg/cm2g)(ss upto 30 kg/cm2g & CS upto 60 kg/cm2g)	INDIA
SHOP FABRICATED TANKS & NONCODED VESSELS		
1.	ALTECH INFRASTRUCTURE (INDIA) PVT. LTD.	INDIA
2.	ARTSON ENGINEERING LIMITD	INDIA
3.	BAKSHI CHEMPHARMA EQUIPMENTS PVT. LTD.	INDIA
4.	ESSAR HEAVY ENGINEERING SERVICES	INDIA
5.	FLOWLINK INDUSTRIES PVT. LTD. (CS/SS only)	INDIA
6.	G R ENGINEERING PRIVATE LIMITED	INDIA
7.	GANSONS LTD.	INDIA
8.	GAYATRI TANKS & VESSELS	INDIA
9.	GEMINI ENGI-FAB PVT. LTD.	INDIA
10.	GENERAL MECH & PROCESS EQUIPT. (P) LTD.	INDIA
11.	GODREJ & BOYCE MFG. CO. LTD.	INDIA
12.	GRANDPRIX ENGINEERING PVT. LTD	INDIA
13.	INDIA TUBE MILLS & METAL INDUSTRIES LTD.	INDIA
14.	INDUS ENGG. COMPANY	INDIA
15.	ISHAN EQUIPMENTS PVT. LTD. (CS/SS only)	INDIA
16.	KINETICS TECHNOLOGY INDIA LTD.	INDIA
17.	LAXMI ENGINEERING INDUSTRIES (BHOPAL) PRIVATE LIMITD (CS/SS only)	INDIA
18.	LLOYDS STEEL INDUSTRIES LIMITED	INDIA
19.	MABEL ENGINEERS PVT. LTD.	INDIA
20.	MULTI-MAX ENGINEERING WORKS PVT. LTD.	INDIA

21.	NEWTON ENGG. & CHEMICALS LTD.	INDIA
22.	NIVITA ENGINEERING WORKS	INDIA
23.	NOVATECH PROJECT INDIA (P) LTD.	INDIA
24.	ORIENTAL MANUFACTURERS PRIVATE LIMITED (CS/SS only)	INDIA
25.	PRECISION EQUIPMENTS (CHENNAI) PVT. LTD.	INDIA
26.	PRECISION TANKS & VESSEL	INDIA
27.	PROJECT TECHNOLOGISTS PVT. LTD.	INDIA
28.	R.D. ENGINEERS (INDIA) PVT. LTD.	INDIA
29.	RAJ ENGG. CO.	INDIA
30.	RELIANCE FABRICATIONS PVT. LTD.	INDIA
31.	SHARP TANKS & STRUCTURALS PVT. LTD.	INDIA
32.	TAS ENGINEERING CO. (P) LIMITED	INDIA
33.	TATA CHEMICALS LTD.	INDIA
34.	UNITOP ENGINEERS PVT. LTD. (Max shell Dia 4.65m. Vol 140m3)	INDIA
35.	VIJAY TANKS & VESSELS LIMITED	INDIA
36.	VIP J INDUSTRIAL ENTERPRISES PVT. LTD.	INDIA
37.	RELIABLE FABRICATION & ENGINEERING INDUSTRIES	INDIA
38.	TITANIUM TANTALUM PRODUCTS LTD.	INDIA
39.	VIJAY TANKS & VESSELS LTD. (KANDLA)	INDIA
40.	OSWAL INFRASTRUCTURE LIMITED	INDIA
41.	BTL EPC LIMITED (CS Only)	INDIA
42.	TECKSON STEEL INDUSTRIES	INDIA
43	RELIANCE FABRICATIONS PVT. LTD.	INDIA
44	ATV PROJECTS INDIA LIMITED (NON CODED VESSED ,CS ONLY)	INDIA
45	CRYOSTAR TANKS & VESSEL PVT. LTD	INDIA
46	NUBERG ENGINEERING LIMITED	

STORAGE TANKS (Site Fabricated)		
1.	ARTSON ENGINEERING LIMITD	INDIA
2.	BAKSHI CHEMPHARMA EQUIPMENTS PVT. LTD.	INDIA
3.	BRIDGE & ROOF CO.	INDIA
4.	EXPO GAS CONTAINERS LTD.	INDIA
5.	FABTECH WORKS AND CONSTRUCTION PVT. LTD.	NDIA
6.	FABTECH PROJECTS & ENGINEERS LTD. (For CS only)	INDIA

7.	FACT EINGINEERING WORKS	INDIA
8.	GANSONS LTD.	INDIA
9.	GODREJ & BOYCE MFG. CO. LTD.	INDIA
10.	INDIA TUBE MILLS & METAL INDUSTRIES LTD.	INDIA
11.	INDUS PROJECTS LTD. (FORMERLY INDUS ENGG.)	INDIA
12.	LARSEN & TOUBRO LTD.	INDIA
13.	MABEL ENGINEERS PRIVATE LIMITED	INDIA
14.	MARS DESIGN PVT. LTD.	INDIA
15.	NOVATECH PROJECTS INDIA (P) LTD.	INDIA
16.	PRECISION TANKS & VESSELS	INDIA
17.	PROJECT TECHNOLOGISTS PVT. LTD.	INDIA
18.	RAJ ENGG. CO.	INDIA
19.	SHARP TANKS & STRUCTURALS PVT. LTD.	INDIA
20.	SPS ENGINEERING LIMITED	INDIA
21.	TAS ENGINEERING CO. (P) LIMITED	INDIA
22.	TATA CHEMICALS LTD.	INDIA
23.	VIJAY TANKS & VESSELS LIMITED	INDIA
24.	NEWTON ENGG. & CHEMICAL LIMITED	INDIA
25.	LLYODS STEELS INDUSTRIES LIMITED	INDIA
26.	TECHNO PROCESS EQUIPMENTS (INDIA) PVT. LTD.	INDIA
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
3.	SONAL ENGG. PLASTIC FABRICATOR	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 FILTERATION ENGINEERS LTD	INDIA
8.	OTOKLIN PLANTS & EQUIPMENT LTD.	INDIA
9.	MULTITEX FILTERATION 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 VERFARENSTECNIK GmbH	GERMANY
17.	NORTHEAST CONTROLS EQUIPMENT CO. LTD (FOR VANE TYPE SEPARATORS)	U.S.A
RUBBER LINING		
1	ARUL RUBBERS PVT. LTD.	INDIA
2.	MIL CHENNAI	INDIA
3.	ELASTOMER LINING WORKS,AMBERNATH	INDIA

UF MEMBRANE		
1.	INGE	
2.	MEMBRANE HITECH	
3.	HYDRANAUTIC	
4.	DOW	
5.	DUPONT	
6.	Hydramem	INDIA

Note: LSTK contractor shall evaluate and decide present financial, performance Credential and Shop loading conditions of the vendors.

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.

However 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. Integral static equipment in a package shall be fabricated by package vendor/ proven Sub-suppliers & 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 .

PART-II, TECHNICAL

SECTION-10

RECOMMENDED SUB-VENDOR LIST

ROTATING EQUIPMENTS

1.0 MECHANICAL

1.1 Rotating Equipments:

Sl.No	Vendor's Name	Country
Pumps for HP BFW Service		
1.	Bharat Pumps and Compressors Ltd.	India
2.	KSB Pumps Ltd (upto 190 kg/cm2 diff. pressure)	India
3.	Sulzer Pumps India Limited (upto 960 mlc, 80 m3/hr)	India
4.	KSB AG	Germany
5.	Ebara Corporation	Japan
6.	Shin Nippon Machinery Co. Ltd	Japan
7.	Flowserve (IDP)	U.K
8.	Mather & Platt Pumps Pvt. Ltd.	India
Pumps for Chemicals/ Acid/ Alkali/ Condensate Use		
1.	A.R Wilfley India Pvt. Ltd	India
2.	Akay Industries Pvt. Ltd	India
3.	Beacon Weir Ltd	India
4.	Bharat pumps and Compressors Ltd	India
5.	ITT Corporation India Ltd. (Formerly Gould Pumps Inc.)	India
6.	Kirloskar Brothers Ltd.	India
7.	Kirloskar Ebara pumps Ltd	India
8.	Kishore pumps Pvt. Ltd	India
9.	KSB Pumps Ltd	India
10.	Microfinish Pumps Pvt. Ltd	India
11.	Sulzer pumps India Ltd. (single stage only)	India
12.	Pumpen Fabrik Ernst Vogel	Austria
13.	Ensival Moret S.A	Belgium
14.	GE Power (Nuovo Pignone Spa)	Italy
15.	Weir Gabbioneta SRL	Italy
16.	Arai pump Mfg. Co. Ltd	Japan
17.	Sanwa Hydrotech Corporation	Japan
18.	Flowserve (IDP)	U.K
19.	Labour pump Co. Ltd	U.K
20.	Gould pumps inc.	Singapore
21	Reco process pump	India
22	Leakproof Pumps	India
23.	Swelore Pumps	INDIA
Cooling water pumps (Horizontal)		
1.	A.R Wilfley India Pvt. Ltd	India
2.	Beacon Weir Ltd	India
3.	Bharat pumps and Compressors Ltd	India
4.	Flowmore Pvt. Ltd	India
5.	Jyoti Limited	India
6.	Kirloskar Brothers Ltd.	India
7.	Mather & Platt Pump Ltd.	India
8.	Voltas Ltd. (Pumps & Projects Business division)	India
9.	KSB AG	Germany
10.	Mitsubishi heavy industries Ltd	Japan
11.	Shin Nippon Machinery Co. Ltd	Japan

12.	Torishima Pump Mfg. Co. Ltd	Japan
13.	Flowserve (IDP)	U.K
Pumps for Slurry Service		
1.	A.R Wilfley India Pvt. Ltd	India
2.	Akay Industries Pvt. Ltd	India
3.	Beacon Weir Ltd	India
4.	Bharat pumps and Compressors Ltd	India
5.	Best & Crompton Engg. Co.	India
6.	Flowmore Pvt. Ltd.	India
7.	Greaves Ltd.	India
8.	Kishore Pumps Ltd	India
9.	KSB Pumps Ltd	India
10.	Microfinish Pumps Pvt. Ltd	India
11.	SU Motors Pvt. Ltd	India
12.	Sulzer Pumps India Ltd.	India
Pumps for Utility Services		
1.	Akay Industries Pvt. Limited	India
2.	BDK Enginnering Industries Ltd	India
3.	Beacon Weir Ltd	India
4.	Best & Crompton Engg. Co.	India
5.	Flowmore Pvt. Ltd.	India
6.	Flowserve India Control Ltd.	India
7.	Kirloskar Brothers Limited	India
8.	Kirloskar Ebara Pumps Limited	India
9.	Kishore Pumps Ltd	India
10.	Microfinish Pumps Pvt. Ltd	India
11.	SU Motors Pvt. Ltd	India
12.	Sulzer Pumps India Ltd.	India
13.	Kakati Karshak Industries Pvt. Ltd.,	India
14.	Mather & Platt Pumps Pvt. Ltd.	India
15	KSB PUMPS LTD	INDIA
Pumps for very low NPSH Requirements (Ammonia)		
1.	Bharat pumps & compressors Ltd	India
2.	ITT Corporation India Ltd. (Formerly Gould Pumps Inc.)	India
3.	KSB Pumps Ltd.	India
4.	Sulzer Pumps India Ltd	India
5.	KSB Guinard	France
6.	KSB AG	Germany
7.	GE Power (Nuovo Pignone Spa)	Italy
8.	Weir Gabbioneta SRL	Italy
9.	Arai Pump Mfg. Co Ltd	Japan
10.	Ebara Corporation	Japan
11.	Nikkiso Sundstrand Co. ltd	Japan
12.	Sanwa Hydritech Corporation (Only Horizontal pumps)	Japan
13.	Hayward Tyler Ltd	U.K
14.	Byron Jackson Pump	U.S.A
15.	Gould pumps inc.	Singapore

Pumps for Cooling Water service (Vertical)		
1.	Beacon Weir Ltd	India
2.	Bharat pumps and Compressors Ltd	India
3.	Flowmore Pvt. Ltd	India
4.	Jyoti Limited	India
5.	Kirloskar Brothers Ltd.	India
6.	Mather & Platt (India) Ltd.	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
Centrifugal Monoblock pump set		
1.	Crompton Greaves Ltd	India
2.	Jyoti Limited	India
3.	Kirloskar Brothers Ltd.	India
4.	Mather & Platt Pump Ltd.	India
5.	Precision Engineering Industries (small pumps upto 2 HP)	India
6.	Ujala	India
Sump Pumps		
1.	Akay Industries Pvt. Ltd	India
2.	Beacon Weir Ltd	India
3.	Kishore pumps Pvt. Ltd	India
Pumps for Chemical dosing/ Metering		
1.	Bran & Leube India	India
2.	Matz pumps private limited	India
3.	Milton Roy India (P) Ltd	India
4.	Shapo tools	India
5.	Swelore Engineering Pvt. Ltd	India
6.	V.K Pumps Industries Pvt. Ltd	India
7.	Varicon systems (Motor driven/ Pneumatic)	India
8.	Positive metering pumps(I) pvt. Ltd.	India
9.	Dosapro Millton Roy	France
10.	Lewa Herbertott Gmbh & Co	Germany
11.	Nigata Worthington pumps	Japan
12.	Nikkiso Co. Ltd.	Japan
13.	Bran & Luebbe Ltd.	U.K
Pumps for Misc. Service (Reciprocating/Rotary pumps)		
1.	A.R Wilfley India Pvt. Ltd	India
2.	Bharat pumps and compressors Ltd	India
3.	KSB Pumps Ltd.	India
4.	Sulzer Pumps India Ltd	India
5.	V.K Pumps Industries Pvt. Ltd	India
6.	UT Pumps & system 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
Rubber Lined Pumps		
1	Akay Industries Pvtltd	India
2	Hindustan Door-Oliver Ltd.	India
3	International Combustion India(P) Ltd.	India
4	Kirloskar Brothers Limited	India
5	Kirloskar Ebara Pumps Limited,	India
6	Kishore Pumps Pvt.Lto.	India
7	Ksb Pumps Limited	India
8.	Bharatpumps&Compressorsltd.	India
9	Ensival Sa	Belgium
10	Weir Gabbioneta Srl (Formerly Pompe Gabbioneta Spa)	Italy
11	Ebara Corporation	Japan
12	Shin Nippon Machinery Co. Ltd.	Japan
13	Torishima Pump Mfg.Co. Ltd.	Japan
14	Flowserve(Ldp)	U.K.
Polypropylene Pumps/Frp Pumps/PFA pumps		
1.	A.R.Wilfley India Pvt.Ltd.	India
2.	Bakubhai Ambalal	India
3.	Micro Finish Pumps Pvt.Ltd.	India
4.	Leakproof pumps	India
5.	Swelore Pumps	INDIA
Deep Tube Well Pumps		
1	Bharat Pumps&Compressorslto.	India
2	Flowmore Limited (Formerlyflowmorepvt.Lto.)	India
3	Jyoti Limited	India
4	Kirloskar Brothers Limited	India
5	Ksb Pumps Limited	India
6	Mather & Platt(India) Ltd.(A Subsidiary Of Wilose German	India
7	Precision Engineering Industries	India
8	Voltas Ltd. (Pumps & Projects Business Div.)	India
9	Ksb Guinard	France
10	Ksb Ag	Germany
11	Weir Gabbioneta Srl (Formerly Pompe Gabbioneta Spa)	Italy
Vertical Can Pumps		
1	Ksb Pumps Limited	India
2.	Sulzer Pumps India Limited	India
Vaccum Pumps And Compressors		
1	Flowmore Limited (Formerly Flowmore Pvt.Ltd.)	India
2	Kay International Limited	India

3	Mazda Limited	India
4	Premier Pumps Pvt Ltd. (Liquid Ring Vacuum Pumps & Compressors)	India
5	Slm Maneklal	India
6	Usha Compressors Ltd.	India
Axial Flow Pumps		
1	Flowmore Limited (Formerly Flowmore Pvt.Ltd.)	India
2	Kestner	India

SECTION – 10

VENDOR LIST - PIPING

INSTALLATION OF ULTRA-FILTRATION UNIT

AT
RCF, THAL

MECHANICAL – PIPING		
	CS PIPES IS-1239 (BLACK & GI)	
1	AMBICA TUBES CO.	INDIA
2	ANIL METAL CORPORATION	INDIA
3	CHETAN STEELS (Upto 6")	INDIA
4	DADU PIPES (P) LIMITED (½" to 6")	INDIA
5	GOOD LUCK STEEL TUBES LTD. (15 mm to 150 mm dia)	INDIA
6	GUJRAT STEEL TUBES LTD.	INDIA
7	HI-TECH PIPES LTD. (ERW MS / GI Pipes:½" NB to 6" NB, (Thickness 2.2 mm to 6.0 mm))	INDIA
8	INDIAN TUBE CO. (TATA DIV. OF TUBES & PIPES) (For >200M)	INDIA
9	INDUS TUBES LIMITED (½" to 6")	INDIA
10	JAY LAKSHMI STEEL & ENGINEERING CO.	INDIA
11	JINDAL PIPES LTD. (1/2" to 4")	INDIA
12	JOTINDRA STEEL & TUBES LTD. (½" to 6")	INDIA
13	KALPESH TUBE(INDIA), (TRADER) (upto a max order value Rs.25.0 lakh)	INDIA
14	MUKAT PIPES LTD	INDIA
15	NAVRATAN PIPE AND PROFILE LTD. (Upto 6")	INDIA
16	P.K.FORGE & FITTING INDUSTRIES	INDIA
17	SAGAR STEEL CORPORATION (TRADER)	INDIA
18	SANGHVI METALS (TRADER)	INDIA
19	SURINDRA ENGINEERING CO. PVT. LTD.	INDIA
20	SURYA ROSHNI LTD. (15mm to 150mm)	INDIA
21	THE BENGAL MILL STORES SUPPLY CO.(TRADER)	INDIA
22	WELSPUN GUJARAT STAHL ROHREN LIMITED (ANJAR) (Upto 6")	INDIA
23	ZENITH LIMITED	INDIA
	CS WELDED PIPES IS-3589	
1	ANIL METAL CORPORATION	INDIA
2	DADU PIPES (P) LIMITED (6" to 12" (Thickness up to 9.5 mm))	INDIA
3	EVERGREEN HARDWARE STORES	INDIA
4	GOOD LUCK STEEL TUBES LTD. (Upto 150mm dia, 8 mm thick.)	INDIA
5	GUJRAT STEEL TUBES LTD.	INDIA
6	HEAVY METAL & TUBES LIMITED	INDIA
7	HI-TECH PIPES LTD. (ERW MS / GI Pipes: 6" NB OD to 12", (Thickness 2.6 mm to 8.0 mm))	INDIA
8	INDUS TUBES LIMITED (6" to 12")	INDIA
9	JAY LAKSHMI STEEL & ENGINEERING CO.	INDIA
10	JINDAL PIPES LTD. (8" to 14")	INDIA

11	JOTINDRA STEEL & TUBES LTD. (6" to 14")	INDIA
12	KALPESH TUBE(INDIA), (TRADER)	INDIA
13	LALIT PIPES & PIPES LIMITED (16" to 64", thickness upto 20mm)	INDIA
14	MUKAT PIPES LTD	INDIA
15	NAVRATAN PIPE AND PROFILE LTD. (Upto 10")	INDIA
16	P.K.FORGE & FITTING INDUSTRIES	INDIA
17	PRATIBHA INDUSTRIES LTD., (16" NB to 24" NB, Wall Thickness: 6 mm to 20 mm)	INDIA
18	RATNAMANI METALS & TUBES LIMITED	INDIA
19	SAGAR STEEL CORPORATION (TRADER)	INDIA
20	SANGHVI METALS (TRADER)	INDIA
21	SAW PIPES	INDIA
22	SHRI RAM METALS	INDIA
23	STEEL AUTHORITY OF INDIA LTD.	INDIA
24	SURINDRA ENGINEERING CO. PVT. LTD.	INDIA
25	SURYA ROSHNI LTD. (6" to 16" ,(150mm to 400mm))	INDIA
26	THE BENGAL MILL STORES SUPPLY CO.(TRADER)	INDIA
27	WELSPUN GUJARAT STAHL ROHREN LIMITED (DAHEJ) (Upto 72" (50 mm thk.))	INDIA
28	WELSPUN GUJARAT STAHL ROHREN LIMITED (ANJAR) (Upto 100" (30 mm thk.))	INDIA
	CS WELDED PIPES TO API 5L SPIRAL/ LONG. WELDED	
1	HEAVY METAL PIPE CENTRE (UPTO 24" (Upto SCHXXS) (PDIL approved Manufacturer's Make only)	INDIA
2	JINDAL PIPES LTD. (2" TO 14")	INDIA
3	JOTINDRA STEEL & TUBES LTD. (½" TO 14")	INDIA
4	KALPESH TUBE(INDIA), (TRADER)	INDIA
5	LALIT PIPES & PIPES LTD. (16" to 64" thickness upto 20mm)	INDIA
6	MUKAT PIPES LTD.	INDIA
7	P.K.FORGE & FITTING INDUSTRIES	INDIA
8	PRATIBHA INDUSTRIES LTD. (16" to 24" thickness 6mm to 14.27mm)	INDIA
9	RATNAMANI METALS & TUBES LTD.	INDIA
10	SAGAR STEEL CORPORATION (TRADER)	INDIA
11	STEEL AUTHORITY OF INDIA LTD.	INDIA
12	SURINDRA ENGINEERING CO. PVT. LTD.	INDIA
13	SURYA ROSHINI LTD (GR. A, 3" TO 4", GR. B, 6" TO 14")	INDIA
14	THE BENGAL MILL STORES SUPPLY CO.(TRADER)	INDIA
15	WELSPUN GUJARAT STAHL ROHREN LIMITED (DAHEJ) (upto 72" (50 MM THK))	INDIA

16	WELSPUN GUJARAT STAHL ROHREN LIMITED (ANJAR) (upto 100” (30 MM THK.))	INDIA
17	ETS TROUVAY & CAUVIN	FRANCE
18	PHOCEENNE	FRANCE
19	MANNESMANN HANDEL AG	GERMANY
20	THYSSEN-KRUPP STAHLUNION GMBH	GERMANY
21	DALMINE SPA	ITALY
22	RACCORTUBI SRL	ITALY
23	KOSEI SANGYO LTD	JAPAN
24	MARUBENI ITOCHU STEEL	JAPAN
25	MITSUBISHI CORPORATION	JAPAN
26	NIPPON KOKAN	JAPAN
27	NIPPON STEEL CORPORATION	JAPAN
28	NISHITANI & CO. LTD.	JAPAN
29	NISSHO IWAI CORPORATION	JAPAN
30	OKURA & CO. LTD.	JAPAN
31	SOJITZ CORPORATION	JAPAN
32	SUMITOMO METAL INDUSTRIES LTD.	JAPAN
33	HYUNDAI CORPORATION	KOREA
34	BRITISH STEEL CORPORATION	U.K.
35	CORUS TUBES LIMITED	U.K.
36	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	BHEL (VALVES DIVISION)	INDIA
3	CHETAN STEELS (Upto 12”, SCH80)	INDIA
4	HEAVY METAL & TUBES LIMITED (upto 8”, thickness upto 18.26mm)	INDIA
5	HEAVY METAL PIPE CENTRE (UPTO 24" (upto SCHXXS) (PDIL approved Manufacturer’s make only))	INDIA
6	INDIAN TUBE CO. (TATA DEV. OF TUBES & PIPES)	INDIA
7	ISMT LIMITED	INDIA
8	JAY LAKSHMI STEELS & ENGINEERING CO.	INDIA
9	JINDAL SAW LTD.	INDIA
10	MAHARASHTRA SEAMLESS LTD.	INDIA
11	P.K.FORGE & FITTING INDUSTRIES	INDIA
12	RATNADEEP METAL & TUBES PVT. LTD. (<=168.3MM OD)	INDIA
13	SAINEST TUBES PVT. LTD. (½ “ NB TO 3” upto SCH. 160 (ASTM A 106 GR. B, A333 GR. 1 & 6 & A335 GR. P11))	INDIA

14	ETS TROUVAY & CAUVIN	FRANCE
15	PHOCEENNE	FRANCE
16	HORST KURVERS GMBH	GERMANY
17	MANNESMANN HANDEL AG	GERMANY
18	DALMINE SPA	ITALY
19	GAM RACCORDI S.P.A	ITALY
20	IBF SEAMLESS PIPES SPA	ITALY
21	RACCORTUBI SRL	ITALY
22	MARUBENI ITOCHU STEEL	JAPAN
23	MITSUBISHI CORPORATION	JAPAN
24	NIPPON STEEL CORPORATION	JAPAN
25	NISHITANI & CO. LTD.	JAPAN
26	NISSHO IWAI CORPORATION	JAPAN
27	OKURA & CO. LTD.	JAPAN
28	SOJITZ CORPORATION	JAPAN
29	SUMITOMO METAL INDUSTRIES LTD.	JAPAN
30	HYUNDAI CORPORATION	KOREA
31	AB SANDVIK STEEL	SWEDEN
32	BRITISH STEEL CORPORATION	U.K.
33	CORUS TUBES LIMITED	U.K.
34	VOMAL INTERNATIONAL LIMITED	U.K.
	SS SEAMLESS/ WELDED PIPES	
1	APEX TUBES PVT LIMITED (SEAMLESS upto 8" (SCH. 80S) & WELDED upto 48" (SCH160))	INDIA
2	BHANDARI FOILS & TUBES LIMITED (SEAMLESS upto 4" (SCH. 80) & WELDED UPTO 20" (THK. <= 8MM))	INDIA
3	CHETAN STEELS (upto 6” SCH. 40)	INDIA
4	CHOKSI TUBE COMPANY LTD.	INDIA
5	DIVINE TUBES PVT. LTD. (UPTO 8”)	INDIA
6	HEAVY METAL & TUBES LIMITED (UPTO 8" (THICKNESS UPTO 18.26 MM))	INDIA
7	HEAVY METAL PIPE CENTRE (UPTO 8" (upto SCH80S) (PDIL APPROVED MANUFACTURER'S MAKE ONLY))	INDIA
8	JAY LAKSHMI STEEL & ENGINEERING CO.	INDIA
9	JINDAL SAW LTD.	INDIA
10	KRYSTAL STEEL MANUFACTURING PVT. LTD. (upto 2" (MATERIAL UPTO GRADE SS 321))	INDIA
11	MARDALE PIPES PLUS LTD.	INDIA

12	MODERN TUBE INDUSTRIES LTD. (upto 2" (upto SS Grade 321))	INDIA
13	NUCLEAR FUEL COMPLEX	INDIA
14	P.K.FORGE & FITTING INDUSTRIES	INDIA
15	PRAKASH STEELAGE LTD. (Seamless: upto 12” & Welded: upto 24”)	INDIA
16	QUALITY STAINLESS PVT. LTD. (Seamless: upto 6”(SCH40S), Welded: upto 20”(SCH40S)(UPTO SS GRADE 316L))	INDIA
17	RATNADEEP METAL & TUBES PVT. LTD. (SMLS<=168.3MM O.D., WELDED <=50.8MM O.D.)	INDIA
18	RATNAMANI METALS & TUBES LTD.	INDIA
19	REMI EDELSTAHL TUBULARS LTD. (RAJENDRA MECHANICAL INDUSTRIES (Welded Upto 48” seamless upto 8” (Thk: upto 12.7mm))	INDIA
20	SANDVIK ASIA PVT. LTD. (¾" TO 2" (THK: UPTO 8.74 MM))	INDIA
21	SANGHVI METALS (TRADER)	INDIA
22	SCORODITE STAINLESS (INDIA) PVT. LTD. (Seamless UPTO 16"NB, Welding upto 36”)	INDIA
23	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
24	SURAJ LIMITED (SURAJ STAINLESS LIMITED)	INDIA
25	THE BENGAL MILL STORES SUPPLY CO.(TRADER)	INDIA
26	WELSPUN SPECIALITY SOLUTIONS LIMITED (UPTO 4”(ONLY FOR SEAMLESS PIPES))	INDIA
27	ZHEJIANG JIULI STAINLESS STEEL PIPE CO. LTD.	CHINA
28	ETS TROUVAY & CAUVIN	FRANCE
29	PHOCEENNE	FRANCE
30	H. BUTTING GMBH & CO. (SEAMLESS : UPTO 30" (UPTO 16MM THK) & WELDED: UPTO 72" (UPTO 64MM)	GERMANY
31	HORST KURVERS GMBH	GERMANY
32	MANNESMANN HANDEL AG	GERMANY
33	THYSSEN-KRUPP STAHLUNION GMBH	GERMANY
34	DALMINE SPA	ITALY
35	GAM RACCORDI S.P.A (THICKNESS 2” TO 24”)	ITALY
36	IBF SEAMLESS PIPES SPA	ITALY
37	RACCORTUBI SRL	ITALY
38	MARUBENI ITOCHU STEEL	JAPAN
39	MITSUBISHI CORPORATION	JAPAN
40	NIPPON STEEL CORPORATION	JAPAN
41	NISHITANI & CO. LTD.	JAPAN

42	NISSHO IWAI CORPORATION	JAPAN
43	OKURA & CO. LTD.	JAPAN
44	SOJITZ CORPORATION	JAPAN
45	SUMITOMO METAL INDUSTRIES LTD.	JAPAN
46	HYUNDAI CORPORATION	KOREA
47	T.T.I. – TUBACEX TUBOS INOXIDABLES, S.A. (Upto 10”)	SPAIN
48	AB SANDVIK STEEL	SWEDEN
49	SOSTA BV (UPTO 72" (THICKNESS UPTO 25.4 MM))	NETHERLANDS
50	VOMAL INTERNATIONAL LIMITED	U.K.
51	CORUS TUBES LIMITED	U.K.
52	BRITISH STEEL CORPORATION	U.K.
	SS SEAMLESS TUBES	
1	ANIL METAL CORPORATION	INDIA
2	APEX TUBES PVT. LIMITED (UPTO 50.8 MM OD (THICKNESS UPTO 4.00 MM))	INDIA
3	BHANDARI FOILS & TUBES LIMITED (UPTO 50MM OD)	INDIA
4	DIVINE TUBES PVT. LTD. (UPTO 3”)	INDIA
5	HEAVY METAL & TUBES LIMITED (UPTO 8" (THICKNESS UPTO 18.26 MM))	INDIA
6	KRYSTAL STEEL MANUFACTURING PVT. LTD. (UPTO 50.8 MM OD (MATERIAL UPTO GRADE SS 321))	INDIA
7	MODERN TUBE INDUSTRIES LIMITED (UPTO 50.80 MM OD (UPTO SS GRADE 321))	INDIA
8	PRAKASH STEELAGE LTD. (114.3 mm OD, Thickness upto 6 mm)	INDIA
9	RATNAMANI METALS & TUBES LTD.	INDIA
10	SANDVIK ASIA PVT. LTD. (OD UPTO 60.33 (THK: UPTO 8.74 MM))	INDIA
11	SCORODITE STAINLESS (INDIA) PVT.LTD. (19.05 mm OD TO 50.80mm OD, Thickness upto 3mm)	INDIA
12	SURAJ LIMITED (SURAJ STAINLESS LIMITED)	INDIA
13	WELSPUN SPECIALITY SOLUTIONS LIMITED (UPTO 114.3mm OD)	INDIA
14	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
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 250MM DIA)	INDIA
8	RELIANCE INDUSTRIES “RELPIPE”	INDIA
9	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
13	SURAJ LIMITED (SURAJ STAINLESS LIMITED)	INDIA
14	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	NL HAZRA (upto SCH80)	INDIA
17	P.K TUBES & FITTINGS PVT. LTD. (Forged upto 1 ½" & Seamless upto 24" (SCH160))	INDIA
18	P.K FORGE & FITTING INDUSTRIES	INDIA
19	PARAS FITTINGS PVT. LTD. (Forged: CS ½" to 2" & CS Seamless: 2" to 8"(upto SCHXXS))	INDIA
20	PARMAR TECHNO FORGE (Elbow- ½" to 12"; Tee- ½" to 8"; Reducer (conc & eccn)- ½" to 12" , Cap ½" to 18" (CS&SS))	INDIA

21	PERFECT MARKETTING PVT. LTD.	INDIA
22	PETROCHEM INDUSTRIES (Seamless: Upto 16" (All Fittings) & upto 36" (Only caps) SCH : XXS /80S, Forged: upto 3”-6000#)	INDIA
23	RAJENDRA FORGE INDUSTRIES (CS: UPTO 12" SCH 40 & SS: 6" SCH 40S)	INDIA
24	S & G ENGINEERS (P) LTD.	INDIA
25	SAGAR STEEL CORPORATION (TRADER)	INDIA
26	SANGHVI METALS (TRADER)	INDIA
27	SAWAN ENGINEERS PVT LTD (Upto 36” (SCH160))	INDIA
28	SHIVANANDA PIPE FITTINGS LTD.,	INDIA
29	STEWARTS AND LLOYDS OF INDIA LIMITED	INDIA
30	TEEKAY TUBES PRIVATE LIMITED	INDIA
31	THE BENGAL MILL STORES SUPPLY CO.(TRADER)	INDIA
32	TOPAZ PIPING INDUSTRIES (2” to 36” (SCH 10 to Sch160))	INDIA
33	TUBE BEND (CALCUTTA) PVT. LTD. (CS FITTINGS ONLY)	INDIA
34	TUBE PRODUCTS INCORPORATE	INDIA
35	ZOLOTO INDUSTRIES (15mm to 150mm (only CS Galv.))	INDIA
36	PETROL RACCORD S.P.A. (Seamless: 1” to 42” (Elbows) & 1” to 56” Tee/Reducer/Caps))	ITALY
37	ETS TROUVAY & CAUVIN	FRANCE
38	PHOCEENNE	FRANCE
39	VALLOUREC	FRANCE
40	SEIKMANN ANLAGEN-TECHNIK GMBH.	GERMANY
41	TPS-TECHNITUBE ROHRENWERKE GMBH	GERMANY
42	HORST KURVERS GMBH	GERMANY
43	MANNESMANN HANDEL AG	GERMANY
44	DALMINE SPA	ITALY
45	GAM RACCORDI S.P.A	ITALY
46	IBF SEAMLESS PIPES SPA	ITALY
47	IND MECCANICA BASSI LUIGI & C. SPA	ITALY
48	MANTOVANI SPA	ITALY
49	RACCORTUBI SRL	ITALY
58	TECHNO FORGE SPA	ITALY
51	MARUBENI ITOCHU STEEL	JAPAN
52	NIPPON KOKAN	JAPAN
53	NISHITANI & CO. LTD.	JAPAN
54	NISSHO IWAI CORPORATION	JAPAN
55	OKURA & CO. LTD.	JAPAN

56	SOJITZ CORPORATION	JAPAN
57	SUMITOMO METAL INDUSTRIES LTD.	JAPAN
58	HAITIMA CORPORATION	TAIWAN
59	BRITISH STEEL CORPORATION	U.K.
60	CORUS TUBES LIMITED	U.K.
61	EUROTUBE LIMITED	U.K.
62	VOMAL INTERNATIONAL LIMITED	U.K.
63	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
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#)	
16	P.K TUBES & FITTINGS PVT. LTD. (Upto 24"(upto1500#) & Upto 12"(upto2500#) Spectacle Blind and Spacer & Blinds only)	INDIA
17	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

18	PERFECT MARKETING (P) LTD.	INDIA
19	PUNJAB STEEL	INDIA
20	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
21	RAJENDRA FORGE INDUSTRIES (CS & SS : UPTO 12", 300#)	INDIA
22	S & G ENGINEERS (P) LTD.	INDIA
23	SANGHVI FORGINGS & ENGINEERING LTD (Upto 42" (upto 300#), 36" (600#), 24" (upto 1500#) & 12" (2500#))	INDIA
24	SANGHVI METALS (TRADER)	INDIA
25	SAWAN ENGINEERS PVT LIMITED	INDIA
26	TECHNO FORGE LTD. (UPTO 42" (UPTO 300#), UPTO 24" (600#), UPTO 20" (900#), UPTO 16" (1500#), upto 12" (2500#))	INDIA
27	TUBE BEND (CALCUTTA) PVT LTD	INDIA
28	ETS TROUVAY & CAUVIN	FRANCE
29	PHOCEENNE	FRANCE
30	HORST KURVERS GMBH	GERMANY
31	I.S. INTERNATIONAL	ITALY
32	MANTOVANI SPA	ITALY
33	OFFICINE NICOLA GALPERTI & FIGLIO S.P.A	ITALY
34	RACCORTUBI SRL	ITALY
35	NICHINAN SANGYO CO. LTD.,	JAPAN
36	NISHITANI & CO. LTD.	JAPAN
37	SOJITZ CORPORATION	JAPAN
38	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
	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	P K TUBES & FITTINGS PVT. LTD (Upto 48”- (SCH160))	INDIA
7	PETROCHEM INDUSTRIES (6” to 36” (all Fittings) & 6” to 56” (Only Conc/Ecc. Reducers) SCH :XXS/80S)	INDIA
8	RAJENDRA FORGE INDUSTRIES (CS & SS: Upto 12”, SCH40)	INDIA
9	SAWAN ENGINEERS PVT. LIMITED (Upto 52” (SCH160))	INDIA
10	TOPAZ PIPING INDUSTRIES (8” to 48” (SCH 10 to SCH160))	INDIA
11	PETROL RACCORD S.P.A (4”-56” (Tees/Reducers/Elbows))	ITALY
12	TK CORPORATION	KOREA
	PIPE COATING	
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
	BALL VALVES	
1	INTERVALVE LTD.	INDIA
2	BDK ENGG. INDUSTRIES	INDIA
3	MICRIFINISH VALVES	INDIA
4	BRAY CONTROLS	INDIA
5	KIRLOSKAR VALVES	INDIA
	CHECK VALVES	
1	BDK ENGG. INDUSTRIES	INDIA
2	INTERVALVES LTD.	INDIA
3	MARCK & CARE	INDIA
4	ADVANCE VALVES	INDIA
	GATE & GLOBE VALVES	
1	INTERVALVE LTD.	INDIA
2	BDK ENGG. INDUSTRIES	INDIA
3	KBL	INDIA
4	CHEMTECH	INDIA
5	KSB	INDIA
	BUTTERFLY VALVES	
1	BDK ENGG. INDUSTRIES	
2	KBL	

3	CHEMTECH	
4	INTERVALVE(I) LTD.	
5	AUDCO	
	DIAPHRAGM VALVES	
1	BDK ENGG.INDUSTRIES	
2	FLOWWAY VALVES	
3	PNEUCON VALVES PVT. LTD.	
4	PROCON ENGINEERS	
	PP & PVC VALVES	
1	GEORGE FISHER PIPING LTD.	
2	VIBA FLUIDS	
3	ASTRAL POLYTECHNIC PVT. LTD.	
4	PARTH PLASTIC	
	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 11/2”, 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	LEADER VALVES LIMITED(SIZE<=1 ½”-800#)	INDIA
6	TECNOMATIC (INDIA) PVT LTD.	INDIA
7	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	WEIR BDK VALVES (A UNIT OF WEIR INDIA PVT. LTD.) (UPTO 16"(150#), 12" (300#), 3" (600#))	INDIA
15	XOMOX SANMAR LIMITED (FISHER XOMOX)	INDIA
16	ZHEJIANG JIEHUA VALVE CO. LTD.	CHINA
17	O.M.S. SALERI DI SALERI P & FIGLI S.M.C.	ITALY
18	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
	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 PN1.0 & PN1.6)	INDIA
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	VENUS PUMPS & ENFINEERING WORKS (sluice<900mm, Diaphragm<300mm, stop<500mm)	INDIA
9	WEIR BDK VALVES (A UNIT OF WEIR INDIA PVT. LTD.) (Upto 12” (PN6))	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 3550MM, 150#-2500# FOR EXCH GSKT)	INDIA
4	MADRAS INDUSTRIAL PRODUCTS(UPTO 52”)	INDIA
5	NEOSEAL ENGINEERING PVT. LTD (Upto 84” 150#- AND 30” UPTO600#)	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 800mm DIA)	INDIA
6	KELD ELLENTOFT INDIA PVT. LTD (For Fabric)	INDIA
7	LONESTAR INDUSTRIES	INDIA
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	GRAND PRIX ENGINEERING PVT. LTD. (UPTO 60" PIPELINE, UPTO ANSI 1500#)	INDIA
4	GREAVES LIMITED	INDIA

5	GUJARAT OTOFILT	INDIA
6	HAWA ENGINEERS LTD. (1/2" to 24"(150# / 300# / PN10 / PN40))	INDIA
7	KWIKFLO FILTERS PVT. LTD.	INDIA
8	LEADER VALVES LTD. (upto 300# & upto 12" size)	INDIA
9	MOD FABRICATORS	INDIA
10	MULTITEX FILTERATION ENGINEERS LTD	INDIA
11	ZOLOTO INDUSTRIES (15MM TO 100MM)	INDIA
12	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)	
2	MYRICS PIPING SYSTEM PVT.LTD.	INDIA
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”)	
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
21	UDHERA FASTENERS	INDIA
	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
	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	SENIOR INDIA PVT. LTD.	INDIA
	HOSE PIPE (NON-METALLIC) & CAM LOCK COUPLING	
1	CHHATARIA RUBBER CHEMICALS INDUSTRIES	INDIA
2	D. WREN & CO.	INDIA
3	GAYATRI INDUSTRIES	INDIA
4	GAYATRI INDUSTRIAL CORPORATION (UPTO 8” ID)	INDIA
5	HELIFEX HYDRAULICS & ENGG CO. LTD.	INDIA
6	PADMINI INDUSTRIES LIMITED	INDIA
7	PYROTEK INDUSTRIES (INDIA) PVT. LTD.	INDIA
8	SENIOR INDIA PVT. LTD.	INDIA
	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 SEVICES 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 SEVICES 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 SEVICES 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 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.

SECTION -10

VENDOR LIST

0	27.06.23	27.06.23	CLIENT'S COMMENTS INCORPORATED	BK	RKV	RKV
P	03.04.2023	03.04.2023	FOR CLIENT'S REVIEW	BK	RKV	RKV
REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD

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SUBCONTRACTORS / VENDORS LIST

Enumerated below are the suggested list of vendors for major bought-out components for this project.
For any other vendors not listed hereunder, contractor will seek approval from owner on a case-to-case basis.
For items not covered hereunder, the list of vendors will be finalized after mutual agreement with contractor.

1.0	**ELECTRICAL**	
1.1	**INDUCTION MOTORS-LV(415V) (SAFE AREA)**	
1	ANSALDO ROBICON	ITALY
2	SIEMENS AG	GERMANY
3	BHEL (ELECTRICAL MACHINES DIVN.)	INDIA
4	ASEA BROWN BOVERI LTD.	INDIA
5	SIEMENS LTD.	INDIA
6	TOSHIBA CORPORATION	JAPAN
7	GENERAL ELECTRIC CO.	USA
8	FUJI ELECTRIC SYSTEMS CO. LTD.	JAPAN
9	CG POWER AND INDUSTRIAL SOLUTION LIMITED	INDIA
10	LAXMI HYDRAULICS PVT. LTD. (Upto 355L Frame Size)	INDIA
11	KIRLOSKAR ELECTRIC COMPANY LTD.	INDIA
1.2	**INDUCTION MOTORS-LV(415V) (HAZARDOUS AREA)**	
1	ASEA BROWN BOVERI LTD.	INDIA / SWEDEN
2	CG POWER AND INDUSTRIAL SOLUTION LIMITED	INDIA
3	BHARAT BIJLEE LTD.	INDIA
4	SIEMENS AG.	GERMANY
5	KIRLOSKAR ELECTRIC COMPANY LTD.	INDIA
6	MITSUBISHI CORPORATION	JAPAN
7	TOSHIBA CORPORATION	JAPAN
8	GENERAL ELECTRIC CO.	USA
9	FUJI ELECTRIC SYSTEMS CO. LTD.	JAPAN
10	LAXMI HYDRAULICS PVT. LTD. (Upto 355L Frame Size)	INDIA
1.3	**LT(1.1KV) POWER CABLES**	
1	CABLE CORPORATION OF IINDIA LTD.	INDIA
2	PLAZA CABLE INDUSTRIES LTD.	INDIA

3	RAVIN CABLES LIMITED.	INDIA
5	DELTON CABLES LTD.	INDIA
6	FINOLEX CABLES LTD	INDIA
7	KEI INDUSTRIES LTD.	INDIA
8	TORRENT CABLES LIMITED.	INDIA
9	RADIANT CABLES PVT. LIMITED	INDIA
10	INDUSTRIAL CABLES (I) LIMITED.	INDIA
11	NICCO CORPORATION LIMITED.	INDIA
12	UNIVERSAL CABLES LTD.	INDIA
13	POLYCAB INDIA LIMITED	INDIA
14	CORDS CABLE INDUSTRIES LTD.	INDIA
1.4	**LT(1.1KV) CONTROL CABLES**	
1	CABLE CORPORATION OF INDIA LTD.	INDIA
2	PLAZA CABLE INDUSTRIES LTD.	INDIA
3	RAVIN CABLES LIMITED.	INDIA
5	DELTON CABLES LTD.	INDIA
6	FINOLEX CABLES LTD.	INDIA
7	KEI INDUSTRIES LTD.	INDIA
8	CORDS CABLE INDUSTRIES LIMITED.	INDIA
9	RADIANT CABLES PVT. LIMITED.	INDIA
10	NICCO CORPORATION LIMITED.	INDIA
11	UNIVERSAL CABLES LTD.	INDIA
12	POLYCAB INDIA LIMITED	INDIA
13	CORDS CABLE INDUSTRIES LTD.	INDIA
1.5	**MCC -- SWITCHBOARDS-LV(415V)**	
1	LARSEN & TUBRO.	INDIA
2	CONTROL & SWITCHGEAR CO. LTD.	INDIA
3	INTERLEC	INDIA
4	CG POWER AND INDUSTRIAL SOLUTION LIMITED	INDIA
5	GE POWER CONTROL INDIA LTD.	INDIA
6	ELECMECH CORPORATION.	INDIA
7	SPACEAGE SWITCHGEARS LIMITED	INDIA
8	SIEMENS LTD.	INDIA
~~9~~	~~VIDHYUT CONTROL(INDIA) PVT LTD~~	~~INDIA~~
~~10~~	~~C&S ELECTRIC LTD.~~	~~INDIA~~
1.6	**CABLE TRAYS GI /SS (Perforated /Ladder) & CABLE DUCTS**	
1	Indmark Formtech Pvt Ltd	INDIA
2	Globe Elect. Industries Ltd. India	INDIA

3	Jamna Metal Company	INDIA
4	Indiana Engg works Pvt Ltd.	INDIA
5	METALITE INDUSTRIES	INDIA
6	PAREKH ENGINEERING COMPANY	INDIA
7	SADHANA ENGINEERING CORPORATION	INDIA
8	Premier Power Products Cal Pvt. Ltd	INDIA
9	Ratan Projects & Engineering Co. Pvt. Ltd.	INDIA
10	Rukmani Electrical & Components	INDIA
11	Steelite Engineering Limited	INDIA
1.7	**EARTHING MATERIAL**	
1	ANAND ELECTRIC TRADING CO.	INDIA
2	INDMARK FORMTECH PVT. LTD.	INDIA
3	Jamna Metal Company	INDIA
4	JAYANT METAL MFG CO	INDIA
5	MAHAVIR INDUSTRIAL CORPORATION	INDIA
6	METROPOLITAN INDUSTRIES	INDIA
7	SAI GALVANISERS & FABRICATORS PVT LTD	INDIA
8	Premier Power Products Cal Pvt. Ltd	INDIA
1.8	**CONTROL STATIONS, Sw. Socket & JUNCTION BOX- WEATHERPROOF**	
1	Baliga Lighting Equipments (P) Limited	INDIA
3	Ex-Protecta	INDIA
4	FCG Flamproof Control Gears P. Ltd	INDIA
5	FCG Power Industries Pvt Ltd	INDIA
6	Flameproof Equipments Pvt.Ltd	INDIA
7	Shrenik & Company	INDIA
1.9	**LIGHTING FIXTURES**	
1	Bajaj Electricals Limited	INDIA
2	CG POWER AND INDUSTRIAL SOLUTION LIMITED	INDIA
3	SPACEAGE SWITCHGEARS LIMITED	INDIA
4	PHILIPS INDIA LTD.	INDIA
5	SURYA ROSHNI LTD.	INDIA
6	WIPRO LIGHTING	INDIA
2.0	**VARIABLE FREQUCY DRIVE**	
1	ASEA BROWN BOVERI LTD.	INDIA
2	CG POWER AND INDUSTRIAL SOLUTION LIMITED	INDIA
3	DANFOSS INDUSTRIES PVT. LTD.	INDIA
4	DELTA ELECTRONICS INDIA PVT.LTD.	INDIA
5	LARSEN & TOUBRO LTD.(EL.PRODUCTS DIVN)	INDIA
6	SIEMENS LTD.	INDIA

PART-II, TECHNICAL

SECTION-10

RECOMMENDED SUB-VENDOR LIST

INSTRUMENTATION VENDOR LIST

REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD
0	27.06.2023	27.06.2023	Comments Incorporated	AKS	RKR	RKR
P	06.04.2023	06.04.2023	FOR ISSUE CLIENT'S COMMENTS	AKS	RKR	RKR

Sl. No.	NAME OF VENDOR	COUNTRY
5.0	**INSTRUMENTATION**	
5.1	**FLOW ELEMENT: ORIFICE/ VENTURI/ FLOW NOZZLE**	
1	BALIGA LIGHTING EQUIPMENTS LIMITED (ONLY ORIFICE)	INDIA
2	GENERAL INSTRUMENTS CONSORTIUM (ONLY ORIFICE)	INDIA
3	INSTRUMENTATION LTD, PALAKKAD	INDIA
4	MICRO PRECISION PRODUCTS PRIVATE LTD.	INDIA
5	EURECA INDUSTRIAL EQIPMENTS PVT LTD.	INDIA
6	UNICONTROLS INSTRUMENTS PVT. LTD.	INDIA
7	BOPP & REUTHER MESSTECHNIKGMBH	GERMANY
8	TECHNOMATIC SPA	ITALY
9	ISA CONTROLS LIMITED	U.K
10	DANIEL MEASUREMENT & CONTROL	U.S.A
11	FLOWTECH INSTRUMENTS SERVICES (ORIFICE/VENTURI)	
12	CHEMTROL INDUSTRIES LTD	INDIA
13	EMERSON PROCESS MANAGEMENT	INDIA
5.2	**ROTAMETERS**	
1	INSTRUMENTATION ENGINEERS PVT. LTD.	INDIA
2	KROHNE MARSHALL PVT. LTD.	INDIA
3	PLACKA INSTRUMENTS & CONTROLS PVT. LTD. (PURGE ROTAMETER ONLY)	INDIA
4	ROTA INSTRUMENTATION	INDIA
5	EURECA INDUSTRIAL EQIPMENTS PVT LTD.	INDIA
6	ABB INDIA LTD.	INDIA
7	KROHNE	GERMANY
8	ROTA YOKOGAWA GMBH& CO. KG	GERMANY
9	TOKYO KEISO CO. LTD.	JAPAN
10	YAMATAKE CORPORATION	JAPAN
11	EMERSON PROCESS MGT	U.S.A
12	FLOWTECH INSTRUMENTS SERVICES	
5.3	**PRESSURE GAUGES**	
1.	GENERAL INSTRUMENTS CONSORTIUM,	INDIA
2.	H.GURU INDUSTRIES	INDIA
3.	MANOMETER (INDIA) PVT. LTD	INDIA
4.	PEEJEEENGG. WORKS	INDIA
5.	PRECISION INDUSTRIES LTD. (STANDARD NORMAL TYPE)	INDIA

Sl. No.	NAME OF VENDOR	COUNTRY
6.	PREMIUM INST. & CONTROLS LTD.	INDIA
7.	WALCHANDNAGAR INDUSTRIES LTD.	INDIA
8.	ASHCROFT INDIA(P) LTD. (STANDARD NORMAL TYPE)	INDIA
9.	DRESSER EUROPE S.A	GERMANY
10.	WIKAALEXENDERWIEGARDGMBH& CO.	GERMANY
11.	SPRIANO SPA	ITALY
12.	NAGANO KEIKI SEISAKUSHO	JAPAN
13.	RUEGER SA	SWITZERLAND
14.	BUDENBERG GAUGE CO. LTD	U.K
15.	A.N.INSTRUMENTS	
5.4	**LOCAL D/P INDICATORS**	
1.	SWITZER INSTRUMENT CO.	INDIA
2.	BARTON INSTRUMENT SYSTEMS LIMITED	U.K
3.	DELTA CONTROLS LTD.	U.K
5.5	**PRESSURE & D/P TRANSMITTERS**	
1.	EMERSON PROCESS MANAGEMENT (I) PVT. LTD.	INDIA
2.	HONEYWELL AUTOMATION INDIA LIMITED	INDIA
3.	YOKOGAWA LIMITED	INDIA
4.	SIEMENS LTD.	INDIA
5	ENDRESS + HAUSER (INDIA) PVT.LTD.	INDIA
6.	SIEMENS AG, GERMANY	GERMANY
7	YAMATAKE CORPORATION	JAPAN
8	YOKOGAWA ELECTRIC CORPORATION	JAPAN
9	EMERSON PROCESS MGT SINGAPORE LTD	SINGAPORE
10	HONEYWELL INC.	U.S.A
5.6	**PRESSURE & D/P SWITCHES INCLUDING VOL. SEAL**	
1.	INDFOS INDUSTRIES LTD. (EXCEPT VOL.SEAL)	INDIA
2.	SWITZER INSTRUMENT CO., (EXCEPT VOL.SEAL)	INDIA
3.	ENDRESS + HAUSER(INDIA) PVT. LTD.	INDIA
4.	NAGANO KEIKI SEISAKUSHO	JAPAN
5.	YAMATAKE CORPORATION	JAPAN
6.	DELTA CONTROLS LTD.	U.K
7.	SOR INC.	U.S.A
8.	UNITED ELECTRIC CONTROLS CO.	U.S.A
5.7	**TRANSPARENT/ REFLEX / BICOLOR MAG.LEVEL GAUGES**	
1.	KROHNE (INDIA) PVT. LTD.	INDIA

Sl. No.	NAME OF VENDOR	COUNTRY
2.	PUNE TECHTROLPVT.LTD. (<=300# RATING ONLY)	INDIA
3.	TECNOMATIC (INDIA) PVT. LTD.	INDIA
4.	V-AUTOMAT & INST. (P) LTD., (UPTO 300#)	INDIA
5.	NISAN SCIENTIFIC PROCESS EQUIPMENTS PVT. LTD.	INDIA
6	ABB INDIA LTD.	INDIA
7.	BLISS ANAND PRIVATE LTD.	INDIA
8	RICHARD KLINGER AG	AUSTRIA
9.	CESAREBONETTI	ITALY
10	TECHNOMATIC SPA	ITALY
11	NIHON KLINGAGE CO. LTD.	JAPAN
12	CLARK-RELIANCE CORP.	U.S.A
13	JERGUSON GAUGE & VALVE CO.	U.S.A
14	TYCO INTERNATIONAL INC.	U.S.A
15.	FLOWTECH INSTRUMENTS SERVICES	
16.	FORBES MARSHALL PVT LTD.	INDIA
5.8	**ULTRASONIC LEVEL TRANSMITTERS**	
1.	MAGNETROL INTERNATIONAL N.V	BELGIUM
2.	ENDRESS + HAUSER (INDIA) PVT. LTD.	INDIA
3.	SIEMENS LTD.	INDIA
4.	EMERSON PROCESS MANAGEMENT	INDIA
5.	WIKA INSTRUMENTS	INDIA
5.9	**CAPACITANCE TYPE LEVEL TRANSMITTER**	
1.	MAGNETROL INTERNATIONAL N.V	BELGIUM
2	ENDRESS + HAUSER (INDIA) PVT. LTD.	INDIA
3	SIEMENS LTD.	INDIA
4	ENDRESS + HAUSER GMBH& CO.	GERMANY
5	KROHNE	GERMANY
6	KDGMOBREY LTD	U.K
7.	VEGA GRIESHABER KG	
5.10	**TEMPERATURE ELEMENTS (THERMOCOUPLE, RTD)**	
1.	ABB INDIA LIMITED	INDIA
2.	PYRO ELECTRIC INSTRUMENTS GOA PVT. LTD. (A. THERMOCOUPLE ASSEMBLIES WITH/WITHOUT THERMOWELSS; B.RTD ASSEMBLIES WITH/WITHOUT THERMOWELLS)	INDIA
3.	GENERAL INSTRUMENTS CONSORTIUM	INDIA
4.	ENDRESS + HAUSER (INDIA) PVT. LTD.	INDIA
5.	SENSYCON (M/S DEGUSSA AG)	GERMANY

Sl. No.	NAME OF VENDOR	COUNTRY
6.	W.C. HERAEUSGMBH	GERMANY
7.	THERMO ELECTRIC CO. LTD.	HOLLAND
8.	OKAZAKI MANUFACTURING CO.	JAPAN
9.	YAMATAKE CORPORATION	JAPAN
5.11	**BIMETALLIC THERMOMETER**	
1.	GENERAL INSTRUMENTS CONSORTIUM	INDIA
2.	H.GURU INDUSTRIES	INDIA
3.	KROHNE MARSHALL PVT. LTD.	INDIA
4.	ASHCROFT INDIA(P) LTD.	INDIA
5.	TECHNOMATIC SPA	ITALY
6.	NAGANO KEIKI SEISAKUSHO	JAPAN
7.	RUEGER SA	SWITZERLAND
8.	TREND INSTRUMENT INC.	U.S.A
5.12	**DIAL THERMOMETER (HG IN STEEL/GLASS)**	
1.	GENERAL INSTRUMENTS CONSORTIUM,	INDIA
2.	H.GURU INDUSTRIES	INDIA
3.	PEEJEEENGG. WORKS	INDIA
4.	WAAREE INSTRUMENTS LTD	INDIA
5.	WALCHANDNAGAR INDUSTRIES LTD.	INDIA
6.	ASHCROFT INDIA(P) LTD.	INDIA
5.13	**TEMPERATURE TRANSMITTERS**	
1.	ENDRESS+ HAUSER (INDIA) PVT. LTD.	INDIA
2.	SIEMENS LTD.	INDIA
3.	SIEMENS AG, GERMANY	GERMANY
4.	M-SYSTEM	JAPAN
5.	EMERSON PROCESS MANAGEMENT	INDIA
6.	YOKOGAWA INDIA LTD	INDIA
5.14	**TEMPERATURE SWITCHES**	
1.	GOA INSTRUMENTS INDUSTRIES LTD	INDIA
5.15	**GATE/PLUG VALVES**	
1.	AUDCO INDIA LIMITED(L&T VALVES DIVN.)	INDIA
2.	BHEL(VALVES DIVISION)	INDIA
3.	KSB PUMPS LIMITED (VALVES DIVN)	INDIA
4.	FLOWSERVE INDIA CONTROL PVT. LTD.(PLUG VALVE UPTO 12”300# UPTO 6” 600#)	INDIA
5.	VELAN INC.	CANADA

Sl. No.	NAME OF VENDOR	COUNTRY
6.	MALBRANQUES.A.	FRANCE
7.	CESAREBONETTI	ITALY
8.	FASANI S.P.A.	ITALY
9.	PETROL VALVES S.R.L	ITALY
10.	MATSURA H. P MACHINE WORKS CO.LTD.	JAPAN
11.	BEL VALVES	U.K
12.	FLOSERVE XOMOX	
5.16	**GLOBE / ANGLE VALVES**	
1.	DRESSER VALVE INDIA PVT LTD (RATING <= 600# , SIZE 3/4 TO 6")	INDIA
2.	EMERSON PROCESS MANAGEMENT INDIA LTD	INDIA
3.	MIL CONTROLS LIMITED (=<600#,EXCEPT SLURRY,NOISE,CAVITATION)	INDIA
4.	FLOWSERVE INDIA CONTROL PVT. LTD. (GLOBE VALVE UPTO 30" 600# UPTO 24" 900#, UPTO 16" 2500# UPTO 4" 4500#)	INDIA
5.	KOSO FLUIDS CONTROLS PVT. LTD. (GLOBE VALVES: UPTO 8" 2500# 10 TO 18" 300# ANGLE VALVES UPTO 8" 300#)	INDIA
6.	SEVERN GLOCON (I) PVT. LTD. (1 TO 8 " RATING 2500# (EXCEPT SLURRY ,NOISE , CAVITATION); 1 TO 12 " RATING 600# (EXCEPT SLURRY ,NOISE CAVITATION)	INDIA
7.	ARCA-REGLERGMBH (=< 2500#)	GERMANY
8.	PARCOL SPA (=<2500#,UREA SERVICE ALSO)	ITALY
9.	NIPPON FISHER CO. LTD. (=<2500#)	JAPAN
10.	YAMATAKE CORPORATION (=<2500#)	JAPAN
11.	FISHER XOMOX (=< 2500#)	SINGAPORE
12.	FLOWSERVE (=<2500#)	U.S.A
5.17	**SOLENOID VALVES**	
1.	ASCO (INDIA) LIMITED	INDIA
2.	IMI NORGREN-HERION FLUIDTRONIC GMBH&CO.	GERMANY
3.	ALEXENDER CONTROLS LTD.	U.K
4.	ASCO JOUCOMATIC LTD.	U.K
5.	ROTEX AUTOMATION LTD.	INDIA
5.18	**ELECTRIC ACTUATOR**	
1.	ROTORK CONTROL (DEUTSCHLAND) GMBH	GERMANY
2.	BIFFI ITALIA S.R.L	ITALY
3.	LIMITORQUE, U.S.A	U.S.A
5.19	**AIR FILTER REGULATOR**	
1.	ASEA BROWN BOVERI LTD.	INDIA
2.	DIVYA CONTROL ELEMENTS PVT. LTD.	INDIA

Sl. No.	NAME OF VENDOR	COUNTRY
3.	MIL CONTROLS LIMITED	INDIA
4.	PLACKA INSTRUMENTS & CONTROLS PVT. LTD.	INDIA
5.	SHAVO NORGREN(INDIA) PVT LTD.	INDIA
6.	ABB INDIA LIMITED	INDIA
5.20	**PRESSURE REGULATOR**	
1	EMERSON PROCESS MANAGEMENT LTD (FISHER BRAND)	INDIA
5.21	**LIMIT/PROXIMITY SWITCHES**	
1.	PEPPERL + FUCH	INDIA
2.	EL-O MATIC INDIA PVT LTD(FOR NON CRITICAL APPS)	INDIA
3.	PEPPERL + FUCH	GERMANY
4.	PEPPERL + FUCHS PTE LTD.	SINGAPORE
5.	HONEYWELL INC.	U.S.A
5.22	**VALVE ACTUATOR (PNEUMATIC/ ROTARY)**	
1.	BIFFI ITALIA S.R.L	ITALY
2.	STI (IMI)	ITALY
3.	ELOMATIC (INDIA) PVT. LTD.	INDIA
5.23	**SELF ACTUATED PRESSURE CONTROL VALVE**	
1	NIRMAL INDUSTRIAL CONTROLS PRIVATE LIMITED (SIZE ½" TO 6 " & RATING : < =300#)	INDIA
2	EMERSON PROCESS MANAGEMENT LTD (FISHER BRAND)	INDIA
5.24	**ELECTRONEUMATIC POSITIONER**	
1.	M/s METSO	
2.	EMERSON PROCESS MANAGEMENT LTD (FISHER BRAND)	INDIA
3.	GE (DRESSER)	INDIA
4.	M/s STI (IMI)	
5.	SIEMENS INDIA LTD.	INDIA
5.25	**SAFETY VALVES & THERMAL RELIEF VALVES UPTO 2500#**	
1.	FAINGERLESER VALVES (P) LTD. (UPTO 600#, ½" TO 6")	INDIA
2..	INSTRUMENTATION LTD. (PALAKKAD)	INDIA
3.	TYCO SANMAR LTD.	INDIA
4.	BLISS ANAND PRIVATE LIMITED (8" * 10" 300#, 6" * 8 " 600# ,4 * 6" 1500#)	INDIA
5.	DRESSER VALVE & CONTROLS	CANADA
6.	PARCOL SPA (FOR UREA SERVICE ALSO)	ITALY
7.	TAI MILANO S.P.A (FOR UREA SERVICE ALSO)	ITALY
8.	ITOCHU CORPORATION (REP. KUBOTA CORPN.)	JAPAN
9.	CROSSBY VALVE &ENGG. COMPANY LTD.	U.K

Sl. No.	NAME OF VENDOR	COUNTRY
10.	FARRIS	U.K
11.	DRESSER INDUSTRIES INCORPORATED	U.S.A
12	TELEDYNE FLUID SYSTEM	THAILAND
13.	SAPAG GEC ALSTHOM	FRANCE
14.	BOPP & REUTHER MESSTECHNIC GMBH	GERMANY
5.26	**PILOT RELIEF VALVES**	
1.	M/s TYCO (M/s Anderson Greenwood Crossby Sanmar)	
2.	M/S GE (DRESSER)	
3.	BLISS ANAND PRIVATE LIMITED (SIZE 1"* 2" 2500#)	INDIA
5.27	**I/P CONVERTER**	
1.	EMERSON PROCESS MANAGEMENT (I) PVT. LTD.	INDIA
2.	INVENSYS (FOXBORO)	INDIA
3	YOKOGAWA LIMITED	INDIA
4.	YOKOGAWA ELECTRIC CORPORATION	JAPAN
5.	EMERSON PROCESS MANAGEMENT LTD	U.S.A.
5.28	**PURGE ROTAMETER**	
1.	INSTRUMENTATION ENGINEERS PVT. LTD.	INDIA
2.	PLACKA INSTRUMENTS & CONTROLS PVT. LTD.	INDIA
3.	EURECA INDUSTRIAL EQUIPMENTS PVT LTD	INDIA
5.29	**SELF ACTUATED PRESSURE CONTROL VALVES**	
1.	NIRMAL INDUSTRIES CONTROL PVT LTD (1/2'' TO 4'' &<300#)	INDIA
2.	EMERSON PROCESS MANAGEMENT LTD (FISHER BRAND)	INDIA
5.30	**AMMONIA ANALYSER**	
1.	FUJI ELECTRIC	INDIA
2.	SIEMENS	INDIA
3	TELEDYNE	INDIA
4.	SICK MAHEK	JAPAN
5.31	**BALL VALVES (ON-OFF VALVES)**	
1.	FLOWSERVE INDIA CONTROL PVT. LTD. (Upto 16" 600#)	INDIA
2..	KOSO INDIA PVT. LTD. (Upto 8": 2500 # , 10" to 18": 900#)	INDIA
3.	L&T VALVES LTD. (Upto 24" - 2500#, except Urea Grade)	INDIA
4.	METSO INDIA PVT. LTD. (ON-OFF VALVE Upto 18" - 150#)	INDIA
5.	PENTAIR VALVES AND CONTROLS INDIA PRIVATE LIMITED (=< 150 #)	INDIA
5.32	**pH/CONDUCTIVITY ANALYSER**	
1.	ABB	INDIA
2..	YOKOGAWA	INDIA

Sl. No.	NAME OF VENDOR	COUNTRY
3.	HACH	INDIA
4.	FORBES MARSHALL	INDIA
5.33	**SAUNDERS VALVE**	
1.	PROCON	INDIA
2.	CRANE SAUNDERS	INDIA
3.	WEIR BDK PVT. LTD.	INDIA
5.34	**BUTTERFLY VALVE**	
1.	INTERVALVE POONAWALA LTD.	INDIA
2.	FLOWSERVE	INDIA
3.	TRILLIUM FLOW TECHNOLOGIES PVT. LTD.	UK

PART II: TECHNICAL

SECTION – 10

DESIGN PHILOSOPHY – CIVIL & STRUCTURAL WORKS
CIVIL & STRUCTURAL ITEMS VENDOR LIST

1.0 CIVIL & STRUCTURAL VENDOR LIST

GENERAL NOTES:

a) Only 'First' Quality materials shall be used

b) 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.

c) 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.

d) 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.

SL. NO.	ITEM	NAME
1.0	FLOOR FINISHING	
1.1	CEMENT TILES (FLOOR/WALL)	a) EUROCON b) ALTRA TILE PVT. LTD. c) DAZZLE or Approved equivalent
1.2	Vitrified Ceramic tiles	a ORIENT b) BELL c) SOMANY d) H&R JOHNSON e) KAJARIA f) SIMPOLO g) NIITCO
1.3	Glazed CERAMIC TILES	a) SPARTEK CERAMICS b) BELL CERAMICS c) SOMANY CERAMICS d) H&R JOHNSON CERAMICS e) KAJARIA CERAMICS f) ORIENT CERAMICS g) NIITCO h) Euro i) RAK
1.4	HEAVY DUTY FLOOR TILES	a) BHARAT TILES b) RESTILE CERAMICS c) PELICAN CERAMIC INDUS. d) DIAMOND REGINA e) SONA TILES

1.5	INDUSTRIAL FLOOR HARDENER ADMIXTURE	a) SAMKOCK CHEMICALS (P) LTD. b) STRUCTURAL WATER PROOFING CO. (P) LTD.
1.6	PVC ROLLS	a) PREMIER VINYL b) ARMSRONG INARCO c) PREMIER POLYFILM d) FORBO
1.7	PVC TILES	a) BHOR INDUSTRIES b) ARMSTRONG c) SHYAM VINYLES
1.8	PVC TILES/ROLL ANTISTATIC	a) PREMIER VINYL b) PREMIER POLYFILM c) ARMSTRONG d) FORBO
1.9	ACID RESISTANT TILES(BATTERY ROOM)	a) H&R JOHNSON OR APPROVED EQUIV.
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 d) KUTTY e) MERINO PLY f) DUROBOARD
2.2	PLY WOOD/BLOCK BOARD	a) WOODCRAFT PRODUCTS b) KITPLY PRODUCTS c) GREEN PLY d) MERINO PLY e) CENTURY PLY f) GARNET
2.3	PARTICLE BOARD (EXTRA GRADE)	a) BHUTAN BOARD b) BEST BOARD c) NOVAPAN INDIA LTD. d) THE BOMBAY BURMAN TRACING CORPN. LTD. f) MERINO g) ANCHORLAM
2.4	MDF BOARD/MD PARTICLE BOARD (EXTRA GRADE) VENEEREED/LAMINATED	a) NUCHEM LTD. b) MANGALAM TIMBER PRODUCTS LTD. c) WESTERN BIO SYSTEMS LTD.
2.5	DECORATIVE LAMINATES	a) THE BOMBAY BURMAN TRADING CORPN. LTD. b) GREENPLY INDUS. LTD. c) BAKELITE HYLAM LTD. d) RAMMICA INDUSTRIES e) CENTURY f) MERINO
2.6	MARINE PLYWOOD	a) INDIAN PLYWOOD MFG. CO. LTD. b) SWASTIC PLYWOOD c) GREENPLY d) GARNET e) CENTURY
2.7.0	DOORS & WINDOWS FITTINGS	

2.7.1	MORTICE LOCKS WITH HANDLES	a) GODREJ & BOYCE b) EVERITE AGENCIES (P) LTD. c) GOLDEN INDUSTRIES d) DORSET e) GEZE f) DORMA GUARDIAN g) INGERSOLRAND
2.7.2	CYLINDRICAL PIN TUMBLER LOCK WITH KNOBS	a) SECURE INDUSTRIES b) GOLDEN INDUSTRIES c) GODREJ & BOYCE d) DORSET e) GEZE f) DORMA GUARDIAN g) INGERSOLRAND
2.7.3	HYDRAULIC DOOR CLOSER (OVER HEAD/ FLOOR)	a) DOORKING INDUSTRIES b) EVERRITE AGENCIES (P) LTD. c) HARDWYN d) DORSET e) GEZE f) DORMA GUARDIAN g) INGERSOLRAND
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 f) DORSET g) GEZE h) DORMA GUARDIAN i) INGERSOLRAND j) MAGNUM
2.7.5	THREE WAY BOLTING LOCKING DEVICE HANDLE	a) SRIMA SALES & SERVICES b) DHIMAN INDUSTRIES
2.7.6	PANIC BAR LATCH (FOR EMERGENCY DOOR)	a) SRIMA SALES & SERVICES OR APPROVED EQUIV.
2.7.7	UPVC WINDOWS	a) FENESTA b) ENCRAFT c) WINDOW MAGIC
2.7.8	FASTENERS	a) HILTI INDIA PVT. LTD. b) FISCHER c) WURTH d) HALFEN
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.
3.2	ALMUNIUM / DOORS/ WINDOWS SECTIONS	a) JINDAL ALUMINIUM LTD. b) HINDALCO INDUSTRIES c) INDAL
3.3	FIRE-PROOF DOORS(APPROVED)	a) NAVAIR INTERNATIONAL b) RDG ENGINEERING c) SIGNUM d) PROMAT e) GODREJ
3.4	PVC DOORS / WINDOWS	a) SINTEX b) INFRA Or APPROVED EQUIV.
3.5	PVC WATER TANKS	a) SINTEX b) INFRA Or APPROVED EQUIV.
3.6	STAINLESS STEEL	a) JINDAL

	(BUILDING)	b) SAIL
4.0	PLASTERING	
4.1	WATERPROOFING/ COMPOUND IN CEMENT PLASTER	a) STRUCTURAL WATER PROOFING CO. (P) LTD. b) PIDILITE INDUSTRIES c) CICO d) BASF e) SIKA f) SUNANDA CHEMICALS g) MC-BAUCHEMIE
5.0	ROOF TREATMENT (WATER PROOFING)	
5.1	BRICK BAT COBA	a) INDIA WATER PROOFING CO. b) OVERSEAS WATERPROOFING CORPN. c) APPROVED I
5.2	ACRYLIC BASED CEMENTATIOUS PRIMER COATING FOR ROOF WATERPROOFING	a) STRUCTURAL WATER PROOFING CO. (P) LTD. b) SIKA QUALCRETE LTD. c) PIDILITE d) BASF e) STP
5.3	APP MODIFIED POLYMERIC WASTER PROOFING MEMBRANE	a) PIDILITE INDUSTRIES LTD. b) STP TEXAS LTD. c) BITUMET CO. LTD. d) TEXSA e) SIKA
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
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. f) DULUX
6.2	DRY OILBOUND DISTEMBER	a) ASIAN PAINTS LTD. b) KANSAI NEROLAC PAINTS LTD. c) BERGER d) JOTUN e) DULUX
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) SNOWCEM INDIA LTD. b) RAJDOOT PAINTS c) NITCO CEM
6.5	WOOD MELAMINE POLISH	a) ASIAN PAINTS b) SHALIMAR PAINTS
6.6	WASTERPROOFING TRANSPARENT EXTERIOR WALL COATING (OVER PAINTED SURFACE)	a) PIDILITE INDUSTRIES b) INDUSTRIAL PROD. MFG c) STRUCTURAL WATER-PROOFING CO.(P) LTD.
6.7	FIRE PROOF	a) NAVAIR INTERNATIONAL

	COATING	b) HILTI c) JOTUN d) AKZONOBEL OR APPVD. EQUIV.
7.0	ROOFING SHEETS & ACCESSORIES	
7.1	NON-ASBESTOS CEMENT SHEETS	a) ETERNIT EVEREST LTD. b) CHARMINAR INDUSTRIES c) RAMCO
7.2	C.G.I. SHEETS	a) ISPAT INDUSTRIES LTD. b) STEEL AUTHORITY OF INDIA c) TATA STEEL
7.3	PRECOATED G.I. PROFILE SHEETS FOR ROOFING & WALL CLADDING	a) ISPAT INDUSTRIES LTD. b) SHREE PRECOATED STEELS LTD. c) INTERARCH BUILDING PRODUCTS (P) LTD. d) HARDCASTLE & WAUD MFG. CO. LTD. e) LLOYD INSULATION (I) LTD. f) SHIV SHAKTI FIBER UDYOG
7.4	ALUMINIUM SHEET (PLAIN/PROFILE)	a) INDIAN ALUMINIUM CO. LTD. b) JINDAL c) HINDALCO Or APPROVED EQUIVALENT
7.5	FIBRE GLASS SHEETS & PANELS (MACHINE MOULDED)	a) SIMBA FRP (P) LTD. b) GE INDIA c) SHIV SHAKTI FIBER UDYOGOr APPROVED EQUIVALENT
7.6	PROOFING J/L HOOKS, BOLTS & OTHER ACCESSORIES (POLYMER COATED)	a) KATALIST CONSULTANT (P) LTD. b) ADVANCED MACHINEOr APPROVED EQUIVALENT
7.7	FRP TRANSLUCENT SHEETS	Brand names to be added by PDIL.
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 f) CERA g) ROCA h) JAQUAR
8.2	PLUMBING FITTINGS & FIXTURES	a) GEM b) PARKO c) KINGSTON OR APPROVED EQUIVALENT
8.3	GLASS/MIRROR (SHEET/ FLOAT/ TOUGHENED/ LAMINATION	a) GUJARAT GUARDIAN LTD. b) SAINT GOBAIN c) ASAHI FLOAT d) MODI GURAD / FLOAT
8.4	GI PIPES	a) JINDAL b) SURYA c) PRAKASH d) SWASTIK e) TATA
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 d) ARMSTRONG e) INDIA GYPSUM LTD.

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 f) HEWETSON g) UNIFLOOR h) UNITILE
9.3	UNDERDECK/WALL HEAT INSULATION	a) BAKELITE HYLAM LTD. b) U.P. TWIGA F.G. LTD. c) LLOYD INDULATION (I) LTD.
9.4	OVERDECK HEAT INSULATION	a) LLOYD INSULATION (I) LTD. b) BEST PLASTRONICS LTD.
9.5	GYPSUM BOARD TILES (FIBRE GLASS REINFORCED)	a) INTERARCH BUILDING PRODUCTS (P) LTD. b) INDIA GYPSUM LTD.
10.0	SPECIALITY PRODUCTS (CEMENT ADDITIVES/ ADMIXTURES/CORRO SION INHIBITORS/ SURFACE TREATMENT/ GROUT & ANCHORS/SEALING/ COASTING	a) FOSROC b) SIKA c) MYK Arment Pvt Ltd d) STP e) SUNANDA CHEMICALS f) BASF
10.1	EPOXY FLOOR COATING (BATTERY ROOM)	a) FOSROC b) SIKA c) FAIRMATE d) MYK Arment Pvt Ltd e) BASF f) STP
10.2	EPOXY COATING TO CONCRETE	a) FOSROC b) SIKA c) SUNANDA CHEMICALS d) ROFFE e) BASF f) STPOR APPROVED EQUIVALENT
10.3	NON-SHRINK GROUT	a) FOSROC b) BASF c) MC-BAUCHEMIE
11.0	MISCELLANEOUS ITEMS	
11.1	WOOD PRESERVATIVE	a) ASCU HICKSON LTD.OR APPROVED EQUIVALENT
11.2	WALL SURFACE TEXTURED COATING	a) UNITILE b) SPECTRUM PAINTS c) BAKELITE HYLAM
11.3	PVC PLUMBING FITTINGS	a) PRAYAG POLYMERS (P) LTD. b) ASTRAL c) PRINCE d) SWASTIK OR APPROVED EQUIVALENT
11.4	REINFORCED FIBRE GLASS WATERPROOFING FELT	a) FGP LTD. b) U.P. TWIGA F.G. LTD.OR APPROVED EQUIVALENT
11.5	ANTI TERMITE TREATMENT	a) PCI Or APPRVD EQUIV.

11.6	MATERIAL TEST HOUSE	a) SHRIRAM TEST HOUSE b) SPECTRO ANALYTICAL LABS c) BHARAT TEST HOUSE OR GOVT. APPROVED TEST LABORATORY
12.0	**CEMENT**	a) ACC b) J K CEMENT c) BINANI CEMENT d) L & T CEMENT e) GUJARAT AMBUJA f) ULTRA TECH CEMENT g) BIRLA CORPN. LTD. h) GRASIM i) SHREE
12.1	SULPHUR RESISTANT CEMENT	a) SAURASHTRA CEMENT LTD. b) SHREE DIGVIJAY CEMENT
13.0	RCC DESIGN MIX	GOVT. APPROVED TEST LABORATORY
14.0	WRAPPING COATING (I/C TAPE & PRIMER)	a) IWL OR APPROVED EQUIVALENT
15.0	FIRE PROOFING MATERIAL	a) CAFCO b) CARBOLINE
16.0	STRUCTURAL STEEL / CS PLATE	a) SAIL b) TATA STEEL c) RINL d) JINDAL/ JSW e) ESSAR f) ISPAT INDUSTRIES g) JINDAL STEEL & POWER LTD.
16.1	MS PIPES (HAND RAIL APPLICATION)	a) HITEX b) ASHWANI STEELS c) SURYA d) PRAKASH e) VIKRANT ISPAT UDYOG f) TATA g) JINDAL h) ZENITH
17.0	TMT BAR / REBAR	a) SAIL b) TATA STEEL c) RINL d) JSW/ JINDAL e) ELECTROSTEEL STEELS LTD.
18.0	GRATINGS/HANDRAILS	a) INDIANA GRATINGS b) WESTCOAST ENGINEERING c) GREATWELD GRATING d) KANADE ANAND UDYOG
19.0	WELDING ELECTRODE	a) ADOR b) ESAB c) D & H d) HANOVAR f) ADVANI
20.0	FUSION BONDED EPOXY COATING TO TMT BAR / REBAR	a) PSL b) ELECTROTHERM INDIA
21.0	UPVC PIPES/ FITTINGS	a) SUPREME b) FINOLEX c) PRINCE d) ASTRAL
22.0	CPVC PIPES/ FITTINGS	a) SUPREME b) FINOLEX c) PRINCE d) ASTRAL
23.0	ACID PROOF BRICKS (38 X 115 x 230 mm)	APPROVED BRAND CONFORMING TO IS:4860

24.0	POLYCARBONATE SHEET	a) DAMPALON b) ALCOX c) POLYGALOR APPROVED EQUIVALENT
25.0	BITUMEN IMPREGNATED BOARD	SHALITEX OR APPROVED EQUIVALENT
26.0	POLYSULHIDE SEALANT	a) PIDILITE b) SIKA c) STPOR APPROVED EQUIVALENT
27.0	CHROMIUM PLATED FITTINGS	a) JAQUAR b) PARRYWARE c) HINDWARE d) ROCA e) CERA

INDICATIVE QAP/ITP- TANKS
(TANKS etc)

PROJECT: INSTALLATION OF ULTRAFILTRATION UNIT

CLIENT : RCF-THAL

STORAGE TANK

Sl. No.		INSPECTION BY					
		VENDOR	TPIA	LSTK CONTRACTOR	LICENSOR	OWNER/PMC	RECORD
01		Detailed Inspection & Test Plan (including for bought out items)	P	A	A		R	X
02		Design & Drawing Approval	P	I	A		R	X
03		Inspection & Test Procedures such as NDT, PWHT, Pressure test, Hardness, Painting, etc.	P	A	A		I	X
04		Inspection of construction Equipment and measuring apparatus	P	R	H		I	X
05		Welding Procedure Specification (WPS) & Procedure Qualification Record (PQR) with weld map	P	H	A			X
06		Welders Qualification Record	P	R	R			X
07		Welding Consumable Batch Certificate	P	R	R			X
8		Material for Pressure Parts after receipt – Visual/Dimension Inspection, Verification of Marking and Correlation w.r.t. Mill / Manufacturer's Test Certificate, Review of MTC -Measuring thickness of material - shell, roof & bottom plate etc.	P	H	W/R			X
9		Material for Non Pressure Parts / Structural – Inspection, Identification with Test certificate & Review of certificate.	P	R	R			X
10		**Fit-up Inspection**						
		Bottom Sketch Plate & Annular Plate - Plates Lapping & spacing connection	P	W	R			X
		Shell Horizontal & Vertical joint & Shell Opening	P	W/R	R			X
		Plumpness, Roundness, Local Deviation - Bending , Peaking e.t.c	P	W/R	R			X
		Roof Plate/Roof Opening & Non Pressure Parts	P	R	R			X
		Dimensional Inspection of Nozzle	P	W/R	R			X
11		**Weld Visual Inspection**						
		Bottom Sketch Plate & Annular Plate	P	W/R	R			X
		Shell Horizontal & Vertical joint & Shell Opening	P	W	R			X
		Roof Plate, Roof Opening & Non Pressure Parts	P	W	R			X
	d	Nozzle butt weld joint	P	W	R			X
12	a	Vacuum Box Test for Bottom, Annular Plate Joint & Annular Plate to Shell Joint	P	W	R			
	b	Diesel Oil Chalk Test for Shell to Annular Plate & Compression Ring to Shell Joint	P	W/R	R			X
13		Inspection of completed pressure retaining weld joints						X

								X
	a	Visual check for reinforcement, undercuts, surface defects etc.	P	W/R	R			X
	b	Non destructive and other tests-RT,UT,MT,PT e.t.c (as applicable)	P	W/R	R			X
14		PWHT (as applicable)	P	R	R			X
15		Pneumatic Test of RF Pad	P	W	R			X
16		Final Visual & Dimensional Check, NDT Clearance prior to hydro test	P	W	R			X
17		Temporary Attachment removal area - weld / PT or MT Check	P	W/R	R			X
18		Hydro static Test	P	H	H			X
19		Settlement of tank foundation during hydro test	P	W	R			X
20		Internal cleanliness inspection	P	W	R			X
21		NDE after Hydro test as applicable	P	RW	R			X
22		Pickling and Passivation for SS tank						
23		Surface Preparation and Painting	P	W	R			X
	a	WFT check of intermediate coat	P	R	R			X
	b	DFT check of final coat	P	W	R			X
	c	Adhesion test as applicable	P	W/R	R			X
	d	Visual check of final coat	P	W	R			X
24		Final stamping & issue of Inspection release certificate	P	W	R		I	X

LEGEND		**1) LSTK CONTRACTOR , 2) PMC – PROJECT MANAGEMENT CONSULTANT, 3) TPIA – THIRD PARTY INSPECTION AGENCY 4) H - HOLD, 5) A - APPROVE, 6) W - WITNESS, 7) RW – RANDOM WITNESS 8) R - REVIEW, 9) P - PERFORM10) SUB-VENDOR –VENDOR SELECTED BY LSTK FOR DESIGN & FABRICATION OF TANK /LSTK CONTRACTOTR**
NOTE	1)	**CROSS (X) INDICATES REQUIREMENT OF RECORD**
	2)	**This is only an indicative ITP and covers major inspection stages only. Vendor shall submit detailed ITP for all manufacturing/inspection activities including bought out items in line with above and specific technical requirements of applicable PR/PS/design code**
	3)	**Responsibility Of Performing/ Coordinating All Inspection Activities As Per ITP is with vendor/LSTK contractor only irrespective of the place of inspection i.e. Vendor shop / sub vendor shop / sub-sub vendor shop/contractor facility/site etc**
	4)	**Inspection Stages Of OWNER/PMC/Licensor Would Be Informed During Order Execution/Pre-Inspection Meeting**
	5)	**Owner/PMC reserves the right to involve in all inspection activities irrespective of whether it is witness point or not**
	6)	**For Sub-Vendor Items, Main Vendor Shall Be Involved In The Inspection Prior To Offering To LSTK/TPIA**
	7)	**Vendor shall ensure that all test and measuring instruments are duly calibrated and calibration shall be valid at the time of inspection. Calibration records shall be reviewed by LSTK & TPIA**
	8)	**For 'R' No Issue Of Inspection Call Is Required**
	9)	**For "W" & "H" Points – Inspection Call To Be Issued By Vendor**
	10)	**Sub Vendor For All Bought Out Items Shall Be From Approved Vendor List**
	11)	**ITP shall be prepared as per format provided by LSTK contractor if any**
	12)	**Approved Third Party Inspection Agencies as per NIT.**
	13)	**Wherever "W/R" Is Mentioned, It Is At The Sole Discretion Of Owner To Decide "W" Or "R" While Approval Of ITP During Order Execution.**
	14)	**A new welding procedure shall be qualified for the project. A proposed welding procedure specification (WPS) shall be submitted to approved inspection agency for approval. On approval, a procedure qualification test shall be conducted which shall be witnessed by approved inspection agency. Approved inspection agency may accept previously qualified WPS/PQR at his sole discretion**
	15)	**This ITP is applicable for Pressure Vessels, Filter, etc. and all Vessels Designed As Per ASME SECTION VIII.**
	16)	**TPIA agency shall be Lloyds/BV/TUV/**

INDICATIVE QAP/ITP-VESSEL
(PRESSURE VESSEL, FILTER, etc)

PROJECT: INSTALLATION OF ULTRAFILTRATION UNIT

CLIENT : RCF-THAL

INDICATIVE QAP/ INSPECTION AND TEST PLAN- PRESSURE VESSELS, FILTER, etc (ITP-01)

PRESSURE VESSELS, FILTER, etc								
Sl. No.		**DESCRIPTION OF ACTIVITY**	**INSPECTION BY**					
			VENDOR	**TPIA**	**LSTK CONTRACTOR**	**LICENSOR**	**OWNER/ PMC**	**RECORD**
01		Detailed Inspection & Test Plan after issue of PO/PR/PS (including for bought out items)	P	A	A		R	X
02		DESIGN & DRAWING Approval	P	I	A		R	X
03		Inspection & Test Procedures such as NDT, PWHT, Pressure test, Hardness, Painting, etc.	P	A	A		I	X
04		Pre inspection meeting	P	H	H		I	X
05		Welding Procedure Specification (WPS) & Procedure Qualification Record (PQR) with weld map	P	H	A			X
06		Welders Qualification Record	P	R	R			X
07		Welding Consumable Batch Certificate in accordance with EN 10204 3.1 / ISO10474 3.1b	P	R	R			X
08		Inspection of Bought out items at Sub vendor's works for Flanges / Forgings, Fitting, Pipes, Fasteners, Plates, dished ends, Expansion Bellows, Clad plates, etc.	P	R	R			X
09		Sub order verification						
	a	Material Identification	P	W/R	R			X
	b	Sampling for test	P	W/R	R			X
	c	Mechanical/Corrosion Testing	P	W/R	R			X
	d	Relevant NDT	P	W/R	R			X
	e	Hydro test as applicable	P	W/R	R			X
	f	Final Visual/Dimension	P	W/R	R			X
10		Material for Pressure Parts after receipt – Visual/Dimension Inspection, Verification of Marking and Correlation w.r.t. Mill / Manufacturer's Test Certificate, Review of MTC	P	H	W/R			X
11		Material for Non Pressure Parts / Structural – Inspection, Identification with Test certificate & Review of certificate.	P	R	R			X
12		Formed Components such as Dished ends, Cones etc.						
	a	Visual, Dimensional, (Profile, Thickness, ovelity, diameter etc.)	P	W	R			X
	b	NDE of weld joint	P	W/R	R			X
	c	PT on inside & outside surface	P	W/R	R			X
	d	Heat treatment chart (if applicable)	P	R	R			X
	e	Testing of Test coupon as applicable including IGC test as applicable	P	W/R	R			X
	f	UT for lack of bond in formed shall, cone etc. for Cladded equipment	P	W/R	R			X
13		Inspection for Weld Overlay						

INDICATIVE QAP/ INSPECTION AND TEST PLAN- PRESSURE VESSELS, FILTER, etc (ITP-01)

	a	PT after first layer of weld overlay	P	W/R	R			X
	b	PT after final layer of weld overlay	P	W	R			X
	c	Check of effective thickness of weld overlay	P	W	R			X
	d	Check of Chemical composition at required depth as applicable	P	W	R			X
	e	Ferrite check of weld overlay	P	RW	R			X
	f	Visual & Dimensional						
14		Weld edge preparation & set up of pressure parts						
	a	Visual & Dimensional	P	W/R	R			X
	b	MT / PT of weld edges	P	W/R	R			X
15		ISR, DHT for LAS as applicable during welding	P	W/R	R			X
16		PT of root run for single side weld / back chipped surface of weld for pressure retaining weld joints	P	R	R			X
17		Inspection of completed pressure retaining weld joints						X
	a	Visual check for reinforcement, undercuts, surface defects etc.	P	W	R			X
	b	NDE before PWHT as applicable	P	W/R	R			X
	c	Ferrite check of weld	P	W	R			X
	d	Dimensional check before PWHT	P	W	R			X
	e	Clearance for PWHT	P	H	R			X
	f	PWHT	P	R	R			X
	g	NDE after PWHT as applicable	P	W/R	R			X
	h	Hardness check after PWHT as applicable	P	RW	R			X
	i	Testing of Production Test coupon as applicable including IGC test as applicable	P	W	W/R			X
18		NDE of Non pressure weld joints	P	R	R			X
19		PMI of all pressure parts and welds for AS/SS material	P	RW	R			X
20		Final visual & Dimensional check, including internal, external & alignment, match markings for site joints etc. (before PWHT as applicable)	P	H	H			X
21		Trial assembly of internals / trays and column/vessel section etc. as applicable.	P	W	W/R			X
22		Pneumatic test of pads	P	W/R	R			X
23		Hydrostatic test	P	H	H			X
24		Check Chloride content of Hydro test water	P	R	R			X
25		NDE after Hydro test as applicable	P	RW	R			X
26		Drying of equipment	P	W/R	R			X
27		Pickling and Passivation (Inside & Outside surface) for SS Equipment						
	a	Visual check	P	W	R			X
28		Surface Preparation and Painting						
	a	WFT check of intermediate coat	P	R	R			X
	b	DFT check of final coat	P	W	R			X
	c	Adhesion test as applicable	P	W/R	R			X
	d	Visual check of final coat	P	W	R			X
29		Visual/Dimension of Foundation Template, Gage plat for base ring & foundation bolt as applicable	P	W/R	R			X
30		Review of final documents including MDR of AI (as applicable)	H	R	R			X
31		Final stamping & issue of	P	H	H		I	X

INDICATIVE QAP/ INSPECTION AND TEST PLAN- PRESSURE VESSELS, FILTER, etc (ITP-01)

		Inspection release certificate						
32		Rust Prevention (N2 purge, VCI)	P	W/R	R			X
33		Packing & Marking inspection	P	W/R	R			X

LEGEND		**1) LSTK CONTRACTOR , 2) PMC – PROJECT MANAGEMENT CONSULTANT, 3) TPIA – THIRD PARTY INSPECTION AGENCY 4) H - HOLD, 5) A - APPROVE, 6) W - WITNESS, 7) RW – RANDOM WITNESS 8) R - REVIEW, 9) P – PERFORM 10) I - INFORMATION**
NOTE	1)	**CROSS (X) INDICATES REQUIREMENT OF RECORD**
	2)	**This is only an indicative ITP and covers major inspection stages only. Vendor shall submit detailed ITP for all manufacturing/inspection activities including bought out items in line with above and specific technical requirements of applicable PR/PS/design code**
	3)	**Responsibility Of Performing/ Coordinating All Inspection Activities As Per ITP is with vendor/LSTK contractor only irrespective of the place of inspection i.e. Vendor shop / sub vendor shop / sub-sub vendor shop/contractor facility/site etc**
	4)	**Inspection Stages Of OWNER/PMC/Licensor Would Be Informed During Order Execution/Pre-Inspection Meeting**
	5)	**Owner/PMC reserves the right to involve in all inspection activities irrespective of whether it is witness point or not**
	6)	**For Sub-Vendor Items, Main Vendor Shall Be Involved In The Inspection Prior To Offering To LSTK/TPIA**
	7)	**Vendor shall ensure that all test and measuring instruments are duly calibrated and calibration shall be valid at the time of inspection. Calibration records shall be reviewed by LSTK & TPIA**
	8)	**For 'R' No Issue Of Inspection Call Is Required**
	9)	**For "W" & "H" Points – Inspection Call To Be Issued By Vendor**
	10)	**Sub Vendor For All Bought Out Items Shall Be From Approved Vendor List**
	11)	**ITP shall be prepared as per format provided by LSTK contractor if any**
	12)	**Approved Third Party Inspection Agencies as per NIT.**
	13)	**Wherever "W/R" Is Mentioned, It Is At The Sole Discretion Of Owner To Decide "W" Or "R" While Approval Of ITP During Order Execution.**
	14)	**A new welding procedure shall be qualified for the project. A proposed welding procedure specification (WPS) shall be submitted to approved inspection agency for approval. On approval, a procedure qualification test shall be conducted which shall be witnessed by approved inspection agency. Approved inspection agency may accept previously qualified WPS/PQR at his sole discretion**
	15)	**This ITP is applicable for Pressure Vessels, Filter, etc. and all Vessels Designed As Per ASME SECTION VIII.**
	16)	**TPIA agency shall be Lloyds/BV/TUV**

PART II: TECHNICAL

SECTION – 11

DESIGN PHILOSOPHY – CIVIL & STRUCTURAL WORKS

QUALITY ASSURANCE PLAN

QUALITY ASSURANCE PLAN

SL NO.	MATERIAL/ OPERATION	NAME OF TEST	FIELD/ LAB.	TEST PROCEDURE	FREQUENCY OF CHECKING	EXTENT OF CHECKING	REFERENCE DOCUMENT
1.	Earthwork in excavation	Lines, levels & depth	Field	Measurement	As per decision of site engr.	100%	Specn. & approved drg.
2.	**Concrete work**						Test will be carried out while establishing mix. design
	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.
		iii) Specific Gravity	Lab	IS:2386 Part III, IS:456, IS:383	Once in 12 weeks or change of source whichever is earlier	-do-	IS:2386 Part III, IS:456, IS:383
		iv) Petrography examination including visual inspection	Field/Lab	IS:2386 Part VIII, IS:383	Once for each source	-do-	IS:2386 Part VIII, IS:383
		v) Mechanical Properties	Lab	IS:2386 Part IV,IS:383	Once for each source	-do-	IS:2386 Part IV, IS:383
		vi) Soundness	Lab	IS:2386 Part V,IS:383	Once for each source	-do-	IS:2386 Part V, IS:383
		vii) Acid & Alkali Reactivity	Lab	IS:2386 Part VII, IS:383	Once for each source	-do-	IS:2386 Part VII, IS:383
		viii) Flakiness	Lab	IS:2386 Part-I, IS:2386 Part VII, IS : 383	Once for each source	-do-	IS:2386 Part-I, IS:2386 Part VII, IS : 383
		ix) Bulk Density	Lab	IS:2386	One Sample per 200 m3 or part thereof	-do-	IS:2386
	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
		iii) Bulk age Moisture	Lab	IS : 2386 Part-III, IS : 383	One sample per 20M3 (or part thereof)	-do-	IS : 2386 Part-III, IS : 383
		iv) Deleterious material	Lab	IS : 2386 Part-II, IS : 383	Once for each source	-do-	IS : 2386 Part-II, IS : 383

		v) Soundness	Lab	IS:2386 Part V, IS:383	Once for each source	-do-	IS:2386 Part V, IS:383
		vi) Acid & Alkali Reactivity	Lab	IS:2386 Part VII, IS:383	Once for each source	-do-	IS:2386 Part VII, IS:383
		vii) Mortar Making Properties	Lab	IS : 2386 Part-VI, IS : 383	Once for each source	-do-	IS : 2386 Part-VI, IS:383
		viii) Petrography examination including visual inspection	Field/Lab	IS:2386 Part VIII, IS:383	Once for each source	-do-	IS:2386 Part VIII, IS:383
		ix) Specific Gravity	Lab	IS:2386 Part III, IS:456, IS:383	Once in 12 weeks or change of source whichever is earlier	-do-	IS:2386 Part III, IS:456, IS:383
	c) Cement	i) Physical properties	Lab	As per IS 269 & 4031	-do-	-do-	IS 269,1489,4031 & 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	-do-	CPWD Specn. &

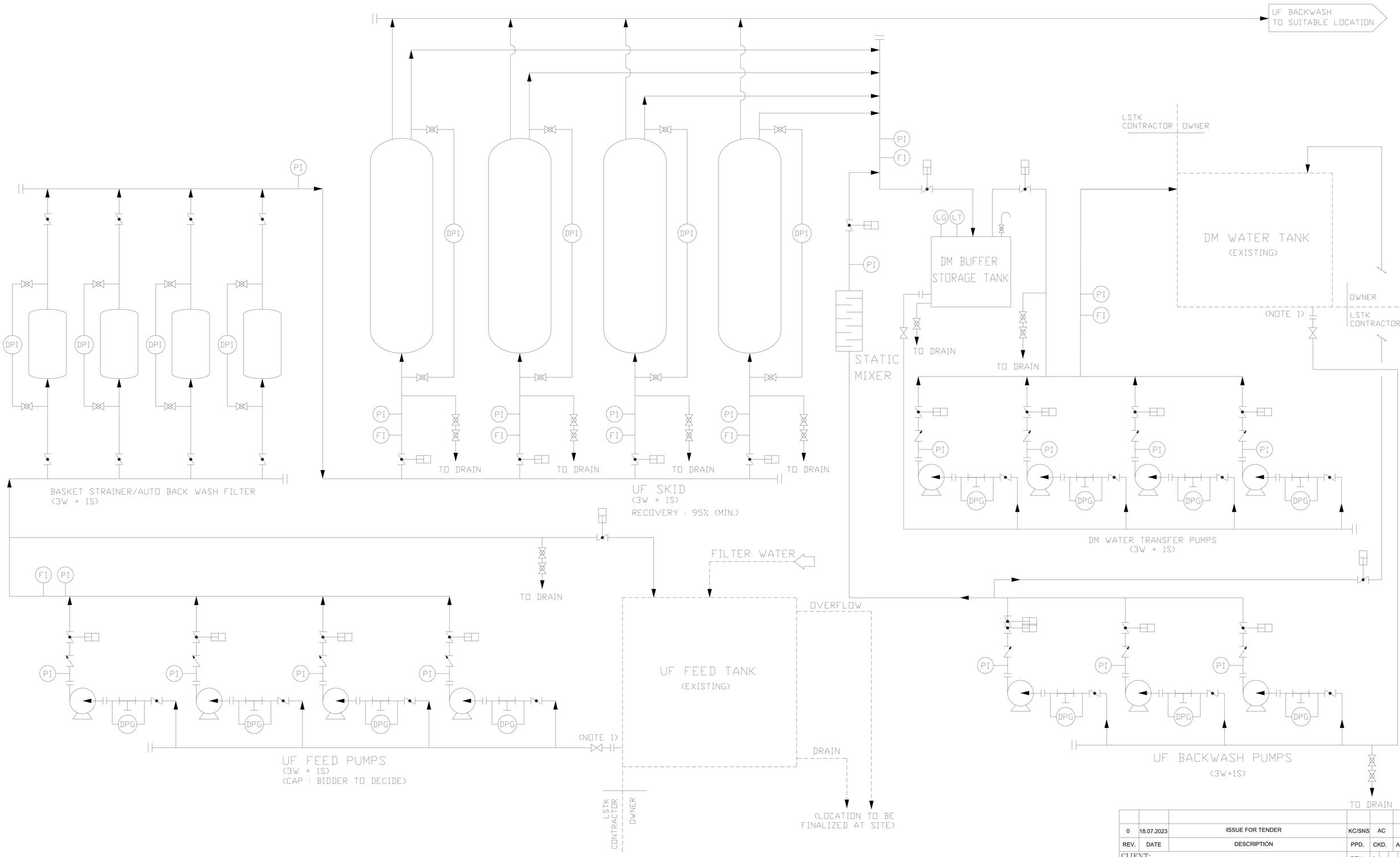
					concreting		IS 1199
		ii) Cube test at 7/28 days	Field/Lab.	As per IS 516	No. of cubes to be decided as per given in IS 456/ Specn.	-do-	IS 456,IS 516
	g) Shuttering / Formwork Checking of levels, dimensions, unevenness, joints, cleanliness, oiling etc.	Physical	Field	Measurement	All	-do-	As per drawing, CPWD specifications & instruction of E.I.C
3.	**Brick Work/Hollow Concrete Block/ Cement Concrete Block work**						
	a) Brick/ Hollow Concrete Block / CC Block work	i) Physical properties & crushing strength	Field/Lab.	As specified in Specn & IS 1077	Once for each source	100%	Specn. / IS 1077
		ii) Water absorption and efflorescence	Lab	IS 3495, IS 1124	Once for each source/supply	-do-	IS 3495, IS 1124& Test certificates
	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 certilficates	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 (As per Painting Specifications)	Visual inspection, Visual gauges, adhesive tape test, DFT, etc. confirming to ISO 8501/8502/SSPC as required.	Field/Shop	ISO 8501-1, ISO 8502-3, ISO 8502-6, ISO 8503-2	Regular checks as per respective ISO/SSPC standards.	-do-	ISO 8501-1, ISO 8502-3, ISO 8502-6, ISO 8503-2, ISO 4628-1 to 6, SSPC
	v) Fabrication & Erection works	Alignment, levels, angles, etc.	Field/Shop	IS:7215,IS:12843, IS:1852	As per discretion of site Engineer / Quality engineer.	-do-	IS:7215, IS:12843, IS:1852 and other approved guidelines

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	Non-asbestos roofing sheet / PVC sheet (Virgin PVC) roofing laying & fixing.	Physical	Field	IS 14871, ISO 9933, ISO 390, IS 3007, ISO 6603	Once for each source/supply	-do-	IS 14871, ISO 9933, ISO 390, IS 3007, ISO 6603 and other test certificates.
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.

ANNEXURE-1



NOTES:

1. ALL THE INSTRUMENTS SHOWN IN THE PFD ARE TENTATIVE. THIS SHALL BE FINALIZED DURING DETAILED ENGINEERING.
2. PIPELINE HOOK-UP SHALL BE IN BIDDER'S SCOPE.
3. THIS IS AN INDICATIVE PFD WHICH SHALL BE FURTHER DEVELOPED BY THE CONTRACTOR AS PER REQUIREMENT.
4. VENDOR TO INDICATE NORMAL/DESIGNED FLOW, OPERATION PRESSURE & TEMPERATURE OF EACH STREAM.
5. ADEQUATE CHEMICAL & TYPE SHALL BE DOSED AT VARIOUS POINTS BY THE BIDDER TO MEET SYSTEM REQUIREMENTS & GUARANTEES..

LEGEND:

————	LSTK CONTRACTOR
- - - - - - - - - - -	OWNER

REV.	DATE	DESCRIPTION	PPD.	CKD.	APPD.
0	18.07.2023	ISSUE FOR TENDER	KC/SNS	AC	MN

CLIENT: RASHTRIYA CHEMICALS & FERTILIZERS LTD.

REV. 0

SHEET 1 OF 2

SCALE NTS

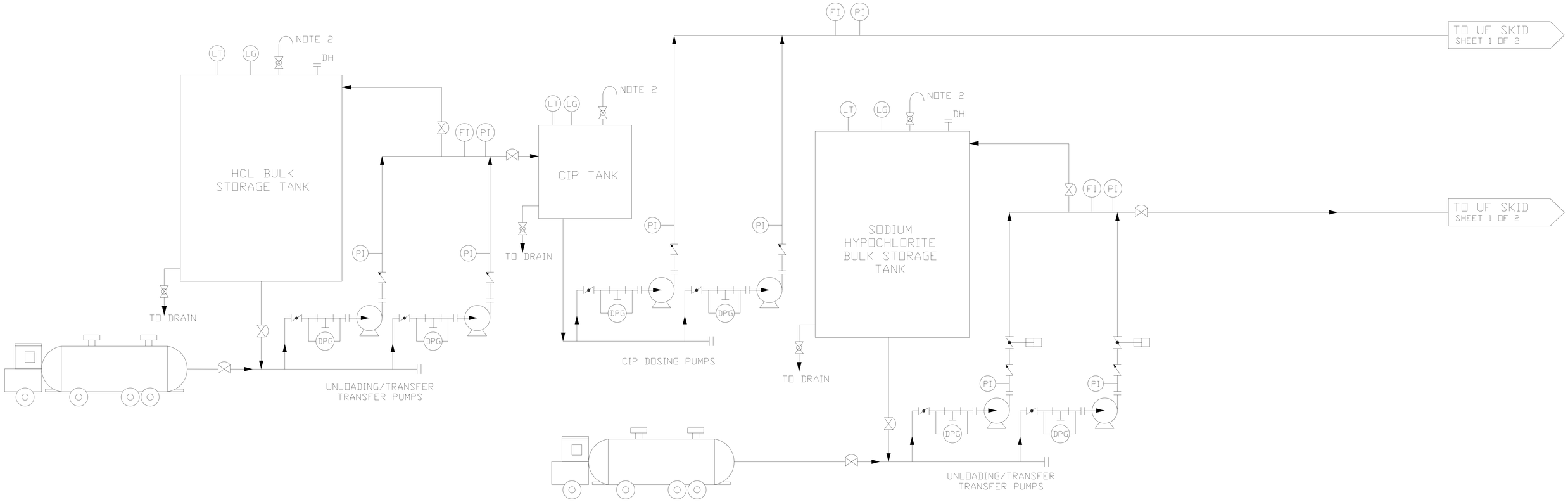
TITLE: SCHEMATIC PROCESS FLOW DIAGRAM FOR ULTRA FILTRATION UNIT

DWG.NO. PC284-7311-0046

PROJECT: INSTALLATION OF ULTRA FILTRATION UNIT AT RCF THAL

FILE:

PROJECTS & DEVELOPMENT INDIA LTD.
NOIDA



CEP DOSING PUMPS
(TYPE: POSITIVE DISPLACEMENT PUMP)

NOTES:

1. ALL THE INSTRUMENTS SHOWN IN THE PFD ARE TENTATIVE. THIS SHALL BE FINALIZED DURING DETAILED ENGINEERING.
2. ALL TANKS SHALL HAVE FOLLOWING PROVISIONS: LEVEL TRANSMITTER,LOCAL LEVEL GAUGE, VENT WITH ISOLATION VALVE & DRAIN WITH ISOLATION VALVE.
3. ALL PUMPS SHALL HAVE INDIVIDUAL ISOLATION VALVES AT DISCHARGE FOR PUMP ISOLATION DURING MAINTENANCE.

REV.	DATE	DESCRIPTION	PPD.	CKD.	APPD.
0	18.07.2023	ISSUE FOR TENDER	KC/SNS	AC	MN

CLIENT: RASHTRIYA CHEMICALS & FERTILIZERS LTD.

REV. 0

SHEET 2 OF 2

SCALE NTS

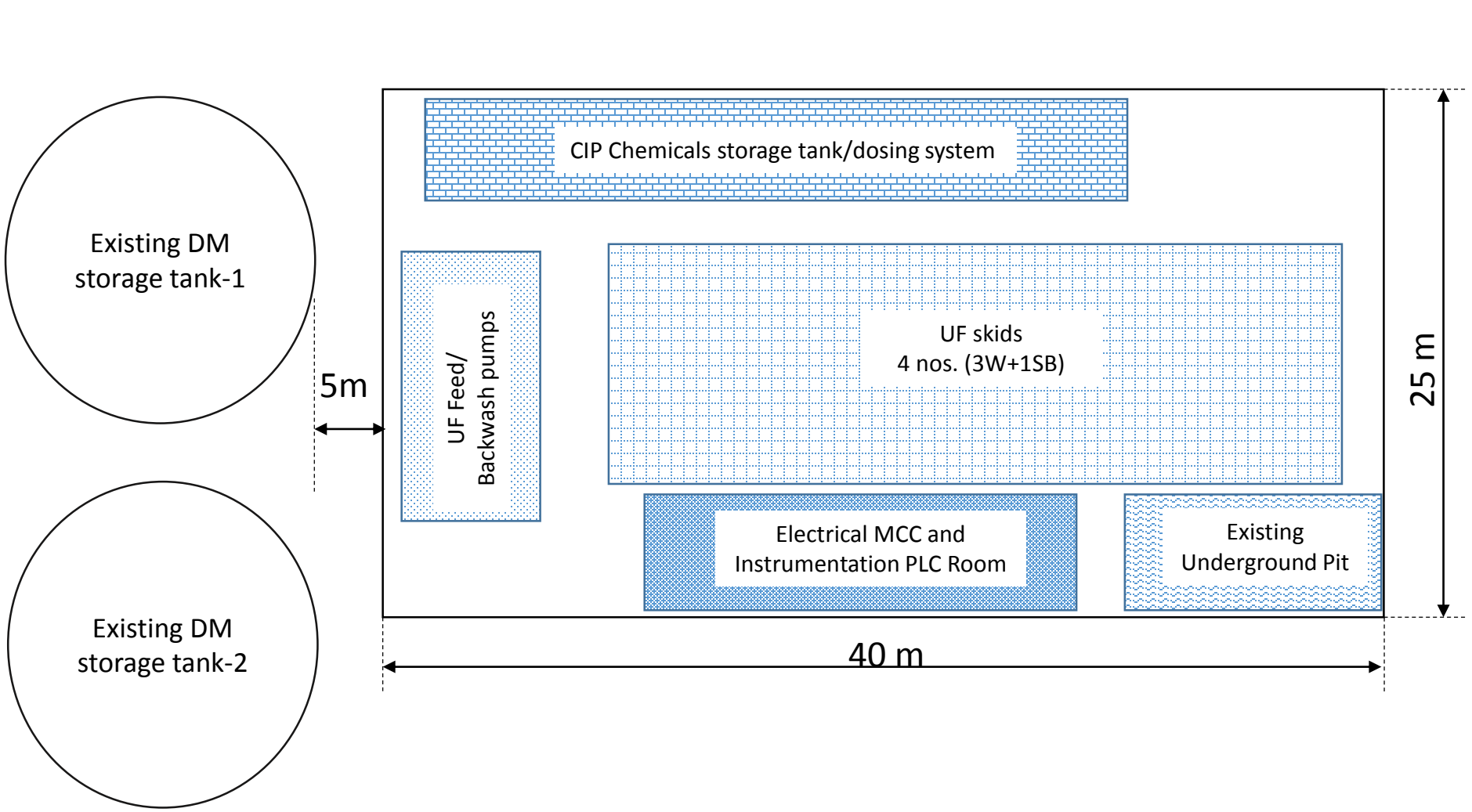
TITLE: SCHEMATIC PROCESS FLOW DIAGRAM FOR ULTRA FILTRATION UNIT

DWG.NO. PC284-7311-0046

PROJECT: INSTALLATION OF ULTRA FILTRATION UNIT AT RCF THAL

FILE:

PROJECTS & DEVELOPMENT INDIA LTD.
NOIDA



Tie in points:

1. **UF feed pump suction line:** From existing DM storage tank-1
2. **UF skid outlet line:** To existing DM storage tank-2 (Elevation-16 m)
3. **All utility line:** Up to North east corner of given plot
4. **Electrical supply cable:** Up to MCC feeder.