

**TELANGANA STATE POWER
GENERATION CORPORATION
LIMITED (TSGENCO)**

**4X270 MW BHADRADRI
THERMAL POWER PROJECT**

VOLUME – II B & III

**TECHNICAL SPECIFICATION
FOR
PRE-TREATMENT PLANT**

SPECIFICATION NO. PE-TS-411-158A-A001, R0



**BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA, INDIA**

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE-TREATMENT PLANT**

SPECIFICATION NO. PE-TS-411-158A-A001

VOLUME: II B & III

REV 00

SHEET 1 of 2

INDEX**VOLUME – IIB**

SECTIONS	TITLE	PAGE NO.
SECTION-A	INTENT OF SPECIFICATIONS	1-3
SECTION-B	PROJECT INFORMATION WITH WIND AND SEISMIC DESIGN CRITERIA	4-6
SECTION-C	SPECIFIC TECHNICAL REQUIREMENT	
SECTION-C1 – A	SCOPE OF SUPPLY & SERVICES, EXCLUSION AND TERMINAL POINTS ETC.	8-22
SECTION-C1 – B	GENERAL REQUIREMENT	23-96
SECTION-C1 – C	FUNCTIONAL / PERFORMANCE / DEMONSTRATION GUARANTEE	97-99
SECTION-C1 - D	QUALITY ASSURANCE	100-131
SECTION-C1 - E	PAINTING SPECIFICATION	133-144
SECTION-C1 - F	DATASHEET – A	145-156
SECTION-C2	TECHNICAL SPECIFICATION FOR ELECTRICAL	157-165
SECTION-C3	TECHNICAL SPECIFICATION FOR CONTROL AND INSTRUMENTATION	166-171
	<u>ANNEXURES</u>	
i)	ANNEXURE-I: LIST OF MAKES	173-184
ii)	ANNEXURE-II: MANDATORY SPARE LIST	185-191
iii)	ANNEXURE-III: RAW WATER ANALYSIS AND CLARIFIED WATER ANALYSIS	192-193
iv)	ANNEXURE-IV: LIST OF TOOLS & TACKLES	194-195
v)	ANNEXURE-V: DRAWING / DOCUMENT SUBMISSION SCHEDULE	196-198
vi)	ANNEXURE-VI: MAIN DRAWING LIST WITH SCHEDULE OF SUBMISSION	199-204
vii)	ANNEXURE-VII: FORMAT FOR OPERATION AND MAINTENANCE MANUAL	205-208
x)	ANNEXURE-VIII: SITE STORAGE AND PRESERVATION	209-223
xi)	ANNEXURE-IX: INPUT DRAWING	224-229
SECTION-D	STANDARD TECHNICAL SPECIFICATIONS	
SECTION D1	STANDARD TECHNICAL SPECIFICATION FOR MECHANICAL	231-302
SECTION D2	STANDARD TECHNICAL SPECIFICATION FOR ELECTRICAL	303-314
SECTION D3	STANDARD TECHNICAL SPECIFICATION FOR CONTROL AND INSTRUMENTATION	315-425
SECTION D3	STANDARD TECHNICAL SPECIFICATION FOR CIVIL	426-799

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE-TREATMENT PLANT**

SPECIFICATION NO. PE-TS-411-158A-A001

VOLUME: II B & III

REV 00

SHEET 2 of 2

VOLUME-III

S. NO.	TITLE	PAGE NO.
1	LIST OF DOCUMENTS TO BE SUBMITTED WITH BID	801
2	COMPLIANCE CUM CONFIRMATION CERTIFICATE	802
3	PRE BID CLARIFICATION SCHEDULE	803
4	SCHEDULE OF TECHNICAL DEVIATION	804
5	SUGGESTIVE PRICE FORMAT	805
6	GUARANTEED AUXILIARY POWER CONSUMPTION	806

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT****SPECIFICATION NO.**

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 1 of 3

**SECTION - A
INTENT OF SPECIFICATION**

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT****SPECIFICATION NO.**

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 2 of 3

1.0 SCOPE:**1.1 PRE TREATMENT PLANT (PT PLANT)**

The indent of this specification is to cover design of all equipment and civil design, structural & construction work at site for all equipment (except Chemical House and centrifuge shed/building), engineering, manufacturing, assembly, inspection, shop testing, supply, packing and delivery at site, loading, unloading, storage, erection and commissioning, start-up, mandatory & commissioning spares, site testing and demonstration test and handling over to the customer of **PRETREATMENT PLANT** for **4X270 MW BHADRADRI TPS**. The scope of supply shall fully cover the requirement of the Design Criteria and Technical specification of this specification.

The bidder's scope shall also include any other services, etc. if called for in the succeeding sections of the specification.

2.0 GENERAL TECHNICAL INSTRUCTIONS

- 2.1 The contractor shall be responsible for providing all material, equipment & services, which are required to fulfil the intent of ensuring operability, maintainability, reliability and complete safety of the complete work covered under this specification, irrespective of whether it has been specifically listed herein or not. Omission of specific reference to any component / accessory necessary for proper performance of the equipment shall not relieve the vendor from the responsibility of providing such facilities to complete the supply and erection & commissioning of PRE-TREATMENT PLANT
- 2.2 It is not the intent to specify herein all the details of design and manufacture. However, the equipment shall conform in all respects to high standards of design, engineering and workmanship and shall be capable of performing the required duties in a manner acceptable to purchaser who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material which in his judgment is not in full accordance herewith.
- 2.3 The extent of supply under the contract includes all items shown in the drawings, notwithstanding the fact that such items may have been omitted from the specification or schedules. Similarly, the extent of supply also includes all items mentioned in the specification and /or schedules, notwithstanding the fact that such items may have been omitted in the drawing.
- 2.4 The general term and conditions, instructions to tenderer and other attachment referred to elsewhere are made part of the tender specification. The equipment materials and works covered by this specification are subject to compliance to all attachments referred in the specification. The bidder shall be responsible for and governed by all requirements stipulated herein.
- 2.5 While all efforts have been made to make the specification requirement complete & unambiguous, it shall be bidders' responsibility to ask for missing information, ensure completeness of specification, to bring out any contradictory / conflicting requirement in different sections of the specification and within a section itself to the notice of BHEL and to seek any clarification on specification requirement in the format enclosed under VOL-III of the specification. In absence of any such clarifications, in case of any contradictory requirement, the more stringent requirement as per interpretation of Purchaser / Customer shall prevail and shall be complied by the bidder without any commercial implication on account of the same. Further in case of any missing information in the specification not brought out by the prospective bidders as part of pre-bid clarification, the same shall be furnished by Purchaser/ Customer as and when brought to their notice either by the bidder or by purchaser/ customer themselves. However, such requirements shall be binding on the successful bidder without any commercial & delivery implication to BHEL / Customer.

	TITLE 4 X 270 MW BHADRADRI TPS TECHNICAL SPECIFICATION FOR PRE- TREATMENT PLANT	SPECIFICATION NO. PE-TS-411-158A-A001
		VOLUME: II B
		REV 00
		SHEET 3 of 3

2.6

Deviations along with cost of withdrawal (positive or negative), if any, should be very clearly brought out clause by clause in the enclosed schedule; otherwise, it will be presumed that the vendor's offer is strictly in line with tender specification & there is no deviation. (Price to be given in sealed envelope only.)

2.7

In case all above requirements are not complied with, the offer may be considered as incomplete and would become liable for rejection.

2.8

Unless specified otherwise, all through the specification, the word contractor shall have same meaning as successful bidder / vendor and Customer / Purchaser / Employer will mean BHEL and /or TELANGANA STATE POWER GENERATION CORPORATION LIMITED (TSGENCO), HYDERABAD.

2.9

The equipment covered under this specification shall not dispatch unless the same have been finally inspected, accepted and shipping release issue by BHEL/Customer.

2.10

BHEL's/Customer's representative shall be given full access to the shop in which the equipments are being manufactured or tested and all test records shall be made available to him.

Page 3 of 806

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 1 of 3

SECTION - B**PROJECT INFORMATION WITH WIND AND SEISMIC DESIGN CRITERIA**

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT****SPECIFICATION NO.**

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 2 of 3

INTRODUCTION

4x270 MW Bhadradi TPS is being set up by Telangana State Electricity Corporation Limited (TSGENCO) at Manuguru in the district of Khammam, Telangana, India.

The Bidder shall acquaint himself by a visit to the site, if felt necessary, with the conditions prevailing at site before submission of the bid. The information given here in under is for general guidance and shall not be contractually binding on BHEL/Owner. All relevant site data /information as may be necessary shall have to be obtained /collected by the Bidder.

APPROACH TO SITE

The distance from Manuguru to Major cities in state:

City	Km
Hyderabad	345
Warangal	180
Bhadrachalam	38
Kothagudem	70
Khammam	130
Vijayawada	195

District : KHAMMAM
State : TELANGANA

Nearest Airport: The nearest airport is Vijayawada Airport but the most used airport is the Hyderabad International Airport.

Nearest Railway Station: Manuguru railway station is 10KM from nearby town. However Warangal/Vijaywada railway Station is major railway station near to Manuguru.

- Owner : TSGENCO
- Project Title : 4X270 MW Bhadradi TPS
- Location : 16 Km from Manuguru Railway station
- Nearest Railway Stn. : Manuguru
- Temperature
 - Mean daily minimum ambient temperature during oldest month of the year: 11.5 Deg.C
 - Mean daily minimum ambient temperature during hottest month of the year: 45.1 Deg.C
- Rainfall: Intensity of rainfall @ 50 mm/hr considering heaviest fall in 24 hrs
- Wind Data: Basic wind speed at 10m height : 44 m/sec



TITLE

4 X 270 MW BHADRADRI TPS TECHNICAL SPECIFICATION FOR PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 3 of 3

8. Wind pressure As per IS: 875 Part III- 1987

9. Seismic Zone: Zone III as defined in IS:1893 (part-1)-2002 according to Indian Standard Seismic Zoning Map

10	Power Supply : The power supplies for distribution and auxiliaries shall be as under:	
	a) In plant generation	16.5kV $\pm 5\%$, 3ph, 50Hz $\pm 5\%$, high resistance earthed.
	b) MV distribution	6.6kV $\pm 6\%$, 3ph, 3w , 50 Hz , + 5 % to – 5%, Non-effectively earthed
	c) LT distribution	415V $\pm 10\%$, 3ph, 4W, 50Hz + 5% to – 5%, Effectively earthed
	d) Motor rated above 160kW	6.6kV $\pm 6\%$, 3 ph 50Hz +5% to -5%.
	e) Motor rated 160kW and below all motorized actuators.	415V $\pm 10\%$, 3 ph, 50Hz +5% to -5%.
	f) For motors equal and below 30kW winding heating	24V AC $\pm 10\%$, 50 Hz % , [to be generated in 415V switchgear by vendor]
	g) DC Motors	220V DC + 10% to - 15%, 2 wire ungrounded system
	h) Control supply for relay panel/ 6.6kV breakers/415V breakers and DC emergency lighting.	220V DC + 10% to - 15%, 2 wire ungrounded system
	i) UPS for instrumentation & Control system	240V AC $\pm 1\%$, 1 ph ,50Hz $\pm 0.5\%$ 2 Wire AC system
	j) Control supply for 415V Motor contactors/AC Control circuits [to be generated in MCC /panel by vendor]	110V AC $\pm 10\%$, 50Hz + 5% to –5%.
	k) Diesel Generator emergency supply	415V $\pm 10\%$, 3ph,3W, 50Hz +5%to – 5%.
11	Fault levels	
	a) 400kV	40kA rms for 1 sec
	b) 6.6kV	40 kA rms for 1 sec.
	c) 415V	50 kA rms for 1 sec.
	d) DC Supply	25 kA

**TITLE**

4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE-TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 1 of 1

SECTION – C**SPECIFIC TECHNICAL REQUIREMENTS****SECTION – C1: SPECIFIC TECHNICAL REQUIREMENTS FOR MECHANICAL****SECTION – C2: SPECIFIC TECHNICAL REQUIREMENTS FOR ELECTRICAL****SECTION – C3: SPECIFIC TECHNICAL REQUIREMENTS FOR CONTROL AND**
INSTRUMENTATION

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 1 of 15

SECTION C1 – A**SCOPE OF SUPPLY & SERVICES, EXCLUSION AND TERMINAL POINTS ETC.**

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT****SPECIFICATION NO.**

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 2 of 15

PRETREATMENT PLANT**1.0 INTENT OF SPECIFICATION**

- 1.1 The indent of this specification is to cover mechanical design of all equipment and civil design, structural & construction work at site for all equipment (except Chemical House and centrifuge shed/building), engineering, manufacturing, assembly, inspection, shop testing, supply, packing and delivery at site, loading, unloading, storage, erection and commissioning, start-up, mandatory & commissioning spares, site testing and demonstration test and handling over to the customer of **PRETREATMENT PLANT** for **4X270MW, BHADRARI THERMAL POWER STATION**. The scope of supply shall fully cover the requirement of the Design Criteria and Technical specification of this specification.

**1.1 BROAD SCOPE OF SUPPLY
(REFER FLOW DIAGRAM FOR PRETREATMENT PLANT)**

Bidder to note that pre-treatment plant shall be a complete system which shall include associated civil design, structural & construction work for all equipment (except Chemical House and centrifuge shed/building), mechanical, electrical, control & instrumentation work only. BHEL shall do the civil design and work for Chemical House and centrifuge shed/building. Except all the work i.e. mechanical work, civil work (except Chemical House and centrifuge shed/building), c & I, electrical works (refer electrical, C & I for respective scope) shall be in the scope of bidder. Broad scope of supply has been listed below.

- i. Raw water inlet piping to aerator complete with piping, fitting and valves. The inlet piping is to include motorised butterfly type control valve with necessary manual isolation/control valve and necessary instrumentation.
- ii. Piping along with valves from raw water supply pumps to aerator as per flow diagram enclosed for pre-treatment plant.
- iii. One no. aerator of RCC construction with instrument and accessories.
- iv. Two no. stilling chamber with instrument and accessories.
- v. Two (2) nos. parshall flume with instrument and accessories.
- vi. Two (2) nos. inlet chamber with motorised stirrer and valves, instrument and accessories.
- vii. Two (2) nos. HRSCC (High Rate Solid Contact Type Clarifier) with sampling points at different elevation of clarifiers.
- viii. Clarifier bridge assembly, hand railing, required motors, valves, piping, instrumentation etc for each clarifier.
- ix. Sludge disposal system from clarifier with piping, valves, instrumentation upto sludge collection pit as indicated in flow diagram of Pre-treatment plant.
- x. One (1) no. RCC Sludge Pit (in twin section) interconnected through gate.
- xi. Two (2) nos. sludge transfer pump with piping, valves, fittings and instrumentation upto thickener.
- xii. One (1) no. thickener with clarifier bridge assembly, hand railing, required motors, valves, piping, fitting, instrumentation as per enclosed flow diagram.
- xiii. One (1) no. thickened sludge sump with instrumentation as per enclosed flow diagram.
- xiv. Three (3) no. thickener sludge transfer pumps with piping, valves, fittings and instrumentation upto respective centrifuge.
- xv. Three (3) no. Centrifuge along with piping, fitting as per enclosed flow diagram.
- xvi. Two nos. MSRL polyelectrolyte dosing tanks along with Motorised stirrer, flushing arrangement, instrumentation, valves, fittings and piping up to the respective clarifiers.
- xvii. Two (2) nos. (1w+1s) polyelectrolyte dosing pumps with instrumentation for respective clarifiers.
- xviii. Two nos. MSRL polyelectrolyte dosing tanks along with Motorised stirrer, flushing arrangement, instrumentation, valves, fittings and piping up to the thickener.
- xix. Two (2) nos. (1w+1s) polyelectrolyte dosing pumps with instrumentation for thickener.



TITLE

4 X 270 MW BHADRADRI TPS TECHNICAL SPECIFICATION FOR PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 3 of 15

- xx. Two nos. MSRL polyelectrolyte dosing tanks along with Motorised stirrer, flushing arrangement, instrumentation, valves, fittings and piping up to the respective centrifuge.
- xxi. Two (2) nos. (1w+1s) polyelectrolyte dosing pumps with instrumentation for centrifuge.
- xxii. Two nos. MSRL alum dosing tanks along with Motorised stirrer, flushing arrangement, instrumentation, valves, fittings and piping for clarifiers.
- xxiii. Two (2) nos. (1w+1s) alum dosing pumps with instrumentation.
- xxiv. Two nos. RCC lime dosing tanks along with Motorised stirrer, flushing arrangement, instrumentation, valves, fittings and piping for clarifiers.
- xxv. Two (2) nos. (1w+1s) lime dosing pumps with instrumentation.
- xxvi. Filtered water overhead storage tank (civil work by BHEL) with float type valve, overflow arrangement, level indicator etc.
- xxvii. One nos. weighing scale, three nos. electrically operated monorail hoist, gates etc.
- xxviii. One no. Pressure Sand Filter for potable water system along with instrumentation, valves, fittings, piping etc. as per flow diagram of pre-treatment plant.
- xxix. Two (1w+1s) Air blower for Pressure Sand Filter with instrumentation, valves, fittings, piping etc.
- xxx. All piping, valves, instruments as required for the system completion.
- xxxi. All other things are also included in scope of supply as specified in other part of the specification including under design criteria and technical details.
- xxxii. Coating, rapping and protection of buried pipes will be in bidder's scope.
- xxxiii. All pipes, fittings etc. required for hand railing, platforms, and ladders shall be in the scope of bidder of supply and erection of complete PT plant. Hand railing shall be provided by bidder wherever required for safety point.
All insert plates, puddle pipes, nuts and bolts, counter flanges wherever applicable shall be in the scope of bidder.
- xxxiv. Edge angle required in a proper shape for edge protection in civil works will be provided by bidder.
- xxxv. All sluice gates shall be in the scope of bidder.
- xxxvi. The pipe sizes indicated in the tender specification/ flow Diagram are minimum. Wherever pipe sizes are not indicated, the same shall be selected based on the specification requirement and shall be subject to BHEL/ customer approval during detailing engineering. All pipes shall be carbon steel unless exclusively mentioned.
- xxxvii. Bidder to be note that the outlet suspended solid guarantee for PT clarifier shall be 10 ppm.
- xxxviii. One set of (2 x 100% Capacity) centrifugal type blower with acoustic enclosures for clarifier sludge sump.
- xxxix. Pipe racks shall be provided by BHEL wherever available. However where pipe racks are not available the pipe shall run on pipe pedestals All auxiliary steel structures (U-clamps, nuts, bolts, channels etc.) for fixing the pipe on the pedestal or trestles shall be in the scope of bidder.
- xl. All motorized valves shall be provided with integral starter.
- xli. Bidder to note that 3 ppm continuous chlorine will be dosed by chlorination plant vendor in stilling chamber. Bidder to take care while selection of MOC due to effect of chlorine.
- xlii. Initial charge of all lubricants & grease are in bidder's scope.
- xliii. Wherever terminal points between BHEL and bidder indicated, bidder shall provide pipes with counter flange.
- xliv. Bidder to note that civil of Chemical House and centrifuge shed/building shall be done by BHEL. However, all the other necessary inputs for construction of foundations of equipment etc. shall be provided by the bidder.
- xlvi. RCC pedestals design and construction for all piping of PT plant except chemical house and centrifuge building / shed shall be in bidder's scope.
- xlvi. Filter Media for PSF shall be in scope of bidder.
- xlvi. Two (2) nos. Travelling Trolley.

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT****SPECIFICATION NO.**

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 4 of 15

1.2 PAINTING

The painting of the supplied equipment shall be as per section C1-E of the technical specification only. Painting as per specified above. However, any variation in the painting schedule as finally approved by customer shall be taken care by bidder without any commercial and delivery implication. Colour-coding scheme shall be intimated to vendor during detailed engineering.

1.3 SCOPE OF SERVICE

The bidder's scope also includes following services for scope under this specification:

- a) Erection and commissioning including Control & Instrumentation, & Electrical work.
- b) Packing, loading, transportation and delivery at site.
- c) Unloading, handling and storage at site.
- d) In-site transportation.
- e) Civil design, construction & structural work unless specifically excluded.
- f) All necessary personnel required during maintenance and Demonstration Test.
- g) Complete routing for equipment, fixing and any concreting inside the tanks and lining.
- h) Arrangement of all Instruments and Lab Facilities, Chemicals and Reagents to carry out trial run/maintenance commissioning and Demonstration test.
- i) Commissioning, Trial run for requisite period, Demonstration Test, & Handing over to Customer.
- j) Consumable such as greases, oil, lubricants, servo fluids/ control fluids, as specified in this technical specification.
- k) Painting as specified and final touch up paint at site.

1.4 TERMINAL POINT

- a) Raw water: 20m from Aerator central shaft at 0.5m above FGL.
- b) Service Water and Instrument Air: 5m at 0.5m above FGL from PTP chemical House.
- c) Potable water for PSF: 10 m from PT plant boundary at the flow of 10 m³/hr at a pressure of 10 kg/cm².
- d) Piping upto RW chlorination plant (placed adjacent chemical house of PTP):- 80m from filtered water overhead tank.

1.5 CIVIL SCOPE

- a) **All civil design and construction works except Chemical House and centrifuge shed/building are in bidder's scope.** All steel inserts, plates, bolts, nuts, sleeves, edge angle, rungs ladder, puddle pipes and all other embedding components etc. as required to grout in bidder's and BHEL civil works to hold/support the equipment being supplied under this specification for the pre-treatment plant shall be in the bidder's scope.

1.6 EXCLUSIONS

- a) Instrument air up to the terminal point.
- b) Air-conditioning, ventilation and fire fighting facilities.
- c) Civil works of Chemical House building and centrifuge shed/building at site.
- d) Service water and potable water up to the terminal point.

1.7 QUALITY ASSURANCE PLANS

Bidder to note the QP requirement shall be inline with the section C1-D of technical specification. However, detailed QP, inspection checklist, certificate of conformance etc. for each sub-vendor shall be decided during detailed engineering. All inspection & testing etc. shall be carried out accordingly. Any changes/additional tests insisted upon by Owner during detailed engineering shall be accepted by bidder without any commercial implication to BHEL/Owner.



TITLE

4 X 270 MW BHADRADRI TPS TECHNICAL SPECIFICATION FOR PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 5 of 15

1.8 SUB VENDOR

Bidder to note the sub vendors shall be selected from the sub vendor list enclosed in Annexure-I of the technical specification. Additionally proposed sub vendor over and above specified in the enclosed list shall be subjected to BHEL / Customer approval during detailed engineering without any commercial / delivery implication to BHEL / Customer. Requirement of detailed QP, inspection checklist, certificate of conformance etc. for each sub-vendor shall be finalized during detailed engineering stage; decision of BHEL/Owner shall be binding on vendor in this regard.

1.9 SPARE

- i) Start up and Commissioning spares as required will be in the scope of bidder. Bidder will give a list of these spares.
- ii) Mandatory spares shall be supplied as per Annexure-II of the technical specification.

1.9.1 START-UP & COMMISSIONING SPARES

- a. Start-up and commissioning spares are those spares which are required during the start-up and commissioning of the equipment/system. All spares used till the plant is handed over to the BHEL/Customer shall come under this category. The Bidder shall provide for an adequate stock of such start up and commissioning spares to be brought by him to the site for the plant erection and commissioning. They must be available at site before the equipments are energized. The unused spares, if any, should be removed from there only after the issue of Taking Over certificate. All start up spares which remain unused at the time shall remain the property of the Bidder.
- b. The Bidder shall indicate the service expectancy period for the spares under normal operating conditions before replacement is necessary.
- c. All spares supplied under this contract shall be strictly inter changeable with the parts for which they are intended for replacements. The spares shall be treated and packed for long storage under the climatic conditions prevailing at the site e.g. small items shall be packed in sealed transparent plastic with desecrator packs as necessary.
- d. All the spares (mandatory) shall be manufactured along with the main equipment components as a continuous operation as per same specification and quality plan.
- e. Each spares part shall be clearly marked or labelled on the outside of the packing with its description. When more than one spares part is packed in a single case, a general description of the content shall be shown on the outside of such case and a detailed list enclosed. All cases, containers and other packages must be suitably marked and numbered for the purposes of identification.
- f. All cases, containers or other packages are to be opened for such examination as may be considered necessary by BHEL / Customer.
- g. The Bidder will provide the BHEL/Customer with all the addresses and particulars of his sub suppliers while placing the order on vendors for items/components/equipments covered under the contract and will further ensure with his vendors that the BHEL/Customer, if so desires, will have the right to place order for spares directly on them on mutually agreed terms based on offers of such vendors.
- h. The Bidder shall warrant that all spares supplied will be new and in accordance with the contract Documents and will be free from defects in design, material and workmanship.

**TITLE**

4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 6 of 15

- i. The bidder to provide datasheets/assembly drawings of the manufacturer/ any other relevant document showing Bill of Material(s), Make, Model Number, Part Number etc. through which the mandatory spares to be supplied can be uniquely identified.

1.9.2 MANDATORY SPARES

- a. The list of mandatory spares which is to be considered by bidder in their scope are indicated in Annexure II.
- b. All mandatory spares shall be delivered at site at least two months before scheduled date of initial operation of the first unit. However, spares shall not be dispatched before dispatch of corresponding main equipment.
- c. Wherever quantity is specified both as a percentage and a value, the Bidder has to supply the higher quantity until and unless specified otherwise.
- d. Inspection of mandatory spares shall be in line with the approved quality plans for the respective items/equipment. The inspection categorization of mandatory spares shall also be in line with the approved Categorization plan for the respective items/equipment.

1.10 CONTROL PHILOSOPHY

PT plant shall be controlled from a PLC based control panel located at PT plant Chemical house.

All the drives shall be started and stopped from PLC.

The following shall be started and stopped from PLC.

- a) Alum dosing pumps.
- b) Lime dosing pumps.
- c) PE dosing pumps for Clarifier, Thickener & Centrifuge.
- d) Sludge transfer pump.
- e) Thickened sludge transfer pump.
- f) Agitator of all the chemical tanks.

In addition to above Local Start/Stop facility from individual pump shall be provided.

The following shall be monitored from PLC.

- a) Scrapers on the clarifier/Thickener tank.
 - b) Centrifuge motor.
 - c) Agitators of inlet chamber, Alum dosing tanks dosing Tanks, PE Dosing Tanks.
- 1.0 A soft mimic in the OWS with the status of drives including ON, OFF, TRIP indication of respective motors/pumps and control valve shall be provided.
- 2.0 All the dosing pumps shall be capable of being adjusted manually to any out put with in the stated range.
- 3.0 All pumps shall trip at level low in respective tanks or Sumps.
Standby pump will start in case of pressure low at running pump discharge.
- 4.0 Alarms pertaining to Clarified water Storage tank- High (H) and Low (L) shall be indicated in PLC.
- 5.0 Flow at inlet of aerator shall be controlled through motor operated valve w.r.t. clarified water storage tank.

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT****SPECIFICATION NO.**

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 7 of 15

6.0 Motor operated sluice gate shall be controlled w.r.t. the water level in Clarified Water Storage Tank i.e, in case one compartment of clarified water storage tank is full then the inlet valve of this compartment will be closed and the inlet valve of other compartment will be open.

1.11 ADDITIONAL REQUIREMENT

- Bidder to submit BBU during detailed engineering after approval of Basic documents. BBU shall be equal to BOQ for the package and there shall be no price and delivery implication is applicable to BHEL / customer for the same. None of the items supplied for the project as non-billable. Incomplete BBU shall not be review by BHEL.
- Any statutory requirement / clearance required for the package from government / local body shall be in bidder's scope.
- the vendor of their contractual obligations of completing the work as per specification requirement. Any deviation from specified requirement shall be reported by the vendor in writing and require written approval shall be taken from BHEL. Unless any change in specified requirement has been brought out by the vendor during detail engineering in writing while submitting the document to customer for approval, approved document (with implicit deviation) will not be cited as a reason for not following the specification requirement.
- KKS numbering if required, as per BHEL/Customer requirement shall be provided by the Bidder during detailed engineering stage without any commercial/delivery implication to BHEL.
- Any item/work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the works for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification. The bidder without any extra charge shall provide the same.
- Buried piping shall be protected as under (as per IS-10221).
 - Surface cleaning by wire brush, power tool cleaning etc.
 - Apply one coat of coaltar/primer/enamel.
 - Apply one layer of tape comprising of coaltar. Application of tape shall conform to AWWA C- 203/IS 10221 (appendix-B) with Minimum thickness of tape as 4MM +10%
- Final Electrical Load list will be submitted by the successful bidder as per agreed drawing/ doc submission schedule. Thereafter any change in the electrical load list shall be entertained only subject to its feasibility, and BHEL reserves the right to debit the vendor cost of any changes necessitated in the switch gear /MCC on account of changed loads.
- In case vendor submits revised drawing after approval of the corresponding drawing, any delay in approval of revised drawing shall be to vendor's account and shall not be used as a reason for extension in contract completion.
- Bidders shall make Site visit in order to familiarize themselves with existing condition of site before submitting the bid in order to make their offer complete. During detail engineering also, the successful bidder shall be responsible for the correctness of details w.r.t. existing facility at site. Customer approval on any drawing having details of existing facility shall not be cited by the successful bidder a valid reason for any shortcoming in the work by them. BHEL shall also not entertain any cost implication for any lack of input data with regard to site during detail engineering.

1.12 DRAWING/DOCUMENTS REQUIREMENT

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT****SPECIFICATION NO.**

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 8 of 15

1.12.1 For the Drawings/Documents distribution Procedure, please refer attached Annexure-V. Bidder has to submit the revised drawing/document along with the compliance sheet indicating enumerate reply to all BHEL and customer comments or observations. Without compliance sheet the submission of the drawings/documents will not be considered and the delay on this account will be solely on bidder's side only. The numbers of soft copies & hard copies of drawing/documents to be submitted by the bidder shall be as per enclosed Annexure-V.

1.12.2 After award of LOI/LOA, drawing/documents to be submitted by the bidder for BHEL/Customer approval has been indicated in Annexure VI. However any additional drawing/document if found necessary for completion of the engineering, the same shall be submitted by bidder without any commercial & delivery implication to BHEL.

1.12.3 Bidder to note that the successful bidder, during detail engineering, will submit the drg/doc through web based Document Management System in addition to hard copies to be submitted as per the Annexure III of this specification. Bidder would be provided access to the DMS for drg/doc approval and adequate training for the same. Detailed methodology would be finalized during the kick-off meeting. Bidder to ensure following at their end:

- Internet explorer version – Minimum Internet Explorer 7
- Internet speed – 2 mbps (Minimum preferred)
- Pop ups from our external DMS IP (124.124.36.198) should not be blocked
- Vendor's Internal proxy setting should not block DMS application's link (<http://124.124.36.198/wrenchwebaccess/login.aspx>)
- DMS user manuals to be used by BHEL PEM vendors for uploading, viewing, revising, commenting and tracking documents on PEM's DMS have been uploaded on PEM internet website (www.bhelpem.com) under the Vendor session.

For quick access bidder may refer the link

<http://bhelpem.com/DMSManuals/DMSManuals.html>

MATERIAL HANDLING EQUIPMENTS**1.0 ELECTRIC HOIST AND MANUAL HOIST (CHAIN PULLEY BLOCK)**

Required number of electric hoist / manual hoist of adequate capacity, to meet the erection and maintenance requirements are to be provided for the various areas where handling weight is more than 500 kg.

Manual hoists (hand operated) shall be designed to duty class 2 as per IS 3832 and electric wire rope hoist shall be designed as per IS: 3938 (latest).

The stipulations of all statutory codes like Indian Electricity Act, Indian Electricity Rules, Factory Acts, Local Municipality act etc. shall however prevail over the specification requirements, in case any conflict arises between this specification and the statutory codes.

Maintenance tools and tackles shall be as per data sheet attached.

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT****SPECIFICATION NO.**

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 9 of 15

DESIGN CRITERIA

For the hoists with more than 2.0 tonne lifting capacity and/ or more than 10.0 M lift i.e. either capacity or lift is more than 2T or 10 m, Electrical hoist shall be provided. Less than or equal to 2T and lift $\leq$ 10m hoist blocks shall be of hand operated type for both travel and lift.

However, all monorails coming out of the building shall be provided with electric hoist block, irrespective of load and lift.

Capacity of electric and manual (Chain pulley block) hoists shall be decided keeping 25% margin over heaviest equipment to be handled.

For hand operated hoists, the hoists shall be suitable for operation from floor level. Hand chain shall be provided for long travel of trolley and the Hoisting mechanism. For electric hoist, operator shall be able to control the movement of the electrical hoist with the help of floor operated pendant

Note;

1. Area, type, capacity mentioned are minimum requirement and shall be finalized during detail engineering without any commercial implication
2. Travel and Lift are layout dependent and shall be finalized during detail engineering without any commercial implication
3. Additional electric/manual hoist required during detail engineering shall be provided as per design criteria given above without any commercial implication.

2.0 SCOPE OF SUPPLIES

Equipment and services to be furnished by the bidder for the ELECTRIC HOIST/ MANUAL HOIST with accessories as per the details given in the technical specification and data sheet A. Any equipment / accessories not specified in the specification but required to make the ELECTRIC HOIST/ MANUAL HOIST complete and efficient operation shall also be under the bidder's scope of work.

Compliance with this specification shall not relieve the bidder of the responsibility of furnishing material and workmanship to meet the specified working/duty conditions.

2.1.0 ELECTRIC HOIST

Electric hoist shall include but not be limited to the following: -

- a. Hoisting and CT drive arrangement
- b. All electrical equipment including cables (as per electrical scope matrix) and panels.
- c. PVC insulated shrouded bus bar DSL
- d. Earthing arrangement.
- e. Fill of lubricant till commissioning / handling over to customer.
- f. Painting of electric hoist and accessories.
- g. Maintenance tools & Tackles
- h. Erection & Commissioning spares
- i. Isolating switch in enclosure at operating floor for disconnecting supply to DSL while maintaining the electric hoist.
- j. Mandatory spares

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT****SPECIFICATION NO.**

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 10 of 15

2.2.0 MANUAL HOIST (CHAIN PULLEY BLOCK)

Manual hoist shall include but not be limited to the following:

- a. Chain pulley blocks with/without traveling trolleys
- b. Maintenance Tools and Tackles
- c. Mandatory spares

2.3.0 Erection and Commissioning spares (ELECTRIC HOIST)

The Bidder shall also supply erection & commissioning spares along with his main equipment as per his experience, for replacement of damaged or unserviceable parts during the execution of the project at site, to avoid delay in the project schedule. This shall form part of the main equipment supply. The Purchaser shall retain the unutilized commissioning spares. The initial fill of lubricants, oil etc. shall also be supplied by the bidder.

2.4.0 Services to be provided by the bidder

Packing, forwarding and transportation to site, storage and handling at site.

2.5.0 Erection and Commissioning**2.6.0 Functional test (Overload testing, load testing at rated speed, travel and hoisting motion checks as per relevant Indian standards)****2.7.0 Obtaining clearance and acceptance certificate from the concerned competent authority after site test as applicable. Necessary fees/expenditure as required shall be borne by the supplier.****3.0 Inspection and Testing**

Inspection and testing shall be carried out as per enclosed standard quality plan approved QAP and as per IS 3938 (latest revision). Prime inspection agency shall be NBPPL/End Customer. Equipment supplied shall be strictly in accordance with nomenclature & technical specification. Any additional testing requirement/ CHP(Customer Hold Point) at any stage of inspection deemed necessary by Customer/NBPPL during detailed engineering shall be carried out without any commercial or technical implication.

4.0 Works Excluded

Supply of ISMB monorail.

5.0 PAINTING SPECIFICATION

As per painting details specified elsewhere in specification.

ELECTRIC HOIST COLOR SHADE:

Color shade: Structure: Golden Yellow, RAL 1004

Panel : paint shade RAL-9002 for complete panel except on end covers whose shade shall be RAL-5012.

However, same shall be finalized during detail engineering)

MANUAL HOIST COLOR SHADE:

Trolley: Lemmon yellow (Shade 355 as per IS 5)

Hook: Light grey (Shade 631 as per IS 5)

6.0 PACKING

As per packing details specified elsewhere in specification.

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT****SPECIFICATION NO.**

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 11 of 15

7.0 DEMONSTRATION TEST

Hoist along with its drives, controls and other accessories shall be demonstrated for the rated capacity against the rated speed of motions and for the service conditions specified as specified in QAP and as per IS 3938 for electric hoist and IS 3832 for manual hoist.

The bidder shall have the full responsibility for the safe and efficient operation of the hoist with associated accessories as a single unit.

If the shop/site performance tests indicate the failure of any of the components to achieve the guaranteed performance, the deficiency shall be made good at bidder's cost.

Demonstration tests shall be carried out each time after the rectification /modification is carried out.

8.0 MAKE OF SUB - VENDOR ITEMS

Makes of bought out items will be as per list specified in the specification. No other make will be acceptable, until and unless specifically got it approved by the purchaser/ end client.

9.0 TESTING AT SITE**A) ELECTRIC HOIST:**

As required for statutory clearance for operating at site i.e., overload test, load test and other tests as per IS 3938.

Test for Operation -After the supply has been connected, tests shall be carried out to prove the following:

- The satisfactory operation of each controller, switch, contactor, relay and other control devices and in particular the correct operation of all limit switches under the most unfavorable conditions;
- The correctness of all circuits and interlocks and sequence of operation; and
- The satisfactory operation of all protective devices.

Overload Test -After test but before the hoist is put into service, it shall be tested with overload relays appropriately set, to lift and sustain a test load of 125 percent of the working load. During the overload test, the hoist shall sustain the load under full control. The specified speeds need not be attained but the hoist shall show itself capable of dealing with the overload without difficulty.

B) MANUAL HOIST:

As required for statutory clearance for operating at site with following minimum test i.e., overload and load test.

10.0 Maintenance Tools and Tackles

One (1) complete unused new set of special purpose tools, tackles and accessories along with detailed instructions and maintenance manual shall be supplied for each EH/CPB. Tools shall be

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT****SPECIFICATION NO.**

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 12 of 15

of suitable sizes for maintenance of electric hoist of each type and capacity. Each tool shall be stamped so as to be identified easy for its use. The tools shall be supplied in steel toolbox. The items supplied shall be of the best quality, specially protected against rusting. The following shall be provided as minimum requirement:

S-No.	Description	Qty.
1	Complete set of ring spanners (Indicate the sizes offered)	1 Set
2	Complete set of screwdrivers (Indicate the sizes)	1 Set
3.	Adjustable Spanner	1 No.
4.	Insulated plier	1 No.
5.	Grease gun	1 No.
6.	Oil gun	1 No.
7.	Line tester	1 No.

Note:- Bidder shall ensure that the tools & tackles mentioned in above list are sufficient to handle all sizes/capacities of hoists & in case any other /additional tool is required for handling/maintenance any size/capacity of hoist the same shall be included in this list.

11.0 DRAWING/DOCUMENT SUBMISSION

The successful bidder shall submit the following drawings / documents during detail engineering for customer's approval /information:

A) ELECTRIC HOIST

Sl. No.	BHEL DRG.NO	DRAWING TITLE
1	PE-V0-XXX-563-A100	Manufacturing Quality Plan with Sub vendor list
2	PE-V0-XXX-563-A101	GA Drawing for Electric Hoist, DSL arrangement and painting details
3	PE-V0-XXX-563-A102	Schematic Circuit Diagram
4	PE-V0-XXX-563-A103	Mechanism Sizing Calculation
5	PE-V0-XXX-563-A104	Detailed BOM/BOQ for EH
6	PE-V0-XXX-563-A105	O & M Manual including Erection procedure
7	PE-V0-XXX-563-A106	Mandatory spare parts list

A) MANUAL HOIST (CHAIN PULLEY BLOCK):

Sl. No.	BHEL DRG.NO	DRAWING TITLE
1	PE-V0-XXX-563-A200	Manufacturing Quality Plan
2	PE-V0-XXX-563-A201	GA Drawing for Chain Pulley Block with detail BOM with painting details

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT****SPECIFICATION NO.**

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 13 of 15

3

PE-V0-XXX-563-
A202

O & M Manual including Erection procedure

Notes;

1. The above drawing list is tentative and shall be finalized with the successful bidder after placement of order.
2. Drawings shall be prepared in Auto-Cad latest edition. Required no. of hard and soft copies (editable) of the drawings shall be furnished as per requirement specified elsewhere in the specification.
3. All the drawings and documents including general arrangement drawing, data sheet, calculation etc. to be furnished to the customer during detailed engineering stage shall include / indicate the following details for clarity w.r.t. Inspection, construction, erection and maintenance etc.:-
 - a) All drawings and documents shall indicate the list of all reference drawings including general arrangement.
 - b) All drawings shall include / show plan, elevation, side view, cross - section, skin section, blow - up view; all major self-manufactured and bought out items shall be labeled and included in BOQ / BOM in tabular form.
 - c) Painting schedule shall also be made as a part of general arrangement drawing of each equipment / items indicating at least 3 trade names.
 - d) All the drawings required to be furnished to customer during detailed engineering stage shall include technical parameters, details of paints and lubrication, hardness and BOQ / BOM in tabular form indicating all major components including bought out items and their quantity, material of construction indicating its applicable code / standard, weight, make etc.
 - e) Drawings/ documents to be submitted for purchasers review/ approval shall be under Revision A, B, C... etc. while drawings /documents to be submitted thereafter for customer's approval after purchaser's approval shall be under R-0, 1, 2, 3 etc.

12.0 MAKES:**MAKES OF ELECTRIC HOIST AND CHAIN PULLEY BLOCK AS PER LIST BELOW:**



TITLE

4 X 270 MW BHADRADRI TPS TECHNICAL SPECIFICATION FOR PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 14 of 15

Package Name	Vendor Name
ELECTRIC HOIST	Alpha Services
	CONSOLIDATED HOISTS PVT LTD
	CENTURY CRANE ENGINEERS PVT. LTD.
	EDDY CRANES PVT. LTD.
	Grip Engineers Pvt. Ltd.,
	GLOBAL TECHNOLOGIES
	HERCULES HOISTS LTD.
	LIFTING EQUIPMENTS and ACCESSORIES
	Mangla Hoists Pvt Ltd
	REVA INDUSTRIES LTD.
	ROCKWELL HOISTO CRANES PVT. LTD.
	SAFEX ENERGY PVT. LTD.
	TUOBRO FURGUSON (INDIA) PVT LTD
CHAIN PULLEY BLOCK	ARMSEL MHE PVT. LTD
	HERCULES HOISTS LTD.
	LIFTING EQUIPMENTS and ACCESSORIES
	TUOBRO FURGUSON (INDIA) PVT LTD
	TRACTEL TIRFOR INDIA PVT. LTD.

Note: No other make will be acceptable, until and unless specifically got approved by BHEL/Customer / Customer's consultant during detail engineering only. Acceptance/non acceptance of same shall not have any impact on manufacturing, delivery schedule and on cost of the Electric hoists

MAKES OF SUB VENDORS ITEMS AS APPLICABLE TO ELECTRIC HOIST:

Sl no.	ITEM	MAKES
1.0	STEEL	SAIL/IISCO/TATA STEEL / JINDAL
2.0	HOOKS	MOOZUMDAR / SIMRITI FORGING / HARMAN MOHTA / STEEL FORGING & ENGG. CO., KOLKATA /
3.0	GEAR COUPLINGS	ALLIANCE / HICLIFF / OEM
4.0	WIRE ROPE	USHA MARTIN Black / BOMBAY WIRE ROPES / FORT WILLIAMS / UNITED WIRE ROPE/BHARAT WIRE ROPES.
5.0	BEARINGS	SKF/ FAG
6.0	MOTORS	SIEMEN/ ABB /NGEF/ CROMPTON /KIRLOSKAR /GECA / BHARAT BIJLI / MARATHON / LHP.
7.0	BRAKES	STROM CRAFT/ ELECTROMAG /SPEED-O- CONTROL / EMCO LENZE
8.0	CONTACTOR	SIEMENS / L&T /TELE MECHANIQUE / BCH
9.0	OVER LOAD RELAYS	SIEMENS / L&T / TELE MACHANIQUE / ABB
10.0	HRC FUSES	SIEMENS / L&T/ ENGLISH ELECTRIC/GE Power
11.0	ISOLATING SWITCH	SIEMENS/ L&T / CONTROL & SWITCH GEAR
12.0	SWITCH FUSE UNITS	SIEMENS/ L&T/ CONTROL/ & SWITCH GEAR/ GEC A



TITLE

4 X 270 MW BHADRADRI TPS TECHNICAL SPECIFICATION FOR PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 15 of 15

13.0	TIME DELAY RELAYS	SIEMENS/ L&T/ ABB/ BCH/ GEC A
14.0	TRANSFORMERS	INDCOIL/AE / LOGICSTAT/ PRAGATI / KAPPA / SOUTHERN ELECTRIC
15.0	BULB & FLOURESCENT TUBES/FITTINGS	PHILIPS/ BAJAJ/ CROMPTON
16.0	CABLE LUGS (HEAVY DUTY)	DOWELLS
17.0	CABLES	
a)	POWER CABLES	NICCO / UNIVERSAL / INCAB / FORT GLOSTER TORRENT / CCI / ICL / RADIANT / FINOLEX/ POLYCAB/KEI/HAVELL
b)	CONTROL CABLES	NICCO / UNIVERSAL / INCAB / FORT GLOSTER / DELTON / FINOLEX / TORRENT / CCI / ICL / RADIANT POLYCAB / KEI/ HAVELL.
c)	TRAILING CABLE	UNIVERSAL/ FGL/CCL/HVP/KEI/RADIANT.
18.0	CABLE GLAND	COMMET / SIEMEN / SUNIL&CO.
19.0	PUSH BUTTONS	SIEMENS / L&T / BCH /TEKNIC/VAISHNO
20.0	LIMIT SWITCHES	SPEED-O-CONTROL / ELECTROMAG / JAI BALA JI / KAYCEE / BCH
21	SELECTOR SWITCHES	KAYCEE/ SULZER
22	PENDENT PUSH BUTTON STATION	OEM
23	INDICATING LAMPS	TECKNIC / BCH / SIEMENS / STANDARD/ VAISHNO
24	MCB	MDS / INDO COPP / STANDARD
25	PANELS	OEM/BCH
26	DSL	SUSHEEL/STROMAG
27	TERMINAL BLOCKS	ELMEX/CONNECTWELL/WAGO (FOR CONTROL ONLY)
28	VVVF	YASAKAWA(L&T)/ABB/SIEMENS/SCHNIDER
29	CASTING	KOLHAPUR STEEL / GNAT FOUNDRY / KIRTI ALLOYS
30	Tools & tackles	Reputed make

Note : 1 All the trailing cables shall be sourced from only one sub-vendor from the list
2 No other make will be acceptable, until and unless specifically got approved by BHEL/Customer / Customer's consultant during detail engineering only. Acceptance/non acceptance of same shall not have any impact on manufacturing, delivery schedule and on cost of the Electric hoists/ CPB.

**TITLE**

4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE-TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 1 of 1

SECTION C1 – B
GENERAL REQUIREMENT

CONTENT

CLAUSE NO.	DESCRIPTION
1.00.00	CODES AND STANDARDS
2.00.00	RESPONSIBILITY FOR DESIGN
3.00.00	NAME PLATES (RATING PLATES)
4.00.00	SAFETY AND SECURITY
5.00.00	GUARDS
6.00.00	LOCATION AND LAYOUT REQUIREMENTS
7.00.00	OPERATION, MAINTENANCE AND AVAILABILITY CONSIDERATIONS
8.00.00	MATERIALS
9.00.00	LUBRICATION
10.00.00	LUBRICANTS & CONTROL FLUIDS
11.00.00	OPERATION AND MAINTENANCE
12.00.00	PLANT LIFE AND MODE OF OPERATION
13.00.00	PACKAGING & MARKING
14.00.00	PROTECTION
15.00.00	ENVIRONMENT PROTECTION AND NOISE LEVEL REQUIREMENT
16.00.00	INSPECTION AND TESTING
17.00.00	TRAINING OF OWNER'S PERSONNEL
18.00.00	DEVIATIONS
	ATTACHMENTS
ANNEXURE-I	LIST OF STANDARDS FOR REFERENCE
ANNEXURE-II	CRITERIA FOR LAYOUT

GENERAL TECHNICAL REQUIREMENTS

1.00.00 CODES AND STANDARDS

1.01.00 Except where otherwise specified, the Plant shall comply with the appropriate Indian Standard or an agreed internationally accepted Standard Specification as listed in the annexure to this Section and mentioned in detailed specifications, each incorporating the latest revisions at the time of tendering. Where no internationally accepted standard is applicable, the Bidder shall give all particulars and details as necessary; to enable the Owner to identify all of the Plant in the same detail as would be possible had there been a Standard Specification.

1.02.00 Where the Bidder proposes alternative codes or standards he shall include in his tender one copy (in English) of each Standard Specification to which materials offered shall comply. In such case, the adopted alternative standard shall be equivalent or superior to the standards mentioned in the specification.

1.03.00 The plant will be designed in compliance with applicable National and International Codes and Standards such as ASME, ASTM, DIN, BS, IEC, IEEE, IS, etc. Wherever specified or required the Plant shall conform to various statutory regulations such as Indian Boiler Regulations, Indian Explosives Act, Indian Factories Act, Indian Electricity Act, Environmental Regulations, etc. Wherever required, approval for the plant supplied under the specification from statutory authorities shall be the responsibility of the Contractor.

1.04.00 In the event of any conflict between the codes and standards referred above, and the requirements of this specification, the requirements, which are more stringent, shall govern.

1.05.00 In case of any change of code, standards and regulations between the date of purchase order and the date the Contractor proceeds with manufacturing the Owner shall have the option to incorporate the changed requirements. It shall be the responsibility of the Contractor to advise Owner of the resulting effect.

1.06.00 Successful Bidder to furnish two (2) sets of latest of national/inter-national codes and standards to owner.

2.00.00 RESPONSIBILITY FOR DESIGN

2.01.00 The Contractor shall assume full responsibility for the design of the whole and every portion of the Plant, whether or not the design work was undertaken specifically in relation to the Contract and whether or not the Contractor was directly involved in the design work.

-
- 2.02.00 Notwithstanding the Owner's wish to receive the benefits of new, advanced and improved technologies, a prime requirement is that all the systems and components proposed shall have been already adequately developed and shall have demonstrated good reliability under similar, or more arduous conditions elsewhere, at least for continuous 2 years in two different power station.
- 2.03.00 The successful bidder shall have to carry out surge analysis, BFP transient analysis and other transient condition studies as may be necessary and as required by the Owner as per proven engineering practice.
- 2.04.00 The Bid shall include a detailed discussion on the development status of, and the reasons for any changes made in proposed systems or components for the Plant, as compared with similar items previously supplied in other installations cited by the bidder as reference plants.
- 2.05.00 The Bidder may also make alternate offers, provided such offers are superior in his opinion in which case adequate technical information, operating feed back, etc. are to be enclosed with the offer, to enable the Owner to assess the superiority and reliability of the alternatives offered. In case of each alternative offer, its implications on the performance, guaranteed efficiency, auxiliary power consumptions, etc. shall be clearly brought out to the Owner to make an overall assessment. In any case, the base offer shall necessarily be in line with the specifications i.e. Base offer shall be as per the technical specifications and the same will be considered for techno-commercial evaluation.
- 3.00.00 **NAME PLATES (RATING PLATES)**
- 3.01.00 Instruction plates, name plates or labels shall be permanently attached to each main and auxiliary item of plant in a conspicuous position. These plates shall be engraved with the identifying name, type and manufacturers serial number, together with the loading conditions under which the item of plant has been designed to operate.
- 3.02.00 Items such as valves, etc. which are subject to hand operation, shall be provided with nameplates so constructed as to remain clearly legible throughout the life of the plant giving due consideration to the difficult climatic conditions to be encountered. Nameplates shall be securely mounted where they will not be obscured in service by insulation, cladding, actuators or other equipment. Direction of flow is also to be engraved.
- 3.03.00 All trade nameplates and labels shall be in English language. All measurements shall be in M.K.S. Units.
- 3.04.00 The size and location of nameplates shall be subject to Approval of the Engineer.
- 4.00.00 **SAFETY AND SECURITY**
- 4.01.00 The design shall incorporate every reasonable precaution and provision for the safety of all personnel and for the safety and security of all persons and

property. The design shall comply with all appropriate statutory regulations relating to safety. All structures and equipment shall be designed and constructed to withstand every foreseeable static and dynamic loading condition, including loading under earthquake conditions, with an adequate margin of safety.

- 4.02.00 Ready and safe access with clear head room shall be provided to all parts of the plant for operation, inspection, cleaning and maintenance.
- 4.03.00 Escape routes and clear ways shall be provided to allow speedy evacuation of the plant in the event of fire or explosion, and the plant layout shall allow for ease of access to all parts of the Works by rescue and fire fighting teams. The plant layout shall be designed to localise and minimise the effects of any fire or explosion. The recommendations of NFPA, OSHA, and TAC etc. as necessary shall be followed in all respects.
- 4.04.00 The use of corrosive, explosive, toxic or otherwise hazardous materials shall be kept to a minimum during construction and the design of the plant shall minimise the requirement for such materials during operation and maintenance. Where such materials must be used, all necessary precautions shall be taken in the design, manufacture and layout of equipment to minimise the resulting hazard, and all equipment necessary for the protection and first-aid treatment of personnel in the event of accidents shall be provided. Particular attention is drawn to avoid the use of materials containing asbestos in any form.
- 5.00.00 **GUARDS**
- 5.01.00 Effective guards and fences must be provided to prevent injury to operators through accident or malpractice.
- 5.02.00 Mesh guards which allow visual inspection of equipment with the guard in place are generally preferable. The guards shall be constructed of mesh attached to a rigid framework of mild steel rod, tube, or angle and the whole galvanised to prevent loss of strength by rusting or corrosion. The guards shall be designed to facilitate removal and replacement during maintenance.
- 5.03.00 All drive belts, couplings, gears, sharp metallic edges and chains must be safely guarded. Any lubricating nipple requiring attention during normal running must be positioned where they can be reached without moving the guards.
- 5.04.00 Guards for couplings and rotating shafts shall be in accordance with BS 5304-1975 or similar approved standard. All rotating shafts and parts of shafts must be covered.
- 5.05.00 Suitable fencing shall be provided to enclose all openings or doorways used for the hoisting and lowering of machinery etc. This fencing must be securely fixed but quickly detachable when required. A secure hand hold must be provided on each side of the opening or doorway.

LOCATION AND LAYOUT REQUIREMENTS

The majority of plant and equipment (excluding steam generator and some other auxiliaries) shall all be of indoor installation. A broad list of buildings housing such equipment is given elsewhere in this specification. Layout should facilitate access for operation-maintenance and inspection of any one or more equipment/components at a time without disturbing the operation or installation of rest of the plant. Further, Bidder should comply with the criteria given under the various equipment and system specifications as well as those stipulated in Annexure-II attached to this section.

Enclosed General Layout and other tender layout drawings show the location of major installations and auxiliary buildings. The Bidder shall try to retain these locations as far as practicable. The layout of equipment within the power house as shown in the tender drawings is indicative. The Bidder may, subject to Owner's approval alter the same to suit the space requirement of the equipment offered.

Bidder may give as an alternative his own preferred layout clearly indicating the advantages and other implications, if any. Such alternative will not be considered for evaluating the bid, but may be considered with the successful Bidder if Owner/Engineer finds the proposal more attractive in terms of techno-economic consideration.

While developing the layout of buildings the following criteria shall be given effect :

- a) The minimum width of clear access corridors around equipment shall be 1.2 meter.
- b) Each building shall have an identified vacant space for equipment unloading and maintenance and preferably a separate bay altogether in buildings housing heavy equipment. Provision for handling equipment by monorail hoist and/or overhead crane shall be made as specified.
- c) The minimum clear height available between two consecutive floor slabs shall not be less than five (5) meters. A clear head room of 2.5m shall be maintained between the floor and any overhead piping/ cables or other obstruction. Adequate provision for natural ventilation and illumination shall be made as per good engineering practices.
- d) There shall be at least two (2) nos. main access doors, one on either side of each building, of which one shall be minimum 3 meters wide with rolling shutters for equipment entry. For multistoried buildings, at least two (2) nos. regular staircases diagonally opposite to each other shall be provided connecting all the floors and roof. These minimum requirements shall be augmented as required depending on the floor area, statutory requirements and TAC recommendations.
- e) All buildings shall have provision for toilet and associated effluent discharge system together with facility for drinking water. The criteria for ventilation, fire protection and illumination of building spaces specified

elsewhere in this specification shall be complied with.

- f) All rail/road crossings for pipe/cable racks shall be done with minimum 8 meters headroom from top of rail/road to bottom of rack. Similarly top cover over underground pipes/cables shall be minimum one (1) meter. For other detail refer to Annexure-II.
- g) Cubicle for operating personnel shall be located at safe place near the equipment.
- h) Interplant cable routing will be on overhead cable trays on pipe cum cable trestle or on cable trestle except where approved by purchaser/consultant. In exceptional case, small stretch of outdoor run of interplant cable routing may be taken through cable trench only with the Employer's prior approval.
- i) Concept of various mechanical and electrical equipment location and building dimensions (including column-row spacing) as shown in Plot Plan/Floor Plan drawing are to be adhered to. Any departure from this suggestive layout is primarily not recommended.

7.00.00 OPERATION, MAINTENANCE & AVAILABILITY CONSIDERATIONS

7.01.00 Equipment/works offered shall be designed for high availability, high reliability, low maintenance and ease of operation & maintenance. The Bidder shall specifically state the design features incorporated to achieve high degree of reliability, availability, operability and ease of maintenance. He shall also furnish details of availability records in plants stated in his experience list.

7.02.00 Ample space for ease of operation and maintenance including equipment removal, tube bundle/cartridge/rotor pulling etc. shall be provided. All valves, gates, dampers and other devices shall be located and oriented in such a way that they are accessible from operating floor levels. Where this cannot be adhered to, platforms and walkways with access ladders shall be provided to facilitate operation and maintenance.

7.03.0 Motorised lifting devices, i.e. hoists, chain pulleys, jacks, etc. shall be provided for handling and carrying out maintenance of any equipment and/or part having weight in excess of 2000 Kg. Suitable beams, hooks etc. for this purpose shall be provided in the buildings.

No lifting arrangement is necessary for part having weight less than 500 Kg. Hoist shall be well protected by environment. Suitable painting and coating covering hoist at outdoor shall be provided.

Lifting devices like lifting tackles, slings, etc. to be connected to hook of the hoist/crane shall be provided by the Bidder for lifting the equipment, accessories covered under this specification.

7.04.00 All similar parts of the equipment shall be made to gauge and shall be interchangeable with and shall be made of same material and workmanship as the corresponding parts of the equipment. Where feasible common

components shall be employed in different pieces of equipment in order to optimize the spares inventory and utilization.

8.00.00 **MATERIALS**

8.01.00 In selecting materials of construction of equipment, the Contractor shall pay particular attention to the atmospheric conditions existing at the Site and the nature of material/fluid handled. Wherever deviations are taken in respect of materials specified, the reasons shall be spelt out clearly in the proposal.

All materials shall be new, and shall be of the quality most suited to the proposed application.

8.02.00 In as far as is possible; materials shall be in accordance with Indian or international standard specifications and shall be used in accordance with Indian or international codes of practice. Where such standards or codes of practice are not available sufficient information shall be provided to allow the Owner to assess the suitability of the material for the particular application.

All materials used shall have performed lengthy satisfactory service in similar or more arduous conditions to those proposed by the Contractor.

8.03.00 All parts which could deteriorate or corrode under the influence of the atmospheric, meteorological or soil conditions at the Site, or under the influence of the working conditions shall be suitably and effectively protected so that such deterioration or corrosion is a minimum over the life of the plant.

9.00.00 **LUBRICATION**

9.01.00 Provision shall be made for suitable efficient lubrication where necessary to ensure smooth operation free from undue wear.

9.02.00 Non ferrous capillary tubing shall be used throughout.

9.03.00 Gear boxes and oil baths shall be provided with filling and drain plugs, both of adequate size. An approved means of oil indication including level switches and temperature indication shall be provided.

9.04.00 All high speed gears shall be oil bath lubricated. Low speed gears shall be lubricated by means of soft grease. Removable and accessible drip pans shall be provided to collect lubricant which may drop from operating parts.

9.05.00 All lubrication points shall be conveniently situated for maintenance purposes. It must be possible to carry out lubrication from a gangway or landing and without the removal of guarding or having to insert the hand into it. Where accessibility to a bearing for oiling purposes would be difficult a method of remote lubrication shall be fitted.

9.06.00 The Contractor shall supply grease gun equipment suitable to service each type of nipple fitted.

10.00.00 **LUBRICANTS AND CONTROL FLUIDS**

10.01.00 The Contractor shall provide a detailed and comprehensive specification for all lubricating oils, greases and control fluids required for the entire plant. A sufficient supply of these shall be provided by the Contractor for initial commissioning, first fill and till COD of the unit.

10.02.00 The Contractor shall supply a detailed schedule giving the lubricant testing, cleaning and replacement procedures. All equipment and facilities necessary for the testing, cleaning and changing of lubricants and control fluids shall be provided. The Contractor shall endeavor to reduce the varieties and grades of required lubricants and control fluids to a minimum, matching them where possible to those already in use in the generating station in order to simplify procurement and minimise storage requirements. All lubricants and control fluids shall be of internationally recognised standards and shall be easily obtainable from a large number of Indian suppliers. Bidder shall also indicate the equivalent Indian Standard for the above for easy procurement in future.

10.03.00 No lubricant or control fluid shall have toxic or other harmful effects on personnel or on the environment.

11.00.00 **OPERATION AND MAINTENANCE**

11.01.00 The plant shall be designed and constructed so that operation and maintenance manpower requirements are minimised.

The design and layout shall facilitate inspection, cleaning, maintenance and repair. The importance of continuity of operation is second only to that of safety.

11.02.00 Spare parts for equipment shall be interchangeable with the original components and, so far as possible, be of common design and manufacture.

11.03.00 All similar standard components/parts of similar standard equipment provided shall be interchangeable with one another. Further identical equipments shall be provided for similar duties so that the same are interchangeable with one another in totality and component wise.

11.04.00 All heavy parts (500 Kg and above) must be provided with a convenient arrangement for slinging and handling during erection and overhaul. Any item of plant normally stripped or lifted during periods of maintenance and weighing one tonne or above, shall be clearly marked with its weight.

11.05.00 On completion of commissioning, a complete set of tools for the maintenance of the entire plant shall be provided by the Contractor. This shall include all necessary spanners, special wrenches, extraction equipment and any special tools reasonably required by the Engineer. Tools used during erection and commissioning shall not be accepted except with the specific approval of the Engineer.

11.06.00 All equipment and major valves should be provided with adequate maintenance approach and facility.

12.00.00 **PLANT LIFE AND MODE OF OPERATION**

The complete plant including all the equipment and systems individually and collectively shall be designed for continuous operation for an economic service life of thirty (30) years under the prevailing site conditions and for the type of duty intended.

The critical components of the Steam Generator, Turbine-Generator and Auxiliary equipment, the life of which is limited by time and temperature dependent mechanisms such as thermal stress, creep and low cycle fatigue, are to be designed considering expected (hot, warm and cold) start-up, shut-down and cyclic load variations.

The allowable stresses shall be reduced so that life expectancy to minimum 2,00,000 hours of operation can be achieved. The Bidder shall discuss this aspect in his technical proposal.

The unit would be operated on base load with cyclic load variation. The load variation is expected to be as per schedule depending on power demand.

The expected start-ups should be considered as minimum
(Based on HPT metal temperature)

Cold start-up (>72 hrs. shutdown)	:	6 per year
Warm start-up (between 10 to 72 hrs. of shutdown)	:	40 per year
Hot start-up (less than 10 hrs. shutdown)	:	160 per year

13.00.00 **PACKAGING & MARKING**

All the equipment shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at site till the time of erection. While packing all the materials, the limitations from the point of view of availability of railway wagon sizes in India should be taken account of. The details of various wagons normally available with Indian Railways for transportation of heavy equipment shall be considered by the Bidder. The Contractor shall be responsible for all loss or damage during transportation, handling and storage due to improper packing.

As per the information available, the dimensions of OD consignment for transportation of the equipment by rail (if any equipment to be handled through rail transportation) are as below :

a)	Width of the Package (from centre-line of rails - 1.6 metres on both sides)	:	3.2 Meters
b)	Height of the package from rail top	:	4.47 Meters

The above indicates the dimensions which can be normally transported on the

wagons without infringement of the "moving gauge". This is however not indicative of the consignment which can be carried out with infringement of "moving gauge" duly authorised and approved by the Indian Railways. There may be difference between the "moving gauge" and the "fixed structure gauge" and consignments infringing the "moving gauge" can be moved after investigation regarding possible infringement with the fixed structures. As the critical fixed structures in each route are different, consignments infringing moving dimensions have to be individually investigated to select a route and also determine the restrictions under which such movement is to be carried out. Such routes selected or other mode of transport envisaged is to be clearly brought out in the proposal wherever transport of over dimensional equipment is involved.

Bidder to consider unloading of material delivered through rail transportation, at near by railway station/ site unloading siding. The subsequent transportation up to project work place shall be considered by road only. All unloading and handling equipment both at railway station siding and at project site shall be arranged by the Bidder. Necessary arrangement to be organized with the railway authority for such purpose shall also be under the scope of services of the Bidder. Bidder may consider entire material delivered up to site through rail transportation only.

The identification marking indicating the name and address of the consignee shall be clearly marked in indelible ink on two opposite sides and top of each of the packages. In addition the Contractor shall include in the marking gross and net weight, outer dimension and cubic measurement. Each package shall be accompanied by a packing note (in weather proof paper) quoting specifically the name of the Contractor, the number and date of contract and names of the office placing the contract, nomenclature of contents and Bill of Material.

For imported equipment and material, suitable port facilities may be used in which case material may be transported from the port by tractor-trailer. Bidder may consider this aspect.

14.00.00

PROTECTION

Equipment having antifriction or sleeve bearings shall be protected by weather-tight enclosures. Coated surfaces shall be protected against impact, abrasion, discoloration and other damages. Surfaces that are damaged shall be repainted.

Electrical equipment, controls and insulations shall be protected against moisture and water damages. All external gasket surfaces and flange faces, couplings, rotating equipment shafts, bearings and like items shall be thoroughly cleaned and coated with rust preventive compound as specified above and protected with suitable wood, metal or other substantial type covering to ensure their full protection. All exposed threaded parts shall be greased and protected with metallic or other substantial type protectors.

All piping, tubing and conduit connections on equipment and other equipment openings shall be closed with rough usage covers or plugs. Female threaded openings shall be closed with rough usage covers or forged steel plugs. The closures shall be taped to seal the interior of the equipment. Open ends of

pipings, tubing and conduit shall be sealed and taped.

Returnable containers and special shipping devices shall be returned by the manufacturer's field representative at the Contractor's expense.

15.00.00 **ENVIRONMENT PROTECTION AND NOISE LEVEL REQUIREMENT**

15.01.00 **Environment Protection**

The plant shall be designed for installation and operation in harmony with the surrounding environment and all measures of pollution control shall be ensured by the Bidder to restrict pollution from the liquid effluent and stack emission within the limits as given below with due consideration of Environment (Protection) Rules 1986 as amended till date.

In case the Ministry of Environment & Forest stipulate any other conditions not specified hereunder while clearing the project shall be complied with the plant by the contractor.

15.01.01 For Liquid Effluent

- a) Provision laid down in schedule-I for Thermal Power Plants and also in Schedule-VI. General Standards for discharge of Environmental pollutants Part-A : Effects of Environmental (protection) Rules 1986, as amended till date.
- b) Any specific requirement of State Pollution Authorities over and above the above stipulation.

15.01.02 For Air Emission

- a) Suspended Particulate Matter i.e. dust burden at chimney outlet - Maximum 50 mg/Nm³ (with worst coal and one field out at TMCR).
- b) NO_x - 365 ppm Max. or 750 mg/Nm³ (Equivalent NO₂).
- c) SO₂ - Concentration based standard 2000 mg/Nm³. Load based standard 0.2 metric tonne /MWe/day (for first 500 MW and 0.1 metric tonne/MWe/day for rest of the capacity above 500 MW)

In absence of Indian Standard for emission from power plants as on date, for certain gaseous effluents, the internationally accepted World Bank Standard is to be followed. Indian Standard for emission of power plants are under formulation. Should this standard is published before finalisation of the contract, the bidder has to comply the more stringent of the above norm or the new Indian Standard.

The bidder shall include in his scope all necessary equipment and measuring instruments to comply with above requirements. Location and accessibility of the instruments shall be properly coordinated.

15.02.00 Noise Level Requirement

The plant will be designed, constructed and provided with suitable acoustic measures to ensure the noise level criteria as per the following stipulations.

- a) Maximum noise level shall not exceed 85 dB (A) when measured at 1.0M away from the noise emission source.
- b) Maximum noise level from its source within the premises shall not exceed 70 dB (A) as per Environment (Protection) Rules 1986, Schedule-III, 'Ambient Air Quality Standards' in respect of noise.
- c) Any statutory changes in stipulations regarding noise limitation that may occur in future according to State Pollution Control Board or Central pollution Control Board or Ministry of Environment & Forest regulation during tenure of the contract, the contractor shall comply with the requirement.

An exception will be made for the plant at startup operations and other big pressure reducing devices operating during emergency periods and for the safety valves.

16.00.00 INSPECTION AND TESTING

16.01.00 Inspection and Tests during Manufacture

16.01.01 The method and techniques to be used by the Contractor for the control of quality during manufacture of all plant and equipment shall be agreed with the Owner prior to the Award of Contract.

16.01.02 The Owner's general requirements with respect to quality control and the required shop tests are set out elsewhere in this specification.

16.01.03 Before any item of plant or equipment leaves its place of manufacture the Owner shall be given the option of witnessing inspections and tests for compliance with the specification and related standards.

16.01.04 Advance notice shall be given to the Owner as agreed in the Contract, prior to the stage of manufacture being reached, and the piece of plant must be held at this stage until the Owner has inspected the piece, or has advised in writing that inspection is waived. If having consulted the Owner and given reasonable notice in writing of the date on which the piece of plant will be available for inspection, the Owner does not attend the Contractor may proceed with manufacture having forwarded to the Owner duly certified copies of his own inspection and test results.

The Contractor shall forthwith forward to the engineer duly certified copies of the Test Certificates in six copies (one to the Purchaser and five to the Consulting Engineer) for approval. Distribution of six (6) copies of Test Certificates for approval will be two(2) copies to owner and four(4) copies to consultant. These four(4) copies will be further distributed by consultant after approval to owner, site and bidder. One copy will be retained with the

consultant for record purpose.

Further, nine (9) copies of Shop Test Certificates shall be bound with Instruction Manuals referred to elsewhere. Distribution of nine (9) copies of Shop Test Certificates for approval will be Two (2) copies to owner, Three (3) copies to site, Two (2) copies to consultant, Two (2) copies to owner's library / record.

- 16.01.05 Under no circumstances any repair or welding of castings be carried out without the consent of the Owner's Engineer. Proof of the effectiveness of each repair by radiographic and/or other non-destructive testing technique, shall be provided to the Engineer along with Defect Map.
- 16.01.06 All the individual and assembled rotating parts shall be statically and dynamically balanced in the works.
- Where accurate alignment is necessary for component parts of machinery normally assembled on site, the Contractor shall allow for trial assembly prior to despatch from place of manufacture.
- 16.01.07 All materials used for the manufacture of equipment covered under this specification shall be of tested quality. Relevant test certificates shall be made available to the Purchaser. The certificates shall include tests for mechanical properties and chemical analysis of representative material or any other test as required by approved QAP/ Material specification.
- 16.01.08 All pressure parts connected to pumping main shall be subjected to hydraulic testing at a pressure of 150% of shut-off head for a period not less than one hour. Other parts shall be tested for one and half times the maximum operating pressure or as required by design code of that part, for a period not less than one hour.
- 16.01.09 All necessary non-destructive examinations shall be performed to meet the applicable code requirements.
- 16.01.10 All welding procedures adopted for performing welding work shall be qualified in accordance with the requirements of Section-IX of ASME code or IBR as applicable. All welded joints for pressure parts shall be tested by liquid penetrant examination according to the method outlined in ASME Boiler and Pressure Vessel code. Radiography, magnetic particle examination magnflux and ultrasonic testing shall be employed wherever necessary/recommended by the applicable code. At least 10% of all major butt welding joints shall be radiographed.
- 16.01.11 Statutory payments in respect of IBR approvals including inspection for design and manufacturer of equipment shall be made by the Bidder. All payment for erection and testing at site (i.e. under IBR jurisdiction) shall also be made by the Bidder. In such case Contractor's scope shall also be extended to preparation of all necessary documents, co-ordination and follow-up with IBR authorities for above approval.
- 16.02.00 **Performance Tests at Site**

- 16.02.01 The full requirements for testing the system shall be agreed between the Owner and the Bidder prior to Award of Contract. The completely erected System shall be tested by the Contractor on site under normal operating conditions. The Contractor shall also ensure the correct performance of the System under abnormal conditions, i.e. the correct working of the various emergency and safety devices, interlocks, etc.
- 16.02.02 The Bidder shall provide complete details of his normal procedures for testing, for the quality of erection and for the performance of the erected plant. These tests shall include site pressure test on all erected pipe work to demonstrate the quality of the piping and the adequacy of joints made at site.
- 16.02.03 The Contractor shall furnish the quality procedures to be adopted for assuring quality from the receipt of material at site, during storage, erection, pre-commissioning to tests on completion and commissioning of the complete system/equipment.
- 16.03.00 For details of specific tests required on individual equipment refer to respective section of this specification.

17.00.00 **TRAINING OF OWNER'S PERSONNEL**

The Contractor shall extend all possible assistance and co-operation to the Purchaser regarding the transfer of technology and developing expertise in the area of engineering operation and maintenance of the Plant.

Number of man-days of training as mentioned below shall be included in his Tender.

17.01.00 **Training at Contractor's Premises**

The Contractor shall conduct training of sixty (60) engineers of the Owner on engineering, operation and maintenance of the Plant at the Contractor's or Associates or Sub-contractor's premises where adequate training facilities are available during the design and manufacturing stage of the Contractor.

The total man-months for training of engineers shall be maximum sixty (60), having following indicative break-up :

Discipline	No. of Engineers	No. of Man-month
Operation	20 heads	20
Maintenance Boiler, Turbine, Mechanical	20 heads	20
Electrical Maintenance	8 heads	4
Control & Instrumentation	8 heads	4
Maintenance Planning	4 heads	2
	-----	-----

However, the details of the training programme will be discussed and finalised with the successful Bidder.

The training may also be arranged by the Contractor in any Plant where the equipment manufactured by the Contractor or his Associates is under installation, operation or testing to enable the trainees to become familiar with the equipment being furnished by the Contractor. All expenses inherently related to the training shall be borne by the Contractor and shall include but not limited to travel expenses (international and inland fares), lodging and per diem charges as well as medical insurance, instructors fee, programme and miscellaneous cost to be incurred during the training.

The training programme shall be adequate for the trainees to acquire the necessary expertise and competence in the area of engineering, operation and maintenance and as trainers for in-house technology transfer programme of the Purchaser.

The Contractor shall be responsible for the development of the Training Module and Programme Schedule which shall be submitted to the Purchaser for approval.

The components of the training modules shall include but not be limited to the training procedures/methodology, instructional materials such as audio visual materials, CDs and slides and manuals for each trainee.

Three (3) sets of the materials included in the training modules shall be handed over to the Purchaser upon completion of the training. An evaluation shall be jointly undertaken by the Contractor and the Purchaser's representative on the adequacy, appropriateness and relevance of the training and the programme effectiveness after the training. The training material shall be in English language only.

The content of the training programme shall include but not be limited to:

1. Coal fired thermal plant principles in management and practice for operators, technicians and maintenance personnel.
2. Plant operation and systems training for operators including simulator training as applicable.
3. Maintenance training programme covering electrical, mechanical and instrumentation and control.

Said training programme shall be submitted to the Purchaser for approval.

The timing of the training should be such that the participants will be conversant with sufficient know-how to participate in the pre-commissioning and commissioning tests of the Plant.

The Contractor shall provide qualified English speaking instructors and training

coordinator(s) during the tenure of the training programme.

17.02.00 Operation and Maintenance Training at Site

The Contractor shall provide a comprehensive training programme related to design application, plant management, operation and maintenance, including trouble shooting, of the Contractor's supplied system and equipment at the Site starting from Start of Commissioning and thereafter up to the Final Acceptance of the first Unit.

The following instructors shall be at the Site continuously during the training :

- a) One (1) for Steam Generator and Auxiliaries ;
- b) One (1) for Turbine Generator and Auxiliaries ;
- c) One (1) for Electrical Works ;
- d) One (1) for Instrumentation and Control (Boiler and Auxiliaries) ;
- e) One (1) for Instrumentation and Control (Turbine and Auxiliaries).

17.03.00 On-the-Job Training

During the period of pre-commissioning, commissioning and trial operation, the Purchaser shall provide operation and maintenance personnel to assist the Contractor in the operation and maintenance of his supply and work under the direction of the Contractor for the purpose of on-the-job training.

The Purchaser shall have the right to send to the Site his employees later intended to operate and maintain the equipment supplied under this Contract. The Contractor shall, without additional cost, use his site staff to instruct these employees on the operation and maintenance of the equipment. All instructions shall be in the English language.

17.04.00 For detail C&I training refer to Volume-VI, Section-9.

18.00.00 DEVIATIONS

The Bidder is required to submit with his proposal in the relevant schedules a detail list of any and all deviations taken by him clearly without any ambiguity. In the absence of such a list it will be understood and agreed that the Bidder's proposal is based on strict conformance to this specification and no post-contract negotiations would be allowed in this regard.

Unless otherwise specifically indicated in the deviation list, it will be construed and agreed that details indicated in documents & drawings furnished by the Bidder along with the offer is in-line with the specification requirement.

ANNEXURE-I

LIST OF STANDARDS FOR REFERENCE

- a) International Standards Organisation (ISO).
- b) International Electro-technical Commission (IEC).
- c) American Society of Mechanical Engineers (ASME).
- d) American National Standards Institute (ANSI).
- e) American Society for Testing and Materials (ASTM).
- f) American Institute of Steel Construction (AISC).
- g) American Welding Society (AWS).
- h) Architecture Institute of Japan (AIJ).
- i) National Fire Protection Association (NFPA).
- j) National Electrical Manufacturer's Association (NEMA).
- k) Japanese Electro-technical Committee (JEC).
- l) Institute of Electrical and Electronics Engineers (IEEE).
- m) Federal Occupational Safety and Health Regulations (OSHA).
- n) Instrument Society of America (ISA).
- o) National Electric Code (NEC).
- p) Heat Exchanger Institute (HEI).
- q) Tubular Exchanger Manufacturer's Association (TEMA).
- r) Hydraulic Institute (HIS).
- s) International Electro-Technical Commission (IEC) Publications.
- t) Power Test Code for Steam Turbines (PTC).
- u) Applicable German Standards (DIN).
- v) Applicable British Standards (BS).
- w) Applicable Japanese Standards (JIS).

- x) Electric Power Research Institute (EPRI).
- y) Standards of Manufacturer's Standardization Society (MSS).
- z) Bureau of Indian Standards Institution (BIS).
- aa) Indian Electricity Rules.
- bb) Indian Boiler Regulations (IBR).
- cc) Indian Explosives Act.
- dd) Indian Factories Act.
- ee) Tariff Advisory Committee (TAC) rules.
- ff) Emission regulation of Central Pollution Control Board (CPCB).
- gg) Pollution Control regulations of Dept. of Environment, Govt. of India
- hh) Central Board of Irrigation and Power (CBIP) Publications.
- ii) The Air Prevention and Control of Pollution Act.
- jj) The Environmental Protection Act
- kk) The Public Liability Insurance Act.
- ll) The Forest Conservation Act
- mm) The Wildlife protection Act.
- nn) The EIA Notification, 1994.
- oo) IS: 14665-Specification for Electric Traction Lift
- pp) Any other statutory Codes/Standards/Regulations

ANNEXURE-II
CRITERIA FOR LAYOUT

PLOT PLAN LAYOUT REQUIREMENTS

ITEM	SPECIFICATION REQUIREMENT
A. Site conditions to be considered	
1. Prevalent wind direction	See wind-rose in plot plan. Also refer Metrological Data.
B. Layout Requirements	
1. Maximum permissible slope in	
a) Rail track	1 in 400
b) Road	1 in 30
c) Sides of unpaved embankment	1 in 2
2. Required road width	
a) Main roads	As per Civil DBR
b) Auxiliary interconnections	
c) Road to the power house unloading bay :	
• Only for entry to the unloading bay	Yes
• To pass through the unloading bay	No
3. Required minimum horizontal distance between the nearest points of	
a) Plant boundary and the boundary of residential area	(Local municipality/factory rule)
b) Electrical transformer and any other building/facility	As per the Tariff Advisory Committee/ LPA Rules
c) Fire water supply installation and any building/facility subject to fire risk.	As per the Tariff Advisory Committee/ LPA Rules
d) Inflammable liquid (fuel oil, etc.) storage & handling installation and their fencing and other buildings/facilities.	Rules of the Indian Explosive (Indian Explosives Act) and Indian Petroleum Code

ITEM	SPECIFICATION REQUIREMENT
4. Required minimum vertical clearance	
a) Under pipes/cable racks at road crossings	8.0 Metres
b) Soil coverage over underground pipes	1.0 Metre (minimum)
5. Railway Wagon clearance	Rules of the Indian Railways
6. Minimum Clearance between any road edge and building/structure/ any fixed installation.	3 Metres
7. Required level, above the local developed grade level, of	
a) top of all roads	150 mm above FGL
b) all outdoor paved areas	100 mm above FGL
c) Temporary storage areas, workshops, offices, residence etc. required at the time of erection work.	Yes
d) Green belt around power plant area	As per environmental guidelines of MOEF, Govt. of India.

BUILDING/ EQUIPMENT LAYOUT REQUIREMENTS

A. Minimum clear space required at all working and walking areas for operating & maintenance personnel	
1. Horizontal, in all directions	
a) Adjacent to any electrical equipment, electrical cables, running (rotating/reciprocating) equipment, safety valve or vent/drain pipe outlet, pipe/ equipment of surface temperature exceeding 60°C.	1200 mm
b) Adjacent to any other plant facilities (including walls/structures)	1000 mm
2. Vertical (head-room clearance)	
a) Under any pipe/equipment surface of temperature exceeding 60°C and any electrical cables or other electrical items.	2.5 Metre
b) Under any other plant facilities (including structures, pipes etc.)	2.5 Metre

ITEM	SPECIFICATION REQUIREMENT
3. For all areas where any equipment (including trucks, trolleys and other material handling equipment) will move or maneuver.	Minimum 500 mm clear in all direction from the outer edges of the equipment
4. Minimum clear hand space required for	
a) The application of thermal insulation	100 mm
b) Welding work	150 mm
c) Bolt tightening	150 mm
B. Floors, platforms, staircase, ladders, walls, doors & windows	
1. Statutory Requirement	As per the regulations of Tariff Advisory Committee, Indian National Building Code, Indian Factories Act, Local Municipal Rules, etc.
2. Operation & Maintenance Requirement	
a) Adequate floor space shall be kept to permit dismantling, temporary storing and in-situ maintenance of plant & equipment parts, satisfying the clear space requirements stated above. A separate unloading bay for such purpose is required.	Yes
b) Floors or fixed/portable platforms with stairs/ ladders shall be provided for easy approach to any plant item, including valves, instruments, etc. to be operated, observed and/or to be frequently (more than once a month) maintained.	Yes
3. Plinth level of all buildings, above the finished grade level	500 mm
4. Minimum access opening required (with rolling shutter) for transportation, wherever entry of truck for material handling is envisaged	3.5M wide x 4M high or, more depending upon the equipment size to be handled.

ITEM	SPECIFICATION REQUIREMENT
C. Other Maintenance Requirement	
1. Generator stator handling In case the Generator stator cannot be handled by the turbine house crane, all provisions for its overhauling, including the arrangement to slide the stator on the turbine house floor, the foundation work for stator jacking /lowering assembly, dismantling of building end walls/structures etc. shall be kept.	Yes
2. Maintenance of the internals/impellers of all important equipment, like boiler feed pumps, feed water heaters, Surface Condenser, fans of the boiler draft plant, Intake and circulating water pumps, cooling water pumps, coal mills, compressors, blowers, heat exchangers, fuel oil pumps, filters etc.	Shall be possible without disconnecting or dismantling any piping/ducting.
3. Overhauling and handling of the casings for the above items	Shall be possible without disturbing/dismantling any piping/ducting not directly connected to them.
4. Crane Approach	
Wherever required the unobstructed approach of the crane hook/other hoisting equipment hook to various plant & equipment shall be possible.	Yes
D. Central Control Room	
All electronic equipment other than those directly associated with control, operation or presentation of displays shall be mounted external to the control room in air conditioned control equipment room.	Yes
The bidder shall describe in his bid the proposed layout philosophy of the Central Control Room and Control Equipment Room and the arrangement of equipment best suited for the system offered by him and as per good ergonomically consideration.	
However, as a guide line, following features are given :	
a) False ceiling and false flooring shall be provided.	
b) Uniform height, colouring schemes for cabinets etc. shall be available.	

ITEM	SPECIFICATION REQUIREMENT
c) The total area of floor space covered by Control Consoles/Panels in the Control Room shall not exceed 15% of floor area.	
d) No opening shall be provided from Boiler side.	
e) Two double leaf doors, suitably located for entering the Control room shall be provided with opening towards the turbine floor.	
f) Cable entry for the panels/consoles shall be from bottom and suitable openings shall be provided.	
g) The Control Room lighting shall be designed to provide a glare free uniform illumination. The level of illumination shall be minimum 400 LUX.	
h) Necessary Air Conditioning shall be provided for Central Control room, Control Equipment Room and SWAS room etc.	
i) Basic amenities like toilet, Tiffin rooms, wash basins, rest rooms etc. shall be provided near the Control Room.	
E. Toilet and drinking water facility	Required in all buildings and on all floors wherever operating personnel are to be deployed.

PROJECT MANAGEMENT AND SITE SERVICES

CONTENT

CLAUSE NO.	DESCRIPTION
1.00.00	PROJECT MANAGEMENT SERVICES
2.00.00	SITE SERVICES
3.00.00	PROJECT INFORMATION AND MANAGEMENT SYSTEM, INCLUDING DCOUMENT MANAGMENT SERVER (DMS)

PROJECT MANAGEMENT AND SITE SERVICES

1.00.00 PROJECT MANAGEMENT SERVICES

1.01.00 Responsibility

The Bidder shall identify a separate and independent project management team headed by a Project Manager for the execution of this project. Responsibilities of this project Management team shall cover the areas listed below :

- a) Planning and Monitoring
- b) Engineering Management
- c) Contracts Management
- d) Project Safety Management
- e) Quality Assurance, Inspection & Expediting
- f) Construction Management
- g) Spares Management
- h) Erection & Commissioning Management

Detailed responsibilities in the above areas are discussed below :

1.02.00 Organisation

1.02.01 Headquarters

The headquarters of the project management team shall be headed by a senior level executive designated as the Project Manager who shall be responsible to Owner for the execution of the project. He should have adequate financial power and authority to give decision.

Separately, designated leaders shall be identified for each of the areas mentioned under 1.01.00, who, in turn, will report to the Project Manager for all matters relative to this contract.

1.02.02 Central Co-ordination Cell

The central coordination cell shall have sufficient technical personnel to coordinate technical matters and to quickly resolve day to day queries or

	references made by Owner and his Consultants without having the need to refer to his headquarters each time.
1.02.03	Site Organisation The site should have a competent construction manager for all site operations with adequate financial power and sufficient level of authority to take site decisions. The organisation chart for site should indicate the various levels of experts to be posted for supervision in the various fields in civil construction, erection, commissioning etc.
1.02.04	Organisation Chart The Bidder shall furnish a detailed organisation chart for the project management team, clearly identifying the key personnel in each of the areas mentioned at 1.01.00 above. The expected number of executives at different levels shall also be indicated, separately for headquarters, central coordination cell and site organisation.
1.03.00	Implementation Schedule The schedule for the completion of the Project would be as follows : As per project specific special condition of contract. To achieve these targets, the Contractor shall furnish to the Owner, various schedules as defined below:
1.03.01	Engineering Schedules These schedules shall cover various design submissions indicating different engineering activities to be performed. Such schedules shall be furnished by the Bidder for each and every plant/systems/ equipment item covered in the scope of this specification.
1.03.02	Manufacturing Schedule The Contractor shall submit to the Engineer his manufacturing and delivery schedules for all equipment within thirty (30) days from the date of issue of the Letter of Intent (LOI). Such schedules shall be in line with the detailed network for all phases of the work of the Contractor. Such schedules shall be reviewed, updated and submitted to the Engineer, once in every two months thereafter, by the Contractor. Schedules shall also include the materials and equipment purchased from outside suppliers.

1.03.03 **Erection Schedules**

In order to achieve the overall completion schedule, the Contractor shall provide the Owner all the information covering erection sequence, testing and commissioning activities. These schedules may be based on the recommended erection procedures and will be subject to discussions/agreements with the Owner subsequent to the award of contract.

1.03.04 The successful Bidder shall have to provide all the above schedules (i.e. 1.03.01, 1.03.02 & 1.03.03) in a tabular form in addition to that in the form of L2 & L3 networks and these shall necessarily include information not limited to the earliest and latest dates for various activities/submissions and also any related constraints. However, the Bidder shall include in his proposal a Level-1 (L-1) network showing the major activities and various milestones to achieve the above mentioned completion schedule.

1.03.05 The Contractor shall provide the Owner the original disc/software for all such schedules alongwith requisite no. of copies (as required by the Owner) within an agreed time schedule. This time schedule will be agreed between Owner/Bidder at the time of award of contract. The Contractor's project management software shall be compatible with that of the Owner and the input data shall be furnished to the Owner in a manner compatible with Owner's project management software, SAP.

1.04.00 **Detailed Responsibilities**

1.04.01 **Planning & Monitoring**

a) **Planning**

The Bidder shall prepare a Master Network Schedule in the form of PERT network.

The network shall be prepared on a Work Breakdown Structure for the project which sub-divides the project into a set of manageable systems/sub-systems. The master network will identify milestones of key events for each system/package in the areas of engineering, procurement, manufacture and despatch and erection and commissioning. The master network shall represent the Level-I plan and will form the basis for development of detailed second and third tier execution plans. The master network shall conform to the overall schedule prescribed by Owner.

The master network should be submitted along with the bid which would be mutually discussed and finalised before the Award of Contract. This master network would clearly indicate the responsibility of the Bidder and project management team. This master network would form a part of the contract. The master network shall also identify a complete list of inputs to be furnished by the Owner which may be required for proper interfacing and tie-up. Scheduled dates for providing such inputs shall also be indicated, which will be mutually discussed and finalised.

b) Monitoring & Progress Reporting

The progress reports would be emanated every month, one from the head office of the Contractor and another from the site office. The progress report emanating from the head office should necessarily include the following sections:

- i) Report on key milestones.
- ii) Management summary indicating critical areas with details of actions initiated and effect of any on the project.
- iii) Action needing attention of the Owner/Consultant.
- iv) Detailed packagewise status of engineering submissions, quality plan submissions and approval, procurement manufacture and despatch.

The monthly report generated from the site office should necessarily include:

- i) Report on key milestones.
- ii) Management summary indicating critical areas with details of actions initiated and effect if any on the project.
- iii) Action needing attention of the Owner/Consultant.
- iv) This report would also cover the areas pertaining to the receipt of the equipment at the port, port clearance, transport, receipt at site, erection and commissioning.

In addition to the above, as the project execution progresses, the Contractor shall also be responsible for generating more frequent reports in the form of fax/e-mail information on progress in critical areas so that actions can be expedited. The exact format of the progress report shall be finalised after award of Contract.

1.04.02 Engineering Management

Based on the master network for the project (L-1) the Contractor will prepare an exhaustive list of engineering activities for the equipment/systems covered in his scope and a detailed programme of accomplishing the same within the time frame specified in the master network. This schedule will form the Level-2 (L-2) network for engineering activities.

Based on (L-2) network, the Contractor shall further develop the Level-3 (L-3) network for engineering activities which will indicate schedule for data availability, drawing release date and document submission dates.

Detailed (L-2) and (L-3) networks would be submitted sequentially by the Contractor within two months from the date of issue of Letter of Intent and finalised within one (1) month thereafter.

All such networks shall be provided in MS PROJECT software as well as in other format / software suitable to Owner.

The engineering management team should also co-ordinate all interface engineering activity between the Contractor and the equipment sub-vendors so as to ensure the correctness and completeness of related engineering documentation before the same is submitted to the Owner.

TSGENCO is implementing SAP ERP. Hence the bidder apart from submission of the hard copies shall upload all the documents, drawings etc. in soft format in the relevant C- folder environment (web based) and comply with the additional requirements, if any.

1.04.03 Contracts Management

Based on the master network, the Contractor shall submit L-2 programmes of manufacture and despatch. In addition, the master network shall also include periods considered for site activities viz. erection, commissioning etc. These L-2 programmes would be submitted in 2 months time from the date of award of contract and finalised within one (1) month thereafter. The Contractor will also submit site mobilisation plan. This programme would be submitted at the time of finalisation of award of contract and agreed immediately thereafter so that immediate development of the various activities at site could take place.

The Contractor should also submit L-3 programmes for the manufacturing, despatch of the various items. These networks shall also show the customer hold points (CHP) which have to be cleared by Owner or their authorised representative(s) before further manufacture can take place. These L-3 programmes for the manufacture and despatch would clearly identify responsibilities of the Contractor, sub-Contractor and Owner. These networks shall be submitted within one (1) month of the date of finalisation of the various sub-contracts by the Contractor.

In case all the manufacture is being done by the Contractor then the L-2 programmes would be themselves amplified to cover details of the manufacture, inspection, clearance by Owner and despatch.

The Contractor shall also submit the programme for procurement of boughtout items, detailed shipping schedule and cash flow statement for Owner's approval.

1.04.04 Quality Assurance, Inspection and Expediting

The Contractor shall submit the list of manufacturers/sub-vendors from whom the equipment are expected to be procured and the quality assurance plans thereof for the manufacture shall be approved by the QA group of Owner before the manufacture is commenced. The list of major suppliers would be submitted along with the bid and this shall be mutually discussed and approval will be given by the Owner during contract negotiation meeting prior

to placement of Letter of Intent. This approved list will be binding to the bidder. In the said list, Owner reserves the right to include reputed/reliable vendors of his own choice. Regarding the various other sub-vendors, the list would be submitted within six (6) months of the award of the contract that shall be scrutinized by the Owner to accord approval. In such list Owner reserves the right to include vendors of his own choice. No further vendor approval will be given after twelve (12) months. On the quality plans, the customer hold points will also be identified based on which Owner would give clearance for the manufacture to proceed further.

Quality assurance/Inspection group of Owner or its representative would issue a material despatch clearance certificate (MDCC) after the inspection clearance which will enable the Contractor to despatch the equipment and claim the payment. In the despatch programme, the Contractor shall indicate a schedule of estimated programme, tonnages specifically identifying various oversize dimensioned consignments (ODC). Further the Contractor will also be required to ensure at all stages of shipment that packing of all shipments despatched are suitable for ocean freight to India, handling at the port of entry, inland transportation and preservation at site upto erection. All despatch details & item lists shall be made available to both Owner & site immediately after shipping.

The Contractor shall also expedite all despatches from their own works/works of their sub-vendors, so as to match with the various activities mentioned at 1.04.03 above.

1.04.05 Construction Management

Based on the L-1 Master Network Programme, within two (2) months of the issue of Letter of Intent, the Contractor shall submit a programme of construction/ erection/ commissioning, either in continuation with the manufacture and despatch or separately for the implementation. These programmes would be amplified showing when the civil drawings shall be released by him and construction of civil works shall be completed by him to facilitate start of erection and subsequent activities and shall form the basis for site execution and detailed monitoring. The three monthly rolling programme with the first month's programme being tentative based on the site conditions would be prepared based on these L-3 programmes. The Contractor shall also be involved along with the Owner to tie up detailed resource mobilisation plan over the period of time of the contract matching with the performance targets.

The L-3 programme would be jointly finalised by the site in charge of the Contractor with the Owner's project coordinator as well as the site planning representative. The erection programme will also identify the sequential erectable tonnages that are required for various equipment which should be taken care of in the despatch programmes.

Erection and commissioning of the equipment shall also be done under the supervision of experts from the respective equipment/ system supplier.

1.04.06 Spares Management

Alongwith the proposal for the plant and equipment, the Contractor shall also submit proposals/schedule for the following:

- a) Mandatory spares
- b) Recommended spares

While the award for mandatory spares will be finalised at the time of the award of contract, recommended spares will be finalised thereafter.

1.05.00 Project Progress Review Meetings

Keeping in mind the overall responsibility of the Contractor it is intended that periodic progress reviews on the entire activities of execution of the project will be held initially at least once in two (2) months at Hyderabad/site/ at the discretion of the Owner.. During peak period it may be held once in a month. These meetings will be attended by reasonably higher officials of the Contractor and their leading sub- contractors and will be used as a forum for discussing all areas where progress needs to be speeded up. Actions will be placed on the concerned agencies and decisions will be taken to expedite/speed up the progress. Minutes of such meetings will be issued reflecting the major discussions and decisions taken and circulated to all concerned for reference and action. The Contractor shall be further responsible for ensuring that suitable steps are taken to meet various targets decided upon such meetings.

In addition to the above, and to streamline the construction and erection at site, a suitable frequency and forum of periodic meetings between the Contractor and the Owner will be decided upon as part of erection coordination procedure. Site co-ordination meeting may be held on weekly basis.

1.06.00 Owner's Consultant

The Owner would appoint a consultant to assist him in some of the areas mentioned at 1.01.00 above. The details of interaction and procedures for coordination between Owner / Owner's Consultant and Contractor/ Contractor's project management team shall be finalised during contract negotiations.

1.07.00 Commissioning Management

1.07.01 For commissioning of the various equipment/system covered under the scope of contract, Owner will form an organisation structure which may consist of the following committees. The Contractor shall nominate his representative on one or more of the committee as decided by the Owner:

- a) Steering Committee
- b) Commissioning Panel.
- c) Working Parties
- d) Testing Teams.

1.07.02 Commissioning documents shall be prepared by the Contractor in the

following manner and submitted for Owner's approval :

a) Field Quality Plan

This document shall be prepared for the various equipment/ systems under commissioning and shall have the following objectives to fulfill and shall be submitted for Owner's approval at least six (6) months before their actual commissioning :

- i) Establish design data against which Plant Performance will be compared.
- ii) Set-out the testing objectives and proposals.
- iii) Define the documentation required.

b) Testing/Commissioning Schedule

These shall be prepared for the various equipment/systems under consideration and shall contain sections like detailed testing method, programme, safety, individual responsibility and results.

c) Standard Check Lists

Standard check lists are intended for use at the completion of erection to ensure correct erection, testing and to a limited extent operation for repetitive items.

1.07.03 Test Reports

After the completion of commissioning activity of equipment/ systems, the Contractor shall prepare the test reports which shall include all the relevant information related to various commissioning checks, tests carried out, any deviations/commissions noticed with respect to the intended design requirements, sequence of various commissioning activities as actually adopted vis-a-vis as recommended in the procedures, programme schedules achieved and any other such information as required. These test reports shall be submitted in requisite number of copies to the Owner and this should be duly signed jointly by the Owner/Consultant and the Contractor/Equipment supplier, who are involved during the commissioning activities.

2.00.00 **SITE SERVICES**

These services shall be rendered by the Bidder as part of the overall project management service. The services shall broadly include but not be limited to the following :

2.01.00 Arranging material despatch from the shop by rail/road and/or sea as applicable.

2.02.00 Monitoring movement of materials & follow-up as necessary with Railways, road transport, port clearance etc. from the time of despatch F.O.R. works/ F.O.B. port of shipment by Contractor till receipt of the same at site.

- 2.03.00 Unloading of materials at Railway Station/Railway Siding inside project area/ Road Transportation, transportation to site store, assessment of lost/damaged items in transit and arranging insurance claims and replacement of lost/damaged items. The Contractor shall submit to the Engineer a report detailing all the receipts during the week as well as storing, preservation of material at site.
- 2.04.00 Issuing materials from site store/open yard from time to time for erection as per the construction programme. The Contractor shall be the custodian of all the materials issued till the plant is officially taken over by the Owner after complete erection and successful trial run & commissioning.
- 2.05.00 Transportation of materials to their respective places of erection and erection of the complete plant & equipment as supplied under this specification.
- 2.06.00 Trial run and commissioning of individual equipment/sub-systems and the plant as a whole to the satisfaction of the Owner, including supply of temporary equipment & services for chemical cleaning, steam blowing as well as performance guarantee tests.

Apart from Boiler, proper chemical cleaning shall be carried out in following pipe lines/equipment before commissioning

- a) Deaerator
- b) Boiler feed suction, recirculation leak-off lines
- c) Boiler Feed discharge line by passing heaters
- d) Attenuation lines
- e) Condensate suction & discharge piping upto deaerator by passing the feed water heaters.
- f) Fuel oil lines.

Provision for preservation of individual equipment after trial run and commissioning e.g. Nitrogen blanketing etc. as necessary shall also be in the scope of the Bidder.

Safe disposal of effluent after chemical cleaning shall be done by the contractor.

- 2.07.00 Supply and application of the final paints and first fill lubricants on all the equipment to be erected under this specification. Supply of chemicals, lub oils and other consumables upto COD.
- 2.08.00 For the purpose of erection and commissioning the Contractor's scope of work shall include but not be limited to the following :
- 2.08.01 Deployment of all skilled and unskilled manpower required for erection, supervision of erection, watch & ward, commissioning and other services to

	be rendered under this specification.
2.08.02	Deployment of all erection tools & tackle, construction machinery, transportation vehicles and all other implements in adequate number and size, appropriate for the erection work to be handled under the scope of this specification.
2.08.03	Supply of all consumables, e.g. welding electrodes, cleaning agents, diesel oil, grease, lubricant etc. as well as materials required for temporary supports, scaffolding etc. as necessary for such erection work except those listed under exclusion elsewhere in this specification.
2.08.04	Construction of all civil/structural/architectural works, including construction of foundation for all equipment supplied as required, grouting of equipment on foundation after alignment, and all other incidental civil activities as detailed elsewhere.
2.08.05	All structural steel fabrication and erection work as detailed elsewhere in the specification.
2.08.06	Providing support services for the Contractor's erection staff e.g. construction of site offices, temporary stores, residential accommodation and transport to work site for erection personnel, insurance cover, watch & ward for security and safety of the materials under the Contractor's custody etc. as required.
2.08.07	Maintaining proper documentation of all the site activities undertaken by the Contractor as per the proforma mutually agreed with the Owner; submitting monthly progress reports as also any such document as and when desired by the Owner; taking approval of all statutory authorities e.g. Boiler Inspector, Factory Inspector, Inspector of Explosives, Electrical Inspector etc. for respective portions of work under the jurisdiction of such statutes or laws.
2.08.08	The Contractor shall provide 'Industrial Relations' unit and 'Medical' unit to take care of his erection staff and the Owner shall have no obligation in the regard.
2.08.09	The successful Bidder shall arrange for Tower cranes of adequate capacity for speedy erection activities.
2.09.00	Site Organisation The Contractor shall maintain a site organisation of adequate strength in respect of manpower, construction machinery and other implements at all times for smooth execution of the contract. This organisation shall be reinforced from time to time, as required, to make up for slippages from the schedule without any commercial implication to the Owner. The site organisation shall be headed by a competent construction manager having sufficient authority to take decisions at site. On award of contract, the Contractor shall submit to the Owner a site organisation chart indicating the various levels of experts to be deployed on the job. The Owner reserves the right to reject or approve the list of personnel

proposed by the Contractor. The persons, whose bio-data have been approved by the Owner, will have to be posted at site and deviations in this regard will not generally be permitted.

The Contractor shall also submit to the Owner for approval a list of construction equipment, erection tools, tackle etc. prior to commencement of site activities. These tools & tackle shall not be removed from site without written permission of the Owner.

2.10.00 General Guidelines for Field Activities

2.10.01 The Contractor shall execute the works in a professional manner so as to achieve the target schedule without any sacrifice on quality and maintaining highest standards of safety and cleanliness.

2.10.02 The Contractor shall co-operate with the Owner and other Contractors working in site and arrange to perform his work in a manner so as to minimise interference with other Contractors' works. The Owner's engineer shall be notified promptly of any defect in other Contractor's works that could affect the Contractor's work. If rescheduling of Contractor's work is requested by the Owner's engineer in the interest of overall site activities, the same shall be complied with by the Contractor. In all cases of controversy, the decision of the Owner shall be final and binding on the Contractor without any commercial implication.

2.10.03 The Engineer shall hold weekly meetings of all the Contractors working at Site at a time and a place to be designated by the Engineer. The Contractor shall attend such meetings and take notes of discussions during the meeting and the decisions of the Engineer and shall strictly adhere to those decisions in performing his Work. In addition to the above weekly meeting, Engineer may call for other meetings either with individual contractors or with selected number of contractors and in such a case the Contractor, if called will also attend such meetings.

2.10.04 Time is the essence of the Contract and the Contractor shall be responsible for performance of his Work in accordance with the specified construction schedule. If at any time the Contractor is falling behind the schedule, he shall take necessary action to make good of such delays by increasing his work force or by working overtime or otherwise accelerate the progress of the work to comply with the schedule and shall communicate such action in writing to the Engineer, satisfying that his action will compensate for the delay. The Contractor shall not be allowed any extra compensation for such action.

2.10.05 The Engineer shall however not be responsible for provision of additional labour and or materials or supply or any other services to the Contractor except for the co-ordination work between various Contractors as set out earlier.

2.10.06 The works under execution shall be open to inspection & supervision by the Owner's engineer at all times. The Contractor shall give reasonable notice to the Owner before covering up or otherwise placing beyond the reach of inspection any work in order that same may be verified, if so desired by the Owner.

- 2.10.07 Every effort shall be made to maintain the highest quality of workmanship by stringent supervision and inspection at every stage of execution. Manufacturer's instruction manual and guidelines on sequence of erection and precautions shall be strictly followed. Should any error or ambiguity be discovered in such documents, the same shall be brought to the notice of the Owner's engineer. Manufacturer's interpretation in such cases shall be binding on the Contractor.
- 2.10.08 The Contractor shall comply with all the rules and regulations of the local authorities, all statutory laws including Minimum Wages, Workmen Compensation etc. All registration and statutory inspection fees, if any, in respect of the work executed by the Contractor shall be to his account.
- 2.10.09 All the works such as cleaning, checking, leveling, blue matching, aligning, assembling, temporary erection for alignment, opening, dismantling of certain equipments for checking and cleaning, surface preparation, edge preparation, fabrication of tubes and pipes as per general engineering practice at site, cutting grinding, straightening, chamfering, filling, chipping, drilling, reaming, scrapping, shaping, fitting-up bolting/welding, etc., as may be applicable in such erection and are necessary to complete the work satisfactorily, are to be treated as incidental and the same shall be carried out by the Contractor as part of the work.
- 2.10.10 In case of any class of work for which there is no such specification as laid down in the contract such as, blue matching, welding of stainless steel parts, etc., the work shall be carried out in accordance with the instructions and requirements of the Engineer and as per the Standards.
- 2.10.11 It may sometimes be necessary to remove some of the erected structural members to facilitate erection of bigger/pre-assembled equipment. In such cases, the removal and re-erection of such members, which are essential, and if so agreed by the Engineer, will have to be done by the Contractor.
- 2.10.12 Attachment welding of necessary instrumentation tapping points, thermocouple pads, root valves, condensing vessels, flow nozzles and control valves etc., both for regular measurement and performance testing to be provided on equipment, its auxiliaries or pipelines covered within the scope of this tender, will also be the responsibility of the Contractor and the same will be done as per the instructions of Engineer. The erection and welding of all above items will be the Contractor's responsibility, even if :
- a) Product groups under which these items are re-leased are not covered in the scope of this tender.
 - b) Items are supplied by an agency other than the Contractor.
- 2.10.13 Preservation of all materials/equipment under custody of the Contractor during storage, pre-assembly & erection, commissioning etc., shall be the responsibility of the Contractor. All necessary preservatives and consumables like paints, etc., shall be arranged by the Contractor. Necessary touch up painting, periodic application of preservatives/paints on pressure parts/other equipment even after erection until completion of work shall be carried out by

the Contractor. The Contractor shall fabricate piping, install lub oil systems and carry out the acid cleaning of fabricated piping. The Contractor shall also service the lub. oil system, carryout the hydraulic test of oil coolers, etc.

- 2.10.14 It is responsibility of the Contractor to do the alignment etc. if necessary, repeatedly to satisfy Engineer, with all the necessary tools & tackle, manpower, etc. The alignment will be complete only when jointly certified so, by the Contractor's Engineer & Owner. Also the Contractor should ensure that the alignment is not disturbed afterwards.
- 2.10.15 Additional platforms for approaching different equipment as per site requirement, which may not be indicated in drawings, shall be fabricated and erected by the Contractor. The materials required for these works shall be supplied by the Contractor and he will have to fabricate them to suit the requirement.
- 2.10.16 Equipment and material which are wrongly installed shall be removed and reinstalled to comply with the design requirement at the Contractor's expense, to the satisfaction of the Owner/ Consultant.
- 2.10.17 Before erection of any equipment on a foundation, the Contractor shall check and undertake if necessary rectification of foundation bolts, reaming of holes, drilling of dowels, matching of bolts and nuts, making new dowel pin, etc.
- 2.10.18 Assistance for calibrating/testing the power cylinders, valves, gauges, instruments, etc., and setting of actuators coming under various groups shall be provided by Contractor.
- 2.10.19 It shall be the responsibility of the Contractor to provide ladders on columns for initial works till such time stairways are completed. For this, the ladder should not be welded on the column and should be prefabricated clamping type. No temporary welding on any structural member is permitted except under special circumstances with the approval of Owner.
- 2.10.20 Structural materials required for the supporting/operating platforms required for the valves at various levels for the same operation of valves will be arranged by the Contractor.

2.11.00 **Safety**

Safety and overall cleanliness of work site shall be given top priority.

- 2.11.01 The Contractor shall ensure the safety of all workmen, materials and equipment either belonging to him or to others working at site. He shall observe safety rules & codes applied by the Owner at site without exception.
- 2.11.02 The Contractor shall notify the Owner of his intention to bring to site any equipment or material which may create hazard. The Owner shall have the right to prescribe the conditions under which such equipment or material may be

handled and the Contractor shall adhere to such instructions. The Owner may prohibit the use of any construction machinery, which according to him is unsafe. No claim for compensation due to such prohibition will be entertained by the Owner.

- 2.11.03 Storage of petroleum products & explosives for construction work shall be as per rules and regulation laid down in Petroleum Act, Explosive Act and Petroleum and Carbide of Calcium Manual. Approvals as necessary from Chief Inspector of Explosives or other statutory authorities shall be the responsibility of the Contractor.
- 2.11.04 The Contractor shall be responsible for safe storage of his and his sub-contractor's radioactive sources.
- 2.11.05 All requisite tests & inspection of handling equipment, lifting tools & tackle shall be done by the Contractor and certified copies shall be supplied to the Owner. Defective equipment shall be removed from service. Any equipment shall not be loaded in excess of its recommended safe working load.
- 2.11.06 All combustible waste and rubbish shall be collected and removed from the worksite at least once each day. Use of undercoated canvas paper, corrugated paper, fabricated carton, plastic or other flammable materials shall be restricted to the minimum and promptly removed.
- 2.11.07 The Contractor shall provide adequate number of fire protection equipment of the required types for his stores, office, temporary structures, labour colony etc. Personnel trained for fire-fighting shall be made available by the Contractor at site during the entire period of the Contract.
- 2.11.08 All electrical appliances used in the work shall be in good working condition and shall be properly earthed. No maintenance work shall be carried out on live equipment. The Contractor shall maintain adequate number of qualified electricians to maintain his temporary electrical installation.
- 2.11.09 All workmen of the Contractor working in construction site shall wear safety helmets, safety boots and safety belts. The Contractor shall take appropriate insurance cover against accidents for his workmen as well as third party.
- 2.11.10 All the worksites shall be provided with adequate lighting facilities e.g. flood lighting, hand lamps, area lighting etc. by the Contractor for proper working environment during night times.
- 2.11.11 All safety precautions shall be taken for welding and cutting operations as per IS-818.
- 2.11.12 All safety precautions shall be taken for foundation and other excavation marks as per IS-3764.
- 2.12.00 **Taking Delivery & Storage**
- 2.12.01 The Contractor shall arrange issue of all equipment and materials to be erected under the contract from the stores/open yard at site by signing on standard indent forms. After completion of work, detailed auditing of the

materials so issued shall be submitted to the Owner.

- 2.12.02 The Contractor shall arrange for proper and safe storage of materials till the same are taken over by the Owner as per terms of the contract. Manufacturer's instructions for preservation shall be strictly followed.
- 2.12.03 All empty containers, packing materials, gunny bags, transport frames and also surplus and unused materials reconciliation prior to completion of contract shall be the property of the Owner and returned to the Owner by the Contractor.
- 2.13.00 **Site Welding & Heat Treatment**
- 2.13.01 Welding shall be done in accordance with IS-813, IS-816, IS-9595 & other relevant IS/International standards and as per instructions of Contractor. Only those welders, who are qualified as per IS-817 for ordinary welds and as per IBR/ASME Section-IX for high pressure welds, shall be employed in the job.
- 2.13.02 All welders shall be tested and approved by Engineer before they are actually engaged on the work even though they may possess the requisite certificates. The Owner reserves the right to reject any welder without assigning any reason. The welder identification code as approved by the Engineer shall be stamped by the welder on each joint done by them. The Contractor will be responsible for the periodic renewal, re-testing of the welders as demanded by Owner.
- 2.13.03 The Engineer is entitled to stop Contractor's any welder from his work if his work is unsatisfactory for any technical reason or there is a high percentage of the rejection of joints welded by him, which in the opinion of Engineer will adversely affect the quality of welding even though the welder has earlier passed the tests. The welders having passed the tests do not relieve the Contractor from his contractual obligations, to check the performance of the welders.
- 2.13.04 All charges for testing of welders including destructive and non- destructive tests if conducted by Owner or by the inspection authority at site shall have to be borne by the Contractor. The necessary test materials and consumables will have to be arranged by the Contractor and all testing facility made available, as required.
- 2.13.05 All welded joints shall be subject to acceptance by Engineer. Inspection of welds shall be in accordance with IS-822 or equivalent code.
- 2.13.06 Preheating/post heating and stress relieving after welding are part of fabrication and erection work and shall be performed by the Contractor in accordance with the instruction of Engineer. Contractor shall arrange to supply heating equipment with automatic recording devices. Also the Contractor shall have to arrange for the labour, heating elements, thermocouples, compensating cables, insulation materials like mineral wools, asbestos cloth, ceramic beads, asbestos rope, etc. required for the heat-treatment and stress relieving works. During pre- heat/stress relieving operations, the temperature shall be measured at one or more points as required by attaching thermocouples and recorded on a continuous printing

type recorder. All the record graphs for the heat treatment works carried out shall be got signed by the Engineer prior to the commencement of each cycle and handed over to Engineer on completion. The graphs will be the property of Owner. The Contractor has to provide thermo-chalks temperature recorders, thermocouple attachments, units, graph sheets, etc. required for the job and maintain them in good condition.

- 2.13.07 All electrodes shall be baked and dried in the electric/electrode drying oven to the required temperature and for the period specified by the Engineer before they are used in erection work. The electrodes used shall be as per IS-814, IS-815, IS-1442, IS-7280 and other codes as applicable, and shall be of approved reputed manufacture. The electrodes shall meet the requirement of the pipe material. No electrode manufactured more than 12 months ago and the type covered under certificate issued after conducting tests more than 6 months ago shall be used. All electrodes shall be preserved at works and at site as per manufacturer's recommendations.
- 2.13.08 Oxy-acetylene flame or Exothermic chemical heating for stress relieving is not permitted. Heating shall be by means, of electric induction coil or electric resistance coil.
- 2.13.09 It may become necessary to adopt inter layer radiography/MPT/UT depending upon the site/technical requirement necessitating interruptions in continuation of the work and making necessary arrangement for carrying out the above work.
- 2.13.10 Gas tungsten arc welding process (TIG) shall be adopted for all root pass welds except for structural works until 4.75 mm thickness is deposited. Subsequent welding after root pass can be carried out by manual metal arc welding with coated electrodes. For pipes of thickness less than 6 mm the entire welding has to be carried out by TIG welding.
- Fillet weld shall be made by shielded metal arc process as per applicable codes.
- However, the Engineer will have the option of changing the method of welding as per site requirement. The method adopted for manual arc welding shall be weaving technique and the width of weaving shall not exceed 1.5 times of the dia. of the electrode.
- In case of deviation from welding process and electrodes, the Contractor shall take approval of the Owner prior to adoption of same.
- 2.13.11 The root pass for butt joints shall be such as to achieve full penetration with complete fusion of root edges.
- 2.13.12 Each pass shall be cleared and freed of slag before the next pass is deposited.
- 2.13.13 On completion of each run, craters, weld irregularities, slag etc. shall be removed by grinding or chipping.
- 2.13.14 Each layer of welding shall have an even and smooth appearance.

- 2.13.15 Welding sequence shall be adjusted in such a way that distortion due to welding shrinkage is minimised. Further any movement, shock or vibration during welding shall be avoided to prevent weld cracks.
- 2.13.16 Proper protection of welders and the work shall be taken during periods of rain. No welding shall be carried out when surface to be welded are wet from any cause.
- 2.13.17 Following will be stages of inspection during welding :
- a) Two pieces to be joined shall be individually checked for the weld edge preparation and profile dimensionally and to the template. Dye penetrant check shall be carried out on edge prepared surfaces at random. The percentage will depend upon on criticality as specified by Engineer.
 - b) Joint fit up will be a stage of inspection. Misalignment after fit up may vary from 0.3 mm to 1.6 mm depending on outside diameter and thickness.
 - c) All joints shall be offered for visual inspection after root run. Subsequent welding should be made only after the approval of root run.
- 2.13.18 All welded joints shall be painted with anti-corrosive paint immediately on completion of radiography and stress-relieving.
-
- 3.00.00 **PROJECT INFORMATION AND MANAGEMENT SYSTEM, INCLUDING DCOUMENT MANAGMENT SERVER (DMS)**
- 3.01.00 Contractor shall submit as part of its Work Scope detailed documentation as outlined in this section and / or required by the Technical Requirements. The content and format of the documentation to be submitted are subject to Owner's approval.
- 3.02.00 Contractor shall utilise a computer based system for control and management of project documentation. The system must be capable of producing customized reports and information on demand. This control system should have been successfully applied to similar projects and be familiar to the project control personnel selected. Contractor's detailed project documentation plan shall identify all documentation requirements for the project, the party responsible for production of the document, the basic content of the document and the required timing for issue. This plan shall include, but not be limited to the details of all Drawings to be produced, plant specification / definition documentation, equipment orders and manuals. The documentation identified shall be entered into the computer based control system The database thus created shall be capable of being sorted and

ordered on a variety of selected parameters such as document type, subject description, responsible party, start date and finish date, to enable review and update to be conducted only on those documents which are relevant.

3.03.00 Regular documentation control progress reports shall be prepared by the Contractor to record the status of documentation. In the event either Party or Engineer expresses concern with the content of such progress reports, the accuracy of progress reports, status of documentation production and other such matters, the concern will be identified to the Project Manager. Within five days of notification of this concern, the Project Manager will attend a meeting with relevant Owner Representatives and provide details of specific actions to be initiated to satisfactorily overcome the difficulties identified. It will be the Project Manager's responsibility to initiate whatever action is necessary to ensure that the production of documentation is completely in accordance with Project Information Management System (PIMS).

3.04.00 Within 90 days after Effective Date of Contract, the Contractor shall establish an integrated PIMS which will support the needs of Project and management, detail design and engineering, procurement, construction and operation, and maintenance.

PIMS shall utilise software which links various software and database programs to form a composite system. The typical scope of PIMS shall include, but not be limited to, the following:

- (a) Power plant systems and equipment data, from which Project specific flow diagrams, data sheets and other integrated data are derived. The Power plant systems and equipment data, from which Project specific flow diagrams, data sheets and other integrated data are derived. This data shall include, but not be limited to, the following:
 - (i) System descriptions and design requirements and design criteria
 - (ii) Equipment and material technical specifications for all engineering disciplines
- (b) Detail engineering data to create flow diagrams, plant arrangements, piping configurations, equipment layout and design, electrical and instrumentation systems, structures, and other systems. The software tool used shall be capable of manipulation and storage of plant layout and design information. The 3D model of the plant shall also contain details of the various components like pipe, structural steel work, etc., and relevant information shall be available on-line from relevant data base. Software shall be multi-user, multi-access nature allowing the designers of Contractor and major Sub-Contractors, if required, to work in interactive real time environment and software shall be capable of interference checking. The software shall allow access to different types of information held in the database. It shall estimate the type and quantity of materials required to build the plant and it shall be possible for such data to be taken off the system at any time.

-
- (c) Construction data to monitor and manage site activities, including material control, scheduling and progress, quality control, start-up and testing, operation, maintenance, training, and all other site functions.
 - (d) Plant design and construction records to provide data for safe and efficient maintenance and operation. Records to include may be maintenance schedule, man power tracking, tools, spare parts, and test equipment inventory, equipment list, drawing, control, technical specifications, and equipment instruction manuals.

3.05.00 The PIMS shall be installed in a distributed processing array system and operated through personal computer work stations at the Contractor's site office. A complete integrated system shall be implemented. This system shall be utilised by Contractor during the Project execution.

ENGINEERING SERVICES

CONTENT

CLAUSE NO.	DESCRIPTION
1.00.00	GENERAL
2.00.00	DESIGN COORDINATION MEETING
3.00.00	CO-OPERATION WITH OTHER CONTRACTORS AND CONSULTING ENGINEERS
4.00.00	GUIDELINES FOR ENGINEERING SERVICES
5.00.00	OPERATING MANUALS AND MAINTENANCE INSTRUCTIONS
6.00.00	PLANT HANDBOOK
7.00.00	CONTRACT STAGE DOCUMENT SUBMISSION AND APPROVAL PROCEDURE
8.00.00	TENDER STAGE DOCUMENT SUBMISSION

ATTACHMENTS

ANNEXURE-1	DISTRIBUTION SCHEDULE

ENGINEERING SERVICES

1.00.00 GENERAL

1.01.00 As part of the overall project management activity, the Contractor shall be responsible for proper engineering and co-ordination of activities during various phases of execution of the contract. The Contractor shall identify a person, designated as Project Manager, with whom the Owner, the Consulting Engineer or the Review Consultant shall interact on matters related to engineering as well as execution of the contract. The Project Manager shall be the single-point contact person on behalf of the Contractor and shall be responsible for all engineering co-ordination. The Owner/Consultant/Review Consultant shall interact with the Project Manager only on all matters of co-ordination between the Owner and the Contractor or on matters involving the Contractor, his manufacturing units and sub-vendors. For the purpose of expediting the Owner or his representative may sometimes interact with the manufacturing units or sub-vendors of the contractors. However such interaction will not, under any circumstance, dilute the responsibility of the Contractor to provide a fully engineered and co-ordinated package under this contract.

1.02.00 On finalization of the contract, a procedure for exchange of engineering information will be mutually agreed and finalized between the Owner and the Contractor.

2.00.00 DESIGN COORDINATION MEETING

The Contractor and his sub-vendors will be called upon to attend design co-ordination meetings with the Engineer, other Contractors and the Consultants of the Owner during the period of execution of contract. The Contractor including his sub-vendors shall attend such meetings at their own cost at Owner's or Consultant's office in Kolkata or at mutually agreed venue as and when required and fully cooperate with such persons and agencies involved during those discussions.

3.00.00 CO-OPERATION WITH OTHER CONTRACTORS AND CONSULTING ENGINEERS

The Contractor shall agree to cooperate with the Owner's other Contractors and Consulting Engineers and freely exchange with them such technical information as is necessary to obtain the most efficient and economical design and to avoid unnecessary duplication of efforts. The Engineer shall be provided with copies of all correspondences addressed by the Contractor to other Sub- contractors and Consulting Engineers in respect of such exchange of technical information.

- 4.00.00 **GUIDELINES FOR ENGINEERING SERVICES**
- 4.01.00 Prior to commencement of the engineering work as part of design submissions, all aspects of design viz., criteria for selection and sizing of all equipment and systems, design margins etc. including that for structural steel and civil work shall be outlined and these shall form the basis for the detailed engineering work.
- 4.02.00 Engineering work shall be performed on modern and proven concepts and internationally accepted good engineering practices but fully compatible with the Indian environments. Owner shall have the right to review and approve the engineering work by themselves and/or through consultant and ask for any clarifications and changes/modifications to the work performed by Contractor.
- 4.03.00 At any stage during the performance of assignment, the Contractor may be required to make certain changes/modification/improvements in design/drawing/other documents which are applicable to 800 MW Unit, which in the opinion of the Owner could result in better improved design, layout, operability, plant availability, maintainability, reliability or economy of the plant and its systems/sub-systems in view of revised and more accurate information/data available at a later date(s) or feedback(s) received during execution / operation of similar units. Such changes / modifications/improvements required could be identified by Owner and/or consultant and mutually discussed. Owner requires the Bidder to incorporate such action in the subject assignment appropriately without any additional cost liability and time implication to the Owner and same shall be within the responsibilities and scope of the Contractor.
- 4.04.00 During the course of review of detailed engineering stages, it may be essential in the opinion of Owner to obtain certain classified data for review purposes only. In case Owner so desires, the Bidder shall submit such data to Owner.
- 4.05.00 During the course of review of detailed engineering, it may be essential in Owner's opinion to obtain data and information on similar equipment and plants engineered by the Bidder. In case Owner so desires the Bidder shall submit such data and information to the Owner.
- 4.06.00 It is not the intent to give details of every single task covered in the total engineering work to be carried out by Contractor, however, all engineering work required for the satisfactory completion of the plant/systems as specified shall be carried out by the Contractor. Broadly, the following are the minimum requirements in respect of scope of major items of work:
- 4.06.01 Preparation, updating and finalisation of scheme drawings, control and interlock diagrams, detailed and fully dimensioned layout drawings (plant layout and equipment layout detailed plan, elevation and cross-sectional drawings at different elevations / floor levels) covering all mechanical, electrical, C&I, civil and structural items, equipment, systems and facilities. Drawings and Schedules prepared by the Contractor from time to time, as detailed designs are developed, shall be submitted for Owner's / Consultant's

approval before the work is taken up. Revisions, corrections, additions to drawings and schedules shall not be considered to change the scope of work.

- 4.06.02 Preparation of detailed technical specifications including data sheets, tender drawings and bill of material for all bought out items, as also finalisation of corresponding sub-contractors.
 - 4.06.03 Review of sub-contractor's data, drawings, design calculations, schedules, bill of materials, instruction manuals etc. for all equipment, before forwarding them to Owner/Consultant for approval.
 - 4.06.04 Preparation of civil construction drawings for all equipment showing foundation details and full details regarding equipment loads, floor openings, details of embedments etc. required for preparation of civil construction drawings and also as referred at relevant sections of Scope, Terminal Points & Exclusions. These documents shall be preceded by appropriate design calculations, static and dynamic analysis as necessary.
 - 4.06.05 Preparation and finalisation of process piping and instrumentation diagrams and schematics, complete in all respects for all systems/packages of the power plant.
 - 4.06.06 Preparation of consolidated schedules and bills of materials, including line numbers, tag numbers, source of supply, service conditions, specifications, materials, types and connections details, quantities for items of the plant including dampers, steam traps, strainers, instrumentations, ducting.
 - 4.06.07 Sizing of all piping and equipment as per the stipulated design criteria; carrying out of flexibility analysis/dynamic analysis as necessary; hangers & support engineering.
 - 4.06.08 Final revision of all documents including preparation and compilation of Instruction Manuals for installation, commissioning, operation and maintenance for all equipment and systems. Refer clause 5.00.00 for the specific requirement in this regard.
 - 4.06.09 Certification and submission of final as-built drawings for all areas.
 - 4.06.10 Preparation and compilation of all drawings, schedules and instructions which may be required at site, whether separately mentioned or not.
 - 4.06.11 All erection and assembly drawings which may be required at site.
 - 4.06.12 For all bought out item packages, the Contractor shall provide complete material / component list along with detail specification, drawings, component part no. etc. during detail engineering stage prior to final approval. Such approved drawing/document shall be made available at site in adequate number prior to commencement of work. Moreover, such document/drawing shall be provided in soft form (CD)
 - 4.06.13 Preparation of necessary documentation, design calculations etc. required for submission to statutory authorities like IBR, Chief Electric Inspector, Factory Inspector etc.
-

5.00.00 **OPERATING MANUALS AND MAINTENANCE INSTRUCTIONS**

5.01.00 The Contractor shall provide at least six (6) months before the time of commissioning and before taking over of the plant and equipment, all necessary maintenance manuals and operating instructions. The instruction manual shall be submitted in the form of one (1) soft copy in CD and 15 hard copies as per distribution schedule (Annexure-1).

5.02.00 The information provided, which shall be contained in loose leaf stiff backed covers, shall include :

- a) A complete inventory of all main items of plant, with identification details.
- b) Service manuals for all plant and equipment giving full descriptions of the main items and auxiliary items such as power packs, hydraulic equipment, actuators, lubricating pumps, etc.
- c) A separate electrical manual covering items such as switchgear, cabling, instrumentation, controls, cabling layouts and wiring diagrams.
- d) A schedule of recommendations for routine maintenance of all electrical and mechanical equipment, recommended inspection point, information on detection, cause and rectifications of troubles & faults.
- e) A lubrication schedule with all necessary drawings diagrams to identify the lubrication points.
- f) Manufacturer's literature.

5.03.00 The instruction manual shall be subject to the approval of Owner.

6.00.00 **PLANT HANDBOOK**

The Contractor shall submit to the Engineer, a preliminary plant handbook preferably in A-4 size sheets which shall contain the design and performance data of various plant, equipment and systems covering the complete project including single line flow diagrams, within twenty four (24) months from the date of his acceptance of the Letter of Intent. The final plant handbook complete in all respects shall be submitted by the Contractor six (6) months before start-up and commissioning activities. The plant handbook shall be submitted as per distribution schedule.

7.00.00 **CONTRACT STAGE DOCUMENT SUBMISSION AND APPROVAL PROCEDURE**

7.01.00 Within fifteen (15) days to one month of issue of Letter of Intent (LOI) by the Owner, the Contractor shall furnish a schedule of drawings and design

document to be submitted by him to the Owner/Engineer indicating dates against each document.

The documents shall be divided into two categories : a) for approval and b) for information/further engineering and co-ordination by the Owner.

In preparing this schedule, the Contractor shall allow two (2) weeks from date of receipt for review and comments by the Owner/Engineer for each submission of a document.

This document submission schedule shall require approval by the Owner/Engineer.

7.02.00 All contract documents shall be marked, without fail, with the name of the Owner, the Project, the specification title and number and the unit designation.

All dimensions shall be in metric units.

All notes, markings etc. shall be in English.

7.03.00 Documents/Drawings, submitted during tender stage, shall be revalidated or revised as required and submitted as certified contract document for approval / information of the Owner/Engineer.

7.04.00 Unless specified otherwise, the following categories of documents/drawings would require approval of the Owner/Engineer:

- a) List of sub-vendors (from Owner only)
- b) System scheme and instrumentation diagrams
- c) Design basis justifying selection of equipment & process parameters where not specified in the Contract
- d) Equipment data sheets and general arrangement drawings
- e) Materials of construction
- f) Layout drawings.
- g) Operation logic diagrams.
- h) Typical control circuit.
- i) Drawings of Instrumentation and control.

7.05.00 Unless specified otherwise, the following categories of documents/ drawings would be treated for information/further engineering by the Owner/Engineer. The Contractor shall, however, incorporate all additional information and clarifications in these documents / drawings as and when desired by the Owner/Engineer.

- a) Equipment foundation drawings.
- b) Equipment cross-section drawings, product literature etc. which are of proprietary nature.
- c) Predicted performance curves of equipment.
- d) Various bills of quantity, schedules etc.
- e) Piping fabrication drawings, isometrics etc.
- f) Panel wiring diagrams.
- g) Instruction/Operation manuals.
- h) Service manuals and trouble shooting guide for C & I system including field instruments.
- i) Cable schedule and interconnection chart.
- j) Drive/feederwise control scheme showing all external interfaces.

In essence, the Contractor is solely responsible for corrections and adequacy of design & engineering for documents under this category.

7.06.00 Upon review, the Owner/Engineer shall put his remarks and one of the following action stamps on the drawing/document:

- a) A - Drawing submitted as approved, proceed with fabrication
- b) B - Drawing approved subject to comments noted, proceed with fabrication, considering our comments. Correct as necessary and resubmit for record.
- c) C - See attached memo.
- d) D - Correct your original drawing incorporating our comments and resubmit for approval.
- e) E - Information furnished is noted.
- f) F - Prints not enclosed

For action stamps in category (c) & (d), documents must be resubmitted for review by the Owner/Engineer. For action stamp in category (b), further review by Owner/Engineer would not be necessary provided the Contractor agrees & incorporates the comments made on the document.

Except for action stamp under category (c) & (d), the Contractor can proceed with manufacturing and other sequential activities for those areas of a drawing/document which do not have any review comment by the Owner/Engineer.

The Owner/Engineer may accord approval in category (c) or (d) in more than one submission of a document till he is satisfied that the intent of the specification has been fully complied with. The Contractor shall be responsible for delay in such cases and no extension of time shall ordinarily be allowed on such grounds. Approval of contract documents by the Owner/Engineer shall not relieve the Contractor of his responsibility for any errors and fulfillment of contract requirements.

The Contractor's work shall be in strict accordance with the finally approved drawings and no deviation shall be permitted without written approval of the Owner/Engineer.

- 7.07.00 Except key plan/general yard plan, any layout drawing requiring scrutiny shall not be drawn to a scale less than 1:50.
- 7.08.00 For review by the Consulting Engineer, the Contractor shall furnish soft copies of drawings & documents and three (3) prints of each drawing/document. Two (2) prints of such submission shall also be sent to the Owner. After review, comment/approval will be sent to the Contractor. Upon action under category (a) or (e), the Contractor shall directly distribute the documents to the various offices of the Owner and other agencies in number of copies as specified in the contract document. Such distribution copies shall be marked with the reference and date of the letter by which the Owner/Engineer has accorded his final approval. Penal action shall be taken against the Contractor for any unauthorised revision in the drawings so distributed from the drawings approved by the Owner/Engineer. The contractor shall furnish three (3) CDs of all as built/final drawings for Owner/Consultant site.
- 7.09.00 In case of contradiction between the stipulations above and those stated elsewhere in the specification, the stipulations herein shall prevail.

ANNEXURE-1

DISTRIBUTION SCHEDULE

S. No	Description	TSGENCO										Consultant			Equipment Vendor	Remarks
		Director Projects	Director Technical	CE/Civil Thermal Projects Hyd.	CE/TPC-I, Hyd	CE/O&M/	SE/Civil	SE/E&M /	DE Constr.		HYD	BTPS				
A	Letter Of Intent or Contract Documents	1	1	1	S	1	2	2	1	1	1	1	2			
B	Vendor Drawings															
1.	Preliminary	1	1	1	2	1	1	2	2	12	1	-	S			
2.	Return preliminary with comments	-	-	1	2	1	1	1	1	S	1	-	1			
3.	Final and any revision thereof															
	a. Civil	1	1	6+1T	1	1	6+1T	1	-	2+1T	1	1	S			
	b. E&M	1	1	1	6+1T	1	1	6+1T	1	2+1T	1	1	S			
C.	Design Drawings															
1.	Preliminary															
	a. Civil	1	1	2	1	1	2	1	1	4	1	1	S			
	b. E&M	1	1	1	2	1	1	2	1	4	1	1	S			
2.	Released for construction															
	a. Civil	1	1	2	1	1	6	1	1	1	1	2	S			
	b. E&M	1	1	1	1	2	1	6	1	1	1	2	S			
3.	Return marked 'As built'															
	a. Civil	-	-	1	-	-	1	-	-	1	1	S	1			
	b. E&M	-	-	-	1	-	-	1	1	1	1	S	1			
4.	As built drawings															
	a. Civil	-	-	1+1T	-	2+1T	5+1T	-	1	1+1T	-	1	S			
	b. E&M	-	-	1	2+1T	2+1T	-	5+1T	1+1T	1+1T	-	1	S			

S. No	Description	TSGENCO										Consultant			Equipment Vendor	Remarks
		Director Projects	Director Technical	CE/Civil Thermal Projects Hyd.	CE/ TPC-I, Hyd	CE/ O&M/	SE/ Civil	SE/E&M /	DE Constr.		HYD	BTPS				
D	Progress Report Monthly															
1.	Equipment vendor	1	1	1	2	1	1	2	1	1	1	1	S			
2.	Consultant	1	1	2	2	1	1	2	1	S	1	1	Nil			
E	Test & Inspection Reports															
1.	Equipment manufacturer															
s	a. Civil	1	1	1	2	1	1	1	-	11	1	1	S			
	b. E&M	1	1	-	2	1	-	1	1	11	1	1	S			
	Consultant	1	1	-	2	1	-	1	1	S	-	1	-			
F	Instruction Manuals/Data Books															
1.	Equipment manufacturer															
2.	a. Civil	1	1	1+1T	1	1	6+1T	1	1	2+1T	1	1	S			
	b. E&M	1	1	-	3+1T	1	-	6+1T	2	3+1T	1	1	S			
	Consultant	1	1	-	10+1T	1	-	15+1T	-	S	1	1	Nil			
G	Consultant	1	1	1	8+1T	1	1	2	1	1	1	1	S			
H	Design Calculations	1	1	1	8+1T	1	1	2	1	1	1	1	S			
I	Final consulting Engineering Report	1	1	1	10	1	1	2	1	S	1	1	Nil			

S – Source, T – Transparency & Soft Copy on CD,

TSGENCO : Telangana State Power Generation Corporation Limited
Director, Projects, Hyd : Director/ Projects, TSGENCO, Vidyut Soudha, Hyderabad – 500 082

QUALITY ASSURANCE REQUIREMENTS

CONTENT

CLAUSE NO.	DESCRIPTION
1.00.00	QUALITY ASSURANCE PROGRAMME
2.00.00	GENERAL REQUIREMENTS QUALITY ASSURANCE
3.00.00	QUALITY ASSURANCE DOCUMENTS
4.00.00	INSPECTION, TESTING & INSPECTION CERTIFICATES

ATTACHMENTS

ANNEXURE-I	FORMAT OF QUALITY ASSURANCE PROGRAMME
ANNEXURE-II	FIELD WELDING SCHEDULE

QUALITY ASSURANCE REQUIREMENTS

1.00.00 QUALITY ASSURANCE PROGRAMME

1.01.00 To ensure that the equipment and services under the scope of Contract whether manufactured or performed within the Contractor's works or at his Sub-contractor's premises or at the Owner's site or at any other place or work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance programme to control such activities at all points, as necessary. Such programmes shall be outlined by the Contractor and shall be finally accepted by the Owner/Authorised representative after discussions before the award of contract. A quality assurance programme of the Contractor shall generally cover the following :

- a) His organisation structure for the management and implementation of the proposed quality assurance programme.
- b) Documentation control system.
- c) Qualification data for Bidder's key personnel.
- d) The procedure for purchase of materials, parts, components and selection of Sub-contractor's services including vendor analysis, source inspection, incoming raw-material inspection, verification of materials purchased etc.
- e) System for shop manufacturing and site erection control including process controls and fabrication and assembly controls.
- f) Control of non-conforming items and system for corrective actions.
- g) Inspection and test procedure both for manufacture and all site related works.
- h) Control of calibration and testing of measuring and testing equipments.
- i) System for quality audit.
- j) System for indication and appraisal of inspection status.
- k) System for authorising release of manufactured product to the Owner.
- l) System for handling storage and delivery.
- m) System for maintenance of records.

- n) Furnishing of quality plans for manufacturing and field activities detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of equipment/component as per format enclosed at Annexure-I to this section for Owners approval
- o) Internal standards, if referred in the quality plans shall generally be compatible with National / International standards and shall be mentioned in the quality plans. Alternatively bidder shall furnish extracts of the internal standards detailing out acceptance norm for the product / material.

2.00.00 **GENERAL REQUIREMENTS - QUALITY ASSURANCE**

2.01.00 All materials, components and equipment covered under this specification shall be procured, manufactured, erected, commissioned and tested at all the stages, as per a comprehensive Quality Assurance Programme. An indicative programme of inspection/tests to be carried out by the Contractor for some of the major items is given in the respective technical specification. This is however, not intended to form a comprehensive programme as it is the Contractor's responsibility to draw up and implement such programme duly approved by the Owner/Consultant. The detailed Quality Plans for manufacturing and field activities should be drawn up by the Bidder, separately in the format attached at Annexure-I and will be submitted to Owner/Authorised representative for approval. Schedule of finalisation of such quality plans will be finalised before award.

Contractor shall furnish list of Manufacturing Quality Plans of major equipments indicating proposed inspection categorisation indicating items that will be offered for Owner's inspection etc and the Field Quality Plans

2.02.00 Manufacturing Quality Plan for all the major equipment will detail out their respective important components, their in-process various tests/inspection & final inspection / tests, to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by Contractor's Quality Control organization. The relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing are to be comprehensively documented by Contractor.

Manufacturing Quality Plan for all major equipments/ items will be approved by owner. In these approved quality plans, Owner / Authorised representative shall identify customer hold points (CHP), test / checks which shall be carried out in presence of the Owners Engineer or his authorised representative and beyond which the work shall not proceed without consent of Owner / Authorised representative in writing. Inspection/ Test reports are to be submitted to owner as specified in final approved Manufacturing Quality Plans.

2.03.00 Field Quality Plans / Procedures for all field activities shall be submitted to

	owner for review / approval. These Quality Plans / procedures will detail out, for all equipment, the quality practices and procedures etc. to be followed by the Contractor's site Quality Control organisation, during various stages of site activities from receipt of materials/ equipment at site.
2.04.00	The Bidder shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans along with Quality Plans. These Quality plans and reference documents/standards etc. will be subject to Owner's approval without which manufacture shall not proceed. These approved documents shall form a part of the contract. In these approved quality plans, Owner/Authorised representative shall identify customer hold points (CHP), test/checks which shall be carried out in presence of the Owners Engineer or his authorised representative and beyond which the work will not proceed without consent of Owner/Authorised representative in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and major deviations in the form of Non Conformity Report shall be referred to Owner/Authorised representative for approval and dispositioning.
2.05.00	No material shall be despatched from the manufacturer's works before the same is accepted subsequent to pre-despatch final inspection including verification of records of all previous tests/inspections by Owner's Engineer/ Authorised representative for "CHP" and "W" points marked in quality plans , and duly authorised for despatch by issuance of Material Despatch Clearance Certificate (MDCC). For items which is not under owner's inspection the contractor shall apply for despatch clearance (MDCC) from owner by submitting their internal inspection reports and quality records
2.06.00	All materials used or supplied shall be accompanied by valid and approved materials certificates and tests and inspection report. These certificates and reports shall indicate the sheet serial numbers or other such acceptable identification numbers of the material. The material certified shall also have the identification details stamped on it.
2.07.00	Castings and forgings used for construction shall be of tested quality. Details of results of chemical analysis, heat treatment record, mechanical property test results shall be furnished.
2.08.00	All welding and brazing shall be carried out as per procedure drawn and qualified in accordance with requirements of ASME Section - IX (latest edition) or other International equivalent standard acceptable to the Owner. All brazers, welders etc. employed on any part of the contract at Contractor's/ Sub-Contractor's works or at site shall be qualified as per ASME Section-IX (latest edition) or equivalent international standard approved by the Owner. Such qualification tests shall be conducted in presence of Owner / his authorised representative or owner approved Third Party Inspection Agency(TPIA). Previously qualified WPS & PQR shall be acceptable if witnessed by owner's approved TPIA. For welding of pressure parts and high pressure piping coming under IBR purview, the requirements of IBR shall also be complied with.

2.09.00	All non-destructive examination (NDT) shall be carried out in accordance with LIST OF STANDARDS FOR REFERENCE as given below in this section. The NDT operator shall be qualified as per SNT-TC-IA (of American Society of non- destructive examination). Results of NDT for the list major equipments / items identified for owner's inspection shall be properly recorded and submitted for review and approval. Other items not covered under owner's inspection, contractor shall review and approve the NDT results and such reports shall be submitted to owner in the final documentation of the items / equipments
2.10.00	All the sub-vendors proposed by the Contractor for procurement of major bought out items including castings, forgings, semi-finished and finished components/equipment list of which shall be drawn up by the Contractor and finalised with the Owner shall be subject to Owner's approval. Quality Plans of the successful vendors shall be discussed, finalised and approved by the Owner/Authorised representative and form part of the Purchase Order between the Contractor and the Vendor.
2.11.00	All the purchase specifications for the major bought-out items, list of which shall be drawn up by the Contractor and finalised with the Owner shall be furnished to the Owner for comments and subsequent approval before orders are placed. Owner reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the Contractor's or their sub-vendor's quality management and control activities. The Contractor shall provide all necessary assistance to enable the Owner carry out such audit and surveillance. Quality audit/approval of the results of tests and inspection will not prejudice the right of the Owner to reject equipment not giving the desired performance after erection and shall not in no way limit the liabilities and responsibilities of the Contractor in earning satisfactory performance of equipment as per specification.
2.12.00	Quality requirements for main equipment shall equally apply for spares and replacement items.
2.13.00	Repair/rectification procedures to be adopted to make any job acceptable shall be subject to the approval of the Owner.
2.14.00	For quality assurance of all civil works refer to the specifications for civil works.
3.00.00	QUALITY ASSURANCE DOCUMENTS
3.01.00	The Contractor shall be required to submit two (2) copies and two (2) sets of microfilms / CDs of the following Quality Assurance documents within three (3) weeks after despatch of the equipment: a) Material mill test reports on components as specified by the specification.

- b) The inspection plan with verification, inspection plan check points, verification sketches, if used and methods used to verify that the inspection and testing points in the inspection plan were performed satisfactorily.
- c) Non-destructive examination results /reports including radiography interpretation reports.
- d) Factory tests results for testing required as per applicable codes and standards referred in the specification.
- e) Welder identification list listing welder's and welding operator's qualification procedure and welding identification symbols.
- f) Sketches and drawings used for indicating the method of traceability of the radiographs to the location on the equipment.
- g) Stress relief time temperature charts.
- h) Inspection reports duly signed by QA personnel of the Owner and Contractor for the agreed inspection hold points. During the course of inspection, the following will also be recorded :
 - i) When some important repair work is involved to make the job acceptable.
 - ii) The repair work remains part of the accepted product quality.
- i) Letter of conformity certifying that the requirement is in compliance with finalised specification requirements.

4.00.00 **INSPECTION, TESTING AND INSPECTION CERTIFICATES**

4.01.00 The Owner's Engineer, or his duly authorised representative and/or an outside inspection agency acting on behalf of the Owner shall have access inside the workshops, test labs, establishments at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection and if part of the works is being manufactured or assembled on other premises or works, the Contractor shall obtain for the Owner's Engineer and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works.

4.02.00 The Contractor shall give the Owner's Engineer/ Authorized Inspector twenty one (21) days written notice for "CHP" / "W" points of any material being ready for testing by owner' engineer / Authorized inspector. Such tests shall be to the Contractor's account except for the expenses of the Inspector. The Engineer/ Inspector, unless the witnessing of the tests is virtually waived, will attend such tests within fifteen (15) days of the date on which the equipment is notified as being ready for test/inspection. If owner's Engineer / Authorised Inspector fail to attend the inspection, next mutually convenient date for test shall be agreed with Contractor. Contractor shall, in

	no case proceed with the test without owner or his authorized inspectors, unless the witnessing is officially waived and advised Contractor to proceed with the test. Contractor shall forthwith forward duly certified completed test report and a product quality certificate in six (6) copies to owner upon completion of such test.
4.03.00	The Engineer or Inspector shall within fifteen (15) days from the date of Inspection as defined herein give notice in writing to the Contractor, or any objection to any drawings and all or any equipment and workmanship which is in his opinion not in accordance with the contract / QAP or other approved quality documents. The Contractor shall give due consideration to such objections and shall either make modifications that may be necessary to meet the said objections or shall confirm in writing to the Engineer/Inspector giving reasons therein, that no modifications are necessary to comply with the contract / QAP or other approved quality documents.
4.04.00	When the factory tests have been completed at the Contractor's or sub-contractor's works, the Engineer/Inspector shall issue a certificate to this effect fifteen (15) days after completion of tests excluding the test completion date subject to submission of all certified documents related to the test, If the tests are not witnessed by the Engineer/Inspectors, the certificate shall be issued within fifteen (15) days of the receipt of the Contractor's test certificate by the Engineer/Inspector. Failure of the owner's Engineer/Inspector to issue such a certificate shall not prevent the Contractor from proceeding with the works. The completion of these tests, or the issue of the certificates shall not bind the Owner to accept the equipment should it, on further tests after erection be found not to comply with the contract / QAP or other approved quality documents.
4.05.00	In all cases where the contract provides for tests whether at the premises or works of the Contractor or any sub-contractor, the Contractor, except where otherwise specified shall provide free of charge such items as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the owner's Engineer/Inspector or his authorised representatives to carry out effectively such tests on the equipment in accordance with the Contract / QAP or other approved quality documents. Contractor and shall give facilities to the owner's Engineer/ Inspector or to his authorised representative to accomplish testing.
4.06.00	To facilitate advance planning of inspection in addition to giving inspection notice as per Clause 4.02.00, the Contractor shall furnish quarterly inspection programme indicating proposed schedule dates of inspection at customer hold point and final inspection stages. Updated quarterly inspection plans will be made for each three consecutive months and shall be furnished before beginning of each calendar month.

LIST OF STANDARDS FOR REFERENCE

- a) International Standards Organisation (ISO).
- b) International Electro-technical Commission (IEC).
- c) American Society of Mechanical Engineers(ASME)
- d) American National Standards Institute (ANSI).
- e) American Society for Testing and Materials (ASTM).
- f) American Institute of Steel Construction (AISC).
- g) American Welding Society (AWS).
- h) Architecture Institute of Japan (AIJ).
- i) National Fire Protection Association (NFPA).
- j) National Electrical Manufacturer's Association (NEMA).
- k) Japanese Electro-technical Committee (JEC).
- l) Institute of Electrical and Electronics Engineers (IEEE).
- m) Federal Occupational Safety and Health Regulations (OSHA).
- n) Instrument Society of America (ISA).
- o) National Electric Code (NEC).
- p) Heat Exchanger Institute (HEI).
- q) Tubular Exchanger Manufacturer's Association (TEMA).
- r) Hydraulic Institute (HIS).
- s) International Electro-Technical Commission Publications.
- t) Power Test Code for Steam Turbines (PTC).
- u) Applicable German Standards (DIN).
- v) Applicable British Standards (BS).
- w) Applicable Japanese Standards (JIS).
- x) Electric Power Research Institute (EPRI).
- y) Standards of Manufacturer's Standardization Society (MSS)

-
- z) Bureau of Indian Standards Institution (BIS).
 - aa) Indian Electricity Rules.
 - bb) Indian Boiler Regulations (IBR).
 - cc) Indian Explosives Act.
 - dd) Indian Factories Act.
 - ee) Tariff Advisory Committee (TAC) rules.
 - ff) Emission regulation of Central Pollution Control Board (CPCB).
 - gg) Pollution Control regulations of Dept. of Environment, Govt. of India
 - hh) Central Board of Irrigation and Power (CBIP) Publications

ANNEXURE-I
FORMAT OF QUALITY ASSURANCE PROGRAMME

VENDOR'S LOGO , NAME & ADDRESS		MANUFACTURING QUALITY ASSURANCE PLAN		DOC NO: XXXXX-CAL-QAP-M-0001	
ITEM :		-		REV NO : 0	DATE : 1 2 3 4
CLIENT :		LOCATION :		REFERENCE PURCHASE ORDER NO. & DT :	
PROJECT :		REFERENCE APPROVED DATA SHEET :		REFERENCE APPROVED DRAWING. NO. :	
VENDOR :		AGENCY :		GENERAL REMARKS	
SUB VENDOR :		ABBREVIATIONS : QAP - QUALITY ASSURANCE PLAN, CR - CRITICAL, MA - MAJOR, MI - MINOR SPEC - SPECIFICATION, TC - TEST CERTIFICATES P - PERFORM W - WITNESS V - VERIFY CHP - CUSTOMER HOLD POINT		1 - PROJECT AUTHORITY 2 - SUPPLIER 3 - SUB-SUPPLIER 4 - MANUFACTURER 5 - THIRD PARTY INSPECTION AGENCY	
NOTES:		1. EXACT MATERIAL / PROCESS / INSPECTION / TESTS FOLLOWED BY THE MANUFACTURER SHALL BE SPECIFIED 2. EXACT REFERENCE DOCUMENT/ACCEPTANCE STANDARD SHALL BE SPECIFIED 3. IN CASE SPECIFIED ACCEPTANCE STANDARD / NORMS IS OTHER THAN NATIONAL / INTERNATIONAL STANDARDS . STANDARD / COPY OF THE ACCEPTANCE NORMS FOLLOWED BY THE MANUFACTURER SHALL BE SUBMITTED FOR REVIEW RECORD 4. FINAL INSPECTION DOSSIER SHALL BE PREPARED BY MANUFACTURER & SHALL BE ENDORSED BY INSPECTION AGENCY		1 THE ITEMS WHICH ARE FALLING UNDER ANY STATUTORY AUTHORITY'S (LIKE I.B.R. ETC.) SCOPE SHALL BE SUBJECTED TO THAT STATUTORY AUTHORITY'S INSPECTION CLEARANCE.	
Prepared by		Checked by		Approved By	
Revision	R0	R1	R2	R0	R1
DATE					R2

ANNEXURE-II

FIELD WELDING SCHEDULE

PROJECT : FWS NO :
 CONTRACTOR : REV NO. :
 PACKAGE : FIELD WELDING CODE :
 SYSTEM : PAGE NO. :

Sl No.	Drawing No. for Weld Locations & Identification mark	Description of parts to be welded	Material specification	Dimensions	Process of Welding	Type of Weld	Electrode Filler Specification	WPS No.	Minimum Pre-heat Temperature	Heat Treatment Temperature [Holding Time in secs]	NDT Method	NDT Specification Number	Acceptance Norm Ref.	Remarks

The Field Welding Schedule should be submitted for :

- ☐ Pressure Parts
- ☐ Tanks/Vessels
- ☐ Piping
- ☐ Heavy/Important Structural Steel
- ☐ Heat Exchangers
- ☐ Bus Ducts

REQUIREMENTS OF SPARES, TOOLS & TACKLE, LUBRICANTS/OIL/CONSUMABLES

CONTENT

CLAUSE NO.	DESCRIPTION
1.00.00	TOOLS AND TACKLE
2.00.00	SPARES
	ATTACHMENT
ANNEXURE-I	MANDATORY SPARE LIST

REQUIREMENTS OF SPARES, TOOLS & TACKLE, LUBRICANTS/OIL/CONSUMABLES

1.00.00 TOOLS & TACKLE

The Contractor shall supply with the equipment one complete set of special tools and tackle as required for the erection, assembly, dismantling & maintenance of the equipment. These special tools will also include special material handling equipment, jigs & fixtures for maintenance and calibration/readjustment, checking & measurement aids etc. A list of such tools & tackle shall be submitted by the Bidder along with the offer. Detailed description of each tools/tackle, its function along with the equipment/part for which it is meant for and the price of each tools/tackle shall also be indicated in the offer. These tools & tackle shall be separately packed and sent to site before the first unit commissioning. The Bidder shall also ensure that these tools are not used for erection purpose.

2.00.00 SPARES

2.01.00 General

The Bidder shall indicate and include in his scope of supply all the necessary start-up, commissioning and recommended spares in addition to mandatory spares as specified elsewhere in the specification. The Owner reserves the right to buy any or all mandatory and recommended spares. The Contractor shall also state for each item of spares both mandatory and recommended, the normal expected service life.

2.01.01 All spares supplied under this contract shall be strictly interchangeable with the parts for which they are intended to replace. The spares shall be treated and packed for long storage under the climatic conditions prevailing at the site, e.g. small items shall be packed in sealed transparent plastic bags with dessicator packs as necessary.

2.01.02 Each spare part shall be clearly marked or labelled on the outside of the packing with the description. When more than one spare part is packed in a single case, a general description of the contents shall be shown on the outside and a detailed list enclosed. All cases, containers and other packages must be suitably marked and numbered for the purposes of identification.

2.01.03 All cases, containers or other packages are liable to be opened for examination as may be considered necessary by the Engineer.

2.01.04 All mandatory spares shall be delivered to site within one to three months prior to the scheduled date of the trial operation of the plant. However, they shall not be despatched before the despatch of the associated main equipment.

2.01.05 The Bidder shall also guarantee supply of spare parts, which will be made, based on manufacturer's drawings on special order from the Purchaser for 30 years after commissioning of the plant.

2.02.00 **Recommended Spares**

2.02.01 The Contractor shall provide a list of recommended spares giving unit prices and total prices for 2 years of normal operation of the plant for spares of indigenous origin, and for 5 years of normal operation for spares of non-indigenous origin. This list shall take into consideration the mandatory spares specified elsewhere in the specification and should be a separate list.

2.02.02 The price of recommended spares will not be used for the evaluation of bids. The price of these spares shall remain valid for a period as specified elsewhere in the specification from the date of Award of the Contract. Where the recommended spares are the same as mandatory spares, the prices shall be the same. The prices of any recommended spares, which are not common with mandatory spares, shall be subject to review by the Owner, and shall be finalised after mutual discussion.

2.03.00 **Start-up Commissioning Spares**

2.03.01 Start-up commissioning spares are those spares which may be required during the start-up and commissioning of the equipment/system. All spares used until the plant is handed over to the Owner shall come under this category. Said spares, properly marked, shall be supplied together with the main equipment and shall be used by the Contractor, if needed, during erection & commissioning stage. All such spares which remain unused till issuance of Taking Over Certificate by the Owner, along with an equipment-wise quantitative consumption report shall be returned to the Owner during time of handover. The list of commissioning spares to be brought by the Contractor to ensure smooth commissioning of the plant shall be subject to the Engineer's approval.

2.03.02 The Contractor shall submit a complete BBU list inclusive of recommended, mandatory, initial start-up and commissioning spares. Costs of the above spares, which are consumed before the handing-over of the plant, shall be deemed to have been included in the lump sum proposal price of the package, and the Contractor shall have no claim on this account to the Owner.

2.04.00 **Mandatory Spare Parts**

2.04.01 The Owner considers some of the spares are essential for running the equipment irrespective of whether they are included in the list of recommended spares by the Bidder as mentioned above.

Since the components involved can not be foreseen at the bidding stage, only

broad requirements of the Owner in this respect are outlined hereinafter. The bidder shall include his proposal, on the basis of this guideline, an item-wise list of all components and the quantity, unit prices & total price thereof, offered as mandatory spares for each and every equipment. This list shall be separate from the list of recommended spares and shall be used for bid evaluation purposes. Any clarification in this respect may be obtained by the Bidder at the pre-bidding stage.

- 2.04.02 The mandatory spares should be supplied to the Owner at least one month before the trial run. The despatch programme is subject to approval of the Owner/Consultant after award of contract.

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT****SPECIFICATION NO.**

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 1 of 3

SECTION – C1-C**FUNCTIONAL / PERFORMANCE / DEMONSTRATION GUARANTEE**

**TITLE**

4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 2 of 3

The Bidder shall guarantee that the equipment offered shall meet the rating and performance requirements stipulated for various equipment covered in this specifications.

The guaranteed performance parameters furnished by the bidder in his offer, shall be without any tolerance values and all margins required for instrument inaccuracies and other uncertainties shall be deemed to have been included in the guaranteed figures.

The bidder shall demonstrate all the guarantees covered herein during demonstration test / PG test.

The various tests which are to be carried out during demonstration tests are listed in the specification. The guarantee tests shall be conducted by the bidder at site in presence of BHEL/ CUSTOMER. All costs associated with the tests shall be included in the bid price.

In case during demonstration test /PG test, it is found that the equipment/system has failed to meet the guarantees, the bidder shall carry out all necessary modifications and/or replacements to make the equipment/system comply with the guaranteed requirements at no extra cost to the BHEL/ CUSTOMER and re-conduct the demonstration test(s) / PG test with BHEL/ CUSTOMER's consent.

I. TECHNICAL GUARANTEES**1. PT PLANT****a) CLARIFIER**

Each clarifier unit of PT plant shall be guaranteed for an effluent capacity of not less than 1954 CU.M/ hr. meeting the effluent quality as mentioned below.

Effluent quality at the outlet of all clarifiers shall be guaranteed for the following:-

- Organic matter: Less than 0.05 mg/ litre
- Iron content: Less than 0.3 mg/ litre.
- Total Suspend Solids: Less than 10 ppm

Note: Organic matter shall be tested as per KMnO₄ method

Each clarifier shall be tested to demonstrate the above mentioned Guarantees at site under Demonstration test. In addition, demonstration of satisfactory working of all the clarifiers, its drives, scrapper mechanism, operation of sludge blow-off etc., shall be demonstrated by bidder.

b) PRESSURE SAND FILTER

The capacity of pressure sand filter for PT-Potable system shall not be less than 10 CU.M/ hr. meeting the effluent quality as mentioned below with one backwash and air scouring in not less than 24 hours or more. Backwash water requirement not to exceed 2% of the water treated between two successive backwashes.

Total Suspend Solids at outlet of filter of PT Potable system shall not exceed 2 ppm.

Filter shall be tested to demonstrate the above mentioned Guarantees at site under demonstration test. In addition, demonstration of satisfactory working of all the filters, its backwashing operation, operation of various valves, pump etc. instrument shall be demonstrated by the bidder.

II. AUXILIARIES POWER CONSUMPTION GUARANTEES

Bidder to refer guaranteed auxiliary power requirement for water treatment packages drives listed on continuous basis. The total power consumption should be well within the values as mentioned below. **Bidder to include guaranteed power consumption in their bid submission in sealed envelope as per format attached in technical specification.** Auxiliary

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT****SPECIFICATION NO.**

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 3 of 3

power consumption shall be used for technical loading as per mentioned criteria during bid evaluation stage.

Liquidated damages shall be applicable during demonstration / PG test at site as per rate given in below on difference between actual power consumption of drives listed and guaranteed auxiliary power consumption.

Bidder to note that guaranteed auxiliary power consumption value for station (in KW) for PT and DM plant shall be well within the values given below:

- a) **PRE-TREATMENT PLANT – 100 KW** (for all continuous drives considering two nos. clarifier working at a time)

LOADING CRITERIA FOR AUXILIARY POWER CONSUMPTION DURING BID EVALUATION STAGE

For bid evaluation purpose on account of guaranteed auxiliary power consumption, the same shall be loaded at the rate of ₹ 2, 52,000/- per KW (Rupees Two lacs and fifty two thousand per Kilowatt) for the differential power consumption for above packages.

LIQUIDATED DAMAGES CRITERIA FOR AUXILIARY POWER CONSUMPTION DURING DEMONSTRATION / PG TEST

If the actual power consumption exceeds the guaranteed power consumption, liquidated damages shall be payable by the bidder at the rate of ₹ 2, 52,000/- per KW (Rupees Two lacs and fifty two thousand per Kilowatt) excess power consumption, over the base guaranteed figure as indicated by BHEL above or indicated by bidder in their bid for respective packages.

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT****SPECIFICATION NO.**

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 1 of 1

**SECTION C1 – D
QUALITY ASSURANCE**

QUALITY ASSURANCE	

Tests/Check	Material Test	WPS/PQR/Welder Qualification	DPT/MPi	Assembly Fit up	Dimension	RT	Hydraulic / Water Fill	Performance Test	Test as per relevant Std/ Appd. Data Sheets	Other Tests	Remarks
Items / Components				Y	Y			Y ¹	Y		
1. Horizontal Centrifugal Pumps											LEGENDS: Y Applicable Y ^a One per Heat/Heat Treatment batch./Lot Y ^b On machined surfaces only. Also 100% on Butt Welds & 10% on Fillet Welds. Y ^c UT shall be done for shafts with Dia 50 mm or above & Plates of Thickness 20 mm or above. Y ^d Dynamic Balancing per ISO: 1940, Grade 6.3 minimum.
1.1. Casing	Y ^a		Y ^b				Y				
1.2. Impeller	Y ^a		Y ^b							Y ^d	
1.3. Shaft	Y ^a		Y					Y ¹	Y ^c		
2. Vertical Pumps				Y	Y				Y		
2.1. Casing	Y ^a		Y ^b				Y				
2.2. Impeller	Y ^a		Y ^b							Y ^d	
2.3. Shaft	Y ^a		Y						Y ^c		
2.4. Fabricated Parts	Y ^a	Y	Y ^b			Y ²	Y				
3. Dosing/ Metering Pumps	Y ^a						Y	Y ¹	Y		
4. Gate/ Globe/ Check Valves	Y ^a		Y ^b		Y		Y	Y	Y	Y ⁶	
5. Dual Plate Check Valves	Y ^a		Y ^b		Y		Y	Y	Y	Y ¹²	
6 Diaphragm Valves	Y ^a				Y		Y ³		Y	Y ⁴	
6. Butterfly Valves (Low Pr.)				Y	Y		Y ³	Y		Y ⁵	
7.1Body (Cast)	Y ^a		Y ^b								
7.2Disc (Cast)	Y ^a		Y ^b								
7.3 Shaft	Y ^a		Y ^b							Y ^c	
8. Plug/ Ball Valves (Low Pr.)	Y ^a		Y ^b	Y	Y		Y	Y	Y		
9. Blowers	Y ^a		Y ^b	Y	Y		Y	Y	Y	Y ^{d6}	
10. Atmospheric Storage Tanks/ Pressure Vessels	Y ^a	Y	Y ^b	Y	Y	Y ⁸	Y		Y ^c	Y ⁷	

QUALITY ASSURANCE

Tests/Check Items / Components											Remarks
	Material Test	WPS/PQR/Welder Qualification	DPT/MPi	Assembly Fit up	Dimension	RT	Hydraulic / Water Fill	Performance Test	Test as per relevant Std/ Appd.	Data Sheets	Other Tests
11. Rubber lining	Y ^a				Y				Y	Y ⁹	Y ⁹
12. Reactor Clarifier	Y ^a	Y	Y ^b	Y	Y				Y	Y ¹⁰	Y ¹⁰
13. Clariflocculator/ Plate or Tube Settler	Y ^a			Y	Y				Y		
14. Hoists & Cranes	Y ^a	Y	Y ^b	Y	Y	Y ⁸		Y	Y		
15. Chlorine Tonner	Y ^a	Y	Y ^b	Y	Y	Y ⁸	Y				
16. Chlorine Evaporator	Y ^a	Y	Y	Y	Y	Y	Y				
17. Chlorinator & injector	Y ^a			Y	Y		Y	Y			
18. Agitators /Flash Mixer/ Flocculator	Y ^a	Y	Y ^b	Y	Y			Y		Y ¹⁰	Y ¹⁰
19. Pipes	Y ^a	Y		Y	Y		Y		Y		
20. Ventilation/Exhaust Fan	Y ^a		Y ^b	Y	Y			Y ¹¹	Y	Y ^{dc}	Y ^{dc}
After erection, the complete Piping system along with valves & fittings shall be hydraulically tested.											

NOTE:- Category of inspection for items / equipment shall be decided by BHEL only during detailed engineering. All the inspection shall be carried out by BHEL or its designated agency only. And further no customer / consultant inspection is envisaged.

MANUFACTURER'S NAME & ADDRESS :			MANUFACTURING QUALITY PLAN			PROJECT : PACKAGE : CHAIN PULLEY BLOCKS VOL IIB, SEC C				
			ITEM : Chain Pulley Block QP No.: PE-TS-XXX-XXX-A001 REV :0, Date.: PAGE: 1 OF 4							

Sr. No.	COMPONENT / OPERATION	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY			REMARKS
									M	C	N	
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.			11.

1	RAW MATERIAL & B/OUT ITEMS:												
1.1	HOOKS	DIMENSIONS,	MA		One sample	IS: 15560	IS: 15560	MTC	✓	P	V	V	UT FOR SHANK DIA 50MM AND ABOVE
		CHEMICAL COMPOSITION, MECHANICAL, PHYSICAL PROPERTIES	MA	LAB ANALYSIS	PER LOT	Material specification as per approved drawings		T.C.	✓	P	V	V	
		IDENTIFICATION & COMPLIANCE WITH TC.	MA	VISUAL	100%	HOOK TC FROM COMPETENT AUTHORITY		IR	✓	P	V	V	
		INTERNAL DEFECTS	MA	UT	100%	ASTM A-388 (REFER NOTE 1)		TC	✓	P	V	V	
		PROOF LOAD TEST	MA	REVIEW	100%	IS 15560		TC	✓	P	V	V	
		NDT AFTER PROOF LOAD	MA	DPT	100%	ASTM E-165	NO RELEVANT IDENTIFICATION	TC	✓	P	V	V	
1.2	LOAD CHAIN	- DIMENSIONS	MA	MEASUREMENT	100 %	IS: 6216 & APPD. DRGS.	IS: 6216 & APPD. DRGS.	IR	✓	P	V	V	
		- BREAKING STRENGTH	MA	-TENSILE TEST	1/LOT			MTC	✓	P	V	V	
		- PROOF LOAD	MA	-TENSILE TEST	100%			HT	✓	P	V	V	
		-HEAT TREATMENT	MA	REVIEW	100%			CHA	✓	P	V	V	
		-GRADE	MA	REVIEW	1/BATCH			RT	✓	P	V	V	
1.3	RAW MATL. FOR GEAR/ RATCHET PAWL / RATCHET WHEEL	CHEMICAL COMPOSITION, MECHANICAL PROPERTIES	MA	LAB ANALYSIS	ONE SAMPLE PER LOT	MATERIAL SPECIFICATION AS PER	MATERIAL SPECIFICATION AS PER	MTC	✓	P	V	V	TC or inspection report for components

LEGEND:		FOR CUSTOMER USE	
** M : MANUFACTURER / SUB-CONTRACTOR C : BHEL / NOMINATED INSPECTION AGENCY. N : CUSTOMER INDICATE "P" PERFORM "W" WITNESS AND "V" VERIFICATION			
MANUFACTURER / CONTRACTOR			
SUB-CONTRACTOR SIGNATURE	REVIEWED BY		NAME & SIGN OF APPROVING AUTHORITY & SEAL

MANUFACTURER'S NAME & ADDRESS :		MANUFACTURING QUALITY PLAN		PROJECT :	
ITEM : Chain Pulley Block		ITEM : Chain Pulley Block		PACKAGE : CHAIN PULLEY BLOCKS	
QP No.: PE-TS-XXX-XXX-A001		REV.:0, Date:., PAGE: 2 OF 4		VOL IIB, SEC C	

Sr. No.	COMPONENT / OPERATION	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	REMARKS
1.	2.	3.	4.	5.	6.	7.	8.	9.	M C N 10.	11.

						APPROVED DRAWING	APPROVED DRAWING			shall be given.
		INTERNAL DEFECTS	MA	UT	10%	ASTM A-388 (REFER NOTE 1)		✓	P	
1.4.	LOAD CHAIN WHEELS	- CHEMICAL COMPOSITION MECHANICAL PROPERTIES	MA MA	CHEMICAL MECHANICAL PROPERTIES	ONE SAMPLE PER LOT	APPD. DRG.	APPD. DRG.	✓	P	
1.5	BEARINGS	MAKE, TYPE, CATALOGUE NO.	MA	VISUAL	RANDOM	APP DRG / MFR'S CATALOGUE	APP DRG / MFR'S CATALOGUE	✓	P	
1.6	HAND CHAIN WHEEL	CHEMICAL MECHANICAL PROPERTIES	MA	CHEMICAL MECHANICAL PROPERTIES	ONE SAMPLE PER LOT	AS PER DRAWING	AS PER DRAWING	✓	P	
1.7	HAND CHAIN	GRADE/ DIMENSION	MA	GRADE DIMENSION	100 %	AS PER DRAWING	AS PER DRAWING	✓	P	
1.8	TROLLEY GEARS, PINION, WHEELS, AXLE	CHEMICAL & MECHANICAL	MA	LAB ANALYSIS,	100%	APPVD DRGS	APPVD DRGS	✓	P	
2	IN PROCESS									
2.1	RATCHET PAWL / RATCHET WHEEL	-HARDNESS	MA	HARDNESS	100%	IS:3832 / APPD DRG.	IS:3832/ APPD. DRG.	✓	P	

		LEGEND: ** M : MANUFACTURER / SUB-CONTRACTOR C : BHEL / NOMINATED INSPECTION AGENCY. N : CUSTOMER INDICATE "P" PERFORM "W" WITNESS AND "V" VERIFICATION	FOR CUSTOMER USE	
MANUFACTURER / CONTRACTOR				
SUB-CONTRACTOR SIGNATURE			REVIEWED BY	NAME & SIGN OF APPROVING AUTHORITY & SEAL

	MANUFACTURER'S NAME & ADDRESS :	MANUFACTURING QUALITY PLAN ITEM : Chain Pulley Block QP No.: PE-TS-XXX-XXX-A001 REV :0, Date.: PAGE: 3 OF 4	PROJECT : PACKAGE : CHAIN PULLEY BLOCKS VOL IIB, SEC C

Sr. No.	COMPONENT / OPERATION	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTU M OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	REMARKS
1.	2.	3.	4.	5.	6.	7.	8.	9.	M C N 10.	11.

		-SURFACE CRACK	MA	DPT	100 %	ASTM E165	NO DEFECT	IR	✓	P	V	V	
2.2	GEARS AND PINIONS AFTER MACHINING	SURFACE HARDNESS HEAT TREATMENT, SURFACE CRACK, CASE DEPTH	MA	HARDNESS HT CHART, DPT FOR SURFACE CRACK	RANDOM ASTM E 165 FOR DPT	MFG STANDARD NO DEFECT	MFG STANDARD	IR	✓	P	V	V	
3.0	FINAL INSPECTION												
3.1	COMPLETE ASSEMBLY	OVERALL DIMENSION	MA	MEASUREMENT	100 %	IS:3832 /APPD DRG	IS:3832 /APPD DRG	IR	✓	P	W	V	
		PROOF LOAD TEST	CR	LOAD TEST	100%	-DO-	No cracks, flaws & other defects	IR	✓	P	W	V	
		LIGHT LOAD TEST	MA	LOAD TEST	100%	IS 3832	IS 3832	IR	✓	P	W	V	
		HEIGHT OF LIFT	MA	MEASUREME NT	100%	-DO-	-DO –	IR	✓	P	W	V	
		SWIVELING OF HOOK	MA	VISUAL	100 %	-DO-	-DO-	IR	✓	P	W	V	
		EFFORT	MA	PULL ON CHAIN	100%	-DO-	-DO-	IR	✓	P	W	V	
3.2	PAINTING	-CLEANING	MA	VISUAL	AT RANDOM	APPROVED	APPROVED	IR		P	--	--	
		- SHADE & DFT OF PAINT (Blue / Black)	MI	VISUAL	AT RANDOM	DRAWING/ SPECIFICATION	DRAWING/ SPECIFICATION	IR		P	W	-	

LEGEND:		FOR CUSTOMER USE	
MANUFACTURER / CONTRACTOR	** M : MANUFACTURER / SUB-CONTRACTOR C : BHEL / NOMINATED INSPECTION AGENCY. N : CUSTOMER		
SUB-CONTRACTOR SIGNATURE	INDICATE "P" PERFORM "W" WITNESS AND "V" VERIFICATION		REVIEWED BY
			NAME & SIGN OF APPROVING AUTHORITY & SEAL

	MANUFACTURER'S NAME & ADDRESS :	MANUFACTURING QUALITY PLAN ITEM : Chain Pulley Block QP No.: PE-TS-XXX-XXX-A001 REV.:0, Date.:, PAGE: 4 OF 4	PROJECT : PACKAGE : CHAIN PULLEY BLOCKS VOL IIB, SEC C

Sr. No.	COMPONENT / OPERATION	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTU M OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	REMARKS
1.	2.	3.	4.	5.	6.	7.	8.	9.	M C N 10.	11.

3.3	NAME PLATE	VERIFICATION	MA	VISUAL	100%			IR	P V --	
3.4	PACKING	-VERIFICATION	MI	VISUAL	100%	SPECS.	SPECS.	IR	P -- -	
3.5	REVIEW OF QA DOCUMENTATION	VERIFICATION	MA	VISUAL	100%	APPD. QP	APPD. QP	✓	V V V	

CR – CRITICAL, MA – MAJOR , MI – MINOR

NOTE 1: BACK WALL ECHO SHALL BE ADJUSTED TO 100% OF FULL SCREEN HEIGHT IN SOUND (DEFECT FREE) AREA. DEFECT ECHO HEIGHT MORE THAN 20% OF SCREEN HEIGHT SHALL BE TREATED AS UNACCEPTABLE. BACK WALL ECHO SHALL NOT BE LESS THAN 80% OF SCREEN HEIGHT IN ANY CASE.

NOTE 2: RECORDS IDENTIFIED WITH TICK SHALL BE ESSENTIALLY INCLUDED IN QA DOCUMENTATION.

	LEGEND:	FOR CUSTOMER USE	
MANUFACTURER / CONTRACTOR	** M : MANUFACTURER / SUB-CONTRACTOR C : BHEL / NOMINATED INSPECTION AGENCY. N : CUSTOMER INDICATE "P" PERFORM "W" WITNESS AND "V" VERIFICATION		
SUB-CONTRACTOR SIGNATURE		REVIEWED BY	NAME & SIGN OF APPROVING AUTHORITY & SEAL

		MANUFACTURERS NAME & ADDRESS				STANDARD QUALITY PLAN				PROJECT			
		AS PER APPROVED VENDOR LIST				ITEM:	ELECTRIC WIRE ROPE	QP NO	PACKAGE	WIRE ROPE ELECTRIC HOIST			
										CONTRACT No			
										CONTRACTOR			
						DATE				BHEL			
						PAGE				1 of 4			
CHARACTERISTICS		CATEGORY	TYPE OF CHECK		EXTENT OF CHECK	REFERENCE DOCUMENT				ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	REMARKS
SL.No	COMPONENT & OPERATIONS												
1	2.3* WELD SET UPS	3	4	5	6	7	8	9	10	11			
		MA	MEAS. , VISUAL	100%	WPS, APPD. DRG.								
	2.4* WELDMENTS -FINAL RUN	MA	PT	100%	IS:3658 / ASTM E:165								
		MA	PT / UT	100%	ASTME:165								
	2.5 TRUNION / TROLLEY WHEELS, GEARS PINION	MA											
		CR	PT & RT	100%	ASME SEC. VIII DIV. I								
	2.6 NDT OF LOAD BEARING BUTT WELDS (IF ANY)												
		MA	MEAS.	100%	MFG. DRG.								
	2.7 GEAR BOXES	MA	MEAS.	100%	MFG. DRG.								
		MA	NO LOAD RUNNING FOR TWO HOURS	100%	MFG. DRG.								
	2.8 ELECTRICALS	MA	TYPE TESTS	1 / TYPE, 100%	IS:3938								
		MA	ROUTINE TESTS	100%	IS:325								
	2	MA	ROUTINE TESTS	100%	IS:3938, RELV. ISS								
		MA	ROUTINE TESTS	100%	IS:6875/TECH. SPEC.,								
	3	MA	ROUTINE TESTS	100%	IS:6975/TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:3938/TECH. SPEC.,								
	4	MA	ROUTINE TESTS	100%	IS:3938/TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
	5	MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
	6	MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
	7	MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS	100%	IS:2959 AND TECH. SPEC.,								
		MA	ROUTINE TESTS	100%	IS:6547 / IS:3938								
		MA	ROUTINE TESTS										

		MANUFACTURERS NAME & ADDRESS			STANDARD QUALITY PLAN			PROJECT			
		AS PER APPROVED VENDOR LIST			ITEM:	ELECTRIC WIRE ROPE	Q.P NO	PACKAGE	WIRE ROPE ELECTRIC HOIST		
							REV	CONTRACT No			
							DATE	CONTRACTOR			
							PAGE	1 of 4			
CHARACTERISTICS		CATEGORY	TYPE OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	REMARKS		
1. 2		3	4	5	6	7	8	9	10	11	
8	CABLES	TYPE AND ROUTINE TESTS	MA	TYPE & ROUTINE TESTS	100%	AS PER TECH. SPEC. IS:1554/IS:9968- PART - I / IS:694 / RELEVANT IS FOR FRLS CABLES	AS PER TECH. SPEC. IS:1554/IS:9968- PART - I / IS:694	MNFRS' TEST CERT.			
3.0	FINAL INSPECTION										
3.1	COMPLETELY ASSEMBLED HOIST	1. COMPLETENESS, CORRECTNESS, OVERALL DIMENSIONS	MA	VISUAL, MEAS	100%	100% APPD. DRG.	APPD. DRG.	MNFRS' TEST CERT.	✓	P	W
3.2	ASSEMBLED HOIST PERFORMANCE	1. LOAD TEST	CR	LOAD TEST at SWL	100%	IS:6547 / IS:3938	IS:6547 / IS:3938	MNFRS' TEST CERT.	✓	P	W
		2. HOISTING & LOWERING SPEED, PERFORMANCE OF CONTROLLERS SWITCHES AND OTHER CONTROL DEVICES CORRELATIONS OF CIRCUITS AND INTERLOCKS AND SEQUENCES OF OPERATION	CR	MEAS & VISUAL	100%	IS:6547 / IS:3938, TECH SPEC.	TECH SPEC.	MNFRS' TEST CERT.	✓	P	W
		3. OPERATION OF ALL PROTECTIVE DEVICES	CR	VISUAL	100%	TECH SPEC	TECH SPEC.	MNFRS' TEST CERT.	✓	P	W
3.3	OVER LOAD TEST	1. OVER LOAD	CR	TEST AT 125 % OF-SWL	100%	IS:6547 / IS:3938	IS:6547 / IS:3938	INSRN REPORT	✓	P	W
4	PAINTING										
1	PRIMER & FINISHING AND SHADE	1. TO RELEVANT IS	MI	CORRECTNESS OF MFG. TEST CERT.	EACH CONSIGNMENT	DRG. & DATA SHEET & RELV. IS SPEC.	DRG. & DATA SHEET & RELV. IS SPEC.	MNFRS' TEST CERT.		P	V
	NOTE:										
	* 1.0 Clause from 2.1 to 2.4 shall be applicable for load bearing welded joints.										
	2.0 Back Wall Echo shall be adjusted to 100% of Full Screen Height in sound (Defect Free) Area. Defect Echo Height more than 20% of Screen Height shall be treated as unacceptable. Back Wall Echo shall not be less than 80% of Screen Height in any case.										
		LEGENDS									
		* RECORDS IDENTIFIED WITH 'TICK' (✓) SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION									
		** M: MANUFACTURER/SUBCONTRACTOR									
		C: CONTRACTOR NOMINATED INSPECTION AGENCY(BHEL) N: CUSTOMER									
	MANUFACTURER/ SUB CONTRACTOR	CONTRACTOR	INDICATE 'P' PERFORM 'W' WITNESS AND 'V' VERIFICATION AS APPROPRIATE " CHP" CUSTOMER SHALL IDENTIFY IN COLUMN"N"								
	SIGNATURE		REVIEWED BY								
			NAME & SIGN OF APPROVING AUTHORITY & SEAL								

भारतीय विद्युत निगम 		QUALITY PLAN		CUSTOMER :		PROJECT TITLE		SPECIFICATION : NUMBER :				
		SHEET 4 OF 9		BIDDER/ VENDOR		QUALITY PLAN		SPECIFICATION : TITLE				
				SYSTEM		NUMBER PED-506-00-Q-007, REV-03		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)				
				SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD
1	2	3	4	5	6	7	8	9	10	11		
1.10	BEARINGS	3.DIMENSIONS	MA	MEASUREMENT	-DO-	-DO-	MANFR'S DRG./ APPROVED DATASHEET	-DO-	Log Book	3	-	2
		1.MAKE & TYPE	MA	VISUAL	100%	100%	MANFR'S DRG./ APPROVED DATASHEET	MANFR'S DRG./ APPROVED DATASHEET	-DO-	3	-	2
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	SAMPLE	BHEL DATA SHEET	BHEL DATA SHEET BEARING MANUF'S CATALOGUES	-DO-	3	-	2
		3.SURFACE FINISH	MA	VISUAL	100%	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	2
1.11	SLIP RING (WHEREVER APPLICABLE)	1.SURFACE COND.	MA	VISUAL	100%	100%	-	-DO-	-DO-	3	-	-
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	SAMPLE	MANUF'S DRG	MANUF'S DRG	-DO-	3	-	-
		3.TEMP.WITH-STAND CAPACITY	MA	ELECT.TEST	-DO-	-DO-	MANUF'S SPEC./ BHEL SPEC.	MANUF'S SPEC./ BHEL SPEC.	-DO-	3	-	2
		4.HV/IR	MA	-DO-	100%	100%	-DO-	-DO-	-DO-	3	-	2
1.12	OIL SEALS & GASKETS	1.MATERIAL OF GASKET	MA	VISUAL	100%	100%	MANUF'S DRG/SPECS	MANUF'S DRG./ SPECS.	-DO-	3	-	-
		2.SURFACE COND.	MA	VISUAL	100%	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	-
		3.DIMENSIONS	MA	MEASUREMENT	SAMPLE	SAMPLE	MANUF'S DRG	MANUF'S DRG	-DO-	3	-	-
BHEL		PARTICULARS		BIDDER/VENDOR								
		NAME										
		SIGNATURE										
		DATE										
										BIDDER'S/VENDORS COMPANY SEAL		

		QUALITY PLAN		CUSTOMER :		PROJECT TITLE		SPECIFICATION :			
								NUMBER :			
								SPECIFICATION :			
SL. NO.		COMPONENT/OPERATION		SHEET 5 OF 9		BIDDER/ VENDOR SYSTEM		QUALITY PLAN		TITLE	
		CHARACTERISTIC CHECK		CAT.		TYPE/ METHOD OF CHECK		EXTENT OF CHECK		REFERENCE DOCUMENT	
										ACCEPTANCE NORM	
										FORMAT OF RECORD	
										AGENCY	
										REMARKS	
										P W V	
										SECTION	
										VOLUME III	
										10 11	
1	2	3	4	5	6	7	8	9			
2.0	IN PROCESS		MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	3/2	2	-
2.1	STATOR FRAME WELDING (IN CASE OF FABRICATED STATOR)	1.WORKMANSHIP & CLEANNESS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-
2.2	MACHINING	1.FINISH	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	2	-	-
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-
2.3	PAINTING	3.SHAFT SURFACE FLOWS	MA	PT	-DO-	RELEVANT SPEC./ ASTM-E165	MANUF'S SPEC./ BHEL SPEC./	-DO-	2	-	1
		1.SURFACE PREPARATION	MA	VISUAL	100%	MANFR'S SPEC./BHEL SPEC./ SAME AS RELEVANT STAND	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-
		2.PAINT THICKNESS (BOTH PRIMER & FINISH COAT)	MA	MEASUREMENT BY ELCOMETER	SAMPLE	-DO-	-DO-	-DO-	2	-	-
		3.SHADE	MA	VISUAL	-DO-	-DO-	-DO-	Log Book	2	-	-
		4.ADHESION	MA	CROSS CUTTING & TAPE TEST	-DO-	-DO-	-DO-	Log Book	2	-	-
BHEL		PARTICULARS		BIDDER/VENDOR							
		NAME									
		SIGNATURE									
		DATE									
						BIDDER/SVENDORS COMPANY SEAL					

		QUALITY PLAN		CUSTOMER :		PROJECT TITLE		SPECIFICATION :																			
								BIDDER/ VENDOR		NUMBER :		SPECIFICATION :															
										SYSTEM		TITLE															
												NUMBER PED-506-00-Q-007, REV-03 ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)															
SHEET 7 OF 9		CHARACTERISTIC CHECK		CAT.		TYPE/ METHOD OF CHECK		EXTENT OF CHECK		REFERENCE DOCUMENT		ACCEPTANCE NORM		FORMAT OF RECORD		AGENCY		REMARKS									
SL. NO.		COMPONENT/OPERATION		3		4		5		6		7		8		9		P		W		V		SECTION		VOLUME III	
1	2					4		5		6		7		8		9				10				11			
2.7	COMPLETE STATOR ASSEMBLY	4.DURATION		MA		-DO-		-DO-		-DO-		-DO-		-DO-		Log Book		2		-		1					
		1.COMPACTNESS & CLEANLINESS		MA		VISUAL		100%		-DO-		-DO-		-DO-		Log Book		2		-		-					
2.8	BRAZING/COMPRESSION JOINT	1.COMPLETENESS		CR		-DO-		-DO-		-DO-		-DO-		-DO-		Log Book		2		-		-					
		2.SOUNDNESS		CR		MALLET TEST & UT				-DO-		-DO-		-DO-		Log Book		2				1					
2.9	COMPLETE ROTOR ASSEMBLY	3.HV		MA		ELECT. TEST				-DO-		-DO-		-DO-		Log Book		2				1					
		1.RESIDUAL UNBALANCE		CR		DYN. BALANCE				-DO-		MFG SPEC./ ISO 1940		MFG. DWG.		Log Book		2				1		VERIFICATION FOR MV MOTOR ONLY			
2.10	ASSEMBLY	2.SOUNDNESS OF DIE CASTING		CR		ELECT. (GROWLER TEST)				-DO-		MFG. SPEC.		MFG. SPEC.		Log Book		2				1					
		1.ALIGNMENT		MA		MEAS.				-DO-		-DO-		-DO-		Log Book		2		-		-					
		2.WORKMANSHIP		MA		VISUAL				-DO-		-DO-		-DO-		Log Book		2		-		-					
		3.AXIAL PLAY		MA		MEAS.				-DO-		-DO-		-DO-		Log Book		2		-		1					
		4.DIMENSIONS		MA		-DO-				-DO-		MFG.DRG./ MFG SPEC.		MFG. DRG/ RELEVANT IS		Log Book		2		-		-					
		5.CORRECTNESS, COMPLETENESS, TERMINATIONS/ MARKING/ COLOUR CODE		MA		VISUAL				100%		MFG SPEC. RELEVANT IS		MFG SPEC. RELEVANT IS		Log Book		2		-		-					
		6. RTD, BTD & SPACE HEATER MOUNTING.		MA		VISUAL				100%		MFG SPEC. RELEVANT IS		MFG SPEC. RELEVANT IS		Log Book		2				1					
BHEL		PARTICULARS		BIDDER/VENDOR																							
		NAME																									
		SIGNATURE																									
		DATE																									

		QUALITY PLAN		CUSTOMER :		PROJECT TITLE		SPECIFICATION :				
								NUMBER :		SPECIFICATION :		
								BIDDER/ VENDOR :		TITLE		
SHEET 8 OF 9								NUMBER PED-506-00-Q-007, REV-03		SECTION		
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT. SYSTEM	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	REMARKS			
									P	W	V	
1	2	3	4	5	6	7	8	9	10	11		
3.0	TESTS	1.TYPE TESTS INCLUDING SPECIAL TESTS AS PER BHEL SPEC.	MA	ELECT.TEST	1/TYPE/SIZE	IS-325/ BHEL SPEC./ DATA SHEET	IS-325/ BHEL SPEC./ DATA SHEET	TEST REPORT	2	1*	1	* NOTE - 1
		2.ROUTINE TESTS INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1\$	1	\$ NOTE - 2
		3.VIBRATION & NOISE LEVEL	MA	-DO-	100%	IS-12075 & IS-12065	IS-12075 & IS-12065	-DO-	2	1\$	1	\$ NOTE - 2
		4.OVERALL DIMENSIONS AND ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPC. REPORT	2	1	-	
		5.DEGREE OF PROTECTION	MA	ELECT. & MECH. TEST	1/TYPE/ SIZE	RELEVANT IS	BHEL SPEC. AND DATA SHEET	TC	2	-	1	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		6. MEASUREMENT OF RESISTANCE OF RTD & BTD	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1\$	1	\$ NOTE - 2
		7. MEASUREMENT OF RESISTANCE, IR OF SPACE HEATER	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1\$	1	\$ NOTE - 2
		8. NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPC. REPORT	2	1\$	1	\$ NOTE - 2
		9.EXPLOSION FLAME PROOF NESS (IF SPECIFIED)	MA	EXPLOSION FLAME PROOF TEST	1/TYPE	IS-3682 IS-8239 IS-8240	IS-3682 IS-8239 IS-8240	TC	2	-	1	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		10. PAINT SHADE, THICKNESS & FINISH	MA	VISUAL & MEASUREMENT BY ELKOMETER	SAMPLE	BHEL SPEC. & DATA SHEET	BHEL SPEC. & DATA SHEET	TC	2	1\$	1	SAMPLING PLAN TO BE DECIDED BY INSPECTION AGENCY \$ NOTE - 2
BHEL		PARTICULARS		BIDDER/VENDOR								
		NAME										
		SIGNATURE										
		DATE										
				BIDDER/S/VENDORS COMPANY, SEAL, ...								

		QUALITY PLAN		CUSTOMER :		PROJECT TITLE		SPECIFICATION : NUMBER :		
				BIDDER/ VENDOR :		QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03		SPECIFICATION : TITLE		
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	SYSTEM CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	SECTION AGENCY	VOLUME III REMARKS
1	2	3	4	5	6	7	8	9	10	11
NOTES: 1 DEPENDING UPON THE SIZE AND CRITICALLY, WITNESSING BY BHEL SHALL BE DECIDED. 2 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON. 3 IN CASE TEST CERTIFICATES FOR THESE TESTS ON SIMILAR TYPE, SIZE AND DESIGN OF MOTOR FROM INDEPENDENT LABORATORY ARE AVAILABLE, THESE TEST MAY NOT BE REPEATED. 4 WHEREVER CUSTOMER IS INVOLVED IN INSPECTION, AGENCY (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER. <u>Legends for Inspection agency</u> 1. BHEL/CUSTOMER 2. VENDOR (MOTOR MANUFACTURER) 3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER) P. PERFORM W. WITNESS V. VERIFY										
BHEL			PARTICULARS		BIDDER/VENDOR					
			NAME							
			SIGNATURE							
			DATE							
					BIDDER'S/VENDORS COMPANY SEAL					

		QUALITY PLAN		CUSTOMER :		PROJECT 4 x 270 MW BHADRADRI TPS		SPECIFICATION : NUMBER :					
COMPONENT/OPERATION		SHEET 1 OF 2		SYSTEM		BIDDER/ VENDOR		QUALITY PLAN		PE-QP-411-158-A001 Rev-0		SPECIFICATION TITLE	
SL. NO.	2	3	4	5	6	7	8	9	10		11		
									P	W	V		
1.0	ASSEMBLY	1.WORKMANSHIP 2.DIMENSIONS 3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/COLOUR CODE	MA	VISUAL	100%	MANUF'S SPEC	MANUF'S SPEC	-DO-	2	-	-		
			MA	-DO-	-DO-	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	-DO-	2	-	-		
			MA	VISUAL	100%	MFG.SPEC./ RELEVANT IS	MFG.SPEC./ RELEVANT IS	-DO-	2	-	-		
2.0	PAINTING	1.SHADE	MA	VISUAL	SAMPLE	MANUF'S SPEC/BHEL SPEC./RELEVANT STANDARD	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-		
3.0	TESTS	1.ROUTINE TEST INCLUDING SPECIAL TEST AS PER BHEL SPEC. 2.OVERALL DIMENSIONS & ORIENTATION	MA	-DO-	100%	IS-325/ BHEL SPEC./ DATA SHEET	SAME AS COL.7	TEST REPORT	2	1		NOTE -1 & NOTE-3	
			MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPN. REPORT	2	1	-	NOTE -1 & NOTE-3	
BHEL		PARTICULARS		BIDDER/VENDOR									
		NAME											
		SIGNATURE											
		QUALITY PLAN		CUSTOMER :		PROJECT 4 x 270 MW BHADRADRI TPS		SPECIFICATION : NUMBER :PE-TS-411-158-A001		SPECIFICATION : TITLE :			
SHEET 2 OF 2		SYSTEM		NUMBER PE-QP-411-158-A001		Rev-0		SECTION			VOLUME IIC		
						ITEM AC ELECT. MOTORS BELOW 55KW (LV)							

SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
		3.NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPN. REPORT	2	1	-	
	NOTES: 1 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON 2 WHERE EVER CUSTOMER IS INVOLVED IN INSPECTION, (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER. 3 FOR EXHAUST/VENTILATION FAN MOTORS OF RATING UPTO 1.5KW , ONLY ROUTINE TEST CERTIFICATES SHALL BE FURNISHED FOR SCRUTINY. <u>Legends for Inspection agency</u> 1. BHEL/CUSTOMER 2. VENDOR (MOTOR MANUFACTURER) 3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER) P. PERFORM W. WITNESS V. VERIFY											
	BHEL											
			PARTICULARS	BIDDER/VENDOR								
			NAME									
			SIGNATURE									
			DATE									
				BIDDER'S/VENDORS COMPANY SEAL								

		STANDARD QUALITY PLAN FOR PROGRAMMABLE LOGIC CONTROLLER										QUALITY PLAN NO.: PE-QP-999-145-1036			
												VOLUME IIB			
												SECTION C1-D			
												REV. NO. 0 DATE:			
												SHEET OF			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records P	Agency \$			Remarks			
1.0	Materials /Components														
1.1	Panels & Control Desks	Physical Inspection for Dimensions, Painting, Cutouts, Lifting / Locking Arrangements, Components, Drawing Pocket, Mounting accessories, Plinth & AV Pads, Cable Gland Plates, Hardwares, Hinges, Louvers & Filters, Fans & Panel Lamps	MA Visua	I	100%	Contract specifications, Approved GA Drawings, BOQ	As per ref documents. No physical damage.	BHEL Quality Inspection Report.	3/2 2		1				
1.2	Power Supply/Packs, Battery charger, Transformer, UPS.	Physical Inspection Physical Damages Dimensions Mounting Accessories	MA Visua	I	100%	Contract specifications, BOQ.	As per reference documents, Test Report	BHEL Quality Inspection Report.	3/2 2		1				
1.3	Indicating Lamp, Annunciator, Meters, Transducers, Signal Converters, Single Instruments, Single Loop Controllers	Physical Verification Physical Damages Dimensions Accessories	MA Visua	I	100%	Contract specifications, BOQ.	As per ref documents No physical damage. Test/ Calibration report.	BHEL Quality Inspection Report	3/2 2		1				
1.4	PLC processors, I/O modules, Power Supply modules, Communication modules, Mounting Racks, Ethernet	Physical Inspection - Identification Labels - Physical Damages - Quantity - Spare Capacity	MA Visua	I	100%	Product Catalogue, Data sheets, Approved Configuration diagram, BOQ	As per ref documents. Test Certificates	BHEL Quality Inspection Report.	3/2 2		1				

LEGEND: * CR - Critical characteristics		\$		P - Agency Performing the Test.		1 - BHEL	
MA - Major characteristics		W		V - Agency Witnessing the Test.		2 - Vendor	
MI - Minor characteristics		V		- Agency Verifying the Test.		3 - Sub-vendor	

		STANDARD QUALITY PLAN FOR PROGRAMMABLE LOGIC CONTROLLER										QUALITY PLAN NO.: PE-QP-999-145-1036 ____					
		VOLUME IIB															
		SECTION C1-D															
		REV. NO. 0 DATE:															
		SHEET OF															
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records P	Agency \$			Remarks					
										W	V						
1.5	CPU, Monitor, Keyboard, Mouse, CD Drives, Printers, OS, System Software, Engineering software in the form of Licensed CD.	Physical Inspection Identification Labels, Tech. Specification Physical Damages Accessories Installation arrangements for Computers & Printers	MA	Visual	100%	Contract specifications, Product Catalogue, Approved GA / Configuration drawing, BOQ.	As per reference documents.	BHEL Quality Inspection Report.	3/2	2	1						

LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics	\$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.	1 - BHEL 2 - Vendor 3 - Sub-vendor

		STANDARD QUALITY PLAN FOR PROGRAMMABLE LOGIC CONTROLLER						QUALITY PLAN NO.: PE-QP-999-145-1036 _____				
								VOLUME IIB				
								SECTION D				
								REV. NO. 0		DATE:		
								SHEET _____ OF _____				
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records P	Agency \$			Remarks
										W	V	

2.0	Ass embly												
2.1	Functional Test for HMI/OWS devices such as Monitors, Keyboards, Mouse, Printers etc.	Operation	MA	Functional	100%	Approved Configuration Diagram & BOQ and FAT	Correct Operation of interconnected Devices of HMI system.	BHEL Quality Inspection Report.	2 1			1	
2.2	Hardware Functional Verification.	Physical arrangement, Wiring check & labeling, Continuity Checking, IR & HV test	MA	Visual/ Electrical	100%	Approved GA Drawing, Panel Wiring Diagram, IR & HV as per relevant International standard	Test Certification	BHEL Quality Inspection Report.	2 2			1	
2.3	Powering Up	Healthiness of all the modules/equipment, associated with Powering of PLC system	MA	Visual /Electrical	100%	Approved power supply scheme	All equipment to be healthy on power ON	BHEL Quality Inspection Report.	2 1			1	
2.4	Burn in test for PLC modules	Healthiness of PLC modules on Continuous Energisation, Temperature maintenance	MA	Visual/ Electrical	100% F	AT Procedure	Test certification as per FAT	BHEL Quality Inspection Report.	2 2			1	

LEGEND:

* CR

- Critical characteristics

MA

- Major characteristics

MI

- Minor characteristics

\$

P

- Agency Performing the Test.

W

- Agency Witnessing the Test.

V

- Agency Verifying the Test.

1

- BHEL

2

- Vendor

3

- Sub-vendor

	STANDARD QUALITY PLAN FOR PROGRAMMABLE LOGIC CONTROLLER						QUALITY PLAN NO.: PE-QP-999-145-1036 _____					
							VOLUME IIB					
							SECTION D					
							REV. NO. 0		DATE:			
							SHEET _____ OF _____					
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records P	Agency \$			Remarks
										W	V	

3.0	Factory Acceptance Test (FAT)											
3.1	Input Output Functional Verification	I/O configuration, I/O operation	MA	Visual/ Eletrical	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1			1
3.2	Processor Verification	Processor configuration, Powering up, standby operation (as applicable) and Loading	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1			1
3.3	Power Supply Module Verification	Redundancy Operation	MA	Electrical	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1			1
3.4	Communication System Verification	Redundancy operation of Communication System, Measurement of Response Time, Communication with third party system	MA	Electrical	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1			1
3.5	Diagnostic Verification	Self Diagnostic features of PLC system	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1			1
3.6	Control Panel/Desk Verification	Operation of PLC driven annunciation system, Mosaic, Push buttons & selector switches, Indicating lamps	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1			1
3.7	Software Verification	(i) Control Logics (ii) Engineering Features (iii) HMI Features	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1			1

LEGEND:

* CR

- Critical characteristics

MA

- Major characteristics

MI

- Minor characteristics

\$

P

- Agency Performing the Test.

W

- Agency Witnessing the Test.

V

- Agency Verifying the Test.

1

- BHEL

2

- Vendor

3

- Sub-vendor

 PEM :: C&I		STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL										STD QUALITY PLAN NO.: PE-QP-999-145-1056				
												VOLUME IIB				
												SECTION D				
												REV. NO. 01 DATE: 22-02-2008				
												SHEET 1 OF 7				
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks				
									P	W	V					
1.0	INCOMING Sheet Steel (CRCA & HR)	1. Chemical Composition	MA	Chemical analysis	Sample	Relevant standard	Relevant standard	Test Certificate	3	---	2					
		2. Bend Test	CR	Mech. test	Sample	Relevant standard	Relevant standard	Log Book	2	---	---					
		3. Surface finish	MA	Visual	100%	Factory Standard / Sample	Factory Standard / Sample	Log Book	2	---	---					
		4. Waviness	MA	Visual	100%	Factory Standard	No Waviness	Log Book	2	---	---					
		5. Thickness	MA	Measurement	100%	BHEL Spec.	BHEL Spec.	Log Book	2	---	---					
		6. Mill marking	MA	Visual	100%	Factory Standard	Factory Standard	Log Book	2	---	1					
2.0	Flats / Angles / Channels	1. Dimensions	MA	Measurement	Sample	Relevant standard	Relevant standard	Log Book	2	---	---					
		2. Surface Defects	MA	Visual	100%	Factory Standard / Sample	Factory Standard / Sample	Log Book	2	---	---					
		3. Straightness	MA	Measurement	100%	Factory Std.	Factory Std.	Log Book	2	---	---					
		4. Mill marking	MA	Visual	100%	Relevant standard	Relevant standard	Log Book	2	---	1					
3.0	Cables / Wires	1. Visual / Surface defects	MA	Visual	100%	BHEL Spec. and Relevant standard	BHEL Spec. and Relevant standard	Log Book	2	---	---					
		2. IR and HV	MA	Electrical	100%	BHEL Spec. and Relevant standard	BHEL Spec. and Relevant standard	Log Book	2	---	---					
LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics																
P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test. 1 - BHEL 2 - Vendor 3 - Sub-vendor																

 PEM :: C&I		STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL										STD QUALITY PLAN NO.: PE-QP-999-145-1056				
												VOLUME IIB				
												SECTION D				
												REV. NO. 01 DATE: 22-02-2008				
												SHEET 2 OF 7				
Sl. No.	Component / operation	Characteristics Checked	* Cate gory	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks				
									P	W	V					
		3. Conductor a) Resistance b) Size c) Sheet colour	MA MA MA	Electrical Measurement Visual	100% 100% 100%	BHEL Spec. and Relevant standard	BHEL Spec. and Relevant standard	Log Book	2	---	---	---				
		4. Type / Routine Test Certificates	MA	Verification	100%	BHEL Spec. and Relevant standard	BHEL Spec. and Relevant standard	Log Book	3	---	---	2				
4.0	Electrical Components like Annunciator Transformers Lamps Switches PBs Contactors Relays Timers Space Heaters Thermostat Indicating meters etc.	1. Verification at make and Type	CR	Visual	Sample	BHEL Spec. and BOM	BHEL Spec. and BOM	Log Book	2	---	---	---	+ for relay & contactors only @ for all components except relays & contactors.			
		2. Verification of Test Certificates	CR	Scrutiny of Type / Routine T.Cs.	100%	Relevant standard	Relevant standard	Log Book	2	---	---	---				
		3. Operation / Functional check	CR	Electrical	Sample+ 100%@	Relevant standard & Catalogue	Relevant standard & Catalogue	Log Book	2	---	---	---				
		4. I.R.	MA	Electrical	100%	Relevant standard & Catalogue	Relevant standard & Catalogue	Log Book	2	---	---	---				
		5. H.V.	MA	Electrical	100%	Relevant standard & Catalogue	Relevant standard & Catalogue	Log Book	2	---	---	---				
		6. Calibration	MA	Electrical	100%	Relevant standard & Catalogue	Relevant standard & Catalogue	Log Book	2	---	---	1				
		7. Pick up / Drop off Voltage	MA	Electrical	100%	Relevant standard & Catalogue	Relevant standard & Catalogue	Log Book	2	---	---	---				
LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics														1 - BHEL 2 - Vendor 3 - Sub-vendor		
														P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.		

STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL												STD QUALITY PLAN NO.: PE-QP-999-145-1056							
												VOLUME IIB							
												SECTION D							
												REV. NO. 01 DATE: 22-02-2008							
												SHEET 3 OF 7							
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks							
									P	W	V								
5.0	Misc. Components like Gaskets, Terminal Blocks etc.	1. Verification of Type / Make 2. Surface defects 3. IR / HV on Terminal Blocks	MA MA MA	Visual Visual Electrical	Sample Sample Sample	BHEL Spec. & Mfrs. Catalogue BHEL Spec. & Mfrs. Catalogue BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue BHEL Spec. & Mfrs. Catalogue BHEL Spec. & Mfrs. Catalogue	Log Book Log Book Log Book	2 2 2	--- --- ---	--- --- ---								
6.0	IN PROCESS Blanking / Bending / Forming	1. Dimensions 2. Surface defects after bending	MI MA	Measurement Visual	100% 100%	Approved Mfr. drgs. Factory Standard	Approved Mfr. drgs. Factory Standard	Log Book Log Book	2 2	--- ---	--- ---								
7.0	Nibbling / Punching	1. Cutout Sizes 2. Deburring	MI MA	Measurement Visual	100% 100%	Approved Mfr. drgs. Approved Mfr. drgs.	Approved Mfr. drgs. Approved Mfr. drgs.	Log Book Log Book	2 2	--- ---	--- ---								
8.0	ASSEMBLY Frame Assembly & Sheet fixing	1. Dimensions 2. Alignment 3. Welding Quality 4. Surface defects	MA MA MA MA	Measurement Measurement Visual Visual	100% 100% 100% 100%	Approved drg. / Mfr. Standards Approved drg. / Mfr. Standards Approved drg. / Mfr. Standards Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards Approved drg. / Mfr. Standards Approved drg. / Mfr. Standards Approved drg. / Mfr. Standards	Log Book Log Book Log Book Log Book	2 2 2 2	--- --- --- ---	2 2 2 2								
LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics												\$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.				1 - BHEL 2 - Vendor 3 - Sub-vendor			

 PEM :: C&I	STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL											
	STD QUALITY PLAN NO.: PE-QP-999-145-1056											
	VOLUME IIB											
	SECTION D											
	REV. NO. 01 DATE: 22-02-2008											
SHEET 4 OF 7												
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$ P W V			Remarks
9.0	Pre-treatment and Painting	1. Pretreatment Process 2. Process parameters like bath temp. concentration etc. 3. Dipping / Removal Time 4. Surface quality after every dip 5. Primer after phosphating 6. Putty Application & Rubbing after primer 7. Paint first coat 8. Putty Application and Rubbing after first coat of paint 9. Paint second coat	MA MA MA MA MA MA	Visual Measurement Measurement Visual Visual, Thickness Visual Visual, Thickness Visual Visual, Thickness, Scratch test Colour adhesion	100% Periodic 100% 100% 100% 100% 100%	Factory Standard & Relevant standard Factory Standard & Relevant standard Factory Standard & Relevant standard Factory Standard & Relevant standard Factory Standard & Relevant standard Factory Standard & Relevant standard Factory Standard & Relevant standard Factory Standard & Relevant standard	Factory Standard & Relevant standard Factory Standard & Relevant standard Factory Standard & Relevant standard Factory Standard & Relevant standard Factory Standard & Relevant standard Factory Standard & Relevant standard Factory Standard & Relevant standard Factory Standard & Relevant standard	Log Book Log Book Log Book Log Book Log Book Log Book Log Book Log Book	2 2 2 2 2 2 2 2	--- --- --- --- --- --- --- ---	1 1 1 1 1 1 1 1	
LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics												
P - Agency Performing the Test. 1 - BHEL W - Agency Witnessing the Test. 2 - Vendor V - Agency Verifying the Test. 3 - Sub-vendor												

STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL													STD QUALITY PLAN NO.: PE-QP-999-145-1056							
													VOLUME IIB							
													SECTION D							
													REV. NO. 01				DATE: 22-02-2008			
													SHEET 5				OF 7			
Sl. No.	Component / operation	Characteristics Checked	* Cate gory	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks								
									P	W	V									
10.	Panel Wiring	1. Wiring Layout 2. Wiring Termination (Crimped Lugs) 3. Ferrule numbers 4. Colour of wiring 5. Size of Conductor	MA MA MA MA MA	Visual Visual Visual Visual Measurement	100% 100% 100% 100% 100%	Approved drgs. & Specs. Approved drgs. & Specs. Approved drgs. & Specs. Approved drgs. & Specs. Approved drgs. & Specs.	Approved drgs. & Specs. Approved drgs. & Specs. Approved drgs. & Specs. Approved drgs. & Specs. Approved drgs. & Specs.	Log Book Log Book Log Book Log Book Log Book	2 2 2 2 2	--- --- --- --- ---	--- --- --- 1 1									
11.	Component Mounting	1. Correct components 2. Fixing	MA MA	Visual Visual	100% 100%	Approved drgs., Specs. & BOM Approved drgs., Specs. & BOM	Approved drgs., Specs. & BOM Approved drgs., Specs. & BOM	Log Book Log Book	2 2	--- ---	--- ---									
12.	FINAL Final Inspection	1. Workmanship 2. Component layout (neatness, accessibility & safety) Mounting / Proper fixing of all components 3. Components identification Marking / Name plates	MA MA MA	Visual Visual Visual	100% 100% 100%	Factory Standard BHEL approved drg. / Spec. BHEL approved drg. / Spec.	Factory Standard BHEL approved drg. / Spec. BHEL approved drg. / Spec.	Inspection Report Inspection Report Inspection Report	2 2 2	1 1 1	1 1 1		At Random by BHEL, based on 100 % internal test reports by Mfr.							
LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics													\$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.				1 - BHEL 2 - Vendor 3 - Sub-vendor			

 PEM :: C&I		STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL										STD QUALITY PLAN NO.: PE-QP-999-145-I056				
												VOLUME IIB				
												SECTION D				
												REV. NO. 01 DATE: 22-02-2008				
												SHEET 6 OF 7				
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks				
									P	W	V					
		5. Dimensions	MA	Measurement	100%	BHEL approved drg. / Spec., BOM	BHEL approved drg. / Spec., BOM	Inspection Report	2	1	1	At Random by BHEL, based on 100 % internal test reports by Mfr.				
		6. Door functioning	MA	Functional	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1					
		7. Paint Shade	CR	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1					
		8. Paint Thickness	CR	Measurement	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1					
		9. Workmanship of Gaskets	MA	Visual	100%	Factory Standard	Factory Standard	Inspection Report	2	1	1					
		10. Wiring Layout	MA	Visual	100%	BHEL approved drg.	BHEL approved drg.	Inspection Report	2	1	1					
		11. Wire Termination	MA	Pulling manually	Sample	----	Firm termination	Inspection Report	2	1	1					
		12. Continuity	MA	Electrical	100%	----	Continuity OK	Inspection Report	2	1	1					
LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics																
\$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.																
1 - BHEL 2 - Vendor 3 - Sub-vendor																

 STD QUALITY PLAN NO.: PE-QP-999-145-J056		STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL										VOLUME IIB SECTION D REV. NO. 01 DATE: 22-02-2008 SHEET 7 OF 7			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$				Remarks		
									P	W	V				
13.	TYPE TEST	Degree of Protection	CR	Mech. Protection	Sample	BHEL approved spec., drg relevant IEC-60947, IEC-60079	BHEL approved spec., drg relevant IEC-60947, IEC-60079	Type Test Certificate	3	---	1				
14	ROUTINE TEST	IR before & after HV Test	CR	Electrical	100%	BHEL approved spec., drg., BOM & relevant standard	BHEL approved spec., drg., BOM & relevant standard	Test Report	2	1	1				
15	FUNCTIONAL TEST	1. Control Logic Operation	CR	Electrical	100%	BHEL approved spec. / drg.	BHEL approved spec. / drg.	Inspection Report	2	1	1				
		2. Instrument Calibration	CR	Electrical	10%	BHEL approved spec. / drg.	BHEL approved spec. / drg.	Inspection Report	2	1	1				
		3. Temperature rise	CR	Electrical	100%	BHEL approved spec/drg. & relevant standard	BHEL approved spec/drg & relevant standard	Inspection Report	2	1	1				

LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics		\$ P W V - Agency Performing the Test. - Agency Witnessing the Test. - Agency Verifying the Test.		1 - BHEL 2 - Vendor 3 - Sub-vendor	

**TITLE**

**4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 1 of 1

**SECTION C1 – E
PAINTING SPECIFICATION**

TECHNICAL SPECIFICATION

FOR

PROTECTIVE LINING AND PAINTING

1.00.00 INTENT OF SPECIFICATION

1.01.00 This specification addresses the requirements of all labour, material, and appliances necessary with reference to preparations for lining / painting, application as well as finishing of all lining / painting for all mechanical and electrical equipment, piping and valves, structures etc. included under the scope of this Package.

1.02.00 The Bidder shall furnish and apply all lining, primers including wash primers if required, under-coats, finish coats and colour bands as described hereinafter or necessary to complete the work in all respects.

2.00.00 CODES & STANDARDS

2.01.00 The Bidder shall follow relevant Indian and International Standards wherever applicable in cleaning of surface, selection of lining material / paints and their application. The entire work shall conform to the following standards / specifications (latest revision or as specified).

- a) SSPC SP 10 / NACE 2 / : Near White Blast Cleaning
- b) SSPC PA 2 : Measurement of dry film Coating Thickness with magnetic gauges.
- c) ASTM D 4541 : Method for pull off strength using portable Adhesion Tester.
- d) NACE RP 0274 – 2004 : High-Voltage Electrical Inspection of Pipeline Coatings
- e) NACE SP 0188 – 2006 : Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates

- f) NACE RP 0169 – 2002 : Control of External Corrosion on Underground or Submerged Metallic Piping Systems
- g) AWWA C 210 – 2007 : Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
- h) IS 3589:2001 Annexure B : Steel Pipes for Water and Sewage Specification.
- i) AWWA C222-2000 : Polyurethane Coating for the Interior and Exterior of Steel Water Pipe and Fittings.
- j) IS 13213 : 2000 : Polyurethane Full Gloss Enamel (Two pack)

3.00.00 GENERAL REQUIREMENTS

- 3.01.00** The steel surface preparation prior to actual commencement of coating shall conform to SSPC SP 10 / NACE 2 / Sa2½ (near white metal) with sand blasting.
- 3.02.00** The contractor shall submit a detailed written description in the form of a manual covering coating equipment, procedures, materials inspection test, and repair etc. to Owner/Consultant for approval.
- 3.03.00** The contractor shall also provide copies of test reports from NABL approved laboratory (like National Test House, Kolkata) in support of the paint/primer materials to be used shall conform to the specification requirement.
- 3.04.00** The contractor shall also provide certificates from paint/primer manufacturer mentioning the batch numbers, date of manufacture and shelf life etc. of the materials to be used. In addition to that Manufacturing Quality Plan (MQP) and Field Quality Plan (FQP) shall also be submitted prior to commencement of supply of material and field application.
- 3.05.00** Paint/coating application work at site shall be done either by paint manufacturer or by their authorized applicator. The authorized applicator shall have proper training & certification from manufacturer. Applicator shall possess all the necessary specialized equipment and manpower experienced in similar job.

THIS IS A PART OF TECHNICAL SPECIFICATION NO. PE-TS-411-158A-A001

- 3.06.00 Applied coating shall be tested for dry film thickness, holiday (electrical inspection for continuity) and adhesion as per relevant standard such as SSPC PA 2, NACE RP 0274 and ASTM D 4541.
- 3.07.00 If necessary, the material may be heated and applied by airless spray / plural component spray system.
- 3.08.00 Manufacturer's specific recommendation, if any, shall be followed during application of lining / paints.
- 3.09.00 In areas where there is danger of spotting automobiles or other finally finished equipment or building by wind borne particles from paint spraying, a Purchaser approved method shall be adopted.
- 3.10.00 The colour scheme of the entire Plant, covered under this specification shall be approved by the Purchaser in advance before application.
- 3.11.00 All indoor and outdoor piping, insulated as well as uninsulated will have approved colour bands painted on the pipes at conspicuous places throughout the system, as approved by Purchaser.
- 3.12.00 Inside surfaces of vessels / tanks shall be protected by anticorrosive paints or rubber lining as required / specified elsewhere in the specification. External surfaces of all vessels / tanks shall be protected by anti corrosive painting.
- 3.13.00 For vessels / tanks requiring lining and epoxy painting all inside surface shall be blast cleaned using non-siliceous abrasive after usual wire brushing.
- 3.14.00 Natural rubber lining shall be provided on the inside of vessels / tanks as required / specified elsewhere in the specification, in three layers resulting in a total thickness not less than 4.5 mm.
- 3.15.00 Surface hardness of rubber lining shall be 65 +/- 5 deg. A (shore).
- 3.16.00 After the lining is completed, the vessels / tanks shall not be subjected to any prolonged exposure to direct sunlight in course of its transportation, erection etc. They shall not be stored in direct sunlight. No further lining or burning shall be carried out on the vessel, after application of the lining.

3.17.00 All lining projecting outside of the vessel shall be protected adequately from mechanical damages during shipment, handling storage etc.

3.18.00 Suitable warnings, indicating the special care that must be taken with respect to these lined vessels shall be stenciled on their outside surface with the letters at least 12 mm high.

3.19.00 All insulated piping shall have aluminium sheet jacketing.

4.00.00 EQUIPMENT, MATERIAL AND SERVICES TO BE FURNISHED BY THE BIDDER

4.01.00 After erection at site, the outside surfaces of all equipment having a shop coat shall be given further priming coat and finished coats of paint as detailed in following clauses. However, if the painting system is such that the shop coat and primer coat to be applied at site are not compatible, then shop coat has to be removed from the surface of equipment before application of primer coat with prior blasting.

All factory finished paints shall be touched up at site as required.

All uninsulated piping shall be finished with final paintings after use of proper wash primer and primer. Aluminium sheet jacketed piping need not be painted. Colour bands of Purchaser's approved shade shall however be applied on jacketed piping near walls or partitions, at all junctions, near valves and all other places as instructed by the Purchaser. All structures shall be painted with approved paint.

4.02.00 Surface Preparation

4.02.01 Unless mentioned otherwise, all rust and mill scale shall be removed by blasting to Sa 2-1/2 Swiss Standard before applying the primer.

4.02.02 Special care shall be taken to remove grease and oil by means of suitable solvents like Trichloroethylene or Carbon Tetrachloride.

4.02.03 The minimum degree of surface preparations for all equipment, piping, fittings, valves, structures etc. shall be "Near White" according to Steel Structure, Painting Council-SSPC-SP-10 before application of any primer/paint.

4.03.00 Painting

- 4.03.01 Specification for application of paints for external surfaces protection of vessels / tanks / equipment / piping / fittings / valves etc. to be installed indoor shall be as follows :
- a) Surface preparation shall be done either manually or by any other approved method.
 - b) Primer Coat shall consist of one coat (minimum DFT of 50 microns) of chlorinated rubber based zinc phosphate.
 - c) Intermediate Coat (or Under Coat) shall consist of one coat (minimum DFT of 50 microns) of chlorinated rubber based paint pigmented with Titanium Dioxide.
 - d) Top Coat shall consist of one coat (minimum DFT of 50 microns) of chlorinated rubber paint of approved shade and colour with glossy finish.
 - e) Total DFT of paint system shall not be less than 150 microns.
- 4.03.02 Specification for application of paints for external surfaces protection of vessels / tanks / equipment / piping / fittings / valves etc to be installed **outdoor** shall be as follows :
- a) Surface preparation shall be done by means of sand blasting, which shall conform to Sa 2-1/2 Swiss Standard.
 - b) Primer Coat shall consist of one coat (minimum DFT of 100 microns) of epoxy resin based zinc phosphate primer.
 - c) Intermediate Coat (or Under Coat) shall consist of one coat (minimum DFT of 100 microns) epoxy resin based paint pigmented with Titanium Dioxide.
 - d) Top Coat shall consist of one coat (minimum DFT of 75 microns) of epoxy paint of approved shade and colour with glossy finish. Additional one coat (minimum DFT of 25 microns) of Finish Coat of polyurethane shall be provided.
 - e) Total DFT of paint system shall not be less than 300 microns.
- 4.03.03 Specification for application of paints for external surfaces protection of steel pipes and fittings which are **buried underground / laid inside a huge pipe & or submerged Under Water and laid under Pipe Trenches** (in road/rail/pipe or trench crossings) shall be as follows :

External surface of the pipe, fittings, specialties etc. handling raw water/clarified water/filter water shall be painted with one coat of two part chemically cured polyurethane primer of min 50 micron dry film thickness followed by three or maximum four coats of two part solvent less polyurethane to build up coating of dry film thickness of 2000 micron including primer coat.

4.03.04 Specification for application of paints for **internal surface protection of large diameter pipes** (sizes above 600 mm NB and above) if any, shall be as follows :

- a) All Internal surfaces of steel pipes, fittings, specialties etc. buried underground or located within pipe trenches shall be given epoxy coating to protect them from (except for drinking water service, where the compatible painting shall be so selected to meet relevant quality standards) corrosion.
- b) Internal surface of the pipe should be coated with one coat of two part epoxy primer with not less than 50 micron DFT (dry film thickness) followed by two part polyamide cured solvent less epoxy.
- c) The minimum dry film thickness (DFT) of internal lining shall be 600 micron.

4.03.05 Specification for application of paints for protection of **internal surfaces of DM Water Storage Tank(s)** shall be as follows :

- a) Primer - One coat of epoxy primer containing high level of Zinc Phosphate anticorrosive pigment. Total Dry Film Thickness (DFT) of primer shall not be less than 125 microns.
- b) Finish Paint - Three (3) coats Polyamine HB Epoxy Paint. Total Dry Film Thickness (DFT) of finish paint shall not be less than 125 microns per coat.
- c) Total thickness of primer and paint should not be less than 500 microns.

4.03.06 All motors, local push button stations, cable racks, structures used for supports etc. are to be painted with acid proof paint.

4.03.07 The following surfaces shall not be painted - stainless steel, galvanized steel, aluminum, copper, brass, bronze and other nonferrous materials.

4.03.08 No painting or filler shall be applied until all repairs, hydrostatic tests and final shop inspection are completed.

4.03.09 All machined surfaces shall have two (2) coats of water repellant grease after thorough cleaning.

5.00.00 COATING PROCEDURE AND APPLICATION

5.01.00 Surface Preparation :

Pipe shall be blast cleaned by sand. The cleanliness achieved prior to application shall be in accordance with the requirement of SSPC SP 10 / NACE 2 / Sa2½ of ISO 8501 (near white metal)

- a) The blast pattern or profile depth shall be 40 to 100 micron and shall be measured by dial micrometer.
- b) Before sand blasting is started or during blasting or coating, temperature of the pipe surface should be more than 3°C above dew point temperature. Blast cleaned surface should be primed within 4 hours and shall be protected from rainfall or surface moisture and shall not be allowed to flash rust. If the rust occurs, the surface again to be prepared by sand blasting or wire brushing.

5.02.00 Application of Epoxy Coating

- a) Coating shall be applied when
 - i) When the pipe surface temperature shall be atleast 3°C above dew point temperature.
 - ii) The temperature of mixed coating material and the pipe at the time of application shall not be lower than 10°C or greater than 50°C.
- b) Material preparation shall be in accordance with manufacturer's recommendations.
- c) Application of epoxy coating system :

The epoxy coating system shall be applied as per recommendation of the manufacturer and shall be applied by airless spray / plural component spray machine. For more than one coat, the second shall be applied with the time limits as recommended by the manufacturer.

5.03.00 Application of PU Coating

- a) PU coating shall be applied when the pipe surface temperature atleast 3°C above dew point temperature (when R.H is more than 85%).
- b) Material preparation and application shall be done as per manufacturer recommendation.

6.00.00 TEST REQUIREMENTS :

6.01.00 Measurement of dry film thickness

Measurement of dry film thickness of coating : Coating thickness shall be in the range of $\pm 20\%$ and as per SSPC PA 2.

6.01.01 Apparatus / Instrument:-

The instrument used for dry film thickness may be Type 1 pull of gauges or Type 2 electronic gauges.

6.01.02 Procedures:-

- a) Number of measurements:
For 100 square feet (9.29 square meters), five (5) spots per test area (each spot is 3.8 cm) in diameter. Three gauge readings per spot (average becomes the spot measurement).
- b) If the structure is less than 300 square feet, each 100 square feet should be measured.
- c) If the structure is between 300 and 1000 sq ft, select 3 random 100 square feet test areas and measure.
- d) For structure exceeding 1000 square feet, select 3 random 100 square feet testing areas for the first 1000 sq ft and select 1 random 100 square feet testing area for each additional 1000 square feet
- e) Coating thickness Tolerance: Individual reading taken to get a representative measurement for the spot are unrestricted (usually low or high readings are discarded). Spot measurements (the average of 3 gauge readings) must be within 80% of the minimum thickness and 120% of the maximum thickness. Area measurement must be within specified range.

6.02.00 Electrical Inspection (Holiday) Test

- 6.02.01 All the coated / lined pipes shall be tested with an approved high voltage holiday detector preferably equipped with an audio visual signaling device to indicate any faults, holes, breaks or conductive particles in the protective coating.
- 6.02.02 The applied output voltage of holiday detector shall have a spark discharge of thickness equal to at least twice the thickness of the coating to assure adequate inspection voltage and compensate for any variation in coating thickness. The electrode shall be passed over the coated surface at approximately half the spark discharge distance from the coated surface only one time at the rate of approximately 10 to 20m/min. The edge effect shall be ignored. Excessive voltage shall be avoided as it tends to induce holiday in the coated surface thereby giving erroneous readings.
- 6.02.03 While selecting test voltages, consideration should be given to the tolerance on coating thickness and voltage should be selected on the basis of maximum coating thickness likely to be encountered during testing of a particular pipe.
- The testing voltage shall be calculated by using following formula. (as per NACE 0274 : 2004)
- Testing Voltage $V = 7900 \sqrt{T} \pm 10$ percent where T is the average coating thickness in mm.
- 6.02.04 Any audio visual sound or spark leads to indicate pinhole, break or conductive particle.
- 6.03.00 Adhesion Pull off Test :**
- After holiday the coated surface is subjected to adhesion pull off test as per ASTM D 4541.
- 6.03.01 Apparatus / Instrument: Adhesion tester consists of three basic components:
- A hand wheel, a black column containing a dragging indicator pin and scale in the middle and a base containing three legs and a pulling "Jaw" at the bottom and also dollies.
- 6.03.02 Prepare the test surface :
- Once test area is selected, test area shall be free of grease, oil, dirt, water. The area should be flat surfaces and large enough to accommodate the specified number of replicate test.
- 6.03.03 Prepare Dolly (Test Pull Stub) :

The dolly is a round, two sided aluminium fixture. Both sides of the dolly looks same, however, one side sloped on top surface while flat on bottom surface. As the surface of the dolly is polished aluminium, roughen the same using a coarse sand paper.

6.03.04 Select an adhesive:

Use araldite, a 100% solid epoxy adhesive. This adhesive requires at least 24 hours at room temperature to cure.

6.03.05 Attach the dolly to the surface.

- a) Using a wooden stick, apply an even layer of adhesive to the entire contact surface area of the dolly.
- b) Carefully remove the excessive adhesive by using a cotton swab. Allow the adhesive to fully cure before performing the adhesion test.
- c) Attach the dolly to the coated surface and gently push downward to displace any excessive adhesive.
- d) Push the dolly inward against the surface, then apply tape across the head of the dolly.

6.03.06 Adhesion Test Procedure

- a) Attach the adhesion tester to the dolly by rotating the hand wheel counter clockwise to lower the jaw of the device.
- b) Slide the jaw completely under the head of the dolly. Position the three legs of the instruments so that they are sitting flat on the coated surface.
- c) Slide the dragging indicator pin on the black column to zero by pushing it downward.
- d) Firmly hold the base of the instrument in one hand and rotate the handwheel clockwise to raise the jaw of the device that is attached to the head of the dolly. The dragging indicator pin will move upward on the black column as the force is increased and will hold the reading. Apply the tension using a moderate speed. Continue to increase the tension on the head of the dolly until (a) the minimum PSI/MPa/Kg/cm² required by project specification is exceeded and the test is discontinued, (b) the maximum PSI/MPa/Kg/cm² of adhesion tester has been achieved and dolly is still attached, (c) The force applied by the adhesion tester causes the dolly to dislodge.

e) Read the scale and record the adhesion value.

6.04.00 Coating Repair

Defective Coating shall be repaired in accordance with the following subsections.

6.04.01 Surface Preparation:

Accessible areas of pipe requiring coating repairs shall be cleaned to remove debris and damaged coating using surface grinders or other means. The adjacent coating shall be feathered by sanding, grinding or other method. Accumulated debris shall be removed by blowing with contaminant free air or wiping with clean rags.

6.04.02 Areas not accessible for coating repair such as interior surfaces of small diameter pipe shall be reprocessed and recoated.

6.04.03 Coating Application :

The coating system shall be applied to the prepared areas in accordance with procedure.

6.04.04 Repair Inspection :

Repaired portion shall be electrically inspected using a holiday detector.

6.05.00 Welded Field Joints

6.05.01 Preparation :

The weld joints shall be cleaned so as to be free from mud, oil, grease, welding flux, weld spatter and other foreign contaminants. The cleaned metal surfaces of the weld joint shall then be blasted or abraded using rotary abrading pads. The adjacent liquid Epoxy / PU coating shall be feathered by abrading the coating surface for a distance of 25 mm.

6.05.02 Electrical Inspection :

After curing the coating system applied to the welding joints shall be holiday tested. Any holidays indicated by the detector shall be marked with chalk to identify the area of repair.

7.00.00 INFORMATION/DATA REQUIRED

The Bidder shall submit complete list of paints and primers proposed, giving detail information, such as, chemical composition, drying time etc. and also unit rates for application of each type of paint along with supply shall be furnished.

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT****SPECIFICATION NO.**

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 1 of 12

SECTION C1 – F**DATASHEET A**



TITLE

4 X 270 MW BHADRADRI TPS TECHNICAL SPECIFICATION FOR PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 2 of 12

DATASHEET A FOR PT PLANT

1.0	INLET VALVES	
1.1	Inlet valves	One (1) number motorized butterfly flow control valve, located at inlet to aerator , with manual upstream and downstream isolation valves along with by-pass manual butterfly flow valve. Control valve shall have “auto manual” selection option, position indicator with “open-close” push buttons. Inching operation of valve shall be possible from OWS.
1.2	Inlet control valve size	Suitable to cater to total flow
1.3	Code	AWWA – C 504 for butterfly valve
1.4	Control	Under “Auto” mode of flow control valve, valve shall automatically maintain the level of water in the clarified water reservoir, i.e valve shall automatically close when reservoir level becomes high.
2.0	AERATOR	
2.1	Nos.	One (1)
2.2	Material of construction	RCC
2.3	Number of Steps	5 (Minimum).
2.4	Surface Velocity	20 CuM/Hr/SqM.
2.5	Height of each steps	200 to 300 mm.
3.0	STILLING CHAMBER	
3.1	No.	Two Number (2)
3.2	Purpose	To dampen out any turbulence of the incoming water.
3.3	Retention time	120 seconds minimum
3.4	Material of construction	RCC
3.5	Drain arrangement	Suitable draining arrangement shall be provided for the stilling chamber and drain lines shall be connected to sludge sump.
4.0	PARSHALL FLUME	
4.1	No.	Two Number (2)
4.2	Purpose	To measure flow.
4.3	Material of construction	RCC
5.0	INLET CHAMBER	
5.1	Nos.	One Number per clarifier
5.2	Retention time	60 seconds minimum
5.3	Capacity	Suitable to provide minimum one (1) minute retention time
5.4	MOC of Flash Mixer Pit	RCC
5.5	Agitator (MOC: SS 304)	One (1) for each inlet chamber
5.6	Motor rating for agitator	During Detail Engineering
5.7	Drain arrangement	Suitable draining arrangement shall be provided for the stilling chamber and drain lines shall be connected to sludge sump.
6.0	HRSCC (HIGH RATE SOLID CONTACT CLARIFIER)	
6.1	Number	Two Number (2)
6.2	Capacity (Net output)	Clarifier -1915 CuM/Hr (each).
6.3	Rise rate	2.5 CuM/Hr/SqM.
6.4	Side Water Depth (SWD)	4.5 m (minimum).
6.5	Sludge consistency	2%
6.6	Sludge Blow Off	By gravity through telescopic stand-pipe for continuous discharge and through manual operated blow-off valve for intermittent.
6.7	Platform with hand railing	Shall be provided (1.2 meter wide all along Clarifier)
6.8	Rake bridge	Full Bridge (fixed type) Shall be provided (MOC: MS epoxy painted as per IS 2062).
6.9	Flocculation agitator	Minimum four (4) nos. for each clarifier.



TITLE

4 X 270 MW BHADRADRI TPS TECHNICAL SPECIFICATION FOR PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 3 of 12

6.9.1	Type	Vertical, slow speed motor-reduction gear driven, paddle type and shall be suitably braced to provide rigidity.
6.9.2	Material	SS as per AISI-304 (shaft and paddle)
6.10	Overflow weir/peripheral orifice	Shall be provided by bidder
6.10.1	Location	To be fixed in the overflow launder of clarifier.
6.10.2	Type	Open type all along the periphery of clarifier.
6.10.3	Weir loading	Not to exceed 300 cu.m/m/day.
7.0	CLARIFIER SCRAPPERS	
7.1	Type	Designer's Design Specific
7.2	Number required	One per clarifier.
7.3	Material	Mild steel (MS).
7.4	Protective coating	All wetted portion painted with minimum three (3) coats of epoxy resin paint, over two (2) coats of epoxy based primer.
7.5	Traction drive	Slow speed motor driven.
8.0	SUITABLE ACCESSORIES	
8.1	Access ladder, platform, staircase, hand railings etc.	Shall be provided of structural steel by bidder
8.2	Walkway	Shall be provided with hand railings around launder periphery of width 1200 mm.
8.3	Electrical requirements	For each Clarifier, one (1) Distribution Board to be located on Clarifier bridge for all drives of Clarifier bridge assembly.
9.0	SLUDGE COLLECTION PIT	
9.1	Number	One (1) with two compartments.
9.2	Capacity (effective)	Each compartment shall be sized for 1 hrs sludge generation from all running clarifier.
9.3	Dimension	Suitable
9.4	Material	RCC with epoxy paint.
9.5	Location	Inside PT plant
9.6	Isolation gates with hand wheel and penstock	One (1) number at inlet and One (1) number at outlet of each compartment.
9.7	Air blower for sludge pit	
9.7.1	Quantity	Two Numbers (2X100 %).
9.7.2	Type	Centrifugal Twin Lobe Type
9.7.3	Duty	Intermittent
9.7.4	Capacity & Head	As required
9.7.5	MOC	Casing-CI IS-210 FG 260, Shaft-CS to EN8 (BS 970), Lobe-CI IS 210 FG 260
9.7.6	Accessories Required	Suction Filter, Silencer, relief Valve etc
10.0	THICKENER	
10.1	Type	Circular (Center Drive Mechanism).
10.2	MOC	RCC.
10.3	Number	1 No (1X100 %)
10.4	Capacity	100 m3/hr
10.5	Minimum solid loading	25 Kg./day/M2.
10.6	Maximum solid loading	80 Kg./day/M2.
10.7	Thickened sludge consistency	6% (min.).
10.8	Full bridge	Shall be provided by bidder
10.9	Scraper rake	Shall be provided by bidder
10.10	Torque switch for alarm and for tipping	Shall be provided by bidder
10.11	Side water depth	4.5 Meter (Minimum) + 500 MM free board.



TITLE

4 X 270 MW BHADRADRI TPS TECHNICAL SPECIFICATION FOR PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 4 of 12

11.0	THICKENED SLUDGE SUMP	
11.1	Number	One (1) number.
11.2	Capacity (effective)	Two hours sludge storage capacity from thickener.
11.3	Material	RCC.
12.0	CENTRIFUGE	
12.1	Number	3 Nos (2W+1S).
12.2	Type	Variable differential speed control type.
12.3	Lining material of scrapper bowl	Tiles.
12.4	Capacity (each)	17 m3/hr
12.5	Thickened sludge consistency	20-25 %.
12.6	Screening at inlet	Shall be provided by bidder.
12.7	Location	At suitable height to take the sludge directly to dumper Trolley.
12.8	Bowl & scrapper material	SS 304
12.9	All wetted parts	SS-304.
12.10	Conveyor differential speed variation arrangement.	Shall be provided by bidder
12.11	Bowl wear protection lining	Shall be provided by bidder (SS-304).
12.12	Feed Nozzle	SS-304 (hole coated with sintered tungsten carbide).
12.13	Travelling trolley	Two nos.
12.14	Handling arrangement	Electric monorail hoist one no. of 1 T capacity
13.0	CHEMICAL HOUSE	
13.1	Number	One (1).
13.2	Type	Two storied building of civil construction.
13.3	Building dimensions	As per specification Requirement.
13.4	Ground floor	Storage of chemical required for lime, Alum and Poly Electrolyte dosing for 15 days storage capacity and MCC Room.
13.5	First floor	All chemical dosing tanks, pumps and PLC room.
14.0	WEIGHING SCALE FOR CHEMICAL	
14.1	Type	Platform, dial type.
14.2	Number	One (1)
14.3	Capacity	0-1000 Kgs
15.0	ELECTRIC HOIST	
15.1	Type	Electric monorail hoist on ground floor and first floor of chemical house
15.2	Number	Two (2)
15.3	Capacity	1 T
16.0	PRESSURE SAND FILTER	
16.1	Type	Vertical Shell Type with dished ends
16.2	Numbers and Design Flow (Net output)	One (1) no @ 10 CuM/Hr for Plant Potable water
16.3	Design Surface Flow Rate and Design pressure at design flow	Not more than 10 M3/M2/Hr and 10 Kg/Cm2 (minimum)
16.4	Media Type	Sand/Gravel
16.5	Fill	Bed Depth not less than 1000 mm (excluding supporting material)
16.6	Supporting Material for the fill	As per manufacturer standard
16.7	Shell & Dish End Material	Shell: Carbon Steel as per IS 2062 Gr. B, Dish end: Carbon Steel as per IS 2002 Gr. 2A
16.8	Internal Painting	Three (3) coats of solvent free epoxy finish paint over two (2) coats epoxy based primer. (To be compatible for drinking water).



TITLE

4 X 270 MW BHADRADRI TPS TECHNICAL SPECIFICATION FOR PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 5 of 12

16.9	External Painting	Three (3) coats of epoxy finish paint over two (2) coats epoxy based primer or as per painting schedule (PE-DC-281-100-A999) whichever is superior.
16.10	Manhole	One (1).
16.11	Sight windows with minimum clear width of 75 mm	Two (2).
16.12	Intervals between two successive backwash	24 hrs
16.13	Design code	As per IS 2825 or ASME Section-VIII.
16.14	Free board	100% (minimum).
16.15	Filter Media Trap	Shall be provided at filter outlet and backwash water outlet of each filter.
16.16	Air Scouring Blower	Two Numbers (2X100 %).
16.16.1	Type	Centrifugal Twin Lobe Type
16.16.2	Duty	Intermittent
16.16.3	Capacity & Head	As required
16.16.4	MOC	Casing-CI IS-210 FG 260, Shaft-CS to EN8 (BS 970), Lobe-CI IS 210 FG 260
16.16.5	Accessories Required	Suction Filter, Silencer, relief Valve etc
17.0	FILTERED WATER OVERHEAD TANK	
17.1	Capacity (Net)	To suit the system requirement
17.2	Location	Top of Chemical House.
17.3	Nos.	One (1)
17.4	Material	RCC
17.5	Free board over the maximum water level	200 mm
18.0	CHEMICAL DOSING	
18.1	POLYMER DOSING SYSTEM FOR CLARIFIER (@ 1 ppm)	
	a) Tank –	Number-Two Number (1W+1S/Under Preparation) Capacity (effective) - Each tank to store 12 Hrs storage capacity of 0.5% PE solution +20% margin including freeboard to dose PE to all clarifiers. Type – vertical cylindrical. Material- MSRL (4.5 MM Thick RL), IS 2062, Gr. B. Motorized Stirrer (MOC-SS 316)- One (1) number per tan (Top mounted)
	b) Pump -	Number-Two (2) numbers (1W+1S). Type – Plunger Type positive displacement pump. Capacity and Head- As per requirement. Material- All Wetted Parts SS-316, Shaft-EN19, Casing-CI to Is 210 Gr. FG220.
18.2	POLYMER DOSING SYSTEM FOR THICKENER (@ 5 ppm)	
	A) Tank –	Number-Two Number (1W+1S/Under Preparation). Capacity (effective) - Each tank to store 12 Hrs storage capacity of 0.5% PE solution +20% margin including freeboard to dose PE to Thickener.



TITLE

4 X 270 MW BHADRADRI TPS TECHNICAL SPECIFICATION FOR PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 6 of 12

		Type – vertical cylindrical. Material- MSRL (4.5 MM Thick RL), IS 2062, Gr. B. Motorized Stirrer (MOC-SS 316)- One (1) number per tank (Top mounted)
	B) Pump -	Number-Two (2) numbers (1W+1S). Type – Plunger Type positive displacement pump. Capacity and Head- As per system requirement. Material- All Wetted Parts SS-316, Shaft-EN19, Casing-CI to Is 210 Gr. FG220.
18.3	POLYMER DOSING SYSTEM FOR CENTRIFUGE (@ 30 ppm)	
	B) Tank –	Number-Two Number (1W+1S/Under Preparation). Capacity (effective) - Each tank to store 12 Hrs storage capacity of 0.5% PE solution +20% margin including freeboard to dose PE to all running Centrifuge. Type – vertical cylindrical. Material- MSRL (4.5 MM Thick RL), IS 2062, Gr. B. Motorized Stirrer (MOC-SS 316)- One (1) number per tank (Top mounted)
	B) Pump -	Number-Two (2) numbers (1W+1S). Type – Plunger Type positive displacement pump. Capacity and Head- As per system requirement. Material- All Wetted Parts SS-316, Shaft-EN19, Casing-CI to Is 210 Gr. FG220.
18.4	ALUM DOSING SYSTEM (@ 70 ppm)	
	A) Tank –	Number-Two Number (1W+1S/Under Preparation). Capacity (effective) - Each tank to store 12 Hrs storage capacity of 5% Alum solution +20% margin including freeboard to dose Alum to all clarifiers. Type – vertical cylindrical. Material- MSRL (4.5 MM Thick RL), IS 2062, Gr. B. Motorized Stirrer (MOC-SS 316)- One (1) number per tank (Top/Side mounted). Dissolving Basket-One Per Tank (MOC: SS 316)
	B) Pump-	Number-Two (2) numbers (1W+1S). Type – Plunger Type positive displacement pump. Capacity and Head- As per system requirement. Material- All Wetted Parts SS-316, Shaft-EN19, Casing-CI to Is 210 Gr. FG220.
18.5	LIME DOSING SYSTEM (@ 30 ppm)	
	A) Tank –	Number-Two Number (1W+1S/Under Preparation). Capacity (effective) - Each tank to store 12 Hrs storage capacity of holding lime solution (of about 6% W/V concentration) + 20% margin including freeboard to dose lime to all clarifiers. Material- RCC Motorized Stirrer (MOC-SS 316)- One (1) number per tank (Top/Side mounted). Dissolving Basket-One Per Tank (MOC: SS 316)
	Pump-	Two (2 x 100% capacity) numbers of horizontal centrifugal types each suitable for lime to all the clarifiers at design dosage rate (suitable for lime of 6% W/V strength) whichever is higher and head as required. Semi-open type impeller shall be provided. Shaft sealing shall be thru Gland packing (TIWA) or Mechanical seal as per manufacturer's standard.



TITLE

4 X 270 MW BHADRADRI TPS TECHNICAL SPECIFICATION FOR PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 7 of 12

		Casing, Gland and Stuffing Box shall be of 2.5 Ni Cast Iron to IS:210 Grade FG 260. Impeller, Wearing rings (as applicable) shall be of Stainless Steel -316 grade and Shaft & Shaft sleeves shall be of SS-410 grade. Pump re-circulation line shall be provided for all the pumps. Pumps shall be provided with accessories such as Y-type suction strainers, Pressure Gauge, Coupling guard, drain plugs, vent valves etc.

19.0 MOC and type of the pumps shall be as per the following details.

	Pump Description	Quantity	Pump Type	Capacity	Material of Construction
19.1	Sludge transfer pump	Two (2X100%)	Vertical Centrifugal Impeller open	100 CuM/Hr. (each).	Casing – 2% Ni Cast Iron. Pump shaft/line shaft – EN8. Impeller – SS 304.
19.2	Thickened sludge transfer pump	Three (3X50%)	Single screw, vertical	17 CuM/Hr. (each).	Casing – rust proof stainless steel. Stator- rubber. Rotor- Cr-Ni steel. Pump shaft/line shaft – EN8.

20.0 VALVES

BUTTERFLY VALVE

Butterfly valves shall be of Lugged wafer type of low leakage rate confirming to AWWA-C-504 class 150 (min.) or BS:5155 PN 10 (min.)

Body: cast Iron IS:210 Gr. FG 260

Disc: SS 316.

Shaft:ASTM.A296 Gr. CF8M

Seat rings:Nitrilerubber,EPDM,Hypalon

All the butterfly valves shall be provided with Hand wheel or lever as per the requirements.

All the butterfly valves shall be provided with an indicator to show the position of the disc. Flanges shall conform to ANSI B 16.5 Cl.150 (min).

DIAPHRAGM VALVE

The Diaphragm shall conform to following requirement

i) Design standard: BS:5156 or equivalent of required rating/class. (minimum rating of valves shall be PN 10).

ii) Type: Flanged and lined body ends, sealed bonnet, weir pattern, tight shut off type

iii) Material of Construction

- Body , Bonnet: Cast iron IS 210 Gr. FG 260 or equivalent or Cast steel ASTM A-216 Gr. WCB
- Body lining : Soft natural rubber, ebonite , Polypropelene
- Handwheel : Cast Iron
- Compressor : Stainless Steel
- Stem and Bush : Stainless Steel

GATE VALVE

Body: CI 210 Gr FG 260.

Type :Outside screw and rising stem type

Stem,seat ring and wedge facing ring:SS,

Rating: PN 10 (min).

Other parts of the valve:As per IS:14846.

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT****SPECIFICATION NO.**

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 8 of 12

BALL VALVE/PLUG VALVE

Type :Full bore

Rating: PN 10 (min).

Body: cast Iron/carbon steel

Ball: stainless steel

Seat ring: PTFE

Stem: Stainless steel

Seat:Nitrile rubber,PTFE

GLOBE

Type: Double flanged.

Rating: PN 10 (min).

Body: Cast iron:IS 210 Gr FG260

Stem:stainless steel.

NON RETURN VALVE

These valves shall be swing check type or dual plate type

Swing check type (non corrosive application)

Body and disc : Cast iron.

Hinge pin and door/disc pin: Cast steel ASTM A216 Gr.WCB

Disc facing ring: stainless steel

Body Seat ring: Stainless steel

For application of lime, corrosive water, and air, the body, cover and disc shall be lined with natural rubber, PTFE or Viton. Bolting shall be stainless steel.

For all chemical handling valves shall be of SS 304 (body and wetted parts).

DATA SHEET A FOR ELECTRIC HOIST

Sl.no	DESCRIPTION	TECHNICAL PARTICULARS
1.0	Type	Steel wire electric hoist with electrically operated trolley
2.0	Scope (Qty., Capacity, Lift, Travel Length)	As per specification and layout requirement
3.0	Type of service	Indoor
4.0	Overload test	125% of SWL
5.0	Design Ambient temperature	50° C
6.0	General Design	As per IS: 3938 / 1983 or latest, Class-II duty
7.0	Operating speed	
7.1	Hoisting speed	3 MPM.
7.2	Trolley speed	15 MPM
8.0	Type of transmission	Through Electric motor and gear box.
9.0	Wire Rope	
9.1	Construction / core	6 x36/ 6X37 (Steel core / fibre core)
9.2	Code	IS:2266
9.3	Number of falls	Min. 4
9.4	Factor of safety	Not less than 5


TITLE

4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 9 of 12

10.0	Load Hook and block	NORMALISED HOOK ONLY
10.1	Type of load hook	Plain shank trapezoidal section with safety latch.
10.2	Load hook Code	IS: 15560
10.3	Load hook Material	As per IS:15560
10.4	Hook suspension	Thrust bearing
10.5	Material of block suspension	Fabricated from steel plate, Material: IS: 2062
11.0	Gearing	
11.1	Type	Spur / Helical
11.2	Gear/ pinion material	as per IS 3938
11.3	Lubrication	Oil splash/ grease lubricated
11.4	Bearing type	Antifriction Ball / Roller
12.0	Trolley drive	
12.1	Wheel	Single flange taper thread
12.2	Wheel conform to (Std. / code)	IS: 3938
12.3	Wheel material	C55Mn75/ En-8/ En-9. (Max hardness 200 BHN)
12.4	Bearing type	Antifriction Ball / Roller
12.5	Trolley type	Rolled structural steel with side plates extended beyond wheel flanges to protect wheels.
12.6	Hardness	Max hardness 200 BHN
13.0	SHEAVE	
13.1	Material	Fabricated from steel plate. IS: 2062 Gr. A or Gr. B / as per IS: 3938
13.2	Bearing type	Antifriction Ball / Roller.
14.0	BRAKE (HOIST and TROLLEY)	
14.1	Type	DC EM brakes disc type (fail to safe).
14.2	Capacity	As per IS 3938.
14.3	Number	One number for each motor.
15.0	ROPE DRUM	
15.1	Material	Cast iron, cast steel or mild steel.


TITLE

4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 10 of 12

15.2	Flange / Flangeless	Flanged	
15.3	Type of groove	As per manufacturers standard to suit the layout requirement.(Shall be decided during detail engineering)	
17.0	TYPE OF DSL		
17.1	CT travel	PVC Shrouded bus bar conductor type DSL	
18.0	MOTORS		
18.1	Type	Sq. Cage induction, TEFC, S4 duty, 40% CDF.	
18.2	Number of start	150 starts / hr	
18.3	Voltage , Phase and Frequency	415V ±10%, 3 phase, 4 wire, 50 Hz	
18.4	Class of insulation	Class “F” and temperature rise limited to class B.	
18.5	Type of enclosure	TEFC	
18.6	Degree of protection provided for enclosure	IP-54/IP-55 depending upon Indoor / Outdoor application	
18.7	Margin	Motor rating will be calculated keeping margin of at least 10% over the maximum power requirement in the duty condition specified.	
19.0	LIMIT SWITCHES	Hoisting	Trolley
19.1	Type	Snap action, self actuating type	Lever type
20.0	Control panel	* Fabricated from Cold rolled sheet steel not less than 2.5mm for front & rear & 2mm for side, top & bottom portion with gland plate of 3mm thick. * Degree of protection shall be IP 54. * Power on indicating lamps shall be provided * Panel illumination lamps operated by door switch. * 2 nos earthing terminals on panel. * 20 % spares terminals (clip on type) shall be provided. * Power and control terminals (clip on type) shall be on separate channels. * Gland plate shall be double brass compression type.	
20.1	Qty	1 No.	
21.0	Pendent Push buttons	Up /down / forward / Reverse push buttons. Indicative marking for easy operation shall be provided.	
22.0	Power cables	FRLS / EPR flexible Cu cable / Aluminum cable	
23.0	Control cable	FRLS / EPR flexible Cu cable / Aluminum cable	
24.0	Control Voltage	110 V	



TITLE

4 X 270 MW BHADRADRI TPS TECHNICAL SPECIFICATION FOR PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 11 of 12

DATA SHEET A FOR CHAIN PULLEY

1	Type	Chain pulley block with/without travelling trolley
2	General Design	IS: 3832
3	Duty Class as per IS:3832	Class –II
4	Hoisting Mechanism	
a)	Type	Hand operated gear transmission
b)	Type of gear	Spur / Helical
c)	Load Chain	
i)	Type	Link type
ii)	Material	T (8) as per IS: 6216
iii)	Conforms to (Std./Code)	IS: 6216
d)	Hand Chain	
i)	Type	Link type
ii)	Material	Mild steel Grade 30
iii)	Conform to Std.	IS:2429 (Part I)
e)	Load Hook & Hook Block	
i)	Type of load hook	Plain shank- Trapezoidal section
ii)	Load hooks conforms to	IS: 15560
iii)	Type of hook suspension	Swivelling type with lock
iv)	Type of make of bearing	Thrust ball bearing of hook suspension
v)	Type & Material of hook	Carbon steel/forged steel As per IS 15560
f)	Gears/ Pinion	
i)	Type	Spur
ii)	Material	Alloy steel / carbon steel
iii)	Type of Bearing	Antifriction ball bearing / Roller
h)	Sprockets:	
	Type of bearings used	Antifriction ball bearing / Roller
i)	Method of lubrication	
	Bearings	Grease
	Gearing & Pinions	Grease
	Sprockets	Grease
j)	Brakes	
	Type	Screw and friction disc type
5	Trolley and Bridge drive	
a)	Trolley	
i)	Type	Geared (Manually operated)
ii)	Material of frame	Mild steel (IS:2062 Grade A or B)
b)	Drive Chain	
i)	Type	Link type
ii)	Material	Steel Gr.30 as per IS 2429 (part 1)

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 12 of 12

c)	Wheel	
i)	Number of pairs of wheel	Two in each trolley/bridge
ii)	Flange	Single flanged
iii)	Wheel material	Cast Iron Gr. FG 200 as per IS:210
iv)	Type of bearings need	Antifriction
d)	Gears	
i)	Type	Spur / helical
ii)	Material	EN8
iii)	Type of bearings used	Antifriction
e)	Method of lubrication for	
i)	Bearings	Grease
ii)	General	Grease
iii)	Sprockets	Grease
6	Painting	As per manufacturer standard

**TITLE**

**4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE-TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 1 of 3

SECTION – C2**SPECIFIC TECHNICAL REQUIREMENTS FOR ELECTRICAL**

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE-TREATMENT PLANT****SPECIFICATION NO.**

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 2 of 3

1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER:

- a) Services and equipment as per “Electrical Scope between BHEL and Vendor”.
- b) Any item/work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the work for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification. The same shall be provided by the bidder without any extra charge.
- c) Supply of mandatory spares as specified in the specifications of mechanical equipments.
- d) Bidder shall furnish all AC as well as DC loads required for the system at different voltage levels (eg. 415V AC, 240 V AC, 220 V DC etc.) of all types, such as motor feeders, supply feeders in PEM format along with the offer.
- e) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.
- f) Bidder to furnish list of makes for each equipment at contract stage, which shall be subject to customer/BHEL approval without any commercial and delivery implications to BHEL.
- g) Various drawings, data sheets as per required format, Quality plans, calculations, test reports, test certificates, operation and maintenance manuals etc shall be furnished as specified at contract stage. All documents shall be subject to customer/BHEL approval without any commercial implication to BHEL.
- h) Motor shall meet minimum requirement of motor specification.
- i) Vendor to clearly indicate equipment locations and local routing lengths in their cable listing furnished to BHEL.
- j) Cable BOQ worked out based on routing of cable listing provided by the vendor for “ both end equipment in vendor’s scope”shall be binding to the vendor with +10 % margin to take care of slight variation in routing length & wastages.

2.0 EQUIPMENT & SERVICES TO BE PROVIDED BY PURCHASER FOR ELECTRICAL & TERMINAL POINTS:

Refer “Electrical Scope between BHEL and Vendor”.

3.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

- 3.1 The electrical specification without any deviation from the technical/quality assurance requirements stipulated shall be deemed to be complied by the bidder in case bidder furnishes the overall compliance of package technical specification in the form of compliance certificate/No deviation certificate.
- 3.2 No technical submittal such as copies of data sheets, drawings, write-up, quality plans, type test certificates, technical literature, etc, is required during tender stage. Any such submission even if made, shall not be considered as part of offer.

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE-TREATMENT PLANT****SPECIFICATION NO.**

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 3 of 3

4.0**List of enclosures :**

- a) Electrical scope between BHEL & vendor
- b) Standard BHEL specification for motors (Volume D2).
- c) Quality plan for motors (Section C1-D).
- d) Electrical Load data format
- e) BHEL cable listing format

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGES: PRE-TREATMENT PLANT

SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT

PROJECT: 4X270MW TSEGENO BHADRADRI TPS

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V MCC	BHEL	BHEL	240 V AC (supply feeder)/415 V AC (3 PHASE 4 WIRE) supply shall be provided by BHEL based on load data provided by vendor at contract stage for all equipment supplied by vendor as part of contract. Any other voltage level (AC/DC) required will be derived by the vendor.
2	Local Push Button Station (for motors)	BHEL	BHEL	Located near the motor.
3	Power cables, control cables and screened control cables for a) both end equipment in BHEL's scope b) both end equipment in vendor's scope c) one end equipment in vendor's scope	BHEL BHEL BHEL	BHEL Vendor BHEL	1. For 3.b) & c): Sizes of cables required shall be informed by vendor at contract stage (based on inputs provided by BHEL) in the form of cable listing. Finalisation of cable sizes shall be done by BHEL. Vendor shall provide lugs & glands accordingly. 2. Termination at BHEL equipment terminals by BHEL. 3. Termination at Vendor equipment terminals by Vendor.
4	Junction box for control & instrumentation cable	Vendor	Vendor	Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 10-12 mtrs) and trunk cable.
5	Any special type of cable like compensating, co-axial, prefab, MICC, optical fibre etc.	Vendor	Vendor	Refer C&I portion of specification for scope of fibre Optical cables if used between PLC/ microprocessor & DCS.
6	Cable trays, accessories & cable trays supporting system 100/ 50 mm cable trays/ Conduits/ Galvanised steel cable troughs for local cabling	BHEL Vendor	BHEL Vendor	Local cabling from nearby main route cable tray (BHEL scope) to equipment terminal (vendor's scope) shall be through 100/ 50 mm. cable trays/ conduits/ Galvanised steel cable troughs, as per approved layout drawing during contract stage.
7	Cable glands ,lugs and bimetallic strip for equipment supplied by Vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty tinned copper lugs for power and control cables.
8	Conduit and conduit accessories for cabling between equipment supplied by vendor	Vendor	Vendor	Conduits shall be medium duty, hot dip galvanised cold rolled mild steel rigid conduit as per IS: 9537.
9	Lighting	BHEL	BHEL	
10	Equipment grounding (including electronic earthing) &	BHEL	BHEL	Refer note no. 4 for electronic earthing

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGES: PRE-TREATMENT PLANT

SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT

PROJECT: 4X270MW TSEGENO BHADRADRI TPS

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
	lightning protection			
11	Below grade grounding	BHEL	BHEL	
12	LT Motors with base plate and foundation hardware	Vendor	Vendor	Makes shall be subject to customer/ BHEL approval at contract stage.
13	Mandatory spares	Vendor	-	Vendor to quote as per specification.
14	Recommended O & M spares	Vendor	-	As specified elsewhere in specification
15	Any other equipment/ material/ service required for completeness of system based on system offered by the vendor (to ensure trouble free and efficient operation of the system).	Vendor	Vendor	
16	a) Input cable schedules (Control & Screened Control Cables) b) Cable interconnection details for above c) Cable block diagram	Vendor Vendor Vendor	- - -	Cable listing for Control and Instrumentation Cable and electronic earthing cable in enclosed excel format shall be submitted by vendor during detailed engineering stage.
17	Electrical Equipment & cable tray layout drawings	Vendor	-	For ensuring cabling requirements are met, vendor shall furnish Electrical equipment layout & cable tray layout drawings (both in print form as well as in AUTOCAD) of the complete plant (including electrical area) indicating location and identification of all equipment requiring cabling, and shall incorporate cable trays routing details marked on the drawing as per PEM interface comments. Cabling arrangement of the same (wherever overhead cable trays, trenches, cable ducts, conduits etc.) shall be decided during contract stage. Electrical equipment layout & cable tray layout drawing shall be subjected to BHEL/ customer approval without any commercial implications to BHEL.
18	Electrical Equipment GA drawing	Vendor	-	For necessary interface review.

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGES: PRE-TREATMENT PLANT

SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT

PROJECT: 4X270MW TSEGENO BHADRADRI TPS

NOTES:

1. Make of all electrical equipment/ items supplied shall be reputed make & shall be subject to approval of BHEL/customer after award of contract.
2. All QPs shall be subject to approval of BHEL/customer after award of contract without any commercial implication.
3. In case the requirement of Junction Box arises on account of Power Cable size mis-match due to vendor engineering at later stage, vendor shall supply the Junction Box for suitable termination.
4. Vendor shall indicate location of Electronic Earth pit in their Civil assignment drawing.

REV: 00 DATE:

STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (FOR EPC PROJECTS)

PACKAGE: CW/RW/PW CHLORINATION PLANT

PROJECT : 4 X 270 MW BHADRADRI TPS

SCOPE OF VENDOR: SUPPLY , ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT

<u>S. NO</u>	<u>DETAILS</u>	<u>SCOPE SUPPLY</u>	<u>SCOPE E&C</u>	<u>REMARKS</u>
1	Isolating Switch	Vendor	Vendor	BHEL will provide one number 415 V(3ph, 4W) supply feeder only up to isolating switches for cranes. Any other voltage level (AC/DC) required will be derived by the vendor. Motor starter shall be part of crane control panel.
2	Power cables, control cables, screened control cables and any special cables (if required) between equipment supplied by vendor.	Vendor	Vendor	Cable from supply feeder to isolating switch shall be in BHEL scope.
3	Cabling material (cable trays, accessories, cable tray supporting system, conduits etc).	Vendor	Vendor	
4	Equipment Earthing	Vendor	Vendor	All equipment metallic enclosures / frames, metal structure etc. shall be grounded at two points each to the nearest grounding points / risers provided by BHEL.
5	Motors	Vendor	Vendor	
6	Cable glands and lugs for equipment supplied by vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty tinned copper lugs for power & control cables.
7	a) Input cable schedules (C & I) b) Cable interconnection details for above c) Cable block diagram	Vendor Vendor Vendor	- - -	Cable listing for Control and Instrumentation Cable in enclosed excel format shall be submitted by vendor during detailed engineering stage.
8	Equipment layout drawings	Vendor	-	
9	Electrical Equipment GA drawing	Vendor	-	For necessary interface review.

CABLE SCHEDULE FORMAT

[illegible]

[illegible]

**TITLE**

4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PACKAGES

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 1 of 1

SECTION – C3

SPECIFIC TECHNICAL REQUIREMENTS FOR CONTROL AND
INSTRUMENTATION



**SPECIFIC TECHNICAL REQUIREMENT FOR
4X270 MW BHADRADRI TPS**

SPECIFICATION NO. PE-TS-411-158A-A001

VOLUME **II-B**

SECTION - C3

REV. NO. 00

DATE: 19.03.2015

SHEET

OF

1. Bidder to include Field instrumentation along with necessary fittings, accessories and valve manifold etc. and Field Junction Box (JB's), in his scope of supply. Each instrument/ equipment shall have a unique KKS Tag no. Field instrument specification and Data Sheet are given elsewhere in this specification. Bidder to provide local control panel wherever required.
2. All fields cabling for instruments/motor/pump/blower to JB is in bidder's scope and details are given elsewhere in the specification. The field I/O s should be grouped together in JB's suitably and a common trunk cable shall be taken to the panel. Cable between JB to PLC shall be provided by BHEL as free issue as per 'Electrical scope split sheet' in Electrical portion of the specification whereas cable schedule, cable interconnection details and wiring diagram for the same shall be in bidders' scope.
3. Cable schedule, cable interconnection details and wiring diagram where one end equipment and/or both end equipments are in bidder scope shall be provided by the bidder.
4. Instrument installation drawings are to be provided by bidder. All instrument fitting and erection hardware/racks as per instrument installation diagram shall be in bidder's scope.
5. All manual valves at pump discharge shall be provided with Open and Close Limit Switches.
6. PLC control system as defined in the enclosed specification and Data Sheets shall be in bidder scope. The PLC system shall comprise of (i) PLC based local panel (ii) UPS Power supply (iii) Operator interface in the form of CRT, keyboard and OWS along with required furniture.
7. PLC shall have the facility to synchronize its time with BHEL plant master clock system using IRIG-B signals. Necessary Hardware (IRIG-B port) for same at PLC end to be provided by bidder. The cable connecting PLC and plant master clock system shall be in BHEL scope.
8. PLC shall be connected to DCS through serial link with OPC Compliant for monitoring/Control. For details, please refer PLC Configuration Diagram.
9. All furniture (tables, chairs etc.) required for PLC operator HMI shall be in bidder's scope. Chairs shall be capable of being adjusted for height and position of backrest. The chairs shall be mounted on five castors, shall swivel and shall have arm rests'. One table and chair shall be provided for each operator station and separate table for each printer.



**SPECIFIC TECHNICAL REQUIREMENT FOR
4X270 MW BHADRADRI TPS**

SPECIFICATION NO. PE-TS-411-158A-A001

VOLUME **II-B**

SECTION : - C3

REV. NO. 00

DATE: 19.03.2015

SHEET

OF

10. The requirements given below are to be read in conjunction with detailed Technical specification enclosed.
11. For instrument and control cable scope of supply, refer 'Electrical scope split sheet' in Electrical portion of the specification.
12. Bidder shall provide at least 20% or minimum two numbers, spare channels each type.
13. Every panel-mounted instrument, requiring power supply, shall be provided with a pair of easily replaceable glass cartridge fuses of suitable rating. Every instrument shall be provided with a grounding terminal and shall be suitably connected to the panel grounding bus.
14. Supplied system shall provide critical group alarms for the system to be hardwired to plant DCS.
15. Provision for input fire signal from fire alarm system to be ensured in the PLC panel for opening/ closing of the motor operated fire dampers.
16. Provision for separate Terminal block/wiring diagram for power and control blocks of control panel to be ensured.
17. Provision for earthing of the panel to be provided by vendor.
18. Vendor to submit GA drawing of control panel indicating layout of instruments, construction details, wiring diagram, class of protection for enclosure, paint type, paint color, thickness and material of enclosure sheet, control scheme during detailed engineering.
19. Layout & space requirement of panel to be specified during detailed engineering.
20. All bidirectional drives (Motor Operated Valves, MOVs) are integral starter type. Typical Hook Up diagram of all types of drives is attached for use(subject to Customer approval).
21. Bidder shall provide Cable Schedule in BHEL excel format provided in Electrical portion of the specification. Also, Cable Interconnections details for Complete System shall be in Bidders' scope.
22. 415 V AC (3 Phase, 3 Wire) supply shall be provided by BHEL at a single point as per 'Electrical scope split sheet' in Electrical portion of the specification. Further distribution to various instruments/Equipment shall be in Bidder's

	SPECIFIC TECHNICAL REQUIREMENT FOR 4X270 MW BHADRADRI TPS	SPECIFICATION NO. PE-TS-411-158A-A001	
		VOLUME II-B	
		SECTION : - C3	
		REV. NO. 00	DATE: 19.03.2015
		SHEET	OF

scope. Bidder to include the necessary power distribution board in his scope. Any power supply other than the above, if required for any instrument/equipment has to be derived from the above supply & all the necessary hardware for the same shall be in Bidder's scope.

23. Bidder to provide all control panels, system cabinets, termination & relay cabinets complete with all accessories, wiring and all mounting and erection hardware including junction boxes, canopies, structural steel as required. All instruments/drives shall be terminated on Junction Boxes/Panel in Bidder scope of supply. 20% Spare terminals shall be provided on Junction Boxes.
24. Bidder to delegate/depute their person/experts as per owner/consultant requirements.
25. The make of all the items shall be from approved sub-vendor list.
26. The design, manufacture, inspection, testing, site calibration and installation of all C&I equipment and systems covered under this specification shall conform to the latest editions of applicable codes and standards eg. ANSI, ASME, IEEE, ISO, IEC, IGCI, AWS, NFPA, AISC, IGS, SAMA, UBC, UL, NESC, NEMA, ISA, DIN, VDE, IS etc.
27. Bidder shall provide the signal exchange, to Plant DCS in BHEL prescribed format to be furnished during detailed engineering.

NOTES:

1. All equipment items shall be of latest design with proven on track record from reputed experienced manufacturers of specified type and range of equipment. The make/model of various instruments/items/systems and instrument sub-vendor shall be subject to approval of BHEL/Customer during detailed engineering stage.
2. The above given scope is indicative & minimum. Any item/ equipment not indicated above however required for the completeness of the system is to be supplied by bidder without any technical, commercial and delivery implication to BHEL.



**SPECIFIC TECHNICAL REQUIREMENT FOR
4X270 MW BHADRADRI TPS**

SPECIFICATION NO. PE-TS-411-158A-A001

VOLUME **II-B**

SECTION : - C3

REV. NO. 00

DATE: 19.03.2015

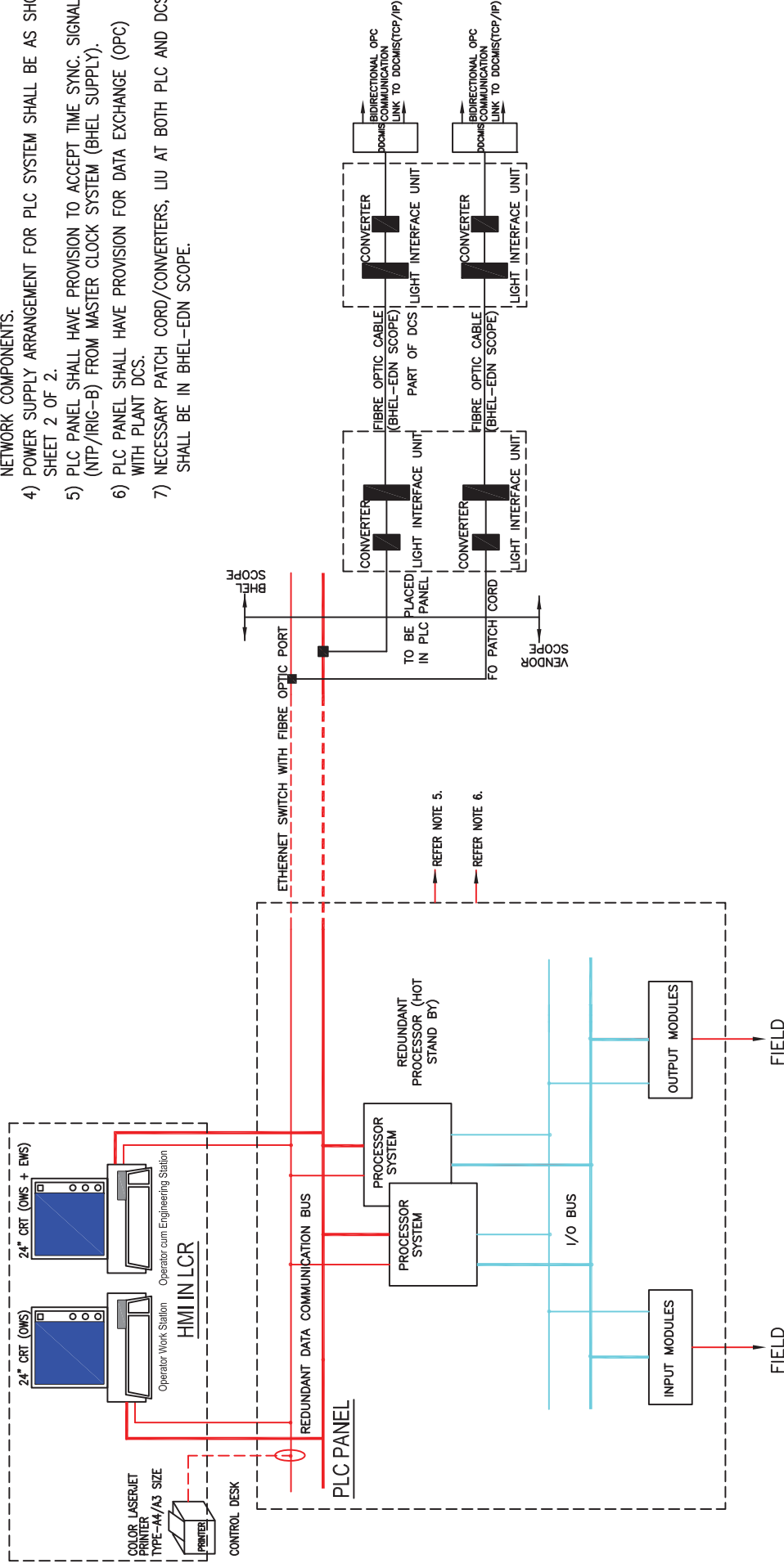
SHEET

OF

3. Documents of C&I System shall be submitted to end user/owner for approval during detail engineering. Changes, if any, shall be accommodated by the bidder without any price/time implication.

NOTES:

- 1) TABLE TOP OWS/EWS SHALL BE 24" OR AVAILABLE INDUSTRY STANDARD.
- 2) PLC SYSTEM SHALL HAVE REDUNDANCY IN PROCESSOR, POWER SUPPLY AND COMMUNICATION SYSTEM.
- 3) UPS POWER SUPPLY SHALL BE USED FOR PLC PANEL(S), OWS/EWS AND NETWORK COMPONENTS.
- 4) POWER SUPPLY ARRANGEMENT FOR PLC SYSTEM SHALL BE AS SHOWN ON SHEET 2 OF 2.
- 5) PLC PANEL SHALL HAVE PROVISION TO ACCEPT TIME SYNC. SIGNAL (NTP/IRIG-B) FROM MASTER CLOCK SYSTEM (BHEL SUPPLY).
- 6) PLC PANEL SHALL HAVE PROVISION FOR DATA EXCHANGE (OPC) WITH PLANT DCS.
- 7) NECESSARY PATCH CORD/CONVERTERS, LIU AT BOTH PLC AND DCS END SHALL BE IN BHEL-EDN SCOPE.



LEGEND: -

- PLC - PROGRAMMABLE LOGIC CONTROLLER
- DCS - DISTRIBUTED CONTROL SYSTEM
- UPS - UNINTERRUPTED POWER SUPPLY
- OWS/EWS - OPERATOR WORK STATION/ ENGINEERING WORK STATION
- HMI - HUMAN MACHINE INTERFACE
- NTP - NETWORK TIME PROTOCOL
- OPC - OLE PROCESS CONTROL
- MCCB - MOULDED CASE CIRCUIT BREAKER
- MCB - MINATURE CIRCUIT BREAKER
- LCR - LOCAL CONTROL ROOM
- CCR - COMMON CONTROL ROOM



PROJECT:

4X270 MW BHADRADRI TPS

DRG.NO. PE-DM-411-145-1900

TITLE:

PLC CONFIGURATION
PTP SYSTEM

DATE 21.03.2015

REV.NO. 00

SHT 5 Page 171 of 806

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT****SPECIFICATION NO.**

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 1 of 1

ANNEXURES

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT****SPECIFICATION NO.**

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 1 of 12

ANNEXURE I**LIST OF MAKES**



TITLE

4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 2 of 12

S.No.	ITEM	SUPPLIERS	PLACE	QP / INSPN CAT	REMARKS
1.	PRESSURE VESSELS	GLOBAL STRUCTURES & COMPOSITE LTD	-		
		JASMINO POLYMERTECH	TALOJA		
		SYSCON ENGINEERS	AMBERNATH		
		S.V. FABRICATORS	NAVI MUMBAI		
		SPARK FABRICATORS / STEELCON	-		
		ANUP ENGINEERING	AHMEDABAD		
		MURTHAL TANKS & VESSELS	SONEPAT		
		TITAN ENGG.	DURGAPUR		
		RISHI INDUSTRIES	BAHALGARH		
		UNIVERSAL HEAT EXCHANGERS	-		
		ATS CHEM	SALEM/HOSUR		
		CHEM PROCESS SYSTEM	SANAND		
		PROGEN	CHENNAI		
		CRYSTAL ENGINEERING	HOSUR		
		ISHAN EQUIPMENTS	VADODARA		
2.	ATMOSPHERIC/ STORAGE TANKS	GLOBAL STRUCTURES & COMPOSITE LTD	-		
		JASMINO POLYMERTECH	TALOJA		
		SYSCON ENGINEERS	AMBERNATH		
		S.V. FABRICATORS	NAVI MUMBAI		
		SPARK FABRICATORS / STEELCON	-		
		ANUP ENGINEERING	AHMEDABAD		
		MURTHAL TANKS & VESSELS	SONEPAT		
		TITAN ENGG.	DURGAPUR		
		RISHI INDUSTRIES	BAHALGARH		
		UNIVERSAL HEAT EXCHANGERS	-		
		ATS CHEM	SALEM/HOSUR		
		CHEM PROCESS SYSTEM	SANAND		
		PROGEN	CHENNAI		
		CRYSTAL ENGINEERING	HOSUR		
		ISHAN EQUIPMENTS	VADODARA		
3.	RUBBER LINING (AT SHOP)	TEMSEC	KOLKATA		
		RISHI INDUSTRIES	SONEPAT		
		CORI ENGINEERS	CHENNAI		
		POLY RUBBER	MUMBAI		
		INDUSTRIAL LINING	VADODARA		



TITLE

4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 3 of 12

		ARUL RUBBERS	CHENNAI		
		JASMINO POLYMERTECH	TALOJA		
		WESTERN RUBBER	NAVI MUMBAI		
		ELASTOMER LINNING	AMBERNATH		
		EMKAY RUBBER	MUMBAI		
4	ACTIVATED CARBON	INDUSTRIAL CARBON	ANKLESHWAR		
		VVD & SONS	TUTICORIN		
		GLOBAL ABSORBENT PVT LTD	KOLKATA		
		ACTIVE CARBON	-		
		WESTERN CHEMICALS	-		
5	AIR BLOWERS (TWIN LOBE TYPE)	SWAN PNEUMATIC	NOIDA		
		EVEREST TRANSMISSION	NEW DELHI		
		KAY INTERNATIONAL	NEW DELHI / SONEPAT		
		EVEREST BLOWER	BAHADURGARH		
		KULKARNI POWER TOOLS	KOLHAPUR/ PUNE		
6	METERING PUMPS	VK PUMPS	NASIK		
		MILTON ROY INDIA	CHENNAI		
		SWELLORE	AHMEDABAD		
		POSITIVE METERING PUMPS	NASIK		
		METACHEM	MUMBAI		
7	AGITATOR	REMI PEOCESS PLANT & M/C	MUMBAI		
		FIBRE & FIBRE	MUMBAI / SILVASA		
		CEECONS	CHENNAI		
		STANDARD ENGINEERS	MUMBAI		
8	HORIZONTAL CENTRIFUGAL PUMPS	KIRLOSKAR BROTHERS LTD.	WADI		
		MATHER & PLATT	PUNE		
		KSB	PUNE		
		SAM TURBO IND LTD	COIMBATORE		
		KISHOR PUMPS	PUNE		
		SULZER	PUNE		
		WPIL	GHAZIABAD		
		FLOWMORE UNIT-I &II	SAHIBABAD		
		BEST & CROMPTON	CHENNAI		
9	HORIZONTAL CENTRIFUGAL PUMPS (RUBBER LINED)	KISHOR PUMPS	PUNE		
		SU MOTORS	MUMBAI		
10	NON METALLIC (PP/FRP)	ENGINEERS COMBINE	THANE		



TITLE

4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 4 of 12

	HORIZONTAL CENTRIFUGAL PUMPS	ANTICORROSIVE LEAK PROOF PUMPS PVT. LTD. (RAJEDIA)	VALSAD -		
11	MISC. PUMP VERTICAL TURBINE TYPE	KBL M&P WPIL KISHORE PUMPS FLOWMORE	PUNE PUNE GHAZIABAD PUNE SAHIBABAD		
10	RESIN TRAP ELEMENT	JHONSONS SCREEN	AUSTRALIA/ IRELAND		
11	UNDER BED NOZZLE	JONSONS SCREEN	AUSTRALIA/ IRELAND		
12	RESIN	ROHM & HASS ION EXCHANGE LANXESS PUROLITE THERMAX	FRANCE / USA INDIA GERMANY ROMANIA/CHINA INDIA		
13	HEATER	ESCORTS RACOLDS	FARIDABAD FARIDABAD		
14	MANUAL GATE / GLOBE / CHECK VALVES	HAWA ENGINEERS / MARCK & CARE WEIR BDK A.V.VALVES LEADER OSWAL INDUSTRIES CHEMTECH INDUSTRIAL VALVES PVT LTD H SARKAR FOURESS HAWA ENGINEERS / MARCK & CARE BANKIM & COMPANY	- - - - - - - - - -		
15	BALL VALVE (MANUAL /PNEUMATIC/ ELECTRIC) CLASS 150	FLOWCHEM INDUSTRIES WEIR BDK L&T (AUDCO) MICROFINISH VALVES AKAY VALVES	KALOL HUBLI COIMBATORE HUBLI HUBLI		
	ELECTRIC MOTOR	ABB	-		



TITLE

4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 5 of 12

16		SIEMENS	-		
		CGL	-		
		MARATHON/ ALSTOM	-		
		BHARAT BIJLEE	-		
		KEC	-		
		ABB	-		
17	BALL VALVE (HIGH PRESSURE)	VELAN	CANADA		
		BRAY	CHINA		
18	BUTTER-FLY VALVE (MANUAL / PNEUMATIC/ELECTRIC) CLASS 150	FLOW SERVE	CHENNAI		
		WEIR BDK	HUBLI		
		CRANE FLOW PROCESS	SATARA		
		INTERVALVE (I) PVT LTD	PUNE		
		BRAY CONTROL	CHINA		
		FOURESS	BANGALORE		
		KBL	KOHNDAHAPURI		
		PENTAIR VALVES	HALOL		
19	DUAL PLATE TYPE NON-RETURN VALVE (SS & CI /CIRL UPTO 200 NB, CLASS 150)	ADVANCE VALVES	GREATER NOIDA		
		HAWA ENGINEERS	AHMEDABAD		
		LEADER	JALANDHAR		
20	DIAPHRAGM VALVE (MANUAL / PNEUMATIC) CLASS 150	WEIR BDK	HUBLI		
		CRANE FLOW PROCESS	SATARA		
		PROCON	MUMBAI		
		MAJESTIC VALVES (LABLINE)	-		
		HAWA ENGINEERS	AHMEDABAD		
21	CHECK VALVE / NRV (LINED / UNLINED), FLAP TYPE SIZE UPTO 50 NB	MAJESTIC VALVES (LABLINE)	-		
		WEIR BDK	HUBLI		
22	Y-TYPE STRAINER / STRAINER (WATER SERVICE)	OTOKLIN	MUMBAI		
		GRAND PRIX	NEW DELHI		
		JAYPEE	NEW DELHI		
		GREAVES COTTON	MUMBAI		
		MULTITEX	NEW DELHI / NOIDA		
		FILTRATION ENGINEERING	-		
		FLUIDNYE	-		



TITLE

4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 6 of 12

23	RUBBER FLAP TYPE CHECK VALVES	ASHVIK VALVES	-		
		FLOW WAY VALVES	-		
		BDK	-		
		MAJESTIC VALVES (LABLINE INST)	-		
		ADVANCE VALVES	-		
24	SOLENOID VALVES	ROTEX	-		
		AVCON	-		
25	PRESSURE GAUGE	GENERAL INSTRUMENTS			
		WAAREE (BAUMER INSTRUMENTS)			
		H.GURU INSTRUMENTS			
		A.N.INSTRUMENTS			
		FORBES MARSHALL			
26	DIFFERENETIAL PRESSURE GAUGE	GENERAL INSTRUMENTS			
		WAAREE (BAUMER INSTRUMENTS)			
		H.GURU INSTRUMENTS			
		A.N.INSTRUMENTS			
		SWITZER			
27	TEMPERATURE GAUGE	FORBES MARSHALL			
		GENERAL INSTRUMENTS			
		WAAREE (BAUMER INSTRUMENTS)			
		H.GURU INSTRUMENTS			
		A.N.INSTRUMENTS			
28	LEVEL GUAGE (F&B, TUBULAR, REFLEX)	SWITZER			
		FORBES MARSHALL			
		GENERAL INSTRUMENTS			
		SBEM			
		CHEMTROL			
29	ROTAMETER	PUNE TECHTROL			
		SIGMA			
		V AUTOMAT			
		GENERAL INSTRUMENTS			
29	ROTAMETER	SWITZER			
		EUREKA			
		INSTRUMENT ENGINEERS			
		TRAC			



TITLE

4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 7 of 12

30	LEVEL SWITCH (ALL TYPES)	LEVCON			
		CHEMTROLS SAMIL (INDIA) PVT LTD.			
		SWITZER			
		WAAREE (BAUMER INSTRUMENTS)			
		V AUTOMAT			
		PUNE TECHTROL			
31	MAGNETIC FLOW METER	ABB	-		
		WAAREE (BAUMER INSTRUMENTS)	-		
		EUREKA	-		
		EMERSON	-		
		YOKOGAWA	-		
		HACH (POTENSE)	-		
		KROHNE MARSHALL	-		
32	FLOW TRANSMITTERS (ALL TYPES)	E & H	-		
		KHRONE MARSHALL	-		
		EMERSON	-		
		ABB	-		
		HONEYWELL	-		
		YOKOGAWA	-		
33	LEVEL TRANSMITTERS (ALL TYPES)	EMERSON	-		
		E & H	-		
		ABB	-		
		HONEYWELL	-		
		V AUTOMAT	-		
		YOKOGAWA	-		
		SIEMENS	-		
		KROHNE MARSHALL	-		
34	PRESSURE TRANSMITTERS (ALL TYPES)	EMERSON	-		
		SIEMENS	-		
		HONEYWELL	-		
		YOKOGAWA	-		
		ABB	-		
		FORBES MARSHALL	-		
35	TEMPERATURE TRANSMITTERS	EMERSON	-		
		E & H	-		
		ABB	-		
		HONEYWELL	-		



TITLE

**4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 8 of 12

		V AUTOMAT	-		
		YOKOGAWA	-		
		SIEMENS	-		
		FORBES MARSHALL	-		
36	PH TRANSMITTERS	EMERSON	-		
		YOKOGAWA	-		
		HONEYWELL	-		
		ABB	-		
		HACH	-		
		FORBES MARSHALL	-		
37.	ANALYSERS (ALL TYPES)	ABB	-		
		EMERSON	-		
		YOKOGAWA	-		
		HONEYWELL	-		
		HACH POLYMETRON	-		
		SIEMENS	-		
		FORBES MARSHALL	-		
38	PLC WITH ENCLOSURE	GE FANUC	-		
		HONEYWELL	-		
		SIEMENS	-		
		ROCKWELL AUTOMATION	-		
		SCHNEIDER	-		
		MITSHUBISHI	-		
		YOKOGAWA	-		
		ABB	-		
39	UPS	HIREL HITACHI	-		
		EMERSON	-		
		DB POWER ELECTRONICS	-		
40	CABLE GLAND	COMET	-		
		DOWELL	-		
		CHETNA	-		
41	CABLE LUGS	ELECTRO BILLETS	-		
		COMET	-		
		DOWELL	-		
		CHETNA	-		
42	MS PLATES	SAIL	-		
		ESSAR	-		



TITLE

4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 9 of 12

		TISCO	-		
		ISPAT	-		
		JINDAL	-		
43	CS PIPE (ASTM A 106 GR. B)	INDIAN SEAMLESS METAL TUBES	AHMEDABAD		UPTO 150 NB
		MAHARASHTRA SEAMLESS	RAIGAD		UPTO 350 NB
44	MS PIPES (IS: 1239 & 3589)	SAIL	-		
		SURYA ROSHANI	-		
		JINDAL	-		
		MAHARASHTRA SEAMLESS	-		
		LLOYDS STEEL	-		
		SAW PIPES	-		
45	SS PIPES / TUBES	APEX TUBES	BEHROR (ALWAR)		
		RATNAMANI	CHATTRAL		
		REMI	TARAPUR		
		PRAKASH STEELAGE	-		
46	POWER/CONTROL/INSTRUMENT CABLE	POLYCAB	-		
		FINOLEX CABLE	-		
		NICCO CABLE	-		
		DELTON CABLE	-		
		CORD CABLE	-		
		PARAMOUNT	-		
		UNIVERSAL CABLE	-		
		RADIANT CABLES	-		
47	SAFETY SHOWER	UNICARE	-		
		MOHAN INDUSTRIES	-		
		SUPER SAFETY SERVICES	-		
48	FRP TANKS & FITTINGS	GLOBAL COMPOSITE	-		
		EPP	-		
		DEEPA COMPOSITE	-		
		COROSEAL INDUSTRIES	-		
		CHEMICAL PROCESS & EQUIPMENT PVT LTD	-		
		J.R FIBRE INDUSTRIES PVT LTD	-		
		POLYPLAST	-		



TITLE

4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 10 of 12

49	EJECTOR	ESSEM TECHNOLOGIES	-		
		RATNA PRASAD	-		
50	LOCAL CONTROL PANEL	INDUSTRIAL SWITCHGEAR & CONTROL	-		
		POSITRONICS	-		
		DELTA CONTROL	-		
		L & T	-		
		GE POWER	-		
		PYROTECH	-		
		C& S	-		
51	TANK (FRP)	INDUSTRIAL SERVICE	KOLKATA		
		SUNRISE	BARODA		
		GANDHI & ASSOCIATES	AHMEDABAD		
		MODERN EQUIPMENTS	CHENNAI		
		EAGLE PLAST	PUNE		
		OMEGA PLAST	MUMBAI		
52	STROKE CONTROLLER	V K PUMPS	NASIK		
		METACHEM	MUMBAI		
		SWELORE	AHMEDABAD		
		MILTON ROY INDIA	CHENNAI		
53	SAFETY VALVES/RELIEF VALVES	METACHEM	MUMBAI		
		KEYSTONE	BARODA		
		V K PUMPS	NASIK		
		MILTON ROY	CHENNAI		
54	STRAINER	OTOKLIN	MUMBAI		
		GRAND PRIX	NEW DELHI		
		AYPEE	NEW DELHI		
55	ORIFICE PLATE	MICRO PRECISION	FARIDABAD		
		INSTRUMENTAION LTD	PALGHAT		
		CARLO DYNAMICS	HYDERABAD		
56	SLUICE GATE	H SARKAR	KOLKATA		
		JASH ENGINEERING	-		
		YASHWANT INDUSTRIES	-		
57	3 WAY VALVE	HI TECH	AHMEDABAD		
		ADVANCE VALVES PVT.LTD	NOIDA		
		BDK	HUBLI		
		FOURESS ENGG.INDIA LTD.	MUMBAI		



TITLE

4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 11 of 12

		FLUIDLINEVALVES COMPANY PRIVATE LTD.,	MUMBAI		
		INSTRUMENTATION LTD.	PALAKAD		
		KIRLOSKAR BROTHERS LTD.	PUNE		
		VENUS PUMP & ENGG. WORKS	KOLKATA		
		Surya Valves and Instruments Manufacturing Company	Chennai		
		STAFFORD CONTROLS LIMITED	PUNE		
		MICON VALVES (INDIA) PVT.LTD	MUMBAI		
58	PLUG VALVE(MANUAL)	BDK	HUBLI		
		HAWA ENGINEERS / MARCK & CARE	-		
		MICON VALVES	-		
		MICON VALVES (INDIA) PVT.LTD	MUMBAI		
59	FITTINGS (CS/SS)	BHARAT FORGE	PUNE		
		RELIANCE FORGE			
		EBY	MUMBAI		
		SIDDARTH & GAUTAM	FARIDABAD		
		MS FITTINGS	KOLKATA		
		PRADEEP METALS LTD	MUMBAI		
		TUBE PRODUCT INCORPORATION	BARODA		
60	FLANGES (SS/CS)	PRADEEP METALS LTD	MUMBAI		
		TUBE PRODUCT INCORPORATION	BARODA		
		MS FITTINGS	KOLKATA		
		HAWA ENGINEERING	-		
		ALIANCE PIPE & PLANGES	KOLKATA		
		JAI AMBE	MUMBAI		
61	PIPE & FILLTING (PP,HDPE,PVC & CPVC)	GEROGE FISHCHER	DELHI		
		ASTROL PLYTECHINC LTD	AHMEDABAD		
		JAIN IRRIGATION	-		
		ORIPLAST	-		
62	VALVES (GATE/GLOBE/NRV/BALL)- (PP,HDPE,PVC & CPVC)	GEROGE FISHCHER IPING SYSTEMS PVT LTD	DELHI		
		ASTROL PLYTECHINC LTD	AHMEDABAD		
		JAIN IRRIGATION	-		
		ORIPLAST	-		



TITLE

4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 12 of 12

63	AIR FILTER REGULATOR	SHAVO NORGEN	-		
		PLACKA INSTRUMENTS	-		
64	FILTER MEDIA	GLOBAL ABSORBENT	KOLKATA		
		BHARAT MINERALS			
65	BATTERIES	AMCO (BATTERY NI-CD)	-		
		HBL (BATTERY NI-CD)	-		
66	PAINT	BERGER	-		
		ASIAN PAINTS	-		
		SHALIMAR PAINTS	-		
		KANSAI NEROLAC	-		
		AKZO NOBEL	-		
67	PNEUMATIC ACTUATOR	PROCON ENGINEERS	-		
		TYCO	-		
		CRANE PROCESS	-		
		BDK	-		
		INTERVALVE	-		
		BRAY CONTROL	-		
68	MOTORISED ACTUATOR	ROTARK	-		
		AUMA	-		
		LIMITORK	-		
69	CABLE TRAYS	RATAN ENGG	-		
		INDIANA	-		
		DOLPHIN	-		
		INDUSTRIAL PERFORMATIONS	-		
		MJ ENGG	-		
		ANAND UDYOG	-		
		VATCO	-		
		STEELITE	-		

NOTE:

The sub vendor list enclosed ANNEXURE-I is indicative only and is subject to approval / acceptance by customer (TSGENCO). Bidder to propose his sub vendor list with back up documents (experience list, end user certificate as applicable) etc. The same shall subject to BHEL and Customer approval during detailed engineering stage without any technical, commercial & delivery implications to BHEL/TSGENCO.

**TITLE**

**4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 1 of 7

ANNEXURE II**MANDATORY SPARE LIST**


TITLE

4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 2 of 7

Vertical Sump Pumps – (For each Type and Size)

Sl. No.	Name of Items	Unit	QUANTITY
i.	Complete Casing including suction (if applicable) bell	Set	1
ii.	Impeller	Set	1
iii.	Wearing rings (Impeller & Casing ; as applicable)	Set	2
iv.	Impeller Shaft, line shaft and head shaft	Set	1
v.	Shaft Sleeves	Set	2
vi.	Stuffing box	Set	1
vii.	Coupling between Pump & motor, bushes, pins with all fasteners & coupling Guards.	Set	1
viii.	Line Shaft Couplings (if applicable)	Set	1
ix.	Impeller, Line and Head shaft bearings (as applicable)	Set	1
x.	Gland , Packing & Gland Assembly	Set	1
xi.	Impeller key	Number	1
xii.	Mechanical seal as applicable	Set	1

Horizontal Centrifugal Pumps (For each Type and Size)

Sl. No.	Name of Items	Unit	QTY
i.	Impeller for each type	Set	1
ii.	Wearing rings – Impeller for each type (if applicable)	Set	1
iii.	Wearing rings – Casing for each type (if applicable)	Set	1
iv.	Shaft for each type	Set	1
v.	Shaft Sleeves for each type	Set	1
vi.	Stuffing box for each type	Set	1
vii.	Coupling between Pump & motor, bushes, pins with all fasteners & coupling Guards	Set	1
viii.	Pump bearings for each type	Set	1
ix.	Gland , Packing & Gland Assembly for each type	Set	1
x.	Mechanical seal as applicable	Set	1
xi.	Impeller key	Number	1

BLOWERS (For each Type and Size)

Sl. No.	Name of Items	Unit	QTY
i.	Impeller with lock nuts & washers	Set	1



TITLE

4 X 270 MW BHADRADRI TPS TECHNICAL SPECIFICATION FOR PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 3 of 7

ii.	Shaft	Set	1
iii.	Bearings of Blowers	Set	1
iv.	Suction filter Assembly	Set	2
MOTOR			
Sl. No.	Name of Items	Unit	QTY
i.	Motor bearing for each type of pump	Set	1

VALVES AND PIPING

Sl. No.	Name of Items	QUANTITY
i.	Piping valves & traps - Complete assembly	5% or min. 1 no. (whichever is more) for each size, type & rating for total population

MANDATORY SPARES FOR CONTROL SYSTEM AND MEASURING INSTRUMENTS

Sl. No.	Name of Items	QUANTITY
Mandatory Spares for Temperature Elements and Thermowells		
i.	Thermocouple / RTD elements (10% of each type and length of elements, or a minimum of one number, whichever is more.)	2 Lot
ii.	Thermowells for each type of temperature sensors (10% or a minimum of one for each type, whichever is more.)	2 Lot
Mandatory Spares for Electronic Transmitters (for pressure, DP, Flow, level, Temperature) and Electrical Transducers.		
i.	Transmitters and Electrical Transducers (10% of total number of offered for each model and type for the project or a minimum of one number, whichever is more)	2 Lot
Mandatory spares for local gauges/switch (for Pressure, DP, Temperature, Flow, level, etc.)		
i.	Local gauges/ Switch (for Pressure, DP, Temperature, Flow, level, etc.) (10% of total number of instruments offered for each model and type for the project or a minimum of one number, whichever is more.)	2 Lot
Programmable Logical Control (PLC)		
i.	Function controller and control modules (10% of number for each type or minimum of 4 number for each type whichever is high.)	2 Lot
ii.	Process I/O cards and drive modules (10% of the number of cards offered for the project from each category.)	2 Lot
lii	All other type of electronic modules like CPU of workstation, Power supply modules, communication modules, modules for Data highway / modules for LAN, controllers not covered above (10% of each type or minimum of 2 nos. of each type whichever is more).	2 Lot
lv	All cards, controllers, lamp and other components used in LVS.	2 Lot (10%)
v	Control logic power supply fuses at each current rating	2 Lot



TITLE

4 X 270 MW BHADRADRI TPS TECHNICAL SPECIFICATION FOR PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 4 of 7

	(Three times the one hundred percent spare replacement).	
Vi	Electric to pneumatic converters (10% of each type utilized with automatic control system using pneumatic drives or a minimum of one of each type, whichever is more.)	2 Lot
vii	Plug-in type keyboard	2 No. of each type
Viii	Dot matrix Printer	2 No.
ix	CRT	2 No.
x	DVDs	40 Nos.
Xi	Printer ribbons /inking mechanism for colour printer.	20 Nos.
Xii	Ribbons for dot matrix printer.	60 Nos.
Xiii	Data highway cable with adequate connectors.	500 meters
Xiv	Hard disc drive unit as offered for system complete with accessories.	2 No.
Xv	Interface cables for each type	4 Sets
Xvi	Power supply modules of each type and rating	2 Lot (10%)
xvii	Interposing / coupling relays of each type.	2 Lot (5% of total quantity)
MANDATORY SPARES FOR UN-INTERRUPTIBLE POWER SUPPLY SYSTEM		
I	Fuses (3 times, the one hundred percent spare replacement fuses shall be furnished with each panel board.)	2 Lot
ii	Electronic modules for UPS , Charger, static switch & stabilizer and DC power supply system with each set consisting of at least one number of each type of electronic module for inverters, chargers, static switch, stabiliser etc.	2 Set
iii	Battery cells	2 Lot (10%)
iv	Thyrister without heat sink	2 Lot (10%)
v	Semiconductor fuse	2 Lot (10%)
Mandatory Spares for Control Panels / Desks		
i	Crimping Pins	2 Rolls
ii	Bulbs for indicating lights (Three times the one hundred percent spare replacement)	2 Lot
iii	control circuit fuses of each current rating (Three times, the one hundred percent spare replacement)	2 Lot
iv	Push buttons, electrical control switches and Illuminated push buttons etc	Lot (20%)
CONTROL VALVES		
i	Diaphragm	2 nos. of each type of actuator
ii	Gland packing	1 set for each type of valve
iii	Trim	1 set for each type of valve
iv	Gasket	2 set for each type of valve
v	Position transmitter complete set	10 % of total quantity used in the system for each type & model
vi	Complete set of solenoid valve for on/off valve	5 nos.for each type &



TITLE

4 X 270 MW BHADRADRI TPS TECHNICAL SPECIFICATION FOR PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 5 of 7

		ratings
vii	Position limit switch	5 nos.for each type & ratings

LIST OF MANDATORY SPARES FOR HOIST AND CHAIN PULLEY BLOCK

1	HOISTS (for each type and rating, hoists)	
1.1	Bearings for long travel wheels	2 sets
1.2	Bearings for gear boxes for each type of hoist	2 sets
1.3	Break liners for all the brakes	100% of total population of each type & size
1.4	Oil seals	100% of total population of each type, size rating
1.5	Brake springs for all brakes	-do-
1.6	Wire ropes for hooks	100% installed on each crane and hoist
1.7	Solenoid coils for brakes	2 sets
1.8	Overload relay for motors	2 Nos.
1.9	Limit switches for hoists and travel mechanisms	2 sets
1.10	Spare motors for hoists	2 Nos.
1.10.1	Long travel machinery	
	i. Gear wheel	1 set
	ii. Internal clip	2 Nos.
	iii. Pinion	1 No.
2.0	Chain pulley block	
	i. Load chain wheel	1 No.
	ii. Load chain stripping fork	5 Nos.
	iii. Hand chain wheel	2 Nos.
	iv. Ratchet pawl	1 No.
	v. Locking ratchet wheel	2 Nos.
	vi. Guide roller	2 Nos.
	vii. Brake disc	2 Nos.
3	Electrical Items	
3.1	Trailing Cable	One set of full length of each size/type of cables as used for each type of Electrical Hoist
3.2	415 Volt Motor (Up to 30KW Rating	
A	Driving End & Non-Driving End Bearing	3Set for each type and rating of Motor
B	Cooling Fan	2No. for each type and rating of Motor
C	Motor Terminal Block	5Nos. for each type and rating of Motor
D	Complete Set of Coupling	1Set for each Application
3.3	Control Panel	
a	Back-up panel mounted devices (Selector switches/ Push buttons/ Indicators etc.	5% of installed capacity
b	Lamps/ LEDs	100% of the total quantity
c	Blank Tiles	10% of installed capacity
d	MCBs	10% of each type & rating
e	Fuses/ Fuse holder	100% of each type & rating

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT****SPECIFICATION NO.**

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 6 of 7

Notes:

- i) The Mandatory spares for the equipment under the contract provided by the vendor will strictly conform to the specifications and documents and will be identical to the corresponding main equipment/components supplied under the contract.
- ii) The quality plan and the inspection requirement finalized for the main equipment will also be applicable to the corresponding mandatory spares.
- iii) In case, mandatory spares are not applicable as per equipment / item selected, bidder has to provide equivalent mandatory spare as per for selected equipment / item in line with list of mandatory spares.

The vendor warrants:

1. That all spares supplied will be new and in accordance with the contract document and will be free from defects in design, material and workmanship and shall further guarantee as under:
2. In case of any failure in the original component/equipments due to faulty designs, materials and workmanship, the corresponding spare parts if any, supplied will be replaced without any extra cost to the BHEL and customer unless a joint examination and analysis by BHEL and/or customer of such spare parts prove that the defect found in the original part that failed can safely be assured not to be present in spare parts.
3. The long term availability of spares to the BHEL and the customer for the full life of the equipment covered under the contract and that before going out of production of spare parts of the equipment covered under the contract, vendor and his sub-vendors shall give the BHEL and the customer at least 24 (Twenty Four) months advance notice so that the latter may order his bulk requirements of spares, if he so desires. The same provision will also be applicable to the sub-vendors. Further, in case of discontinuance of manufacture of any spares by the vendors or his sub-vendors the vendors and his sub-vendors, will provide the BHEL and the customer, 2 (two) years in advance, with full manufacturing drawings, material specifications and technical information required by the BHEL and the customer for the purpose of manufacture of such items and also the right to manufacture such spares for their own requirements.
4. Further in case of discontinuance of supply of spares by the vendors or his sub-vendors, the vendor will provide the BHEL and the customer with full information for replacement of such spares with other equivalent makes, if so required by the BHEL and the customer.
5. Notwithstanding the above, the vendor shall be responsible for supply of spares for the lifetime of the package at reasonable prices. The prices of all future requirements of spares shall be derived from the corresponding ex-works price at which the orders for such spares have been placed by the BHEL and the customer as a part of the mandatory or long term or any other kind of spares. The base indices for calculating ex-works price shall be commissioning of last equipment under main contract.
- iv) The vendor will indicate the delivery period of the spares, which the BHEL and the customer may procure in accordance with this clause.
- v) In case of emergency requirements of spares, the vendor would make every effort to expedite the manufacture and delivery of such spares on the basis of mutually agreed time schedule.

	TITLE 4 X 270 MW BHADRADRI TPS TECHNICAL SPECIFICATION FOR PRE- TREATMENT PLANT	SPECIFICATION NO. PE-TS-411-158A-A001
		VOLUME: II B
		REV 00
		SHEET 7 of 7

vi) In case the vendor fails to supply the mandatory or long term or any other kind of spares on the terms stipulated above, the BHEL and the customer shall be entitled to purchase the same from the alternate sources at the risk and the cost of the vendor and recover from the vendor, the excess amount paid by the BHEL and the customer over the rates as per the contract. In the event of such risk purchase by the BHEL or the customer, the purchases will be as per the works and procurement policy of the BHEL and the customer prevalent at the time of such purchases and BHEL & the customer at his option may include a representative from the vendor in finalizing the purchases.

vii) It is expressly understood that the final settlement between the parties in terms of relevant clauses of the tender document shall not relieve the vendor of any of his obligations under the provision of long term availability of spares and such provisions shall continue to be enforced till the expiry of 30 (thirty) years period reckoned from the scheduled date of completion of trial operation of the last equipment unless otherwise discharged expressly in writing by the BHEL or the customer.

Page 191 of 806

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
WATER TREATMENT PACKAGES****SPECIFICATION NO.**

PE-TS-411-174A-A001

VOLUME: II B

REV 00

SHEET 1 of 2

ANNEXURE III**RAW WATER ANALYSIS AND CLARIFIED WATER ANALYSIS**

**TITLE**

4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
WATER TREATMENT PACKAGES

SPECIFICATION NO.

PE-TS-411-174A-A001

VOLUME: II B

REV 00

SHEET 2 of 2

RAW WATER ANALYSIS

SL. NO.	Constituent	Unit	Value
1.	pH	-	7.73
2.	Suspended solids	mg/l	500
3.	Turbidity	NTU	16
4.	Calcium as Ca	mg/l	60
5.	Magnesium as Mg	mg/l	34
6.	Total Hardness as CaCO ₃	mg/l	94
7.	Chloride as Cl	mg/l	30
8.	Sulphate as SO ₄	mg/l	58
9.	Sulphide	mg/l	-
10.	Total Alkalinity as CaCO ₃	mg/l	140
11.	Silica as SiO ₂	mg/l	5.2
12.	Iron as Fe	mg/l	0.007
13.	Total dissolved solids	mg/l	218
14.	Conductivity at 25 degree C	Micro Siemens /cm	328

CLARIFIED WATER ANALYSIS

Outlet of PT shall be 10 ppm

Clarified Water Analysis should take care of the following chemical dosage in Pre-Treatment Plant:

- a) Alum Dosing – 70 ppm
- b) Lime Dosing – 30 ppm
- c) PE Dosing – 1 ppm
- d) Chlorine dosing – 3 ppm continuous

COC shall be 5.0.

**TITLE**

**4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 1 of 2

ANNEXURE IV**LIST OF TOOLS AND TACKLES**

	TITLE 4 X 270 MW BHADRADRI TPS TECHNICAL SPECIFICATION FOR PRE- TREATMENT PLANT	SPECIFICATION NO. PE-TS-411-158A-A001
		VOLUME: II B
		REV 00
		SHEET 2 of 2

Bidder to consider necessary tools and tackles for mechanical, electrical and control & instrument as per their system requirement. In addition bidder to adhere relevant clauses of tender specification also. List of tools and tackles to be furnish by bidder during bid submission.

**TITLE**

**4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 1 of 3

ANNEXURE V**DRAWING DOCUMENT / SUBMISSION SCHEDULE**



DISTRIBUTION SCHEDULE

TITLE		4 X 270 MW BHADRADRI TPS TECHNICAL SPECIFICATION FOR PRE- TREATMENT PLANT												SPECIFICATION NO.	
														PE-TS-411-158A-A001	
														VOLUME: II B	
														REV 00	
SHEET 2 of 3															

S. No	Description	TSGENCO										CONSULTANT			Equipment Vendor	Remarks
		Director Projects	Director Technical	CE/Civil Thermal Projects Hyd.	CE/ TPC-I, Hyd	CE/ O&M/ KTPS	SE/ Civil KTPS	SE/E&M / KTPS	DE Constr. KTPS	Kolkata	HYD	KTPS				
A	Letter Of Intent or Contract Documents	1	1	1	S	1	2	2	1	1	1	1	2			
B	Vendor Drawings															
1.	Preliminary	1	1	1	2	1	1	2	2	12	1	-	S			
2.	Return preliminary with comments	-	-	1	2	1	1	1	1	S	1	-	1			
3.	Final and any revision thereof															
	a. Civil	1	1	6+1T	1	1	6+1T	1	-	2+1T	1	1	S			
	b. E&M	1	1	1	6+1T	1	1	6+1T	1	2+1T	1	1	S			
C.	Design Drawings															
1.	Preliminary															
	a. Civil	1	1	2	1	1	2	1	1	4	1	1	S			
	b. E&M	1	1	1	2	1	1	2	1	4	1	1	S			
2.	Released for construction															
	a. Civil	1	1	2	1	1	6	1	1	1	1	2	S			
	b. E&M	1	1	1	1	2	1	6	1	1	1	2	S			
3.	Return marked 'As built'															
	a. Civil	-	-	1	-	-	1	-	-	1	1	S	1			
	b. E&M	-	-	-	1	-	-	1	1	1	1	S	1			
4.	As built drawings															
	a. Civil	-	-	1+1T	-	2+1T	5+1T	-	1	1+1T	-	1	S			
	b. E&M	-	-	1	2+1T	2+1T	-	5+1T	1+1T	1+1T	-	1	S			

Page 197 of 806



TITLE

4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 3 of 3

S. No	Description	TSGENCO										CONSULTANT			Equipment Vendor	Remarks
		Director Projects	Director Technical	CE/Civil Thermal Projects Hyd.	CE/ TPC-I, Hyd	CE/ O&M/ KTPS	SE/ Civil KTPS	SE/E&M / KTPS	DE Constr. KTPS	Kolkata	HYD	KTPS				
D	Progress Report Monthly															
1.	Equipment vendor	1	1	1	2	1	1	2	1	1	1	1		S		
2.	M/s DCPL, Kolkata	1	1	2	2	1	1	2	1	S	1	1		Nil		
E	Test & Inspection Reports															
1.	Equipment manufacturer															
a.	Civil	1	1	1	2	1	1	1	1	11	1	1		S		
s	b. E&M	1	1	-	2	1	-	1	1	11	1	1		S		
2.	M/s DCPL, Kolkata	1	1	-	2	1	-	1	1	S	-	1		-		
F	Instruction Manuals/Data Books															
1.	Equipment manufacturer															
a.	Civil	1	1	1+1T	1	1	6+1T	1	1	2+1T	1	1		S		
b.	E&M	1	1	-	3+1T	1	-	6+1T	2	3+1T	1	1		S		
2.	M/s DCPL, Kolkata	1	1	-	10+1T	1	-	15+1T	-	S	1	1		Nil		
G	M/s DCPL, Kolkata Criteria	1	1	1	8+1T	1	1	2	1	1	1	1		S		
H	Design Calculations	1	1	1	8+1T	1	1	2	1	1	1	1		S		
I	Final consulting Engineering Report	1	1	1	10	1	1	2	1	S	1	1		Nil		

S – Source, T – Transparency & Soft Copy on CD,

**TITLE**

**4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 1 of 6

ANNEXURE VI**MAIN DRAWING LIST WITH SCHEDULE OF SUBMISSION**

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 2 of 6

SI No	DOCUMENT / DRAWING NO.	DRAWING / DOCUMENT TITLE	SCHEDULE OF SUBMISSION FROM LOI	SIZE
PT PLANT				
1	PE-V0-411-158-A009	QAP FOR HORIZONTAL / VERTICAL CENTRIFUGALPUMPS WITH MOTOR	10	A4
2	PE-V0-411-158-A030	MECH. GA FOR CLARIFIER	10	A1
3	PE-V0-411-158-A051	PLC DOCUMENTS FOR PT PLANT--PLC CONFIGURATION DIAGRAM, DATA SHEET FOR PLC, GA & WIRING DETAILS FOR PLC PANEL, I/O LIST, BOM, MIMIC DIAGRAM, SCADA SCREEN , LIST FOR SIGNALS EXCHANGE WITH DDCMIS (BOTH HARDWIRED & SERIAL INTERFACE IN BHEL	10	A4
4	PE-V0-411-158-A015	TECHNICAL DATASHEET FOR BUTTERFLY VALVES	10	A4
5	PE-V0-411-158-A003	HYDRAULIC FLOW DIAGRAM & HYDRAULIC LEVEL CALCULATIONS	4	A1
6	PE-V0-411-158-A004	PROCESS SIZING CALCULATION	4	A4
7	PE-V0-411-158-A023	PIPING SUPPORT DRAWING FOR PT PLANT	10	A1
8	PE-V0-411-158-A044	CABLE SCHEDULE & INTERCONNECTION DRG.	10	A4
9	PE-V0-411-158-A065	REINFORCEMENT DRAWING FOR CLARIFIER	12	A0
10	PE-V0-411-158-A024	PIPING SPECIFICATION	10	A4
11	PE-V0-411-158-A036	MECH. GA FOR SLUDGE SUMP, THICKENED SLUDGE SUMP AND FILTER BACKWASH SUMP	10	A1
12	PE-V0-411-158-A098	QAP for Control Cable & screened control cables	10	A4
13	PE-V0-411-158-A018	TECHNICAL DATASHEET FOR NON RETURN VALVES	10	A4
14	PE-V0-411-158-A039	MECHANICAL GA FOR TRENCHES, PIPE SUPPORTS PEDESTALS AND FOR ANCHOR PLATES	10	A1
15	PE-V0-411-158-A060	CIVIL DESIGN CALCULATION FOR STILLING CHAMBER, FLASH MIXER AND PARSHALL FLUME FOR DM CLARIFIER	12	A4
16	PE-V0-411-158-A002	LAYOUT FOR PT LANT	10	A0
17	PE-V0-411-158-A066	CIVIL DESIGN CALCULATION FOR DM CLARIFIER	12	A4
18	PE-V0-411-158-A042	TECHNICAL DATASHEET FOR MOTORS (HORIZONTAL CENTRIFUGAL PUMPS , METERING PUMPS, BLOWERS, AGITATORS)	10	A4
19	PE-V0-411-158-A012	TECHNICAL DATA SHEET FOR BLOWERS	10	A4
20	PE-V0-411-158-A033	MECH. GA AND DATA SHEET FOR CLARIFIER BRIDGE MECHANISM	10	A4
21	PE-V0-411-158-A064	CIVIL GA FOR CLARIFIER	12	A1
22	PE-V0-411-158-A076	CIVIL GA FOR SLUDGE SUMP, THICKENED SLUDGE SUMP AND FILTER BACKWASH SUMP	12	A1
23	PE-V0-411-158-A037	MECHANICAL GA FOR THICKENER	10	A1
24	PE-V0-411-158-A021	VALVE SCHEDULE	12	A4
25	PE-V0-411-158-A020	QAP FOR VALVES	10	A4



TITLE

4 X 270 MW BHADRADRI TPS TECHNICAL SPECIFICATION FOR PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 3 of 6

26	PE-V0-411-158-A095	O&M MANUAL COVERING CATALOGUE FOR ALL ITEMS.	26	A4
27	PE-V0-411-158-A011	QAP FOR METERING PUMPS WITH MOTOR	10	A4
28	PE-V0-411-158-A006	SUB VENDOR LIST AND INSPECTION CATEGORY	4	A4
29	PE-V0-411-158-A091	CIVIL GA DRAWING FOR TRENCHES, PIPE SUPPORT PEDESTAL AND FOR ANCHOR PLATES.	12	A1
30	PE-V0-411-158-A016	TECHNICAL DATASHEET FOR DIAPHRAGM VALVES	10	A4
31	PE-V0-411-158-A014	TECHNICAL DATASHEET FOR BALL VALVES	10	A4
32	PE-V0-411-158-A013	QAP FOR BLOWERS WITH MOTOR	10	A4
33	PE-V0-411-158-A034	MECH. GA AND DATA SHEET FOR THICKENER MECHANISM	10	A4
34	PE-V0-411-158-A055	QAP AND FAT FOR PLC	10	A4
35	PE-V0-411-158-A094	PG TEST	20	A4
36	PE-V0-411-158-A058	CIVIL GA FOR CASCADE AERATOR, STILLING CHAMBER, FLASH MIXER AND PARSHALL FLUME FOR CLARIFIER	12	A1
37	PE-V0-411-158-A035	MECH. GA FOR CHEMICAL HOUSE INCLUDING ALL DOSING TANKS	10	A0
38	PE-V0-411-158-A077	REINFORCEMENT DRAWING DARWING FOR SLUDGE SUMP, THICKENED SLUDGE SUMP AND FILTER BACKWASH SUMP	12	A1
39	PE-V0-411-158-A046	TECHNICAL DATSHEET AND HOOK UP DRAWING FOR LOCAL INSTRUMENTS	10	A4
40	PE-V0-411-158-A067	CIVIL GA FOR DM CLARIFIER	12	A0
41	PE-V0-411-158-A063	CIVIL DESIGN CALCULATION FOR CLARIFIER	12	A4
42	PE-V0-411-158-A056	CIVIL DESIGN BASIS REPORT	12	A4
43	PE-V0-411-158-A057	CIVIL DESIGN CALCULATION FOR CASCADE AERATOR, STILLING CHAMBER, FLASH MIXER AND PARSHALL FLUME FOR CLARIFIER	12	A4
44	PE-V0-411-158-A019	TECHNICAL DATASHEET FOR SOLENOID VALVES	10	A4
45	PE-V0-411-158-A038	MECHANICAL GA AND DATA SHEET FOR CENTRIFUGE	10	A4
46	PE-V0-411-158-A029	MECH. GA FOR STILLING CHAMBER, FLASH MIXER AND PARSHALL FLUME FOR DM CLARIFIER	10	A1
47	PE-V0-411-158-A097	Data sheet Control Cable & screened control cables	10	A4
48	PE-V0-411-158-A061	CIVIL GA FOR STILLING CHAMBER, FLASH MIXER AND PARSHALL FLUME FOR DM CLARIFIER	12	A1
49	PE-V0-411-158-A025	3D MODEL FOR PT PLANT	15	A0
50	PE-V0-411-158-A085	CIVIL GA FOR THICKENER	12	A1
51	PE-V0-411-158-A086	REINFORCEMENT DARWING FOR THICKENER	12	A1
52	PE-V0-411-158-A043	ELECTRICAL LOAD LIST	10	A4
53	PE-V0-411-158-A001	P&I DIAGRAM FOR PT PLANT	4	A1
54	PE-V0-411-158-A022	PIPING LAYOUT FOR PT PLANT	10	A1
55	PE-V0-411-158-A007	CONTROL PHILOSOPHY	6	A4
56	PE-V0-411-158-A050	TECHNICAL DATA SHEET AND GA FOR JUNCTION BOX	10	A4
57	PE-V0-411-158-A010	TECHNICAL DATA SHEET FOR METERING PUMPS	10	A4
58	PE-V0-411-158-A084	CIVIL DESIGN CALCULATION FOR THICKENER	12	A4
59	PE-V0-411-158-A027	TECHNICAL DATA SHEET HOIST, WEIGHING SCALE , TROLLEY AND CHAIN PULLEY BLOCK	10	A4



TITLE

4 X 270 MW BHADRADRI TPS TECHNICAL SPECIFICATION FOR PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 4 of 6

60	PE-V0-411-158-A048	TECHNICAL DATSHEET AND HOOK UP DRAWING FOR ANALYSERS	10	A4
61	PE-V0-411-158-A026	TECHNICAL DATA SHEET FOR AGITATOR	10	A4
62	PE-V0-411-158-A069	CIVIL DESIGN CALCULATION FOR CLARIFIED WATER CHANNEL TO DM CLARIFIED WATER TANK	12	A4
63	PE-V0-411-158-A047	TECHNICAL DATSHEET AND HOOK UP DRAWING FOR TRANSMITTERS	10	A4
64	PE-V0-411-158-A017	TECHNICAL DATASHEET FOR GATE VALVES	10	A4
65	PE-V0-411-158-A059	REINFORCEMENT DRAWING FOR CASCADE AERATOR, STILLING CHAMBER, FLASH MIXER AND PARSHALL FLUME FOR CLARIFIER	12	A1
66	PE-V0-411-158-A093	ERECTION PROCEDURE	20	A4
67	PE-V0-411-158-A031	MECH. GA FOR DM CLARIFIER	10	A1
68	PE-V0-411-158-A052	UPS AND BATTERY SIZING CALCULATION, DATA SHEET AND GA FOR UPS	10	A4
69	PE-V0-411-158-A008	TECHNICAL DATA SHEET FOR HORIZONTAL / VERTICAL CENTRIFUGAL PUMPS	10	A4
70	PE-V0-411-158-A041	QAP for PT PLANT (BALANCE ITEMS)	10	A4
71	PE-V0-411-158-A062	REINFORCEMENT DRAWING FOR STILLING CHAMBER, FLASH MIXER AND PARSHALL FLUME FOR DM CLARIFIER	12	A0
72	PE-V0-411-158-A089	MECHANICAL GA OF CENTRIFUGE SHED / BUILDING	12	A1
73	PE-V0-411-158-A090	FABRICATION DETAIL DRAWING FOR PUDDLE PIPES	12	A1
74	PE-V0-411-158-A075	CIVIL DESIGN CALCULATION FOR SLUDGE SUMP, THICKENED SLUDGE SUMP AND FILTER BACKWASH SUMP	12	A4
75	PE-V0-411-158-A053	QAP FOR UPS	10	A4
76	PE-V0-411-158-A005	PRESSURE DROP CALCULATIONS	4	A4
77	PE-V0-411-158-A054	QAP / CHECK LIST FOR ALL INSTRUMENTS	10	A4
78	PE-V0-411-158-A096	ENGINEERING BOQ	20	A4
79	PE-V0-411-158-A071	REINFORCEMENT DRAWING FOR CLARIFIED WATER CHANNEL TO DM CLARIFIED WATER TANK	12	A1
80	PE-V0-411-158-A028	MECH. GA FOR CASCADE AERATOR, STILLING CHAMBER, FLASH MIXER AND PARSHALL FLUME FOR CLARIFIER	10	A1
81	PE-V0-411-158-A049	INSTRUMENT SCHEDULE	10	A4
82	PE-V0-411-158-A070	CIVIL GA FOR CLARIFIED WATER CHANNEL TO DM CLARIFIED WATER TANK	12	A0
83	PE-V0-411-158-A092	PAINTING SCHEDULE	15	A4
84	PE-V0-411-158-A068	REINFORCEMENT DRAWING FOR DM CLARIFIER	12	A1
85	PE-V0-411-158-A045	CABLE TRAY/TRENCH & CONDUIT ROUTING DIAGRAM FOR PTP	10	A1
86	PE-V0-411-158-A078	TECHNICAL DATA SHEET & GA OF THICKNER FOR EFFLUENT TREATMENT PLANT	10	A4
87	PE-V0-411-158-A079	QAP FOR CENRIFUGE AND THICKNER MECHANISM	10	A4
31	PE-V0-411-163-A027	DATA SHEET OF INSTREMENTS FOR DM PLANT	10	A4

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT****SPECIFICATION NO.**

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 5 of 6

Notes:

1. The above drawing list is tentative and shall be finalized with the successful bidder after placement of order. While some of the drawings indicated above may not be applicable, some additional drawings may also be required based on scope of work.
2. Drawings shall be prepared in Auto-Cad latest edition. Required no. of hard and soft copies (editable) of the drawings shall be furnished as per requirement specified elsewhere in the specification.
3. Only manual calculation with authentic supporting literature (e.g. extracts of hand Book/ standard/codes) shall be acceptable. All design calculations and drawings shall be in SI system only.
4. All the drawings and documents including general arrangement drawing, data sheet, calculation etc. to be furnished to the customer during detailed engineering stage shall include / indicate the following details for clarity w.r.t. Inspection, construction, erection and maintenance etc.:-
 - a) All drawings and documents shall indicate the list of all reference drawings including general arrangement.
 - b) All drawings shall include / show plan, elevation, side view, cross - section, skin section, blow - up view; all major self-manufactured and bought out items shall be labeled and included in BOQ / BOM in tabular form.
 - c) Painting schedule shall also be made as a part of general arrangement drawing of each equipment / items indicating at least 3 trade names.
 - d) All the drawings required to be furnished to customer during detailed engineering stage shall include technical parameters, details of paints and lubrication, hardness and BOQ / BOM in tabular form indicating all major components including bought out items and their quantity, material of construction indicating its applicable code / standard, weight, make etc.
 - e) Drawings/ documents to be submitted for purchasers review/ approval shall be under Revision A, B, C... etc. while drawings /documents to be submitted thereafter for customer's approval after purchaser's approval shall be under R-0, 1, 2, 3 etc.
 - f) Drawings and documents not covered above but required to check safety of machines/ system, shall be submitted during detailed engineering stage without any commercial implication.
 - g) All drawings shall include "B.O.M" and indicate quantity, material of construction, make along with IS/BS No., Technical parameters, dimensions, hardness, machining symbol and tolerance, requirement of radiography and hydraulic tests, painting details, elevation, side view, plan, skin section and blow-up view for clarity.
 - h) All drawings shall be prepared as per BHEL's title block and shall bear BHEL's drawing No.
 - i) Schedule of drawings submissions, comment incorporations & approval shall be as stipulated in the specifications. The successful bidder shall depute his design personnel to BHEL's/ Customer's/ Consultant's office for across the table resolution of issues and to get documents approved in the stipulated time.
 - j) Bidder to follow the following the drawing submission schedule:
 - k) 1st submission of drawings from date of LOI as per the submission schedule.
 - l) Every revised submission incorporating comments – within 7 days.

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT****SPECIFICATION NO.**

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 6 of 6

- m) Bidder to submit revised drawings complete in all respects incorporating all comments. Any incomplete drawing submitted shall be treated as non-submission with delays attributable to bidder's account. For any clarification/ discussion required to complete the drawings, the bidder shall himself depute his personal to BHEL for across the table discussions/ finalizations/ submissions of drawings.
5. Bidder to note that the successful bidder, during detail engineering, will submit the drg/doc through web based Document Management System in addition to hard copies to be submitted as per the Annexure III of this specification. Bidder would be provided access to the DMS for drg/doc approval and adequate training for the same. Detailed methodology would be finalized during the kick-off meeting. Bidder to ensure following at their end:
- Internet explorer version – Minimum Internet Explorer 7
 - Internet speed – 2 mbps (Minimum preferred)
 - Pop ups from our external DMS IP (124.124.36.198) should not be blocked
 - Vendor's Internal proxy setting should not block DMS application's link (<http://124.124.36.198/wrenchwebaccess/login.aspx>)
 - DMS user manuals to be used by BHEL PEM vendors for uploading, viewing, revising, commenting and tracking documents on PEM's DMS have been uploaded on PEM internet website (www.bhelpem.com) under the Vendor session.
 - For quick access bidder may refer the link <http://bhelpem.com/DMSManuals/DMSManuals.html>

	TITLE 4 X 270 MW BHADRADRI TPS TECHNICAL SPECIFICATION FOR PRE- TREATMENT PLANT	SPECIFICATION NO. PE-TS-411-158A-A001
		VOLUME: II B
		REV 00
		SHEET 1 of 4
ANNEXURE VII		
FORMAT FOR OPERATION AND MAINTENANCE MANUAL		
Page 205 of 806		



TITLE

4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 2 of 4

Bidder to submit operation and Maintenance manual with minimum information as listed in below check list during contract stage.

Check List for Operation & Maintenance Manual

Project name :
Project number :
Package Name :
PO reference :
Document number :
Revision number :

Sl.no. & Sections	Description	Tick (√)if included in Manual			Remarks
		Yes	No	Not Applicable	
1.	Cover page				
1.1	Project Name				
1.2	Customer/consultant Name				
1.3	Name of Package				
1.4	Supplier details with phone, FAX ,email address , Emergency Contact number				
1.5	Name and sign of prepared by , checked by & approved by				
1.6	Revision history with approval Details				
2.0	Index				
2.1	showing the sections & related page nos All the pages should be numbered section wise				
3.0	Description of Plant/System				
3.1	Description /write up of operating principle of system equipment/ associated sub-systems & accessories/controls system , operating conditions, performance parameters under normal , start up and special cases				
3.2	Equipment list and basic parameter with Tag numbers				
3.3	Data sheets approved by Customer/for information and catalogues provided by original manufacturer				
3.4	Associated other packages and Interface /terminal points				
3.5	P&ID & Process Diagrams				
3.6	GA Layout drawings, As-built drawings , Actual photograph of items/system (Drawings of A2 & bigger sizes are to be attached in the last)				
3.7	Single line/wiring diagrams				
3.8	Control philosophy /control write-ups				
4.0	Commissioning Activities (if not covered in				



TITLE

4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 3 of 4

	separate document i.e. erection manual, commissioning manual)				
4.1	Pre-Commissioning Checks				
4.2	handling of items at site				
4.3	Storage at site				
4.4	Unpacking & Installation procedure				
5.0	Operation Guidelines for plant personal/user/operator				
5.1	Interlock & Protection logic along with the limiting values of protection settings for the equipment along with brief philosophy behind the logic, drawings etc. to be provided.				
5.2	Start up, normal operation and shut down procedure for equipments along with the associated systems in step by step mode. Valve sequence chart, step list, interlocks etc. with Equipment isolating procedures to be mentioned.				
5.3	Do's & Don't of the equipments.				
5.4	Safety precautions to be taken during normal operation. Safety symbols, Emergency instructions on total power failure condition/lubrication failure/any other condition				
5.5	Parameters to be monitored with normal values and limiting values				
5.6	Trouble shooting with causes and remedial measures				
5.7	Routine operational checks, recommended logs & records				
5.8	Changeover schedule if more than one auxiliary for the same purpose is given				
5.9	Painting requirement and schedule				
5.10	Inspection, repair , Testing and calibration procedures				
6.0	Maintenance guidelines for plant personal				
6.1	List of Special Tools and Tackles required for Overhaul/Trouble shooting including special testing equipment required for calibration etc.				
6.2	Stepwise dismantling and re-assembly procedure clearly specifying the tools to be used, checks to be made, records to be maintained, clearances etc. to be mentioned. Tolerances for fitment of various components to be given.				
6.3	Preventive Maintenance & Overhauling schedules linked with running hours/calendar period along with checks to be given				
6.4	Long term maintenance schedules especially for structural, foundations etc.				
6.5	Consumable list along with the estimated				



TITLE

4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 4 of 4

	quantity required during commissioning, normal running and during maintenance like Preventive Maintenances and Overhaul. Storage/handling requirement of consumables/self-life.				
6.6	List of lubricants with their Indian equivalent, Lubrication Schedule, Quantity required for each equipment for complete replacement is to be given				
6.7	List of vendors & Sub-vendors with their latest addresses, service centres ,Telephone Nos., Fax Nos., Mobile Nos., e-mail IDs etc.				
6.8	List of mandatory and recommended spare parts list				
6.9	Tentative Lead time required for ordering of spares from the equipment supplier				
6.10	Guarantee and warranty clauses				
7.0	Statutory and other specific requirements considerations.				
8.0	List of reference documents				
9.0	Binding as per requirement				

**TITLE**

**4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 1 of 15

ANNEXURE VIII**SITE STORAGE AND PRESERVATION**

	TITLE 4 X 270 MW BHADRADRI TPS TECHNICAL SPECIFICATION FOR PRE TREATMENT PLANT	SPECIFICATION NO. PE-TS-411-158A-A001
		VOLUME: II B
		REV 00
		SHEET 2 of 15

CONTENT

- 1 SCOPE OF THE DOCUMENT
- 2 PURPOSE OF STORAGE & PRESERVATION
- 3 MEASURES TO BE TAKEN FOR STORAGE AND PRESERVATION
 - a) GENERAL STORAGE REQUIREMENTS
 - b) GENERAL PRESERVATION REQUIREMENTS
 - c) GENERAL INSPECTION REQUIREMENTS
- 4 TYPE OF STORAGE FOR VARIOUS EQUIPMENT
5. CONCLUSION
6. STACKING ARRANGEMENT FOR PLATES AND STRUCTURAL STEEL

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE TREATMENT PLANT****SPECIFICATION NO.**

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 3 of 15

1. SCOPE OF THE DOCUMENT

This guideline is prepared in intent to provide proper site storage and preservation of the Mechanical, Electrical and C & I items / equipment supplied under various bought out packages/items. This storage procedure shall be followed at different power plant sites by concerned agency for storage and preservation from the date of equipment received at site until the same are erected and handed over to the customer.

2. PURPOSE OF STORAGE & PRESERVATION

Many of the items may be required to be kept in stores for long period. It shall therefore be essential that proper methods of storage and preservation be applied so that items do not deteriorate, lose some of their properties and become unusable due to atmospheric conditions and biological elements.

3. MEASURES TO BE TAKEN FOR STORAGE, HANDLING & PRESERVATION**a) GENERAL STORAGE REQUIREMENTS**

1. To the extent feasible, materials should be stored near the point of erection. The storage areas should have adequate unloading and handling facilities with adequate passage space for movement of material handling equipment such as cranes, fork lift trucks, etc. The storage of materials shall be properly planned to minimise time loss during retrieval of items required for erection.
2. The outdoor storage areas as well as semi-closed stores shall be provided with adequate drainage facilities to prevent water logging. Adequacy of these facilities shall be checked prior to monsoon.
3. The storage sheds shall be built in conformity with fire safety requirements. The stores shall be provided with adequate lights and fire extinguishers. 'No smoking' signs shall be placed at strategic locations. Safety precautions shall be strictly enforced.
4. Adequate lighting facility shall be provided in storage areas and storage sheds and security personnel positioned to ensure enforcement of security measures to prevent theft and loss of materials.
5. Adequate number of competent stores personnel and security staff shall be deployed to efficiently store and maintain the equipment / material.
7. The equipment shall be stored in an orderly manner, preserving their identification slips, tags and instruction booklets, etc., required during erection. The storage of materials shall be equipment-wise. Loose parts shall be stored in sheds on racks.

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE TREATMENT PLANT****SPECIFICATION NO.**

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 4 of 15

preserving the identification marks and tags in good condition. The group codes shall be displayed on the racks

6. At no time shall any materials be stored directly on ground. All materials shall be stored minimum 200 mm above the ground preferably on wooden sleepers

b) GENERAL PRESERVATION REQUIREMENTS

1. All special measures to prevent corrosion shall be taken like keeping material in dry condition, avoiding the equipment coming in contact with corrosive fluid like water, acid etc.
2. Materials which carry protective coating shall not be wrapped in paper, cloth, etc., as these are liable to absorb and retain moisture. The material shall be inspected and in case of signs of wear or damages to protective coating, that portion shall be cleaned with approved solution and coated with an approved protective paint. Complete record of all such observations and protective measures taken shall be maintained.
3. Generally equipment supplied at site are properly greased or rust protective oil is applied on machined/ fabricated components. However periodic inspection shall be carried out to ensure that protection offered is intact.
4. While handling the equipment, no dragging on the ground is permitted. Avoid using wire rope for lifting coated components. Use polyester slings (if possible) otherwise protective material (e.g. clothes, wood block etc.) should be used while handling the components with rope / slings
5. For Equipment supplied with finished paint, touch paint shall be done in case any surface paint gets peeled off during handling. Otherwise such surfaces shall necessarily be wrapped with polythene to avoid any corrosion. Further for equipment wherein finish coat is to be applied at site, site to ensure that equipment is received with primer coat applied.
6. It shall be ensured by periodic inspection that plastic inserts are intact in tapped holes, wherever applicable.
7. Pipes shall be blown with air periodically and it shall be ensured that there is no obstruction.
8. Silica gel or approved equivalent moisture absorbing material in small cotton bags shall be placed and tied at various points on the equipment, wherever necessary.
9. Heavy rotating parts in assembled conditions shall be periodically rotated to prevent corrosion/jamming due to prolonged storage.

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE TREATMENT PLANT****SPECIFICATION NO.**

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 5 of 15

10. All the electrical equipment such as motors, generators, etc. shall be tested for insulation resistance at least once in three months and a record of such measured insulation values shall be maintained.

11. Following preservatives/preservation methods can be used depending upon type of equipment

- a. Rust preventive fluid (RPF)
- b. Rust protective paints
- c. Tarpaulin covers, in case of outdoor storage
- d. De-oxy aluminate for weld-ments

c) GENERAL INSPECTION REQUIREMENTS

1. Period inspection of materials with specific reference to –

- Ingress of moisture and corrosion damages.
- Damage to protective coating.
- Open ends in pipes, vessels and equipment -
 - In case any open ends are noticed, same shall be capped.

2. Any damages to equipment / materials.

- In case of any damages, these shall be promptly notified and in all cases, the repairs / rectification shall be carried out.
- Any items found damaged or not suitable as per project requirements shall be removed from site. If required to store temporarily, they shall be clearly marked and stored separately to prevent any inadvertent use.

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE TREATMENT PLANT****SPECIFICATION NO.**

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 6 of 15

4. TYPE OF STORAGE FOR VARIOUS EQUIPMENT

The types of storage are broadly classified under the following heads:

i Closed storage with dry and dust free atmosphere. (C)

The closed shed can be constructed by using cold-rolled / tubular components for structure and corrugated asbestos sheets / galvanised iron sheets for roofing. Brick walls / asbestos sheets can be used to cover all the sides. The floor of the shed can be finished with plain cement concrete suitably glazed. The shed shall be provided with proper ventilation and illumination.

**ii Semi-closed storage. (S)**

The semi closed shed can be constructed by using cold-rolled / tubular components for structure and corrugated / asbestos sheets for roofing. The floor shall be brick paved. If required a small portion of sides can be covered to protect components from rainwater splashing onto the components.



**TITLE**

4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 7 of 15

**iii Open storage (O)**

The open yard shall be levelled, well consolidated to achieve raised ground with the provision of feeder roads for crane approach along with access roads running all sides. One part of the open yard shall be stone pitched, levelled and consolidated with raised ground suitable for storing / stacking heavier and critical components with due space to handle them by cranes etc . Adequate number of sleepers, concrete block etc. to be provided to make raised platforms to stack critical materials.

A separate yard to be identified as "scrap yard" slightly away from main open yard to store wooden/steel scraps, which are to be disposed off. This is required to avoid mix up with regular components as well as to avoid fire hazard.

Some of the components, which are having both machined & un-machined surfaces and are bulky, shall be stored in open storage area on a raised ground and suitably covered with water proof / fire retardant tarpaulin.





TITLE

4 X 270 MW BHADRADRI TPS TECHNICAL SPECIFICATION FOR PRE TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 8 of 15

The equipment listed below shall be stored and inspected as per requirement mentioned in the table below.

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
Raw material /mechanical items like pipes, plates, structure sections etc.)				
1.	Steel pipes (lined/unlined)	S	Damage , paint, corrosion, rubber lining peeling	Provide end cap
2.	MS Plates	S	Damage, paint, corrosion	
3.	SS Plates	S	Damage	
4.	Non-metallic pipes	S	Damage, cracks	Provide end cap
5.	Stainless steel pipes	S	Damage ,	Provide end cap
6.	MS sections, beams	S	Damage, paint, corrosion	
7.	Cable trays	S	Damage, condition of preservations	
8.	Insulation sheets	S	Damage	
9.	Insulation	C	Damage, packing	
10.	Hangers Rods	S	Damage, paint, packing	
11.	Tubes	S	Damage, paint , packing	Provide end cap
12.	Hume pipes	O	Damage	
13.	Castings	O	Damage, paint, corrosion	
Fabricated mechanical items (pressure vessels, tanks etc.)				
14.	Pressure vessels (unlined)	O	Damage, paint, corrosion,	Covered nozzles
15.	Atmospheric storage tanks (unlined)	O	Damage, paint, corrosion	Covered nozzles



TITLE

4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 9 of 15

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
16.	Pressure vessels (lined)	S	Damage, paint, corrosion, rubber lining	
17.	Atmospheric storage tanks(lined)	S	Damage, paint, corrosion, rubber lining	
18.	Support structures	O	Damage , paint, corrosion	
19.	Flanges	C	Damage , paint, corrosion	
20.	Fabricated pipes	S	Damage , paint, corrosion	Provide end cap
21.	Vessels internals	C	Damage , paint, corrosion ,packing	
22.	Grills	S	Damage , paint, corrosion	
23.	Angles	S	Damage , paint, corrosion	
24.	Bridge mechanism/clarifier mechanism	O	Damage , paint, corrosion	
25.	Cranes, rails	S	Damage , paint, corrosion	
26.	Stair cases	O	Damage , paint, corrosion	
27.	Ladders/handrails	O	Damage , paint, corrosion	
28.	Fabricated ducts	S	Damage , paint, corrosion	
29.	Isolation Gates	O	Damage , paint, corrosion	
30.	Fabricated boxes/panels	S	Damage , paint, corrosion	
Mechanical components like valves, fittings, cables glands, spares etc.)				
31.	Valves	S	Damage , packing	



TITLE

4 X 270 MW BHADRADRI TPS TECHNICAL SPECIFICATION FOR PRE TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 10 of 15

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
32.	Fittings	S	Damage , packing	Provide end cap
33.	Cable glands	C	Damage , packing	
34.	Tools & tackles	C	Damage , packing	
35.	Nut , bolts, washers,	C	Damage , packing	
36.	Gasket & Packings	C	Damage , packing	
37.	Copper tubes	C	Damage , packing, corrosion	Provide end cap
38.	SS tubing	C	Damage , packing	Provide end cap
Rotating assemblies (pumps, blowers, stirrers, fans, compressors etc.)				
39.	Pumps	S	Damage , packing, corrosion	Shaft rotation
40.	Blowers/Compressors	S	Damage , packing, corrosion	Shaft rotation
41.	Agitators/stirrers/radial launders	C	Damage , packing, corrosion	Shaft rotation
42.	Rollers for chlorine tonner mounting	C	Damage , packing, corrosion	
43.	Centrifuge	S	Damage , packing,	
44.	Gear box	C	Damage , packing, corrosion	
45.	Bearings	C	Damage , packing, corrosion	
46.	Fans	S	Damage , packing, corrosion	
47.	Dosing skids	S	Damage , packing, corrosion	
48.	Pump assemblies	S	Damage , packing, corrosion	
49.	Air washers(INTERNALS)	S	Damage , packing	
50.	Air conditioners (split)	C	Damage , packing	



TITLE

4 X 270 MW BHADRADRI TPS TECHNICAL SPECIFICATION FOR PRE TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 11 of 15

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
51.	Elevators(CONTAINERIZED)	O	Damage , packing, corrosion	
52.	Chillers/VA machines	S	Damage , packing	
53.	Air handling Unit/Package unit	S	Damage , packing	
54.	Chlorinators & Evaporators	C	Damage , packing	
55.	Ejectors	C	Damage , packing	
56.	Electrolyser	C	Damage , packing	
Miscellaneous items like chain pulley blocks, hoists etc.				
57.	Chain pulley blocks	S	Damage, Packing	
58.	Electric hoists	S	Damage, Packing	
59.	Fire extinguishers	C	Damage, expiry date	
60.	Fork Lift Truck	S	Damage, Packing	
61.	Hydraulic Mobile Crane	O	Damage, Packing	
62.	Mobile Pick Up & Carry Crane	O	Damage, Packing	
63.	Motor boats	O	Damage, Packing	
64.	Safety showers	S	Damage, Packing	
65.	Diffusers/dampers	S	Damage, Packing	
Chemicals and consumables (acid, alkali, paints, oils, reagents and special chemicals)				
66.	Hydro Chloric Acid (HCl)	Store in canes/ storage tank in dyke area	Date of production/ leakage/fumes	hazardous chemical
67.	Sulphuric acid (H ₂ SO ₄)	Store in canes/ storage tank in dyke area	Date of production/ leakage/fumes	hazardous chemical



TITLE

4 X 270 MW BHADRADRI TPS TECHNICAL SPECIFICATION FOR PRE TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 12 of 15

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
68.	Sodium hydroxide (NaOH)	Store in canes/ storage tank in dyke area	Date of production/ leakage/ fumes/ breather	hazardous chemical ,breather to be checked for air ingress
69.	Sodium hypo chlorite	To be stored under shed	Date of production/ leakage/ fumes	hazardous chemical ,self-life normally 15-30 days after which strength of chemical decays
70.	Ammonia	S	Date of production/ leakage/ fumes	Store in closed storage tanks, hazardous chemical
71.	CW treatment chemicals	S	Date of production , Self-life	Store in closed canes
72.	RO/UF cleaning chemicals	S	Date of production , Self-life	Store in closed canes
73.	Lime	C	Damage to packing , seepage	Prevent moisture, rain
74.	Alum bricks	C	Damage to packing	Prevent moisture, rain
75.	Poly electrolyte	S		Store in closed storage tanks
76.	Laboratory chemicals(powder)	C	Damage, Packing self-life	
77.	Laboratory chemicals(liquid)	C	Damage, Packing self-life	
78.	Lubrication oils	C	Leakage	
79.	Paints	S	Leakage ,air tightness	
80.	Sand	O	Damage of packing	No hooks
81.	Salt (NaCl)	C	Damage of packing, water ingress	Prevent moisture, rain
82.	Anthracite	S	Damage of packing	
83.	Activated carbon	S	Damage of packing	



TITLE

4 X 270 MW BHADRADRI TPS TECHNICAL SPECIFICATION FOR PRE TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 13 of 15

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
84.	Thermal insulation	S	Damage of packing	
85.	Cement	C	Damage of packing	Prevent moisture, rain
86.	Gravels	O	Damage of packing	
87.	ION exchange resins	C	Damage , packing	Refer manufacturer guidelines
88.	RO membranes	C	Damage , packing	Refer manufacturer guidelines
89.	UF membranes	C	Damage , packing	Refer manufacturer guidelines
90.	Cleaning chemicals	C	Damage , packing	Refer manufacturer guidelines
91.	Chemicals for analysers/calibration	C	Damage , packing	Refer manufacturer guidelines
Electrical and C & I items (motors, cables etc.)				
92.	Motors	C	Damage , packing	
93.	Cable drums	O	Damage	
94.	Control Panel /control desk, UPS ,JB	S	Damage, Packing	
95.	Instruments(gauges/analysers)	C	Damage	
Special items		As per Manufacturer's item, like Hydrogen cylinders, Ozonator, Analyser, Chlorine dioxide generators etc.		

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE TREATMENT PLANT****SPECIFICATION NO.**

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 14 of 15

5. CONCLUSION

Concerned storage agency at site should make sure that loss in equipment performance and wear & tear are minimised through proper storage and preservation. The above are broad guidelines and cover major equipment / materials. However specific storage practices shall be followed as per manufacturer recommendation. All the necessary measures even in addition to the ones mentioned above, if found necessary, should be taken to achieve the objective.



TITLE

4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 15 of 15

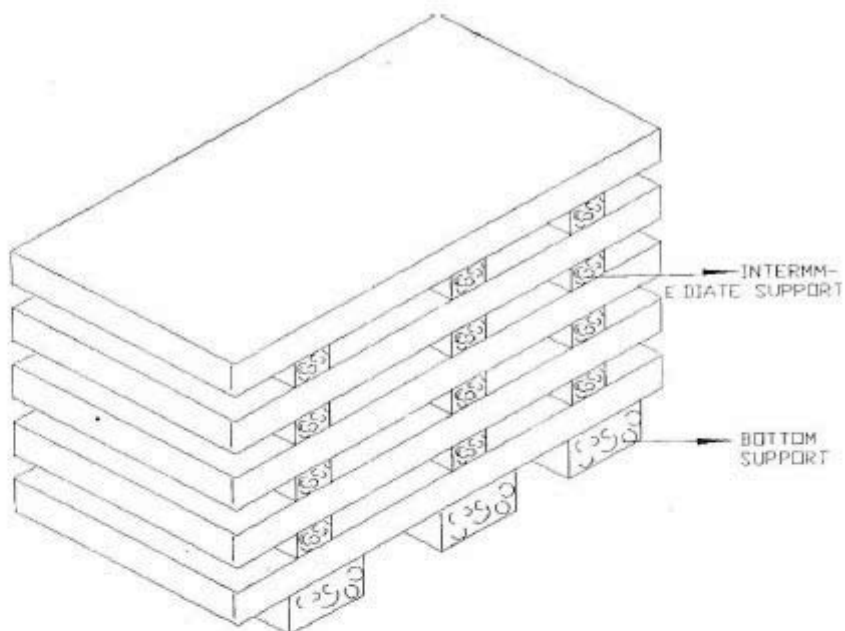


Figure – 1 – PLATE STACKING ARRANGEMENT

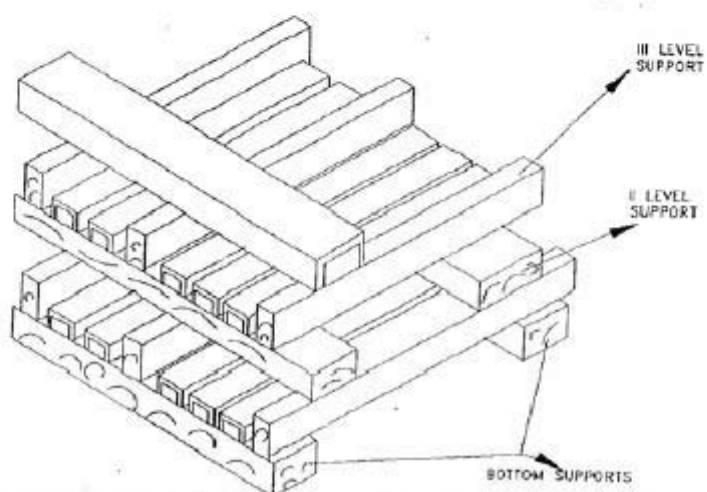


Figure – 2 – STRUCTURAL STEEL STACKING ARRANGEMENT

**TITLE**

**4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 1 of 2

ANNEXURE IX**INPUT DRAWINGS**

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 2 of 2

SL. NO.	DRAWING TITLE	DRAWING NO.
1.	FLOW DIAGRAM OF PT PLANT	PE-DG-411-158A-A001
2.	CLARIFIED WATER PUMP HOUSE / CLARIFIED STORAGE TANK	PE-DG-K27-172-N102
3.	PLOT PLAN	PE-DG-411-100-M001
4.	PLANT WATER SYSTEM P&ID	PE-DG-411-172-N001

ON SHAWED

FIRST ANGLE PROJECTION

PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT

ALL DIMENSIONS ARE IN MM

Fold-1

10

11

ON SHAWED S.S. JAWED

E.G.E.N.D

LIME DOSING SYSTEM.

ALUM DOSING SYSTEM.

POLYMER DOSING SYSTEM FOR CLARIFIER.

FILTERED WATER OVERHEAD TANK

DIAPHRAGM VALVE

GATE VALVE (NORMALLY OPEN)

GLOBE VALVE (NORMALLY CLOSED)

GLOBE VALVE (NORMALLY OPEN)

NON RETURN VALVE

BUTTERFLY VALVE

ISOLATION GATE VALVE

SAFETY RELIEF VALVE

STIRNER

MOTOR OPERATED

MOTOR OPERATED WITH GEAR

LEVEL SWITCH (FOR HIGH LEVEL)

LEVEL SWITCH (FOR LOW LEVEL)

PTV PT VENDOR

LEVEL INDICATOR

PRESSURE INDICATOR

ALARM

INTERLOCK

SCREEN PUMP

CENTRIFUGAL PUMP

PRESSURE GAUGE

FLOW INDICATOR CUM TRANSMITTER

POSITIVE DISPLACEMENT PUMP

TO RW CHLORINATION PLANT (80 METER)

OVER FLOW TO CLARIFIER SLUDGE SUMP

TO SLUDGE COLLECTION PIT

TO POTABLE WATER STORAGE TANK (FOR POTABLE WATER)

BY BHEL

TO DCS

TO PLC

TO FLOW METER

TO PRESSURE METER

TO TEMPERATURE METER

TO PH METER

TO DO METER

TO ORP METER

TO TSS METER

TO VIBRATION METER

TO ACCELERATION METER

TO DISPLACEMENT METER

TO FORCE METER

TO TORQUE METER

TO POWER METER

TO ENERGY METER

TO FLOW RATE METER

TO VOLUME METER

TO MASS METER

TO WEIGHT METER

TO LENGTH METER

TO AREA METER

TO VOLUME FLOW METER

TO MASS FLOW METER

TO ENERGY FLOW METER

TO POWER FLOW METER

TO TORQUE FLOW METER

TO DISPLACEMENT FLOW METER

TO FORCE FLOW METER

TO TEMPERATURE FLOW METER

TO PH FLOW METER

TO DO FLOW METER

TO ORP FLOW METER

TO TSS FLOW METER

TO VIBRATION FLOW METER

TO ACCELERATION FLOW METER

TO DISPLACEMENT FLOW METER

TO FORCE FLOW METER

TO TORQUE FLOW METER

TO POWER FLOW METER

TO ENERGY FLOW METER

TO FLOW RATE FLOW METER

TO VOLUME FLOW METER

TO MASS FLOW METER

TO WEIGHT FLOW METER

TO LENGTH FLOW METER

TO AREA FLOW METER

TO VOLUME FLOW METER

TO MASS FLOW METER

TO ENERGY FLOW METER

TO POWER FLOW METER

TO TORQUE FLOW METER

TO DISPLACEMENT FLOW METER

TO FORCE FLOW METER

TO TEMPERATURE FLOW METER

TO PH FLOW METER

TO DO FLOW METER

TO ORP FLOW METER

TO TSS FLOW METER

TO VIBRATION FLOW METER

TO ACCELERATION FLOW METER

TO DISPLACEMENT FLOW METER

TO FORCE FLOW METER

TO TORQUE FLOW METER

TO POWER FLOW METER

TO ENERGY FLOW METER

TO FLOW RATE FLOW METER

TO VOLUME FLOW METER

TO MASS FLOW METER

TO WEIGHT FLOW METER

TO LENGTH FLOW METER

TO AREA FLOW METER

TO VOLUME FLOW METER

TO MASS FLOW METER

TO ENERGY FLOW METER

TO POWER FLOW METER

TO TORQUE FLOW METER

TO DISPLACEMENT FLOW METER

TO FORCE FLOW METER

TO TEMPERATURE FLOW METER

TO PH FLOW METER

TO DO FLOW METER

TO ORP FLOW METER

TO TSS FLOW METER

TO VIBRATION FLOW METER

TO ACCELERATION FLOW METER

TO DISPLACEMENT FLOW METER

TO FORCE FLOW METER

TO TORQUE FLOW METER

TO POWER FLOW METER

TO ENERGY FLOW METER

TO FLOW RATE FLOW METER

TO VOLUME FLOW METER

TO MASS FLOW METER

TO WEIGHT FLOW METER

TO LENGTH FLOW METER

TO AREA FLOW METER

TO VOLUME FLOW METER

TO MASS FLOW METER

TO ENERGY FLOW METER

TO POWER FLOW METER

TO TORQUE FLOW METER

TO DISPLACEMENT FLOW METER

TO FORCE FLOW METER

TO TEMPERATURE FLOW METER

TO PH FLOW METER

TO DO FLOW METER

TO ORP FLOW METER

TO TSS FLOW METER

TO VIBRATION FLOW METER

TO ACCELERATION FLOW METER

TO DISPLACEMENT FLOW METER

TO FORCE FLOW METER

TO TORQUE FLOW METER

TO POWER FLOW METER

TO ENERGY FLOW METER

TO FLOW RATE FLOW METER

TO VOLUME FLOW METER

TO MASS FLOW METER

TO WEIGHT FLOW METER

TO LENGTH FLOW METER

TO AREA FLOW METER

TO VOLUME FLOW METER

TO MASS FLOW METER

TO ENERGY FLOW METER

TO POWER FLOW METER

TO TORQUE FLOW METER

TO DISPLACEMENT FLOW METER

TO FORCE FLOW METER

TO TEMPERATURE FLOW METER

TO PH FLOW METER

TO DO FLOW METER

TO ORP FLOW METER

TO TSS FLOW METER

TO VIBRATION FLOW METER

TO ACCELERATION FLOW METER

TO DISPLACEMENT FLOW METER

TO FORCE FLOW METER

TO TORQUE FLOW METER

TO POWER FLOW METER

TO ENERGY FLOW METER

TO FLOW RATE FLOW METER

TO VOLUME FLOW METER

TO MASS FLOW METER

TO WEIGHT FLOW METER

TO LENGTH FLOW METER

TO AREA FLOW METER

TO VOLUME FLOW METER

TO MASS FLOW METER

TO ENERGY FLOW METER

TO POWER FLOW METER

TO TORQUE FLOW METER

TO DISPLACEMENT FLOW METER

TO FORCE FLOW METER

TO TEMPERATURE FLOW METER

TO PH FLOW METER

TO DO FLOW METER

TO ORP FLOW METER

TO TSS FLOW METER

TO VIBRATION FLOW METER

TO ACCELERATION FLOW METER

TO DISPLACEMENT FLOW METER

TO FORCE FLOW METER

TO TORQUE FLOW METER

TO POWER FLOW METER

TO ENERGY FLOW METER

TO FLOW RATE FLOW METER

TO VOLUME FLOW METER

TO MASS FLOW METER

TO WEIGHT FLOW METER

TO LENGTH FLOW METER

TO AREA FLOW METER

TO VOLUME FLOW METER

TO MASS FLOW METER

TO ENERGY FLOW METER

TO POWER FLOW METER

TO TORQUE FLOW METER

TO DISPLACEMENT FLOW METER

TO FORCE FLOW METER

TO TEMPERATURE FLOW METER

TO PH FLOW METER

TO DO FLOW METER

TO ORP FLOW METER

TO TSS FLOW METER

TO VIBRATION FLOW METER

TO ACCELERATION FLOW METER

TO DISPLACEMENT FLOW METER

TO FORCE FLOW METER

TO TORQUE FLOW METER

TO POWER FLOW METER

TO ENERGY FLOW METER

TO FLOW RATE FLOW METER

TO VOLUME FLOW METER

TO MASS FLOW METER

TO WEIGHT FLOW METER

TO LENGTH FLOW METER

TO AREA FLOW METER

TO VOLUME FLOW METER

TO MASS FLOW METER

TO ENERGY FLOW METER

TO POWER FLOW METER

TO TORQUE FLOW METER

TO DISPLACEMENT FLOW METER

TO FORCE FLOW METER

TO TEMPERATURE FLOW METER

TO PH FLOW METER

TO DO FLOW METER

TO ORP FLOW METER

TO TSS FLOW METER

TO VIBRATION FLOW METER

TO ACCELERATION FLOW METER

TO DISPLACEMENT FLOW METER

TO FORCE FLOW METER

TO TORQUE FLOW METER

TO POWER FLOW METER

TO ENERGY FLOW METER

TO FLOW RATE FLOW METER

TO VOLUME FLOW METER

TO MASS FLOW METER

TO WEIGHT FLOW METER

TO LENGTH FLOW METER

TO AREA FLOW METER

TO VOLUME FLOW METER

TO MASS FLOW METER

TO ENERGY FLOW METER

TO POWER FLOW METER

TO TORQUE FLOW METER

TO DISPLACEMENT FLOW METER

TO FORCE FLOW METER

TO TEMPERATURE FLOW METER

TO PH FLOW METER

TO DO FLOW METER

TO ORP FLOW METER

TO TSS FLOW METER

TO VIBRATION FLOW METER

TO ACCELERATION FLOW METER

TO DISPLACEMENT FLOW METER

TO FORCE FLOW METER

TO TORQUE FLOW METER

TO POWER FLOW METER

TO ENERGY FLOW METER

TO FLOW RATE FLOW METER

TO VOLUME FLOW METER

TO MASS FLOW METER

TO WEIGHT FLOW METER

TO LENGTH FLOW METER

TO AREA FLOW METER

TO VOLUME FLOW METER

TO MASS FLOW METER

TO ENERGY FLOW METER

TO POWER FLOW METER

TO TORQUE FLOW METER

TO DISPLACEMENT FLOW METER

TO FORCE FLOW METER

TO TEMPERATURE FLOW METER

TO PH FLOW METER

TO DO FLOW METER

TO ORP FLOW METER

TO TSS FLOW METER

TO VIBRATION FLOW METER

TO ACCELERATION FLOW METER

TO DISPLACEMENT FLOW METER

TO FORCE FLOW METER

TO TORQUE FLOW METER

TO POWER FLOW METER

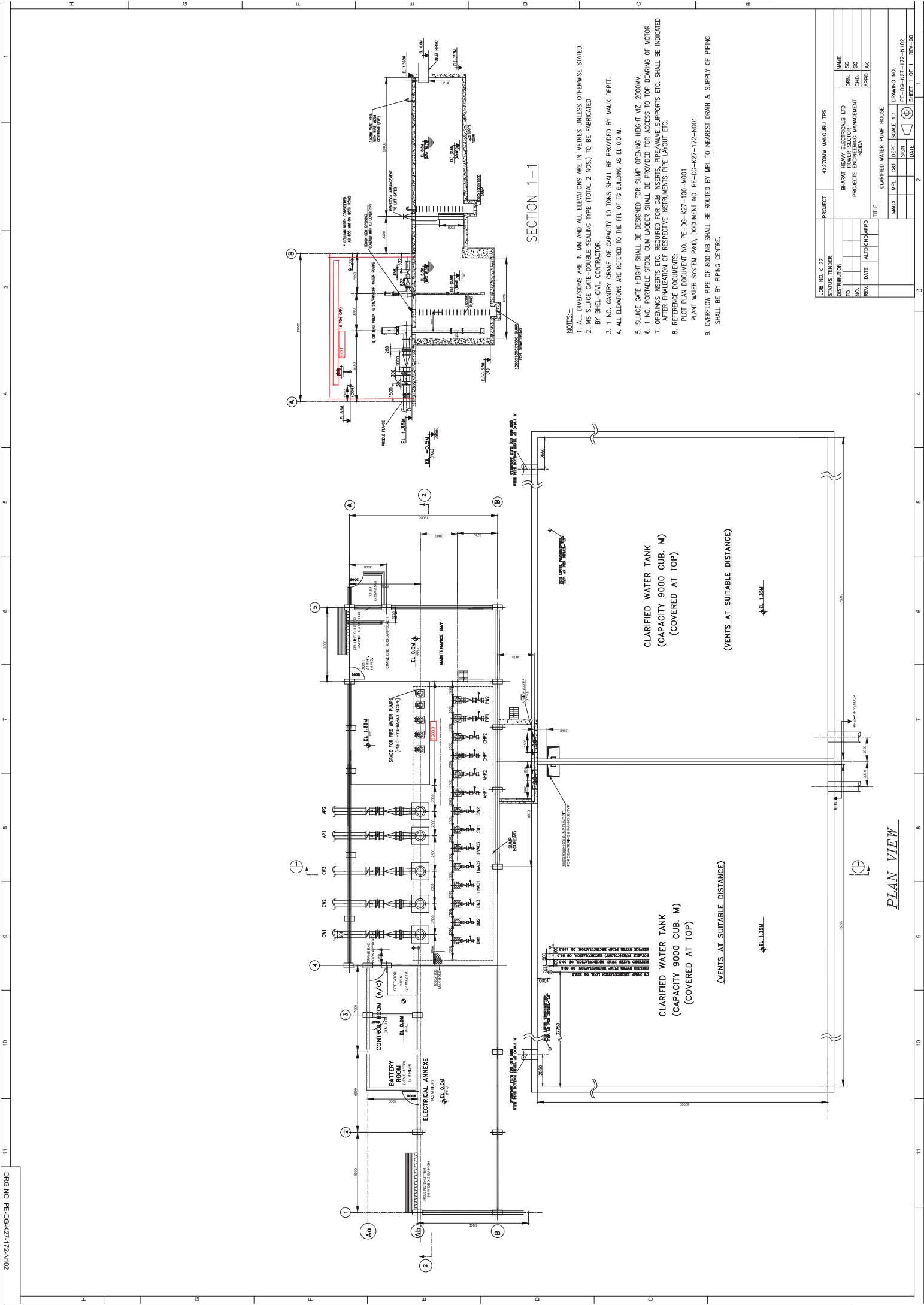
TO ENERGY FLOW METER

TO FLOW RATE FLOW METER

TO VOLUME FLOW METER

TO MASS FLOW METER

TO WEIGHT FLOW METER



SECTION 1-1

- NOTES:-
1. ALL DIMENSIONS ARE IN MM AND ALL ELEVATIONS ARE IN METRES UNLESS OTHERWISE STATED.
 2. MS SLUICE GATE-DOUBLE SEALING TYPE (TOTAL 2 NOS.) TO BE FABRICATED BY BHEL-CIVIL CONTRACTOR.
 3. 1 NO. GANTRY CRANE OF CAPACITY 10 TONS SHALL BE PROVIDED BY MAUX DEPT.
 4. ALL ELEVATIONS ARE REFERRED TO THE FFL OF TO BUILDING AS EL 0.0 M.
 5. SLUICE GATE HEIGHT SHALL BE DESIGNED FOR SLUMP OPENING HEIGHT VIZ. 2000MM.
 6. 1 NO. PORTABLE STOOL Q/W LADDER SHALL BE PROVIDED FOR ACCESS TO TOP BEARING OF MOTOR.
 7. OPENINGS INSERTS ETC. REQUIRED FOR C&I INSERTS, PIPE/VALVE SUPPORTS ETC. SHALL BE INDICATED AFTER FINALIZATION OF RESPECTIVE INSTRUMENTS PIPE LAYOUT ETC.
 8. REFERENCE DOCUMENTS:
 - PLOT PLAN DOCUMENT NO. PE-DG-K27-100-M001
 - PLANT WATER SYSTEM P&ID, DOCUMENT NO. PE-DG-K27-172-N001
 9. OVERFLOW PIPE OF 800 NB SHALL BE ROUTED BY MPL TO NEAREST DRAIN & SUPPLY OF PIPING SHALL BE BY PIPING CENTRE.

PLAN VIEW

JOB NO. K 27		PROJECT		44270MW MANGURU TPS	
STATUS TENDER		DISTRIBUTION			
TO		NAME		BHARAT HEAVY ELECTRICALS LTD	
NO.		DRN.		SC	
REV.		DATE		PROJECTS ENGINEERING MANAGEMENT	
		TITLE		CLARIFIED WATER PUMP HOUSE	
		MAUX		MPL	
		C&I		DEPT.	
		SCALE		1:1	
		DRAWING NO.		PE-DG-K27-172-N002	
		SHEET		1 OF 1	
		REV.		00	

**TITLE**

4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 1 of 1

SECTION – D**STANDARD TECHNICAL REQUIREMENTS****SECTION – D1: STANDARD TECHNICAL REQUIREMENTS FOR MECHANICAL****SECTION – D2: STANDARD TECHNICAL REQUIREMENTS FOR ELECTRICAL****SECTION – D3: STANDARD TECHNICAL REQUIREMENTS FOR CONTROL AND**
INSTRUMENTATION**SECTION – D4: STANDARD TECHNICAL REQUIREMENTS FOR CIVIL**

	TITLE 4 X 270 MW BHADRADRI TPS TECHNICAL SPECIFICATION FOR PRE- TREATMENT PLANT	SPECIFICATION NO. PE-TS-411-158A-A001
		VOLUME: II B
		REV 00
		SHEET 1 of 6

SECTION – D1

STANDARD TECHNICAL SPECIFICATIONS (MECHANICAL)

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO. PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 2 of 6

1.0 DESIGN CRITERIA AND TECHNICAL DETAILS

1. The Clarification Plant shall have 2x50% capacity clarifiers. Design net output capacity of each Clarifier shall be 1915 m³/hr. Pl. refer Datasheet – A for pretreatment plant. The Raw water analysis to be adopted for design of pre- treatment Plant shall be as indicated in Annexure – III.
2. The proposed schematic arrangement of the Pre-treatment Plant is detailed out in tender drawing titled flow diagram for pre-treatment plant.
3. Stilling chamber, Clarifiers etc. shall be of RCC construction unless otherwise mentioned.
4. The hydraulic circuit of the complete Pre-treatment plant shall be designed in such a way that Water from stilling chamber shall flow by gravity upto the clarified water tank under various flow rates upto maximum flow.
5. The system shall be designed so that the Top water level in the clarified water distribution chamber shall be atleast 4 M from the finished ground level or higher.
6. The effluent water from the PT-plant shall meet the guaranteed parameters specified elsewhere.
7. Plant shall be designed considering the available head at the terminal point water level of filtered water storage tank and the head loss between the aerator to Filtered water sump.
8. Hydraulics of the Complete Pre-treatment Plant shall be designed to take an occasional over loading of 20% over the design flow.
9. Complete Pre-treatment Plant shall design to run continuously.
10. Layout for pre-treatment plant shall be designed in such a way that all units (e.g., stilling chamber, clarifier, inlet channel, chemical house first floor, centrifuge shed/building etc.) shall be interconnected by at least 1.2 M wide walkway at appropriate elevations with hand-railing on both sides and pathway at ground level.
11. Capacity of monorail hoists/E.O.T crane or chain pulley block wherever required / specified indicated in datasheet – A are are minimum and capacity of such hoists/ cranes etc. shall be suitable for handling 125% of maximum weight to be handled during erection and maintenance of the equipment in the chemical house buildings etc. as the case may be.
12. Operating platforms shall be provided for all the structures such as, stilling chamber, clarifier, sludge chamber etc. along with ladders and hand railing.
13. One no. filter water overhead tank (RCC) in twin compartment will in bidder's scope (civil construction by BHEL) as indicated in plant water flow diagram including all instrumentations.
14. All the sumps, tanks, reservoirs and other water retaining structures shall be provided with access ladders/rungs from operating platforms/ground level as the case may be and de-watering pits one for each section. Hand railing will be provided by bidder for safety purpose in all civil structures. Supply and erection of Hand railing as desired for safety purpose will be in bidder's scope.
15. All the tanks shall be provided with vent, overflow, drain and sample connections. Effective capacity for chemical tanks & water retaining structures/ tanks/sumps means the capacity between the bottoms of the overflow nozzle to the top of the outlet nozzle. Outlet nozzle centre line shall be kept at least 200 mm from the Invert Level of the chemical tanks / water retaining structures / tanks/sumps. A minimum free board of 300 mm shall be provided in all the water retaining structures of PT Plant (such as stilling chamber, all the channels, Clarifiers, Overhead water tank, etc) above the maximum water level / overflow level as the case may be excluding the thickness of the slab / beam thickness if any.
16. One number of electrically operated monorail hoist to be provided in centrifuge building and capacity of the same shall be minimum 1 Ton.
17. For all pumps, while calculating the pump head, 10% margin shall be considered on frictional losses.
18. All centrifugal pumps shall have recirculation lines.
19. Pipe routing shall be decided during detailed engineering, however bidder will consider 12 m static head + 10% margin during pump selection.
20. Max. support length in meters for MS pipe shall be as follows:-

a)	PIPE DIAMETER (MM)	1200	1000	800

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO. PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 3 of 6

b)	SPAN (METERS)	12	10	8

For pipe sizes less than 800 NB, span shall be as per ANSI B31.1.

1.1 AERATOR

The aerator shall be of stepped design and shall allow water to flow downward after spreading over inclined thin sheets and the turbulence is secured by allowing the water to pass through a series of steps and baffles. Exposure time shall be suitably designed by providing adequate number of steps in the aerator. Water from aerator launder shall be led into the Stilling Chamber.

1.2 STILLING CHAMBER

The stilling chamber shall be provided with a baffle wall so that water shall enter the chamber from the bottom and velocity of water rise through the stilling chamber shall be 0.05 m/sec to avoid any turbulence of the incoming water and volume of stilling chamber shall have a retention time of 2 minute min. Draining arrangement with a valve shall be provided for the stilling chamber.

1.3 CLARIFIERS

The type of clarifier shall be High Rate Solid Contact type with integral variable speed impeller/turbine to internally re-circulate water and sludge at adjustable rate to produce consistent water quality at varying hydraulic load and turbidity.

- i) The unit shall be designed with a minimum retention time of 90 minutes in the settling zone. Larger retention time may be provided to meet the equipment guarantee.
- ii) The overall area of the unit shall be based on an average flow velocity not more than 3 M3/hr/m2.
- iii) Weir loading shall not exceed 300 M3/m/day. For uniform overflow over weirs, triangular notches (saw tooth weir) shall be provided as necessary.
- iv) Clear width of the bridge shall not be less than 1200 mm.
- v) The clarifier unit shall be circular, central feed type with concentric recirculation zone (rapid mixing) with sampling points at different elevation, reaction zone (slow mixing) and clarification zone in RCC construction.
- vi) Bridge type rake arm and suitable equipment such as turbine/ impeller shall be provided for internal sludge recirculation.
- vii) Design of the sludge removal system should be such as to reduce loss of water during sludge blow off within 3% of rated flow. Inlet portion of the unit, (i.e. pumps, stilling chamber, inlet channel and clarifier) shall be designed to handle excess water to make good for water loss during sludge blow-off.
- viii) The clarifier periphery (all around) shall have sufficient width (minimum 850 mm) to have an easy walkway for general inspection. This walkway shall be provided with handrail along with periphery access ladders (at least from two locations) with platforms and hand railing for the clarifier for good approach. Permanent ladders shall also be provided (not rungs) for approaching the sludge pipeline valves for maintenance. (However the sludge valves shall be operation able from the top of the sludge chamber through head stock and extended spindle arrangement.
- ix) The sludge blanket shall be suspended and maintained in the lower portion.
- x) The design of the turbine/impeller shall be such as not to break the flocks during recirculation.
- xi) Suitable mechanism for varying the recirculation rate shall also be provided such that the reactor clarifier shall be capable of operating at varying hydraulic load and turbidity with consistent effluent quality.
- xii) Clarifiers shall be provided with radial launders.
- xiii) The bottom of clarifier shall be sloped towards the center and mechanically driven sludge scraper and collector shall be used to remove the settled sludge down the sloping bottom to the central sludge area. Rubber squeezer pads shall be provided on sludge scraper and skimmer. Sludge removal system design shall consist of central sludge area with rotating pickets and back flush arrangement for proper control of sludge accumulation at the bottom.

	TITLE 4 X 270 MW BHADRADRI TPS TECHNICAL SPECIFICATION FOR PRE- TREATMENT PLANT	SPECIFICATION NO. PE-TS-411-158A-A001
		VOLUME: II B
		REV 00
		SHEET 4 of 6

- xiv) Suitable scum collecting arrangement shall be provided in the clarifying section for removal of floating debris, foam etc. if possible. The scrapper shall consist of blades (Mild steel with rubber inserts with bitumastic paint protective coating) which are inclined to the radius in the opposite direction to that of the floor scrapper.
- xv) The rake bridge and agitators shall be constructed of structural steel and suitably braced to provide rigidity.
- xvi) Sludge blow off shall be effected by the static head of water in the clarifier unit. Sludge outlet pipes from the concentrated sludge hopper shall be branched into main disposal line and continuous sludge disposal line. Main sludge disposal line, which includes a blow-off valve, shall drain sludge to the sludge collection pit. This is an intermittent operation. Continuous sludge disposal line consists of telescopic stand pipe, the top of which is maintained at a desired elevation to ensure trickle flow of water or sludge water mixture to the sludge sump. Alternate proven system of sludge disposal is also acceptable, subject to Employer approval. The de-sludging of clarifiers shall be done twice in a shift. The de-sludging of one (1) Clarifiers shall not exceed one (1) hour. All equipment / sumps shall be designed accordingly.
- xvii) Suitable sampling connections from the various levels and zones of clarifier and at the outlet shall be provided for performance monitoring.
- xviii) Generally each of the clarifier shall be provided with a gate at the outlet for isolation of any of the clarifier for maintenance.
- xix) Arrangement of clarifier sludge pit/ sump shall be as indicated in data sheet and schematic drawings. Minimum capacity of each section of the pit shall be referred in the data sheets. Bidder shall supply all necessary piping, valves and other accessories as required. Each section of the pit shall be provided with agitation by recirculation (jetting nozzles) systems and air agitation system.

1.4 Filtered Water Overhead Tank

The overhead tank (civil work by BHEL) Shall have approach from chemical house through permanent staircases (RCC) and door. The water level in the tank shall be maintained by means of a float operated valve. The tank shall be provided with an overflow and drain connection with valve. The capacity of the overhead water tank shall 150% of total water requirement such as chemical preparation, flushing etc.

1.5 Chemical House

- i) The civil construction of the Chemical House shall be in scope of BHEL. However, all the other civil inputs like foundation of the equipment etc. shall be in scope of bidder.
Chemical house storage area, tanks, dosing pumps etc equipments of PT Plant shall be sized for the following minimum dosing Requirements. Chemical storage area in ground floor of Chemical house shall be designed to store these chemicals (except chlorine) for 15 days period considering working of all the clarifiers:
 - a) Polymer Dosing System for Clarifier (@ 1 ppm) on 100% basis.
 - b) Polymer Dosing System for Thickener (@ 5 ppm) on 100% basis.
 - c) Polymer Dosing System for Centrifuge (@ 30 ppm) on 100% basis.
 - d) Alum Dosing System for Centrifuge (@ 70 ppm) on 100% basis.
 - e) Lime Dosing System for Centrifuge (@ 30 ppm) on 100% basis.
- i) The storage rooms (civil work by BHEL) shall have suitable bins/partitions sufficiently large enough to accommodate storage requirement of PE lime and alum. The chemical house shall have sufficient unloading space, wide corridors for movement of chemicals, office, toilet etc.
- ii) In the first floor of chemical house, all chemical preparation tanks and respective dosing pumps shall be located. Suitable staircases, walkways, platforms shall be in scope of Vendor. Suitable space for maintenance of pumps, valves etc shall be provided to have clear access to different units.
- iii) Alum, lime and PE solution shall be dosed by positive displacement type pumps with facility for adjusting the dosages rate of alum solution by changing the stroke length of the pump.
- iv) The chemical house shall be equipped with one weighing scales of platform & dial type suitable for chemicals being handled. Range of weighing scale shall be suitable for weighing 0-1000 Kg.

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO. PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 5 of 6

Technical requirements of weighing scale shall be as specified in Datasheet – A.

- v) Suitable pressurized water connections shall be provided in PE lime and alum piping network for flushing purpose. Flushing connections should be provided at regular interval.
- vi) Two numbers of electrically operated monorail hoist to be provided in chemical house and capacity of the same shall be minimum 1 Ton.
- vii) Slow speed Agitators with reduction gear units for each lime, alum and PE solution preparation tank.
- viii) Each of the chemical tanks shall be provided with dissolving chamber of SS-316 grade. Overflow sampling and drain connections shall be provided for all the tanks.
- ix) Water required for preparation of chemical solution shall be taken from the filtered water overhead tank located on top of Chemical House.

ii) Overflow & Drain Disposal System

Overflow & drains from the various chemical tanks and floor wash drains of chemical house building (except overflow from O/H water storage tank) shall be led to the PT Plant sludge sump. Overflow from water overhead tank shall be led to the inlet channel of clarifiers. Concrete sewerage pipe/Hume pipe shall not be used for any of the drain disposal system. Ductile/ Cast Iron pipes or Carbon steel (mild steel pipes) pipes may be used for drain disposal system.

iii) Weighing Scales

- a) The weighing scale shall be of platform type, consisting of compound levers, food receptacle in the form of a platform and coupled to a direct reading, dial type indicator and BSI standard/approved.
- b) The platform will be provided with a locking arrangement which will permit placement of the load continuously on it without its weight being transferred to the levers and measuring system. The lock will be released only during taking a reading on the machine.
- c) The platform shall be capable of accepting concentrated loading.
- d) The weighing scale shall be suitable for weighing miscellaneous chemicals like alum, PE, lime etc.
- e) All graduations in weighing instruments shall consist of notches or uniform lines, sharply defined which may be painted, incised or embossed so that the position of all pointers or sliding poles is easily readable. All number graduations and their subdivision shall be marked by line longer than the minor graduation and the minimum distance between any two considered graduations shall be 1.5 mm. The knife edges shall be of agate or of suitable quality steel.
- f) Marking sealing and testing shall be line with IS: 1432. The manufacturer shall conduct all test required to ensure equipment conform to the requirements of the applicable Codes/standards. All material test certificates shall be made available to the owner.
- g) Least account of the dial limits of sensitiveness and greatest error for platform weighing scales shall be as follows:

Capacity	Least count	Sensitiveness when fully loaded	Greatest error allowed in excess or deficiency when fully loaded	Greatest error allowed in excess or deficiency when quarter of full load is loaded
100 kg	200gm	10 gm	A weight corresponding to one half of the internal minimum graduation.	Within half the limits of error prescribed for full load.
300 kg	500gm	60 gm		
500 kg	1 kg	100 gm		
2000 kg	2kg	250		

- h) Knife edges and bearings shall be accurately and firmly secured preferably by shanks and nuts or by bolts and nuts or by set screws. The knife edges and bearings shall be protected against corrosion and dirt. Racks and pinions shall be suitable hard wearing materials and shall be finished smooth.

iv) Metering Pumps

	TITLE 4 X 270 MW BHADRADRI TPS TECHNICAL SPECIFICATION FOR PRE- TREATMENT PLANT	SPECIFICATION NO. PE-TS-411-158A-A001
		VOLUME: II B
		REV 00
		SHEET 6 of 6

- a) Pumps shall be Plunger Type positive displacement pump, driven by electric motor through suitable speed reduction unit. Maximum pump stroke speed shall not exceed 100 per minute.
- b) The stroke shall be continuously adjustable to give a capacity variation 10-100% range while the pumps are running or stopped. Adjustment of capacity shall be done by automatically from remote location and / or manually (micrometric adjusting type) locally for each of the pump as described elsewhere.
- c) Capacity variation may be effected by changing eccentricity of the driving crank or by suitable hydraulic circuit. Pump accuracy shall be industry standard + 1% of capacity setting.
- d) Pumps shall be provided with an integral relief valve, spring operated, to release pressure when delivery line blockage occurs. Crank case shall be constructed of high quality cast iron which will also house the gear box and guides for cross head. Guided, controlled travel, double-ball check valves or equivalent, shall be provided both on the suction and discharge sides. Suitable gland seal be provided to prevent leakage.

SECTION-VII

TECHNICAL SPECIFICATION FOR PRESSURE AND STORAGE VESSELS

1.00.00 INTENT OF SPECIFICATION

This specification covers the design, manufacture, shop testing, shop testing, construction, fabrication, erection, testing, inspection & commissioning of pressure and storage vessels at works & site.

2.00.00 CODES AND STANDARDS

The design, manufacture, shop testing, site fabrication and erection, testing and commissioning of the pressure vessels and atmospheric storage tanks vessels shall conform to the latest revisions of the following standards, in addition to other standards addressed elsewhere in the Bid Specification subject to any modification and requirement, as specified elsewhere:

a)	ASME Section VIII	Rules for Construction of Pressure Vessels
b)	ASTM Standards	Standards published by American Society for Testing and Materials
c)	BS EN 12285-2	Workshop fabricated steel tanks. Horizontal cylindrical single skin and double skin tanks for the aboveground storage of flammable and non-flammable water polluting liquids
d)	IS-803	Code of Practice for Design Fabrication and Erection of Vertical Mild Steel Cylindrical Welded Oil Storage Tanks
e)	IS-816	Code of Practice for Use of Metal Arc Welding for General Construction in Mild Steel
f)	IS-817	Code of Practice for Training and Testing of Metal Arc Welders
g)	IS-822	Code of Procedure for Inspection of Welds
h)	IS-1363 Part 1 to Part 3	Hexagon Head Bolts, Screws and Nuts of Product Grade C
i)	IS-1367 Part 1 to Part 16	Technical Supply Conditions for Threaded Steel Fasteners
j)	IS-2002	Steel Plates for Pressure Vessels for Intermediate

		and High Temperature Service including Boilers
k)	IS-2062	Hot Rolled Medium and High Tensile Structural Steel
l)	IS-2825	Code for Unfired Pressure Vessels
m)	IS-3133	Manhole and Inspection Openings for Chemical Equipment - General Requirements
n)	IS-4049 Part 1 & Part 2	Formed Ends for Tanks and Pressure Vessels
o)	IS-4682 Part 1 to Part 10	Code of Practice for Lining of Vessels and Equipment for Chemical Processes
p)	IS-4864 to IS-4870	Shell Flanges for Vessels and Equipment

3. 00.00 **GENERAL DESIGN FEATURES**

3. 01.00 Design of all pressure vessels shall conform to IS 2825 or ASME Section VIII Division-I or equivalent code / standard (subject to approval by Purchaser).

3. 02.00 Design of all vertical cylindrical atmospheric storage tanks containing water, acid, alkali and other chemicals shall conform to IS-803.

Supporting frame where required for design of Demineralized Water Storage Tanks shall be in accordance with IS-800. The tank shall be "Non-pressure" fixed roof type with atmospheric vents.

3. 03.00 Design of all horizontal cylindrical atmospheric storage tank containing decationized water, acid, alkali and other chemicals shall conform to BS EN 12285-2.

3. 04.00 Design temperature of all pressure vessels and atmospheric storage tanks shall be 10 deg. C higher than the maximum temperature that any part of the vessel / tank is likely to attain during operation.

3. 05.00 Design pressure shall be the maximum expected pressure to which the vessels may be subjected to plus 5% additional margin. Maximum expected pressure for vessels placed in the discharge line of pumps shall be based on the shut-off head of the pumps plus static head at pumps suction, if any.

3. 06.00 In case, tank is subjected to vacuum under any situation, the same shall be duly considered as one of the criteria for design of the tank.

3. 07.00 Each pressure vessel / atmospheric storage tank without inside rubber lining shall have a corrosion allowance of minimum 2.0 mm.

3. 08.00 Mill tolerance as per applicable code (minimum 0.3 mm) shall be duly considered for each shell as well as dished end.

3. 09.00 Thinning allowance of 2.0 mm (minimum) shall be considered for each dished end.

3. 10.00 Effective liquid volume for an atmospheric storage tanks tank shall be considered as the liquid volume in between the design highest operating level / design highest level switch set point and design lowest operating level / design lowest level switch set point.
3. 11.00 A liquid volume (corresponding to a minimum of 100 mm shell / liquid height in between design lowest operating level / design lowest level switch set point and top of side mounted outlet nozzle / bottom of tank) below the required effective liquid volume shall be considered & provided for satisfactory functioning of concerned level switch.
3. 12.00 Each atmospheric tank shall have sufficient free board (minimum 300 mm unless specified otherwise) above the design highest level / design highest level switch set point.
3. 13.00 The invert of overflow nozzle shall be kept at least 50 mm or 5 % of total height whichever is higher above the design highest level / design highest level switch set point for each of the atmospheric tanks, except for the Demineralized Water Storage Tanks.
3. 14.00 For Demineralized Water Storage Tanks, the invert of overflow nozzle shall be kept at least 500 mm or 5 % of total shell height whichever is higher above the design highest level / design highest level switch set point.
3. 15.00 A minimum 100 mm shell height shall be provided above the top of overflow nozzle of each atmospheric storage tank.
3. 16.00 Wall thickness of each of atmospheric tanks shall not be less than 6 mm. If higher thickness for any atmospheric storage tank is specified elsewhere in this Specification, the same shall be provided.
3. 17.00 Vessels coming under preview of IBR shall be designed accordingly.
4. 00.00 **MATERIAL OF CONSTRUCTION**
4. 01.00 The pressure vessels shall be designed as Class 3 vessels (as per IS-2825) and fabricated of steel as per IS-2062 / IS-2002 Grade 3 or SA-515 / 516 Grade 60 / 70 In case, the vessels are designed as Class 1 or Class 2 vessels (as per IS-2825), the material of construction shall conform to IS-2002 Grade 3.
4. 02.00 Atmospheric storage tanks shall be fabricated of mild steel as per IS-2062.
4. 03.00 The material of construction for various connections, for all the lined or unlined vessels/tanks shall be same as that of interconnecting piping material suitably lined wherever required. The pipe flanges, manhole/manhole covers, reinforcement pads etc. shall be fabricated out of the same material as that one used for the vessel / tank. However, screwed fittings for instrumentation, sample connection, drain connection of size 25 mm NB and less shall be of stainless steel construction (SS-316).

5. 00.00 FABRICATION

5. 01.00 All pressure vessels and storage tanks except the large tanks like Demineralised Water Storage Tanks should preferably be fabricated and tested completely at manufacturer's works to ensure better workmanship.
5. 02.00 The plates to be used for fabrication shall preferably have a minimum width of 1500 mm.
5. 03.00 Ends of pressure vessels shall be of dished design and constructed of forging, pressing or spinning as per IS-4049.
5. 04.00 Interior surfaces of all atmospheric storage tanks shall be clear of stiffeners and other structural supports. Tanks shall be reinforced and stiffened externally as required.
5. 05.00 Plates to be used for fabrication of atmospheric vertical storage tanks shall be accurately formed in bending rolls to the diameters called for and cold rolled through plate bending machine by several number of passes to true curvature and joined by welding.
5. 06.00 The atmospheric vertical storage tanks shall have flat bottom.
5. 07.00 Ends of atmospheric horizontal storage tanks shall be of dished design and constructed of forging, pressing or spinning as per IS-4049. Conical or Flat Ends shall not be accepted.
5. 08.00 All welding shall be as per IS-816 or equivalent code (subject to approval by Purchaser). The qualification of the welders should be as specified in IS-817 and welding electrodes shall be as per relevant Codes / Standards.
5. 09.00 Bidder shall state clearly in his proposal the make and type of welding rods necessary for fabrication / construction work.
5. 10.00 Welding sequence shall be adopted in such a way so as to minimize the distortion due to welding shrinkage. The Bidder shall indicate in drawing, the sequence of welding proposed which should meet prior approval of the Purchaser. Welding shall not be carried out when the surface of the parts to be welded are wet from any cause and during periods of rain and high winds unless the welder and work are properly shielded.
5. 11.00 All seams shall be so positioned that they do not pass through connections of vessel / tank. The connections shall be flushed with inner surface of vessel / tank and welded continuous on both sides of the vessel / tank. Sharp inside edges shall be rounded to a minimum 3 mm radius. Inside seam weld shall be ground smooth, suitable for applicable of corrosion resistant coating / lining.
5. 12.00 All the joints (circumferential / longitudinal) shall be double butt welded with full penetration or single butt welded without backing strip. For joints involving small thickness 6 mm or less, back chipping to metal followed by DP test and re-welding shall be done to have full penetration.
5. 13.00 All internal baffles, wear plates, pipes etc. shall be continuously welded on both sides at all contact points with full fillet welds which shall be free of voids, gaps,

- craters, high spots, sharp edges, and undercutting. Sharp edges shall be ground to a 3 mm minimum radius.
5. 14.00 All welds on inner surface of vessel / tank shall be free of voids, gaps, craters, pits, high spots, sharp edges, abrupt ridges and valleys or undercut edges. High spots, irregularities and sharp edges shall be removed by grinding.
5. 15.00 Weld splatter shall be removed.
5. 16.00 Inspection of all welds shall be carried out in accordance with IS-822 'Code of Practice for Inspection of Welds.'
6. 00.00 **APPURTENANCES**
6. 01.00 Internals for pressure vessels and atmospheric storage tanks shall be provided as detailed out elsewhere in the specification and as further required.
6. 02.00 All the pressure vessels and atmospheric storage tanks shall be provided with drain connections along with drain valves of suitable size.
6. 03.00 All the pressure vessels and atmospheric storage tanks shall be provided with the vent connections. The design shall be as to offer adequate area for venting. Venting area shall be such that over pressure/vacuum is not created during maximum filling / withdrawal rate. The maximum withdrawal rate for the Demineralized Water Storage Tanks shall be intimated later at detail engineering stage to the Bidder.
6. 04.00 Various instrumentation and the fittings required for the pressure vessels and atmospheric storage tanks shall be provided as elaborated elsewhere in the specification.
6. 05.00 **Manholes / Hand Holes**
- 6.05.01 Manholes shall be provided for all pressure vessels and atmospheric storage tanks to provide easy access into the same. The diameter shall be minimum 500 mm and each manhole will be provided with cover plate, nuts, bolts and gaskets to ensure leak tightness at the test pressure. Manholes shall be davit type for rubber lined vessels.
- 6.05.02 Each of the pressure vessels and horizontal type storage tanks shall be provided with at least one manhole at the top.
- 6.05.03 Each of the vertical type atmospheric storage tanks with diameter 1200 mm or more shall be provided with a manhole on the top. For the Demineralized Water Storage Tanks, manholes shall be provided as per IS-803.
- 6.05.04 Each of the pressure vessels filled with ion exchange resins shall be provided with a handhold of diameter at least 150 mm at a level in the vicinity of bottom of resin bed.
- 6.05.05 The required lining / coating for the inside surface of the manhole / handhold, nozzle and cover plate of the manhole/ handhold shall be same as that of the respective vessel/tank.
6. 06.00 **Nozzle Connections**

- 6.06.01 Bidder shall furnish all materials required for nozzle connections with reference to system requirements. In addition to these, additional nozzle connections, if required by the Purchaser for the inter-connection with other systems / piping / instruments etc. shall also be provided. Such additional requirements may be intimated to the Bidder later at detail engineering stage and Bidder shall provide the same complete with necessary supports and other accessories without any sort of price implication whatsoever.
- 6.06.02 Nozzle wall thickness shall be as per relevant code for design to be followed for the vessel/tank in questions.
- 6.06.03 All flanged connections should be supplied complete with matching counter flanges, bolts, nuts and gasket materials. The flange design (thickness and drilling etc.) shall match with the interconnected piping flanges.
- 6.06.04 Bolts and nuts to be used externally to the vessels shall be of hexagonal head conforming to IS-1367. However fasteners if any within tanks shall be of SS-316 / SS-304 or Hastalloy-B as per the duty conditions / requirements.
- 6.06.05 Gaskets shall be of full face type.
6. 07.00 Sight glasses shall be provided for the tanks/vessels as specified elsewhere in the specification. The material for sight glass shall be high quality transparent PLEXIGLASS of sufficient thickness to withstand the test pressure. The sight glass shall be provided with suitable gaskets and bolts to ensure leak tightness at the test pressure.
6. 08.00 **Vessels Supports / Lifting Lugs**
- 6.08.01 Adequate supporting arrangements like legs, straps, saddles, skirt boards, pillars etc. for the pressure vessels and atmospheric storage tanks shall be provided to transfer all loads to civil foundation. All foundation bolts, inserts etc. shall also be provided.
- 6.08.02 All vessels shall be provided with lifting lugs, eye bolts etc. for effective handling during erection.
- 6.08.03 All vessels of internal, diameter of 1200 mm or greater shall be provided with minimum four (4) lifting lugs for safe and effective handling during erection. Smaller vessels shall be provided with atleast two (2) lifting lugs.
- 6.08.04 Material of construction for these vessel supports, saddles, lugs shall conform to IS-2062.
6. 09.00 **Special Accessories for Tanks**
- 6.09.01 Each of all the tanks shall be provided with over flow connection designed for the filling rate of the respective tank.
- 6.09.02 Water Seal shall be provided for the overflow line of Demineralized Water Storage Tanks. Vent line of Demineralized Water Storage Tanks shall be provided with Carbon-Di-Oxide Absorber / Breather of proven design to prevent contamination from atmospheric air. Carbon-Di-Oxide Absorber / Breather shall preferably be located at finished floor / pavement level.

- 6.09.03 The vent and overflow lines of Acid Bulk Storage / Day / Measuring Tanks shall be provided with fume absorber using suitable packing material, such as pall rings / raschig rings.
- 6.09.04 The vent and overflow lines of Alkali Bulk Storage / Preparation / Day / Measuring Tanks shall be provided with Carbon-Di-Oxide Absorber / Breather as addressed under clause no. 6.05.02 above.
- 6.09.05 Conservation Vent Valve shall provided on each of Demineralized Water Storage Tanks to ensure minimum contact with air. The valve should normally be closed. With vacuum or pressure to the extent of 65mm water gauge into the tank, the valve shall open to relieve the vacuum or pressure.

Material of construction should be as follows:

Body & valve disc	-	Die cast aluminium.
Spindle	-	Steel
Spring	-	Phosphor Bronze
Seal	-	Rubber

7.00.00 **ERECTION**

- 7.01.00 Each of all pressure vessels and atmospheric storage tanks should be directly placed on the civil foundation when supplied in fully fabricated form.
- 7.02.00 All fabricated part, before assembly, shall be transported by the Bidder to installation at site. All preliminary work and fabrication in part or full shall be done at the Bidder's fabrication yard or shop.
- 7.03.00 All material before final installation over the foundation at the respective locality shall be inspected and faired as necessary to ensure that any damage received during transportation is corrected before erection to the satisfaction of the Purchaser. Particular attention shall be given towards removal of buckles and other form of distortion in shell and bottom plates of vertical atmospheric storage tanks. Irregularities and dirt which would prevent metal to metal contact at the jointing faces shall be removed.
- 7.04.00 The method of holding the plates in position during welding and all devices used for this purpose should be approved by the Purchaser. All lap joints shall be held in close contact during welding and the surface in contact shall be thoroughly cleaned before assembly.
- 7.05.00 Holes in plate work to assist in erection should be avoided as far as possible. The location of the holes shall be indicated in the fabrication drawing. The method of filling holes shall be approved by the Purchaser. Lugs attached by welding to the tank and required only for the purpose of erection shall be removed and any projections of weld metal shall be chipped and grounded flush with the plate surface.
- 7.06.00 In the construction of the shell, every care shall be taken to minimize distortion or lack of circularity due to welding or for any other reason.

- 7.07.00 Tanks shall be safeguarded against damage due to wind or any other external causes by providing suitable steel cable guys until completion.
- 7.08.00 All materials used by the Bidder such as electrodes, gaskets, bolts and nuts, paints and any other appurtenance shall be conforming to relevant Indian Standard Code of Practice or equivalent (subject to approval by the Purchaser). Manufacturer's test certificate for guaranteed performance shall have to be provided when called for.
- 7.09.00 The finished bottom plate of vertical atmospheric tanks shall be crowned from the outer periphery to the centre with a slope of 1:36. Sufficient number of plugged holes shall be provided in bottom plate of the tanks for bottom testing.
8. 00.00 **PROTECTIVE LINING AND PAINTING**
8. 01.00 Inside surfaces of all pressure vessels and atmospheric storage tanks shall be protected by anticorrosive paints or rubber lining as required / specified. External surfaces of all pressure vessels and atmospheric storage tanks shall be protected by anti corrosive painting.
8. 02.00 The supply and application of Protective Lining and Painting with reference to pressure vessels and atmospheric storage tanks need to be as per **Sub Section: M7 – Technical Specification for Protective Lining and Painting**, attached herewith.
9. 00.00 **TESTS AND INSPECTION**
9. 01.00 All pressure vessels shall be hydraulically tested at 1.5 times design pressure or 2 times the maximum working pressure whichever is higher, for a period not less than one (1) hour.
9. 02.00 All atmospheric storage tanks shall be tested for leak tightness by filling up with water up to the highest level for a period not less than 8 hours.
9. 03.00 Full rubber lining is to be tested as per IS-4682 Part I for the following tests:
- (a) Adhesion tests
 - (b) Tests to check resistance to bleeding
 - (c) Measurement of lining thickness
 - (d) Shore hardness test
 - (e) Spark test at high voltages 5 KV / mm of thickness with a gap of 8 mm between the probe and lining.
9. 04.00 Thickness of painting shall be checked with dry type thickness gauge.
9. 05.00 Vessels as per IBR shall be tested accordingly.
9. 06.00 DP test after back gauging and on complete welds on atmospheric tanks and pressure vessels need to be carried out.
9. 07.00 All non-destructive tests shall be carried out as per the applicable design code / standard for all pressure vessels and atmospheric tanks.

9. 08.00 Butt welds if any on the dished ends shall be radio graphed after dishing and shall be stress relieved.
9. 09.00 All dished ends for pressure vessels shall be stress relieved after dishing.
9. 10.00 All weld procedure and welder qualification certificates shall be verified.
9. 11.00 All painting on vessels and tanks shall be checked for the thickness as per the specification mentioned elsewhere.
9. 12.00 All materials to be used for the pressure vessels and atmospheric tanks and accessories should be of tested quality and test certificates shall be made available to the Purchaser.

SECTION : IX

**TECHNICAL SPECIFICATION
FOR
HORIZONTAL CENTRIFUGAL PUMPS**

1.00.00 INTENT OF SPECIFICATION

The specification covers the design, performance, manufacturing, shop testing, erection, testing and commissioning at site, of the horizontal centrifugal pumps.

2.00.00 CODES AND STANDARDS

2.01.00 The design, manufacture and performance of the horizontal centrifugal pumps shall conform to the latest revisions of the following codes and Indian standards, in addition to other stipulations and standards mentioned elsewhere in the specification :

- a) IS-1520 : Horizontal centrifugal pumps for clear cold fresh water.
- b) IS-5120 : Technical requirement rotodynamic special purpose pumps.
- c) IS-5639 : Pumps handling chemicals and corrosive liquids.
- d) IS-5659 : Pumps for process water.
- e) Standards of Hydraulic Institute, U.S.A.

2.02.00 The material of construction for the various components of the pumps shall conform to the applicable standards like "American Society of Testing & Materials (ASTM)" and Indian Standards.

3.00.00 DESIGN AND CONSTRUCTION

3.01.00 Pumps shall be of horizontal/vertical split casing with speed preferably be limited to 1500 RPM. Design and construction of various components of the pumps shall conform to the following general specifications. For material of construction of the components, data sheets in Appendix-I of SECTION-III may be referred to.

3.01.01 Casing

The casing shall be structurally sound to provide housing for the pump assembly and shall be designed hydraulically to minimize radial loads at part load operations.

3.01.02 Impeller

The impeller shall be as per the proven design of the manufacturer. It shall be keyed to the shaft and locked in position. The rotor assembly shall be statically and dynamically balanced and designed with critical speed substantially above the operating speed.

3.01.03 Impeller/Casing Wearing Rings

Replaceable type wearing rings shall be provided at suitable locations for each pump. The rings shall be so fitted as to prevent turning while the pump is in operation.

3.01.04 Shaft

The shaft shall be adequately sized to withstand all stress from rotor weight and hydraulic loads etc. The shaft shall be ground and polished to final dimensions.

3.01.05 Shaft Sleeves

Pump shafts shall be protected by renewable type shaft sleeves which shall extend well beyond the pump glands. The sleeves shall be highly polished and shall be securely fastened to the shaft to prevent any loosening.

3.01.06 Bearings

Heavy duty bearings, adequately designed for the type of service specified and for long and trouble-free operations, shall be furnished. The design shall be such that the bearing lubricating oil does not contaminate the liquid being pumped.

3.01.07 Thrust Bearings

Adequately designed thrust bearings to absorb pump thrust or other unbalanced force, if any, shall be provided.

3.01.08 Lubrication system shall be designed in such a way that in case of total power failure, there will not be any damage while coasting down to stop.

3.01.09 Stuffing Boxes

Stuffing boxes of packed ring construction or of mechanical seal type as desired in the Data Sheet - Appendix-II attached with this specification shall be provided. The necessary piping, valves, fitting etc. for the gland sealing connection shall be provided. For mechanical seals, the mating surfaces shall be suitably hard faced to ensure long life.

3.01.10 Pump Shaft-Motor Shaft Coupling

The pump shaft and motor shaft shall be connected with a suitably designed flexible coupling of approved design preferably with a spacer to facilitate dismantling of the

pump without disturbing the motor. Necessary coupling guards for the coupling shall also be furnished.

3.01.11 Base Plate

A common base plate for mounting the pump and the corresponding driver motor shall be furnished. The base plate shall be of fabricated steel and of rigid construction, properly ribbed as required. Driplip with drain tap suitable for type of service specified shall be furnished.

3.01.12 Drain, Vent and Priming Connections

Each pump shall be provided with a casing drain, vent and priming connection at suitable locations.

3.01.13 Drive Motor and Its Control

Please refer Electrical Specification enclosed herewith this specification.

3.01.14 Anchor Bolts, Sleeves, Inserts, Lifting Lugs, Eye Bolt, etc.

All anchor bolts, foundation plates, sleeves, nuts, inserts etc. to be embedded in concrete for the equipment are to be supplied. The length of the foundation bolts shall be liberally sized to reach below the reinforcement level.

Each equipment shall be provided with suitable lifting lugs, eye bolts etc. to facilitate maintenance.

3.02.00 Consistent with good operating characteristics and high efficiency, each pump shall have a continuously rising head capacity characteristics curve without any zone of instability. Power flow characteristic shall preferably be non-overloading type beyond rated duty point. The characteristic curves of each set of pumps shall match each other for equal sharing in case of parallel operation. The pump motor set shall be designed in such a way that there is no damage due to reverse flow through the pump which may occur due to any mal-operation of the system.

3.03.00 The pumps shall be suitably designed also for smooth and trouble free continuous solo operation in the event of trip out of the remaining pumps running in parallel.

3.04.00 The pumps shall be designed to have best efficiency at the rated duty point. The pumps shall be suitable for continuous operation within a wide range above and below the rated duty point. Such range of operation within which category of pumps can satisfactorily operate on continuous basis, shall be clearly indicated.

3.05.00 Drive motors for each category of pumps shall be suitable for use on 415V $\pm 10\%$, 3 ϕ , 50 Hz $\pm 5\%$ and neutral grounded system. Drive motors shall have 15% spare margin over the maximum power requirement of the pump within the range of operation.

THIS IS A PART OF TECHNICAL SPECIFICATION NO. PE-TS-411-158A-A001

Telangana State Power Generation Corporation Ltd.
1x800 MW Kothagudem TPS

EPC Bid Document
e-PCT/TS/K/02/2014-15

4.00.00 TESTING

4.01.00 **Testing and Inspection at Manufacturer's Works**

4.01.01 All tests required shall be conducted to ensure that the equipment furnished shall conform to the requirements of this specification and in compliance with requirements of the applicable codes.

The particulars of the proposed tests and the procedures for the tests shall be submitted for approval before conducting the tests.

4.01.02 The representatives of Purchaser shall be given full access to all tests. Prior to pump performance tests, the manufacturer shall inform the Purchaser allowing adequate time so that if the Purchaser desires, his representatives can witness the test.

4.01.03 All materials and casting used for the equipment shall be of tested quality. The test certificates shall be made available to Purchaser.

4.01.04 The pump casing shall be hydraulically tested at 200% of pump rated head or at 150% of shut-off head, whichever is higher. The test pressure shall be maintained for at least half an hour.

4.01.05 The pump rotating parts shall be subjected to static and dynamic balancing tests.

4.01.06 All pumps shall be tested at the shop for capacity, head efficiency and brake horse power and cavitation. The tests are to be done according to the requirement of the "Hydraulic Institute" of USA, ASME Power Test Code PTC-8.2 (latest edition) and Indian Standards as applicable.

4.01.07 The pump accessories e.g. the thrust bearing, the motor pump shaft coupling etc. will be subjected to tests as per Manufacturer's standard.

4.01.08 The combined vibration of pump and motor should be restricted to the limits specified by Hydraulic Institute Standards, USA, when the pump is in operation at any load singly or in parallel.

4.01.09 Tests on motors shall be conducted as per electrical specification enclosed herewith this specification.

4.01.10 The reports and certificates of all the above mentioned tests to ensure satisfactory operation of the system shall be submitted to the Purchaser before despatch.

4.01.11 Cast heat marks are to be provided on castings for casing and impeller.

4.02.00 Tests at Site

After erection at site, pumps under different services shall be operated to prove satisfactory performance as individual equipment as well as a system.

**TECHNICAL SPECIFICATION
FOR
VERTICAL CENTRIFUGAL PUMPS**

SECTION: X

**TECHNICAL SPECIFICATION
FOR
VERTICAL CENTRIFUGAL PUMPS**

1.00.00 INTENT OF SPECIFICATION

The specification covers the design, performance, manufacturing, shop testing, erection, testing and commissioning at site, of the vertical centrifugal pumps.

2.00.00 CODES AND STANDARDS

2.01.00 The design, manufacture and performance of the vertical centrifugal pumps shall conform to the latest revisions of the following codes and Indian Standards in addition to other stipulations and standards mentioned elsewhere in the specification :

- a) IS-1710 : Vertical turbine pumps for clear, cold, fresh water.
- b) IS-5120 : Technical requirement for rotodynamic special purpose pumps.
- c) IS-5639 : Pumps handling chemicals and corrosive liquids.
- d) IS-5659 : Pumps for process water.
- e) Standards of Hydraulic Institute, USA.

2.02.00 The material of construction for the various components of the pumps shall conform to the applicable standards like "American Society of Testing & Materials (ASTM)" and Indian Standards.

3.00.00 DESIGN AND CONSTRUCTION

**Telangana State Power Generation Corporation Ltd.
1x800 MW Kothagudem TPS**

**EPC Bid Document
e-PCT/TS/K/02/2014-15**

3.01.00 Pump Type

The pumps shall be vertical wet pit type with open shaft or enclosed shaft construction depending on the type of liquid to be pumped. Material of construction shall be as per the data sheets in Appendix-II. The pump speed shall preferably be limited to 1500 RPM.

3.02.00 Discharge Head Assembly

The pump shall have fabricated discharge head disposed above the ground. The head shall be capable of supporting the pump and motor on the foundation; expansion joint shall be provided immediately at the pump discharge; but no thrust block shall be provided for the unbalanced hydraulic thrust thus developed. The anchor bolts and pump fixing arrangement shall be suitably designed to take up the back thrust due to the expansion joint.

The head shall contain a packed type stuffing box to prevent any leakage.

A water stinger may be fitted to the top shaft to protect the motor from water spray.

3.03.00 Bowl

In addition to housing the impellers properly, the bowls shall provide a smooth path to water passage and shall be hydraulically designed to minimise radial thrust.

3.04.00 Impeller

The impeller shall be closed or open as per standard design of the manufacturer. All rotating parts including the impeller shall be statically and dynamically balanced. The critical speed of all the rotating parts shall be substantially above the design speed.

3.05.00 Pump Shaft and Motor Shaft Coupling

The pump shaft shall be connected to motor shaft by a heavy duty flexible coupling.

3.06.00 Column Pipe and Shaft

DEVELOPMENT CONSULTANTS
(e-PCT-TS-K-02-2014-15 -V-IIIC-Sec-X.doc)

V.III-C/S-X: 2

**Telangana State Power Generation Corporation Ltd.
1x800 MW Kothagudem TPS**

**EPC Bid Document
e-PCT/TS/K/02/2014-15**

The line shaft and the shaft enclosing tube shall be made in convenient sections and shall be joined securely by union couplings. The column pipe shall also be made in sections and shall be joined by flanged coupling. In case of flanged joint gaskets shall be provided at each connection.

For sludge handling, vertical cantilever pump with no submerged bearing shall be provided.

3.07.00 Shaft Sleeves

Replaceable shaft sleeves shall be furnished. The shaft sleeve shall be securely locked to shaft to prevent loosening while in operation.

3.08.00 The necessary supporting frame, base-plates, sole-plates, mounting-plates, etc. as required shall be supplied under this specification, alongwith anchor bolts, foundation bolts, pipe sleeves etc.

3.09.00 Thrust Bearings

Thrust bearing of adequate design shall be furnished for taking the pump weight as well as maximum hydraulic thrust. The bearing may be lubricated by grease or oil. The design should be such that the bearing lubricating oil does not contaminate the liquid being pumped. Cooling of thrust bearing, if necessary, shall be done by liquid tapped from the discharge of the pump itself. The thrust bearing shall be designed on the basis of 20,000 working hours minimum for the load corresponding to the duty point.

3.10.00 Line Shaft and Bowl Bearing

Adequate number of properly designed bearings shall be furnished to prevent undue vibration.

3.11.00 Lubrication system shall be designed in such a way that in case of total power failure, there will not be any damage while coasting down to stop.

3.12.00 Shaft Enclosing Tube

For sludge/turbid/dirty water/chemical services, the pump shaft shall be of enclosed tube construction. For the lubrication of shaft necessary clarified/filtered water required shall be arranged. Necessary piping, valves, fittings, booster pumps etc. as required shall be included in scope.

DEVELOPMENT CONSULTANTS
(e-PCT-TS-K-02-2014-15 -V-IIIC-Sec-X.doc)

V.III-C/S-X: 3

**Telangana State Power Generation Corporation Ltd.
1x800 MW Kothagudem TPS**

**EPC Bid Document
e-PCT/TS/K/02/2014-15**

3.13.00 Suction Bell

The pump shall be complete with adequately dimensioned suction bell to guide and streamline intake fluid.

3.14.00 Adjustment of Impeller

The pump shaft shall have suitable arrangement for vertical adjustment of impeller position from an accessible point.

3.15.00 Pump Characteristics

Head capacity curve should be rising upto the shut-off head condition. Power versus capacity curve shall be non-overloading type beyond rated duty point.

The characteristic curves of each set of pumps shall match each other for equal load sharing in case of parallel operation. The pump shall however, be also designed for smooth and trouble-free continuous solo operation in the event of trip-out of the remaining pumps running in parallel.

3.16.00 The pumps shall be designed for reverse flow through them. The drive motor shall be capable of bringing the pump to its rated speed in the normal direction from the point of maximum possible reverse speed when power to the drive is restored.

3.17.00 The pumps shall be designed to have best efficiency at the rated duty point.

The pumps shall be suitable for continuous operation within a wide range above and below the rated duty point. Such range of operation within which the pumps can satisfactorily operate on continuous basis, shall be clearly indicated.

3.18.00 Drive motors for the pumps shall be suitable for use on 415V $\pm$ 10%, 3 ϕ , 50 Hz, $\pm$ 5% and neutral grounded system. Drive motors shall have 15% spare margin over the maximum power requirement of the pump within its range of operation.

4.00.00 TESTING

4.01.00 Testing and Inspection at Manufacturer's works

DEVELOPMENT CONSULTANTS

(e-PCT-TS-K-02-2014-15 -V-IIIC-Sec-X.doc)

V.III-C/S-X: 4

**Telangana State Power Generation Corporation Ltd.
1x800 MW Kothagudem TPS**

**EPC Bid Document
e-PCT/TS/K/02/2014-15**

- 4.01.01 All tests required shall be conducted to ensure that the equipment furnished conforms to the requirements of this specification and is in compliance with requirements of the applicable codes. The particulars of the proposed tests and the procedures for the tests shall be submitted to Purchaser for approval before conducting the tests.
- 4.01.02 The representatives of Purchaser shall be given full access to all tests. Prior to pump performance tests, the manufacturer shall inform the Purchaser allowing adequate time so that if the Purchaser so desires, his representative can witness the test.
- 4.01.03 All materials and casting used for the equipment shall be of tested quality. The test certificates shall be made available to the Purchaser.
- 4.01.04 The pump casing shall be hydraulically tested at 200% of pump rated head or at 150% of shut-off head, whichever is higher. The test pressure shall be maintained for at least half an hour.
- 4.01.05 The pump rotating parts shall be subjected to static and dynamic balancing.
- 4.01.06 All pumps shall be tested at the shop for capacity, head, efficiency, brake horse power and cavitation. The tests are to be done according to the requirements of the Hydraulic Institute of USA, ASME Power Test Code, Indian Standards, as applicable.
- 4.01.07 The pump accessories e.g. the thrust bearing, the motor pump shaft coupling etc. will be subjected to tests as per manufacturer's standards.
- 4.01.08 The combined vibration of pump and motor should be restricted within limits specified by Hydraulic Institute Standards, USA when the pump is in operation at any load singly or in parallel.
- 4.01.09 Tests on motors shall be conducted as per electrical specification enclosed with this specification.
- 4.01.10 Test reports and certificates of the above mentioned tests to ensure satisfactory operation of the system shall be submitted to the Purchaser before despatch.
- 4.01.11 Cast heat marks shall be provided on castings for casing and impeller.
- 4.02.00 Test at Site

DEVELOPMENT CONSULTANTS
(e-PCT-TS-K-02-2014-15 -V-IIIC-Sec-X.doc)

V.III-C/S-X: 5

**Telangana State Power Generation Corporation Ltd.
1x800 MW Kothagudem TPS**

**EPC Bid Document
e-PCT/TS/K/02/2014-15**

After erection at site, pumps under different services shall be operated to prove satisfactory performance as individual equipment as well as a system.

**TECHNICAL SPECIFICATION
FOR
POSITIVE DISPLACEMENT PUMPS**

SECTION: XI

**TECHNICAL SPECIFICATION
FOR
POSITIVE DISPLACEMENT PUMPS**

1.00.00 INTENT OF SPECIFICATION

This specification covers the design, performance, manufacturing, shop testing, erection, testing & commissioning at site, of the positive displacement pumps.

2.00.00 GENERAL DESIGN FEATURES

This specification provides guideline for design, manufacturing and testing of positive displacement pumps with variable capacity to inject chemicals, generally used in the treatment of water in metered amounts.

2.01.00 Pumps shall be simplex/duplex type, positive displacement hydraulically operated diaphragm design, driven by squirrel cage induction motor through suitable speed reduction unit.

2.02.00 The stroke shall be continuously adjustable to give a capacity variation 0-100% range, while the pump is running or stopped. Adjustment of capacity shall be done automatically, wherever required, by pneumatic stroke positioner in proportion to a 0.2 - 1.0 Kg/Sq.Cm air signal or manually. For automatic pumps, in addition to the automatic control, manual control facility shall also be provided. Manual control facility shall be of micrometric adjusting type.

2.03.00 Capacity variation may be effected by changing eccentricity of the driving crank or by suitable hydraulic circuit. Pump accuracy shall be industry standard, $\pm 1\%$ of capacity setting.

2.04.00 Pumps shall be provided with an integral relief valve, spring operated, to release pressure when delivery line blockage occurs.

2.05.00 Crank case shall be constructed of high quality cast iron, which will also house the gear box and guides for cross head.

2.06.00 Material of construction should be as follows :

◆ Crank case	Cast iron.
◆ Pump head	Polypropylene.
◆ Valve and valve housing	Polypropylene.
◆ Wheel	Cast iron to a 48.

THIS IS A PART OF TECHNICAL SPECIFICATION NO. PE-TS-411-158A-A001

Telangana State Power Generation Corporation Ltd.
1x800 MW Kothagudem TPS

EPC Bid Document
e-PCT/TS/K/02/2014-15

♦ Worm	AISI 4142.
♦ Shafts (worm)	En 19.
♦ Diaphragm	Chemically inert teflon.
♦ Base plate	MS.
♦ Foundation bolts	MS.

2.07.00 Suitable gland seal should be provided to prevent leakage.

2.08.00 Electric drive motor particulars should follow Electrical Specification, enclosed herewith.

3.00.00 TESTING

3.01.00 Testing and Inspection at Manufacturer's Works

3.01.01 The Manufacturer shall conduct all tests required to ensure that the equipment furnished conforms to the requirements of this specification and is in compliance with requirements of the applicable codes.

The particulars of the proposed tests and the procedures for the tests shall be submitted to Purchaser for approval before conducting the tests.

3.01.02 The representatives of Purchaser shall be given full access to all tests prior to pump performance tests. The Manufacturer shall inform the Purchaser allowing adequate time so that if the Purchaser so desires, his representatives can witness the test.

3.01.03 All materials and castings used for the equipment shall be of tested quality. The test certificates shall be made available to Purchaser.

3.01.04 The pump casing shall be hydraulically tested at 200% of pump operating pressure or 15 Kg/Sq.Cm(g) whichever is higher. The test pressure shall be maintained for at least half an hour.

3.01.05 The rotating parts of pump drive shall be subjected to static balancing.

3.01.06 All pumps shall be tested at the shop for capacity volumetric accuracy, repeatability accuracy, power and volumetric efficiency. The tests are to be done according to the requirements of the "Hydraulic Institute" of U.S.A. ASME Power Test Code and Indian Standards or as per API.- 675.

3.01.07 The pump accessories e.g. gear box, speed reduction unit etc. will be subjected to tests as per Manufacturer's standards.

3.01.08 The combined vibration of pump and motor should be restricted within limits specified by Hydraulic Institute Standards, USA, when the pump is in operation singly or in parallel.

DEVELOPMENT CONSULTANTS
(e-PCT-TS-K-02-2014-15 -V-IIIC-Sec-XI.doc)

V.III-C/S-XI: 2

THIS IS A PART OF TECHNICAL SPECIFICATION NO. PE-TS-411-158A-A001

**Telangana State Power Generation Corporation Ltd.
1x800 MW Kothagudem TPS**

**EPC Bid Document
e-PCT/TS/K/02/2014-15**

- 3.01.09 Test reports and certificates of all the above mentioned tests to ensure satisfactory operation of the system shall be submitted to the Purchaser before despatch.
- 3.01.10 Performance test shall be carried out for the setting of pressure relief valve.
- 3.02.00 Test at Site
- After erection at site, pumps under different services shall be operated to prove satisfactory performance as individual equipment as well as a system.

SECTION-XII

**TECHNICAL SPECIFICATIONS
FOR
SCREW PUMPS**

01.00.00 GENERAL

This section covers general requirement of design, construction features. manufacture, inspection and performance testing of screw / gear pump for water, oily water, fuel oil and sludge applications.

2.00.00 CODES AND STANDARDS

The equipment supplied shall comply with the latest applicable Indian Standards listed below. Other national standards are acceptable provided they are established to be equal or superior to the Indian Standards mentioned herewith.

IS : 5120. 1977	Technical requirements of rotodynamic purpose pumps
BS : 599. 1966	Method of testing for pumps
HIS	Hydraulic Institute Standards, USA
API: 676. 1980	Positive Displacement Pumps - Rotary
VDMA 24284. 1970	Positive Displacement Pumps - Code for Acceptance
	Test
IS: 210.1993	Grey Iron Castings
IS : 2062, 1992	Steel for general structural purposes
ANSI B16.5	Pipe flanges and flanged fittings
ASME Sec II	Engineering
	Materials

03.00.00 TECHNICAL REQUIREMENTS

03.01.00 Design & Performance Requirements

- 03.01.01 The pump shall be horizontal, rotary, positive displacement type with gear or screw as rotary element.
- 03.01.02 The pump shall be capable of developing the required total head at rated flow under continuous operation. The maximum efficiency of the pump shall be within $\pm 10\%$ of rated flow.
- 03.01.03 Pumps of a particular category shall be identical and shall be suitable for parallel operation with equal load sharing. Components of identical pumps shall be Interchangeable.
- 03.01.04 Pumps shall run smoothly without undue noise and vibration. The noise level at a distance of 1 m from the equipment shall not exceed 85 dBA.
- 03.01.05 The pumps shall be suitable to handle fluid of characteristics as indicated in technical data sheet.
- 03.01.06 The pumps shall be suitable to handle the specified fluid for the complete range of operating conditions. The pump capacity shall be selected based on lowest possible viscosity and driving motor power shall be selected based on highest possible viscosity.
- 03.01.07 Each pump shall be connected to its drive motor directly and shall be mounted on a common base plate. The pump set along with drives shall be designed to permit rapid and economical maintenance.
- 03.01.08 All pumps shall be provided with suitable mechanical seals of proven design and material.
- 03.01.09 The supplier shall assume full responsibility in the operation of pump and motor as a unit.
- 03.02.00 Construction Requirements
- 03.02.01 Pump Casing
- Casing and supports shall be designed to have sufficient strength and rigidity to prevent any adverse effect on internal clearances and to limit change of alignment to 50 micrometers at the coupling

flange caused by the worst combination of pressure, torque or allowable piping stress.

Pump casing shall be provided with a vent connection along with piping, fittings & valves unless pump is self-venting by the arrangement of nozzles. Casing drain, as required, shall be provided complete with drain valves, piping and plugs. It shall be provided with a connection for suction and discharge pressure gauge as standard feature.

Jacket for cooling or heating shall be provided, if specified in technical particulars. Passages shall not open into casing joints.

Inlet and outlet connections shall be flanged. Flanges shall be raised face and shall conform to ANSI B 16.5. Counter flanges with necessary bolts, nuts, gasket etc. shall be supplied along with the pump.

03.02.02 Rotating Elements

Rotating parts shall be properly aligned. Rotor and shaft shall be stiff enough to prevent contact between the rotor bodies and the casing. It shall be of material that have wear, corrosion and erosion resistance compatible with the application.

03.02.03 Mechanical Seals

The Pumps shall generally be employed with mechanical seals, which shall be arranged that replacement of seal should be possible with minimum downtime. T sealing faces should be highly lapped surfaces of materials known for their frictional coefficient and resistance to corrosion against the liquid being pumped

The seal end plate or rotating cover and bolting shall be designed to retain the SI with sufficient rigidity to prevent distortion that might impair seal operation. T stationary seal member shall be positively retained to prevent its rotation. For 1 seals under vacuum service, the seal design must ensure sealing against atmospheric pressure even when the pumps are not operating.

If seal flushing and cooling is provided by the pumped fluid, the pump supplier shall ensure that sufficient flow reaches the primary seal faces to provide for cooling and maintenance of a stable film at

the seal faces.

03.02.04 Stuffing Box

Stuffing box, if provided, should permit replacement of packing without removing any part other than the gland. Asbestos shall not be used as a packing material.

Stuffing Boxes of packed ring construction type preferably to accommodate five rings of packing (minimum four rings of packing) plus a lantern ring shall be provided wherever specified. Packed ring stuffing boxes shall be properly lubricated and sealed as per service requirements and manufacturer's standards. If external gland sealing is required, it shall be done from the pump discharge. The Bidder shall provide the necessary piping valves, fittings etc. or the gland sealing connection.

03.02.05 Bearing

Heavy duty antifriction bearings, adequately designed for the type of service specified in the technical data sheet and for long, trouble free operation shall be furnished.

The bearings offered shall be capable of taking both the radial and axial thrust coming into play during operation. Antifriction bearings shall be designed for a rated life of either 25000 hours with continuous operation at rated conditions or 16000 hours at maximum axial and radial loads and rated speed.

Proper lubricating arrangement for the bearings shall be provided. The design shall be such that the bearing lubricating element does not contaminate the liquid pumped. Where there is a possibility of liquid entering the bearings suitable arrangement in the form of deflectors or any other suitable arrangement must be provided ahead of bearing assembly.

Bearings shall be easily accessible without disturbing the pump assembly. A drain plug shall be provided at the bottom of each bearing housing.

03.02.06 Pump & Motor shaft Coupling

The pump and motor shafts shall be connected with an adequately sized flexible coupling of proven design with a spacer to facilitate dismantling of the pump without disturbing the motor. Necessary coupling guards shall also be provided.

03.02.07 Base plate

A common base plate for the pump and motor shall be provided. The base plate shall be of fabricated steel (minimum 6 mm thickness) and of rigid construction suitably ribbed and reinforced. Base plate and pump supports shall be constructed and the piping unit so mounted as to minimize misalignment caused by mechanical forces such as normal piping strain, internal differential thermal expansion and hydraulic piping thrust. The base plate shall be suitably drilled for the anchor bolts. The base plate shall have drip pan and suitable draining arrangement.

03.02.08 Relief Valve

To protect against damage due to accidental closure of discharge valve, each pump shall be provided with a relief valve of adequate capacity,

Relief valve shall be able to handle the pump rated capacity when fully open, at a pressure not more than 10 percent above the set pressure.

03.02.09 Material of Construction

The material of construction of various components shall be as indicated in technical particulars. These are to be considered as minimum requirement and it is the responsibility of supplier to select and offer proper material of construction for the required service,

03.02.10 Assembly and Dismantling

Assembly and dismantling of each pump with drive motor shall be possible without disturbing the grouted base plate or alignment.

03.02.11 Drive Motor

The motor shall be sized to meet the maximum specified operating conditions. including external gear and/or coupling losses. Continuous Motor rating (at 50 ° C ambient) shall be atleast ten percent (10%) above the maximum load demand of the pump in the entire operating range including the run out condition to take care of the system frequency & voltage variation.

The enclosure of motor shall comply various requirements of flame proof construction as per IS-2148 and degree of protection shall be as per IP-55.

Other design and construction features of the drive motor shall be as specified, elsewhere, under Standard Electrical Specifications.

4.00.00 TESTS

Material test certificates from recognized laboratories shall be furnished for review\for various components.

Following are the minimum shop and site tests to be conducted by the supplier:

4.01.00 Shop Tests

4.01.01 Hydrostatic Test

Pressure containing parts, including cooling and heating jackets, shall be test hydrostatically with liquid at a minimum of 1.5 times the maximum allowable working pressure but at not less than 1.38 bar gauge.

Tests shall be maintained for a sufficient period of time to permit complete examination of parts under pressure. The hydrostatic test shall be considered satisfactorily when no leaks are observed for a minimum of 30 minutes.

4.01.02 Mechanical Balancing

All rotating components of the pumps shall be subjected to static and dynamic balancing at shop as per ISO 1940. The dynamic balancing shall be done at or near the operating speed and the supplier shall furnish its acceptance norms for approval before conducting the test.

4.01.03 Non-destructive Testing

Non-destructive testing of the pump components shall be conducted in accordance with relevant standards. Prior to testing, the test procedure and repair procedure shall be submitted for approval. All components subjected to testing shall be identified and only those which are tested successfully shall be used for the manufacture of final product. All test results shall be submitted by the supplier for approval

All cast iron parts shall be tested in accordance with IS - 210. Test bars shall be cast or physical tests from the same ladle of metal as the casting they represent.

Steel forgings used in pump shall be tested for both physical properties and chemical composition. steel forgings shall be ultrasonically tested.

4.01.04 Performance Testing

All pumps shall be performance tested at the Manufacturer's Works as per testing code. The test shall be conducted to determine the following characteristics:

- a) Speed
- b) Discharge Pressure
- c) Suction Pressure
- d) Capacity
- e) Power

The test shall be conducted preferably with the tested job motor.

04.02.02 Noise and vibration shall be measured during the performance testing, for reference purposes.
For pumps operating in parallel, the load sharing should not vary by more than 5%.

The pumps showing any abnormal behaviour during the performance testing or the pumps as required shall be stripped down for a thorough examination after the performance test. The performance test report shall be prepared by the supplier and submitted for approval, before despatch of the pumps.

04.02.00 Site Tests

04.02.01 After installation, the pumps supplied shall be operated to prove satisfactory performance as individual equipment as well as a system. The noise and vibration level of the pumps shall be measured and it should be within the design values. For pumps operating in parallel, the load sharing should not vary by more than 5%. If performance at site is found to be unsatisfactory, then the supplier shall rectify or replace the equipment.

04.02.03 Test Procedure Instruments

The test procedures to be followed and instruments to be used for testing shall be subject to the approval. All instruments to be used for stage and performance testing shall be calibrated at reputed third party laboratories.

SECTION: VIII

**TECHNICAL SPECIFICATION
FOR
PIPING, FITTINGS & VALVES**

1.00.00 INTENT OF SPECIFICATION

This specification covers the design, manufacturing, inspection, shop testing, erection, testing and commissioning at site of all the piping, fittings, valves and all other accessories as specified and as further required.

2. 00.00 SCOPE

The items & materials to be supplied shall include but not be limited to the following:

- 2. 01.00 Pipes, bends, elbows, tees, branches laterals, crosses, reducing unions, couplings, cap, expansion joints, flanges, blank flanges, saddles, shoes, sampling connections etc. necessary for making a reliable piping system.
- 2. 02.00 Gaskets, ring joint, backing rings, jointing material etc. as required.
- 2. 03.00 Instrument tapping connection, stub and thermowells.
- 2. 04.00 Supply and machining work of flanges, pipe spools and matching pipes to connect flow measuring orifice nozzles etc., pressure accumulators as necessary.
- 2. 05.00 Valves and Isolation Gates, to start/stop and control / regulate flow.
- 2. 06.00 Strainers.
- 2. 07.00 Anchor blocks (for buried / over ground piping), support brackets, clamps, support trestles, hangers, vibration dampener etc. for the piping under the scope of contract.
- 2. 08.00 Bolts, nuts, fasteners as required for interconnecting piping, valves and fitting as well as for terminal points.
- 2. 09.00 Steel for pipe supports and embedded steel. Also pipe supports and necessary embedment required to be embedded in concrete for underground / above ground pipes.
- 2. 10.00 Painting, anti-corrosive coatings, etc. inside and outside of pipes as necessary and as specified.
- 2. 11.00 All embedded parts required for all tanks/water retaining structures made of RCC including puddle pipes shall be supplied by the Bidder.

3. 00.00 **CODE & STANDARDS**

The design, manufacture, fabrication shop testing & inspection, erection, testing and commissioning of piping fittings and valves shall conform to the latest revisions of the following Indian / International codes / standards and other applicable statutory codes / ordinances, rules, regulations as well as safety codes, in addition to other codes / standards if any as addressed elsewhere in the Tender Specification.

Other National / International Standards may also be considered acceptable (subject to specific approval by Purchaser) with reference to any specific situation / requirement provided they are recognized to be equivalent or superior to the Standards as stipulated in the Tender Specification.

ANSI	-	B 16.5	:	Steel pipe flanges and flanged fittings.
ANSI	-	B 16.9	:	Wrought steel Butt welding fittings
ANSI	-	B 16.11	:	Forged steel socket welding and screwed fittings
ANSI	-	B 16.21	:	Non Metallic Gaskets for Pipe Flanges
ANSI	-	B 16.25	:	Butt welding ends
ANSI	-	B 16.28	:	Wrought Steel Butt Welding short radius elbows and returns
ANSI	-	B 31.1	:	Power Piping code.
ANSI	-	B 36.10	:	Welded & seamless wrought steel pipe
ANSI	-	B 36.19	:	Stainless steel pipe
API	-	5L	:	Specification for Line Pipe
ASME	-	Section II	:	Ferrous Materials Specification
ASTM	-	A 53	:	Seamless carbon steel.
ASTM	-	A 106	:	Grade C Seamless carbon steel pipe.
ASTM	-	F441 / F441M - 09	:	Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM	-	F439 - 11	:	Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80

AWWA	-	C-203	:	Coal tar protective coatings and linings for steel water pipe lines - Enamel and Tape - Hot Applied
AWWA	-	C-208	:	Dimensions for Steel Water pipe fittings
AWWA	-	C-504	:	Standard for butterfly valve.
BS	-	1868	:	Specification for steel check valves (flanged and butt-welding ends) for the petroleum, petrochemical and allied industries
BS	-	5158	:	Specification for cast iron plug valves
BS	-	5353	:	Specification for steel plug valves
BS EN	-	593	:	Industrial valves. Metallic butterfly valves
BS EN	-	1796	:	Plastics piping systems for water supply with or without pressure. Glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP)
BS EN	-	13397	:	Industrial valves. Diaphragm valves made of metallic materials
BS EN	-	13789	:	Industrial valves. Cast iron globe valves
BS EN	-	14364	:	Plastics piping systems for drainage and sewerage with or without pressure. Glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP). Specifications for pipes, fittings and joints
BS EN ISO	-	16138	:	Industrial valves. Diaphragm valves of thermoplastics materials
DIN	-	16966	:	Glass fibre reinforced polyester resin (UP-GRP) pipe fittings and joint assemblies - Requirements for and testing of bushes, flanges, and flanged and laminated joints
IS	-	210	:	Grey Iron Castings
IS	-	318	:	Leaded Tin Bronze Ingots and Castings
IS	-	458	:	Precast Concrete Pipes (with and without reinforcement).
IS	-	554	:	Pipe Threads where Pressure Tight-Joints are made on the Threads – Dimensions, Tolerances and Designation.

IS	-	778	:	Copper Alloy Gate, Globe and Check Valves for Waterworks Purposes.
IS	-	783	:	Code of Practice for Laying of Concrete Pipes.
IS	-	1239 Part 1	:	Steel Tubes, Tubulars and other Wrought Steel Fittings - Specification Part 1 Steel Tubes
IS	-	1239 Part 2	:	Specification Steel Tubes, Tubulars and other Steel Fittings Part 2 Steel Sockets Tubular and other Steel Pipe Fittings
IS	-	1363	:	Hexagon Head Bolts, Screws and Nuts of Product Grade C.
IS	-	1364	:	Hexagon Head Bolts, Screws and Nuts of Product Grades A and B.
IS	-	1367	:	Technical Supply Conditions for Threaded Steel Fasteners.
IS	-	1536	:	Indian Standard for Centrifugally Cast (Spun) Iron Pressure Pipes for Water, Gas and Sewage.
IS	-	1537	:	Vertically Cast Iron Pressure Pipes for Water Gas and Sewage.
IS	-	1538	:	Cast Iron Fittings for Pressure Pipes for Water, Gas and Sewage.
IS	-	1703	:	Water Fittings - Copper Alloy Float Valves (Horizontal Plunger type)
IS	-	1879	:	Malleable Cast Iron Fittings
IS	-	2016	:	Plain washers
IS	-	2062	:	Hot Rolled Low, Medium and High Tensile Structural Steel.
IS	-	2629	:	Recommended practice for Hot dip galvanising of iron and steel
IS	-	2633	:	Method for testing uniformity of coating on zinc coated articles.
IS	-	2379	:	Colour Code for Identification of Pipe Lines.

IS	-	2685	:	Code of Practice for Selection, Installation and Maintenance of Sluice Valves.
IS	-	2712	:	Gaskets and Packings- Compressed Asbestos Fibre Jointing.
IS	-	2825	:	Code for Unfired Pressure Vessels.
IS	-	3006	:	Chemically Resistant Glazed Stoneware Pipes and Fittings.
IS	-	3042	:	Single Faced Sluice Gates (200 to 1200 mm size).
IS	-	3114	:	Code of Practice for Laying of Cast Iron Pipes.
IS	-	3589	:	Steel Pipes for Water and Sewage (168.3 to 2540 mm Outside Diameter).
IS	-	4038	:	Foot Valves for Waterworks Purposes.
IS	-	4682 (Part I)	:	Code of practice for lining of vessels and equipment for chemical - rubber lining.
IS	-	4736	:	Hot-dip Zinc Coatings on Mild Steel Tubes.
IS	-	4984	:	High Density Polyethylene Pipes for Potable Water Supplies.
IS :	-	4985	:	Unplasticized PVC Pipes for Potable Water Supplies.
IS :	-	5312	:	Swing Check Type Reflux (non-return) Valves for Water Works Purpose.
IS :	-	5822	:	Code of practice for laying of electrically welded steel pipes for Water supply.
IS :	-	8062	:	Code of practice for cathodic protection (Part-II) of steel structure
IS :	-	10221	:	Code of practice for coating and wrapping of underground mild steel pipes
IS :	-	14846	:	Sluice Valve for Water Works Purposes (50 to 1200 mm Size).

4. 00.00 **DESIGN, MANUFACTURE, FABRICATION AND ERECTION**

4.01.00 The piping system, fittings and accessories supplied shall conform to high standards of engineering, design, workmanship and be capable of performing in continuous commercial operation in a manner acceptable to Purchaser.

4.02.00 All the piping systems, fittings and accessories supplied under this package shall be designed to operate without replacement and with normal maintenance for a plant service life of 25 years and shall withstand the operating parameter fluctuations and cycle variations which can be normally expected during this period.

4.03.00 Material of construction for pipes under different services shall be as below:

Service	Recommended Material of Construction
River Water	Carbon Steel
Clarified Water	Carbon Steel
Filtered Water	Carbon Steel (inside rubber lined)
Degassed Water	Carbon Steel (inside rubber lined)
Demineralised Water	Carbon Steel (inside rubber lined)
Service Air	Galvanized Steel
Instrument Air	Stainless Steel (schedule 40)
Potable Water	Galvanized Steel
Chlorine (liquid under pressure)	Seamless Carbon Steel (schedule 80)
Chlorine (dry gaseous under pressure)	Seamless Carbon Steel (schedule 80)
Chlorine under vacuum	CPVC (schedule 80)
Chlorine in water	CPVC (schedule 80) / Carbon Steel (inside rubber lined)
Sodium Hydroxide Solution	CPVC (schedule 80) / Carbon Steel (inside rubber lined)
Alum Solution	CPVC (schedule 80) / Carbon Steel (inside rubber lined)

Service	Recommended Material of Construction
Lime Solution	Galvanized Steel
Polyelectrolyte Solution	CPVC (schedule 80) / Carbon Steel (inside rubber lined)
Hydrochloric Acid (concentrated)	Carbon Steel (inside rubber lined)
Hydrochloric Acid (dilute)	Carbon Steel (inside rubber lined)
Sodium Hydroxide (concentrated)	Carbon Steel (inside rubber lined)
Sodium Hydroxide (dilute)	Carbon Steel (inside rubber lined)
Sulfuric Acid Solution (concentrated)	Carbon Steel
Sulfuric Acid Solution (dilute)	Carbon Steel (inside rubber lined)
Scale Inhibitor Solution	Stainless Steel (schedule 40) / CPVC (schedule 80)
Corrosion Inhibitor Solution	Stainless Steel (schedule 40) / CPVC (schedule 80)
Biocide Solution	Stainless Steel (schedule 40) / CPVC (schedule 80)
Filter Backwash Wastewater	Carbon Steel
Ammonia Solution	Seamless Stainless Steel (304 grade)
Hydrazine Solution	Seamless Stainless Steel (304 grade)
Oxygen Line	Aluminum
Crude Condensate	Carbon Steel (inside rubber lined)
Treated Condensate	Carbon Steel (inside rubber lined)
Demineralized Water with ion exchange resins	Stainless Steel (304 grade)
Non Oily Sludge	Cast Iron (underground) Carbon Steel (overground)
Neutralized Wastewater	Carbon Steel (inside rubber lined)

Cooling Tower Blowdown	Carbon Steel
Boiler Blowdown	Carbon Steel
Crude Oily Wastewater	Seamless Carbon Steel
Treated Oily Wastewater	Seamless Carbon Steel
Rainfall Runoff	Carbon Steel
Equalized Wastewater	Carbon Steel
Oily Sludge	Seamless Carbon Steel

The portion of pipe lines at the downstream of isolation valves, conveying flushing water shall be of the material & type same as those of the pipelines which are being flushed.

4.04.00 Material & Dimensional Standards for Piping and Fittings

4.04.01 The welded Carbon Steel Pipes shall conform to the following codes / standards:

Pipes	Material Code / Standard	Dimension Code / Standard
50 mm NB and below	Mild Steel, ERW, IS-1239 Part-1 / ASTM-A 53 Grade B (Welded), Type-E, Schedule 80.	IS-1239 Part-1. Plain ends for Socket Welding.
65 mm to 150 mm NB	Mild Steel, ERW, IS-1239 Part-1 / ASTM-A 53 Grade B (Welded), Type-E, Schedule 40.	IS-1239 Part-1. Bevelled ends for Butt Welding.
200 mm to 450 mm NB	Mild Steel, ERW, IS-3589 Grade Fe 410 / ASTM-A 53 Grade B (Welded), Type-E, Schedule 40.	IS-3589. Bevelled ends for Butt Welding.
500 mm NB and above	Rolled and Butt Welded from IS-2062 Grade A plates or SA-285 Grade C or Equivalent (subject to approval by Purchaser). / Spiral Welded pipes.	IS-3589. Bevelled ends for Butt Welding.

Elbows (R=1.5 D)	Material Code / Standard	Dimension Code / Standard
50 mm NB and below	Forged carbon steel from ASME-SA 105 / Carbon Steel to IS-1239 Part-2 (Heavy grade).	SW ends to ANSI-B 16.11 (3000#) / IS-1239 Part-2.
65 mm to 150 mm NB	ASME-SA 234 Grade WPB / Carbon Steel to IS-1239 Part-2 (Heavy grade).	BW ends to ANSI-B 16.9 / IS-1239 Part-2.
200 mm to 350 mm NB	ASME SA-234 Grade WPB	BW ends to ANSI-B 16.9 / IS-1239 Part-2.
Mitre Bends (R=1.5 D)	Material Code / Standard	Dimension Code / Standard
400 mm NB and above	Fabricated from parent pipe.	ANSI-B 31.1 / AWWA-C 208. 90° - 3 cut, 4 piece constructions. 45° - 2 cut, 3 piece constructions.
Tees	Material Code / Standard	Dimension Code / Standard
50 mm NB & below	Forged Carbon Steel to ASME-SA 105 / ASME-SA 234 Grade WPB / Carbon Steel to IS-1239 Part-2 (Heavy grade).	SW ends to ANSI-B 16.11 (3000#) / IS-1239 Part-2.
65 mm to 150 mm NB	ASME-SA 234 Grade WPB / Carbon Steel IS-1239 Part-2 (Heavy grade).	BW ends to ANSI-B 16.9 / IS-1239 Part-2.
200 mm NB and above	ASME-SA 234 Grade WPB / Fabricated from parent pipe.(set in / set on type).	ANSI-B 16.9
Reducers	Material Code / Standard	Dimension Code / Standard
50 mm NB & below	Forged carbon steel to ASME-SA 105 / ASME-SA 234 Grade WPB / Carbon Steel to IS-1239 Part-2 (Heavy grade).	SW ends to ANSI-B 16.11 (3000#) / IS-1239 Part-2.
65 mm to 150 mm NB	ASME-SA 234 Grade WPB / Carbon Steel to IS-1239 Part-2 (Heavy grade).	BW ends to ANSI-B 16.9 / IS-1239 Part-2.

200 mm NB and above	ASME-SA 234 Grade WPB / Fabricated from parent pipe.(set in / set on type)	ANSI-B 16.9
Slip On Flanges / Blind Flanges	Material Code / Standard	Dimension Code / Standard
All sizes	IS-226 / IS-2062 Grade A / ASME-SA 105 / ASTM-A 216 Grade WCB. Flanges shall be either machined or forged from plate / casting.	Dimensions / Drilling as per ANSI-B 16.5, Pressure rating 150# / 300# or otherwise as applicable, generally Flat face.
Bolts & Nuts	Material Code / Standard	Dimension Code / Standard
All sizes	IS -1367 CI 4.6 for bolts IS-1367 CI 4 for nuts	IS -1367
Gaskets	Material Code / Standard	Dimension Code / Standard
All sizes	3 mm thick wire reinforced rubber. Material shall contain no asbestos.	ANSI-B 16.21.

- 4.04.02 Seamless Carbon Steel Pipe shall conform to ASTM-A 106 Grade C (Schedule 80) / ASTM-A 53 / API 5L. Fittings shall conform to applicable codes / standards and be in conformity with the code / standard for the parent pipe.
- 4.04.03 Galvanized Steel Pipes and Fittings shall conform to the clause 4.02.01 above and be galvanized to IS-4736. Ends of all fittings will however be screwed as per IS-554. Mitre Bends shall not be used. Pipe joints shall be screwed for lower size and flanged for higher size. No hot work on G.I. pipes shall be done. Flanges shall be screwed and hot dipped galvanized.
- 4.04.04 Pipes and Fittings which shall be rubber lined, need to conform the clause 4.02.01 above. The inside surfaces of the items shall be completely debanded and made suitable for lining. The items will be inside rubber lined with 3 mm thick (minimum) natural rubber in two layers as per IS-4682. Flanges shall be flat face as per ANSI-B 16.5 and full face rubber lined. Pipe to Pipe joint will be flanged only. For small size fittings, SS-316 fittings shall be used if rubber lined carbon steel fittings are not available.
- 4.04.05 Stainless Steel Pipe shall conform to ASTM-A 312 of specified grade (Schedule 40) with dimensions as per ANSI-B 16.39. Fittings shall conform to applicable codes / standards and be in conformity with the code / standard for the parent pipe. Mitre Bends shall not be used. Elbows / Tees / Reducers shall be of Forged Stainless Steel (ASME-SA 182) with SW ends to ANSI-B 16.11 (3000#).

- 4.04.06 Cast Iron pipes shall conform to IS-1536. Fittings shall conform to applicable codes / standards and be in conformity with the code / standard for the parent pipe.
- 4.04.07 PVC Pipes shall conform to IS-4984 Class 4. Fittings shall conform to applicable codes / standards and be in conformity with the code / standard for the parent pipe.
- 4.04.08 High density Polyethylene Pipes shall conform to IS-4984 Class 5. Fittings shall conform to applicable codes / standards and be in conformity with the code / standard for the parent pipe.
- 4.04.09 CPVC pipe (Schedule 80) shall be produced from compounds which conform to and are specified in ASTM-D 1784. CPVC Pipe shall be manufactured in strict compliance with ASTM-F 441. Pressure-Rated CPVC Pipe shall be manufactured in strict compliance with ASTM-F 442. All CPVC piping shall be manufactured from NSF approved compounds and NSF Listed for potable water use. CPVC Fittings (Schedule 80) shall be as per ASTM-F 437 and F 439.
- 4.04.10 Pipe lines carrying water, chemicals, air etc. shall be sized generally based on the following ranges of velocities. However pipe size if any for any particular service is addressed in the Tender Drawings / Data Sheets, the selected size for the applicable service shall not be less than the specified size.

Pipe Size	Velocity in m/sec		
	Below 50 mm	50 mm - 150 mm	200 mm & above
Pump Suction for Water		1.2 - 1.5	1.2 - 1.8
Pump Discharge for Water	1.2 - 1.8	1.8 - 2.4	2.1 - 2.5
Header		1.5 - 2.4	2.1 - 2.4
Compressed air below 2 Kg/cm ² (g)	15 - 20	20 - 30	25 - 35
Compressed air 2 Kg/cm ² & above	20 - 30	25 - 40	35 - 45
Suction to compressor/ Blowers		7 - 8	
Pump Suction for Chemical Solution	1.0 - 1.2	1.1 - 1.3	
Pump Discharge for Chemical Solution	1.2 - 1.4	1.3 - 1.5	

- 4.05.00 Pipe line under gravity flow shall be restricted to a flow velocity of 1 m/sec generally. Channels under gravity flow shall be sized for a maximum flow velocity of 0.6 m/sec.

- 4.06.00 The following "C" Value shall be used in WILLIAM & HAZEN formula for calculating the friction loss in piping and fittings.

i)	Carbon Steel Pipe	:	100
ii)	C.I Pipe	:	100
iii)	Carbon Steel Pipe (inside rubber lined)	:	120
iv)	PVC / HDPE / GRP / CPVC pipes	:	140

For calculating the pump head, atleast 10% margin shall be taken over the pipe friction losses.

- 4.07.00 Piping Layout

- 4.07.01 Piping shall be grouped together as far as practicable and routed to present a neat appearance and orientation. All piping shall generally be installed perpendicular or parallel to the major equipment, building structure and floor. Pipe routing shall be such as to provide sufficient clearance for removal and maintenance of equipment, easy access to valves, instruments and other accessories. The piping shall not encroach on the withdrawal space of other equipment. Piping shall be routed to avoid interferences with other pipes, hangers, structures, equipment electrical trays, HVAC ducts etc. Convenient supporting points, adequate flexibility for thermal expansion and neat appearance shall be considered in piping layout work.

- 4.07.02 Provision shall be made while preparing piping layout to accommodate all system accessories such as valves/ expansion bellows/instrument stubs/instruments/ specialties as per P&ID.

- 4.07.03 All local instruments on the pipeline shall be located such that the reading can be observed without inconvenience.

- 4.07.04 Overhead indoor piping shall have a vertical clearance of minimum 3.0 m above finished floor level of working areas / walkways. Overhead outdoor piping shall have a vertical clearance of minimum 4.0 m above finished ground level and minimum 7.5 m above finished road level unless addressed otherwise elsewhere in this specification. When several pipe lines are laid parallel, flanged joints must be staggered. Welded and flanged joints should as far as possible located at one third span from supports. If the support is situated right under the welded joints this joint must be reinforced with a strap. Flanged and welded joints must be avoided in the middle of the span. Valves should be located in such a manner so as to ensure their convenient operation from the floor or the nearest platform.

- 4.07.05 In specific cases (subject to instruction by Purchaser for any site specific reason), pipes may be routed overground on RCC pedestals with bottom of pipes minimum 300 mm above finished ground level.

- 4.07.06 Pipe, when specifically addressed, shall be laid in trenches or buried. All buried pipes in general shall be laid with the top of the pipe 1.2 m to 1.5 m below the finished ground level unless mentioned otherwise. Full length of buried piping shall be provided with 100 mm thick sand bed.

- 4.07.07 Openings provided to accommodate pipelines must be closed with bricks and mortar with 10 mm to 12 mm clearance between brick work and pipe. The clear space must

be filled with felt or approved filling compound. The details of wall sealing arrangement shall be approved by Purchaser.

4.07.08 Drains shall be provided at low points and at pockets in piping such that complete drainage of system is possible. Vent connections shall be provided at high points where air or gas pockets may occur. Vent for use during hydrostatic test shall be plugged after the completion of the test. Vents shall not be less than 15 mm size. Plugs / cocks required for vent/drain system shall form part of the piping system and shall be supplied by Bidder as per finalized flow diagram. All vent valves & drain valves shall be arranged with easy reach of operation. All pipelines shall be given proper slope towards the drain points.

4.07.09 To facilitate dismantling of piping at the valves and equipment, break up flange/unions shall be provided. The location shall be decided as per the system requirement during detailed engineering.

4.08.00 Line Joints

Line Joints shall be envisaged as follows:

CS and SS pipes	:	Welded (socket welded for 50 mm NB & below & butt welded for 65 mm NB and above)
Galvanized Pipes	:	Screwed
Rubberlined Pipes	:	Flanged

4.08.01 Welded joints

For making welded joints (socket weld or butt weld) the welding shall be performed by manual shielded metal arc process. Any welder employed for carrying out welding shall be qualified as per ASME-Section IX for the type of joints to be welded. Jointing by butt weld or socket weld shall depend upon the respective piping material specification.

For Stainless Steel piping atleast the root run shall be welded with Tungsten Inert Gas (TIG).

Butt welding edge preparation shall be done as per ANSI-B 16.25.

All welding electrodes and welding rods including special ones, if any shall be furnished by the Bidder.

4.08.02 Screwed joints

Threading of pipes shall be carried out after bending, heat treatment etc. If not possible, threading may be done prior to these operations but proper care should be taken to protect them from damage. Threads shall be to ANSI-B 2.1 (taper) NPT / IS 554, unless specified otherwise.

Teflon tapes shall be used to seal screwed joints and it shall be applied to the male threads only. Threaded parts shall be wiped clean of oil or grease (with appropriate

solvent if necessary) and dried before applying the sealant. Pipe ends shall be reamed or filed out to size of bore and all chips shall be removed. Screwed flanges shall be attached by screwing the pipe through the flange and the pipe as well as the flange shall be refaced accurately.

4.08.03 Flanged joints

All flanges and flange drilling shall be to ANSI-B 16.5 of applicable pressure/temperature class. However in case of interface with the pipe of Purchaser, the flange/interconnection details shall be designed to match the applicable interface piping and concerned details.

When weld neck or socket weld flanges are used, their bore must be made the same as that of the pipe being welded to. Socket welded or threaded flanges may be used, with the appropriate piping system for connection of pipe to the flanged equipment.

Drilling of flanges on piping must match with the drilling of flanges on the valves /equipments to which the piping is to be connected.

While fitting the mating flanges, care shall be taken to properly align the pipes and to check the flanges to trueness so that the faces of the flanges can be pulled up together without producing any stress on the adjacent pipes and equipment flanges.

Flanges shall be generally Slip-On / Blind Flat Face type. The packing ring or gasket of the flanged joint shall be of full face type. Flanged joints shall not be buried.

4.08.04 With reference to maintenance for carbon steel pipes, three piece socket welded unions for sizes 50 mm NB and below shall be used. For higher sizes, flanged joints shall be used.

4.09.00 Fabrication of Pipes

4.09.01 General Requirements

The Bidder shall prepare necessary fabrication drawings based on approved piping layouts.

Flanges and their contact surfaces shall be concentric with the pipe axis and shall be accurately machined and drilled true to template.

Where welded pipe and fittings are used, the longitudinal weld seams of adjoining sections shall be staggered by 90 degree.

Prefabrication shall be carried out in the fabrication shop to ensure quality of work and to minimize work on the field.

Where fabricated reducers have been specified, they shall be fabricated from parent pipes by the 'cut and shut' method.

All bends, tees and reducers shall be fabricated as per the latest edition of power piping code, ANSI-B 31.1 or approved equivalent. Reinforcement wherever required, shall be provided.

Only shop fabricated mitre bends or mitre fittings shall be acceptable. Mitre bends will not be accepted for steel pipes of 350 NB and below. For sizes 400 mm NB and above, the mitre bends shall conform to BS-534.

For easy handling & removal of equipment, valves etc. and for maintenance purpose, break up flanges shall be provided for 65 mm NB and above. For flanged joints of 50 mm NB and below, suitable type of compression flexible coupling shall be provided.

4.09.02 Rolled and Welded /Spiral Welded Pipes

Pipes of larger diameter shall be fabricated from steel plates conforming to IS-2062 by rolling and welding or spiral welded pipes shall be used.

Where pipe lengths need to be erected before the circumferential joints is welded, the pipe ends at these joints shall be beveled so that the top half is welded mostly from outside and the bottom half mostly from inside of pipe.

Beveled (single V / double V) ends shall be provided for butt welding as per Welding Procedure Specification.

4.09.03 Fabrication of flanges for large diameter pipes (sizes 600 mm NB and above)

Flanges fabricated from plates shall conform to AWWA-C 207 / BS-4504 / ANSI-B 16.47.

All welds in fabricated flanges shall be subjected to 10% radiographic examination.

Flanges shall be flat faced machined to 10 microns surface finish. Back face of the flanges shall also be machined to 25 microns surface finish.

Inspection holes shall be provided at suitable locations for pipes 800 mm NB and above as required for periodic observations and inspection purposes.

4.09.04 Rubber Lined Pipes

All rubber lined pipes shall be seamless or bead removed ERW pipes. Inside surface of the pipes shall be completely cleaned and made suitable for lining.

All rubber lined pipes shall have flanged joints. Pipes shall be welded with flanges before rubber lining.

For rubber lined pipe, natural rubber lining should be applied in two (2) layers on the inside surface of pipes, giving a total thickness not less than 3 mm. Surface hardness of rubber lining shall be 65 ± 5 Shore A class.

4.09.05 Welding

Welding shall be carried out by manual shielded metal arc and Tungsten Inert Gas

Welding process. Electrodes used shall be of Purchaser approved make. Electrodes shall be kept dry and electrode containers shall be protected against moisture. Electrodes that show sign of deterioration or damage shall not be used. Automatic or semiautomatic welding shall be done with the specific approval of Purchaser.

The Bidder shall submit procedures for welding, stress relieving, dye penetrant testing radiography etc. for prior approval of the Purchaser.

Weld shall not be made in pipe bends.

4.10.00 Supports for Overground Pipe

4.10.01 Complete supporting system for the pipe line shall be designed, fabricated and supplied by the Bidder. Inside the building, the overhead portion of the pipe line may be supported from the building structures. No support shall be taken from the brick wall. Outdoor pipes shall run on steel trestles wherever required. All the steel structure for the pipe rack and the supporting posts/trestles along with all necessary hangers, clamps, connecting steel, fixing bolts, nuts etc. shall be supplied and erected by the Bidder.

4.10.02 Hangers and supports shall be capable of carrying the sum of all concurrently acting loads. They shall be designed to provide the required supporting effects and allow pipe line movements as necessary. All guides, anchors, braces, dampener, expansion joint and structural steel to be attached to the building/structure, trenches etc. shall be provided. Type of hangers and components for all piping shall be selected and approval obtained from the Purchaser.

4.10.03 The supports shall meet the general guidelines indicated in the following code / standards:

MSS-SP 58	:	Pipe hangers & supports - Materials, design and manufacture.
MSS-SP 69	:	Pipe hangers & supports Selection and application.
ANSI-B 31.1	:	Power Piping Codes

4.10.04 Bidder shall locate, design, fabricate, supply and erect all supports, restraints and anchors required for supporting of over ground portion of piping under this contract

4.10.05 Support drawings for piping shall be got approved from the Purchaser. BOM for each support shall also be submitted.

4.10.06 All material for supports shall be of tested quality.

4.10.07 All structural steel required for supports shall be provided by the Bidder at no extra cost to the Purchaser.

4.10.08 All pipe supporting element, guides, sliding support, beams, channel section, attachment to supports, beam clamps etc. shall be provided by the Bidder.

4.10.09 Support locations will be shown in the layout drawing to be submitted by the Bidder.

4.10.10 Fabrication, supply and installation of brackets, pipe shoes, saddles etc. shall be

- included in the scope of Bidder and the same shall be carried out as per approved drawings.
- 4.10.11 If an outdoor saddle support is assumed to permit sliding movement of piping over the support, consideration shall be given in selection of supporting material at the interface so that no rust formation takes place and the actual sliding movement is feasible in practice.
- 4.10.12 All pipe supports shall be designed to fully sustain the pipe in normal operating position, allow free and ample expansion or contraction except where anchored and prevent excessive stress.
- 4.10.13 Sway braces, cushioned clamps or other vibration control equipment shall be used in order to prevent unwanted movements of the piping due to vibration, shock or other causes. These shall be of such design as to protect piping against these movements regardless of direction.
- 4.10.14 The supports shall be so interspaced as to minimize sagging of the pipes and to keep them within permissible limits where pipes are full with the conveying media.
- 4.10.15 All piping supports shall be designed to avoid interference with other piping hangers, electrical conduits equipment and structures etc.
- 4.10.16 Saddles, supports etc. shall be capable of carrying the sum of all concurrent acting loads and shall be fabricated from plates/pipes sections conforming to SA 53 / IS-2062 or equivalent. They shall be designed to provide the requirement of supporting effects and allow pipe line movements as necessary. The structural work shall be as per IS-800 / BS-4360.
- 4.10.17 The maximum spans of the supports of straight lengths shall not exceed the recommended values indicated in ANSI-B 31.1. The spans shall be suitably reduced considering the following:
- a) Point loads due to valves and specialties, branch lines etc.
 - b) Pipe bends
 - c) Structural Steel beams.
 - d) Facilities for maintenance of flanged joints.
 - e) Minimum loads on equipment.
- 4.10.18 All vertical lines shall be properly supported on the vertical run and additionally provided with adequate number of lateral-restraints where the length of vertical run exceeds 5M.
- 4.10.19 At all sliding surfaces of restraints and supports Bidder shall provide a teflon lining to minimize sliding friction.
- 4.10.20 Pipe clamps shall have a minimum thickness of 5 mm for indoor piping and 6 mm for outdoor piping.
- 4.11.00 Erection

- 4.11.01 The Bidder shall coordinate the erection of the piping system as required with the erection schedule of other concerned systems. The sequence of work shall be carefully planned to minimize interference with other groups working in the same area. The actual sequence to be followed shall be to the approval of Purchaser who may at any time, direct the Bidder to reschedule his work as per the status of work site
- 4.11.02 Prior to making interface connections with equipment / system supplied by others, the Bidder shall obtain the approval of the concerned authority.
- 4.11.03 All workmanship shall be accomplished using accepted methods and procedures of the highest recognized fabrication and erection code / standards. Workmanship not conforming to the intent of this specification shall be liable to rejection by the Purchaser at any time, during the progress of work. The Bidder shall correct the workmanship immediately at no extra cost to the Purchaser.
- 4.11.04 The Bidder shall make all interface joints of the piping system, covered under this specification at the connecting points with equipment/piping supplied by others.
- 4.11.05 It is the responsibility of the Bidder to ensure correct orientation of all valves, instrument stubs etc. in line with final piping drawings.
- 4.11.06 The Bidder shall utilize the existing structures if any, to support the piping as far as practicable. All auxiliary steels required shall be supplied by the Bidder.
- 4.11.07 Before performing any welding, all corrosion products, dust, grease and other foreign material shall be cleaned from the surfaces to be joined.
- 4.11.08 Piping on both sides of the joint shall be adequately supported during all welding. Temporary supports, if used shall be so designed that no stress due to pipe weight comes on the joints during the joining.
- 4.11.09 All pipes shall be located and laid in accordance with the approved layout drawings. No deviation will be allowed unless written consent is issued by Purchaser in specific case(s).
- 4.11.10 Before laying the pipes, the coordinates and levels of the pipes shall be checked by the Bidder. Any discrepancies between the execution and approved drawings shall be brought to the notice of the Purchaser and corrections shall be carried out as per his instructions.
- 4.11.11 During erection of piping, the Bidder shall provide proper number and size of bolts and nuts as per drawings and specification. The Bidder shall provide approved quality of grease mixed with graphite powder thoroughly on all the bolts, nuts and washers immediately after erection and when the flange joints are dismantled for flushing, testing and alignment of equipment etc. to prevent rusting of nuts, bolts and gaskets. The grease and graphite powder shall be supplied by the Bidder
- 4.12.00 Cleaning and Flushing
- The exterior and interior surface of all piping shall be thoroughly cleaned of all sand, mill scale, grease, oils, dirt and other foreign materials. After cleaning, the interior surfaces of all piping shall be thoroughly blown dry and protected with a completely

water soluble preventive coating.

Flange faces shall be coated with an easily removable rust preventive coating.

Machined surface shall be coated with rust preventive paint. The paint shall be consumable in the welding process.

4.13.00 Pipes and Fittings if any, coming under purview of IBR, should meet its requirements and getting the approval from IBR in respect of the same shall be under the scope of the Bidder.

4.14.00 Valves & Isolation Gates

Valves will be used to start/stop or control flow.

All valves, shall be suitable for service conditions i.e. flow, temperature and pressure under which they are required. The valves shall be of standard pressure rating as per the applicable code/ standard. The pressure rating of diaphragm valves shall be selected considering the maximum expected operating differential pressure. Sample valves will be used in sample collection lines.

Gates will be primarily used for isolation of flow in open channels although these should be capable of throttling the flow too.

For location and type of Valves / Isolation Gates, Bidder need to refer to the P&I drawings enclosed with this specification.

4.14.01 Sluice / Gate Valves (for river water / clarified water / filtered water / similar application)

Sluice / Gate valve shall conform to IS-14846 PN1.6 minimum. Stem, seat ring and wedge facing ring shall be of stainless steel construction. Other parts shall be as per IS-14846. Valves shall be of outside screw and rising stem type. Ends will be flanged and compatible with ANSI-B 16.5 Cl. 150 (minimum) piping flanges.

Sluice / Gate valves for sizes 50 mm NB and below shall conform to IS-778 Class-2 / ANSI-B 16.34 straight, rising stem; with outside screw.

Sluice / Gate valves shall be provided with the following accessories in addition to the standard items.

- a) Hand wheel
- b) Gear Reduction Unit Operator for valves 250 mm NB and above.
- c) Bypass valve for valve of sizes 300 mm NB and above.
- d) Draining / Flushing arrangement wherever required.
- e) Arrow indicating flow direction.
- f) Position indicator.

Sluice / Gate Valves shall be provided with back seating bush to facilitate gland renewal during full open condition.

For lower sizes, the gate valves will be screwed bonnet with outside screw rising stem as per IS-778. The material of construction will be gun metal body, with brass stem and trim. Ends will be screwed to ANSI-B 2.1.

Gate valve on galvanized iron pipe shall be gun metal construction as per IS-778 Class 2. Ends will be screwed to ANSI-B 2.1.

4.14.02 Butterfly Valves (for river water / clarified water / filtered water / similar application)

Butterfly valves shall be of double flanged or lugged wafer type of low leakage rate conforming to AWWA-C 504 class 150 (min.) or BS-5155 PN 10 / class 150 (minimum)

The various components of butterfly valves shall be of the following:

i)	Body	:	Cast Iron – ASTM-A 48 Cl.40; BS-1452 Grade220 SG Iron – BS-2789. Cast Iron IS-210 Grade FG 260 Cast Steel – ASTM-A 216 Grade WCB; BS- 1504 or Equivalent grade (subject to approval by Purchaser).
ii)	Disc	:	Cast Iron – ASTM-A 48 Cl.40; BS-1452 Grade220 SG Iron – BS-2789. Cast Iron IS-210 Grade FG 260 Cast Steel – ASTM-A 216 Grade WCB; BS-1504 or Equivalent grade (subject to approval by Purchaser).
iii)	Shaft	:	ASTM-A 296 Grade CF 8M / AISI 316; AISI-420; BS-970 Grade 316; BS-970 Grade 420 S45.
iv)	Seat rings	:	Nitrile rubber, EPDM (Ethylene propylene rubber), Hypalon.

Butterfly valves shall be fitted with sleeve type bearing such as PTFE. Valves of size 350 mm NB and above shall be provided with one or two thrust bearings to hold the disc securely in the centre of valve seat without hydraulic or external axial shaft loads. Sleeve and other bearings fitted into the valves body shall be of self lubricated materials that do not have any effect on the fluid handled and other components of the valves.

All the butterfly valves shall be provided with Hand wheel or lever/wrench operated as per the requirements.

The use of lever operators shall be limited to valves requiring a maximum of 90 degree stem rotation from full open to full closed position. For lever/wrench operated valves, means shall be provided for positively holding the disc in not less than three intermediate positions

For larger sizes i.e. 150 mm NB and above, hand wheel shall be provided.

Manually operated valves shall be provided with reduction gear unit for valves of size 250 mm NB and above. Valve provided with motorised or pneumatic actuator shall be provided with a hand wheel for manual operation.

All the valves shall be equipped with adjustable mechanical stop-limiting devices to prevent over travel of the valve disc in the open and closed positions. The valve operators (Handwheel or Gear reduction unit or Motor actuator etc.) shall be designed as per applicable International Standard.

All the butterfly valves shall be provided with an indicator to show the position of the disc.

Ends will be flanged and compatible with ANSI-B 16.5 Cl. 150 (minimum) piping flanges.

4.14.03 Butterfly Valves (for decaionized water / deanionized water / demineralized water / desalinated water / similar application)

The butterfly valves shall conform to the requirements addressed under Cl. No. 4.14.02 above along with the requirements delineated below:

- a) Body shall be lined (minimum 3 mm) with natural rubber, ebonite, polypropylene or PVDF.
- b) Disc shall be either lined with PVDF, polypropylene, or natural rubber or shall conform to ASME-SA 479 Grade 316.

4.14.04 Ball Valves (for river water / clarified water / filtered water / similar application)

Ball valves may be used for sizes 40 mm NB and below. Ball valves shall conform to the following technical specifications:

a)	Design Standard	BS:5351
b)	Type	Screwed / Welded / Flanged ends; Full Bore: Split Body & Seat supported construction
c)	Material of Construction	
	Body	Carbon Steel to ASME-216 WCB / Cast Iron to IS-210 Grade 220 or better.
	Ball	Stainless steel ASME-SA 479 Grade 316 or 410.
	Seat ring	PTFE
	Stem	Stainless steel ASME-SA 479 Grade 304 or 316 or 410.
	Seats	Nitrile rubber; PTFE

- d) Valves shall be designed to be directly operable by a wrench / hand lever.

- e) Suitable stops shall be provided for both the fully open & close condition.
- f) All the valves shall be provided with an indicator for showing the position of the ball port.
- g) Ends will be flanged and compatible with ANSI-B 16.5 Cl. 150 (minimum) piping flanges

4.14.05 Globe Valves (for river water / clarified water / filtered water / similar application)

Globe valves shall conform to the following technical specifications:

For sizes 50 mm NB and below

- i) Design Standard : IS-778 Class-2 / BS-1873
- ii) Type : Straight, rising stem, with outside screw.
- iii) Material of Construction

i)	Body, Bonnet, Stuffing Box & seat rings	Leaded Tin Bronze conforming IS-318 Grade 2
ii)	Stem	Stainless Steel, AISI-316
iii)	Disc	IS-318 Grade 2/AISI-316

Note: However, valves in the flushing water lines shall be of type and material specified for the chemicals which are being flushed by the line.

For sizes above 50 mm NB

- i) Design Standard : BS-13789 PN 10 (minimum).
- ii) Type : Double Flanged or wafer body, outside screw and rising stem type.
- iii) Material of construction

a)	Body	: Cast iron: IS-210 Grade FG260 / BS-1452 Grade14.
b)	Stem	: Stainless steel AISI-410 / 13% chrome steel.
c)	Disc	: Cast iron IS-210 Grade 260 / BS-1452 Grade 14.

d)	Packing	:	PTFE
e)	Seat & seat rings	:	13% chromium steel
f)	Gland & gland nut	:	AISI-420
g)	Hand wheel	:	Cast Iron or Malleable Iron

- iv) Back seat shall be provided on the stem or on the disc.
- v) Renewable disc assembly shall consist of disc holder, disc, disc guide, check nut and disc retaining nut with washer.
- vi) Disc of globe valve may be provided with renewable rubber seating ring.
- vii) Handwheels shall be marked with the word. OPEN or SHUT with arrow to indicate direction of opening or closing.

Ends will be flanged and compatible with ANSI-B 16.5 Cl. 150 (minimum) piping flanges

Globe valve on galvanized iron pipe shall be gun metal construction as per IS-778 class 2. Ends will be screwed to ANSI-B 2.1.

Note: However, valves in the flushing water lines shall be of type and material specified for the chemicals which is being flushed by the line.

4.14.06 Diaphragm Valves (for river water / clarified water / filtered water / similar application)

Metallic Unlined Diaphragm valves (manual / auto as specified elsewhere in this specification) may be used for isolation purposes.

The Metallic Unlined Diaphragm valves shall conform to the requirements addressed under Cl. No. 4.14.07 below except the requirements with reference to lining for body and integral flanges.

4.14.07 Diaphragm Valves (for decationized water / deanionized water / demineralized water / desalinated water / dilute and concentrated acidic solution / dilute and concentrated alkaline solution / similar application)

Metallic Diaphragm valves (manual / auto as specified elsewhere in this specification) may be used for isolation purposes.

The metallic diaphragm valves shall conform to the following requirements.

- a) Design Standard : BS EN-13397 or Equivalent (subject to approval by Purchaser) of required

- rating/class. (minimum rating of valves should be PN 10).
- b) Type : Flanged and lined body ends, sealed bonnet, weir pattern, tight shut off type.
- c) **Material of Construction**
- Body/Bonnet : Cast Iron IS-210 Grade FG.260 or Equivalent (subject to approval by Purchaser).
- Cast steel ASTM-A 216 Grade WCB.
- Body lining : Soft Natural rubber - 3 mm thick as per IS-4682 (hardness 85-90 on shore A), Ebonite polypropylene, PVDF.
- Diaphragm : Reinforced rubber, Hypalon
- Handwheel : Cast Iron
- Compressor : Stainless Steel
- Stem & Bush : Stainless Steel
- d) Ends will be flanged and compatible with ANSI-B 16.5 Cl. 150 (min.) piping flanges, full face rubber lined and shall be cast / integral with the body.
- e) Handwheels shall be marked with the direction of closure.
- f) Valves shall be provided with a position indicator to show the open and closed condition.
- h) Valves provided with pneumatic actuators shall be provided with a handwheel for manual operation. The valves operators shall be designed as per applicable International Standard.
- i) The testing of valves will be as per BS EN-13397 and rubber lining will be tested as per IS-4682.

Note: For valves which may come in contact with concentrated acid/ alkali, the material of construction of diaphragm shall be as follows:

Diaphragm shall be of reinforced Teflon, EPDM for acid services and reinforced Neoprene / Hypalon for alkali services.

Use of Nonmetallic Diaphragm Valves for any specific / critical application shall be subject to approval by Purchaser and shall conform to the requirements of BS EN ISO 16138 - Industrial valves. Diaphragm valves of thermoplastics materials.

4.14.08 Plug Valves (for lime solution / sludge / similar application)

The plug valves shall conform to the following requirements.

a)	Design Standard	BS-5158 or Equivalent (subject to approval by Purchaser)
b)	Type	Flanged and non lubricated, regular pattern, plug valves.
c)	Material of Construction	
	Body	Cast Iron IS-210 Grade FG 260 or Equivalent (subject to approval by Purchaser)
	Plug	Stainless Steel AISI-316
	Body Sleeve or Seat	PTFE
	Seat	PTFE
	Gland	AISI-304 / AISI-316
	Cover	Cast Steel ASTM-A 216 Grade WCB
	Gland Nut	AISI-304 / AISI-316

- d) Valves shall be operated by permanently fitted wrench or Hand lever. Wrench shall be mounted so that they are parallel to the valve bore axis when the valve is in fully open condition.
- e) All valves shall be provided with an indicator for the position of the plug part.
- f) Suitable stops shall be provided for the fully open and fully closed positions of the valve.
- g) Valves of size of 250 mm NB and above shall be provided with a suitable reduction gear unit.
- h) Ends will be flanged and compatible with AISI-16.5 Cl. 150 (minimum) piping flanges.

4.14.09 Non Return or Check Valve (for river water / clarified water / filtered water / similar application)

Non return valves shall be of swing check (reflux) type or dual plate type.

The valves shall conform to the following specifications.

- i) Design Standard : IS-5312, BS-1868, BS-5153, API-594 / API-60 or equivalent (subject to approval by Purchaser)
- ii) Type : Swing check Type and Flanged ends.
- iii) Material of Construction:

a)	Body & Cover Hinge Disk/Door	Cast iron IS-210 Grade FG 260 / Cast Iron BS-1452 Grade 220 or equivalent (subject to approval by Purchaser)
b)	Hinge Pin and Door / Disc Pin	Cast steel ASTM-A 216 Grade WCB High tensile Brass IS-320 HT 2 or BS-2872 equivalent (subject to approval by Purchaser)
c)	Disc facing ring	Stainless steel
d)	Body Seat ring	Stainless steel
e)	Bearing bushes	Leaded Tin Bronze IS-318 Grade 2
f)	Bolts	Carbon Steel

Ends will be flanged and compatible with ANSI-B 16.5 Cl. 150 (minimum) piping flanges. .

Body shall be permanently marked with an "arrow" inscription indicating the direction of motion of the fluid for all the check valves.

For sizes 50 mm NB and below, check valves shall be gun metal body swing type as per IS-778. Ends will be screwed type to ANSI-B 2.1.

4.14.10

Non Return Valve (for decationized water / deanionized water / demineralized water / desalinated water / dilute and concentrated acidic solution / dilute and concentrated alkaline solution / similar application)

The valves shall conform to Cl. No. 4.09.00 above along with the following requirements:

- The body, cover & Disc shall be lined with natural Rubber, PTFE or Viton. The Hinge, Hinge Pin & Disc Pin shall be coated with PVDF, or suitable elastomer. The bearing bushes shall be PTFE or Equivalent (subject to approval by Purchaser) material (subject to approval by Purchaser). Bolting shall be of stainless steel. In the absence of lining/coating, the complete valve shall be of stainless steel construction (AISI-316).
- For only acid services Non- Return valves shall be of lined construction & Flap type.
- For alkali services, the complete valve shall be stainless steel construction (AISI-316) or of lined construction as specified above.

4.14.11

Valves for Sampling / Instrument Isolation Service

Each sampling valve / instrument isolation valve shall be full bore ball type.

Ball valves shall conform to the requirements stipulated under Cl.4.04.00 above. However, Body material shall be Stainless Steel (AISI-316).

4.14.12 Valves for Air Service

For Air services globe valves or Ball valves may be used for sizes 50 mm NB and below.

For sizes higher than 50 mm NB, either Butterfly valve or Ball valves shall be used.

Globe valves shall generally conform to Cl. 4.05. 00 above.

Ball valves shall conform to the requirements stipulated in Cl.4.04.00 above. However, Body material shall be leaded Tin Bronze (IS-318 Grade2) or stainless steel (AISI-304 / 316).

Butterfly valves shall conform to the Cl.4.03.05 to 4.03.09 of this section. However, the body & Disc shall be either cast iron lined with elastomer such as PVDF or PTFE or stainless steel construction (AISI-304 / 316).

4.14.13 Safety / Relief Valves

The safety valves / relief valves at the downstream of positive displacement type metering pumps shall be of the standard type manufactured by the pump manufacturer and the material of construction shall suit to the fluid handled.

4.14.14 Valves for Resin Transfer Line

In resin transfer line two way eccentric plug valve shall be used. The valves, shall have type 316 stainless steel body and bearings, resilient faced plug and flanged ends.

4.14.15 Isolation Gates

Design standard for gates shall be IS-3042 or Equivalent (subject to approval by Purchaser).

The gates shall be rectangular or square sluice, rising spindle type conforming to class-1 of IS-3042.

Material of Construction

i.	Frame and Door	Cast Iron IS-210 Grade 20
ii.	Spindles, bolts & nuts	M.S. to IS-2062
iii.	Face & seat rings	Gun metal (as per IS-3042).

All the parts of gates shall be applied with the coats of heavy duty bitumastic paint.

Each of the gates shall be provided with handwheel, and a position indicator.

The gates for DM plant drains shall be rubber lined to a minimum thickness of 4.5 mm.

4.15.00 Strainers
4.15.01 Basket Strainers

- a) Basket strainers of simplex design shall have the following materials of construction for raw/clarified/filtered water application.

i.	Body	Fabricated mild steel : IS-2062 (Tested quality)
ii.	Strainers	Wire shall be stainless steel (AISI:316 18 BWG 30 mesh suitably reinforced. Reinforcement material shall also be of stainless steel construction.
iii.	Drain Plug / Nuts	Gun metal

- b) Inside and outside of basket body shall be protected with one coat of high build zinc phosphate primer and three coats of Chlorinated rubber paint to a total thickness of 200 microns.
- c) Suitable Vent and drain valves shall be provided for the strainers.
- d) Screen (strainer) flow area shall be at least four times pipe sectional area. Flow area in any portion of Basket strainer assembly shall not be less than the pipe cross sectional area.
- e) Pressure drop in clean condition shall not be more than 1.0 mwc at full flow.
- f) Basket Strainer shall be provided with lifting lugs and suitable mounting arrangement.
- g) For DM water service, body shall be rubber lined to minimum 4.5 mm thickness (soft rubber of shore Hardness $65 \pm 5^{\circ}A$).

4.15.02 Y-Type Strainer

- a) Y-Type strainer for water application shall be constructed of following materials:

i.	Body	Cast Iron IS-210 Grade FG 260
ii.	Strainers	Wires of stainless steel AISI-316, 18 BWG 30 mesh suitably reinforced. Reinforcement material shall also be of stainless steel construction.
iii.	Drain Plug / Nuts	Gun metal (threaded construction)

- b) Y-Type strainers shall also conform to Cl. 4.15.01 (b), (c), (d), (e) and (f).
- c) Body of the Y-type strainers of alkali, and demineralised water shall be of Cast Iron (IS-210 Grade FG 260) and lined with soft or hard rubber to a thickness of 3 mm.

- d) For acid services, apart from the rubber lined body material, the screen material, shall be Polypropylene or HDPE wire cloth of suitable mesh and thickness.

4.16.00 Resin Traps

The resin traps for the Ion exchange vessels shall be provided for the collection of Ion exchange resin shall conform to the following:

- 4.16.01 The body shall be of mild steel (IS-2062) and lined internally with rubber (Hard/Soft rubber), Saran or polypropylene. The internals (rod and screen) for all resin traps shall be of AISI-316 construction. All screen components shall be welded at each intersection of wire and support rod for good strength, Resin traps screen opening shall not exceed 120 percent of the associated process vessel under drain/backwash collection header nozzle screen opening and shall be suitably selected to retain even the minimum size of the resin selected for the process.

- 4.16.02 The resin traps shall be provided with a draining arrangement with a valve for collection of trapped resins. Resin trap body shall have lifting lug for easy handling during maintenance/erection.

4.17.00 General Requirements for Valves, Gates, Strainers and Resin traps

- 4.17.01 All the items shall be suitable for service conditions i.e. flow, temperature and pressure to which they may be subjected to.

- 4.17.02 All the items shall be of proven design for the duty conditions and the Bidder or manufacturer shall have sufficient experience in using the above equipment in water treatment application in the plants supplied earlier by them.

- 4.17.03 In case Purchaser desires, the experience list/feedback from the users shall be made available to Purchaser for any or all the equipments during the detailed engineering phase.

- 4.17.04 Valves will be used to start/stop or control flow. Gates will be primarily used for isolation of flow in open channels although these should be capable of throttling the flow too. Sample valves will be used in sample collection lines.

- 4.17.05 All valves shall be suitable for service conditions i.e. flow, temperature and pressure under which they are required. All the valves shall be of standard pressure rating of the applicable design code / standard. Non standard pressure rating shall not be accepted. The pressure and temperature rating of the valve shall not be less than the maximum expected pressure and temperature plus 5% additional margin of the system in which valves are proposed to be installed.

- 4.17.06 Valves pressure classes, sizes, types, body materials, and end preparation shall generally be as described herein, unless mentioned otherwise elsewhere in Bid Specification. All valves shall conform to the requirements of the governing codes, and the requirements specified.

- 4.17.07 Valves (including safety, relief and control valves) body materials shall be compatible with the piping with which they are used. If the body material is not of the same type as the material of the connecting pipe work, the valves shall be fitted with suitable welding nozzles to avoid dissimilar butt welds at site.

- 4.17.08 Each modulating control valve shall be provided with isolation valves. Manual bypass valve shall be provided for each modulating control valve to achieve safe and reliable manual operation.
- 4.17.09 All the actuators of the valves shall be designed to handle the maximum expected pressure differential across the valves and to overcome friction forces and unbalance forces due to the flow through valve.
- 4.17.10 Valve bodies and bonnets shall be designed to support the valve operators (handwheel, gear, or motor) with the valve in any position without external support.
- 4.17.11 Valve ends and size limitations are as follows:
- a) 50mm NB and smaller valves - Class 800 minimum with socket weld ends. (For instruments connections/ isolation valves screwed ends may be acceptable)
 - b) 65mm NB and larger size valves - Class 150 minimum (butt-weld ends or flanged or wafer style).
 - c) Flanged steel butterfly valves - 750mm and larger size; pressure class per AWWA / BS-5155.
- 4.17.12 Gate, globe and angle valves shall be outside stem and yoke construction.
- 4.17.13 Valves sizes 65 mm NB and larger shall have a non-rising handwheel.
- 4.17.14 All the actuator operated valves shall be fitted with handwheel for manual operation. The pneumatic actuators shall be selected based on the available air pressure and operating air pressure (maximum and minimum). The supporting calculations for selection of actuators shall be furnished for Purchaser's approval before finalization of all the actuators.
- 4.17.15 Valves coming under the purview of IBR if any shall meet its requirements and the approval of the same shall be obtained by the Bidder.
- 4.17.16 Sizes of the valves shall be same as that of the interconnected pipe sizes except for the control valves.
- 4.17.17 The various items shall be installed such so that they are easily approachable for the operating and maintenance personnel. All valves shall be accessible without chain pulls, as far as possible. Generally Valves shall be located about 1.2 meter to 1.5 meter from the operating platform and also they shall not be located below the ground level such as beneath the trenches etc. In such cases, extended spindle shall be provided with chain operating from operating floor. Valves which are installed below the ground floor shall be provided with a floor mounted pedestal at the top of the operating floor. Valves which are installed below the ground floor shall be provided with a floor mounted pedestal at the top of the operating floor. The position indicator for such valves shall be also provided along with the stand.
- 4.17.18 All valves shall be provided with hand wheels. Wherever necessary, chain operator shall be provided so that the valve may be operated from the ground floor.
- 4.17.19 All valves shall be provided with cast heat marks on casting of Body and Bonnet.

- 4.17.20 Whenever screwed valves will be installed in a pipe line, it will always be followed by screwed three piece union of same material as that of pipe.
- 4.17.21 Short pieces used for welding of different pipe fittings and valves shall not be less than 80 mm in length.
- 4.17.22 However valves which are provided (in the buried pipe line) with a valves chamber shall have manual operator/Handwheel inside the valve chamber. The valve chamber shall be provided with built in ladders/staircases and sufficient operating space within the chamber shall also be provided for easy operation of such valves.
- 4.17.23 All the valves, strainers, resin traps etc. shall be provided with external painting as that of the interconnected piping as specified in Clause 3.03.14 above. However, surfaces such as Stainless Steel, aluminium, copper, brass, bronze and other non-ferrous materials shall not be painted. No paint or filter shall be applied until all repairs, hydrostatic tests and final shop inspections are completed, but shall be applied prior to shipment.
- 4.18.00 Rubber Expansion Joint
- 4.18.01 The inner cover (i.e. the tube) and also the outer cover shall be made up of natural or synthetic rubber of adequate thickness. The carcass between the tube and the cover shall be made up of high quality cotton and rayon cord having suitable number of plies and impregnated with rubber or synthetic compounds. Moreover, to ensure adequate strength, reinforcements consisting of metal rings embedded in the carcass, shall be provided.
- 4.18.02 In all cases, the expansion joints shall be integral flanges at both ends complete with split retaining rings.
- 4.18.03 Each of the expansion joint shall be provided with adequate number of limit rod assemblies which shall be tightened after erection of the entire suction branch of the pumps, in order to avoid transmittal of undue pressure thrust on to the pump foundation. Each of these limit rod assemblies shall consist of a long bolt and two connecting plates which are, in turn securely bolted to opposite flanges. Each plate is to be drilled with three holes, two for bolting to the flange, the third for passage of the stretcher belt. Rubber washers backed with metal washer shall be placed under the head of the bolt and under the nut.
- 4.19.00 Protective Lining and Painting
- The supply and application of Protective Lining and Painting with reference to Piping, Fittings and Valves need to be as per **Sub Section: Section-XIII of V.III-C-Technical Specification for Protective Lining and Painting**, attached herewith.
- 5.00.00 **TESTS AND INSPECTION**
- 5.01.00 Tests & Inspection for Pipes and Fittings
- 5.01.01 Shop Tests
- Shop test shall include all tests to be carried out at supplier's work, works of sub

suppliers and at works where raw materials supplied for manufacture of equipment are produced. The supplier shall carryout a comprehensive inspection and testing program during manufacture at works. Necessary Manufacturing and Field Quality Plans shall be prepared by supplier and submitted for approval by Purchaser for all checks conducted on raw materials, fabrication etc.

Calibrated instruments required for measuring / testing of pipes shall be arranged by manufacturer at their works during inspection.

Purchaser shall be given full access to all tests. The manufacturer shall inform Purchaser of the testing well in advance so that Purchaser at own option may witness the test.

All the test certificates and reports shall be submitted to Purchaser for approval.

All the mechanical and chemical tests including optional tests if any as per the applicable codes / standards shall be carried out and the test certificates for the same shall be submitted for approval by Purchaser. Material Certificate shall be furnished for each grade / lot of pipes. All material test certificates shall carry material specification, size, class, length, chemical composition, physical properties and heat number or other acceptable reference to enable correlation of the certificate with the pipe. IBR / CCE / TAC approval certificates / any other statutory approval certificates as required shall be furnished.

Welding procedure and welder performance qualifications shall be carried out. Mechanical and chemical tests shall be carried out as per code. Spot radiography check shall be carried out for all butt welds. D.P.T shall be carried out for all root run welds. Segmented flanges exceeding 30 mm thickness shall be stress relieved. Tensile test, eddy current test, bend test, flattening test and dimensional checks as per applicable code shall be carried out.

All rubber lining is to be subjected to the following tests as per IS-4682 Part I:

- a) Adhesion test.
- b) Tests to check resistance to bleeding.
- c) Measurement of thickness of lining.
- d) Shore hardness test.
- e) Spark test at High voltage 5 KV / mm of thickness.

Galvanizing shall be carried out as per IS-4736 / IS-2629 and tested as per IS-2633 / BS- 729. The test shall include weight of coating, uniformity of thickness and adhesion test.

All pipes and fittings shall be subjected to hydraulic tests as per applicable code / standard. When rubber lined, hydraulic tests shall be carried out before and after rubber lining.

Buried pipes where wrapping and coating is done, material for wrapping and coating shall be tested as per applicable code. Procedure for wrapping and coating and its testing shall be submitted for approval by Purchaser. Entire wrapping and coating shall be checked for thickness and Holiday test. Peel test shall be done to ensure

proper bonding of coating to surface.

5.01.02 Site Test

Hydraulic tests of the piping system at 1.5 times the design pressure or twice the working pressure whichever is higher shall be carried out for a period of minimum 30 minutes. However, if the Code / standard of supplied piping specifies more stringer requirements than the above criteria, then the hydraulic tests shall be conducted as per the applicable piping code / standard.

Pneumatic tests shall be carried out for all pressure piping that shall not be subjected to water filling.

The Bidder shall make all temporary closures/connections as required for hydro-static/pneumatic testing and clean/remove the same after successful completion of the test.

The procedure for hydro test and pneumatic test shall be submitted by the Bidder for review and approval by Purchaser.

All tests as indicated in FQP approved by Purchaser shall also be carried out.

5.02.00 Tests & Inspection for Valves / Gates / Strainers

5.02.01 Shop Tests

Chemical composition of all material, castings, forgings, etc. shall be tested for various components of the valves, gates, strainers and test certificates shall be submitted for approval by Purchaser.

Mechanical tests including optional tests if any shall be performed as per the applicable code / standard and the test certificates for the same shall be submitted for approval by Purchaser. The performance requirements of the valves shall also be tested as per the applicable code / standard.

Elastomer wherever coated or lined for the valves shall be tested for the corrosion resistance against the medium for which those are selected as per applicable code / standard and the test certificates shall be furnished for approval by Purchaser.

Rubber lining on Valves / Gates / Strainers / Resin Traps shall be checked in accordance with IS-4682 Part I including Spark Testing at high voltage (5 KV/mm of thickness).

All the valves shall be hydraulically tested for the body, seat, back seat and all valves shall be pneumatically tested for seat as per the applicable code / standard to which these are designed irrespective of the working pressure for which valves are selected.

Wherever specifically required, pressure drop across each type and each size of the valve at various flows shall be conducted, and test reports shall be submitted for approval by Purchaser. Type test report for this test (if already carried out by the manufacturer) may be submitted to fulfill this requirement.

Gates shall be tested against leakage and strength as required in the code / standard.

Strainer shall be hydraulically tested its strength and the pressure drop across the strainer assembly shall be verified at design flow for clean condition.

5.02.02 Site Tests

All valves, gates, resin traps, strainers and other fittings after erection at site shall be tested to hydraulic test pressure of two times the operating pressure or 1.5 times the maximum allowable pressure whichever is higher for a period of 120 minutes.

All valves / gates (Manual / Automatic) shall be operated throughout 100% of the travel manually and as well as from control panel and these should function without any trouble whatsoever.

**TITLE**

**4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 1 of 1

SECTION – D2

**STANDARD TECHNICAL REQUIREMENTS
ELECTRICAL**

FILE.

SPECIFICATION NO.

GENERAL TECHNICAL REQUIREMENTS

PE-SS-999-506-E101

FOR

VOLUME NO. : **II-B**

LV MOTORS

REV NO. : **00** DATE : 29/08/2005

SHEET : 1 OF 1

GENERAL TECHNICAL REQUIREMENTS

FOR

LV MOTORS

SPECIFICATION NO.: PE-SS-999-506-E101 Rev 00



GENERAL TECHNICAL REQUIREMENTS

FOR

LV MOTORS

SPECIFICATION NO.
PE-SS-999-506-E101

VOLUME NO. : II-B

SECTION : D

REV NO. : 00 DATE : 29/08/2005

SHEET : 1 OF 4

1.0 INTENT OF SPECIFICATION

The specification covers the design, materials, constructional features, manufacture, inspection and testing at manufacturer's work, and packing of Low voltage (LV) squirrel cage induction motors along with all accessories for driving auxiliaries in thermal power station.

Motors having a voltage rating of below 1000V are referred to as low voltage (LV) motors.

2.0 CODES AND STANDARDS

Motors shall fully comply with latest edition, including all amendments and revision, of following codes and standards:

IS:325	Three phase Induction motors
IS : 900	Code of practice for installation and maintenance of induction motors
IS: 996	Single phase small AC and universal motors
IS: 4722	Rotating Electrical machines
IS: 4691	Degree of Protection provided by enclosures for rotating electrical machines
IS: 4728	Terminal marking and direction of rotation rotating electrical machines
IS: 1231	Dimensions of three phase foot mounted induction motors
IS: 8789	Values of performance characteristics for three phase induction motors
IS: 13555	Guide for selection and application of 3-phase A.C. induction motors for different types of driven equipment
IS: 2148	Flame proof enclosures for electrical appliance
IS: 5571	Guide for selection of electrical equipment for hazardous areas
IS: 12824	Type of duty and classes of rating assigned
IS: 12802	Temperature rise measurement for rotating electrical machines
IS: 12065	Permissible limits of noise level for rotating electrical machines
IS: 12075	Mechanical vibration of rotating electrical machines

In case of imported motors, motors as per IEC-34 shall also be acceptable.

3.0 DESIGN REQUIREMENTS

3.1 Motors and accessories shall be designed to operate satisfactorily under conditions specified in data sheet-A and Project Information, including voltage & frequency variation of supply system as defined in Data sheet-A

3.2 Motors shall be continuously rated at the design ambient temperature specified in Data Sheet-A and other site conditions specified under Project Information
Motor ratings shall have at least a 15% margin over the continuous maximum demand of the driven equipment, under entire operating range including voltage & frequency variation specified above.

3.3 Starting Requirements

3.3.1 Motor characteristics such as speed, starting torque, break away torque and starting time shall be properly co-ordinated with the requirements of driven equipment. The accelerating torque at any speed with the minimum starting voltage shall be at least 10% higher than that of the driven equipment.

3.3.2 Motors shall be capable of starting and accelerating the load with direct on line starting without exceeding acceptable winding temperature.



GENERAL TECHNICAL REQUIREMENTS

FOR

LV MOTORS

SPECIFICATION NO. PE-SS-999-506-E101

VOLUME NO. : II-B

SECTION : D

REV NO. : 00 DATE : 29/08/2005

SHEET : 2 OF 4

The limiting value of voltage at rated frequency under which a motor will successfully start and accelerate to rated speed with load shall be taken to be a constant value as per Data Sheet - A during the starting period of motors.

3.3.3 The following frequency of starts shall apply

- i) Two starts in succession with the motor being initially at a temperature not exceeding the rated load temperature.
- ii) Three equally spread starts in an hour the motor being initially at a temperature not exceeding the rated load operating temperature. (not to be repeated in the second successive hour)
- iii) Motors for coal conveyor and coal crusher application shall be suitable for three consecutive hot starts followed by one hour interval with maximum twenty starts per day and shall be suitable for minimum 20,000 starts during the life time of the motor

3.4 Running Requirements

3.4.1 Motors shall run satisfactorily at a supply voltage of 75% of rated voltage for 5 minutes with full load without injurious heating to the motor.

3.4.2 Motor shall not stall due to voltage dip in the system causing momentary drop in voltage upto 70% of the rated voltage for duration of 2 secs.

3.5 Stress During bus Transfer

3.5.1 Motors shall withstand the voltage, heavy inrush transient current, mechanical and torque stress developed due to the application of 150% of the rated voltage for at least 1 sec. caused due to vector difference between the motor residual voltage and the incoming supply voltage during occasional auto bus transfer.

3.5.2 Motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torque under above condition.

3.6 Maximum noise level measured at distance of 1.0 metres from the outline of motor shall not exceed the values specified in IS 12065.

3.7 The max. vibration velocity or double amplitude of motors vibration as measured at motor bearings shall be within the limits specified in IS: 12075.

4.0 CONSTRUCTIONAL FEATURES

4.1 Indoor motors shall conform to degree of protection IP: 54 as per IS: 4691. Outdoor or semi-indoor motors shall conform to degree of protection IP: 55 as per IS: 4691 and shall be of weather-proof construction. Outdoor motors shall be installed under a suitable canopy

4.2 Motors upto 160KW shall have Totally Enclosed Fan Cooled (TEFC) enclosures, the method of cooling conforming to IC-0141 or IC-0151 of IS: 6362.

Motors rated above 160 KW shall be Closed Air Circuit Air (CACA) cooled

4.3 Motors shall be designed with cooling fans suitable for both directions of rotation.



GENERAL TECHNICAL REQUIREMENTS

FOR
LV MOTORSSPECIFICATION NO.
PE-SS-999-506-E101

VOLUME NO. : II-B

SECTION : D

REV NO. : 00 DATE : 29/08/2005

SHEET : 3 OF 4

- 4.4. Motors shall not be provided with any electric or pneumatic operated external fan for cooling the motors.
- 4.5. Frames shall be designed to avoid collection of moisture and all enclosures shall be provided with facility for drainage at the lowest point.
- 4.6. In case Class 'F' insulation is provided for LV motors, temperature rise shall be limited to the limits applicable to Class 'B' insulation.
In case of continuous operation at extreme voltage limits the temperature limits specified in table-1 of IS:325 shall not exceed by more than 10°C.
- 4.7. **Terminals and Terminal Boxes**
- 4.7.1 Terminals, terminal leads, terminal boxes, windings tails and associated equipment shall be suitable for connection to a supply system having a short circuit level, specified in the Data Sheet-A.
- Unless otherwise stated in Data Sheet-A, motors of rating 110 kW and above will be controlled by circuit breaker and below 110 kW by switch fuse-contactor. The terminal box of motors shall be designed for the fault current mentioned in data sheet "A".
- 4.7.2 unless otherwise specified or approved, phase terminal boxes of horizontal motors shall be positioned on the left hand side of the motor when viewed from the non-driving end.
- 4.7.3 Connections shall be such that when the supply leads R, Y & B are connected to motor terminals A B & C or U, V & W respectively, motor shall rotate in an anticlockwise direction when viewed from the non-driving end. Where such motors require clockwise rotation, the supply leads R, Y, B will be connected to motor terminals A, C, B or U W & V respectively.
- 4.7.4 Permanently attached diagram and instruction plate made preferably of stainless steel shall be mounted inside terminal box cover giving the connection diagram for the desired direction of rotation and reverse rotation.
- 4.7.5 Motor terminals and terminal leads shall be fully insulated with no bar live parts. Adequate space shall be available inside the terminal box so that no difficulty is encountered for terminating the cable specified in Data Sheet-A.
- 4.7.6 Degree of protection for terminal boxes shall be IP 55 as per IS 4691.
- 4.7.7 Separate terminal boxes shall be provided for space heaters.. If this is not possible in case of LV motors, the space heater terminals shall be adequately segregated from the main terminals in the main terminal box. Detachable gland plates with double compression brass glands shall be provided in terminal boxes.
- 4.7.8. Phase terminal boxes shall be suitable for 360 degree of rotation in steps of 90 degree for LV motors.
- 4.7.9 Cable glands and cable lugs as per cable sizes specified in Data Sheet-A shall be included. Cable lugs shall be of tinned Copper, crimping type.
- 4.8 Two separate earthing terminals suitable for connecting G.I. or MS strip grounding conductor of size given in Data Sheet-A shall be provided on opposite sides of motor frame. Each terminal box shall have a grounding terminal.



GENERAL TECHNICAL REQUIREMENTS

FOR

LV MOTORS

PE-SS-999-506-E101

VOLUME NO. : **II-B**

SECTION : **D**

REV NO. : **00** DATE : 29/08/2005

SHEET : 4 OF 4

- 4.9.1 Motors provided for similar drives shall be interchangeable.
- 4.9.2 Suitable foundation bolts are to be supplied alongwith the motors.
- 4.9.3 Motors shall be provided with eye bolts, or other means to facilitate safe lifting if the weight is 20Kgs. and above.
- 4.9.4 Necessary fitments and accessories shall be provided on motors in accordance with the latest Indian Electricity rules 1956.
- 4.9.5 All motors rated above 30 kW shall be provided with space heaters to maintain the motor internal air temperature above the dew point. Unless otherwise specified, space heaters shall be suitable for a supply of 240V AC, single phase, 50 Hz.
- 4.9.6 Name plate with all particulars as per IS: 325 shall be provided
- 4.9.7 Unless otherwise specified, the colour of finish shall be grey to Shade No. 631 and 632 as per IS:5 for motors installed indoor and outdoor respectively. The paint shall be epoxy based and shall be suitable for withstanding specified site conditions.

5.0 INSPECTION AND TESTING

- 5.1 All materials, components and equipments covered under this specification shall be procured, manufactured, as per the BHEL standard quality plan No. PED-506-00-Q-006/0 and PED-506-00-Q-007/2 enclosed with this specification and which shall be complied.
- 5.2 LV motors of type-tested design shall be provided. Valid type test reports not more than 5 year shall be furnished. In the absence of these, type tests shall have to be conducted by manufacturer without any commercial implication to purchaser.
- 5.3 All motors shall be subjected to routine tests as per IS: 325 and as per BHEL standard quality plan.
- 5.4 Motors shall also be subjected to additional tests, if any, as mentioned in Data Sheet A.

6.0 DRAWINGS TO BE SUBMITTED AFTER AWARD OF CONTRACT

- a) OGA drawing showing the position of terminal boxes, earthing connections etc.
- b) Arrangement drawing of terminal boxes.
- c) Characteristic curves:
(To be given for motor above 55 kW unless otherwise specified in Data Sheet).
 - i) Current vs. time at rated voltage and minimum starting voltage.
 - ii) Speed vs. time at rated voltage and minimum starting voltage.
 - iii) Torque vs. speed at rated voltage and minimum voltage.
For the motors with solid coupling the above curves i), ii), iii) to be furnished for the motors coupled with driven equipment. In case motor is coupled with mechanical equipment by fluid coupling, the above curves shall be furnished with and without coupling.
 - iv) Thermal withstand curve under hot and cold conditions at rated voltage and max. permissible voltage.

	TITLE LV MOTORS <u>DATA SHEET-A</u> 4 X 270 MW TSGENCO BHADRADRI TPS	SPECIFICATION NO.	
		VOLUME	II B
		SECTION	D
		REV. NO.	DATE 18.12.14
		SHEET 1	OF 2

1.0	Design ambient temperature	:	50 °C	
2.0	Maximum acceptable kW rating of LV motor	:	160KW *	
3.0	Installation (Indoors/ Outdoors)	:	As required	
4.0	Details of supply system			
	a)	Rated voltage (with variation)	:	415V ± 10%
	b)	Rated frequency (with variation)	:	50 Hz + 3 % to - 5%
	c)	Combined voltage & freq. variation	:	10% (sum of absolute values)
	d)	System fault level at rated voltage	:	50 kA for 1 sec
	e)	Short time rating for terminal boxes		
		o 110 kW and above (Breaker Controlled)	:	50 KA for 0.20 sec..
		o Below 110 kW (Contactor Controlled)	:	50 KA protected by HRC fuse
	f)	LV System grounding	:	Solidly
5.0	Class of insulation	:	Class 'F', with temp rise limited to class B.	
6.0	Minimum voltage for starting (As percentage of rated voltage)	:	(a) 85% below 110KW (b) 80% from 110KW to 160KW (c) 85% above 160KW to 1000KW (d) 80% from 1001 KW to 4000KW (e) 75% > 4000KW	
7.0	Power cables data	:	Shall be given during detailed engg.	
8.0	Earth Conductor Size & Material	:	As per attached Datasheet of Earthing.	
9.0	Space heater supply	:	240 V, 1ϕ, 50 Hz (for motors above 30 Kw)	
10.0	Rating up to which Single phase motor	:	Acceptable below 0.20 kW	
11.0	Locked rotor current			
	a)	Limit as percentage of FLC	:	As per IS 12615*
12.0	Flame-proof motor			
	a)	Enclosure suitable (As per IS: 2148)	:	As per requirement
	b)	Classification of Hazardous area (As per IS: 5572 part-I)	:	As per requirement
13.0	Makes	:	BHEL/ Customer approval	
14.0	Paint shade	:	Shall be given during detailed engg	
15.0	Degree Of protection for motor/ terminal box	:	IP 54/ IP 55	

	TITLE LV MOTORS <u>DATA SHEET-A</u> 4 X 270 MW TSGENCO MANUGURU TPS	SPECIFICATION NO.	
		VOLUME	II B
		SECTION	D
		REV NO.	DATE 18.12.14
		SHEET 1	OF 2

* Continuous duty LT motors up to 160 KW Output rating (at 50 deg.C ambient temperature), shall be High efficiency (IE2) as per IEC: 60034-30/ IS:12615

16.0 TESTING

16.1 Type Tests

For LT Motors above 55kW, type test reports for type tests as per IS: 325/ IS: 12615 conducted on equipment similar to those proposed to be supplied and carried out within last five years from the date of bid opening shall be submitted. However, if such reports are not available, one motor of each type shall be subjected to type tests for free of cost.

16.2 Routine Tests

All motors shall be subjected to routine tests as per IS: 325/ IS: 12615 in the presence of customer or customer representative.

THIS IS A PART OF TECHNICAL SPECIFICATION NO. PE-TS-411-158-A-001		Specification No.
MOTOR		VOLUME II B
DATA SHEET - C		SECTION D
		REV NO.00 DATE
		SHEET 1 OF 2

S. No.	Description		Data to be filled by successful bidder
A.	General		
1	Manufacturer & country of origin		
2	Motor type		
3	Type of starting		
4	Name of the equipment driven by motor & Quantity		
5	Maximum Power requirement of driven equipment		
6	Rated speed of Driven Equipment		
7	Design ambient temperature		
B.	Design and Performance Data		
1	Frame size & type designation		
2	Type of duty		
3	Rated Voltage		
4	Permissible variation for		
5	a	Voltage	
6	b	Frequency	
7	c)	Combined voltage & frequency	
8	Rated output at design ambient temp (by resistance method)		
9	Synchronous speed & Rated slip		
10	Minimum permissible starting voltage		
11	Starting time in sec with mechanism coupled		
12	a) At rated voltage		
13	b) At min starting voltage		
14	Locked rotor current as percentage of FLC (including IS tolerance)		
15	Torque		
	a) Starting		
	b) Maximum		
16	Permissible temp rise at rated output over ambient temp & method		
17	Noise level at 1.0 m (dB)		
18	Amplitude of vibration		
19	Efficiency & P.F. at rated voltage & frequency		
	a) At 100% load		
	c) At 75% load		

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

THIS IS A PART OF TECHNICAL SPECIFICATION NO. PET-411-158-A-001		Specification No.
MOTOR		VOLUME II B
DATA SHEET - C		SECTION D
		REV NO.00 DATE
		SHEET 2 OF 2

S. No.	Description	Data to be filled by successful bidder
	c) At starting	
C.	Constructional Features	
1	Method of connection of motor driven equipment	
2	Applicable Standard	
3	DOP of Enclosure	
4	Method of cooling	
5	Class of insulation	
6	Main terminal box	
	a) Type	
	b) Power Cable details (Conductor, size, armour/unarmour)	
	c) Cable Gland & lugs details (Size, type & material)	
	d) Permissible Fault level (kArms & duration in sec)	
7	Space heater details (Voltage & watts)	
8	Flame proof motor details (if applicable)	
	a) Enclosure	
	b) suitability for hazardous area	
	i Zone	O / I / II
	ii Group	IIA / IIB / IIC
9	No. of Stator winding	
10	Winding connection	
11	Kind of rotor winding	
12	Kind of bearings	
13	Direction of rotation when viewed from NDE	
14	Paint Shade & type	
15	Net weight of motor	
16	Outline mounting drawing No (To be enclosed as annexure)	
D.	Characteristic curves/ drawings (To be enclosed for motors of rating $\geq 55KW$)	
	a) Torque speed characteristic	
	b) Thermal withstand characteristic	
	c) Current vs time	
	d) Speed vs time	

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			



TITLE

4 X 270 MW BHADRADRI TPS TECHNICAL SPECIFICATION FOR PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 1 of 2

Explanatory notes for filling up cable list for routing.

- For the purpose of clarity, it may please be noted that the information given in regard to the cables to be routed through WinPath as per the system elaborated below is called "Cable List", while the term "Cable Schedule" applies to the cable list with routing information added after routing has been carried out.
- The cable list shall be entered as an MS Excel file in the format as per enclosed template EXT_CAB_SCH_FORMAT.XLS. No blank lines, special characters, header, footer, lines, etc. shall be introduced in the file. No changes shall be made in the title line (first line) of the template.
- The field properties shall be as under:
 - UNITCABLENO: A/N, up to sixteen (16) characters; each cable shall have its own unique, unduplicated cable number. In case this rule is violated, the cable cannot be taken up for routing.
 - FROM: A/N, up to sixty (60) characters; the "From" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
 - TO: A/N, up to sixty (60) characters; the "To" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
 - PURPOSE: A/N, up to sixty (60) characters; the purpose (i.e. power cable/ indication/ measurement, etc.) to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
 - REMARKS: A/N, up to forty (40) characters; Any information pertinent to routing to be specified here (e.g., cable number of the cable redundant to the cable number being entered). Information in excess of 40 characters will be truncated after 40 characters.
 - CABLESIZE: A/N, 7 characters exactly as per the codes indicated below shall be specified here. The program cannot route cables described in any other way/ format.
 - PATHCABLENO: Field reserved for utilization by the program. User shall not enter any information here.
- One list shall be prepared for each system/ equipment (i.e., separate and unique cable lists shall be prepared for each system).
- The cables shall be described as per the scheme listed below:

A	NN	A	NNN
Cable	No. of cores	Cable code	Cable size
Voltage (e.g. 01,03,3H, 07)	(See C below)	(e.g. 035,185,2.5, 0.5)	
Code (see B below)			

- (A) SYSTEM VOLTAGE CODES:
 (ac) A = 11KV, B = 6.6KV, C = 3.3KV, D = 415V, E = 240V, F = 110V
 (dc) G = 220V, H = 110V, J = 48V, K = +24V, L = -24V

- (B) CABLE VOLTAGE CODES:
 A = 11KV (Power cables)
 B = 6.6KV (Power cables)
 C = 3.3KV (Power cables)
 D = 1.1KV (LV & DC system power & control cables)
 E = 0.6KV (0.5 sq. mm. Control cables)

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT****SPECIFICATION NO.**

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 2 of 2

(C) CABLE CODES**PVC Copper**A = Armoured FRLS
C = unarmoured FRLSB = Armoured Non-FRLS
D = Unarmoured Non-FRLS**PVC Aluminium**E = Armoured FRLS
G = unarmoured FRLSF = Armoured Non-FRLS
H = Unarmoured Non-FRLS**XLPE Copper**J = Armoured FRLS
L = unarmoured FRLSK = Armoured Non-FRLS
M = Unarmoured Non-FRLS**XLPE Aluminium**N = Armoured FRLS
Q = unarmoured FRLSP = Armoured Non-FRLS
R = Unarmoured Non-FRLSS = FIRE SURVIVAL CABLES
T = TOUGH RUBBER SHEATH
U = OVERALL SCREENED
V = PAIRED OVERALL SCREENED
W = PAIRED INDIVIDUAL SCREENED
Y = COMPENSATING CABLES
I = PRE-FABRICATED CABLES**Z = JELLY FILLED CABLES**

**TITLE**

4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

SHEET 1 of 1

SECTION – D3
STANDARD TECHNICAL REQUIREMENTS
CONTROL AND INSTRUMENTATION

	TITLE: SPECIFICATION FOR PROGRAMMABLE LOGIC CONTROLLER SYSTEM	SPECIFICATION NO. PES-145-36	
		VOLUME II-B	
		SECTION D	
		REV. NO. 03	DATE: 18.03.2014
		SHEET 1	OF 11

1. SCOPE

This specification covers the Design, Manufacture, Assembly, Inspection and Testing at manufacturer's works, proper packing and delivery to site, erection & commissioning, site acceptance test of the PLC Control & Monitoring System comprising PLC Control panel/Remote I/O panel (housing Processors, I/O cards, power supply packs etc.), Operator workstations(OWS), Printers, Annunciation system, UPS, cables and all other equipment and accessories required for completeness of the system as mentioned in different sections of this specification.

2. GENERAL

- 2.1. The offered PLC shall be of Industrial Grade and from Original Equipment manufacturer (OEM).
- 2.2. The PLC shall perform protection logic, interlock and sequential control functions such as binary logic operation, set/reset operation, timers, counters, logic blocks, math functions, input quality checking engineering unit conversion, Boolean functions & PID control (Analog logic function) etc.
- 2.3. The system shall be redundant in processor, power supply and communication interfaces unless otherwise specified. The control of all drives and equipment shall be effected through the keyboard/mouse / panel mounted push button / control switches as per Data sheets-A&B. The system shall include self-diagnostic features not limited to the following:-
 - Memory Faults, both PROM and EPROM
 - Processor Faults
 - Communication Faults
 - I/O interface or address faults
 - Voltage signal discrepancy on input and output
 - Power supply faults
 - Output loop check
 - Channel level diagnostics such as fault monitoring, contact bounce filtering etc.
 - Failure of main or I/O processor
- 2.4. The system shall have facility for connecting to Main Plant's Distributed control system (DCS) using hardware/software interface for two-way transfer of signals.
- 2.5. The mimic shall be displayed on the OWS screen and may also be provided on the control desk/panel (as per Datasheet).
- 2.6. In case OWS is provided, HMI functions like trends, curves, bar charts, historical storage of data, logs and reports etc. shall be provided in addition to Plant schematics. The necessary catalogue / literature elaborating the features of HMI shall be supplied along with the bid.
- 2.7. It shall be possible to use the same OWS as programming station.
- 2.8. The PLC system shall be sized to meet process/system requirements as per the approved P&IDs and Control write-up.
- 2.9. The PLC system shall be designed to ensure that no single device failure should result in failure of any other device.

	TITLE: SPECIFICATION FOR PROGRAMMABLE LOGIC CONTROLLER SYSTEM	SPECIFICATION NO. PES-145-36	
		VOLUME II-B	
		SECTION D	
		REV. NO. 03	DATE: 18.03.2014
		SHEET 2	OF 11

- 2.10. Signal multiplication where required shall be done in PLC. Use of relays for multiplication of contacts (for control, monitoring and alarm) is not acceptable. The control/ monitoring components on the control panel/ desk shall be driven through I/O modules.
- 2.11. Bidder shall provide all software on CDs along with required software licenses. The original CDs of installed operating & application software shall be maintained by bidder. Software modification and up gradation (as & when required) shall also be covered under the vendor scope without any cost implication.
- 2.12. PLC programming console shall be provided with industry proven antivirus software with perpetual license (free version not acceptable).

3. TECHNICAL REQUIREMENTS

Details of various PLC system components shall be inclusive of but not limited to the following:

3.1. CODES AND STANDARDS

- 3.1.1. The equipment covered under this specification shall meet the requirements of latest edition of all applicable codes and standards like ANSI, NEMA, IEEE, IEC, NEC & IS.
- 3.1.2. PLC shall conform to IEC: 61131
- 3.1.3. The offered PLC shall comply with safety standards as per Data sheet-A&B.

3.2. CONTROL PANEL

- 3.2.1. PLC control panel shall be freestanding type with provision for mimic display, push-button stations, control switches, indicating lamps, metering instruments like Indicators, ammeters etc. and facia windows for critical alarms.
- 3.2.2. The salient features of construction shall be:
- Sheet material: Cold rolled sheet steel
Frame thickness: Not less than 3.0mm
Enclosure thickness: Not less than 2.5 mm for load bearing sections (mounted with instruments) and not less than 1.6 mm for others
Gland plate thickness: 3.0mm
Base channel: ISMC 100 with anti-vibration mounting & foundation bolts.
- 3.2.3. Each panel shall be identified by a name plate, which shall be of non-rusting metal or three ply lamicold, with engraved lettering.

	TITLE: SPECIFICATION FOR PROGRAMMABLE LOGIC CONTROLLER SYSTEM	SPECIFICATION NO. PES-145-36	
		VOLUME II-B	
		SECTION D	
		REV. NO. 03	DATE: 18.03.2014
		SHEET 3	OF 11

- 3.2.4. Vendor shall indicate earthing details along with bid.
- 3.2.5. 25 x 6 mm Copper ground bus to be provided for each panel.
- 3.2.6. 240V AC single phase, thermostatically controlled space heaters shall be provided. Each free standing panel shall have a door switch operated fluorescent lamp and a 240V AC plug point.
- 3.2.7. Painting treatment shall be as per IS: 6005. Two coats of lead oxide primer shall be followed by powder coating. Paint shade shall be as specified in the "Data sheet for PLC system"-Data Sheet-A&B. Project specific paint shade, if applicable, shall be followed.
- 3.2.8. Panel internal wiring shall be as per NEC and NEMA standard.
- 3.2.9. TB points in terminal block shall be cage clamp type/screw type.
- 3.2.10. The annunciation system shall be facia window type, driven by the PLC. Audible alarm, Acknowledge, Reset and lamp test facility shall be provided as per ISA sequence – S18.1, M.

3.3. PROCESSORS

- 3.3.1. The microprocessors shall be 32 bit, and Hot redundant.
- 3.3.2. Hot redundancy: PLC shall be provided with two processors (Main processing unit and memories) one for normal operation and one as hot standby. In case of failure of working processor, there shall be an appropriate alarm and simultaneously the hot standby processor shall take over the complete operation automatically. This transfer from main processor to standby processor shall be bump less and shall not cause any disturbance whatsoever. In the event of both processors failing, the system shall revert to fail safe mode. It shall be possible to keep any of the processor as master and other as standby.
- 3.3.3. An authorized forcing facility shall be provided for changing the status of inputs and outputs, timers and flags to facilitate fault finding and other testing requirements.
- 3.3.4. The standby processor shall be updated automatically in line with the changes made in the working processor.
- 3.3.5. In the event of any replacement of the processor, synchronization of the replaced processor shall be automatic upon live insertion.
- 3.3.6. The cycle time for input scanning, execution of logics, overheads and output scan shall not exceed 120 m sec.
- 3.3.7. The processor & memory shall be loaded up to 50% at normal conditions and maximum up to 60% under worst loading conditions.
- 3.3.8. The memories shall be field expandable. Memory capacity shall be sufficient for complete system operation and have a capability for at least 20% expansion in future.
- 3.3.9. Memory shall be non-volatile, preferably EEPROM type. However, in case volatile memory is provided, battery backup shall be provided for a minimum of three months to keep the stored program intact. Battery drain indication shall be provided at least 1 week before the battery gets drained and same shall be annunciated in OWS.

	TITLE: SPECIFICATION FOR PROGRAMMABLE LOGIC CONTROLLER SYSTEM	SPECIFICATION NO. PES-145-36	
		VOLUME II-B	
		SECTION D	
		REV. NO. 03	DATE: 18.03.2014
		SHEET 4	OF 11

3.4. INPUT / OUTPUT Modules

3.4.1. Input/output card assignments shall be modular i.e. no single card shall be assigned with more than one drive of a particular sub-system. The maximum number of channels per I/O module shall be as follows.

- Analog Input Module: 16
- Analog Output Module: 16
- Binary Input Module: 32
- Binary Output Module: 32
- Analog Input/output combined: 16
- Binary Input/output combined: 32

3.4.2. On line module replacement (hot swappable): All modules cards shall have quick disconnect terminations allowing for card replacement without disconnection of external wiring and without switching off the power supply.

3.4.3. Each I/O shall be protected against the reversal of polarity of the power voltage to I/O.

3.4.4. 10% spare capacity shall be ensured in each card channel assignment. Overall minimum 20% spare channels shall be provided.

3.4.5. Output command to MCC/Switchgear shall be through coupling relays, whose mounting location shall be as per "Data sheet A & B for PLC System". In case coupling relays are located in PLC Panel, the same shall be in PLC vendor's scope of supply.

3.4.6. Status feedback from MCC shall be in the form of potential free contact.

3.5. DATA BUS/ I/O BUS

3.5.1. The Data bus connecting PLC and HMI work stations shall be TCP/IP on Ethernet.

3.5.2. The Data bus and I/O bus communication medium shall be twisted pair shield copper conductor for indoor locations and those areas not subjected to induced signals. Repeaters/signal amplifiers shall not be used. Copper conductor cable used shall be Category-5 or better. The communication medium shall be Fibre optic cable in the event any portion of communication cable run is in outdoor or where distances are beyond 500 meters.



TITLE:

SPECIFICATION FOR PROGRAMMABLE LOGIC CONTROLLER SYSTEM

SPECIFICATION NO. PES-145-36

VOLUME **II-B**SECTION **D**

REV. NO. 03

DATE: 18.03.2014

SHEET 5

OF 11

3.6. OPERATOR WORK STATION (OWS)

3.6.1. The OWS and Keyboard shall be desktop mounted and shall be used for controlling, monitoring and programming function.

3.6.2. Colour CRT(s) with keyboard and mouse shall be as per Data Sheet-A&B. CRT shall have graphic display facility.

3.6.3. The OWS shall be with Windows based operating system having necessary Engineering/Configuring software.

3.6.4 Specification of OWS

(a) CPU

1. Processor	32 Bit or better
2. Main Memory	Min. 1 GB and expandable to at least 4 GB
3. Hard drive	Min 40 GB
4. Floppy drive	3.5", 1.44 MB
5. Removable bulk storage	DVD (R/RW)
6. Graphic memory	Min. 16 MB
7. Auto controller	16 bit or better
8. Operating system	Window XP or better
9. Communication ports	2 serial, 1 parallel, 8 Nos. USB, Dual 100 MB Ethernet
10. Expansion slot	3 Nos. or more

(b) Monitor

1. Type	LCD colour monitor (TFT based)
2. Screen diagonal	22" (approx.) flat
3. Display	XGA or better
4. Degree of Protection	IP-30
5. External controls	Brightness, Contrast, Horizontal/vertical amplification & shift
6. Power supply	240 VAC, 50 Hz, 1 phase
7. Version	Industrial grade

(c) Keyboard & Mouse

1. Type	Flat spill membrane or positive depression type ASCII
2. Life expectancy	50 Million cycles per key
3. Version	Industrial
4. Mouse	Optical

3.7. PRINTER

Printers shall be provided as per Data Sheet-A&B.

	TITLE: SPECIFICATION FOR PROGRAMMABLE LOGIC CONTROLLER SYSTEM	SPECIFICATION NO. PES-145-36	
		VOLUME II-B	
		SECTION D	
		REV. NO. 03	DATE: 18.03.2014
		SHEET 6	OF 11

3.8. COMMUNICATION WITH PLANT DCS/ THIRD PARTY SYSTEM

- 3.8.1. The PLC system shall be provided with hardwired/serial interface for communication with plant DCS. Hardwired outputs from PLC shall be isolated. Necessary isolators shall be part of PLC.
- 3.8.2. Serial communication to / from DCS where provided shall be engineered to ensure that signal communication time from / to DCS shall not exceed 1 seconds for control / feedback.
- 3.8.3. Serial communication to DCS shall be OPC (Data access 2.0), Ethernet based TCP/IP Protocol. Alternatively the serial communication shall be MODBUS protocol on RS 485 network.
- 3.8.4. Data transmitted from PLC to DCS shall include all information necessary for the DCS graphic displays to monitor and control the process equipment and PLC. Such data may include pertinent analog and digital status information, interlock, alarms and maintenance conditions. Data transmitted from DCS to the PLC shall include necessary signals to provide operator control interface from DCS for the process/ equipment being controlled by PLC.
- 3.8.5. Bidder to include 'Light interface units, converters, Ethernet switch, accessories etc. at both ends viz PLC and DCS for connectivity to other system. The bidder's terminal point shall be Ethernet port in case of copper medium connection to DCS or LIU in case of Fiber optic medium for connectivity with plant DCS. In case distance between PLC & DCS is greater than 1.8 Km, single mode of optical fiber cable with compatible accessories shall be used. For distance less than 1.8 Km multimode optical fiber ports shall be used.

3.9. POWER SUPPLY Scheme

- 3.9.1. PLC Panel and I/O Cabinets: PLC system shall be provided with 2x100% UPS fed from Two Nos. redundant 415V, 3-ph feeders, as per the scheme PE-SD-999-145-001, sh-08 of 08. Each UPS shall have 30 minutes back up. Input feeder failure shall be monitored in the PLC system. Necessary redundant power pack and transformers shall be provided (in the PLC panel) to derive the power supply for control desk, PLC panel and input / output cabinets etc
- 3.9.2. Remote I/O panels: Similar power supply arrangement as for PLC panels shall be provided if it is not possible to extend the power cable form UPS of PLC panels.
- 3.9.3. Each OWS and associated HMI peripherals shall be provided with a feeder from Either one of the UPS

4. DRAWING/DOCUMENT AND DATA TO BE FURNISHED AFTER AWARD OF THE CONTRACT:

4.1. For Approval:

- PLC system configuration drawing along with functional write-up.
- Input/output signal list.
- BOM of PLC
- List of PLC controlled devices
- Control panel/control desk GA drawings.
- Control desk/panel component layout drawing.
- Control panel/control desk Foundation detail and cutout drawings.

	TITLE: SPECIFICATION FOR PROGRAMMABLE LOGIC CONTROLLER SYSTEM	SPECIFICATION NO. PES-145-36	
		VOLUME II-B	
		SECTION D	
		REV. NO. 03	DATE: 18.03.2014
		SHEET 7	OF 11

- Power distribution scheme.
- Block logic diagrams/ Ladder diagram mimic.
- Annunciation list.
- PLC control room layout drawing.
- List of soft signal exchange with Plant DCS.
- List of mandatory spares.
- UPS load calculation details.
- Quality plan
- FAT
- Data Sheet-C
- CRT display
- Power supply scheme for PLC system, HMI & peripherals, Remote I/O etc.

4.2. For Information:

- Cable schedule and cable interconnection drawing(in BHEL approved format)
 - Between Field and PLC
 - Between Field and MCC
 - Between MCC and PLC
- Electronic earthing requirements.
- Panel Heat dissipation data
- Product/component catalogues.
- Operation & Maintenance Manual on CDs.
- Softcopy of Final/As-built drawings on CDs.
- Calculation for Processor, Memory & Data bus loading

The above list is the minimum requirements. Additional documents/calculations required shall be finalized during contract stage.

5. DRAWINGS AND DOCUMENTS TO BE SUBMITTED ALONG WITH THE BID

- Proposed PLC system configuration drawing with write-up
- Product catalogues and specifications for PLC as well as HMI application.
- Proposed power supply schemes for PLC system, peripherals, and Remote I/O panels.

	TITLE: SPECIFICATION FOR PROGRAMMABLE LOGIC CONTROLLER SYSTEM	SPECIFICATION NO. PES-145-36	
		VOLUME II-B	
		SECTION D	
		REV. NO. 03	DATE: 18.03.2014
		SHEET 8	OF 11

6. TESTING AND INSPECTION

- 6.1. The bidder shall adopt suitable quality assurance program to ensure that the equipments offered will meet the specification requirements in full.
- 6.2. BHEL's standard Quality Plan for PLC is enclosed with the specification. The bidder shall furnish his acceptance to BHEL's QP and submit the signed and stamped copy of QP along with the offer.
- 6.3. The complete PLC system, including all instrument and devices shall be subjected to standard factory tests (i.e. Type Tests and Routine Tests) as per relevant IS, NEMA, IEEE, IEC.
- 6.4. Factory Acceptance Test-FAT (Functional Tests) shall be performed prior to shipment and Owner/Purchaser shall be notified 15 days before the schedules dates of the test.
- 6.5. The certificates for following type tests, as per IEC Standard, shall be submitted: -
 - Surge protection test as per IEC-225-4
 - Dry heat test as per IEC-68-2-2
 - Damp Heat test as per IEC-68-2-3
 - Vibration Heat test as per IEC-68-2-6
 - Electrostatic discharge test as per IEC-801-2 or equivalent
 - Radio frequency Immunity test as per IEC-801-6 or equivalent
 - Electromagnetic Immunity test as per IEC-801-3 or equivalent

7. SPARES AND CONSUMABLES

- 7.1. Commissioning Spares and consumables
 The bidder shall supply all commissioning spares and consumables 'as required' during Start-up, as part of the main equipment supply.
- 7.2. Mandatory Spares
 The bidder shall offer along with main offer, the Mandatory Spares as specified elsewhere in the specification. The Mandatory Spares offered shall be of the same make and type as the main equipment.
- 7.3. Recommended Spares
 The bidder shall furnish a list of Recommended Spares indicating the normal service expectancy period and frequency of replacement; quantities recommended for 3 years operation along with unit rate against each item to enable BHEL/BHEL's Customer to place a separate order later, if required.
- 7.4. Special Tools & Tackles
 The bidder shall supply all Special Tools & Tackles 'as required' during Start-up and further maintenance of the system, as part of the main equipment supply.
- 7.5. Spares, Service support
 Bidder shall provide availability of spares and service support for minimum 15 years after guarantee period.

	TITLE: SPECIFICATION FOR PROGRAMMABLE LOGIC CONTROLLER SYSTEM	SPECIFICATION NO. PES-145-36	
		VOLUME II-B	
		SECTION D	
		REV. NO. 03	DATE: 18.03.2014
		SHEET 9	OF 11

8. MARKING AND PACKING

8.1. Marking:

A stainless steel name-plate shall be permanently fixed on each equipment giving its Tag/serial Number and salient technical specification.

8.2. Packing:

All equipment/materials shall be suitably packed and protected for the entire period of dispatch, storage and erection against impact, abrasion, corrosion, incidental damage due to vermin, sunlight, high temperature, rain, moisture, humidity, dust, sea-water spray (where applicable) as well as rough handling and delays in transit and storage in open.

9. PERFORMANCE AND GUARANTEE

The PLC system shall be guaranteed to meet the performance requirement as specified and also for trouble-free continuous operation for 12 months from the date of commissioning or 18 months from the date of delivery at site whichever is later unless specified otherwise in Vol-II B Section - B or Section - C.

10. APPLICABLE DATA SHEET FORMS

This document shall be read with the following data sheet forms :

- Data Sheet A & B for PLC system - PE-DC-999-145-I036-1
- Data Sheet C for PLC system - PE-DC-999-145-I036-2



Technical specification for
CONTROL & INSTRUMENTATION

4 X 270 MW BHADRADRI TPS

SPEC NO.: **PE-TS-411-145-I**

VOLUME

SECTION

REV. NO.

00

DATE : 19.03.2015

SHEET

OF

PLC DATA SHEET

	DATA SHEET FOR PLC SYSTEM		SPECIFICATION NO.: PE-TS-411-	
			VOLUME II B	
			SECTION D	
			REV. NO. 00	DATE: 04.03.2015
			SHEET 1	OF 1
Data Sheet No.:				
Data Sheet A&B				
DATA SHEET – A FOR PLC SYSTEM (TO BE FILLED BY PURCHASER)			DATA SHEET – B FOR PLC SYSTEM (TO BE FILLED BY BIDDER)	
GENERAL	PROJECT	4X 270 MW BHADRADRI TPS		
	SERVICE			
	QUANTITY	☐ UNITISED ☒ COMMON		
	LOCATION	☒ INDOOR ☐ OUTDOOR ☒ AC ☐ NON-AC*		
PLC EQUIPMENT	MAKE / MODEL NO.	BIDDER TO INDICATE		
	PROCESSOR	REDUNDANT WITH HOT STANDBY		
	DATA BUS (HMI)	☐ COPPER WIRE ☐ FIBRE OPTIC		
	DATA BUS (I/O - CPU)	☐ COPPER WIRE ☐ FIBRE OPTIC		
	DATA BUS (REMOTE I/O - CPU)	☐ COPPER WIRE ☐ FIBRE OPTIC		
	FIELD CONTACTS INTERROGATION VOLTAGE	☒ 24 V DC ☐ 48 V DC ☐ 110 V AC		
	LOCATION OF COUPLING RELAYS	☐ MCC ☒ PLC PANEL		
	DESKTOP OWS QUANTITY	☐ ONE ☐ TWO ☐ _____ ☒ DESKTOP VERSION ☐ SERVER VERSION ☐ WORK STATION VERSION REQUIREMENT OF OWS IN CCR ☐ YES ☐ NO QUANTITY _____		
	DESKTOP MONITOR TYPE	☐ 19" ☒ 24" TFT/CRT MONITOR ☐ GIU ☐ OTHERS		
	PRINTER	INKJET ☐ A3 ___NOS ☐ A4 ___NOS LASER B/W ☐ A3 ___NOS ☐ A4 ___NOS COLOR INKJET ☐ A3 ___NOS ☐ A4 ___NOS COLOR LASER ☒ A3_1_NOS ☐ A4 ___NOS		
PROGRAMMING / CONFIGURATION FACILITY	A) ☐ HAND HELD ☒ LAPTOP B) ENGINEERING SOFTWARE ☐ ONE OWS ☐ ALL OWS ☐ LAPTOP			
SAFETY STANDARD	☐ SIL-3 ☐ SIL-2 ☒ NIL			
SPARE LIST	COMPUTER FURNITURE	BOQ ☒ YES ☐ NO INDUSTRIAL GRADE ☒ YES ☐ NO ☐ START UP & COMMISSIONING ☒ MANDATORY SPARE ☐ RECOMMENDED		
	SPARE LIST ATTACHED	☒ YES ☐ NO		
REDUNDANCY	CPU	☒ YES ☐ NO		
	POWER SUPPLY	☒ YES ☐ NO		
	COMMUNICATION	☒ YES ☐ NO		
	I/O CARD	☐ YES ☐ NO		
	OTHER ELECTRONICS	☐ YES ☐ NO		
		As per vendor practice		

	DATA SHEET FOR PLC SYSTEM		SPECIFICATION NO.: PE-TS-411-	
			VOLUME II B	
			SECTION D	
			REV. NO. 00	DATE: 04.03.2015
			SHEET 1	OF 1
Data Sheet No.:				
Data Sheet A&B				
DATA SHEET – A FOR PLC SYSTEM (TO BE FILLED BY PURCHASER)			DATA SHEET – B FOR PLC SYSTEM (TO BE FILLED BY BIDDER)	
No. of CHANNELS PER CARD	ANALOG INPUT	☒ 8 NOs ☐ 16 NOs		
	ANALOG OUTPUT	☒ 8 NOs ☐ 16 NOs		
	BINARY INPUT	☒ 16 NOs ☐ 32 NOs		
	BINARY OUTPUT	☒ 16 NOs ☐ 32 NOs		
	RTD**	4 NOs		
	THERMOCOUPLE**	8 NOs		
	ELECTRONIC CARD ISOLATION	☐ GALVANIC ☐ OPTICAL ☐ OTHER		
PANEL	QUANTITY	BIDDER TO INDICATE		
	CLASS OF PROTECTION(Refer Location of PLC)	☒ IP-42		
	REMOTE I/O PANEL	☒ YES ☐ NO AC REQUIREMENT ☒ YES ☐ NO		
	COLOUR#	RAL 7032		
	BACK-UP DESK	☐ YES ☒ NO		
	MIMIC	☐ YES ☒ NO IF YES, THEN ☐ PANEL MOUNTED GUI ☐ ACRYLIC		
	CONTROL HARDWARE	☐ PB ☐ INDICATORS ☒ FACIAS 25 Nos. ☐ OTHERS		
	CONFORMAL COATING	☐ YES ☒ NO		
COMMUNICATION WITH OTHER SYSTEM	HARDWIRED	☒ YES ☐ NO		
	PURPOSE	☐ CONTROL ☒ MONITORING		
	MEDIUM	☐ UTP ☒ FIBRE OPTIC ☐ OTHERS		
	TIME SYNCHRONIZATION SIGNAL FORMAT	☐ PULSE ☐ RS-485 ☒ IRIG-B ☐ NTP		
	SOFTLINK	☐ MODBUS ☒ OPC IF MODBUS THEN ☐ RS-485 ☐ ETHERNET		
	SERIAL LINK	COMMUNICATION PORT TYPE _____		
POWER SUPPLY INPUT FEEDER	PLC PANEL	BIDDER TO INDICATE LOAD DATA		
	REMOTE I/O PANEL	BIDDER TO INDICATE LOAD DATA		
POWER SUPPLY	SOURCE \$\$	☒ UPS(INDUSTRIAL GRADE) ☐ 24V DC CHARGER		
	BATTERY TYPE	☐ Ni-Cd ☒ LEAD ACID ☐ OTHERS		
	BACK-UP TIME	☐ 30 MINS ☒ 60 MINS ☐ OTHERS		
	BATTERY CONFIGURATION	☐ 1X100% ☒ 2X100% ☐ 2X50%		As per MAX philosophy
CUSTOMER TRAINING	TRAINING	☒ REQUIRED ☐ NOT REQUIRED		
	NO OF DAYS	3 DAYS		
	LOCATION	☐ VENDOR'S WORK ☐ PROJECT SITE ☐ OTHERS		

*IF THE LOCATION IS INDOOR, KINDLY SPECIFY IF PLC PANEL IS PLACED IN AC OR NON-AC ENVIRONMENT.

**SHALL NOT BE APPLICABLE IF TEMPERATURE TRANSMITTERS ARE ENVISAGED.

PROJECT SPECIFIC PAINT SHADES, IF APPLICABLE TO BE USED.

\$\$ CHECK & REPLACE WITH MAIN UPS SLD IF POWER SUPPLY IS NOT APPROVED BY CUSTOMER.



Technical specification for
CONTROL & INSTRUMENTATION

4 X 270 MW BHADRADRI TPS

SPEC NO.: **PE-TS-411-145-I**

VOLUME

SECTION

REV. NO.

00

DATE : 19.03.2015

SHEET

OF

PLC Quality Plan

 PEM :: C&I		STANDARD QUALITY PLAN FOR PROGRAMMABLE LOGIC CONTROLLER										QUALITY PLAN NO.: PE-QP-999-145-1036			
												VOLUME IIB			
												SECTION D			
												REV. NO. 01 DATE: 24.08.2007			
												SHEET 1 OF 8			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks			
1.0	Materials /Components														
1.1	Panels & Control Desks	Physical Inspection for Dimensions, Painting, Cutouts, Lifting / Locking Arrangements, Components, Drawing Pocket, Mounting accessories, Plinth & AV Pads, Cable Gland Plates, Hardwares, Hinges, Louvers & Filters, Fans & Panel Lamps	MA Visua	I	100%	Contract specifications, Approved GA Drawings, BOQ	As per ref documents. No physical damage.	BHEL Quality Inspection Report.	3/2	2	1				
1.2	Power Supply/Packs, Battery charger, Transformer, UPS.	Physical Inspection Physical Damages Dimensions Mounting Accessories	MA Visua	I	100%	Contract specifications, BOQ.	As per reference documents, Test Report	BHEL Quality Inspection Report.	3/2	2	1				
1.3	Indicating Lamp, Annunciator, Meters, Transducers, Signal Converters, Single Instruments, Single Loop Controllers	Physical Verification Physical Damages Dimensions Accessories	MA Visua	I	100%	Contract specifications, BOQ.	As per ref documents No physical damage. Test/ Calibration report.	BHEL Quality Inspection Report	3/2	2	1				
1.4	PLC processors, I/O modules, Power Supply modules, Communication modules, Mounting Racks, Ethernet	Physical Inspection - Identification Labels - Physical Damages - Quantity - Spare Capacity	MA Visua	I	100%	Product Catalogue, Data sheets, Approved Configuration diagram, BOQ	As per ref documents. Test Certificates	BHEL Quality Inspection Report.	3/2	2	1				

LEGEND: * CR - Critical characteristics
MA - Major characteristics
MI - Minor characteristics

P - Agency Performing the Test.
W - Agency Witnessing the Test.
V - Agency Verifying the Test.

1 - BHEL
2 - Vendor
3 - Sub-vendor

भारत भारती BHEL भारत भारती PEM :: C&I		STANDARD QUALITY PLAN FOR PROGRAMMABLE LOGIC CONTROLLER										QUALITY PLAN NO.: PE-QP-999-145-1036					
												VOLUME IIB					
												SECTION D					
												REV. NO.		01		DATE: 24.08.2007	
												SHEET 3		OF		8	
												Format of Records		Agency		Remarks	
												P		W		V	

[illegible]

LEGEND:	* CR	- Critical characteristics		P	- Agency Performing the Test.	1	- BHEL
	MA	- Major characteristics		W	- Agency Witnessing the Test.	2	- Vendor
	MI	- Minor characteristics		V	- Agency Verifying the Test.	3	- Sub-vendor
			\$				

 PEM :: C&I	STANDARD QUALITY PLAN FOR PROGRAMMABLE LOGIC CONTROLLER										QUALITY PLAN NO.: PE-QP-999-145-1036			
											VOLUME IIB			
											SECTION D			
											REV. NO. 01 DATE: 24.08.2007			
											SHEET 4 OF 8			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks		
										W	V			

3.0	Factory Acceptance Test (FAT)											
3.1	Input Output Functional Verification	I/O configuration, I/O operation	MA	Visual/ Electrical	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1		1	
3.2	Processor Verification	Processor configuration, Powering up, standby operation (as applicable) and Loading	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1		1	
3.3	Power Supply Module Verification	Redundancy Operation	MA	Electrical	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1		1	
3.4	Communication System Verification	Redundancy operation of Communication System, Measurement of Response Time, Communication with third party system	MA	Electrical	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1		1	
3.5	Diagnostic Verification	Self Diagnostic features of PLC system	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1		1	
3.6	Control Panel/Desk Verification	Operation of PLC driven annunciation system, Mosaic, Push buttons & selector switches, Indicating lamps	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1		1	
3.7	Software Verification	(i) Control Logics (ii) Engineering Features (iii) HMI Features	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1		1	

LEGEND:

- * CR - Critical characteristics
- MA - Major characteristics
- MI - Minor characteristics

\$

- P - Agency Performing the Test.
- W - Agency Witnessing the Test.
- V - Agency Verifying the Test.

1 - BHEL
 2 - Vendor
 3 - Sub-vendor

**STANDARD QUALITY PLAN
FOR
PROGRAMMABLE LOGIC CONTROLLER**

QUALITY PLAN NO.: PE-QP-999-145-I036		
DOCUMENTATION SPECIFICATION FOR PRE-TREATMENT PLANT		
VOLUME B		
SECTION D		
REV. NO. 01	DATE: 24.08.2007	
SHEET 5	OF	8

FACTORY ACCEPTANCE TEST (FAT) PROCEDURE

This document covers procedure to conduct/witness PLC system functional tests in order to demonstrate conformity to purchase specifications and related engineering documents. The test shall be conducted at the system suppliers works. The system supplier shall conduct all functional tests before commencing FAT and test results shall be made available during FAT. Vendor must furnish following relevant drawings, duly approved by BHEL Engineering, for reference during FAT.

- a) Technical Specification of PLC.
- b) PLC System Configuration
- c) General Assembly Drawings.
- d) Panel Wiring Diagrams.
- e) Bill of Quantity for PLC System.
- f) Logic Diagram.
- g) HMI Schematics.
- h) Input / Output List.

Further the vendor shall furnish applicable product specification, datasheets, catalogues, test-certificates, and internal inspection records to enable FAT. Vendor shall also submit, [to the inspecting agency](#), his standard test procedure, for clauses given below; where vendor's standard practice has been referred.

APPLICABLE TEST PROCEDURE:

1. Input/Output Functional Verification.

Check for correctness of addressing of racks, slots and I/O modules as per applicable PLC configuration diagram. Appropriate signal generators shall be used to simulate Inputs and outputs to check operation and SCAN time. [Check online replacement of cards, processors, power supply etc.](#)

2. Processor Verification

PLC Configuration drawing to be referred for ascertaining

- i) Redundancy

STANDARD QUALITY PLAN FOR PROGRAMMABLE LOGIC CONTROLLER

QUALITY PLAN NO.: PE-QP-999-145-I036 ___		
VOLUME IIB		
SECTION D		
REV. NO. 00	DATE: 23.03.2005	
SHEET 6	OF	8

ii) Type (Hot or Cold)

Both the processors are to be checked for healthiness in case of redundant configuration as per vendor's standard practice. In case of hot redundancy, switchover of control from primary processor to standby processor shall be demonstrated for uninterrupted control and data processing as per vendor's standard practice. Switchover shall be witnessed, by manual power off or resetting the Primary CPU or simulating failure of primary processor. Checking should be by witnessing the lighting up of Processor's LEDs as per manufacturer's product standard.

Vendor shall demonstrate, as per Vendor's standard practice, adequate Loading (Spare Capacity) of Processors, as mentioned in contract specs. This shall be done, by simulating worst load operation of fully integrated PLC system.

3. Power Supply Module Verification

Check if PSM is in redundant mode as per specification. Check the healthiness of power supply from both the modules' lamp indication/measurement. Simulate failure of one PSM and verify that standby PSM has taken over without any interruption.

4. Communication System Verification

Communication system has to be in line with approved PLC Configuration Diagram. Verify that both the communication buses are intact and connected. Communication between PLC processors, I/O rack, OWS etc. is to be checked through simulation of input data. Simulate the bus failure by disconnection of working bus. Check that the communication continues without interruption or loss of data.

Following response times are to be demonstrated as per vendor's standard practice for conformance to contract specifications:

1. Screen update time
2. I/O scan time
3. SOE resolution time
4. Data transfer time with third party system using Communication Protocol as per Contract specification and as per quantum of data as per approved signal exchange list.

5. Diagnostic Verification

Product Catalogue/Literature shall be referred for checking of all diagnostic features. Hardware failure to be simulated by removing an I/O

STANDARD QUALITY PLAN FOR PROGRAMMABLE LOGIC CONTROLLER

QUALITY PLAN NO.: PE-QP-999-145-I036 _____			
71	VOLUME IIB		
1	SECTION D		
REV. NO. 00		DATE: 23.03.2005	
SHEET 7		OF	8

6. Control Panel /Desk Verification

- i) PLC driven annunciation system should be checked by alarm signal simulation.
- ii) Push Button and selector switch operation should be checked by verification of corresponding change of status of Data Base point.
- iii) Indicating lamp / MIMIC should be checked by corresponding Data Base point simulation.

7. Software Verification

- i). Control Logics:– Software switches, lamps and Analog sources shall be used for simulation of field conditions. Control logics shall be checked for its correct functionality as per approved logic schemes
- ii). Engineering features:-
 - a) Online changing of parameters, set points.
 - b) Online modification in Control Logic Diagrams.
 - c) Online configuration of Graphics, Trends, Logs, HSR.
- iii). HMI features:-
Check for configuration & operation of Graphics, Trends, Logs, HSR and Alarms, in the form of Displays and Printouts, by simulation of Inputs as per approved documents.

8. Burn in Elevated Temperature test

Electronic equipments shall be subjected to Burn in elevated temperature test as per the procedure detailed below:

- a) (i) PLC modules are kept at 50 Deg c under continuous energized condition for 48 hours.

**STANDARD QUALITY PLAN
FOR
PROGRAMMABLE LOGIC CONTROLLER**

QUALITY PLAN NO.: PE-QP-999-145-I036		
VOLUME IIB		
SECTION D		
REV. NO. 00 23.03.2005	DATE:	
SHEET 8	OF	8

ii) 48 hours test period shall be divided into 4 equal time segments of 12 hours duration each. For every 12 hours duration segment, after lapse of first 11 hours 110% of nominal voltage shall be applied to the panel under test for a period of 30 minutes followed by application of 90% of nominal voltage for the next 30 minutes.

b) Assembled Panels with complete wiring shall be kept under continuous energized condition for 120 hours at ambient temperature. Temperature rise in panels should be below 10 Deg C above ambient.



Technical specification for
CONTROL & INSTRUMENTATION

4 X 270 MW BHADRADRI TPS

SPEC NO.: **PE-TS-411-145-I**

VOLUME

SECTION

REV. NO.

00

DATE : 19.03.2015

SHEET

OF

ACTUATOR SPECIFICATION

VOLUME: V-A

SECTION-III

**TECHNICAL SPECIFICATION
FOR
ELECTRIC MOTOR ACTUATORS**

1.00.00 SCOPE

- 1.01.00 This Section covers the general requirements of Electric Motor Actuators for valves/dampers.
- 1.02.00 All electric motor actuators shall be furnished in accordance with this general specification and the accompanying driven equipment specification. All the electrical actuators shall be INTEGRAL type only.

2.00.00 STANDARDS

- 2.01.00 All electrical equipment shall conform to the latest applicable IS, ANSI and NEMA Standards, except when stated otherwise herein or in driven equipment specification.
- 2.02.00 Major standards, which shall be followed, are listed below. Other applicable Indian Standards for any component part even if not covered in the listed standards shall also be followed
- i) IS -9334
- ii) IS-325

3.00.00 SERVICE CONDITIONS

- 3.01.00 The actuator shall be suitable for operation in hot, humid and tropical atmosphere, highly polluted at places with coal dust and/or fly ash.
- 3.02.00 Unless otherwise noted, electrical equipment/system design shall be based on the service conditions and auxiliary power supply given in the general specification.
- 3.03.00 For actuator motor installed outdoor and exposed to direct sun rays, the effect of solar heat shall be considered in the determination of the design ambient temperature.

4.00.00 RATING

- 4.01.00 For isolating service, the actuator shall be rated for three successive open-close operation of the valve/damper or 15 minutes, whichever is longer.
- 4.02.00 For regulating service, the actuator shall be suitably time-rated for the duty cycle involved with necessary number of starts per hour, but in no case less than 150 starts per hour.

5.00.00 PERFORMANCE

The actuator shall meet the following performance requirements:

- 5.01.00 Open and close the valve completely and make leak-tight valve closure without jamming.
- 5.02.00 Attain full speed operation before valve load is encountered and imparts an unseating blow to start the valve in motion (hammer blow effect).
- 5.03.00 Operate the valve stem at standard stem speed and shall function against design differential pressure across the valve seat.
- 5.04.00 The motor reduction gearing shall be sufficient to lock the shaft when the motor is de-energised and prevent drift from torque switch spring pressure.
- 5.05.00 The entire mechanism shall withstand shock resulting from closing with improper setting of limit switches or from lodging of foreign matter under the valve seat.

6.00.00 SPECIFIC REQUIREMENT

6.01.00 Construction

- 6.01.01 The actuator shall essentially comprise the drive motor, torque/ limit switches, gear train, clutch, hand wheel, position indicator/ transmitter, in-built thermostat for over load protection, space heater and internal wiring.
- 6.01.02 The actuator enclosure shall be totally enclosed, dust tight, weather-proof suitable for outdoor use without necessity of any canopy. Degree of protection of enclosure for motor actuator shall be IP-65.
- 6.01.03 All electrical equipment, accessories and wiring shall be provided with tropical finish to prevent fungus growth.
- 6.01.04 The actuator shall be designed for mounting in any position without any lubricant leakage or operating difficulty.

6.02.00 Motor

- 6.02.01 The drive motor shall be three phase, squirrel cage, induction machine with minimum class B insulation and IPW-55 enclosure, designed for high torque and reversing service. Canopy shall be provided for outdoor service.
- 6.02.02 The motor shall be designed for full voltage direct on-line start, with starting current limited to 6 times full-load current.
- 6.02.03 The motor shall be capable of starting at 85 percent of rated voltage and running at 80 percent of rated voltage at rated torque and 85 percent rated voltage at 33 percent excess rated torque for a period of 5 minutes each.
- 6.02.04 Motor leads shall be terminated in the limit switch compartment.
- 6.02.05 Motor actuators for valves/dampers shall be with integral starter with 3phase/3wire, 415V AC and operable from remote.

- 6.02.06 Earthing terminals shall be provided on either side of the motor.
- 6.03.00 **Limit Switches**
- Each actuator shall be provided with following limit switches: -
- 6.03.01 2 torque limit switches, one for each direction of travel, self-locking, adjustable torque type.
- 6.03.02 4 end-of-travel limit switches, two for each direction of travel.
- 6.03.03 2 position limit switches, one for each direction of travel, each adjustable at any position from fully open to fully closed positions of the valve/damper.
- 6.03.04 Each limit switch shall have 2 NO + 2 NC potential free contacts. Contact rating shall be 5A at 240V A.C. or 0.5A at 220V D.C.
- 6.04.00 **Hand Wheel**
- Each actuator shall be provided with a hand wheel for emergency manual operation. The hand wheel shall disengage automatically when the motor is energized.
- 6.05.00 **Position Indicator/Transmitter**
- The actuator shall have:
- 6.05.01 One (1) built-in local position indicator for 0-100% travel.
- 6.05.02 One (1) position transmitter, 4-20 mA current signal as position feedback, for remote indicator.
- 6.06.00 **Space Heater**
- A space heater shall be included in the limit switch compartment suitable for 240V, 1 phase, 50 Hz supply.
- 6.07.00 **Wiring**
- All electrical devices shall be wired up to and terminated in a terminal box. All wiring shall be done with 1100 V grade fire resistance PVC insulated stranded copper conductor of not less than 2.5 Sq.mm cross section. All wiring shall be identified at both ends with ferrules. All the electrical actuators shall have uniform wiring.
- 6.08.00 **Terminal Box**
- The terminal box shall be weather proof, with removable front cover and cable glands for cable connection. The terminal shall be suitable for connection of 2.5 Sq.mm copper conductor.
- 7.00.00 **ACCESSORIES**

As required for the driven equipment, the actuator shall be furnished with starting equipment mounted on the actuator. This shall include:

- 7.01.00 One (1) triple pole MCCB
- 7.02.00 One (1) reversing starter with mechanically interlocked contactors, 3 thermal overload relays, 2 NO + 2 NC auxiliary contacts for each contactor.
- 7.03.00 One (1) remote-local selector switch.
- 7.04.00 CLOSE-STOP-OPEN oil tight push buttons with indication lights.
- 7.05.00 415/240 V control transformer with primary & secondary fuses.

8.00.00 TEST

The actuator and all components thereof shall be subject to tests as per relevant Standards. In addition, if any special test is called for in equipment specification, the same shall be performed.

9.00.00 DRAWINGS, DATA & MANUALS

- 9.01.00 Drawings, Data & Manuals shall be submitted in triplicate with the bid and in quantities and procedures as specified in General Conditions of Contract and/or elsewhere in the specification for approval and subsequent distribution after the issue of 'Letter of Intent'.

9.02.00 To be submitted with Bid

Data sheet for each type of actuator shall be furnished along with internal wiring diagram, suggested control schematic and torque limit switch contact development and manufacturer's catalogues. Drawings, Data & Manuals shall be submitted in triplicate with the bid and in quantities and procedures as specified in General Conditions of Contract and/or elsewhere in the specification for approval and subsequent distribution after the issue of 'Letter of Intent'.

9.03.00 To be submitted for Owner / Purchaser's Approval and Distribution

All relevant drawings and data pertaining to the equipment like GTP, GA drawing, foundation plan, BOM, control & schematics, QAP, etc. shall be submitted by the Bidder for approval of Owner/Owner's consultant. Also refer clause no. 1.19.02(u) of Section-I of Volume – V-A: Technical Specifications for Electrical Equipment & Accessories.

ANNEXURE-A

DESIGN DATA

1.0 AUXILIARY POWER SUPPLY

S	upply	Description	Consumer
	L.V. Supply (i)	415V, 3Ø, 3W, 50 Hz Effectively earthed	u Motors above 0.2kW pto less than 175kW.
		Fault level 50 kA symm. for 1 sec.	
	(ii)	240V AC/415V AC	Motors upto 0.2kW.
		240V, 1Ø, 2W, 50 Hz effectively earthed	o Lighting, Space heat- ing , A.C supply for Contr- l & protective devices.
	D.C. Supply	220V, 2W, unearthed	& D.C. alarm, control protective devices
		Fault level 25* kA. for 1 sec.	

* Indicative only, the actual value will be decided by the Bidder, after substantiating the same by calculation.

2.0 RANGE OF VARIATION

A.C. Supply :

V	oltage	:	± 10%
	Frequency	:	+3% to -5%.
	Combined Volt + frequency	:	10% (absolute sum)

During starting of large motor, the voltage may drop to 80% of the rated voltage for a period of 60 seconds. All electrical equipment while running shall successfully ride over such period without affecting system performance.

D.C. Supply :

Voltage	:	187 to 242



Technical specification for
CONTROL & INSTRUMENTATION

4 X 270 MW BHADRADRI TPS

SPEC NO.: **PE-TS-411-145-I**

VOLUME

SECTION

REV. NO.

00

DATE : 19.03.2015

SHEET

OF

Actuator Data Sheet

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR		SPECIFICATION NO.: PE-SS-411-145-I007	
			VOLUME	
			SECTION	
			REV. NO. 00	DATE: 14.11.14
			SHEET 1	OF 3
Data Sheet A & B				
DATA SHEET-A (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	

350

GENERAL*	* PROJECT	4X270 MW BHADRADRI TPS	
	OFFER REFERENCE		
	* TAG NO. SERVICE		
	* DUTY	☒ ON / OFF ☒ INCHING (AS REQUIRED)	
	* LINE SIZE (inlet/outlet): MATERIAL		
	* VALVE TYPE	☐ GLOBE ☐ GATE ☐ REG. GLOBE ☐ BUTTERFLY	
	* OPENING / CLOSING TIME		
	* WORKING PRESSURE		
	AMBIENT CONDITION	SHALL BE SUITABLE FOR CONTINUOUS OPERATION UNDER AN AMBIENT TEMP. OF 0-55 DEG C AND RELATIVE HUMIDITY OF 0-95%	
	VALVE SEAT TEST PRESS	BIDDER TO SPECIFY	
	REQUIRED VALVE TORQUE	BIDDER TO SPECIFY	
	ACTUATOR RATED TORQUE	BIDDER TO SPECIFY	
	CONSTRUCTION AND SIZING	MECHANICAL POSITION INDICATOR	TO BE PROVIDED FOR 0-100% TRAVEL
BEARINGS		DOUBLE SHIELDED, GREASE LUBRICATED ANTI-FRICTION.	
GEAR TRAIN FOR LIMIT SWITCH/TORQUE SWITCH OPERATION		METAL (NOT FIBRE GEARS). SELF-LOCKING TO PREVENT DRIFT UNDER TORQUE SWITCH SPRING PRESSURE WHEN MOTOR IS DE-ENERGIZED.	
SIZING		OPEN/CLOSE AT RATED SPEED AGAINST DESIGNED DIFFERENTIAL PRESSURE AT 85% OF RATED VOLTAGE. FOR ISOLATING SERVICE THREE SUCCESSIVE OPEN-CLOSE OPERATIONS OR 15 MINS. WHICHEVER IS HIGHER. FOR INCHING(REGULATING) SERVICE 150 STARTS/HR MINIMUM	
HANDWHEEL	* REQUIRED	☒ YES ☐ NO	
	* ORIENTATION	☐ TOP MOUNTED ☐ SIDE MOUNTED	
	TO DISENGAGE AUTOMATICALLY DURING MOTOR OPERATION.		
ELECTRIC ACTUATOR	ACTUATOR MAKE/MODEL	BIDDER TO SPECIFY	
	MOTOR MAKE / MODEL / TYPE / RATING (KW)	BIDDER TO SPECIFY	
	MOTOR TYPE	SQUIRREL CAGE INDUCTION MOTOR, STARTING CURRENT LIMITED TO SIX TIMES THE RATED CURRENT.	
	ACTUATOR APPLICABLE WIRING DIAGRAM	☒ ENCLOSED (BIDDER TO CONFIRM) A: ☒ DRG. NO. 3-V-MISC-24227 R00 B: ☐ DRG. NO. 3-V-MISC-24550 R00 C: ☐ DRG. NO. 3-V-MISC-24283 R00 D: ☐ DRG. NO. 4-V-MISC-90271 R11	
	COLOUR SHADE	☒ BLUE (RAL 5012) ENAMEL ☐	
	SHAFT RPM	BIDDER TO SPECIFY	
	OLR SET VALUE	BIDDER TO SPECIFY	
	STARTING / FULL LOAD CURRENT	BIDDER TO SPECIFY	
	NO. OF REV FOR FULL TRAVEL	BIDDER TO SPECIFY	
	@ PWR SUPP TO MTR / STARTER	415V, 3PH, AC	
	@ CONTROL VOLTAGE REQUIREMENT	TO BE DERIVED INTERNALLY	
	@ ENCLOSURE CLASS OF MOTOR	☐ IP 65 ☒ IP 67 ☐ FLAME PROOF ☐ IP 55, TOTALLY ENCL, SELF VENTILATED.	
	@ INSULATION CLASS	☐ CLASS-B ☒ CLASS-F (TEMP. RISE LIMITED TO CLASS B)	
	@ WINDING TEMP PROTECTION	☒ THERMOSTAT (3 Nos., 1 IN EACH PHASE) ☐ -----	

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR	SPECIFICATION NO.: PE-SS-411-145-I007	
		VOLUME	
		SECTION	
		REV. NO. 00	DATE: 14.11.14
		SHEET 2	OF 3
Data Sheet A & B			
DATA SHEET-A (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)

350

	SINGLE PHASE / WRONG PHASE SEQUENCE PROTECTION	REQUIRED	
INTEGRAL STARTER	INTEGRAL STARTER	☒ REQUIRED ☐ NOT REQUIRED	
	TYPE OF SWITCHING DEVICE	☒ CONTACTORS ☐ THYRISTORS	
	TYPE	☒ CONVENTIONAL ☐ SMART (NON-INTRUSIVE)	
	STEP DOWN CONT. TRANSFORMER	☒ REQUIRED	
	OPEN / CLOSE PB	☒ REQUIRED ☐ NOT REQUIRED	
	STOP PB	☒ REQUIRED ☐ NOT REQUIRED	
	INDICATING LAMPS	☒ REQUIRED ☐ NOT REQUIRED	
	LOCAL REMOTE S/S	☒ REQUIRED ☐ NOT REQUIRED	
	STATUS CONTACTS FOR MONITORING	☒ REQUIRED ☐ NOT REQUIRED	
		INTEGRAL STARTER DISTURBED SIGNAL	REQUIRED (O/L RELAY OPERATED, CONT./POWER SUPPLY FAILED, S/S IN LOCAL, TORQUE SWITCH OPTD. MID WAY)
INTERPOSING RELAY (Applicable for integral Starter)	INTERPOSING RELAYS	REQUIRED	
	INTERPOSING RELAY (QUANTITY)	☐ 2 NOs. ☒ 3 NOs.	
	DRIVING VOLTAGE	☒ 20.5 – 24V DC ☐ _____ V DC	
	DRIVING CURRENT	☒ 125mA MAX ☐ _____ mA MAX	
	LOAD RESISTANCE	☒ > 192 ohms - <25 k ohms ☐ > _____ ohms - < _____ ohms	
TORQUE SWITCH	MFR & MODEL NO.	BIDDER TO SPECIFY	
	OPEN / CLOSE	☒ 1 No. ☐ 2Nos. / ☒ 1 No. ☐ 2Nos	
	CONTACT TYPE	2 NO + 2 NC	
	RATING	5A 240V AC AND 0.5A 220V DC	
	CALIBRATED KNOBS(OPEN&CLOSE TS)	REQUIRED FOR SETTING DESIRED TORQUE	
	ACCURACY	+3% OF SET VALUE	
LIMIT SWITCH	MFR & MODEL NO.	BIDDER TO SPECIFY	
	OPEN : INT : CLOSE	☒ 1 No ☐ 2 Nos. 2 Nos. (ADJ.) ☒ 1 No. ☐ 2Nos.	
	CONTACT TYPE	2 NO + 2 NC	
	RATING (AC / DC)	5A 240V AC AND 0.5A 220V DC	

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR	SPECIFICATION NO.: PE-SS-411-145-I007	
		VOLUME	
		SECTION	
		REV. NO. 00	DATE: 14.11.14
		SHEET 3	OF 3
Data Sheet A & B			
DATA SHEET-A (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)

350

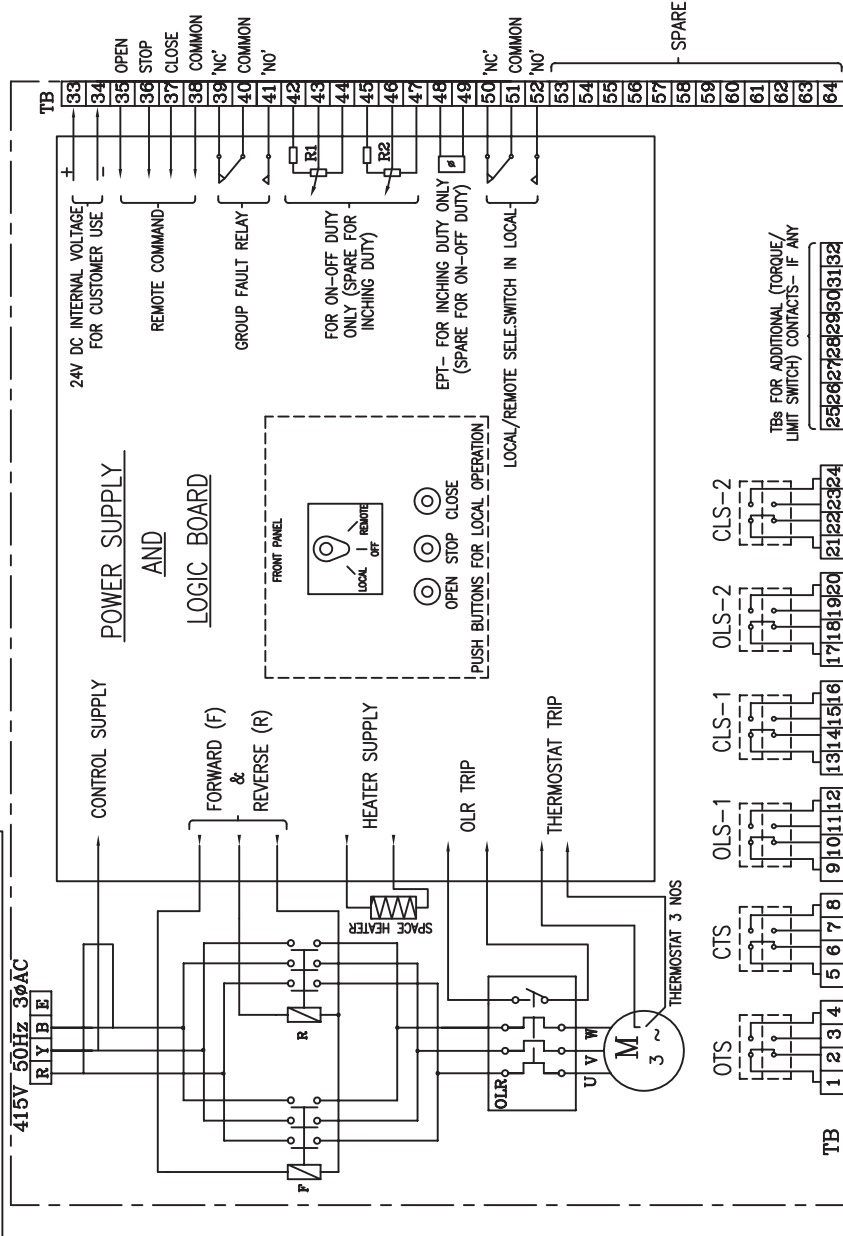
POSITION TRANSMITTER	POSITION TRANSMITTER (For inching duty)	☒ REQUIRED ☐ NOT REQUIRED		
	MFR & MODEL NO.	BIDDER TO SPECIFY		
	TYPE	☒ ELECTRONIC (2 WIRE) R/I CONVERTER ☐ ELECTRONIC (2 WIRE) CONTACTLESS		
	SUPPLY	☒ 24V DC ☐		
	OUTPUT	☒ 4-20mA		
	ACCURACY	$\pm 1\%$ FS		
SPACE HEATER	@SPACE HEATER	REQUIRED		
	@ POWER SUPPLY			
	@ RATING	415v, 3PH, AC FOR RATING > 0.2KW; SINGLE PHASE FOR RATING < 0.2KW		
TERMINAL BOX	MOTOR TERMINAL BOX	REQUIRED		
	ACTUATOR TERMINAL BOX	REQUIRED		
	ENCL CLASS MTR T.B. / ACTUATOR T.B.	@ ☒ IP 67 @ ☐	☒ IP67 ☐	
	@ EARTHING TERMINAL	REQUIRED		
	PLUG & SOCKET(9 PIN) (FOR COMMD, LS/TS FEED BACK, PoT)	☐ REQUIRED ☒ NOT REQUIRED ☐ ☐ 2 NOS. ☐		
CABLE GLANDS	@ POWER CABLE GLAND	SIZE:--DURING DETAIL ENGINEERING		
	@ SPACE HEATER CABLE GLAND	SIZE: 2C x 2.5 sq. mm		
	OTHER CONTROL CABLE GLANDS-1	INSTRUMENT CABLE SIZE FOR ON/OFF DUTY VALVES SHALL BE 8PX0.5 SQMM - ONE CABLE GLAND OF OD SIZE 20 MM. INSTRUMENT CABLE SIZE FOR INCHING DUTY TYPE VALVES SHALL HAVE TWO NO. CABLES (ONE NO. 8PX0.5 SQMM AND 2ND 2PX0.5 SQMM) - TWO NO. GLANDS OF OD SIZES 20 MM & 15 MM.		
	OTHER CONTROL CABLE GLANDS-2			
WEIGHT	TOTAL WEIGHT (ACTUATOR + ACCESSORIES)	BIDDER TO SPECIFY		_____ Kg.

NOTES:

- SCOPE:** DESIGN, MANUFACTURE, INSPECTION, TESTING AND DELIVERY TO SITE OF ELECTRIC ACTUATOR FOR INCHING OR OPEN / CLOSE DUTY.
- CODES & STANDARDS:** DESIGN AND MATERIALS USED SHALL COMPLY WITH THE RELEVANT LATEST NATIONAL AND INTERNATIONAL STANDARD. AS A MINIMUM, THE FOLLOWING STANDARDS SHALL BE COMPLIED WITH:
IS-9334, IS-2147, IS-2148, IS-325, IS-2959, IS-4691 AND IS-4722
- TEMPERATURE RISE SHALL BE RESTRICTED TO 70 DEG. C FOR AMBIENT TEMPERATURE OF 50 DEG C.
- CABLE GLANDS OF DOUBLE COMPRESSION TYPE, BRASS MATERIAL SHALL BE PROVIDED.
- THE TORQUE SWITCHES SHALL BE PROVIDED WITH MECHANICAL LATCHING DEVICE TO PREVENT OPERATION WHEN UNSEATING FROM THE END POSITIONS. THE LATCHING DEVICE SHALL UNLATCH AS SOON AS THE VALVE LEAVES THE END POSITION. IF SUCH PROVISION IS NOT POSSIBLE, THE TORQUE SWITCHES SHALL BE BYPASSED BY END-POSITION LIMIT SWITCHES WHICH OPENS ON VALVE LEAVING END POSITION. THESE LIMIT SWITCHES ARE ADDITIONAL TO THE NUMBER OF LIMIT SWITCHES SPECIFIED ELSEWHERE.
- THE MOTOR SHALL OPERATE SATISFACTORILY UNDER THE +/- 10% SUPPLY VOLTAGE VARIATION AT RATED FREQUENCY, -5% TO +3% VARIATION IN FREQUENCY AT RATED SUPPLY VOLTAGE, SIMULTANEOUS VARIATION IN VOLTAGE & FREQUENCY THE SUM OF ABSOLUTE PERCENTAGE NOT EXCEEDING 10%.
- THE MOTOR SHALL BE SUITABLE FOR DIRECT ON LINE STARTING.

NOTES* = TO BE FILLED BY MPL (LEAD AGENCY). @ = TO BE FILLED BY ES

DRAWING NO. 7227-CSIW-A-E



NOTE:-

1. ALL TORQUE AND LIMIT SWITCHES (OTS,CTS,OLS1&2, CLS1&2) ARE WITH 2NO+2NC CONTACTS '1NO+1NC' IS TERMINATED IN TBS 1-24, REMAINING CONTACTS ARE FOR INTERNAL USE.
2. ANY SPARE CONTACTS WHICH ARE NOT USED INTERNALLY ARE TO BE TERMINATED IN TBS 25-32
3. CTS - TORQUE SWITCHES FOR CW ROTATION (CLOSE)
4. OTS - TORQUE SWITCHES FOR CCW ROTATION (OPEN)
5. OLS-1, OLS-2 - LIMITSWITCHES FOR POSITION OPEN
6. CLS-1, CLS-2 - LIMITSWITCHES FOR POSITION CLOSE
7. EPT - ELECTRONIC POSITION TRANSMITTER (Contactless , FOR INCHING DUTY)
8. R1-R2-POTENTIOMETER 2 x 100 OHMS (FOR ON-OFF DUTY)
9. FOR COMMANDS & EPT EITHER INTERNALLY GENERATED 24 VDC OR EXTERNAL SUPPLY OF 24VDC CAN BE USED
10. M - MOTOR 3Φ 415V 50 Hz AC SUPPLY

CONTACT DEVELOPMENT DIAGRAM

OTS	1-2	OPEN AT OVER TORQUE DURING OPENING TRAVEL
	3-4	CLOSE AT OVER TORQUE DURING OPENING TRAVEL
CTS	5-6	OPEN AT OVER TORQUE DURING CLOSING TRAVEL
	7-8	CLOSE AT OVER TORQUE DURING CLOSING TRAVEL
OLS-1	9-10	OPEN
	11-12	STOP
	13-14	CLOSE
CLS-1	15-16	COMMON
	17-18	NC
OLS-2	19-20	COMMON
	21-22	NC
CLS-2	23-24	COMMON
	25-26	NC
SWITCH	27-28	COMMON
	29-30	NC
	31-32	NO
	33-34	NO
	35-36	NO
	37-38	NO
	39-40	NO
	41-42	NO
	43-44	NO
	45-46	NO
	47-48	NO
	49-50	NO
	51-52	NO
	53-54	NO
	55-56	NO
	57-58	NO
	59-60	NO
	61-62	NO
	63-64	NO

INDICATES CONTACT CLOSED
INDICATES CONTACT OPEN

CONTACT RATING: 5A AT 250V AC & 0.5A AT 220V DC

SETTING PROCEDURE OF POSITION LIMIT AND TORQUE SWITCH			
VALVES	OPEN		CLOSE
	MAIN	BACK UP	BACK UP
GATE VALVE OF 100 mm AND ABOVE IN 1500 CL AND ABOVE RATINGS		OLS *	CLS CTS
ALL OTHER GATE & GLOBE VALVES		OLS *	CTS *
# - CLS NOT TO BE CONNECTED IN TRIP CIRCUIT			
* - BYPASS OTS FOR INITIAL 5% OF TRAVEL (FOR GATE VALVES ONLY)			

TYPE OF PRODUCT ELECTRICAL VALVE ACTUATORS (AC) WITH INTEGRAL STARTERS
OR NAME OF (DRAWN FOR INTERMEDIATE POSITION OF VALVES)
CUSTOMER/PROJECT

BHARAT HEAVY ELECTRICALS LTD., UNIT: HIGH PRESSURE BOILER PLANT. TIRUCHIRAPPALLI-620014.		DRN	N.P.ESWAR	SIGN	N.P	DATE	07.10.04	NO. OF VAR
		CHD	D.DINAKARAN	SIGN	D.D	DATE	07.10.04	
		APPD	K.ARUNACHALAM	SIGN	K.A	DATE	07.10.04	
365-121		DEPT	VL	SCALE	WEIGHT (KG)	REFERENCE INFORMATION		
		CODE						
TITLE		CARD CODE		DRAWING NO.		REV		
WIRING DIAGRAM (TERMINAL PLAN)		U 01		3-V-MISC-24227		0		
FOR ACTUATOR WITH INTEGRAL STARTER						Page 347 of 806		



Technical specification for
CONTROL & INSTRUMENTATION

4 X 270 MW BHADRADRI TPS

SPEC NO.: **PE-TS-411-145-I**

VOLUME

SECTION

REV. NO.

00

DATE : 19.03.2015

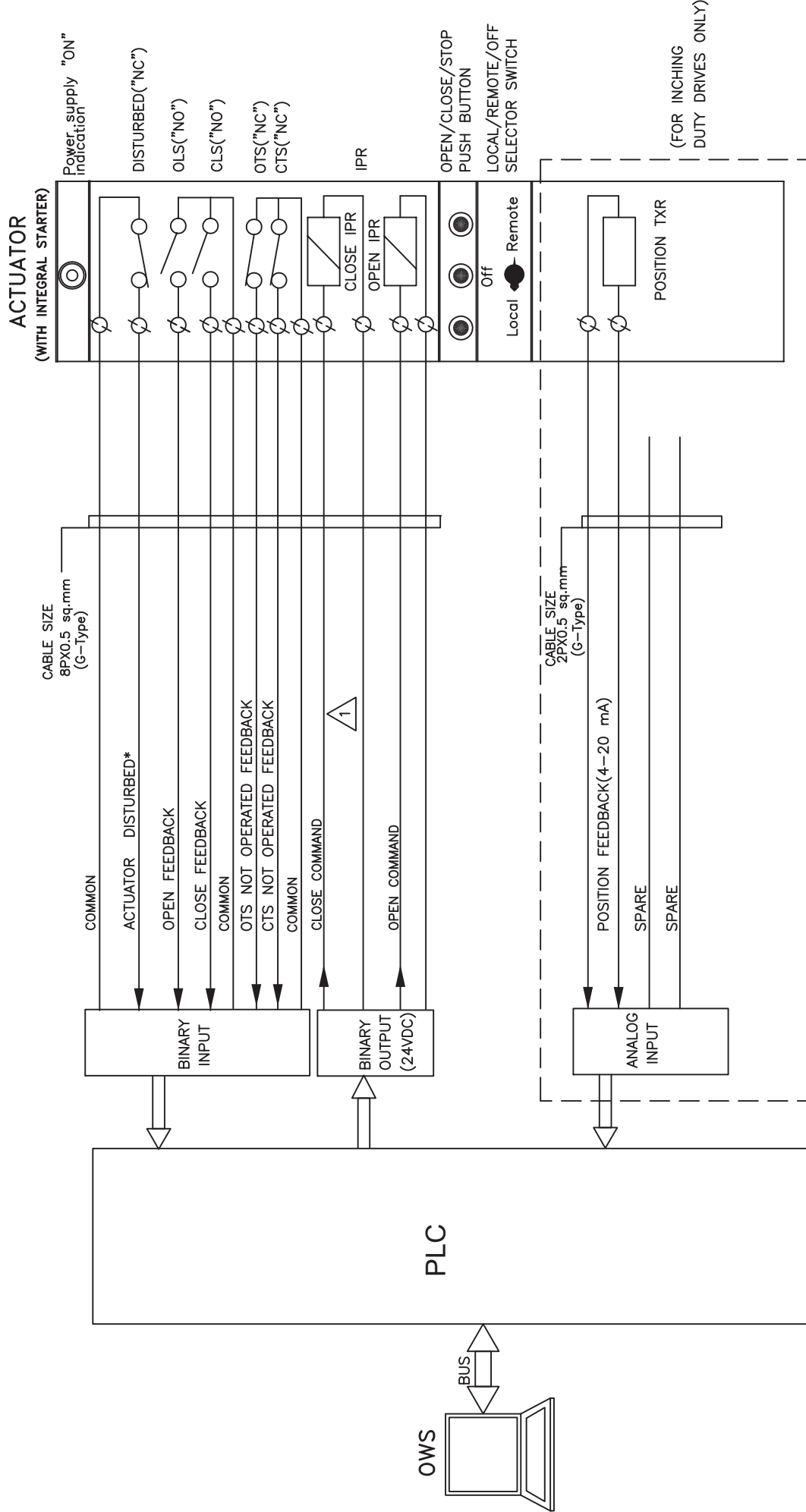
SHEET

OF

Drive Control Philosophy

PLC INTERFACE FOR BIDIRECTIONAL DRIVE(WITH INTEGRAL STARTER)

CONTROL AND INSTRUMENTATION SPECIFICATION FOR PRE-TREATMENT PLANT



NOTE:

- * DISTURBED= Loss of Power supply (1 Phase/3 Phase)/ Loss of control supply/ Motor thermostat trip/ Thermal over load/ Local/Off/Remote Sel. switch in local or off mode/ Stop PB optd.

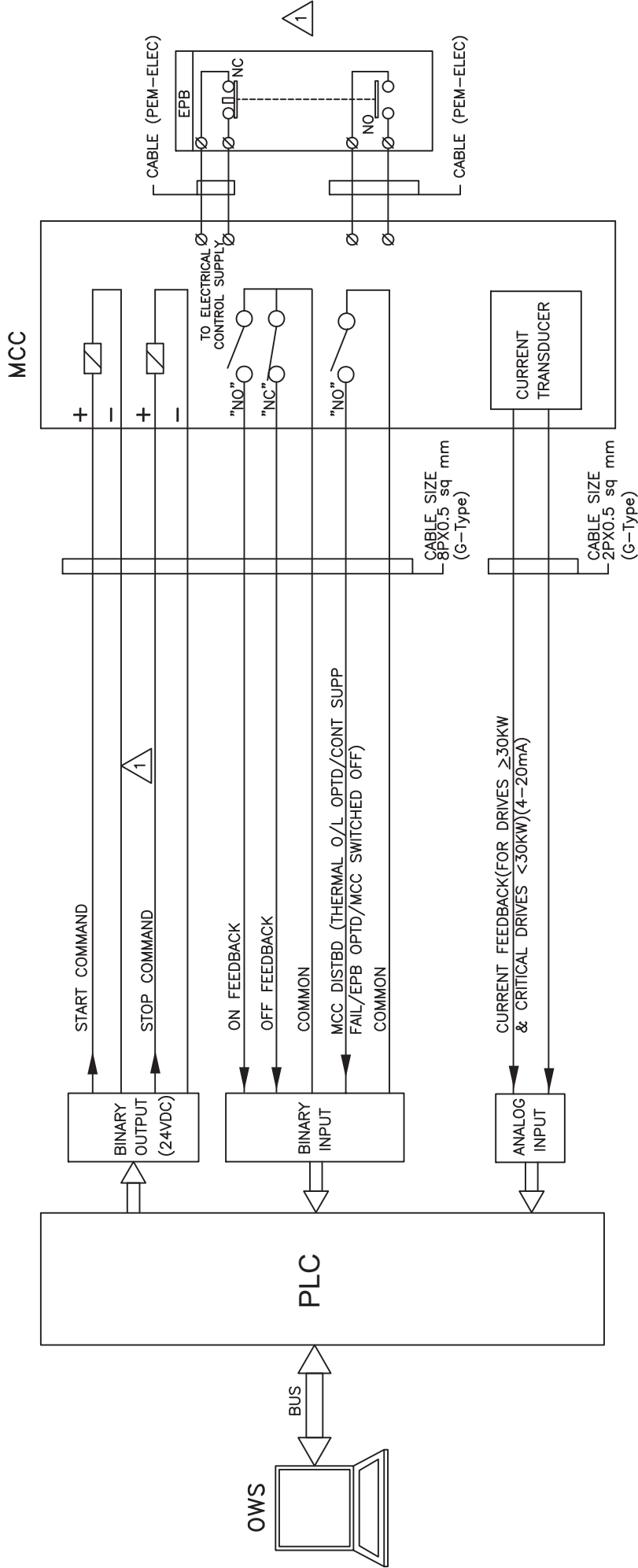


PROJECT: 4 X 270 MW BHADRADRI TPS

TITLE PLC INTERFACE FOR BIDIRECTIONAL DRIVE

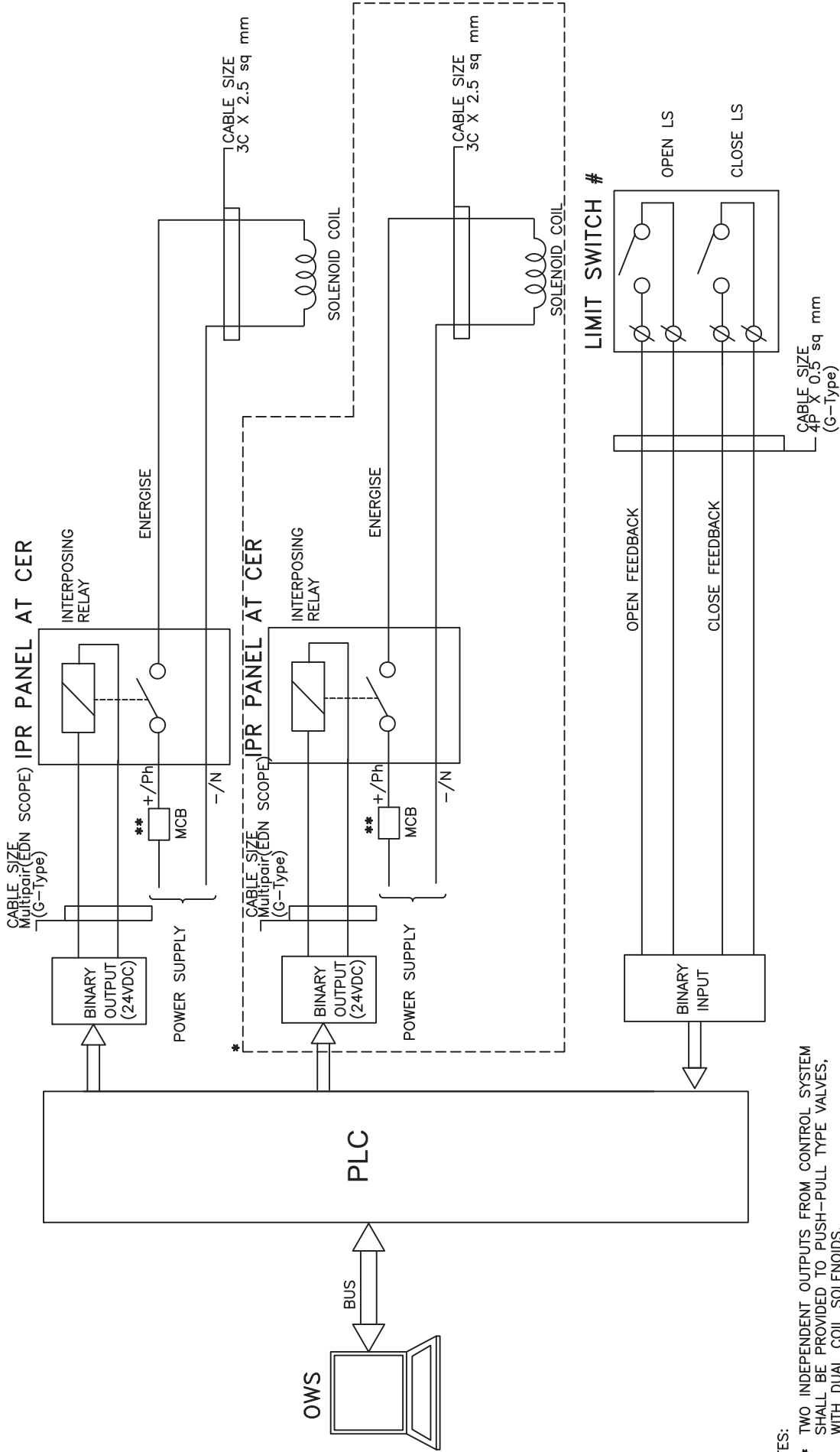
DRG.NO.	PE-DM-411-145-I002
DATE	06.02.2015
REV.NO.	01
SHT	7

PLC INTERFACE FOR UNIDIRECTIONAL LT DRIVE



	PROJECT: 4 X 270 MW BHADRADRI TPS		DRG.NO.	PE-DM-411-145-I002
	TITLE		DATE	06.02.2015
	UNIDIRECTIONAL LT DRIVE		REV.NO.	01
		SHT	8	Page 350 of 806

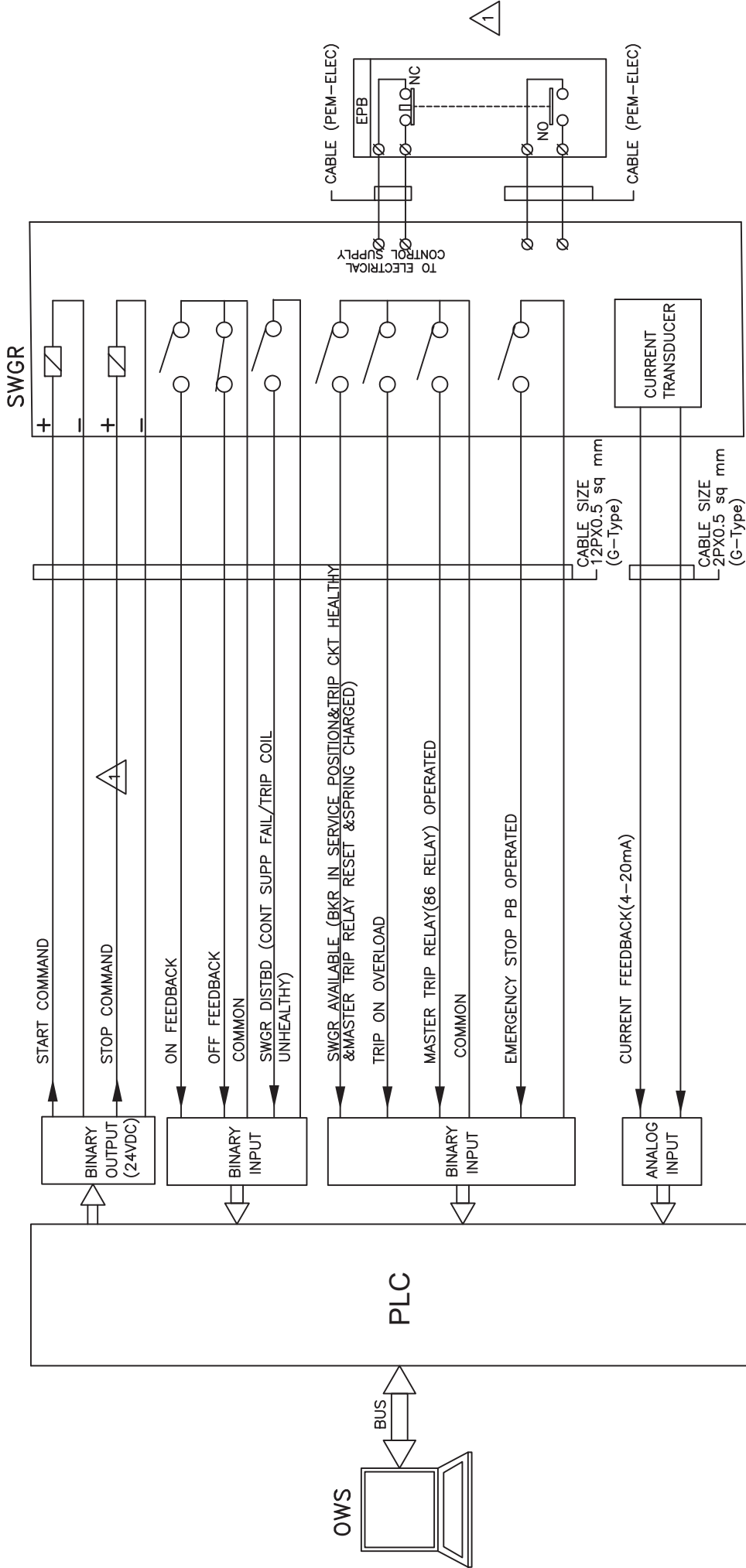
PLC INTERFACE FOR SOLENOID DRIVE
(24V DC / 240V AC UPS)



- NOTES:
- * TWO INDEPENDENT OUTPUTS FROM CONTROL SYSTEM SHALL BE PROVIDED TO PUSH-PULL TYPE VALVES, WITH DUAL COIL SOLENOIDS.
 - ** MCB SHALL BE PROVIDED FOR EACH SOLENOID
 - # FOR ON/OFF TYPE, SOLENOID ACTUATED CONTROL VALVE.

	PROJECT: 4 X 270 MW BHADRADRI TPS		DRG.NO.	PE-DW-411-145-I002
	TITLE PLC INTERFACE FOR SOLENOID DRIVE		DATE	18.11.2014
			REV.NO.	00
			SHT	9

PLC INTERFACE FOR HT/LT UNIDIRECTIONAL DRIVES(BREAKER OPERATED)



	PROJECT: 4 X 270 MW BHADRADRI TPS		DRG.NO.	PE-DW-411-145-I002
	TITLE PLC INTERFACE FOR UNIDIRECTIONAL HT DRIVE		DATE	06.02.2015
			REV.NO.	01
			SHT	10 OF 352 dt 806



- CONTROL DEMAND OVERRIDING IS REQUIRED:
- *** MCB SHALL BE PROVIDED FOR EACH SOLENOID

	PROJECT: 4 X 270 MW BHADRADRI TPS		DRG.NO.	PE-DM-411-145-I002
	TITLE TYPICAL HOOK-UP DIAGRAM ANALOG DRIVE(WITH SMART POSITIONER)		DATE	18.11.2014
			REV.NO.	00
			SHT	11



Technical specification for
CONTROL & INSTRUMENTATION

4 X 270 MW BHADRADRI TPS

SPEC NO.: **PE-TS-411-145-I**

VOLUME

SECTION

REV. NO.

00

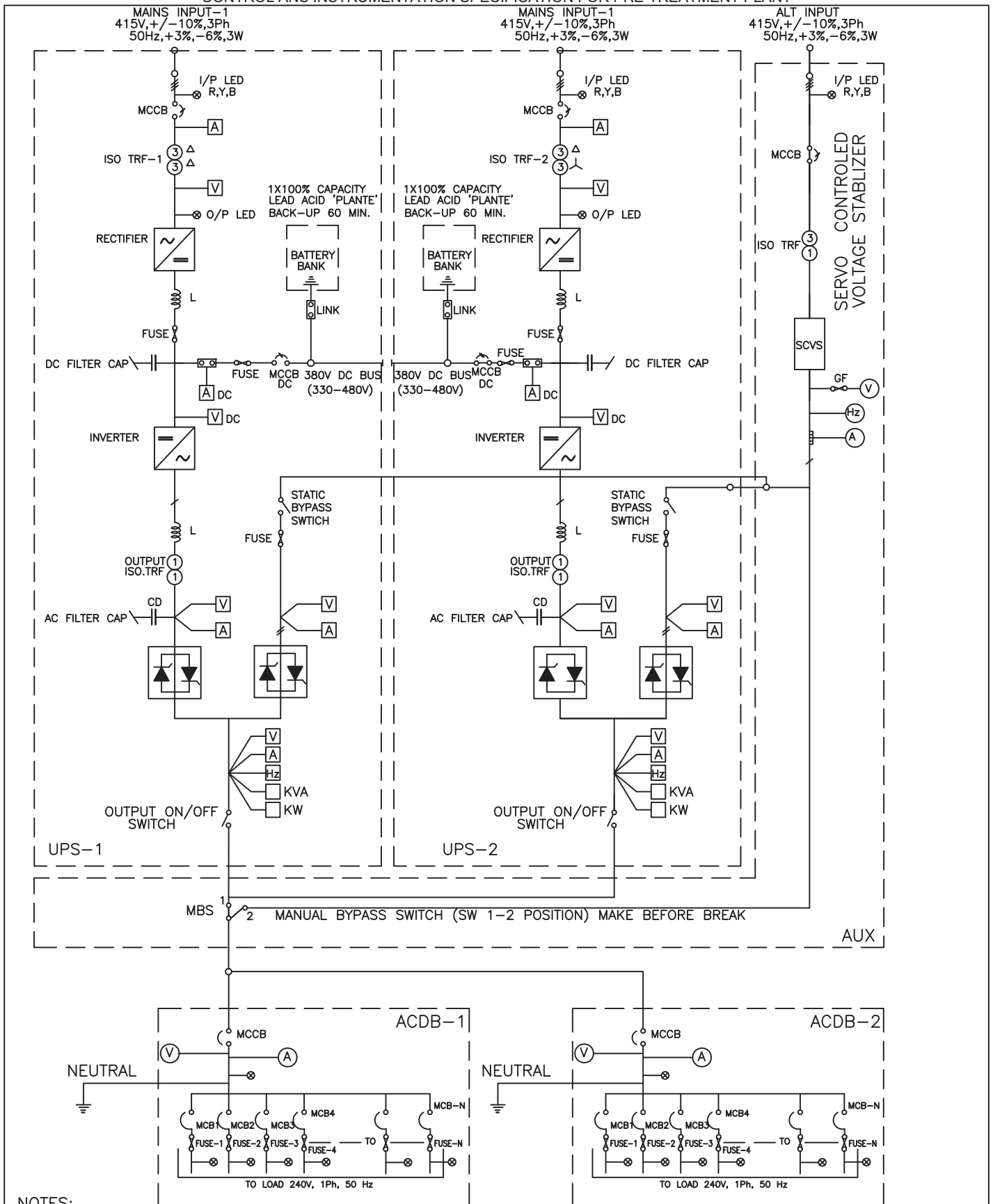
DATE : 19.03.2015

SHEET

OF

UPS SCHEME

CONTROL ANS INSTRUMENTATION SPECIFICATION FOR PRE-TREATMENT PLANT



NOTES:

1. ACDB-1&2 NEUTRAL TO BE GROUNDED TO A DEDICATED GROUND.
2. ALL OUTPUT FEEDERS OF ACDB SHALL BE PROVIDED WITH AN LED AFTER THE FUSE FOR FEEDER ON INDICATION WITH FEEDER DESCRIPTION.
3. REDUNDANT FEEDERS SHALL BE LOCATED IN DIFFERENT ACDBs.



4 X 270 MW BHADRADRI TPS

TITLE:-

UPS SINGLE LINE DIAGRAM

DRG.
No.

PE-DG-411-145-I004

REV.
No.

00

DATE

21.03.2015

SHEET

2 OF 2



Technical specification for
CONTROL & INSTRUMENTATION

4 X 270 MW BHADRADRI TPS

SPEC NO.: **PE-TS-411-145-I**

VOLUME

SECTION

REV. NO.

00

DATE : 19.03.2015

SHEET

OF

INSTRUMENTATION DATA SHEET

1.00.00 SPECIFICATION FOR ELECTRONIC TRANSMITTERS
1.01.00 PRESSURE TRANSMITTER

1.	Working Principle	:	Smart (HART Compatible)
2.	Type	:	Microprocessor based, 2 – Wire
3.	Output Signal	:	4-20 mA DC along with superimposed digital signal
4.	Measuring Element	:	Capsule / Diaphragm
5.	Element material	:	SS-316 (Stainless Steel) or better
6.	Static Pressure	:	150 % of maximum span continuously, without affecting the calibration
7.	Turn-down ratio	:	100: 1
8.	Span and Zero	:	Continuous, tamper proof, remote as well locally adjustable with zero elevation and suppression by 100% of span
9.	Enclosure Class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
10.	Output Indicator	:	LCD (Integral indicator of 5 digit display)
11.	Nameplate	:	Tag number, service engraved in SS tag plate
12.	Body	:	SS
13.	Operating Voltage	:	24V DC
14.	Load	:	600 Ohms (min.) at 24 Volts D.C.
15.	Ambient Temperature	:	0 - 50 °C
16.	Performance:	:	
	i. Accuracy		± 0.075% of Span or better

-
ii.	Repeatability	± 0.05% of Span or better
-
17.	Sealing/Isolation	:	Extended diaphragm (Silicon oil/ Fluorolub filled) with 5 meters SS armoured capillary for corrosive/viscous/solid bearing or slurry type fluid applications
18.	Accessories	:	a. Universal mounting bracket suitable for 2" pipe mounting b. High tensile carbon steel U-bolts c. Siphon for steam and hot water services d. ½" NPT 2-valve stainless steel manifold, constructed from SS316 bar stock e. Companion flange with nuts, bolts and gaskets f. ½" NPT cable gland g. Handheld calibrator
19.	Adjustment/Calibration/ Maintenance	:	From handheld calibrator/ HART management system

Notes: For primary air/ secondary air/ flue gas applications, DP type transmitters shall be provided for pressure measurement.
LVDT type is not acceptable.

1.02.00 DIFFERENTIAL PRESSURE TRANSMITTER / FLOW TRANSMITTER

1.	Working Principle	:	Smart (HART Compatible)
2.	Type	:	Microprocessor based, 2 – Wire
3.	Output Signal	:	4-20 mA DC along with superimposed digital signal
4.	Measuring Element	:	Capsule / Diaphragm

-
5.	Element material	:	SS-316 (Stainless Steel) or better
6.	Static Pressure	:	150 % of maximum span continuously, without affecting the calibration
7.	Turn-down ratio	:	100: 1
8.	Span and Zero	:	Continuous, tamper proof, remote as well locally adjustable with zero elevation and suppression by 100% of span
9.	Enclosure Class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
10.	Output Indicator	:	LCD (Integral indicator of 5 digit display)
11.	Nameplate	:	Tag number, service engraved in SS tag plate
12.	Body	:	SS
13.	Operating Voltage	:	24V DC
14.	Load	:	600 Ohms (min.) at 24 Volts D.C.
15.	Ambient Temperature	:	0 - 50 °C
16.	Performance:		
	i. Accuracy	:	± 0.075% of Span or better
	ii. Repeatability	:	± 0.05% of Span or better
17.	Sealing/Isolation	:	Extended diaphragm (Silicon oil/ Fluorolub filled) with 5 meters SS armoured capillary for corrosive/viscous/solid bearing or slurry type fluid applications
18.	Accessories	:	a. Universal mounting bracket suitable for 2" pipe mounting b. High tensile carbon steel U-bolts

- c. Siphon for steam and hot water services
- d. ½" NPT 5-valve stainless steel manifold, constructed from SS316 bar stock
- e. Companion flange with nuts, bolts and gaskets
- f. ½" NPT cable gland
- g. Handheld calibrator

19. Adjustment/Calibration/ Maintenance : From handheld calibrator/ HART management system

1.03.00 Displacer Type Level Transmitters

- 1. Type : Smart (HART Compatible)
- 2. Stages of operation : Continuous
- 3. Material :
- 4. i. Displacer SS-316
- 5. ii. Suspension wire SS-316
- 6. iii. Torque tube housing SS
- 7. iv. Torque tube Inconel
- 8. v. Displacer chamber SS
- 9. vi. Transmitter Housing SS
- 10. Operating Voltage : 24 V DC
- 11. Transmission : Microprocessor based, 2-wire
- 12. Output Signal : 4-20 mA DC along with superimposed digital signal
- 13. Static / overload : Maximum static pressure without

	pressure		permanent deformation or loss of accuracy
14.	Turn-down ratio	:	10 : 1 or better
15.	Zero & Span	:	Continuous, tamper proof, remote as well locally adjustable with zero elevation and suppression by 100% of span
16.	Enclosure Class	:	IP-65
17.	Output Indicator	:	LCD type (Integral indicator of 5 digit display)
18.	Nameplate	:	Tag number and Service engraved in stainless steel tag plate
19.	Ambient Temperature	:	0 - 50 °C
20.	Load Impedance	:	600 Ohms at 24 Volts (minimum)
21.	Process Connection	:	2" Flanged
22.	Performance - Accuracy	:	± 0.075 % of span or better
23.	Accessories	:	a) Counter Flange, nuts, bolts, gaskets etc b) Weights for 5 point calibration of instruments c) Vent and drain plugs d) ½" NPT Glands e) Handheld calibrator
24.	Preferred Features	:	a) Test plug connection and cutout terminals physically separated from other electronics b) Electronic Damping facility (adjustable)
25.	Adjustment/Calibration/ Maintenance	:	From handheld calibrator/ HART management system

26. Applications : During detail engineering on Owner's approval

1.04.00 MASS FLOW METER

1.04.01 SENSOR

1. Measuring Principle : Coriolis Mass flow
2. Primary Element : Flow Tube of 316SS or better
3. Heating Arrangement : Integral
4. Temperature Control : For heavy fuel oil application
5. Process Connection : Flanged of rating as per process requirement
6. Drain : Self-draining facility
7. Enclosure : Stainless steel
8. Accessories : Counter flanges, Mounting nuts, bolts, gaskets etc.

1.04.02 TRANSMITTER

1. Measured quantities : Mass Flow rate, Total Mass Flow, Density
2. Input Signal Processing : Smart (HART compatible)
3. Display : LCD
4. Output : 2 nos. isolated output of 4-20mA DC selectable from four measured quantities
5. Load : < 750 ohms
6. Power supply : 240V AC, 50 Hz

7.	Turn Down	:	100:1
8.	Accuracy	:	± 0.2 % of measured value
9.	Housing	:	IP 65 (Explosion proof)
10.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
11.	Accessories	:	a) Handheld calibrator b) Mounting U-bolts, nuts, bolts, prefab cable etc c) $\frac{1}{2}$ "NPT cable gland
12.	Adjustment/Calibration/ /Maintenance	:	From handheld calibrator/ HART management system
13.	Applications	:	Fuel Oil service

1.05.00 RADAR TYPE LEVEL MEASUREMENT

1.	Type	:	Smart (HART Compatible)
2.	Antenna	:	Co axial / guided wave radar /Overspill protection
3.	Principle	:	TDR (Time Domain Reflectometry)
4.	Communication	:	Two wire 4-20mA DC with HART
5.	Environmental temperature	:	0 – 50 °C
6.	Enclosure	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
7.	Calibration	:	a) Self calibration with internal reference b) Zero & Span calibration
8.	Process Connection	:	External cage mounting Flanged /screwed
9.	Electronic Housing	:	Epoxy painted Die-Cast aluminium

		alloy	
10.	Antenna / Flange assembly	:	316 SS or Hest alloy (as required)
11.	Power supply	:	24 V DC
12.	Output Indicator	:	LCD
13.	Accuracy	:	5 mm or 0.1% of probe length
14.	Accessories	:	a) Handheld calibrator
		:	b) Counter Flange, nuts, bolts, gaskets etc
		:	c) ½"NPT cable gland
		:	d) SS Nameplate
15.	Adjustment/Calibration/ Maintenance	:	From handheld calibrator/ HART management system
16.	Applications	:	Vessels under vacuum or low pressure applications, solid levels
1.06.00	ULTRASONIC LEVEL TRANSMITTER		
1.	Type	:	Microprocessor based, 2-wire, Smart (HART Compatible)
2.	Operating Principle	:	Detection of reflected ultrasonic pulse
3.	Output Signal	:	4-20 mA DC along with superimposed digital signal
4.	Operating frequency	:	10 KHz to 50 KHz (typical)
5.	Display	:	LCD
6.	Temperature Compensation	:	Built in –Programmable
7.	Power supply	:	24 V DC
8.	Enclosure	:	SS, IP-65 (Explosion proof for NEC Class-1, Division 1 area)

-
9. Zero & Span	:	Continuous, tamper proof, remote as well locally adjustable. It shall be possible to calibrate the instrument without any level in the sump/ tank
10. Accuracy & Repeatability	:	0.15 % of span or better
11. Resolution	:	0.1 % of span
12. Operating temp.	:	Transmitter- 500 C and Sensor - 800 C
13. MOC Sensor	:	SS-316/Body- PVC and Face – Polyurethane
14. Mounting	:	4" Flanged/ 2" NPT for sensor and Transmitter on panel
15. Accessories	:	a) Handheld calibrator b) Weather canopy for protection from direct sunlight and direct rain c) ½"NPT cable gland d) All mounting hardware (SS-316), Prefab cable e) SS Nameplate
16. Diagnosis	:	On-line
17. Status Indication	:	Power On, HI, HI-HI, Lo, LO-LO, Fault
18. Output Contacts	:	2 SPDT, 230V, 5A
19. Adjustment/Calibration/ Maintenance	:	From handheld calibrator/ HART management system
20. Applications	:	Coal Bunker, Water Service etc.

1.07.00 ULTRASONIC FLOW TRANSMITTER

1. Type	:	Ultrasonic – Clamp On					
2. Accuracy	:	+/- 1 % of reading					
3. Repeatability	:	+/- 0.3 % of reading					
4. Rangeability	:	400 : 1					
5. Output Signal	:	4-20 mA DC with HART					
6. Measured Parameter	:	Volumetric flow, Totalized flow and flow Velocity					
7. Display	:	LCD with internal Key Pad (Flow rate & Totalization)					
8. Power Supply	:	24 V DC (2 Wire)					
9. Enclosure	:	SS (IP- 68 – Submersible)					
10. Mounting	:	SS Chain or Strap					
11. Accessories		<table border="0"> <tr> <td>1. Handheld calibrator</td> </tr> <tr> <td>2. ½"NPT cable gland</td> </tr> <tr> <td>3. Transducer cable</td> </tr> <tr> <td>4. All mounting hardware (SS-316)</td> </tr> <tr> <td>5. SS Nameplate</td> </tr> </table>	1. Handheld calibrator	2. ½"NPT cable gland	3. Transducer cable	4. All mounting hardware (SS-316)	5. SS Nameplate
1. Handheld calibrator							
2. ½"NPT cable gland							
3. Transducer cable							
4. All mounting hardware (SS-316)							
5. SS Nameplate							
12. Adjustment/Calibration/ Maintenance	:	From handheld calibrator/ HART management system					
13. Applications	:	Plant water service					

Note: Multi-path insertion type (minimum 4 path) Ultrasonic Flow meter shall be provided for Raw water/ Cooling Water flow measurements.

2.00.00 HART HAND HELD CALIBRATOR

Hand held calibrators (5 nos. for each type) shall be provided for adjustment/ calibration/maintenance of the HART compatible

transmitters. The hand held calibrator shall be suitable for all types of transmitters supplied in the package. If one type of hand held type calibrator is not suitable for communicating with all types of transmitters then separate hand held calibrator will be provided.

3.00.00 PROCESS ACTUATED SWITCHES

3.01.00 PRESSURE SWITCH

1. Type :
 - i. Piston for high pressure application
 - ii. Bellow / Diaphragm for low pressure application
2. Sensing element : SS-316.
material All other wetted part SS316
3. Case Material : SS
4. Setter Scale : Black graduation on white linear scale.
Graduation 0-100% with red pointer for set points
5. Over range : 150 % of maximum pressure
6. Adjustments :
 - a) Internal Set Point
 - b) Differential adjustment
7. End Connection : 1/2" NPT bottom connected
8. Switch configuration : Two SPDT (240V, 5A AC/220V, 0.5A DC)
9. Switch Type : Snap acting, shock & vibration proof
10. Terminal Block : Suitable for full ring lugs
11. Enclosure Class : IP-65 (Explosion proof for NEC Class-1, Division 1 area)
12. Performance :
 - a) Repeat accuracy $\pm 1.0\%$
 - b) Accuracy of Setting Indication of $\pm 1.5\%$
13. Ambient temperature : 0 – 50 Deg.C

14. Nameplate : Tag number, service engraved in SS tag plate
15. Accessories : a) Silicon oil/ Fluorolub filled Remote diaphragm seal with SS-316 capillary for corrosive/ viscous/ solid bearing or slurry type fluid applications
b) Snubbers for pulsating fluid applications
c) Siphons for steam and hot water services
d) Retention ring and screws for surface mounting
e) 1/2" NPT 2 Valve SS-316 barstock manifold
f) 1/2" NPT cable gland
16. Applications : During Detail Engineering on Owner's approval

3.02.00 DIFFERENTIAL PRESSURE SWITCH

1. Type : i. Piston for high pressure application
ii. Bellow / Diaphragm for low pressure application
2. Sensing element : SS-316.
material All other wetted part SS316
3. Case Material : SS
4. Setter Scale : Black graduation on white linear scale. Graduation 0-100% with red pointer for set points
5. Over range : 150 % of maximum pressure

-
6.	Adjustments	:	a) Internal Set Point
		:	b) Differential adjustment
7.	End Connection	:	1/2" NPT bottom/ back connected
8.	Switch configuration	:	Two SPDT (240V, 5A AC/220V, 0.5A DC)
9.	Switch Type	:	Snap acting, shock & vibration proof
10.	Terminal Block	:	Suitable for full ring lugs
11.	Enclosure Class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
12.	Performance	:	a) Repeat accuracy $\pm 1.0\%$ b) Accuracy of Setting Indication of $\pm 1.5\%$
13.	Ambient temperature	:	0 – 50 Deg.C
14.	Nameplate	:	Tag number, service engraved in SS tag plate
15.	Accessories	:	a) Silicon oil/ Fluorolub filled Remote diaphragm seal with SS-316 capillary Diaphragm seals for corrosive/ viscous/ solid bearing or slurry type fluid applications b) Snubbers for pulsating fluid applications c) Siphons for steam and hot water services d) Retention ring and screws for surface mounting e) 1/2" NPT 5 Valve SS-316 barstock manifold f) 1/2" NPT cable gland
16.	Applications	:	During Detail Engineering on Owner's

approval

3.03.00 LEVEL SWITCH

3.03.01 FLOAT OPERATED

1. Float material : SS-316
2. Wetted parts : SS-316
3. Float chamber : Stainless steel/Carbon steel, construction welded
4. Float chamber : Side mounted
mounting
5. Fluid connection : Side – Side
6. Fluid connection size : 1" ANSI RF Flange (rubber line, if required)
7. Drain : ½ inch NPT with Plug
8. Pressure rating of chamber : Minimum 1.5 times of design pressure
9. Repeatability : +/- 1.5 mm or better
10. Switch housing : Stainless Steel
11. Switch housing type : IP- 65
12. Type of switch : Snap acting magnetically operated hermetically sealed
13. Switch configuration : 2 SPDT (5A, 240 V AC, 0.5A, 220V DC)
14. Accessories :
 - a) Counter flange, nuts & bolts, suitable gasket etc.
 - b) Steel globe type drain valve
 - c) ½"NPT cable gland

d) Stainless steel nameplate with alpha-numeric engraved for service and tag

15. Application : During Detail Engineering on Owner's approval

3.04.00 FLOW SWITCH

1. Type : Paddle /Piston/Disk
2. Wetted part material : Stainless steel or Hastelloy for acidic application
3. End connection :
 - a) Threaded upto 1" line size with integral Tee
 - b) Flanged for line size > 1 ½"
4. Enclosure material : Stainless Steel
5. Enclosure class : IP 65
6. Switch configuration : 2 SPDT (5A, 240 V AC, 0.5A, 220V DC)
7. Repeatability : 2%
8. Cable connection : ½"NPTF
9. Accessories :
 - a) Tee, Counter flange, nuts & bolts, suitable gasket etc
 - b) ½"NPT cable gland
 - c) Stainless steel nameplate with alpha-numeric engraved for service and tag

3.05.00 RF LEVEL SWITCH

-
1. Type	:	RADIO FREQUENCY
Sensing probe		
2. Material	:	SS-316
3. Mounting	:	Threaded
Application		
4. Temperature	:	250°C (Max.)
Electronic Controller		
5. Input Supply Voltage	:	240V AC $\pm$ 10%, 50 Hz.
6. Relay Output	:	2 SPDT (240V AC, 5A)
7. Ambient Temperature	:	50 °C
8. Enclosure Protection	:	IP-66
9. Enclosure Housing	:	SS
		Normal Level
		Power On
10. Local LED Indication	:	Alarm Level
		Probe Healthy
11. Switching Repeatability	:	$\pm$ 0.5%
		Co-axial cable for probe connection to
		controller
12. Accessories	:	SS Tag plate
		½" NPT Cable Glands
13. Application	:	Solid level

3.06.00 CONDUCTIVITY TYPE LEVEL SWITCH

1. Type	:	Conductivity discrimination
2. Probe MOC	:	SS-316
3. Mounting	:	Flanged on external cage
Application		
4. Temperature	:	250°C (Max.)
5. Test Pressure	:	Two times rated pressure

-
6.	Input Supply Voltage	:	240V AC $\pm$ 10%, 50 Hz. Four independent channel with
7.	Input	:	selectable switching threshold for water conductivity
8.	Relay Output	:	2 SPDT (240V AC, 5A)
9.	Ambient Temperature	:	50 °C
10.	Enclosure Protection	:	IP-65 (Explosion proof for NEC Class-1, Division-1 area)
11.	Enclosure Housing	:	SS HI,LO, HIGH-HIGH, LOW-LOW
12.	Local LED Indication	:	Power Fault
13.	Accessories	:	a) Interconnecting cable from probe to electronics b) Mounting accessories c) External cage d) Washer & Gasket e) ½" NPT Cable Glands f) SS Tag Plate
14.	Application	:	During Detail Engineering on Owner's approval

3.07.00 TEMPERATURE SWITCH

1.	Type	:	Bimetallic or gas filled
2.	Sensing Element Material	:	SS-316
3.	Bulb Material	:	SS-316
4.	Capillary	:	Stainless Steel armored

-
5.	Movement Material	:	Stainless Steel
6.	Case material	:	Stainless Steel with neoprene gasket and clear glass where applicable cover conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
7..	Scale	:	Black graduation on white linear scale. Graduation 0-100% with red pointer for set points
8.	Over range Protection	:	120 %
9.	Instrument connection	:	Bottom
10.	Switch configuration	:	Two SPDT (240V, 5A AC/220V, 0.5A DC)
11.	Switch type	:	Snap acting, shock and vibration-proof
12.	Adjustability	:	Internal Set point adjustable over span range
13.	Compensation	:	a) Capillary compensation with invar wire throughout the capillary length b) Case compensation
14.	Performance		
	a) Scale Accuracy	:	± 1.0 % of full scale
	b) Repeatability	:	< 0.5 % of full range
	c) Response time	:	Less than 40 seconds with thermowell
15.	Capillary length	:	5 meters (minimum) for local mounting/15 meters for local panel mounting
16.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
17.	Accessories	:	Mounting accessories, 1/2" NPT cable gland
18.	Applications	:	During Detail Engineering on Owner's

approval

4.00.00 LOCAL INSTRUMENTS
4.01.00 PRESSURE GAUGE AND DIFFERENTIAL PRESSURE GAUGE

1. Type	:	Bourdon/Bellows/Diaphragm
2. Sensing & Socket	:	SS-316
3. Movement Material	:	SS-316
4. Case Material	:	Stainless steel. IP-65 (Explosion proof for NEC Class-1, Division 1 area)
5. Dial Size	:	Generally 150 mm
6. Scale	:	Black lettering on white in 270 O arc.
7. Window	:	Shatterproof glass
8. Range Selection	:	Normal process pressure: 50~70 % of range
9. Over-range Protection	:	125% of maximum range by internal stop. External stop at zero
10. Adjustment	:	For Zero adjustment (Micrometer screw external) For Range adjustment (Micrometer screw internal).
11. Element Connection	:	Argon welding
12. Process Connection	:	1/2" NPT (M) Bottom for local, back for panel mounting
13. Performance	:	Accuracy of ± 1.0 % of span or better
14. Operating ambient	:	0 - 50 °C
15. Safety Feature	:	Blow out disc /diaphragm at the back
16. Accessories	:	a) Snubbers for pulsating fluid application.discharge b) Stainless steel Diaphragm seals

for corrosive/ viscous/ solid
bearing or slurry type fluid
applications

c) 3-Way SS316 Gauge cock for
pressure gauges

5-valve SS316 manifold from
d) barstock for differential pressure
gauge

Siphons for steam and hot
e) water services

17. Nameplate : Tag number, service engraved in
stainless steel tag plate

4.02.00 LEVEL INDICATOR (FLOAT & BOARD TYPE)

1. Type : Float and Board
2. Float Material : SS-316
3. Float Cable : SS-316
4. Indicator Assembly : Epoxy painted Aluminium
5. Guide wire spring assembly : SS-316 (2 Nos.)
6. Guide Wire Anchor : SS-316
Anodized Aluminium with engraved
marking (Minimum graduation 10mm),
7. Scale Board :
mounting brackets and suitable
hardware required as per tank height
8. Elbow Assembly : Anodized Aluminium
9. Flanges : RF , ANSI 150 , SS (3 Nos.)
10. Accuracy : ± 10 mm or better
11. Accessories : All mounting accessories including
counter flange, nuts & bolts, suitable

gasket etc. as applicable, SS Tag plate

4.03.00 GAUGE GLASS

1. Type : Reflex /Transparent
2. Material :
 Glass : Toughened borosilicate resistant to thermal shock
 Body Material : ~~Carbon Steel~~ Stainless Steel
 Enclosure : IP-65 (Explosion proof for NEC Class-1, Division 1 area)
3. Integral cocks & valves/Fittings :
 i. SS 316
 Rubber lined corrosion resistant
4. :
 ii. stainless steel (for DM/RO service)
5. Vessel Connection : ANSI Flanged SS316
6. Accessories :
 i. Integral cocks
 ii. Drain Valves
 iii. Companion Flanges, Bolts, nuts, gaskets, SS Tag plate
 iv. Illuminating lamps, Mica shield as required
 v. Calibrated scale
7. Pressure rating : Twice the maximum working pressure
8. Temperature : 300 °C
 For larger lengths (greater than 1200mm), additional gauge glasses
9. Other details : shall be provided with minimum of 50 mm overlap.

-
- 4.04.00 SLIGHT GLASS
1. Type : Flap-type.
 2. End connection : Screwed / Flanged
 3. Material
 - a) Body : SS- 304
 - b) Cover plate : SS- 304
 - c) Indicator : SS- 316
 4. Sight Glass : Toughened Borosilicate
 5. Gasket : Neoprene
 6. Bolts & Nuts : High tensile steel.
 7. Hydraulic Test Pressure : 1.5 times maximum working pressure
 8. Accessories : Companion Flanges, Bolts, nuts, gaskets as required, SS Tag plate.
- 4.05.00 ROTAMETER
1. Type : ON-LINE for line upto and including 50 mm NB.
: Borosilicate BY-PASS for line size above 50 NB
 2. Metering tube : Toughened Borosilicate
 3. Float : SS-316
 4. End fittings : SS-316
 5. Packing material : Teflon / PTFE
 6. Casing : Stainless Steel
 7. Gland Rings : Stainless Steel
/Followers/ Other wetted parts
 8. Orifice Plate : Stainless Steel (for bypass type)
 9. Operating Temperature : 0-50 Deg. c

10. Test Pressure	:	200% of maximum operating pressure
11. Scale	:	250 mm nominal length
12. Graduation	:	Direct reading
13. Process Connection	:	Flanged (RF) to line size as per ANSI standards (150#)
14. Tapping	:	D & D/2
15. Accuracy	:	+/- 2% of full scale reading
16. Reproducibility	:	Within 0.5% of instantaneous reading
17. Accessories	:	SS Tag Plate, orifice plate

5.00.00 TEMPERATURE ELEMENTS & ACCESSORIES

5.01.00 RESISTANCE TEMPERATURE DETECTOR

1. Type	:	Platinum (Duplex), Ungrounded
2. Platinum (Duplex), Ungrounded	:	100 ohm at 0 °C
3. Base	:	Wound on ceramic (anti-inductive)
4. Wiring	:	3 Wire
5. Protecting Tube		
a) O.D.	:	6 mm
b) Material	:	SS-316, Seamless
c) Filling	:	Magnesium oxide (Purity above 99.4%).
6. Response time	:	a) 15 sec. (bare). b) 30 sec. (with thermowell)
7. Calibration	:	DIN 43760
8. Accuracy	:	± 0.5%
9. Head		
a) Type	:	IP-65 universal screwed type

- b) Material : Stainless Steel
- c) Terminal : Nickel plated Brass-screw type / silver
blocks : plated
- d) Cable : ½" NPT gland and grommet
connection
- e) Others : Terminal head cover with SS chain and
suitable gasket.

Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter (as applicable).

- Adjustable nipple-union-nipple
- 10. Accessories : a) [1/2" Sch 80 X ½" NPT] with
thermowell connection
- b) Compression fittings/unions
- Flanges etc. (for flanged
- c) connections only)
- Thermowell (As specified
- d) below)
- 11. Thermowell connection : ½" NPT (M) or 150 RF Flanged
- Tag number, service engraved in
- 12. Nameplate : stainless steel tag plate

Note: The specifications for RTDs of winding/ bearing of motor/pump, can be as per their manufacturer standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice. However, the type of RTD shall be Pt-100.

5.02.00 THERMOCOUPLES

1. Type :
 - a) 16 SWG wire of Chromel Alumel) (Type-K)
 - b) Duplex
 - c) Ungrounded
2. Protecting Tube
 - a) O.D. : 6 mm
 - b) Material : SS-316, Seamless
 - c) Filling : Magnesium oxide (Purity above 99.4%).
3. Response time :
 - a) < 20 seconds for measurement
 - b) < 10 seconds for control
4. Accuracy : $\pm 1.1^{\circ}\text{C}$ up to 300°C & 0.4% of measured temperature range above 300°C
5. Head
 - a) Type : IP-65 universal screwed type
 - b) Material : Stainless Steel
 - c) Terminal blocks : Nickel plated Brass-screw type / silver plated
 - d) Cable connection : $\frac{1}{2}$ " NPT gland and grommet
 - e) Others : Terminal head cover with SS chain and suitable gasket.

Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter (as applicable).

7.	Accessories	:	a) Adjustable nipple-union-nipple [1/2" Sch 80 X 1/2" NPT] with thermowell connection b) Compression fittings/unions c) Flanges etc. (for flanged connections only) d) Thermowell (As specified below)
8.	Thermowell connection	:	1/2" NPT (M) or 150 RF Flanged
9.	Nameplate	:	Tag number, service engraved in stainless steel tag plate

5.03.00 TEMPERATURE GAUGE

1.	Type	:	Expansion type (Liquid filled system)
2.	Sensing Element Material	:	Bourdon – SS-316
3.	Bulb and Capillary Material	:	SS-316
4.	Capillary Tubing	:	Inner sheath - solid drawn Material copper tube Outer sheath - PVC tube
5.	Movement Materials	:	Stainless Steel / Direct Bourdon tip connection to pointer spindle
6.	Case Material	:	Stainless Steel stove enameled, black finish, threaded bezel ring, clear glass

- cover conforming to IP 65.
7. Dial size : 150 mm
 8. Scale : Black lettering on white background in 270 Deg.C arc
 9. Over range protection : 125 percent of FSD
 10. Capillary Glanding : 1/2" NPT(M) x compression fitting (SS) to suit capillary
 11. Instrument Connection : Bottom connection for local mounting, back connection for panel mounting
 12. Process Connection : 1/2" NPT (M) or 150 RF Flanged
 13. Extension Neck Length : 50 mm
 14. Compensation : a) Capillary compensation
 15. : b) Case compensation
 16. Performance : a) Accuracy : + /- 1.0 percent of full scale Deflection
 - : b) Repeatability : Less than 0.5 percent of full range
 - : c) Response time: 15 seconds (max.).
 17. Capillary length : 3.0 meters (local) / 15.0 metres (local panel)
 18. Other features : Shatter proof glass
 19. Nameplate : Tag number, service engraved in stainless steel tag plate
 20. Accessories : SS316 Thermowell

5.04.00 THERMOWELL

1. Material : SS-316
2. Manufacture : Drilled from bar stock, Hex Head, Tapered design (As per ASME PTC 19.3)

3.	Process connection	:	M33x2
4.	Certification	:	Not applicable
5.	Bore concentricity	:	+5% of wall thickness
6.	Identification mark	:	Tag number punched on head
7.	Surface treatment	:	Polish after machining
8.	Element connection	:	½" NPT (M) or 150 RF Flanged
9.	Head	:	Hex
10.	Length of the hex head	:	31.75 mm (min.)
11.	Accessories	:	SS Plug and chain for test thermo wells SS Nameplate, Flange with companion flange & all required accessories for flanged connections.

Note: Wake frequency calculations shall be furnished for all thermowells for approval.

Thermowells shall be designed such that the resonant frequency is above the exciting frequencies generated by vortex shedding in the process fluid.

5.05.00 METAL TEMPERATURE THERMOCOUPLE

1.	Measuring medium	:	Metal temperature
2.	Type	:	Chromel Alumel (Type-K) Duplex, Ungrounded
3.	Insulation	:	Mineral Insulation Magnesium Oxide
4.	Wire gauge	:	16 AWG
5.	Protective sheath	:	SS
6.	Protective sheath diameter	:	8 mm O.D.
7.	Characteristics	:	Special limits of error as in ANSI thermocouple MC 96.01
8.	Accessories	:	½" BSP SS sliding end connector, weld pad, clamps of heat resistant steel

1.	Type	:	Hydrometer Type
2.	Mounting	:	On line
3.	Accuracy	:	+/- 2% of range
4.	Scale	:	Black letter on white scale
5.	End connection	:	PVC flange

9.06.00 DENSITY/ CONCENTRATION METER

1.	Wetted Part		Stainless Steel
2.	Enclosure		Stainless Steel (IP-65)
3.	Power Supply		24 V DC
4.	Output signal	:	4-20 mA DC (isolated) into 600 ohms
5.	Accuracy		±0.001 g/cc
6.	Indication	:	LCD display
7.	Temp. Compensation	:	Integral
8.	Accessories		Mounting hardware, integral amplifier (if required), cable glands, tag plate etc.

10.00.00 SOLENOID VALVES

1.	Operating Principle	:	Electromagnetic (noiseless)
2.	Coil voltage rating	:	240 V AC /24 V DC (as required)
3.	Ways	:	2/3/4 way
4.	Port size	:	1/4" NPT all ports
5.	Body	:	SS bar stock
	Trim	:	SS-316
6.	Duty	:	Suitable for continuous energization
7.	Sealing	:	Airtight and leak proof
8.	Ambient Temperature	:	0 - 50 ° C

-
9.	Fluid Temperature	:	0-150 ° C (approx.)
10.	Coil Enclosure	:	Stainless Steel
11.	Insulation	:	Class-H
12.	Coil Casing	:	IP-65 (Explosion proof for NEC Class-1, Division-1 area)
13.	Mounting	:	On pipe or on panel
14.	Cable Connection	:	½" NPT
15.	Accessories	:	Cable glands, SS Tag plate



Technical specification for
CONTROL & INSTRUMENTATION

4 X 270 MW BHADRADRI TPS

SPEC NO.: **PE-TS-411-145-I**

VOLUME

SECTION

REV. NO.

00

DATE : 19.03.2015

SHEET

OF

Instrumentation Check List



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR PRESSURE SWITCH

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	V	V	
	1.1 MODEL NO/TAG NO						
	1.2 RANGE						
	1.3 END CONN						
	1.4 NO. OF CONTACT						
2	CALIBRATION			P	V	V	
	2.1 REPEATABILITY						
	2.2 SET POINT ADJUSTMENT						
	2.3 DIFFERENTIAL						
3	OVER PR & LEAK TEST		P	V	V		
4	ELECT. INSULATION/HV TEST	ONE		P	V	V	
5	REVIEW OF TC FOR MATERIALS OF	FOR LOT		V	V	V	
	5.1 SENSOR						
	5.2 MOVEMENT						
	5.3 PROCESS CONNECTION						
	5.4 HOUSING						
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	V	
7	REVIEW OF TC OF MICROSWITCH	FOR LOT		V	V	V	

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to carry out ROUTINE TEST on 100 %.
- Contractor to provide compliance certificate for tests/checks verified by contractor and the same alongwith test certificates to be verified by BHEL



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR TRANSMITTER

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECKS FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	VISUAL.						
	MODEL/TAG No						
2	PROCESS CONNECTION			P	W	V	
3	ACCURACY			P	W	V	
4	REPEATABILITY			P	W	V	
5	HYSTERESIS			P	W	V	
6	EFFECT OF TEMP VARIATION ON ACCURACY			P	W	V	
7	SPAN / ZERO ADJUSTMENT	ONE / TYPE		P	W	V	
8	EFFECT OF SUPPLY VOLTAGE VARIATION			P	W	V	
9	EFFECT OF LOADING (500 OHM METERS)			P	W	V	
10	HIGH PRESSURE TEST	SEE NOTE-1 BELOW		P	W	V	
11	BURN-IN TEST	ONE / TYPE		P	W	V	
12	DEGREE OF PROTECTION			P	W	V	
13	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW		V	V	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL,
P = Perform, W = Witness, V = Verification

Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- When material correlation are not available manufacturer's compliance to be provided.
- Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR PRESSURE & DP GAUGE

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	SENSOR TYPE						
	DIAL SIZE						
	MODEL NO/TAG NO						
	RANGE/SCALE						
	SWITCH CONTACT RATING & NOS.						
	END CONNECTION						
2	CALIBRATION			P	W	V	
	ACCURACY						
	REPEATABILITY						
	SET POINT ADJUSTMENT						
3	OVER PRESSURE & LEAK TEST			P	W	V	
4	OPERATION OF PRESSURE. RELIEF DEVICE	ONE		P	W	V	
5	REVIEW OF TC FOR	FOR LOT		V	V	V	
	MATERIALS OF SENSOR						
	MOVEMENT						
	PROCESS CONNECTION						
	HOUSING						
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	V	
7	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW		V	V	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Manufacturer to carry out ROUTINE TEST on 100 %.
- When material correlation is not available, MFR's compliance to be provided
- Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR LEVEL GAUGE

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS / DRWGS	P	W	V	
	TYPE						
	MODEL/ TAG NO.						
	DAIL SIZE						
	RANGE/SCALE						
	END CONNECTION						
2	DIMENSIONS, PROCESS CONNECTION	ONE / LOT		P	W	V	
3	ACCURACY			P	W	V	
4	MATERIAL TC FOR			P	V	V	
	BODY ISO.						
	VALVE						
	GAUGE GLASS						
5	HYD. TEST	SEE NOTE-1 BELOW		P	W	V	
6	ACCESSORIES AS APPLICABLE			P	W	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL,
P = Perform, W = Witness, V = Verification

Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Manufacturer to carry out ROUTINE TEST on 100 %.
- Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR ANNUNCIATORS

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	TYPE/ MODEL						
	DIMENSIONS OF HARDWARE						
	MODULARITY						
	SEQUENCE						
	FACIA DETAILS						
2	FUNCTIONAL TEST	100%		P	W	V	
3	IMMUNE TO STEP VARIATIONS IN THE POWER SUPPLY	SEE NOTE-1 BELOW		P	W	V	
4	DEGREE OF PROTECTION FOR ENCLOSURE	TYPE TEST		P	W	V	
5	I/R CHECK	SEE NOTE-1 BELOW		P	W	V	
6	RESPONSE			P	W	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL,
P = Perform, W = Witness, V = Verification

Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Manufacturer to carry out ROUTINE TEST on 100 %.
- Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.



Technical specification for
CONTROL & INSTRUMENTATION

4 X 270 MW BHADRADRI TPS

SPEC NO.: **PE-TS-411-145-I**

VOLUME

SECTION

REV. NO.

00

DATE : 19.03.2015

SHEET

OF

LCP & JUNCTION BOXES SPECIFICATION

1.00.00 GENERAL REQUIREMENT

1.01.00 ENCLOSURES FOR INSTRUMENTS AND OTHER EQUIPMENT

1.01.01 All panels, cabinets, distribution boxes, junction boxes, terminal boxes and all other field mounted equipment / enclosures shall have suitable environmental protection as detailed in Section-I of this volume of the specification.

1.02.00 SURFACE PREPARATION & PAINTING

1.02.01 All sheet metal panel/ desk exterior steel surfaces shall be sand blasted, ground smooth and painted as specified below.

1.02.02 Suitable filler shall be applied to all pits, blemishes and voids in the surface. The filler shall be sanded so that surfaces are level and flat; corners are smooth and even. Exposed raw metal edges shall be ground burr-free. The entire surface shall be blast clean to remove rust and scale and all other residue due to the fabrication operation. Oil, grease and salts etc. shall be removed from the panels by one or more solvent cleaning methods prior to blasting.

1.02.03 Two spray coats of inhibitive epoxy primer surfacer shall be applied to all exterior and interior surfaces, each coat of primer surfacer shall be of dry film thickness of 1.5 mil. A minimum of two spray coats of final finish color (Catalyzed epoxy or polyurethane) shall be applied to all surface of dry film thickness 2.0 Mil. The finish colors for exterior and interior surfaces shall conform to the following shades:

- Exterior – Opaline green shade 275 of IS: 5 or equivalent international code..
- Interior - Brilliant White.

1.02.04 Paint films, which show sags, cheeks, blisters, teardrops, fat edges or other painting imperfections, shall not be acceptable.

1.03.00 WIRING

1.03.01 All spare contacts of relays, switches and push buttons shall be wired up to the terminal blocks. All intercommunications between sections of panels/desks shall be furnished.

1.03.02 Each wire shall be identified at both ends with wire designation as per approved wiring diagram. Heat shrinkable type ferrules with indelible computerized ink print shall be used with cross- identification.

1.03.03 All wire termination shall be made with insulated sleeve and crimping type lugs. Wire shall not be spliced or tapped between terminals. Open-ended terminal lugs will not be accepted. Wires shall not be looped around the terminal screws or studs.

- 1.03.04 Internal wiring should be terminated uniformly on one side of the terminal block leaving the other side available for termination of outgoing cables. Internal wiring shall be grouped so that all outgoing wiring to each particular remote location is terminated on adjacent terminal blocks. Interior wiring and jumperings shall be arranged so that external connections can be made from internal side of terminal blocks. Common connections shall be limited to two (2) wires per terminal.
- 1.03.05 Wiring shall be arranged to ensure free access to all instrument or devices for maintenance. No wire shall be routed across the face or rear of any device in a manner, which will impede the opening of covers or obstruct access to leads, terminals or devices
- 1.03.06 Wires shall be dressed and run in trays or troughs with clamp-on type covers. Wirings may be neatly bunched in groups by non-metallic cleats or bands. Each group shall be adequately supported along its run to prevent sagging or strain on termination.
- 1.03.07 Shield wires shall be terminated on separate terminal blocks. Common connections shall be limited to two wires per terminal. Signal circuit shields shall be grounded at the power supply end only or as recommended by manufacturer.
- 1.03.08 All low level signal cables shall be separately bundled to from control cable and maintained at 300 mm minimum spacing from control bundles.
- 1.03.09 Panel internal wiring shall follow distinct color-coding to segregate different voltage levels viz. 24V DC, 48V, 110V AC, 240V AC, 220V DC etc.
- 1.03.10 Thermocouple lead wires, analyzer measuring lead wires, or any other lead wires carrying measuring signal of the order of low milli volt or micro volt shall be electrically and physically isolated from other AC and DC wiring. Shielded wires used in such cases for panel internal wiring shall be continuous and ungrounded with the shield terminated individually and separately in panel terminal block.
- 1.03.11 Wiring to door mounted devices shall be provided with multi-strand wires of (49 strands minimum) adequate loop lengths of hinge-wire so that multiple door openings will not cause fatigue failure of the conductor.
- 1.03.12 Internal wiring in factory pre-wired electronic systems cabinets may be installed according to the Contractor's standard wire size, insulation, and method of termination on internal equipment. Insulation for all wiring, including circuit board wiring, back panel wiring, power supply wiring and interconnecting cables between devices shall pass the vertical flame test per IPCEAS-1981. Identification of conductors may be done by insulation color-coding identified on drawings or by printed wiring lists.

1.04.00 TERMINAL BLOCKS

- 1.04.01 All terminal blocks shall be rail mounted/ post mounted type, cage clamp type with high quality non-flammable insulating material of melamine suitable for working temperature of 105 Deg C. The terminal blocks in field mounted junction boxes, instrument enclosures racks etc. shall be suitable for cage clamp connections. The terminal blocks in Control Equipment Room termination/ marshalling cubicles shall be suitable for post mounted cage clamp connection at the field input end. The exact type of terminal blocks to be provided by Bidder shall be subject to Owner.
- 1.04.02 All terminal blocks shall be provided complete with all required accessories including assembly rail, locking pin and section, end brackets, small partitions, transparent covers, support brackets, distance sleeves, warning level, marking etc. For RTDs ring - tong type lugs shall be used at Junction Boxes.
- 1.04.03 The characteristics of the terminal blocks shall be as follows.
- i) High contact force, independent of conductor cross-section and large contact surface area.
 - ii) Integrated self-loosening protection to avoid shifting of contact surface that may allow contamination of connection point.
 - iii) Inspection and maintenance free (resistant to thermal aging and vibration)
 - iv) Low and constant voltage drop
- 1.04.04 The insulation of the terminal blocks shall be of suitable thermoplastic material.
- 1.04.05 The spacing between Terminal blocks channels in panels and cubicles shall be adequate for routing the cable troughs and to allow adequate free workspace for termination and removal of wires. The terminal blocks shall be arranged with atleast 100 mm clearance between two sets of terminal blocks and junction box walls.
- 1.04.06 Signals of different voltage levels shall be clearly segregated by providing separate rows to each type of signal and by using terminal blocks of different color for each type of signal and by providing barrier strips between them.
- 1.04.07 Terminal blocks shall be provided with white marking strips / self-adhesive marker cards and where permitted by the safety codes and standards, shall be without covers. Power terminals and high voltage (above 48 volts) terminals shall have protection covers. All terminals shall be provided with permanent terminal identification numbers on both sides.
- 1.04.08 At least 20% spare unused terminals shall be provided on each terminal block for circuit modifications and for termination of all conductors in a multi-conductor control cable.

- 1.04.09 The bottom of the terminal block shall be at least 200 mm above the cable gland for bottom entry type panels.
- 1.04.10 For extending 24 V DC supply to panels, the size of the terminals shall be decided based on voltage drop and not based on current.
- 1.04.11 Other requirements of the terminal blocks are as follows:
- i) The last terminal in a rail-mounted assembly shall be closed with an end plate and end bracket.
 - ii) For visual and electrical separation of terminal groups, partition plates shall be provided, which can be push fitted after forming an assembly.
 - iii) Design shall permit testing of incoming and outgoing signals by using suitable test plug and socket without disconnecting the cable connections.
 - iv) It shall be possible to use jumper plugs through the above test plug socket to connect adjacent terminals. Adequate number of short circuit jumper plugs shall be provided for the purpose.
 - v) Where more than one connection to a terminal block is required, two tier terminals shall be used.
- 1.05.00 **GROUNDING**
- 1.05.01 Separate Protective and Electronic system ground as required shall be provided.
- 1.05.02 All panels, desks, cabinets shall be provided with a continuous bare copper ground bus (Frame ground), bolted to the panel structure at bottom on both sides and effectively ground the entire structure. The bolts shall face inside of panels.
- 1.05.03 For electronic system cabinets the electronic system ground bus (Electronic ground) shall be similar but insulated from the cabinet and shall be separately connected to the system ground. The same ground may be used to earth the shield of shielded signal cables, otherwise a separate ground bus shall be provided for connecting the signal cable shields. Cable shields shall be grounded at the panel end only and shall never be left open. The electronic ground between panels of a shipping section shall be firmly looped.
- 2.00.00 **CONTROL DESKS & PANELS**
- 2.01.00 **GENERAL**
- 2.01.01 All control desk, panels etc. shall be furnished fully wired with necessary provision for convenience outlets, internal lighting, utility receptacles, grounding, ventilation, space heating, anti-vibration pads, internal piping &

accessories as required for completeness of the system.

- 2.01.02 The design shall conform to the EN ISO 11064 (Ergonomical design of Control Room), Part 1, 2 and 3.
- 2.01.03 The exact dimensions, material, construction details, grounding, general arrangement etc. shall be as per actual requirement and shall be finalized during detail engineering and subjected to Owner's approval.
- 2.01.04 Incoming power supply feeders shall be duplicated. Alarm shall be provided for failure of a power supply feed.
- 2.01.05 For Control desk/ panel mounted instruments/ devices etc. which are to be powered from UPS, all required conversion of interface equipments/ accessories to make such devices compatible with UPS supply shall be provided. All necessary hardware like input switches/ fuse unit for each feeder as well as switch fuse unit for each instrument/ device on the power supply line shall be provided. From UPS redundant feeders shall be provided with suitably rated MCB and provision of fast auto changeover of UPS feeders.
- 2.01.06 Crating of the panels and desks shall be suitable for protection against shock, vibration, inappropriate handling and inclement weather conditions during transportation and warehousing. Mounted equipment shall have adequate protection against damage during handling, transit and storage. Suitable desiccant shall be used inside the packing case.
- 2.01.07 Nameplate
- a) Nameplate shall be provided for instrument or device mounted on the panel.
 - b) Nameplates for panels shall be provided both in front and rear.
- 2.02.00 CONTROL DESK
- 2.02.01 Control desk shall be free standing, floor mounting, table top type with doors at back and shall be constructed of 3 mm thick (minimum) CRCA steel or Aluminium extrusion. Aluminium structure shall be anodized or powder coated paint finish. The top surface of control desk shall be 30 mm (minimum) thick with the top 12 mm (minimum) of acrylic solid surface and the remaining 18 mm of laminated medium density fibre (MDF) board.
- 2.02.02 Monitors with retractable keyboard shall be provided on the desk. Desk shall be arranged in arc-like shape without any sharp edges. Edges shall be extruded PVC or rounded post-formed laminate.
- 2.02.03 Desks shall be of modular, scalable and industrially ruggedized design and shall have connections for PA system handsets & telephone sets.
- 2.02.04 Desks shall have concealed cable trays for wire dressing. Both Horizontal & Side Managers (2 separate horizontal cable routing wire baskets for power & data cables) shall be provided.

Each User station will be provided with 2 separate power distribution units (1 for Main line & 1 for UPS line). Each power distribution unit will have 6 points of 5/13 Amp sockets, Mains MCB On/Off Switch & Indicator.

Adequate heat management provision for Exhaust of heat from within the Console Desk Assembly shall be provided. There will be multiple fans provided in the Main Control Desk. Each Fan will be of 230 VAC 250 CFM Ball Bearing based. Ventilation louvers will be provided on both Front & Rear Modesty with special Air Filters. Adequate space for CPU & Other equipments placed with in the desk.

- 2.02.05 Design shall include Earthing bolts.
- 2.02.06 Back installed items shall be suitably concealed from front view.
- 2.02.07 All operator workstations for SG, TG, Auxiliaries & Off-site Plants shall be mounted on this Control Desk. The cabling / wiring between OWS & CPUs, power supply cables etc. shall be aesthetically routed and concealed from view.
- 2.02.08 **HARDWIRED DEVICES ON CONTROL DESK (DRAW OUT SECTION)**

Release and Lamp Test push buttons shall be provided for a set of push buttons (decided during detail engineering stage). Depending on the type of control/ function, required number of push buttons/ indicating LEDs & their color, push button stations shall be selected. The size of push button stations shall be 24 x 48 mm or 25 x 50 mm and shall have service inscription details at the front. Emergency push buttons (with cover) shall be mounted on top of Control Desk.
- 2.03.00 **BACK UP PANEL**
- 2.03.01 Construction shall be from CRCA steel of thickness not less than 3mm.
- 2.03.02 Upright back-up panel shall be provided where hardwired devices shall be mounted on a mosaic grid type console. The mosaic grid tiles shall be of 24 mm x 48 mm (or 25 mm x 50 mm) size, made of heat & flame retardant, self extinguishing and non-hygroscopic material with flat matt finish without glare and non reflecting type.
- 2.03.03 DDCMIS Back-up Panel (referred as Unit Control Panel-UCP) shall also mount annunciation fascia (minimum 500 nos.) and the flame monitoring cameras along with other hardwired devices as decided during detail engineering stage by Owner. Color coding shall also subject to Owner's approval.
- 2.03.04 Colored Mimic for different Off-site plant control systems (as enumerated elsewhere in this specification) and hardwired annunciation system shall also

be mounted on the back up panels.

2.04.00 PANELS/CABINETS

2.04.01 All DDCMIS system modules, power supply components and other Local Control panels (PLC/Relay based) shall be housed in cabinets as specified below.

2.04.02 The cabinet mounted equipments shall be fully assembled, installed in mounting racks, wired and fully tested as per specification requirements and Owner approved drawings prior to shipment to the project site.

2.04.03 The Bidder shall ensure that the cabinets are complete & ready for installation before dispatch from manufacturing works. The installation work at project site for these cabinets shall only involve connections through multi-pair cables from marshalling cabinets (wherever provided) to system cabinets and inter-cabinet/cabinet to Control Desk/ Back up Panel.

2.04.04 All electronic cards, network components, power supply modules etc. located shall be suitably housed in cabinets and shall be neatly arranged in sub-racks. Network components shall be visible in door closed condition (e.g. Glass doors etc.) as approved by Owner.

2.04.05 Bidder shall design the cabinet internal arrangement, floor cutout and cable gland plate such that all the cables entering or leaving the cabinet can be properly glanded in the gland plate.

2.04.06 The packaging density of panels shall be such that the temperature rise within the panels shall never exceed 10°C above ambient even under worst operating conditions. Cooling Fans shall be provided wherever required and this shall be of industrial grade.

2.04.07 TECHNICAL PARTICULARS

1.	Material of Construction	:	Cold Rolled Steel Annealed (CRCA) steel sheet
2.	Thickness of Sheet	:	a) 2.0 mm for faces supporting instruments / terminals b) 1.6 mm for other sides and top
3.	Construction	:	Welded throughout as per approved National Standards
4.	Post welding operation	:	a) Grounding of all welds to smoothness b) Rounding of corners

	:	c) Cleaning of weld spatters
5. Panel height	:	2300 mm (approx)
6. Corners	:	7 mm inner radius
7. Dimensional Tolerances	:	a) In height & length - 3 mm b) In height between adjacent sections - 2 mm c) Total for a group - 6 mm
8. Doors	:	Double, recessed, turned back edges, full height front & rear
i) Thickness of Sheet	:	2 mm
ii) Hinges	:	Stainless steel
iii) Door latches	:	Three point type
iv) Door gaskets	:	Neoprene rubber on fixed frame to result dust proof/weatherproof enclosure
v) Opening of the doors	:	Outward
vi) Louvers	:	With removable wire mesh to ensure dust and vermin proof
9. Gland plates	:	Removable in sections 4 mm thick (bottom)
10. Cable entry	:	Bottom
11. Hardware	:	a) Anti vibration pad- 15 mm b) Predrilled base channel ISMC – 100 or equivalent for all sides c) Stainless steel buff- finished 2 mm thick kick plate for all sides d) Stainless steel scratch strips along desk edges fixed with pan-head recessed screws e) Rubber strips to ensure air

tightness between kick plate and finished floor

f) Lifting hook / Eye bolt

g) Drawing pocket

Door switch, lamps, thermostat,
h) heaters and industrial grade cooling fans,, illumination fixtures

12. Name Plate : Both at front and back surface of the panel

13. Fixing of name plate : Stainless steel pan head screws

14. Name plate material : Laminated phenolic (3 layers)

15. Lettering : Black with white engraved

16. Mounting of terminal blocks : Vertical angle support bracket tack welded on sheet steel plate, screwed on internal wall of enclosure

2.05.00 FURNITURE

All the furnitures in the Central / Local control Room (s), Engineers' rooms, Instrument laboratory , SWAS Room & any other rooms with C&I equipments located in different plant buildings under Bidder's scope shall be included in Bidder's scope of supply. Bidder shall provide following industrial grade furniture items as a minimum from reputed manufacturers/suppliers meeting International Standards. The furniture shall be modular and latest with ease of operational features. The furniture shall be modern, aesthetically designed, modular, flexible, space saving and future safe.

2.05.01 WORK STATION FURNITURE

Modular work station furniture, suitable for mounting servers & historians, programmer stations, PC based systems, printers (A4/A3 color laserjet) etc. shall be provided.

2.05.02 PC RACK

PC Racks shall be provided to mount CPUs of workstations/PCs of OWS/LVS etc. in control room. For each PC / workstation / monitor at least one chair shall be included.

2.05.03 CHAIRS

Industry standard revolving chairs with wheels and with provision for adjustment of height (hydraulically/gas lift) shall be provided for the operators, unit-in-charge & other personnel in control room area. These shall be designed for sitting for long duration such that these are comfortable for the back.

2.05.04 TABLES

Industry standard computer tables shall be provided & shall be as approved by Owner during detailed Engineering. Glass top teak wood horse shoe shaped table with vertical file mounting arrangement (two layers to house approx. 40 Nos of files and lockable drawers at both ends) for Engineering Room shall be provided.

2.05.05 ALMIRAHs

Steel Almirahs shall be provided for keeping documents in the documentation room. Glass doors for each rack shall be provided such that the documents are visible from outside. Size of the rack shall be sufficient to easily fit technical manuals. The exact details shall be approved by Owner during detailed Engineering.

2.05.06 KEYPAD

One keypad per unit shall be provided for the storing of keys of relevant areas of the unit in the control room.

2.05.07 LOCKERS

Suitable lockers shall be provided in the room adjacent to the control room for storing of personal articles of control room personnel. Also, lockers of bigger size shall be provided in documentation Room for storing of personal documents. Details shall be finalized and approved by Employer during detailed engineering.

3.00.00 LVS PANEL

3.01.00 An arc shaped Large Video Screen (LVS) panel shall be supplied for mounting large video screens in number of tiers in various Control rooms as specified elsewhere in this specification.

Bidder shall provide and fix ACP cladding around the LVS screen including covering the LVS back side and LVS stand. The cladding will be from floor finish to 600 mm above LVS screen like a self-standing partition with necessary openings for system requirement. ACP paneling shall be with 304 grade & approx. 0.5 mm mirror finish SS strip.

3.02.00 The profile, dimensions and the general arrangement shall be finalized & approved by Owner during detailed engineering. Recommendations, if any, for the control room lighting in order to ensure continuous proper viewing of the LVS screen by the operator & shift incharge (without any fatigue) shall be

- clearly brought out by the Contractor in his offer, alongwith all relevant details/basis.
- 3.03.00 Any other requirement for proper LVS mounting & functioning & viewing shall also be specifically brought out by the Contractor in his offer, along with all relevant details.
- 4.00.00 **LOCAL INSTRUMENT RACK (LIR) & LOCAL INSTRUMENT ENCLOSURE (LIE)**
- 4.01.00 GENERAL
- 4.01.01 Devices (Transmitters/ Switches) located in the field shall be suitably grouped together to the extent possible and installed in the LIE (Closed Rack) and LIR (Open Rack) in Boiler/TG Building and Off-site plant areas.
- 4.01.02 Racks and enclosure shall be factory prefabricated & painted and shall complete with internal piping, tubing, manifold, isolation valves, blowdown valves, integral junction box, illumination etc.
- 4.01.03 No more than six instruments shall be grouped in a single rack / enclosure.
- 4.01.04 Racks shall be installed above the tapping points for air, flue gas and coal air mixture application whereas for applications such as for water and steam, racks to be installed below the source point.
- 4.01.05 Attention shall be paid in the layout to avoid air traps in liquid piping and water accumulation in air /gas piping.
- 4.01.06 Racks used for furnace, flue gas and air application shall be provided with intermittent & continuous air purging
- 4.01.07 Welding of impulse lines shall comply with the provisions of the latest applicable ANSI Code for Pressure Piping.
- 4.01.08 Earth stud shall be furnished at rack for safety grounding.
- 4.02.00 LOCAL INSTRUMENT ENCLOSURE (LIE)
- 4.02.01 Enclosure shall be free standing type. Racks shall be adequately reinforced to ensure true surfaces and to provide support. Major load - bearing posts shall be suitably supported by gusset plates or moment members.
- 4.02.02 Enclosure outer shall be constructed from at least 3 mm thick steel plate and epoxy painted to shade gray. Base frame shall be made of ISMC 100 and black colour finish.
- 4.02.03 2" NB galvanized pipes shall be laid horizontally and supported at two end channels to mount transmitters at accessible height. Center posts or any

member, which would reduce access, shall be avoided.

- 4.02.04 Double leaf interlocking front opening doors with three point locking shall be provided and shall be arranged for maximum possible access to the interior. Key shall be of identical for all enclosures.
- 4.02.05 Doors shall have concealed quick removal type pinned stainless steel hinges and locking handles. Gaskets shall be used between all mating sections to achieve dust and weather proof enclosure rated for IP-65 including the internal junction box. All enclosures shall have access doors on front side.
- 4.02.06 Removable type bulkhead plates of thickness not less than 6 mm shall be mounted at the racks with suitable high temperature gasket. Impulse lines within the enclosures shall be properly clamped.
- 4.02.07 All internal wirings between the instruments and junction box shall run through flexible conduits. No exposed wirings within transmitter racks both open and closed type, is admissible.
- 4.02.08 Racks shall have a common blowdown drain header, which will connect individual instrument blowdown line after suitable pressure breaking through regulating globe type blowdown valves. Covered funnels shall be used for saturated liquid and steam service, whereas, open funnels may be used for cold liquid services. Header (2" NB ASTM A 106, Sch-80 Gr. C) shall be suitably sloped and shall have one end flanged and extending beyond the rack for connection to plant drain header..
- 4.02.09 Each rack shall be provided with one receptacle, light fixtures with wire guard and one lighting switch each at instrument & Junction box compartments with wire guard. Lighting switches may be door actuated & mounted inside the panel. Outlet box, switch box and device covers shall be of galvanized stamped steel. Light switches and receptacles shall be installed inside the enclosure on the wall near the latch side of the enclosure door. Light fixtures shall be installed on the ceilings of the enclosures.
- 4.02.10 Power supplies for miscellaneous devices shall be provided with MCB located within the enclosures. MCB shall be mounted in fuse blocks. Nameplates shall be furnished above the MCB blocks, identifying the devices being served.
- 4.02.11 Vibration dampeners shall be installed for supporting each enclosure. The loading at each corner of the enclosure shall be determined by actual test weighting when construction is complete to determine the correct length of each dampener for proper loading of the dampener in accordance with manufacturer's recommendations
- 4.03.00 LOCAL INSTRUMENT RACK (LIR)
- 4.03.01 Rack shall be free standing type constructed from 6 mm thick steel channel frame provided with a canopy to protect the instrument from dripping water or

falling objects and shall be epoxy painted. Canopy shall be of CRCA steel sheet of at least 3 mm thickness.

- 4.03.02 Rack Major load-bearing posts shall be suitably supported by gusset plates or moment members. Suitable fenders grill shall be welded to the end-posts of the rack to outline a boundary beyond which no mounted equipment shall project to protect instrument from accidental contact during personnel movement. Center posts or any member, which would reduce access, shall be avoided.
- 4.03.03 2" NB galvanized pipes laid horizontally and supported at two end channels shall be employed at working accessible height for mounting of instruments.
- 4.03.04 All internal wirings between the instruments and junction box shall run through flexible conduits. No exposed wirings are admissible.
- 4.03.05 Racks shall have a common blowdown drain header, which will connect individual instrument blowdown line after suitable pressure breaking through regulating globe type blowdown valves. Covered funnels shall be used for saturated liquid and steam service, whereas, open funnels may be used for cold liquid services. Header (2" NB ASTM A 106, Sch-80 Gr. C) shall be suitably sloped and shall have one end flanged and extending beyond the rack for connection to plant drain header..

Each rack shall be provided with one receptacle, one light fixture with wire guard and one lighting switch. Outlet box, switch box and device covers shall be galvanized stamped steel. Light fixtures shall be installed on the canopy of the rack

- 4.03.06 Power supplies for miscellaneous devices shall be provided with MCB located within the enclosures. MCB shall be mounted in fuse blocks. Nameplates shall be furnished above the MCB blocks, identifying the devices being served.

4.04.00 JUNCTION BOX

1. Type of Enclosure	:	Dust tight & weatherproof conforming to IP 65
2. Material	:	3 mm sheet steel / fiberglass reinforced polyester(UV stabilized)
3. Type of Cover	:	Solid unhinged with retention chain / Screwed at all four corners
4. Paint	:	i) Exterior : Opaline green shade 275 of IS: 5 ii) Interior - Brilliant Glossy White.

- Surface / Two (2) inch Pipe stanchion
5. Mounting : (At a dry compartment at one side of the enclosure / rack with front opening type door)
6. Cable Entry : 3 mm (min) Bottom / side Gland plate
7. Gasket : Neoprene
8. Grounding : Brass earth lug with green screw head
External-2 nos , Internal-1no. (M6)
9. Number of Drain Holes : Two at bottom capped
10. Identification : Label for JB and Tags for cable
11. Accessories :
- a) Rail mounted cage clamp type screwless terminals (suitable for conductor size up to 2.5sq.mm of suitable voltage grade) with markers and 20% spare terminals
 - b) Cable gland (Brass) & raceways
 - c) Ferrules & lugs (Brass)
 - d) Aluminum back panel
 - e) Canopy at top
 - f) Mounting brackets
 - g) bolts and nuts made of brass etc.

	CONTROL AND INSTRUMENTATION SPECIFICATION FOR PRE-TREATMENT PLANT DATA SHEET FOR LOCAL PANELS		SPECIFICATION NO.: PE-SS-999-145-054A	
			VOLUME	
			SECTION	
			REV. NO. 02	DATE: 16.09.2013
TAG No. Qty.....		SHEET 1 OF 3		
Data Sheet No.: PES-145A-DS1-0				
Data Sheet A & B				
DATA SHEET-A FOR LOCAL PANEL (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
GENERAL	MANUFACTURER			
	CONSTRUCTION		☒ FOLDED ☐ WELDED	
	ENCLOSURE SHEET THICKNESS (As per Section 8.13, Volume V of contract specification)	FRONT	☐ 2.0 mm	
		OTHER	☐ 2.0 mm	
		DOOR	☐ 1.6 mm	
HEIGHT		☐ 2365 mm for stand alone panels. ☐ Other		
	OTHER	☐ Load bearing sheet front shall have 3mm thickness		
TECHNICAL	INPUT POWER SUPPLY * (As per Electrical specification) (ANY OTHER POWER REQUIREMENT TO BE DERIVED FROM THIS SUPPLY ONLY)		☐ 240V 50 Hz AC ☐ 220V DC ☒ 415V 3 PHASE 3W ☐ 400V 3 PHASE 4W	
	NO. OF FEEDERS (As per Electrical specification)		☐ ONE ☐ TWO	
	STARTER WITH MCC		☐ REQUIRED ☒ NOT REQUIRED	
	IPR POSITION		☒ MCC ☐ RELAY PANEL	
	CONTACT RATING OF RELAY		☒ 5 Amp, 230 V AC ☒ 0.25 Amp, 220V DC	
	CONTROL SUPPLY		☐ 110V AC ☐ 220V AC ☐ 220V DC ☐ Other. (As per requirement)	
	ALARM ANNUNCIATOR WINDOW (EXCLUDING SPARES)		____ NOS. (AS REQUIRED)	
	TEMP SCANNER (IF REQUIRED –NO. OF CHANNELS TO BE SPECIFIED UNDER SEC-C)		☐ REQUIRED ☒ NOT REQUIRED	
	PAINT TYPE (As per Annex-1, Section 7.6, Volume IV of contract specification)		☐ EPOXY ENAMEL ☐ EPOXY POWDER COATED	
	MIMIC (TYPE OF MIMIC- MATERIAL, THICKNESS TO BE SPECIFIED DURING DETAILED ENGG.)		☒ REQUIRED ☐ NOT REQUIRED	
	PANEL COLOUR (EXTERNAL) (As per Annex-1, Section 7.6, Volume IV of contract specification)		☐ LIGHT GREY ☐ OPALINE GREEN	
	FINISH (EXTERNAL) (As per Annex-1, Section 7.6, Volume IV of contract specification)		☐ MATT ☐ GLOSSY ☐ SEMI GLOSSY	
	PANEL COLOUR (INTERNAL) (As per Annex-1, Section 7.6, Volume IV of contract specification)		☐ WHITE ☐ CREAM ☐ OFF WHITE	
	FINISH (INTERNAL) (As per Annex-1, Section 7.6, Volume IV of contract specification)		☐ MATT ☐ GLOSSY ☐ SEMI GLOSSY	
	CLASS OF PROTECTION		☒ IP-55 (FOR INDOOR SERVICE) ☒ IP-67 (FOR OUTDOOR SERVICE) ☐ ANY OTHER	
	CONTROL HARDWARE		☒ RELAY BASED	
	FOUNDATION ARRANGEMENT		☐ FOUNDATION BOLTS ☐ ANCHOR FASTENERS	
WEIGHT OF PANEL (Kg.)		(Vendor to specify)		

	CONTROL ANS INSTRUMENTATION SPECIFICATION FOR PRE-TREATMENT PLANT		SPECIFICATION NO.: PE-SS-999-145-054A	
	DATA SHEET FOR LOCAL PANELS		VOLUME	
			SECTION	
			REV. NO. 02	DATE: 16.09.2013
TAG No. Qty.....		SHEET 2 OF 3		
Data Sheet No.: PES-145A-DS1-0				
Data Sheet A & B				
DATA SHEET-A FOR LOCAL PANEL (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
	PANEL TYPE	☐ PRESSURISED ☐ UNPRESSURISED As per Requirement		
	CABLE GLAND	☒ DOUBLE COMPRESSION		
	AMMETER (TYPE OF INPUT) *	☐ 1 Amp CT ☐ 4-20 mA		
	SCOPE OF SUPERVISION FOR ERECTION & COMMISSIONING	☐ APPLICABLE ☒ NA		
	* TO BE CO-ORDINATED WITH PEM ELECTRICAL			
NAME DESIGNATION SIGNATURE DATE	PREPARED BY	CHECKED BY	APPROVED BY	COMPANY SEAL NAME: SIGNATURE: DATE:
	AANCHAL CHOUDHARY	SACHIN SRIVASTAVA	MA MANSOORI	
	SR.ENGR	DY.MNGR	D. GM	
	16.09.2013	16.09.2013	16.09.2013	

FORM NO. PEM-6666-0

	DATA SHEET FOR LOCAL PANELS		SPECIFICATION NO.: PE-SS-999-145-054A	
			VOLUME	
			SECTION	
			REV. NO. 02	DATE: 16.09.2013
			SHEET 3	OF 3
TAG No. Qty.....			Data Sheet No.: PES-145A-DS1-0	
Data Sheet C				
DATA SHEET-C FOR LOCAL PANEL (TO BE FILLED BY CONTRACTOR AFTER AWARD OF CONTRACT)				
GENERAL	MANUFACTURER			
	CONSTRUCTION		☐ FOLDED ☐ WELDED (As per requirement EDN)	
	ENCLOSURE SHEET THICKNESS	FRONT		
		OTHER		
		DOOR		
		HEIGHT		
		OTHER		
TECHNICAL	INPUT POWER SUPPLY			
	NO. OF FEEDERS			
	CONTACT RATING OF RELAY			
	TEMP SCANNER			
	CONTROL SUPPLY			
	ALARM ANNUNCIATOR WINDOW (EXCLUDING SPARES)			
	PAINT TYPE			
	PANEL COLOUR (EXTERNAL)			
	FINISH (EXTERNAL)			
	TYPE OF MIMIC MATERIAL OF MIMIC THICKNESS OF MIMIC			
	PANEL COLOUR (INTERNAL)			
	FINISH (INTERNAL)			
	CLASS OF PROTECTION			
	CONTROL HARDWARE			
	FOUNDATION ARRANGEMENT			
	WEIGHT OF PANEL (Kg.)			

	DATA SHEET FOR LOCAL PANELS			SPECIFICATION NO.: PE-SS-999-145-054A	
				VOLUME	
				SECTION	
				REV. NO. 02	DATE: 16.09.2013
			SHEET 3 OF 3		
TAG No. Qty.....			Data Sheet No.: PES-145A-DS1-0		
Data Sheet C					
DATA SHEET-C FOR LOCAL PANEL (TO BE FILLED BY CONTRACTOR AFTER AWARD OF CONTRACT)					
	PANEL TYPE				
	CABLE GLAND				
	AMMETER (TYPE OF INPUT)				
	SCOPE OF SUPERVISION				
NAME SIGNATURE DATE	PREPARED BY		CHECKED BY		APPROVED BY
	AANCHAL CHOUDHARY		SACHIN SRIVASTYAVA		MA MANSOORI
	16.09.2013		16.09.2013		16.09.2013
					COMPANY SEAL NAME: SIGNATURE: DATE:



Technical specification for
CONTROL & INSTRUMENTATION

4 X 270 MW BHADRADRI TPS

SPEC NO.: **PE-TS-411-145-I**

VOLUME

SECTION

REV. NO.

00

DATE : 19.03.2015

SHEET

OF

PC SPECIFICATION

	Technical specification for Computer For 4X270 MW BHADRADRI TPS	SPEC NO.: PE-TS-411-145-I	
		VOLUME	
		SECTION	
		REV. NO. 00	DATE : 19.03.2015
		SHEET 1 OF 2	

SPECIFICATION FOR PC

a. CPU

1. Processor : Intel core i5 or better, 32 bit
2. RAM : 4 GB min. and expandable to 16 GB
3. Hard Drive : 500 GB or more
4. Removable bulk storage : DVD (R/RW)
5. Graphic accelerator : 8MB (minm.)
6. Graphic Memory : dedicated 1GB or better
7. Operating System : Windows 7 or better
8. Audio controller : 16 bit
9. Communication Port : 2 serial, one parallel, 8 USB, Dual 100Mbps Ethernet
10. Expansion Slot : 3
11. Cache : 512 KB Level 2
12. Video Card : PCI

b. MONITOR

1. Type : LCD COLOUR MONITOR
2. Screen Diagonal : 24" (approx.) flat
3. Display : XGA or better
4. Resolution : 1024 by 768 or better
5. Degree of Protection : IP-30
6. External Controls : Brightness, contrast, Horizontal/Vertical, amplification & Shift
7. Version : To suit Industrial application

	Technical specification for Computer For 4X270 MW BHADRADRI TPS	SPEC NO.: PE-TS-411-145-I	
		VOLUME	
		SECTION	
		REV. NO. 00	DATE : 19.03.2015
		SHEET 2 OF 2	

c. KEY BOARD & MOUSE

1. Type : Flat spill proof membrane or positive depression type ASCII
2. Life Expectancy : 50 million cycles per key
3. Version : To suit Industrial application
4. Mouse : Optical mouse

d. SOFTWARE

Diagnostic Software, Anti Virus, Microsoft office, Acrobat Adobe Software and other application software.



Technical specification for
CONTROL & INSTRUMENTATION

4 X 270 MW BHADRADRI TPS

SPEC NO.: **PE-TS-411-145-I**

VOLUME

SECTION

REV. NO.

00

DATE : 19.03.2015

SHEET

OF

FURNITURE SPECIFICATION

	Technical specification for FURNITURE For 4X270 MW BHADRADRI TPS	SPEC NO.: PE-TS-411-145-I	
		VOLUME	
		SECTION	
		REV. NO. 00	DATE : 19.03.2015
		SHEET	OF

SPECIFICATION FOR FURNITURE

- a) 4 Nos. cushioned revolving, independently adjustable seat and back chairs.
- b) Glass top Teak wood / MDF table for mounting Operator Station monitors.
- c) Printer tables.
- d) Glass top Teak wood / MDT table for System Engineering Room / Engineering stations with drawer at end.
- e) Glass top teak wood / MDF table with vertical file mounting arrangement (two layer to house approx. 40 Nos of files and lockable drawers at both end) for System Engineering Room / Engineers.



Technical specification for
CONTROL & INSTRUMENTATION

4 X 270 MW BHADRADRI TPS

SPEC NO.: **PE-TS-411-145-I**

VOLUME

SECTION

REV. NO.

00

DATE : 19.03.2015

SHEET

OF

CABLE BOQ

CABLE BOQ FOR 4 X 270 MW BHADRADRI TPS PROJECT JOB NO. 411 (PER UNIT)		
Sl no.	Cable Type	Qty (in Km)
	G-TYPE	
1	2P X 0.5 sqmm	40
2	4P X 0.5 sqmm	40
3	8P X 0.5 sqmm	90
4	12P X 0.5 sqmm	5
	F-TYPE	
1	4P X 0.5 sqmm	60
2	8P X 0.5 sqmm	30
3	12P X 0.5 sqmm	15
4	24P X 0.5 sqmm	10
	CONTROL CABLE	
1	3C X 2.5 sqmm	20
2	5C X 2.5 sqmm	8
3	12C X 1.5 sqmm	7



Technical specification for
CONTROL & INSTRUMENTATION

4 X 270 MW BHADRADRI TPS

SPEC NO.: **PE-TS-411-145-I**

VOLUME

SECTION

REV. NO.

00

DATE : 19.03.2015

SHEET

OF

KKS PHILOSOPHY



DOCUMENT TITLE

KKS NUMBERING PHILOSOPHY

4X 270 MW BHADRADRI TPS

KKS NUMBERING PHILOSOPHY

For identifying (tagging) an instrument / equipment in Power plant KKS numbering scheme is used. The purpose is to assign a unique number to every equipment in the power plant. For C&I equipment unique number are to be provided up to the signal level so that a unique number Input / Output exist in DCS for every signal.

Normally KKS number is a 10 digit alpha-numeric code and is typically split into the following:

X	X	X	A A Y			Y B B	B		

First three digits indicate the Sub-System. The Code for the major system are given as per **Annexure-1**.

Fourth and Fifth digits are the **Numerical Keys at System Code Level** and used to distinguish between main systems having same Alpha Codes.

Sixth and Seventh digits are the **Equipment / Apparatus / Measuring Circuit Code**. The code of various Equipment / Apparatus / Measuring Circuit is shown in **Annexure-2**

Eight, Nine and tenth digits are the **Numerical Keys at Equipment / Apparatus / Measuring Circuit Code** and used to distinguish between various instruments in the same sub-group. Numerical keys at System / Equipment / Apparatus / Measuring Circuit is shown in **Annexure-3**.

	DOCUMENT TITLE KKS NUMBERING PHILOSOPHY
	4X 270 MW BHADRADRI TPS

ANNEXURE-1**List of System / Sub-System Codes used in Power Plant:**

- 1) Compressed air system : QEA, QEC
- 2) Ventilation System : SAA TO SAZ
- 3) Fire Detection & Protection System + Fire Water pumps : SGM, SGN, SGO, SGP
- 4) Sewage Treatment : SJA TO SJZ
- 5) Pre-treatment Plant : GBI, GBM, GBV
- 6) RO DM Plant : GCI, GCM, GBV

ANNEXURE-2**Standard Equipment Codes:**

AA	Valves including drives, also hand operated
AB	Seclusions, Lock, Gates, Doors
AC	Heat Exchanger
AE	Turning, Driving, Lifting equipment
AF	Continuous conveyors, Feeders
AG	Generator Units
AH	Heating and Cooling Units
AK	Pressing and Packaging equipment
AM	Mixer, Stirrer
AN	Blower, Air Pumps / Fans, Compressor Units
AP	Pump Units
AT	Purification, Drying, Filter
AV	Combustion Equipment e.g. grates

Standard Apparatus Codes:

BB	Vessels and Tank
BF	Foundation
BG	Boiler Heating Surfaces
BN	Injector, Ejector
BP	Flow and throughput limitation equipment (Orifice)
BQ	Holders, Carrying Equipment, Support
BR	Piping, Ducts, Chutes, Compensator
BS	Sound Absorber
BU	Insulations, Sheatings



DOCUMENT TITLE

KKS NUMBERING PHILOSOPHY

4X 270 MW BHADRADRI TPS

Standard Measuring Circuits Codes:

CD	Density
CE	Electrical Quantities
CF	Flow, throughput
CG	Distance, Length, Position
CK	Time
CL	Level
CM	Humidity
CQ	Analysis (SWAS)
CS	Speed, Velocity, Frequency
CT	Temperature
CY	Vibration, Expansion

ANNEXURE-3**Numerical Keys****A) Numerical Keys at System Code Level**

- i) Use 10, 20, 30, ... To distinguish between main systems having same Alpha Codes. Examples:
 - a) Main Steam (Left) and Main Steam (Right)
 - b) BFP – A/B/C
 - c) ID Fan – A/B, FD Fan A/B, AH – A/B
- ii) For branch off from main system path having code say 10, keep the same alpha code and use 11, 12, 13 etc. Similarly for other branch off from main system path having code say 20, keep the same alpha code and use 21, 22, 23 etc and shall carry on further in the same way.
- iii) If the branch off from main system / sub system path is used for some other system, where different alpha codes can be applied, then in that case the said branch line will be designated by the alpha codes of the system to which it is providing the input.

B) Numerical keys at Equipment Code level:

There are three numerical keys available for each type of equipment code. Following has been agreed upon considering present practice, better flexibility and ease in sorting.

- i) Valves and Dampers --- *Equipment Code – AA*

N1N2 N3

DOCUMENT TITLE			
	KKS NUMBERING PHILOSOPHY		
	4X 270 MW BHADRADRI TPS		
Motorised (<i>on/off duty</i>)	-	0	01 to 50
Motorised (<i>inching duty</i>)	-	0	51 to 99
Pneumatic (Control)	-	1	01 to 50
Motorised (<i>thyrestor Control</i>)	-	1	51 to 99
Sol. Operated	-	2	01 to 99
(Open / Close duty (Valves, NRVs, Gate)			
Hydraulic	-	3	01 to 99
NRV (Without actuation)	-	4	01 to 99
Manual	-	5	01 to 99
Manual	-	6	01 to 99
Relief & Safety Valves	-	7	01 to 99
Reserve	-	8	01 to 99
Reserve	-	9	01 to 99
ii) Field Instruments			
Field Transmitters & Analog Signals	-	0	01 to 99
Field Switches & Binary Signals	-	1	00 to 99
PG Test Point	-	4	00 to 99
Gauges	-	5	00 to 99
Automatic Turbine Tester (ATT)-HWR	-	2	00 to 99
(Reserved for protection Signals used by Hardwar)			
Example of Numerical Key Usage:			
In line with the philosophy adopted for Valves / Dampers /instruments etc. pumps and fans in the main systems (having different system code) can be numbered as AP/N100 and as AP/N101, 102, ... Where system code is same.			



Technical specification for
CONTROL & INSTRUMENTATION

4 X 270 MW BHADRADRI TPS

SPEC NO.: **PE-TS-411-145-I**

VOLUME

SECTION

REV. NO.

00

DATE : 19.03.2015

SHEET

OF

LIST OF DELIVERABLES

CONTROL ANS INSTRUMENTATION SPECIFICATION FOR PRE-TREATMENT PLANT

LIST OF DELIVERABLES OF PEM - C&I DEPARTMENT FOR MAUX PACKAGES						
4 X 270MW BHADRADRI TPS						
DOCUMENT NUMBER PE-GL-411-145-I100						
Sl.No.	DRAWING NO.	DRAWING/DOCUMENT TITLE	CATEGORY	CUSTOMER	FROM	USER
INSTRUMENTATION						
1	PE-V9-411-XXX-1901	INSTRUMENT DATA SHEETS	A	-	VENDOR	C&I
2	PE-V9-411-XXX-1902	INSTRUMENT SCHEDULE	I	-	VENDOR	C&I
3	PE-V9-411-XXX-1903	INSTRUMENT INSTALLATION/ HOOK UP DIAGRAMS	A	-	VENDOR	C&I
4	PE-V9-411-XXX-1904	FIELD JB TERMINATIONS /GROUPING DOCUMENT	I	-	VENDOR	C&I
5	PE-V9-411-XXX-1905	QUALITY PLANS (CV,FE, Tx and Analyser)	A	-	VENDOR	C&I
PLC PANEL						
1	PE-V9-411-XXX-1906	PLC CONFIGURATION DRAWING	A	A	VENDOR	C&I
2	PE-V9-411-XXX-1907	PLC PANEL GA (INTERNAL & EXTERNAL) DRAWING	A	-	VENDOR	C&I
3	PE-V9-411-XXX-1908	CONTROL SCHEMES (BLOCK LOGIC)	A	-	VENDOR	C&I
4	PE-V9-411-XXX-1909	PLC INPUT / OUTPUT SIGNAL LIST	I	-	VENDOR	C&I
5	PE-V9-411-XXX-1910	UPS BATTERY CHARGER/ BATTERY DATASHEET & SLD	I	\$\$	VENDOR	C&I
6	PE-V9-411-XXX-1911	UPS SIZING CALCULATIONS	I	-	VENDOR	C&I
7	PE-V9-411-XXX-1912	BATTERY SIZING CALCULATIONS	I	-	VENDOR	C&I
8	PE-V9-411-XXX-1913	CONTROL DESK LAYOUT / GA DRAWING	A	-	VENDOR	C&I
9	PE-V9-411-XXX-1914	PLC-OWS/PRINTER FURNITURE BOM	A	-	VENDOR	C&I
10	PE-V9-411-XXX-1915	PLC CONTROL ROOM LAYOUT DRAWING	A	-	VENDOR	C&I
11	PE-V9-411-XXX-1916	PLC CATALOGUE	I	-	VENDOR	C&I
12	PE-V9-411-XXX-1917	PLC QUALITY PLAN & FAT PROCEDURE	A	-	VENDOR	C&I
13	PE-V9-411-XXX-1918	LIST OF SIGNAL EXCHANGE WITH DDCMIS (BOTH HARDWIRED & SERIAL INTERFACE IN BHEL FORMAT)	A	,	VENDOR	C&I
14	PE-V9-411-XXX-1919	PROCESS GRAPHIC MANUSCRIPTS PLC	I	-	VENDOR	C&I
15	PE-V9-411-XXX-1920	PROCESS GRAPHIC MANUSCRIPTS FOR DDCMIS	I	-	VENDOR	C&I
16	PE-V9-411-XXX-1921	CABLE SCHEDULE (IN BHEL EXCEL FORMAT) & CABLE INTERCONNECTION DETAILS	I	-	VENDOR	C&I
17	PE-V9-411-XXX-1923	PANEL & ELECTRONIC EARTHING REQUIREMENT	I	-	VENDOR	C&I
18	PE-V9-411-XXX-1924	PANEL HEAT DISSIPATION DATA	I	-	VENDOR	C&I
19	PE-V9-411-XXX-1925	MANDATORY SPARES BILL OF MATERIAL	A	A	VENDOR	C&I
20	PE-V9-411-XXX-1926	PLC O & M MANUAL	I	-	VENDOR	C&I
21	PE-V9-411-XXX-1927	PLC EARTHING SCHEME	I	-	VENDOR	C&I
	Notes:	411 - Project No				
		XXX -SI No of MAX Package				
		\$\$ -Approval by BHEL if Vendor BBU Item Approval by Customer if Customer BBU Item				

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: II B

REV 00

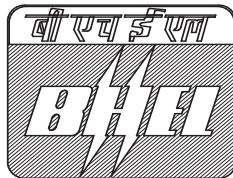
SHEET 1 of 1

SECTION – D4**STANDARD TECHNICAL REQUIREMENTS FOR CIVIL**

TELANGANA STATE ELECTRICITY
CORPORATION LIMITED (TSGENCO)
4X270MW BHADRADRI TPS

TECHNICAL SPECIFICATIONS
FOR
CIVIL STRUCTURAL & ARCHITECTURAL WORKS FOR
PT PLANT.

SPECIFICATION NO. PE-TS-411-600-C002



Bharat Heavy Electricals Limited
Project Engineering Management
Power Sector, PPEI BUILDING
SECTOR 16A, NOIDA-201301

- 1.1.1** The criteria furnished in this document shall govern the design of Civil, Structural and Architectural works of buildings, structures and yard facilities related to the proposed project.

This document covers the general description of structural framing system, applicable design codes and standards, specific design criteria, design loads and combinations, design methodology and characteristics of construction materials to be adopted for the structures indicated above.

1.2 SITE INFORMATION

1.2.1 Site Location

The plant site is located at 10 km from Manuguru town and 20 km from Manuguru railway station and nearest airport is Vijaywada which is about 220km from site.

1.2.2 Grade level

Finished Graded Level (FGL) for entire plant area shall be at least 1 m above HFL. However FGL will be finalized after topographical/contour survey data considering minimum levelling and grading works.

1.2.3 Soil Condition and Ground Water Level & HFL

Type of foundation, depth, safe bearing capacity etc., shall be as per the approved Geotechnical report.

1.2.4 Seismic Location

The project site lies in zone III as defined in IS: 1893 (Part 1)-2002. All the structures shall be designed complying with the requirements specified in IS: 1893 (Part-1) -2002 and (Part-4) - 2005.

1.2.5 Wind Pressure

Wind force on structures has been considered as per the provisions of IS: 875 (Part-3) -1987. The basic wind speed of 44 m/sec at a height of 10m above the ground level and wind assumed to blow in any direction and the most unfavorable condition shall be considered for design.

1.2.6 Reference Level

All elevations shall be marked with reference to Finished Ground Floor elevation of Power House building as EL (±) 0.000m.

In the Boiler, ESP and Chimney Area, paving top shall be at EL(-)0.20 m and main road levels in Boiler Area shall be EL(-)0.20 m.

Transformer yard paving top shall be EL(-)0.10 m .

2.0

REFERENCES, CODES AND STANDARDS

Structural design shall be developed on the basis of the standard codes and documents listed below.

All designs shall generally be prepared in accordance with Bureau of Indian Standards (BIS) codes of practice unless specified elsewhere.

BIS CODES AND REFERENCES

2.1

The analysis, design and construction for structural and civil works shall be in accordance with the BIS codes/standards or equivalent International codes.

2.1.1 EARTHWORK

IS: 1498	Classification and identification of soils for General Engineering Purposes.

2.1.2 LOADS

IS: 875	Code of Practice for design loads (other than earthquake) for buildings and structures (All parts)
IS: 1911	Schedule of Unit Weights of building materials
IS: 1893	Criteria for earthquake resistant design of structure (All parts)

2.1.3 FOUNDATIONS AND SOIL ENGINEERING

IS: 1080	Code of Practice for design and construction of shallow foundations on soils (other than raft, ring and shell)
IS: 1904	Code of Practice for design and construction of foundations in soils (General requirements)
IS: 2911	Code of Practice for design and construction of pile foundations (All parts)
IS: 2950	Code of Practice for design and construction of raft foundations
IS: 2974	Code of Practice for design and construction of machine foundations (All parts)
IS: 8009	Code of Practice for calculation of settlement of foundations (All parts)
IS: 9556	Code of Practice for design and construction of diaphragm walls

IS: 11089	Code of Practice for design and construction of ring foundation
IS: 13301	Guidelines for vibration isolation for machine foundations.

2.1.4 REINFORCED CEMENT CONCRETE

IS: 383	Specification for Coarse and fine aggregate from natural sources for concrete
IS: 432	Specification for Mild steel and Medium tensile steel bars
IS: 455	Specification for Portland Slag Cement
IS: 456	Code of Practice for plain and reinforced concrete
IS: 458	Specification for pre cast concrete pipes
IS: 1443	Code of practice for laying and finishing of cement concrete flooring tiles
IS: 1566	Specification for Hard drawn wire fabric for concrete reinforcement.
IS: 1786	Specification for high strength deformed steel bars and wires for concrete reinforcement.
IS: 1834	Hot applied sealing compounds for joints in concrete
IS: 2502	Code of Practice for bending and fixing of bars for concrete reinforcement
IS: 3370	Code of Practice for concrete structures for storage of liquids (All parts)
IS: 3414	Code of Practice for design and installation of joints in buildings
IS: 3935	Code of Practice for composite construction
IS: 4326	Code of Practice for earthquake resistant design and construction of buildings.
IS: 4948	Welded steel wire fabrics for general use
IS: 4995	Criteria for design of reinforced concrete bins for storage of granular and powdery materials (All parts)
IS: 5525	Recommendation for detailing of reinforcement in reinforced concrete works

IS: 8112	Specification for 43 grade Ordinary Portland cement
IS: 12269	Specification for 53 grade Ordinary Portland cement
IS:11384	Code of Practice for composite construction in structural steel and concrete
IS:11682	Criteria for design of RCC staging for Overhead water tanks
IS:13920	Code of Practice for ductile detailing of reinforced concrete structures subjected to seismic forces.
BS: 8007	British Standard Code of practice for design of concrete structures for retaining aqueous liquid.

2.1.5 STRUCTURAL STEEL

IS: 800-1984	Code of Practice for general construction in steel
IS: 806	Code of Practice for use of steel tubes in general building construction
IS: 808	Dimensions for hot rolled steel beam, column channel and angle section
IS: 813	Scheme of symbols for welding
IS: 816	Code of Practice for use of metal arc welding for general construction in mild steel
IS: 919	Recommendations for limits and fits for engineering.
IS: 1024	Code of Practice for use of welding in bridges and structures subjected to Dynamic loading
IS: 1161	Steel tubes for structural purposes
IS: 1239	Mild steel tubes, tubular and other wrought steel fittings (all parts)
IS: 1363	Black hexagonal bolts, nuts and locknuts (dia 6 to 39 mm) and black hexagon screws (dia 6 to 24 mm) [All parts]
IS: 1364	Precision and semi-precision hexagon bolts, screws, nuts and locknuts (dia. range 6 to 39 mm). [all parts]
IS: 1365	Slotted counter sunk head screws (dia range 1.6 to 20 mm).

IS: 1730	Dimensions for steel plate, sheet and strip for structural and general engineering purpose.
IS: 2016	Plain Washers
IS: 2062	Structural steel (fusion welding quality)
IS: 3502	Specification for steel chequered plates
IS: 3589	Seamless or electrically welded steel pipes for water, gas and sewage.
IS: 3613	Acceptance tests for wire-flux combinations for submerged-arc welding of structural steels.
IS: 4000	Code of Practice for High strength bolts in steel structures
IS: 4759	Hot dip zinc coatings on structural steel and other allied products
IS: 4923	Hollow Steel sections for structural use
IS: 7215	Tolerances for fabrication of steel structures
IS: 7280	Base-wire electrodes for sub-merged arc welding of structural steels
IS: 8500	Structural steel - micro alloyed (medium and high strength qualities).
IS: 8640	Recommendations for dimensional parameters for industrial building
IS: 9178	Criteria for design of steel bins for storage of bulk material (All parts).
IS: 12843	Tolerances for erection of steel structures
2.1.6	MASONRY
IS: 1077	Specification for Common Burnt Clay Building Bricks
IS: 1905	Code of Practice for structural use of unreinforced masonry
IS: 2185	Specification for Concrete Masonry units (All parts)
IS: 2212	Code of Practice for brickwork
IS: 2185	Concrete Masonry units (All parts - Hollow & Solid concrete blocks)

IS: 4860	Specification for Acid Resistant Bricks
IS: 12894	Specification for Pulverized Fuel Ash (Fly Ash) Lime Bricks

2.1.7 DOORS, WINDOWS AND VENTILATORS

IS: 1038	Steel doors, windows and ventilators
IS: 1361	Steel windows for industrial buildings
IS: 1948	Aluminium doors windows and ventilators
IS: 1949	Aluminium windows for industrial building
IS: 2835	Transparent sheet glass for glazing and framing purposes
IS: 3103	Code of practice for Industrial ventilation.
IS: 3548	Code of practice for glazing in buildings
IS: 3614	Specification for Fire check doors.
IS: 4351	Specification for Steel door frames.
IS: 6248	Metal rolling shutters and rolling grills.

2.1.8 ROOF AND FLOORING

IS: 809	Rubber flooring materials for general purposes
IS: 1195	Bitumen mastic for flooring
IS: 1237	Cement concrete flooring tiles

2.1.9 WATER PROOFING

IS: 1322	Bitumen felts for waterproofing and damp proofing
IS: 1346	Code of practice for waterproofing of roofs with bitumen felts
IS: 3067	Code of practice for general design, details and preparatory work for damp proofing and water proofing of buildings.

2.1.10 WATER SUPPLY, DRAINAGE AND SEWERAGE

IS: 1172	Code of basic requirements for water supply, drainage and sanitation

IS: 1742	Code of practice for building drainage
IS: 2065	Code of practice for water supply in buildings
IS: 5329	Code of practice for sanitary pipe work above ground for buildings
IS: 12251	Code of practice for Drainage of Building Basement

2.1.11 MISCELLANEOUS

SP-6	Handbook for Structural Engineers (all parts)
SP-7	National Building Code of India
SP-16	Design Aids for reinforced concrete to IS: 456-1978
SP-20	Handbook on masonry design and construction
SP-22	Explanatory handbook on codes on earthquake engineering (IS 1893-1975 and IS: 4326-1976)
SP-24	Explanatory handbook on Indian Standard code of Practice for plain and reinforced concrete (IS: 456 -1978)
SP-25	Handbook on causes and prevention of cracks in buildings
SP-32	Handbook on functional requirements of industrial buildings
SP-34	Handbook of concrete reinforcement and detailing (SCIP)
SP-35	Handbook on Water Supply and Drainage
SP-38	Handbook on Typified designs for structures with Steel roof trusses (With & without cranes)
SP-40	Handbook on Structures with Steel Portal frames (without cranes)
SP-47	Handbook on Structures with Steel Lattice Portal frames (without cranes)
SP-64	Explanatory handbook on IS Code of Practice for Design loads (other than earthquake) for buildings and structures (Part 3 – wind load IS 875 – Part 3 – 1987)
IRC: 15	Code of Practice for construction of concrete roads
IRC: 19	Standard specification and Code of Practice for Water Bound Macadam

IRC: 36	Recommended Practice for the Construction of Earth Embankments for Road Works
IRC: 37	Guidelines for the design of flexible pavements
IRC: 101	Guidelines for design of continuously reinforced Concrete pavement with elastic joints
IRC: SP - 042	Guidelines on Road drainage

CIVIL SCOPE

All civil design and construction works except Chemical House and centrifuge shed/building are in bidder's scope. All steel inserts, plates, bolts, nuts, sleeves, edge angle, rungs ladder, puddle pipes and all other embedding components etc. as required to grout in bidder's and BHEL civil works to hold/support the equipment being supplied under this specification for the pre-treatment plant shall be in the bidder's scope.

3.0**LOADS AND LOAD COMBINATIONS**

All structures will be designed for the most critical combinations of dead loads, imposed loads, equipment loads, crane loads, steam piping (static and dynamic) and other piping loads, wind loads, seismic loads, temperature loads and any other loading condition which can occur during the design life of the facility.

3.1 DEAD LOADS (DL)

Dead loads consist of the weights of the structure complete with floors, roof, finishes, fixtures, partitions, wall panels, etc.

- 3.1.1** The following unit weight of material shall be considered for computation of loads. Loads given in IS: 875 (part-I) shall be made use of for material not listed below.

Materials	Unit weight
Plain cement concrete	24 kN/m ³
Reinforced cement concrete	25 kN /m ³
Structural steel	78.5 kN /m ³
Brick work	19 kN /m ³
Cement plaster	21 kN /m ³
Floor Finish	24 kN /m ³
Coal	12 kN /m ³
Fly Ash	16 kN /m ³
Bottom Ash	16 kN /m ³

:

- 3.1.2** Following will be considered for evaluation of dead loads:

- Load of RCC slab wherever concrete floors are provided
- Floor finish of 40/50 mm laid over RCC Slab
- Other area flooring will consist of removable electro forged grating/ chequered plate.
- Beams & Columns as per actual size
- Wall cladding loads.
- Self-weight of supporting structure/facilities

3.2 IMPOSED LOADS (IL)

The loads considered as imposed loads are live loads, dust loads, minor equipment loads, cable trays, small pipe racks / hangers (not exceeding 2.5 kN/m²), erection loads, operation / maintenance loads and loads produced by personnel, movable equipment and other items placed on the structure, but not permanently attached to it. Imposed loads for design at various floors in different areas will generally be considered as given below.

Imposed/Live loads will consist of uniform live loads and equipment live loads. Uniform live loads are assumed unit loads which are sufficient to provide for movable and transitory loads, such as the weight of people, portable equipment and tools, equipment, or parts which may be moved over or placed on floors during maintenance operations. These uniform live loads will not be considered on floor areas which will be permanently covered with equipment. In the absence of equipment load, the predefined LL to be considered for whole area for the design of foundation, column & mainframe beams. The floor beams may be designed for the equipment load.

Equipment live loads are calculated based upon the actual weight and size of the equipment and parts to be placed on floors during dismantling and maintenance or to be temporarily placed on or moved over floor during installation. Floors and supporting members, which are subject to heavy equipment loads, will be designed on the basis of the weight of the equipment or specifically defined loads and the erection loads wherever required. Each member in the floor which may carry these loads will be designed for the heaviest piece or pieces of equipment arranged in the most critical position. These loads will also be compared with the superimposed loads given below. Higher of the two will be adopted for analysis and design.

Steam Piping Load: The loads superimposed on structure by piping hangers and at the restraint points will be considered. However, pipe dynamic forces at hanger location / restraint points will not be considered to act simultaneously, in that direction with seismic forces.

Roads

Design of roads shall be in accordance with Indian Road Congress standard IRC 37.

Road culverts and its allied structures including R.C.C. Pipe Crossings & Road Crossing of Trenches shall be designed for Class 'AA' loading (wheeled and tracked both) and to be checked for Class 'A' loading as per IRC standards.

WIND LOAD

3.3

Wind loading will be in accordance with Indian Standard Code IS:875 (Part 3) for a basic wind speed of 44 m/sec. upto a height of 10 metres above mean ground level. Terrain Category-2 shall be considered for all structures.

Risk coefficient (k_1) shall be considered as 1.07 for all structures

3.4 SEISMIC LOADS

The lateral forces will be established in accordance with the recommendations of IS:1893-1984 of Indian Code of practice. The site falls in Zone- III as identified in the map in IS:1893-2002. Analysis and design of structures shall be carried out accordingly taking into consideration the factors related to soil characteristics and importance of the structure together with the basic seismic co-efficient as per provision of Indian code.

Importance factor and response reduction factor shall be taken as per IS:1893(part I & IV).

Response spectrum method shall be used for seismic analysis as per IS : 1893 .

3.5 EARTH PRESSURE LOADS

Earth pressure for all underground structures shall be calculated using coefficients of earth pressure at rest, coefficient of active or passive earth pressure (whichever is applicable). However, for design of substructure of pump house, cold water basin of cooling water and underground liquid storage tanks earth pressure at rest shall be considered.

In addition to earth pressure and ground water pressure, etc., surcharge load shall also be considered for the design of all underground structures including channels, sumps, cable & pipe trenches, etc., to take into account the vehicular traffic in the vicinity of the structure. Intensity of Surcharge Load shall be as described elsewhere in this specification.

3.6 TEMPERATURE LOADS

The effect of temperature loads shall be considered for design of structural frames. For temperature loading calculation the temperature variation shall be considered as 2/3rd of the difference in the mean of the daily maximum ambient temperature during the hottest month of the year (OC) and mean of the daily minimum ambient temperature during the coldest month of the year (OC). The structure shall be designed to withstand stresses due to 50% of the total temperature variation. Expansion and contraction due to changes of temperature of materials of structure

shall be considered and adequate provision shall be made for the effects produced as per provision in the relevant IS codes.

Mean Daily minimum ambient temperature during coldest month of the year = 11.5° C

Mean Daily maximum ambient temperature during hottest month of the year = 45.1° C

3.7 EQUIPMENT LOAD

i) Loadings (both static and dynamic) of major equipments, including boiler, turbine-generator, boiler feed pumps, feed water heaters, de-aerator, PA, FD & ID fans, Coal Mill obtained from the manufacturer's certified drawings of the specified equipment to be furnished. Where design of structures supporting minor equipment other than those included above has to proceed, the loadings will be estimated from similar jobs or catalog data.

ii) All equipment, tank and piping design loadings will include Hydraulic Testing loads.

iii) Air and gas duct loadings will include weight of insulation, duct attachments, dust accumulation loads, seismic, wind and other loads as applicable.

iv) Crane girders and supporting columns will be designed for vertical and horizontal forces (including impact forces) as developed from the crane weights and wheel loads. Unless otherwise specified, the vertical and horizontal loadings will conform to the applicable sections of the IS specifications.

v) Weight of equipments, ducts, tanks, pipes, conduits etc. supported by structure shall include maximum possible loading conditions i.e. flooded material contents and associated impacts, test loadings, anchorage and constraint effects.

vi) All structural components shall be designed to accommodate anticipated concentrated loads which will or may be applied during the life of the plant.

Where both concentrated and uniform loads cannot act simultaneously, the structure or component shall be analyzed for both conditions of loading and shall be designed for most critical condition.

viii) Lay down areas in the Turbine Hall shall be investigated for concentrated loads resulting from equipment components to be stored during erection and maintenance operation. Where live load allowance is inadequate to permit storing of such equipment components, the design live load shall be increased to permit such use or the area shall be restricted by identifying lay down areas for specific components, each area to be identified by permanent marking.

3.8 CRANE, MONORAIL AND ELEVATOR LOADS

Crane girders and supporting columns shall be designed for vertical and horizontal forces (including impact forces) as per crane vendor data. All lifting beams, monorails shall have design loads increased for impact factor. Vertical impact force and surge force in lateral and longitudinal direction shall be taken as per following.

3.8.1 Crane loads

- i) For vertical force, an impact factor of 25% of the maximum crane wheel load.

- ii) A lateral crane surge of 10% of the weight of the trolley plus the lifted load applied at the top of each rail..
- iii) A longitudinal surge of 5% of the maximum static wheel loads of the crane applied at the top of the rail in the longitudinal direction.

3.8.2 Monorail loads

- i) Impact factor of 10% of lifted load hoist for rail and support design
- ii) Impact factor of 25% of the lifted load for electrical hoist for rail and support design

3.8.3 Elevator loads

- i) 100% of the lifted load plus the equipment weight for the elevator support beams.

3.9 Load Combinations

While designing consideration shall be given to the following load combinations :

- i) DL + LL
- ii) DL + LL + PL + Equip (+/-) TL
- iii) DL + LL + PL + Equip + Cb + CtLA(+/-) CS (+/-) TL
- iv) DL + LL + PL + Equip + Cb + CtLB(+/-)CS (+/-) TL
- v) 0.9DL(+/-)EL (for DL only) (+/-) TL
- vi) 0.9DL (+/-) WL1 (+/-) TL
- vii) 0.9DL (+/-)WL2 (+/-)TL
- viii) DL +* LL + PL + Equip + Cb + Ct(+/-) EL (+/-)TL(* Appropriate portion of LL which is considered for working out EL shall only be taken)
- ix) DL + LL + PL + Equip + Cb + CtL1(+/-) (CS1+WL1(+/-)TL
- x) DL + LL + PL + Equip + Cb + CtL1(+/-) (CS1+WL2) (+/-)TL

Where the above loads are :

DL = Dead load of structures, floors, walls etc.
 LL = General live load on floors
 PL = Pipe Load
 Equip = Equipment loads
 Cb = Crane Bridge
 Ct = Crane trolley positioned at middle of bridge
 CtLA = Crane trolley + Load near one row
 CtLB = Crane trolley + Load near other row
 CtL1 = Crane trolley + Half load lifted at centre of bridge
 CS = Crane surge for full load
 CS1 = Crane surge for half load lifted
 WL1 = Wind load from left to right
 WL2 = Wind load from right to left
 EL = Earthquake load
 TL = Temperature load

Appropriate allowable increase in permissible stresses as per IS codes, may be taken only under normal loads along with wind and seismic conditions. However, members which are designed primarily to resist wind, no increase in wind permissible stresses will be permitted. Applicable load factors to be used for design of RCC structures by Limit State Method as per IS:456.

3.10 LOAD COMBINATIONS FOR UNDERGROUND STRUCTURES

Following loading conditions shall be considered in addition to the loading from superstructure for the design of sub structure of pump house, channels, sumps, tanks, reservoirs, trenches and other underground structures.

Only liquid pressure from inside and no earth pressure and ground water pressure and surcharge pressure from outside (applicable only to the structures which are liable to be filled with water or any other liquid).

Earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.

Base slab of the pump house shall be designed for the condition of different combinations of pump sumps being empty during maintenance stages with ground water table up to the finished grade level. Intermediate dividing piers of pump sumps and partition walls in channel shall be designed considering water on one side only and the other side being emptied for maintenance.

Design shall also be checked against buoyancy due to ground water during construction and operation stage. Minimum factor of safety as per IS:3370 against buoyancy shall be ensured considering empty condition ignoring superimposed loads.

3.11 SPECIAL STRUCTURES

The following densities shall be considered for design of coal bunkers:

- a) For volume calculations : 8.0 kN/cum
- b) For Structural design : 12.0 kN/cum

Coal bunker shall be designed as per criteria specified in IS:9178 (Part I&II)

4.0

DESIGN METHODOLOGY

Wind and seismic forces shall not be considered to act simultaneously.

For the design of main plant structures during seismic condition, the Deaerator Feed

Water Tank shall be considered full up to operating level. However, for other load combinations, Deaerator Feed Water Tank in flooded condition shall be considered.

‘Lifted Load’ of crane shall not be considered during seismic condition.

For design of all underground structures/foundations, ground water table shall be considered at the Finished Ground Level..

In Turbine Bay, horizontal wind girders between A-row and B-row columns must be provided below Mezzanine and Operating floor at gable ends to transmit wind load from gable columns.

PTFE bearing shall be provided where horizontal loads not to be transferred.

For calculation of seismic load, equipment load shall be considered as Dead Load.

Gratings / chequered plates shall not be considered as restraining members for compression flange of beams/girders. Diaphragm action shall also be not considered in design. Adequate horizontal bracings to be provided.

4.1 REINFORCED CONCRETE STRUCTURES**4.1.1 GENERAL**

Reinforced concrete structures will be moment resisting frames along both longitudinal & transverse directions. The suspended slab will be considered as continuous over secondary beam and will not form part of the framing system. RCC structures/members will be designed as per the provisions of IS: 456 using limit state method, unless use of working stress method is specifically mentioned elsewhere in this document.

Design strength of materials and design loads shall be calculated using appropriate partial safety factors over characteristic strength and characteristic loads as per IS: 456.

Mix design concrete will be used for all areas other than lean concrete work and plain cement concrete work where nominal/volume mix may be permitted.

Water retaining RCC Structures will be designed in accordance to IS: 3370 (Code of practice for concrete structures for the storage of liquids) by Working Stress Method.

The grade of concrete for various structures shall be as follows;

➤ Mass concrete filling	M7.5
➤ PCC below T G Foundations, Fan foundations and all vibratory foundations / Screed concrete	M10
➤ PCC below Paving(general) incl plinth protection	M10
➤ RCC in grade slabs	M25
➤ Boiler area paving	M20
➤ RCC for Super Structure works in structural Steel buildings / Trench slab and wall	M25
➤ RCC in foundations/ Water retaining Structures	M25
➤ RCC for Super Structure works in RCC building	M25
➤ RCC for T G raft, Mill, BFP & fan foundations	M30
➤ Precast RCC Trench Covers	M25
➤ Encasement of Base plate/Steel columns/ Wall beams	M20
➤ RCC for TG top deck and columns	M35
➤ Drain/cable trench	M25

Minimum cement content, maximum water cement ratio and minimum grade of concrete shall be considered as per IS: 456-2000 for structures not mentioned above.

Minimum cover to reinforcement shall be as per Table 16 of IS: 456-2000 for mild exposure condition. Minimum fire rating of 2 hours shall be considered where fire hazard is expected and accordingly minimum cover shall be increased if required to meet the requirements as per Table 16A of IS:456-2000.

MATERIALS

Cement: Ordinary Portland cement (Grade 53) of approved manufacturer conforming to IS: 12269 and Ordinary Portland Cement (Grade 43) conforming to IS 8112 will preferably be used. However other types of cement such as Portland slag cement conforming to IS: 455 & Portland pozzolana cement confirming to IS: 1489 may also be used except for in TG Foundation top deck and sub-structures including foundation raft, major machine foundation like PA/FD/ID FANS, MILLS,BFP etc where OPC grade 53/43 shall necessarily be used.

Reinforcing Steel: Reinforcing steel will be TMT bars of grade Fe-500 conforming to IS: 1786.

Aggregates: Coarse aggregate for concrete will be chemically inert, hard, strong

durable against weathering, of limited porosity, and free from deleterious materials. It will be properly graded. Coarse aggregates will be either crushed gravel or stone. Aggregates will meet the requirement of IS: 383.

Admixtures: Plasticizers-cum-retarder type admixture will generally be added to concrete for promoting workability in addition to retard setting time for mass concreting work.

Water: Water used for cement concrete, mortar, plaster, grout curing, washing of coarse aggregates, soaking of bricks etc. will be clean and free from oil, acids, alkalis, organic matters or other harmful substances in such amounts that may impair the strength or durability of the structure.

The following minimum thickness of the structural elements shall be followed:

➤ Suspended floor / slab / walkways / canopy slabs, etc	50 mm
➤ Ground floor slab (non-suspended)	150 mm
➤ Water Retaining slabs / walls	200 mm
➤ Cable / pipe trenches / underground pits /	
➤ Launder walls and base slab	100 mm
➤ All footings (including raft foundations)	300 mm
➤ Parapets	125 mm
➤ Sunshades at edge	75 mm
➤ Pre cast louvers / fins	50 mm
➤ Pre cast trench cover slabs / floor slabs / louvers	75 mm
➤ Paving	100 mm
➤ Basement walls and base slab	200 mm
➤ Silo / bin walls	200 mm
➤ Underground reservoir	
➤ Below ground water table	200 mm
➤ Above ground water table	150 mm

Minimum heights for pedestals for steel columns shall be as follows:

- i) Top of pedestals for building structures will be kept at a lower level so that column base plate together with gussets and stiffeners remain below finished floor level

(FFL). The column bases as well as column section shall be encased in concrete above FFL as per following:

- a) Open area : 300mm above paved level
b) Covered area : 150mm above FFL

- ii) Stairs and ladder pedestal will be kept 200mm above the FFL

- iii) Pedestals to steel columns for equipment structures:

- a) Equipment in open area : as required (minimum 300 mm)
b) Equipment in covered area : as required (minimum 150 mm)
c) Structures and equipment : as per vendors data
supplied by vendor subject
to min as specified above

4.1.2 FOUNDATION AND UNDERGROUND STRUCTURES

- 4.1.2.1 Foundation for all main plant structure i.e. Power House Building, Boiler, ESP, Mill and Bunker Bay, Transformer Foundations, Air compressor, and other auxiliary buildings shall be decided based on loading arrangement, load intensity and soil strata. Design of foundation at various levels shall be dependent upon the safe bearing capacity at that level and on the basis of recommendation furnished in the Geotechnical Investigation report.

Foundations will be designed for the most critical combinations of forces and moments, resulting from all possible combinations of the various loading from the structural system. No major foundations will rest on filled up ground. The effect of water table will be considered and the foundation will be checked for overturning for minimum and maximum vertical loads. The foundation sections will be sized and reinforced adequately for bending moments and shear stresses.

- 4.1.2.2 All foundations including machine/equipment foundations will be of RCC block/frame foundations as the case may be. All foundations will be designed in accordance with relevant parts of IS: 2974 and IS: 456 by limit state method. Raft foundation will be designed as per IS: 2950.

- 4.1.2.3 For design of Foundations and underground structures including trenches etc., ground water level shall be considered up to the finished grade level.

- 4.1.2.4 **Stability** : The following minimum safety factors for stability checks of foundations shall be used:

1. Overturning	1.4
2. Sliding	1.4
3. Uplift	
a) Normal loading	1.4
b) Hydrostatic forces	1..2

Where dead load provides restoring forces, only 0.9 times dead load shall be considered. Imposed loads shall be considered as the restoring force.

- 4.1.2.5 **Minimum cover to Foundation Bolts**

Minimum distance from the centerline of foundation/anchor bolt to the edge of pedestal shall be maximum of the following:

Clear distance from the edge of base plate/base frames to the outer edge of the pedestal shall be minimum 50mm.

Clear distance from the face of pocket to the outer edge of pedestal shall be 75mm.

Clear distance from the edge of sleeve of anchor plate to the edge of pedestal shall be 75mm.

4.1.2.6 Permissible settlement of Foundation

For open foundations, the permissible settlement and differential settlement shall be governed by IS: 1904 and IS: 8009. However, total settlement will be restricted to the following.

- a) Foundations for main power house columns, Boiler, Mills, bunker, TP's : 25mm
- b) Foundation for other structures including ESP with Isolated/strip footing of width up to 6.0M : 40mm
- c) Foundation for other structures with Footings greater than 6.0M (raft) : 75 mm

4.1.2.7 Levelling and grading: Each layer of filling shall be watered and thoroughly compacted with proper moisture content and such equipment's as may

be required to obtain a minimum of 95% of its maximum dry density as determined by standard Proctor's test as per IS: 2720 part-VII or 85% of relative density as per IS:2720 part-XIV as specified. Moisture content of the fill material shall be controlled near optimum moisture content during compaction.

4.1.2.8 Backfilling: Backfilling around foundation and bottom of pipes, thrust blocks etc shall be carried out with approved material in layers not exceeding 30 cm thickness and each layer shall be compacted to 90% standard proctor density for cohesive soil and to 75% of relative density for non-cohesive soils.

4.1.3 TANK FOUNDATIONS

The Storage tanks/Day tanks will be resting on hydraulically compacted clear river sand, in layers of 500 mm maximum thickness, topped with 150 thk PCC. PCC layer will be topped with 50 thk. Anti-corrosive asphalt layer, which in turn is topped with 50 thk. Premix carpet. The entire sand fill along with toppings will be confined within a RCC ring beam of appropriate design.

4.1.4 MACHINE FOUNDATIONS

This section outlines the design philosophy and construction aspects of foundations for the following equipments;

- ✓ ID/FD/PA/SEAL AIR Fan Foundations & TG Foundation
- ✓ Boiler Feed pump foundations,
- ✓ Bowl Mill foundations and
- ✓ Miscellaneous Machine foundations.

4.1.4.1 For the foundations of TG & Fans (ID, FD, PA & Seal Air etc.), Boiler feed pump, Bowl Mill, detailed static and dynamic analysis will be performed. The static analysis will include operating conditions load cases and abnormal loads like, maximum unbalance and seismic forces. Unbalanced loads for normal operating condition as given by machine manufacturers or as specified in IS: 2974 whichever is more conservative shall be used. Vibration isolation system shall not be provided in any of rotating foundation except for ID fan foundation

- 4.1.4.2** The dynamic analysis will consist of free vibration analysis and forced vibration analysis. Frequency separation criteria and amplitude criteria as laid down in IS: 2974 and/or DIN 4024 and/or VDI 2056 or as required by the machine manufacturer will be satisfied. RCC design will be done by working stress method for all machine foundations as per IS: 2974. Minimum reinforcement will be governed by the requirements specified in IS: 2974 as well as IS: 456.
- 4.1.4.3** All block foundation supporting rotating equipments and resting on soil will be designed using the elastic half space theory and/or Barkan's method. The mass of the RCC block will not be less than 2.5 times the mass of the machine. Dynamic analysis will be carried out to calculate natural frequencies in all the modes including coupled modes and to calculate vibration amplitudes. Frequency and amplitude criteria as laid down in the relevant codes and/or by machine manufacturer will be satisfied. Minimum reinforcement will be governed by the requirements specified in IS: 2974 and IS: 456.
- 4.1.4.4** The analysis and design of machine foundations will be carried out to ensure the following.
- Compliance with the manufacturer's requirements.
 - No resonance phenomenon of a disturbing nature to machine operation should exist at the normal running speed.
 - **Calculations to be performed for dynamic as well as static cases for reinforced concrete block type pedestals.**
- 4.1.4.5** **Bowl mills shall be supported on conventional block type R.C.C foundations. All machine foundation shall be separated from adjoining building / foundations. Isolation joints shall be given all round to isolate the machine foundation from the grade slab..**
- 4.1.4.6** **Foundation Sizing:** The outline plan dimensions of foundations as given by the machine supplier will be adopted. The height of foundation will be selected after taking into consideration soil strata and operating level of the machine. The eccentricity of common CG of machine and foundation with respect to the centroid of base area should not exceed 5% of the corresponding base dimensions of foundation.
- 4.1.4.7** For other types of machines, most suitable type of foundations will be provided. For the foundations supporting minor equipment weighing less than one ton or if the mass of the rotating parts is less than one hundredth of the mass of the foundation, no dynamic analysis is necessary. Foundation for pumps, and minor rotating equipment etc., are usually in the form of solid block foundations, resting on the ground or on a floor of the building.

At such machine supports, floor may be thickened and extra reinforcement provided. Rubber or neoprene pads under some of these machines to reduce transmission of vibrations to the supporting floor shall be provided if required.

4.1.5 LIQUID RETAINING STRUCTURES

RCC water retaining structure like storage tanks, reservoirs, etc., shall be leak proof and designed as un-cracked section with limiting steel stresses in accordance with IS: 3370 (Part I to IV) by working stress method.

Water channels and substructure of pump houses shall be designed as cracked section with limiting crack width to 0.1mm and limiting steel stresses as per IS: 3370 (Part I to IV) by working stress method for concrete face away from water/liquid. For faces in contact with water/liquid the structure shall be designed as uncracked section in accordance with IS:3370 (part 1 to IV) by working stress method.

All water retaining/ storage structures shall be designed assuming liquid upto the height of wall irrespective of provision of any over flow arrangement. Pressure release valves may not be considered in design. In all liquid structures, PVC water bars shall be provided at each construction/ expansion joint. The sequence of construction shall also be specified on drawings showing construction joints.

Screed layer of concrete grade M10 and of minimum 100 mm thickness shall be provided below all water retaining structures.

All underground water retaining/conveying system structures shall have plasticiser cum waterproofing cement additives conforming to IS:9103. In addition, limits on permeability as given in IS:2545 shall also be met with. The concrete surface of these structures in contact with soil shall be provided with minimum two coats of bituminous painting of grade 85/25 conforming to IS:702 @ 1.7 kg/sqm (minimum) for water / damp proofing. Storm water drains shall not be provided with bituminous paint and weep holes also shall not be provided in storm water drains.

Raw Water Reservoir: The capacity of raw water reservoir shall be for 7 days with minimum capacity of 6.00 Lakhs cu.m. Shape, size and detail of the same shall be as per approved drawings. The reservoir shall be provided with a free board as per requirements of IS: 10635, but in no case, the same shall not be less than 1000 mm. The reservoir shall have two compartments with separate inlet and outlet arrangement.

4.1.6 The reservoir embankment shall be made in earthwork with side slopes 1V : 2H (minimum). The reservoir embankment shall be designed and constructed as an earthen dyke founded on natural ground with proper foundation. The entire area, top soil shall be increased to the required level as per actual conditions to totally removal of all vegetation, organic matters, roots, soft spots etc. Required slush removal sump, provision for deep sump shall be provided in the pumping suction to ensure the pumping head. Also, a suitable spillway arrangement shall be provided to take care of any heavy storm event. The bund shall have adequate width on top to form the road for vehicle movement with minimum width as 4.0 m. bituminous road shall be constructed as per IRC. On the down stream slope of the embankment, turfing shall be provided with a provision of Toe drain. The bund with impervious geo-membrane (LDPE 500 micron thick) layer on water contain face including base. 150 mm thick sand blanket is recommended below the geo-membrane bottom as a cushion. The reservoir shall be provided with 50 mm thick precast concrete tiles of M20 grade concrete over LDPE film / sand planked lining. The protective layer over LDPE shall be provided over entire bed and side slopes. Material to be used for bund construction shall be as per IS: 1498. Top layer of reservoir basin sub grade shall be compacted to at least 95% of Standard Proctor density by vibro compaction equipment or by any other suitable equipment

4.2 STEEL STRUCTURES

4.2.1 MATERIALS

Structural Steel: Structural steel will be straight sound, free from twists, cracks, flow, laminations and all other defects. Structural steel shall conform to IS:2062 for rolled members or plates. Structural steel shall conform to Grade A of IS 2062 for rolled steel members or plates up to 20mm thickness. For plates from 20mm to 40mm thickness steel conforming to Grade BR (killed and rolling normalized) of IS 2062. For plates above 40mm thickness steel conforming to Grade BR (killed and furnace normalised) of IS 2062.

Material: Structural steel shapes, plates, and appurtenances for general use will conform to Indian Standards IS: 800 with minimum yield strength of 250 MPa. Connection bolts will conform to relevant IS codes.

Steel Grating: All indoor gratings shall be electro forged type and outdoor gratings shall be welded type. Minimum thickness of grating shall be 40mm for indoor installation and 32mm for outdoor installation. The opening size shall not be more than 30mm x 100mm. The minimum thickness of the main bearing bar shall be 4mm. All gratings shall be hot dip galvanized @ 610 gm/sqm.

Guard rail /Handrail: For powerhouse building upto operating floor + half landing, main stair & lobby shall have 40mm diameter stainless steel railing with minimum 3mm thick SS posts & decorative minimum 3mm thick seamlessly joined SS handrails. Stainless steel pipe handrail in shall be of approved design to meet the functional requirement as well as very good aesthetic appearance. For any other RCC stairs of non-plant buildings 20mm square MS bar post with suitable MS flat and anodized aluminium handrails are to be provided. For any other floor of power house building, plant & non plant buildings unless otherwise indicated in the specification the post and handrails of stairs, railing, etc will be 32mm nominal bore GI pipes of medium grade conforming to IS: 1161 / IS 1239.

Chequered Plate: **Chequered plate shall conform to IS: 3502 and shall be minimum 6 mm thickness over plane. Steel for chequered plates shall conform to Grade 'A' of IS: 2062.**

Stainless Steel: Stainless steel liner in the Coal Bunkers will be 4.00 mm thick & of grade AISI – 304, Finish Grade 2B (Cold Rolled, Annealed & Pickled and Skin passed) will be provided on the inner faces, Hoppers and mouth of the Hoppers, without allowing any projections in coal flow path. while coal bunker will be made of MS plate.

4.2.2 FRAMING

All steel framed structures shall be either “rigid frame” or “simple space frames” or a combination of two.

Lateral forces shall be resisted by stiff jointed moment connections in rigid frame. The column bases shall generally be fixed to concrete foundation pedestal by providing moment resistant base detail.

Simple space frame design utilizes single-span beam systems, vertical diagonal bracing at main column lines and horizontal bracing at the roof and major floor levels. Most of the plants' steel buildings shall be designed as simple space frame structures.

The turbine building design shall be a combination of rigid frame in transverse direction and simple frame in longitudinal direction.

Pipe rack shall consist of rigid main frame in transverse direction spaced longitudinally as required. In longitudinal direction, pipe rack shall be divided into sections of suitable length with an anchor bay. The main transverse frames shall be connected with longitudinal beams which will transmit horizontal forces to braced anchor bays. The pipe and cable rack bridge structure shall be adequately rigid to carry the forces from pipelines at anchor points without undue deflection so that pipelines are really anchored at the anchor points.

Concrete floors shall be considered to provide continuous lateral support to the top (compression) flange of the support beams. Suitable shear connectors shall be welded to the top of the top flange of all secondary beams to ensure the lateral support.. Grating/chequered plate floor shall neither be considered to provide lateral support to the top flange of supporting beams nor to provide a shear diaphragm. Adequate lateral support and horizontal bracing shall be provided as required.

Floors for vibrating machines of all kind together with supporting framework shall be adequately braced in both horizontal and vertical planes. Floors or structure supporting mechanical equipment shall be designed to minimize vibration, avoid resonance and maintain alignment and level.

Columns shall be designed to support the load combination which produces the maximum stress ratio. Exterior columns shall be designed to resist wind moments between braced elevations as appropriate. Columns shall also be designed to resist moments caused by discontinuous vertical bracing work points.

4.2.3 CONNECTIONS

Shop connections will be by welding, preferably by submerged arc welding. Field connections for light members such as purlins, girt and inaccessible beams, will be done by MS bolts with nuts. All other connections will be designed with welding / high strength friction grips bolts, as necessary.

IS: 816 and IS: 9595 shall be followed for welding of structures.

Connection of vertical bracings with connecting members and diagonal truss members shall be designed for full tensile capacity of the bracings.

Size of fillet weld for flange to web connection for built up column section will be as follows:

Full shear capacity for box section.

80% of full shear capacity or actual shear (if indicated in drawings) or 0.5 times of the web thickness whichever is more for I section. Weld will be double fillet.

All welds will be continuous. The minimum size of fillet weld will be as per relevant IS code.

Shear connections shall be designed for 75% of section strength for rolled sections and 80% of section strength for built up section or rolled section with cover plates. Design shear force should be more than actual shear.

Moment connections between beam and column will be designed for 100% of moment capacity of the beam section.

All butt welds shall be full penetration butt welds.

Connection of base plate & gusset members with the columns will be done considering that total load gets transferred through weld.

All splicing work shall be of full strength. Shop splicing for all sections other than rolled sections shall be carried out by full penetration butt welds. Shop splicing of all rolled sections shall be carried out using web and flange cover plate.

Following connections will be provided during erection :

1.) Welded Connection

- Connection of secondary beam to main beam
- Connection of bracing to column
- Connection of bracing to longitudinal tie beam
- Connection of longitudinal tie beam to column
- Connection of spandrel beam to column
- Connection of other secondary structures

2.) HSFG Connection (Grade 8.8 bolts)

- Splicing of column/transverse frame beam/ longitudinal tie beam
- Connection of Crane Girder to column
- Connection between crane girders
- Other major connections

3.) Bearing Type Connection (HT bolts Grade 8.8)

- All removable type connections
 - M.S. bolts (Grade 4.6)
- Purlins, stairs, wall beams etc

4.2.4 DESIGN

The design of steel structures will be done by linear elastic method as per the provision of IS: 800-1984. Individual members of the frames will be designed for load combinations for moment, axial force, shear force and torsion. Wind and seismic loads will not be considered to act simultaneously in transverse or longitudinal direction as

per IS 1893-2002. The gable end columns of Power House building will be designed for wind and axial loads considering base as fixed and restraints provided by wind girder at operating floor and roof levels. The secondary beams will be designed as simply supported beams between the main beams of frames.

The secondary beams supporting various RCC slabs without cut outs/openings will be designed as composite beam with channel type shear connectors and will be designed as per the provisions in IS: 11384 for composite construction.

All buildings/structures shall be framed structure. Basic consideration for structural framing shall be stability, rigidity, building uses, ease of fabrication / erection and overall economy. Additional bracings / moment connections shall be used to assure stability of structures. Structure shall be designed such that the surface of all parts shall be accessible for inspection, cleaning, painting and maintenance.

Crane gantry girders shall be single web plate girder of welded construction with bearing and intermediate stiffeners. Crane girder shall be designed as simply supported and of single span length. Chequered plate shall be used for gantry girder walkway flooring. For lifting / monorails beams ISMB sections shall be preferred and the bottom flange of all beams shall be checked separately for distortion and reinforced / braced suitably if required.

Base plate shall be fixed on foundation pedestal with grouting. For large base plates necessary grout holes shall be provided for escape of air. All anchor bolts for fixing steel columns to foundation shall be embedded in foundation during concreting itself..

4.2.5 PERMISSIBLE DEFLECTIONS

The permissible deflections of various steel members under normal loading conditions shall be as specified below. For calculation of deflections in structures and individual members, dynamic effects shall not be considered unless specified otherwise. Also, no increase in deflection limits shall be allowed when wind or seismic load are acting concurrent with normal loading conditions.

Vertical Deflection

4.2.5.1

For beams supporting dynamic equipment	Span / 500
For beams supporting floors / masonry	Span / 325
For beams supporting pipes (pipe racks)	Span / 400
Purlins and side runners supporting sheets	Span / 250
For grating and chequered plates	Span / 250 subject to a maximum of 6 mm

For crane gantries or any member subjected to dynamic loads, the maximum deflection under dead load and live load excluding impact shall not exceed the following values:

For manually operated cranes & monorails	Span / 500
For electric overhead cranes.	
Upto 50 t capacity	Span / 750
Over 50 t capacity	Span / 1000

4.2.5.2 Horizontal Deflection

The permissible horizontal deflections shall be as given below unless specified otherwise.

Single storey building	Height / 325
Pipe rack columns	Height / 200
Open structures	Height / 200
Crane gantry girder due to surge	Span/2000 limited to maximum of 15mm
Building main columns at crane rail level due to action of crane surge load only	Height/2500 limited to 10 mm
Open gantry columns at crane rail level due to action of crane surge load only	Height/4000 limited to 10 mm

Provisions of IS: 800-1984 and relevant IS Code shall be followed for limiting deflections of structural elements not listed above.

4.2.6 MINIMUM THICKNESS & SIZES OF ELEMENTS

4.2.6.1 Minimum Thickness

The minimum thickness of various components of a structure and hot rolled sections shall be as follows. The minimum thickness of rolled shapes shall mean flange thickness regardless of web thickness. Structural steel members exposed to significantly corrosive environment shall be increased suitably in thickness or suitably protected otherwise as per good practice and sound engineering judgment in each instance.

a) Trusses, purlins, girts and bracing	6 mm	
b) Columns and beams	8 mm	
c) Gussets		8 mm
d) Stiffeners		8 mm
e) Base plates		10 mm & above
f) Chequered plates		6 mm o/p & above
g) Grating Flats	3 mm for	secondary bars and 6 mm for edge bars
h) Minimum thickness of structural members other than gratings and chequered plates directly exposed to weather and inaccessible for painting and maintenance	8 mm	

4.2.6.2 Minimum Sizes: The flange width of purlins for those supporting roof sheeting and wall cladding shall not be less than 50 mm. Width of steel rolled section connected to other member shall be at least 50mm. The depth of beams for platform of all structures shall not be less than 125 mm.

4.2.7 SLENDERNESS RATIO

The Slenderness ratio of main members in tension, compression or bending shall be in accordance with IS: 800.

4.2.8 PAINTING

All structural steel should be painted with 2 coats of zinc phosphate primer and finished with Synthetic enamel paint of approved make and colour.

All steel structure shall receive two primer coats and two finish coats of painting. First coat of primer shall be given after fabrication, before dispatch to site for erection, after surface preparation as described below. The second coat of primer shall be applied after erection and final alignment of erected structures. Two finish coats shall be applied after the second primer coat.

Steel surface which is to be painted shall be cleaned of dust and grease and heavier layers of rust shall be removed by chipping prior to actual surface preparation. The surface shall be abrasive blasted to Sa-2½ finish as per SIS 05-5900. Primer paint shall be inorganic Zinc phosphate of approved brand. Dry film thickness of each primer coat shall be 25 microns minimum.

Providing and applying two coats of synthetic enamel paint with minimum 50 micron total dry film thickness (DFT) of approved make and shade to achieve an even shade over steel sections already having primer coats and keeping overall DFT with primer not less than 110 microns.

4.2.9 REQUIREMENTS FOR SPECIFIC STRUCTURES

4.2.9.1 Coal bunkers

Design of the bunkers shall be as per IS: 9178. Plates shall be cut to the maximum width to reduce the number of horizontal joints. Vertical joints shall be staggered. All vertical joints above bunker supporting zones and both vertical and horizontal joint below the zone shall be inspected by radiography to ensure quality. Trial assembly of the bunker including hopper shall be made at least for one bunker before commencing regular fabrication of the bunkers..

Stainless steel liner in the coal Bunkers will be 4.0 mm thick & of grade SS: 409M, Finish Grade 2B (Cold Rolled, Annealed & Pickled and Skin passed) will be provided on the inner faces of entire inclined portion of Hoppers and mouth of the Hoppers, without allowing any projections in coal flow path. The suitable electrodes' classification as per AWS will be as followed for welding of stainless steel to stainless steel & for welding of stainless steel to mild steel.

The coal pressure distribution in the bunker walls and hopper will be calculated as per the guideline laid in IS: 9178.

4.3 DESIGN PHILOSOPHY

4.3.1 POWER HOUSE STRUCTURE (TURBO GENERATOR / DEAERATOR BAY)

The Main Power House structure will be moment resisting frame in the transverse direction and will have fixed base. The structure will be braced in longitudinal direction. In the longitudinal direction, the structure will be continuous for the total length of one unit of the power house. Adopting twin columns between the two units of Power house buildings, expansion gap shall be provided.

Columns inside TG bay (auxiliary structures around TG) will be fixed at base and have shear connection with beams supporting R.C.C floor at operating floor level & mezzanine floor level. Beams in transverse direction will have connection with TG bay main columns.

Analysis of Main Frame of the Main Power House: The structural steel main frame will be analyzed as space frame with fixed base. The frame will be subjected to dead load, live load, crane load, equipment load, wind load and seismic load. Structural analysis will be carried out for the different load combinations as specified elsewhere. For the main frame subjected to seismic load, the analysis will be carried out using the response spectrum method using at least five modes of vibration as per IS: 1893-2002.

The structural steel main frame in the longitudinal direction will be analyzed and designed as braced structure with all the applied external forces resisted through axial tension or compression. Individual members of the frames shall be designed for various load combinations for moment, axial force, shear force and torsion. The gable end columns shall be designed for wind and axial loads considering base as fixed and restraints provided by the wind girder at operating floor and roof girder levels. The secondary beams shall be designed as simply supported beams between the main beams of frames.

4.3.2 Electrical Bay

The electrical bay will consist of areas for the cable spreader, switchgear floor, Control Room floor and MCC Floor. It will be supported on structural steel frame work with moment connection in transverse direction and bracings in longitudinal direction.

4.3.3 PIPE AND CABLE RACKS AND PIPE PEDESTALS

Pipe and Cable racks will be latticed steel structure on RCC foundations decided on the basis of Geotechnical Investigation Report. At road crossings the minimum height clearance will be 8 m.

The racks shall generally be designed as braced in the transverse direction below the bottom most rack level and rigid above the level since bracing will interfere with pipe / cables. Longitudinal direction they are braced generally in the centre of an expansion unit. Expansion joint shall be provided whenever there is a change in direction and where length of the rack exceeds 150 meters. Access ladder shall be provided at suitable locations. Where so specified 600 mm wide chequered plate platform will be provided in the cable rack portion for maintenance purpose.

4.3.4 MILL AND BUNKER BAY

The framing shall be of structural steel. This shall be designed as a moment connected framing in the transverse direction and braced in the longitudinal direction. These structures primarily support

coal bunkers, coal feeders and tripper arrangement to feed coal into the coal bunker. The structure shall be designed to have a Moment connection at the base of the frame.

4.4 DRAINAGE AND SEWERAGE

4.4.1 SURFACE DRAINAGE

All the paved and unpaved areas will be adequately drained. The paved areas will be sloped towards the nearest drains with a slope of 1 in 100. The surface drainage from uncontaminated areas will be connected to the nearest storm water drains through rectangular drains. Contaminated area surface drainage will be connected through a separate network. Run off coefficient for paved and unpaved areas will be taken as 0.9 and 0.6 respectively.

4.4.2 STORM WATER DRAINAGE SYSTEM

A network of open rectangular or pipe drain will be constructed for efficient discharge of storm water. The drains shall be constructed of RCC. Minimum clear width of the drains shall be 300mm and minimum depth of drain shall be 300mm. NP3 class pipe culverts will be provided under road and railway crossings.

For pipe drains, concrete pipes of class NP2 will be used. However, for road and rail crossing, concrete pipes of class NP3 will be used. Manholes will be provided at 30m intervals along the length, at connection points and at every change of alignment, gradient or diameter of pipeline. Hume pipe of 150mm diameter shall be provided below each road at every 50m and of 600mm diameter at every 300mm and also at all turnings for maintenance purpose. The runoff collected by the above drains will be suitably discharged at a suitable location at plant boundary.

The plant storm water drainage will be designed taking into account the finished grade levels of the plant and invert levels of existing drains(if any), area drainage pattern within and outside plant area, intensity of rainfall @50mm/hr considering heaviest fall in 24 hrs(As per climatological table furnished by customer). The slope shall not be milder than 1 in 1000 and maximum velocity in open drain shall be limited to 1.8 m/s. However a self-cleansing velocity of 0.6m/s shall be ensured.

Drains inside the building will have minimum 40mm thick grating covers. In areas where heavy equipment loads would be coming, pre-cast RCC covers will be provided in place of steel grating.

Open RCC rectangular section shall be provided for all drains.. In areas where vehicular loads would be coming, pre-cast RCC covers of suitable thickness without perforations and designed for the vehicular loading will be provided.

In the buildings suitable arrangement for draining out water collected from equipment blow downs, leakages, floor washings, fire fighting etc. will be provided for each floor with suitable floor drains. Water from roof surface shall be removed by a system of Roof Drain Heads, rainwater down comers and necessary fixtures. The roof of power house shall be provided with a slope of 1

in 100 in one direction in A-B bay and sloping towards A - row.

Garland drains of minimum 300 mm wide shall be provided all around the buildings to lead away roof drainage to the plant drainage system. Plinth protection shall be provided between the building wall and drains with appropriate slope.

Minimum earth cover of 450mm shall be provided over drainage pipes in paved areas.

4.4.3 PLANT EFFLUENT DRAINAGE (OILY WASTE/PROCESS WASTE DRAINAGE)

The oily / process waste shall be collected and drained through a separate sewer system consisting of cast iron pipes in the paved area and concrete pipe class NP2 in other area. Manholes shall be provided at junctions of pipes.

The minimum dia of pipe shall be 150 mm for C.I pipe and 300 mm for concrete pipes. The pipes shall be adequately sloped and shall carry the flow to Neutralising pit / oil water separator / guard pond of effluent treatment plant as the case may be.

4.4.4 SEWAGE DISPOSAL

All buildings with toilets shall be connected to the sewage treatment plant with a proper sewage disposal network.

Pipe connecting toilet facilities to manholes shall be pipes of,cast iron in paved area whereas in other area hume pipes shall be provided, of minimum size 100 mm dia. Pipes connecting various manholes in the power block area shall be having a minimum dia of 150 mm.

Sewers shall have such slope as to ensure effective discharge. Manholes shall be provided along the sewers at 30 m intervals, at junctions and at changes of gradient or alignment.

4.4.5 BUILDINGS - WATER SUPPLY SYSTEM

Roof water tanks of adequate capacity, depending on the number of users for 12 hours requirement will be provided on the roof of buildings as required. Polyethylene water storage tank conforming to IS: 12701 will be used. The tanks will be complete with fittings including float valve, stop cock etc.

Galvanized MS pipe of medium class conforming to IS: 1239 will be used for internal piping works for potable water supply.

4.5 CABLE TRENCHES

The slab and walls of cable trenches shall be constructed using concrete grade M25 and pre-cast removable RCC cover (with lifting arrangement) will be constructed using concrete grade M25. Each precast removable RCC cover shall not weigh more than 75 kg and shall be provided with lifting hooks. Proper drainage of trenches shall be provided.

The cable trench walls will be designed for the following loads:

1. Triangular earth pressure + Uniform surcharge pressure of 15kN/m².
2. Cable trench covers will be designed for self-weight of top slab and concentrated load of 200 Kg at center of span on each panel.
3. Cable trench crossing the road/rails will be designed for class AA loading of IRC/relevant IS code and should be checked for transformer loading. Lifting hooks will be provided in the pre-cast covers.
4. Cable trenches will be blocked at the ends if required with RCC walls.

Trenches located inside the building will be covered with removable chequered plate covers.

Where the cable trench connects to a building, R.C.C duct banks with PVC / HDPE conduits for running cables will be provided. These conduits shall be sealed with fire resistant sealing compound after cables are laid to prevent ingress of water into the building and to avoid spreading of fire.

4.6 PAVING / GRADE SLAB

RCC Grade Slab / Boiler area paving : Minimum 150 mm thick (with minimum reinforcement of 8 dia (HYSD) @ 300 c/c both ways top & bottom) over an underbed as specified herein will be provided for areas mentioned below. Underbed will consist of preparation and consolidation of sub-grade to the required level, laying of stone soling of 230mm compacted thickness with 63mm and down aggregate with interstices filled with selected sand followed by 75mm thick M10 PCC

Area between main plant building and ESP, ID, FD fan will be provided with paving. This paving will have regular configuration with boundaries of the block extending minimum 2 m from the outermost face of the equipment/structures.

1. For Ground floor of all buildings - Grade slab shall be provided
2. Two meter wide corridor along the entire width of TG & Deaerator bay at both the gable ends - Paving shall be provided
3. Complete Transformer yard area between A-row of main power house and fencing of transformer yard – Paving shall be provided.

ROAD & DRAIN

4.7

The main road to the Power Plant shall originate from the main approach road. The main road shall be 12M wide(carriage way width 10M) with 1M wide shoulder on either side to accommodate large trucks movement .The 10M wide road shall be provided upto service building from the main gate.

Other roads may be of double lane of 7.5M wide (carriage way width) and single lane of 3.75M wide with 1M wide shoulder on either side for both, depending on the location.

Branch roads may be of single lane and 3.75 meter wide with 1meter wide berm on either side.

The minimum recommended road section is as follows :

Sub-base : Sub base shall consist of stones of 150 mm maximum size in two layers compacted to a thickness of 230 mm.

Base : Base shall have a thickness of 225 mm consisting of 3 layers of 75 mm each (compacted thickness).

Topping : The bituminous surfacing shall consist of wearing course of premix carpet 20 mm thick (with seal coat on top) over binder course of 55 mm thick Bituminous Macadam.

Initially only water bound macadam surface shall be constructed and after completion of bitumen topping shall be carried out .

All roads should designed in accordance with IRC 37-2001.

DRAINAGE

Open RCC rectangular drains shall be provided for storm water. The thickness of sides & bottom shall be minimum 100 mm or as per design considerations whichever is higher. RCC culverts shall be provided for road and rail crossing. Drains shall be provided on both sides of the roads except patrol road where drains will be only one side.

Inside surface of the drain will have smooth neat cement finish over with screed concrete. Invert of the drain shall be decided in such a way that the water can easily be discharged to the recommended nearest outfall outside the plant boundary. The minimum slope of the drain shall be 1:1000 longitudinally to take care of the silting problems. It is recommended to maintain the maximum velocity within 1.2 m/sec..

4.8 FENCING

4.8.1 Minimum 2.4m high fencing above toe wall shall be provided around transformer yard. Other areas where fencing is necessary it shall comprise of PVC coated galvanised chain linked fencing of minimum 8 gauge (including PVC coating) with barbed wire for remaining height shall be provided for areas as per safety requirements.

4.8.2 Access in fencing wherever required shall be with steel gates

4.9 Plinth Protection

All buildings will be provided with 1000 mm wide and 75mm thick reinforced cement concrete M25 paving all around on the outside. The plinth protection will be laid over prepared sub-grade and base formed with 100 mm thick compacted sand bed with broken bricks, or rubble laid to a thickness of 75 mm. RCC drains by the side of plinth protection for catering the storm water from roofs and adjacent area will be provided.

4.10 Grouting/Encasement

Grout shall be flow able, and no shrinkable kind. Grouting shall be done with Conbextra GPX-2 of 'Fosroc' or equivalent for Equipment foundations and Conbextra GP-1 or equivalent for all structural column bases. For pipe-supports grouting shall be done with 1:1:2 cement-sand - 6mm down stone chips

4.11 Damp Proofing

Damp proof course in a thickness of 40mm and consisting of cement concrete 1:1.5:3 with minimum of 2% admixture of approved water proofing compound shall be provided at plinth level for masonry walls in super structure.

4.9

Watch Tower

5.0

Watch tower shall be provided at the change of alignment of boundary wall and the inter distance of 500 mtr (approx.).

BRIEF DESCRIPTION OF STRUCTURES IN POWER PLANT

5.1 POWER HOUSE BUILDING

Main power house framing is of structural steel. Columns and framing beams are of built-up section. Main power house comprises of Turbo Generator bay and Electrical bay.

Turbo-Generator Bay: Roof in turbo-generator bay (A-B bay) will be with cast-in-situ RCC slab laid over metal decking sheet as a permanent shuttering.

Other Areas: **Casting of RCC roof slab will be done with the provision of removable shuttering.**

Flooring: The floor slab will be designed as cast-in-situ RCC slabs with removable shuttering unless mentioned elsewhere. The minimum thickness of RCC slabs will be 150mm. Floor finish of 40mm thickness will be provided over the RCC slab. Type of floor finish will be as per the functional requirements of different areas and facilities. Floor finish that will preferably be adopted for important areas will be as per Finish schedule described elsewhere. TG bay will have RCC floors at finished floor levels (FFL) at EL+8.500 and EL +13.500.

For Fire barrier wall, RCC fire barrier wall shall be provided for the transformer in front of power house. Brick partition walls will be 115mm thick. Bricks shall be burnt clay bricks or fly ash bricks of class designation 7.5 conforming to IS 12894 having 75 kg/Sqcm compressive strength shall be used for brick work. Metal cladding shall be of prefabricated, prepainted and insulated metal sheet of Luxalon or equivalent.

5.2 Roof Water Proofing Treatment: The gradient for the roof of Turbine bay will be provided either in steel structure or by use of screed concrete of M10 grade. Water proofing treatment shall be laid over 100mm thick foam concrete insulation over permanent 0.8mm thick metal decking plate. Minimum 15mm thick cement mortar (1:4) will be provided on top to achieve smooth surface. Roof water proofing treatment will be provided over this by providing extra heavy duty four layers of Hessian based bitumen felt and five layers of bitumen paint finish. Wearing course consisting of 25mm thick plain cement concrete of grade M15 (1:2:4) with graded aggregate of 12.5mm size cast in panels of maximum size 1.2mx1.2m and reinforced with 0.56 mm dia. galvanized chicken wire mesh and sealing of joints (in grooves of 6mm X 6mm) using silicon /elastomeric compound will be provided over bitumen paint. Roof waterproofing in all other areas will have 75mm thick foam concrete over conventional RCC slab with extra heavy duty nine layers of bitumen felt over which 20mm thick pressed pre-cast concrete tiles on 15mm thick cement sand (1:4) under bed shall be laid. Rain water down comers shall be GI pipes conforming to IS: 1239 for Power house building. Rain water down take pipes shall be provided one per bay near each column location on both A and C row for Power House building.

5.3 MILL AND BUNKER BAY STRUCTURE

The framing shall be of structural steel. This shall be designed as a moment connected framing in the transverse direction and braced in the longitudinal direction. These structures primarily support coal bunkers, coal feeders and tripper arrangement to feed coal into the coal bunker

Mills are to be located on the ground floor. Mill foundations are to be designed as a dynamic block.

Mill maintenance platform is provided with chequered plate or gratings over steel framing with hand rails all-round. Feeder floor shall be of RCC supported on structural steel framework.

Tripper floor is provided immediately above the bunker. Tripper roof shall be of RCC supported on structural steel frame work. An RCC parapet or steel handrail shall be provided for the tripper roof. An access stair or ladder shall be provided from tripper floor to roof in each unit.

5.4 ESP CONTROL ROOM

This shall be a steel framed structure. The building houses cable vault, toilet, staircase, switch gear rooms, control rooms and AHU room. An auxiliary transformer yard with fencing and gate shall be provided adjoining to the building. Side cladding shall be of brick wall with wall in front of transformer yard made sufficiently thick to satisfy fire rating as per TAC regulations.

5.5 TRANSFORMER YARD

Transformer yard will be provided with foundations for transformers & other equipment, cable trenches and fencing. The transformer yard will be provided with the chain link PVC coated galvanized chain link fencing of minimum 8 gauge supported by steel posts. Gravel will be filled in transformer oil and water collecting pits. The transformer yard area will be provided with RCC paving. Fire barrier wall will be provided between the adjacent transformers and fire wall will be provided in the adjacent buildings on the wall facing the transformers as per TAC requirements.

Transformer yard pit will be leveled to proper slopes for drainage towards sump. Sump will be connected to the nearest drainage system after passing through oil water separator.

The total transformer area shall be paved with 150 mm thick RCC paving over 230 mm thick rubble soling.

5.6 MISCELLANEOUS BUILDINGS/STRUCTURES

SL.No.	Building Name	Description
1.	Service Building	RCC structure with brick cladding. Total area of 4000 sqm (approx)
2.	Clarified water pump house	RCC sump with structural steel framework above FFL only superstructure with brick cladding with RCC roof over deck sheeting.
3.	CW pump house	RCC sump with structural steel framework, superstructure with brick cladding and RCC floor slabs and roof
4.	CW Treatment	Steel Shed
5.	ESP Control room	Steel structure frame with brick cladding RCC floor slabs and roof.
6.	Compressor house	Steel Building
7.	Chemical Lab	RCC structure with brick cladding.
9.	Fuel oil Pressurizing pump house	RCC structure with brick cladding.
11.	Administrative building	RCC structure with brick cladding. G+1 Structure of total area 2500 sqm.
12	Canteen	RCC structure with brick cladding. One floor of 40m x 18m (excluding corridor and portico). The main dining area shall have the arrangement to seat minimum 150 people at one time. In addition there shall be a separate executive dining area to accommodate about minimum 25 executive and separate dining area for women for 25 nos.
13	Fire Water Tank Foundations	RCC ring wall.
14	Fuel Oil Storage Tank Foundations	RCC ring wall.

15	Pipe and Cable Trestles	Structural Steel super structure with RCC foundation.
16.	Raw water pump house	Steel Structure
17.	Fire station	G+1 RCC structure with brick cladding.20m x 15m x 4.0m (ht) of each floor. Additional 2 Nos fire tender parking area
18	Permanent Store Building	RCC columns with brick cladding and steel truss roof. Area 30m x 15m-15 No.s
19	CW Treatment Building	Steel shed with side open
20	Security Building	RCC structure with brick cladding of 300 sqm floor area
21	Parking sheds	Parking sheds shall be provided as mentioned below apart from bus parking for 3No.

Parking Requirement

Sl. No.	Location	Car parking (No.s)	Two Wheeler Parking (No.s)
1	Administrative Building	5	50
2	Service Building	20	200
3	Canteen	10	100
4	Chemical lab	--	10
5	Security Building	2	20
6	Permanent store building	--	50
7	CW pump house	--	10
8	Ash Pump House area	2	20
9	Coal Handling area	2	20

6.0

GENERAL REQUIREMENT OF BUILDINGS

The design and construction of buildings, structures etc. shall take in to account the functional requirements for operation and maintenance of all equipment and its users. The following details indicted will generally apply for all buildings and structures.

6.1 ARCHITECTURAL CONCEPTS AND DETAILS

Architectural scheme components viz shape, form, colour, and basic materials for interior and exterior architecture, will generally conform to that described herein and match with local practice and surroundings.

6.2 ROOF ACCESS

For roofs more than 8m above grade or if major equipments are placed over the roof, shall have access from a proper staircase. Minimum 1000 mm wide access path with tiles shall be provided to approach equipment on roof. For other roofs cage ladder or staircase as appropriate shall be provided.

6.3 PLATFORMS AND WALKWAYS

6.3.1 Platforms shall be provided to all major equipment, not directly accessible from the floors, for maintenance. Platforms located close to each other shall be connected with walkways.

6.3.2 All steel platforms above grade level shall be constructed with kick plates at edge of the platform to prevent tools or materials from falling off.

6.3.3 Continuous walkway with hand rails shall be provided along the crane girder level in the TG building. Approach to EOT crane shall be ensured by Cage ladder or staircase.

6.4 STAIRS & LADDERS

6.4.1 STEEL STAIRS

All steel staircases shall normally have minimum clear width (back to back of stringer) of 1000 mm and minimum inclination with horizontal of 35.7 degree. However, in case of space restriction, minimum 250 mm wide treads of chequered plate/grating, with suitable nosing, and spaced equally so as to restrict the rise to maximum 200 mm .

6.4.2 STEEL LADDERS

Ladders shall be provided to platforms, walkways, instruments and equipments which do not require frequent access. Ladders shall preferably be vertical and its angle with vertical shall not exceed 50.

Ladders shall be of minimum 450 mm clear width with 20 mm dia. MS rungs spaced at 300 mm (maximum).

Ladders shall be provided with a safety cage wherever required starting at 2.5 m above the lower landing level.

6.4.3 RCC STAIRS

All stairs shall have riser of minimum 150 to 200 mm and a minimum tread of 250 mm. However, for administration building riser shall be limited to 150 mm tread width of 300 mm. Minimum width of stairs shall be 1200 mm generally. No staircase shall have more than 15 risers in one flight. Aluminium angle nosing with minimum 50 x 25 x 3 angle shall be provided for edge protection of RCC stairs.

6.5 VERTICAL HEAD ROOM

All accessible areas will be provided with a minimum clear headroom as follows, unless otherwise specified.

1. Finished floor to ceiling (Buildings)	:	3000 mm
2. Doors, walkways, platforms	:	2100 mm
3. False ceiling to office areas/stairs	:	2400 mm
4. Cat walkways above false ceiling	:	1000 mm
5. Safety cage for cage ladders	:	2500 mm
6. Access for forklift trucks	:	2800 mm
7. Roads / railway crossings	:	8000 mm
8. Cable and pipe racks (except road/rail crossing)	:	3000 mm

6.6 GUARD RAIL / HAND RAILS

Guard rail will be a two-rail system with the top rail 1000 mm above the walkway/platform/floor surface and the intermediate rail 500 mm below the top rail. Guard rail post spacing will be proportioned to the length of the protected horizontal opening, but will not exceed 1500mm centre-to-centre of posts.

6.7 EDGE PROTECTION

Wherever possible around floor openings an RCC Kerb of 100 mm wide 150 mm high shall be provided. All concrete edges, where breakage of concrete corner is expected shall be provided with edge angles e.g. around the cut-outs / openings in floor slab, edges of drains supporting grating covers, edges of manholes supporting covers and supporting edges of pre-cast covers etc.

6.8 ANCHOR BOLTS AND INSERT PLATES

Anchor bolts shall be designed for tension and shear, for embedded length of the anchor bolts and pipe sleeves. Shear and crushing strength of concrete shall also be checked. Increase in allowable stress for loading including seismic and wind loads shall not be permitted in design of anchor bolts.

Insert plates shall be designed / checked for shear and bending moment. All lugs shall be checked for tension. Bond strength of concrete shall be checked. Lugs using steel bars shall preferably be fillet welded to the plate to transfer full strength of the lug.

6.9 EXPANSION / CONSTRUCTION JOINTS

Expansion and construction joints shall be provided wherever required. All expansion and construction joints of water retaining structures in RCC shall be made water tight using PVC ribbed water stops with central bulb. However, kicker type (externally placed) PVC water stops may be used for the base slabs and in other areas where it is required to facilitate concreting. The minimum thickness of PVC water stops shall be 6 mm and minimum width 225 mm. At other joints these shall be 150 mm wide. Two part polysulphide sealant conforming to IS: 12118 shall be used for sealing of joints in contact with water. For other cases, bitumen sealing compound conforming to IS: 1834 can be used. Preformed bitumen impregnated fibre board conforming to IS: 1838 shall be used as joint filler.

6.10 BRICK MASONRY / STONE MASONRY

Walls will be non-load bearing in-filled panel of 230mm thick. For initial height upto 3.0 meters from ground level, walls will rest on grade beam. Internal walls and toilet walls will be 115mm thick. 115mm thick brick walls shall be provided with transomes and mullions where the length or height of wall exceeds 2 m.

Bricks shall be clay burnt bricks or fly ash bricks of class designation 7.5 and shall will be laid with cement mortar (1:6) for 230mm thick brick walls and (1:4) for 115 thick brick walls. IS:1905, IS:2212 and SP-20 will be followed for brick work design and construction. Minimum compressive strength of brick shall be 75 kg/Sqcm. Wall cladding loads along with the effects of wind, earthquake etc. will be considered in the design of beams supporting the walls.

6.11 WATER PROOFING & PAINTING OF UNDERGROUND STRUCTURES

All underground structures like basements, pump houses, water retaining structures shall have plasticizer cum waterproofing cement additives conforming to IS: 9103. In addition, limit on permeability as given in IS: 2545 shall also be met with.

6.12 Rolling Shutters: Rolling shutters as per IS:6248 with suitable operating arrangement (manual, mechanical and /or electric) according to size shall be provided in buildings to facilitate handling and transportation of equipment. The curtains of rolling shutter will be of interlocking scrolls made of hot rolled double dipped galvanized steel lath section of 18swg tested mild steel strips at 75mm rolling centers, locked with galvanized malleable iron clips. The bottom lath will be coupled to a locked plated fabricated from 3 mm thick galvanized steel plate and security riveted with stiffening angles.

7.0

FINISHES

7.1

Plastering

The exterior plaster on brick wall shall be 20 mm thick sand face plaster in CM (1:6) and shall be laid in 2 courses. Interior face of all brick walls will have 12 mm thick cement sand plaster (1:6). 2mm thick plaster of paris punning to be provided over plaster to air conditioned areas.

7.2 DOORS, WINDOWS AND VENTILATORS

- a) Generally hollow metal (steel) flush doors with pressed steel frame shall be provided for plant and utility areas.
- b) Solid core factory made wooden flush doors in hard wood frame shall be used in interior office areas. Aluminium doors shall be provided in at entrances and important areas.
- c) Rolling steel shutters shall be used where frequent use is not envisaged and large openings are required. Operation shall be manual/mechanical/electrical depending on the size of opening.
- d) Special areas like control rooms and other special areas shall be provided with minimum 15 micron pre-coated i.e. colour anodised aluminium glazed partitions with air lock facilities having two sets of doors preferably double door system.
- e) Minimum 2 hour Fire rated doors with panic bar shall be provided in cable spreader rooms and other areas having fire hazard and also to all fire exists as per TAC requirement.
- f) Doors shall be provided at appropriate location to prevent dust ingress from outside.
- g) Wooden panel doors shall be provided for toilet entrance and toilet internal doors shall be solid core PVC.
- h) Weather stripping shall be provided to all outside doors as well as air conditioned areas and all other doors where dust-free environment is required.

In Powerhouse building, full glazed windows of sliding type ventilators in minimum 15 micron anodized aluminium window frame shall be provided with 4 to 6 mm thick (depending on the size of panel) clear float glass and 6 mm thick clear wired/laminated glass where required from safety point of view. For an operating floor of Power House, structural glazing may be considered as an important façade element.

In other areas aluminium windows with 4 mm thick clear float glass shall be provided. The window area shall be so decided so as to allow adequate natural ventilation and light.

Note: Glass thickness and member sizes of Aluminium Glazed doors and windows shall be designed by the manufacturer and to be submitted for approval before execution.

7.3 GLAZING

- a) Glazing in Control room between A.C. and non-A.C. areas shall be insulating glass consisting of two 6 mm thick toughened float glass sheet hermetically sealed and separated by 12 mm gap for thermal insulation. Clear glass shall be provided where clear view is required. In other areas tinted glass may be provided.
- b) 4 mm thick ground glass shall be provided for toilets.
- c) Glazing between two A.C. areas shall be with 6 mm thick clear float glass.
- d) All glazing shall be in aluminium frame having 15-micron colour anodised.
- e) 6mm thick Wired / laminated glass shall be used for windows / ventilators at higher level for safety.
- f) 24mm thick insulated double glazing having 6mm thick tinted heat-reflecting type float glass on outer side and 6mm thick clear float glass on inner side with 12mm air gap & hermetically sealed shall be mounted on 15 micron coloured anodised aluminium frame suitable for structural glazing system.

7.4 ACID ALKALI RESISTANT LINING

- 7.4.1** 25mm thick acid and alkali proof tiles will be laid over acid and alkali proof epoxy mortar under bed shall be provided for Battery room, battery charger room, degasser area, chemical house floor etc. Similar tiles over chemical resistant silica based epoxy mortar shall be used as dadoing above floor level. Ceiling will be painted with chemical resistant epoxy paint.

7.5 FLOORING & FLOOR FINISHES

- 7.5.1** The floor slabs will be designed as cast-in-situ RCC slabs with removable shuttering unless mentioned otherwise. The nominal thickness of RCC slabs will be 150 mm.
- 7.5.2** **The nominal total thickness of floor finish will be 40/50 mm i.e. underbed & topping. The floor will be laid on already laid and matured concrete base.**
- 7.5.3** **The finished floor level of toilet areas shall be kept 12 mm below as that of the surrounding area. Toilet area slabs will be made water tight by suitable water proofing treatment.**
- 7.5.4** Floor finishes will be as per Finish schedule of this specification

- 7.5.5** Skirting in general will be 150 mm high. Dado in toilets, will be upto 2.1m. height from finished floor level. Skirting and Dado will match with the floor finish.

7.6 FALSE CEILING

Aluminium pre-painted/Powder coated false ceiling, either lineal panel system or aluminium tile/plank system for control rooms and other important areas, with suspension system as per manufacturer's details shall be used.

Areas like office space or where specified Mineral Fibre Based Acoustic Ceiling Board either Armstrong or similar to Armstrong in aluminium snap grid suspension system as per manufacturer's specification shall be provided. As an alternative Moisture & Fire Resistant Gypsum Board false ceiling system of Saint Gobain Gyproc India Ltd or similar manufacturer may be used.

Unimportant areas Calcium Silicate Board/Tiles false ceiling shall be of HILUX or AEROLITE or Fibre Cement Board of EVEREST Industries Ltd shall be used.

The false ceiling work shall take care of all illumination, fire detection & fighting, HVAC and all other service requirement. False ceiling shall be provided with 25 mm thick insulation of resin bonded mineral wool conforming to IS: 8183. Wherever under-deck insulation is required the insulation shall be 50 mm thick resin bonded rigid mineral wool / polystyrene block with protective aluminium foil lining.

7.7 SCHEDULE OF FINISHES

7.7.1 INTERIOR FINISH SCHEDULE FOR POWER HOUSE BUILDING

BUILDING/ AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING
T.G. Hall Area	Overall 50mm thick flooring shall be finished with 18 mm thick polished Granite for unloading areas and walkways shall be demarcated with 75 mm wide and 18 mm thick Granite stone (black) on both sides of Granite finished walkways.	Granite tiles/10mm thick high polished decorated coloured background 1st quality digital series dual charged glazed tiles of size not less than 18"x12" shall be provided for inner	T.G. Hall – anti-corrosive paint to metal deck and all metal works. Acrylic Distemper on exposed plastered ceiling (without false ceiling). Aluminium panel

		faces of all four sides walls of operating floor TG hall and columns (by encasing structural steel columns along A-row and both gable ends with brick masonry for 3.0mts height above operating floor) up to bottom of window lintel level or 1.80mts height from operating floor level whichever is high and balance portion of brick wall shall be painted with two coats of plastic emulsion paint over primer and white cement putty. A row and gable end shall have double skin metal cladding system above brick masonry wall. Synthetic enamel paint up to 1.50mts height and acrylic emulsion paint for balance height for all other floors of STG building.	pattern false ceiling for false ceiling areas
Switchgear Room, MCC Room,	Electric insulated flexible PVC sheet as per IS: 15625-2006 to be laid over heavy duty IPS flooring. Overall thickness shall be 50mm. pattern.	Synthetic enamel paint upto 1.50mts height from floor level and balance portion with plastic emulsion paint over primer and white cement putty.	Acrylic Distemper
2 Control Rooms, Control Equipment Room, Computer Rooms, etc. Other than Main Control Room.	Non-skid, fully vitrified, 10 mm thick non-porous, homogenous, abrasion resistant, floor tiles similar to 'MARBONITE', FERRASTONE' of "BOSS Profile Ltd", "RESTILE", ENDURA" of H&R jonson (India) Pvt. Ltd, "Kajaria" profile Ltd", of minimum size minimum 600 mm x 600 mm x 9~10 mm of approved colour and shall be laid over concrete floor with laying compound strictly as	Vitrified tiles dadoing up to false ceiling level in UCB control room and annexure room shall be provided. Front portion of the UCB control room facade above glass panelling a suitable combination of Aluminium composite panel (ACP)/granular textured paint may be used. Columns,	Gypsum board plaster false ceiling for control room and annexure rooms. The false ceiling work shall take care of all illumination, fire detection & fighting, HVAC and all other service requirement.

	per manufacturer's specification. Total thickness of the flooring shall be 50mm thick including the thickness of the tiles and under bed.	bracings or any other element within the room as the case may be shall be clad with polyester coated 3mm thick Aluminium Composite Panels (Aluminium thickness minimum 0.2mm) of approved make or composite panelling of approved pattern upto the false ceiling level.	
3 All office areas, Conference Room and other important areas.	10/11 mm thick non-skid fully vitrified dual charged tiles of minimum size 600 mm x 600 mm similar to 'MARBONITE', FERRASTONE' of " BOSS Profile Ltd", "RESTILE", ENDURA" of H&R jonson (India) Pvt. Ltd, "Kajaria" profile Ltd", (overall 40 mm thick) laid in pattern with different colour of tiles.	Acrylic emulsion paint over white cement putty.	Acoustic precoated aluminium alloy panelled ceiling (600x600mm panels) stove enamelled on both sides on pre coated aluminium grid system. Acrylic emulsion paint over white cement putty in areas without false ceiling with necessary lighting arrangements for illumination shall be provided.
4 Access floor where required	Minimum 600 mm high false floor with adjustable metal supporting system and fire resistant floor panels finished with antistatic vinyl flooring and matching skirting		
5 Stairs & Lobby	Kota stone slab in general.	Coloured 6mm thick(min) ceramic tiles up to 1.50mts height and Acrylic emulsion Paint over white cement putty for balance height.	Acrylic Distemper Paint
Main Stair & Landing	Aranga White marble slab//makarana pink / Jaishalmir Yellow and Baroda green combination 25 mm thick (min.) with larger possible size to be approved by the owner.	Acrylic emulsion paint over white cement putty.	Acrylic emulsion paint over white cement putty.

Lift lobby	Aranga White marble slab/makarana pink / Jaishalmir yellow and Baroda green combination 25 mm thick (min.) with larger possible size to be approved by the owner.	Granite slab cladding	Aluminium plank panelled pattern false ceiling.
6 Battery Room & Battery Charger Room, UPS Room	Minimum 20 mm thick acid and alkali resistant vitrified tiles "ENDURA" Or similar set in and jointed with epoxy mortar (overall 40 mm thick)	20mm thick acid resistant tiles over bitumen primer up to 1.20mts height	Acid/Alkali resistant epoxy paint for balance height.
7 Chemical Feed Station	Minimum 20 mm thick acid and alkali resistant vitrified tiles "ENDURA" or similar Minimum 37mm thick Acid /Alkali resistant brick, set in and jointed with epoxy mortar (overall 40 mm thick) .	20mm thick acid resistant tiles over bitumen primer up to 1.20mts height.	Acid/Alkali resistant epoxy paint for balance height.
8 AHU Rooms, Air Washer Rooms, Cable Spreader Rooms & all other service areas	50 mm thick heavy-duty cement concrete floor with metallic hardener.	Synthetic enamel paint up to 1.50mts height and acrylic emulsion paint for balance height over white cement	Acrylic Distemper Paint
9 Toilet and other wet areas	Minimum 10 mm thick non-skid vitrified tile of make 'MARBONITE', FERRASTONE' of " BOSS Profile Ltd", "RESTILE", ENDURA" of H&R jonson (India) Pvt. Ltd, "Kajaria" profile Ltd", of minimum size 400 mm x 400 mm (overall 40 mm thick) with glazed ceramic tile of same make dado topped with 50 mm wide matching moulded ceramic trims. Dado height shall be full height starting from finish floor level.	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with Acrylic emulsion paint over white cement putty.	Acrylic emulsion paint over white cement putty. Aluminium false ceiling where required.
10 Oil Spillage area	Non-skid self-leveling epoxy over IPS (overall 40 mm thick)	Epoxy paint.	Epoxy paint.
11 Electrical Switchgear Room, MCC Room, etc	Electric insulated flexible PVC sheet as per IS: 15625-2006 to be laid over heavy duty IPS	Synthetic enamel paint up to 1.50mts height and acrylic emulsion paint for balance	Acrylic Distemper

	flooring. Overall thickness shall be 40mm.	height over white cement putty.	
12 All other general areas except operating floor	Overall 50 mm thick heavy-duty concrete floor (IPS) with metallic hardener or 40mm thick steelcrete tiles finish.	Synthetic enamel paint up to 1.50mts height and acrylic emulsion paint for balance height over white cement putty.	Acrylic Distemper

7.7.2 Interior Finish Schedule For Auxiliary Plant Buildings

1 Mill Building	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	Metal cladding	Synthetic enamel paint
2 ESP Control Building	10 mm thick non-skid fully vitrified tiles of make "MARBONITE", "FERRASTONE" of minimum size 600 mm x 600 mm (overall 40 mm thick) laid in pattern for Control room. Other areas 50mm thick heavy duty IPS flooring with metallic hardener. MCC & Switchgear rooms shall have flexible electric insulated PVC synthetic sheet finish over IPS.	Acrylic emulsion paint over white cement putty for control room and Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint over white cement putty for balance height for Other areas	Pre-coated aluminium panelled (600mmx600mm size) ceiling "Luxalon" or "INTERARCH" in air-conditioned areas. Acrylic Distemper paint in other areas.
3 Chemical House	Minimum 20 mm thick acid and alkali resistant vitrified tile "ENDURA" or Minimum 37mm thick Acid /Alkali resistant brick, set in and jointed with epoxy mortar (overall 50 mm thick) along with 2100 mm high dado of same tile having 20mm thickness. Where required, other areas with 50mm thick heavy duty flooring with metallic hardener.	20mm thick acid resistant tiles over bitumen primer up to 1.20mts height and Acid/Alkali resistant epoxy paint for balance height in acid & alkali prone area and rest with Acrylic emulsion paint	Chemical resistant paint for acid & alkali resistant area and other areas with Acrylic Distemper paint.
4 Raw Water Pump House & Electrical Building	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	Synthetic enamel paint up to 1.50mts height	Acrylic Distemper

		and Acrylic emulsion paint with white cement putty for balance height	
5 HFO & LDO Forwarding Pump House	Self-levelling epoxy floor paint on oily areas and heavy duty IPS flooring with hardener in balance areas.	-Do-	Acrylic Distemper Paint
6 CW, ACW Pump House	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	-Do-	-Do-
7 CW, ACW Pump House	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	-Do-	-Do-
8 Misc. Pump Houses/ Fire Water Pump House/ Clarified water pump house	-Do-	-Do-	-Do-
9 DM plant			
a) Plant area	Minimum 20 mm thick acid and alkali resistant Vitrified tile of "ENDURA" or similar set in and jointed with epoxy mortar (overall 40mm thick).	20mm thick acid resistant tiles over bitumen primer up to 1.20mts height and Acid/Alkali resistant epoxy paint for balance height in acid & alkali prone area and rest with Acrylic emulsion paint	Chemical resistant paint for acid & alkali resistant area.
b) MCC Room	50 mm thick heavy duty cement concrete floor with metallic hardener or flexible electric insulated PVC synthetic sheet finish and matching skirting.	Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint with white cement putty for balance height	Acrylic Distemper Paint
c) Control room and offices	10/11 mm thick non-skid fully vitrified tiles of make "MARBONITE minimum size 600 mm x 600 mm (overall 40 mm	Acrylic emulsion paint over white cement putty.	Gypsum Board / Clacium Silicate Board or tiles

	thick) laid in pattern for Control room and offices.		false ceiling with insulation on top.
d) Laboratories	Minimum 20 mm thick acid and alkali resistant tile set in and jointed with epoxy mortar (overall 40mm thick) along with 2100mm high dado of same tile.	Acid / Alkali resistant paint in acid & alkali prone area.	Acid / Alkali resistant paint in acid & alkali prone area.
e) Toilet	10 mm thick non-skid fully vitrified tiles of make "MARBONITE" FERRASTONE" of minimum size 400 mm x 400 mm (overall 40 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic trims. Height of dado shall be full height.	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with Acrylic emulsion paint over white cement putty.	Acrylic Distemper Paint
10 CW Chlorination Building	Minimum 20 mm thick acid and alkali resistant vitrified tile "ENDURA" or minimum 37mm thick Acid /Alkali resistant brick, set in and jointed with epoxy mortar (overall 50 mm thick) along with 2100 mm high dado of same tile having 20mm thickness. Where required, other areas with 50mm thick heavy duty flooring with metallic hardener.	Chemical resistant paint in acid & alkali prone area and rest with Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint over white cement putty for balance height	Chemical resistant paint for acid & alkali resistant area and other areas with Acrylic Distemper paint.
11 CW Chemical Treatment Building	-Do-	-Do-	
12 Condensate Transfer Pump House	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint for balance height	Acrylic Distemper

7.7.3 Interior Finish Schedule For Non Plant Buildings

1 Service building/Administrative building			
a) Entry cum reception lounge, VIP lounge, Main meeting/ conference room	Suitable and approved combination shed of marble slab and strips shall be used	Two coats of Acrylic Emulsion paint of approved colour shall be applied over a coat of approved primer on the masonry surface prepared with white cement putty.	Aluminium panelled (600x600mm size) acoustic false ceiling with glass wool insulation on top similar to LUXALON of Hunter Douglas or "INTERARCH" having approved colour with stove enamel finish, integrated with light fixtures, HVAC grills and other ceiling mounted accessories, complete in all respect with metal suspension system, trims, profiles etc.
b) Other floors/ office area etc.	10/11 mm thick non-skid fully vitrified tiles of make "MARBONITE", "FERRASTONE", "Kajaria" of minimum size 600 mm x 600 mm (overall 40 mm thick) laid in pattern with matching shirting of same make	- Do -	Gypsum board or Acoustic pre-coated aluminium alloy panelled ceiling (600x600mm panels) stove enamelled on both sides on pre-coated aluminium grid system false ceiling of approved make as per specification
c) For staircase and Corridors	Steps – risers & tread, stair skirting, corridor floor should be combination of Aranga white marble and Abu green marble. Wall cladding of Elevator Lobby shall be of polished granite slab of light	Two coats of Acrylic Emulsion paint of approved colour shall be	Acrylic Distemper paint colour super white.

	grey shed or colour as approved by the owner.	applied over a coat of approved primer on the masonry surface prepared with white cement putty.	
d) Toilet & pantry	Minimum 10 mm thick non-skid vitrified tile, of minimum size 400 mm x 400 mm (overall 40 mm thick) with glazed ceramic tile of same make dado topped with 50 mm wide matching moulded ceramic trims. Dado shall be 100 mm higher than lintel level starting from finish floor level.	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with Acrylic emulsion paint over white cement putty.	False ceiling shall be perforated aluminium stove enamel finished panels of size 600x600mm
e) AHU room, store Generator room, Electrical room, Etc:	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting.	Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint with white cement putty for balance height	Acrylic Distemper paint
2 Canteen Building			
a) Kitchen, Dining hall etc.	10/11 mm thick non-skid fully vitrified tiles of make "MARBONITE", FERRASTONE" of minimum size 600 mm x 600 mm (overall 40 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic tiles. Dado shall be full height for Kitchen and 1500mm. high for other areas. All counter for Kitchen and service areas shall have Polished Granite slab over RCC slab or Kadapa stone	1st quality coloured glazed tiles of minimum 6/7 mm thickness up to 1.20mts height and balance height with Acrylic emulsion paint over primer	Acrylic Distemper paint over white cement putty. Airconditioned areas shall have Acoustic precoated aluminium alloy panelled ceiling (600x600mm panels) stove

		and white cement putty	enamelled on both sides on pre coated aluminium grid system false ceiling of approved make as per specification
b) Other areas	Kota stone flooring and skirting	Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint with white cement putty for balance height	Acrylic Distemper paint
c) Toilet & wash areas	10/11 mm thick non-skid fully vitrified tiles of make "MARBONITE", "FERRASTONE" of minimum size 400 mm x 400 mm over IPS floor (overall 40 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic trims. Height of dado shall be 100mm higher than the lintel level starting from floor finish level.	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with Acrylic emulsion paint over white cement putty.	Acrylic Distemper paint
3 Permanent Store & Inflammable Store Building	50 mm thick heavy-duty cement concrete floor with metallic hardener and matching skirting. For office areas & AC stores vitrified tiles shall be used.	Acrylic emulsion paint with white cement putty for office & AC store areas and Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint with white	Acrylic Distemper paint over white cement putty. Offices and Airconditioned areas shall have Acoustic precoated aluminium alloy panelled ceiling (600x600mm panels) stove

		cement putty for balance height for other areas	enamelled on both sides on pre coated aluminium grid system false ceiling of approved make as per specification
4 Main Gate Complex	Overall 40 mm thick Kota stone slab flooring	Acrylic emulsion paint over white cement putty	Acrylic emulsion paint over white cement putty
5 Weigh Bridge Control room	10/11 mm thick non-skid fully vitrified tiles of make "MARBONITE", "FERRASTONE" of size 600 mm x 600 mm (overall 40 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic trims	Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint with white cement putty for balance height	Acrylic Distemper paint
7 Fire Station			
a) Office area, Toilet, Stores, Training room, Kitchen / Dining area, Dormitory,	"10/11 mm thick non-skid fully vitrified tiles of make "MARBONITE", "FERRASTONE" of minimum size 600 mm x 600 mm (overall 40 mm thick) laid in pattern for office, dormitory area with 150 high matching skirting with 5 mm thick glazed ceramic tile dado of approved make topped with 50 mm wide matching ceramic trims 2200mm. High."	Acrylic emulsion paint	Acrylic emulsion paint
b) Fire tender parking area and equipment store	50mm thick heavy duty IPS flooring with metallic hardener with matching skirting. or Paving with 65/70 mm thick pressed interlocking precast blocks	Cement paint and for equipment store Acrylic Distemper all be used	Parking area cement paint and for equipment store Acrylic Distemper shall be used.
8 Watch Tower	IPS flooring with Cement Skirting	Acrylic Distemper, Epoxy paint over exposed steel structure.	Acrylic Distemper, Epoxy paint over exposed steel structure.

9 Car & Scooter parking shed and Cycle parking shed	Mimimum 50mm thick coloured and polished interlocking concrete tiles with pattern as approved by the owner, set on sand bed over PCC underbed. Parking near Administrative block shall have vitrified tiles suitable for parking.		Polycarbonate roof sheeting over RCC framed structure.

7.7.4 EXTERIOR AND GENERAL FINISH SCHEDULE

7.8 Cladding for Power house:

Providing and fixing of double skin insulated wall cladding system comprising of profiled external sheet manufactured out of 0.55mm TCT (Total Coated Thickness) permanently colour coated zincalume steel (150 gsm. zinc – aluminium alloy coating total of both sides as per AS 1397: 1993) having 300 Mpa yield strength. The colour coating shall comprise of SMP / super polyester XRW (as per AS/NZS – 2728: 1997 category 3). The inner sheeting shall be 0.50mm/0.6mm TCT of SMP / super polyester XRW (as per AS/NZS – 2728: 1997 category 3) coated zincalume steel 150 gsm. (Zinc – aluminium alloy coating mass total of both sides as per AS 1397:1993) having 550 Mpa yield strength or 180gsm galvanised of 240 mpa. The colour coating shall comprise of 20 microns finish coat over a 5-micron primer coat on the exposed side and a back coat of 5 microns over a primer coat of 5 micron on the reverse side. The external sheet shall have 500mm cover width, 47mm high crests at 250mm centres with special male / female side laps and anti-siphoning feature to prevent leakage. The inner sheet shall have 980mm cover width 28mm high crests at 195mm centres with special male / female side laps and anti-siphoning features to prevent leakages. The inner sheet shall be fixed to the structure by means of self drilling fasteners no. 12-24 x 25 mm conforms to AS: 3566 Class-3 long at valley. Sub-girts of size 50mm x 50mm x 50mm manufactured out of 16G GI (1.6mm GI) 'Z' shape would be fixed the inner sheeting on face side at runner locations and outer sheeting shall be fixed with the help of concealed compatible interlocking clips and wafer head zinc coated self drilling fasteners / screws 4.2 x 25mm long on to the sub-girts. The clips shall be concealed and no fasteners are to penetrate the external sheeting. An insulation of 50mm thick Rockwool insulation (Rockloyd-300) of density 48KG/M3 conforming to IS:8183 shall be provided and fixed to the inner sheet and between the two sheets as per the specification. Wherever single skin metal cladding shall be used over brickwork, the material shall be same as the outer skin of insulated metal cladding system.

Approved make: LLOYD Insulations (India) Ltd, Tata Blue
Scope Steel, CRIL, Metecno or
similar approved.

7.9 The epoxy systems

On the prepared substrate, one coat of a solvent free, resin based dispersion, Primer shall be applied. Density of the primer is around 1kg/lt and the mixing ratio of two components, Comp A and B : 1:2.5 by weight

Over the primed surface, epoxy modified cementitious self _levelling floor topping shall be laid maintaining the thickness of 2mm. The mixing ratio of three component Comp.A :Comp.B: Comp.C: 1:2.5:17 by weight, compressive strength at 30°C approx. 45N/mm² after 28days, the mortar density is around 2.2 kg/lt.

Priming should be done again with a primer of two component product, comp. A: comp. B: 4:1 (By weight). Prior to mixing of these two components, only comp. A shall be stirred mechanically. When all of part B is added to part A, the mix is to be stirred for 3 minutes until a smooth consistency is achieved. Finally, after drying of the primer, two coats of high-build, slightly thixotropic, chemical resistant epoxy protective coating shall be applied as the top coat. Minimum 2 coats are required. This is two component products, comp. A: comp. B: 3:1 (by weight). The mixed density is 1.5kg/lt at 270 C. The system shall be allowed for curing for 3 days.

Approved Make : Sika India (P) Ltd., BASF or similar approved.

7.10 Anti corrosive paint shall be Specification in short: Self Priming, Single Pack, Elastomeric (450% elongation), thermoplastic, fire retardant, Coating skin tensile strength 18 to 21 kg. Per sq. Cm. Antifungal, antibacterial, anticorrosive, nontoxic graft Co-polymer coating of Meta Chem Paints & Adhesive Pvt. Ltd or similar approved.

7.11 False Ceiling : Aluminium pre-painted false ceiling,
either lineal panel system or
aluminium tile/plank system

Approved make: LUXALON by Hunter Douglas,
LLOYD, Armstrong, INTERARCH or
similar approved.

In other air-conditioned areas 12.5 mm
Gypsum board/Mineral fibreboard
/Calcium Silicate Board / Fibre Cement
Board ceiling with aluminium grid will be
used.

Approved make:

Saint Gobain Gyproc India Ltd,
Armstrong, AMF, Everest, HILUX,
Aerolite or similar approved.

7.12 For T.G. Hall (operating floor) Granite / Kota stone flooring finish will be as follows:

Minimum 18~20 mm thick polished Granite/ Kota stone slab or 600x600 mm tiles to be used over minimum 30 mm thick under-bed. Stones shall be hard, sound, homogeneous and dense in texture and free from flaws. Angles and edges shall be true, square, and free from chipping and surface shall be plane. The slabs shall preferably be machine cut to the required dimensions. Tolerance of + 5 mm in dimensions and + 2 mm in thickness will be allowed. During laying the slabs the edges of the slab shall be buttered with slurry of cement, mixed with pigment matching the colour of the stone slabs. Just before handing over the surface shall be dusted with oxalic acid at the rate of 0.33 gm. Per. Sq.m. water sprinkled on to it and finished by buffing with felt or Hessian bobs.

7.13 For battery room, battery charger room, chemical laboratories, chlorination room etc., the areas handling corrosive liquids, overall 40 mm thick Acid and Alkali resistant vitrified tiles flooring with 20mm thick tiles with silica based epoxy mortar shall be used. Acid and Alkali resistant vitrified tiles with silica based epoxy mortar up to 2.1M height from finished floor level shall be used as dado. Acid and Alkali resistant paint shall be applied up to the ceiling level above Acid and Alkali resistant tiles dado. Ceiling shall also be painted with Acid & Alkali resistant paint.

Approved Make :

ENDURA of Jhonson, Chemstone of BOSS
Profiles Ltd, RESTILE Ceramics Ltd. or
similar approved.

Paints :

ICI, ASIAN Paints, Berger or similar approved

7.14

All areas of toilet, including W.C and urinal shall have vitrified ceramic tiles floor. Dado shall be of glazed tiles of minimum 5/6 mm thickness up to 100 mm higher than lintel level starting from finish floor level.

Approved Make :

Ferrastone/Hardstone of BOSS Profiles
Ltd, RESTILE Ceramics Ltd. , Marbonite,
Kajaria, Nitco, Endura of H R Jonson, or
similar approved.

7.15 For MCC and Switchgear rooms flexible electric insulated PVC synthetic sheet as per IS: 15652 2006 of Suntex Insulatic Pvt Ltd or similar shall be applied.

PART 2

TECHNICAL SPECIFICATION(S)

TABLE OF CONTENTS

D1	EARTHWORK IN EXCAVATION AND BACKFILLING
D2	CEMENT CONCRETE (PLAIN & REINFORCED)
D3	CARPENTRY & JOINERY
D4	ROOF AND UNDERGROUND STRUCTURES WATER PROOFING, INSULATION AND ALLIED WORKS
D5	METAL DOORS, WINDOWS, VENTILATORS, LOUVERS ETC.
D6	GLASS AND GLAZING
D7	ROLLING STEEL SHUTTERS AND GRILLS
D8	MISCELLANEOUS METAL
D9	MASONRY AND ALLIED WORKS
D10	FINISH TO MASONRY AND CONCRETE
D11	PAINTING, WHITEWASHING, POLISHING
D12	FLOOR FINISH AND ALLIED WORKS
D13	SHEET WORK IN ROOF AND SIDING
D14	SUSPENDED CEILING
D15	WATER SUPPLY, DRAINAGE AND SANITATION
D16	ROADS AND DRAINAGE
D17	FABRICATION OF STRUCTURAL STEEL WORK
D18	ERECTION OF STRUCTURAL STEEL WORK
D19	ROOF DECKING
D20	FALSE FLOORING
D21	PILLING
D22	SITE LEVELLING & GRADING

SUB-SECTION – D1

EARTHWORK IN EXCAVATION AND BACKFILLING

C O N T E N T

CLAUSE NO. DESCRIPTION

1.00.00	SCOPE
2.00.00	CODES AND STANDARDS
3.00.00	EXECUTION
4.00.00	TESTING AND ACCEPTANCE CRITERIA
5.00.00	RATES AND MEASUREMENTS
6.00.0	INFORMATION TO BE SUBMITTED BY THE BIDDER

TECHNICAL SPECIFICATION

FOR

EARTHWORK IN EXCAVATION AND BACKFILLING

1.00.00 SCOPE

This specification covers earth work excavation in all types of soil, soft rock and hard rock

including setting out, clearing and grubbing, shoring, dewatering, back filling around foundations/pipelines to grade, watering, compaction of fills, testing, approaches, disposal of surplus earth, protective fencing, lighting etc relevant to the structures and locations covered under this contract.

1.01.00 Work To Be Provided By The Contractor

The work to be provided for by the contractor unless specified otherwise shall include but not be limited to the following.

- a) Supplying and providing all labour, supervision services including as required under statutory labour regulations, materials, scaffolding, equipments, tools and plants, transportation etc required for the work.
- b) Preparation and submission of working drawings showing the approaches, slopes, berms, shoring, sumps for dewatering including drainage, space for temporary stacking of soils, disposal area, fencing etc and all other details as may be required by the engineer.
- c) Carrying out sampling and testing on fill materials/fills to assess the quality/moisture content/degree of compaction and submission of the test results whenever required by the engineer.
- d) Design, construction and maintenance of Magazine of proper capacity for storage of explosives for blasting work and removal of the same after completion of the work etc.

1.02.00 Work to be provided by others

No work under this specification will be provided by any agency other than the contractor unless specifically mentioned elsewhere in the contract.

2.00.00 Codes and Standards

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes unless specified otherwise.

IS: 1200 Method of measurement of building and civil engineering works,
Part-I: Earthwork

IS: 2720 Method of test for soils (Relevant parts)

IS: 3764 Excavation work - Code of safety

IS: 4081 Safety code for blasting and related drilling operations

IS: 4701 Indian Standard Code of Practice for earthwork on Canals

IS: 6922 Criteria for safety and design of structures subject to underground blasts

In case of conflict between this specification and those (IS Codes) referred to herein, the former shall prevail. In case any particular aspect of work is not covered specifically by this

specification/IS Codes, any other standard practice as may be specified by the engineer shall be followed.

2.01.00 Conformity with Designs

The contractor shall carry out the work as per the approved drawings, specification and as directed by the engineer.

2.02.00 Materials

2.02.01 General

All materials required for the work shall be of the best commercial variety and approved by the engineer.

2.02.02 Material for Excavation

For the purpose of identifying the various strata encountered during the course of excavation, the following classifications are to be followed.

a) Soil

It include all type of soil including laterite and moorum etc with/without any percentage of kankars which can be excavated by normal means such as shovel, pick axe, crow bar, spade etc and those which do not fall under clause 2.02.02 (b) and (c) etc.

b) Soft Rock

It include the rocks (including weathered rock) which are removable by splitting with the help of crow bar, pick axe, wedges, pavement breakers, pneumatic tools, hammers or such implements etc and not requiring blasting (for excavation) in the opinion of the engineer.

c) Hard Rock

It includes the rocks, which require blasting for excavation in the opinion of the engineer. Where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other method as approved by the engineer. The mere fact that the contractor resorts to blasting shall not classify the soft rock under hard rock.

However, the engineer's decision on the type of strata encountered during excavation shall be the final and binding on the contractor.

2.02.03 Material for Filling

Material to be used for back filling shall be free from vegetations, roots, salts, rubbish, lumps, organic matter and any other harmful chemicals etc and shall be got approved by the engineer. Normally excavated earth shall be used for back filling. In case such earth contains deleterious salts, the same shall not be used. All clods of earth shall be broken or removed. Where the excavated material is mostly rock and if filling with the same is permitted by the engineer in writing, then the filling with rock shall be done in the following manner. The boulders shall be broken into pieces not exceeding 150mm size in any direction and mixed with fine materials

consisting of decomposed rock, moorum or any approved earth to fill the voids as far as possible and the mixture shall then be used for filling.

In case the earth required for backfilling is over and above the earth available from the compulsory excavations within the project area, then borrow areas for obtaining suitable fill material shall be arranged by the contractor himself from outside the plant boundary limits and all expenses including royalties, taxes, duties etc shall be borne by him. The selected earth from the borrow areas shall be got approved by the engineer. The borrowed material shall be free from roots, vegetations, decayed organic matter, harmful salts and chemicals, free from lumps and clods etc. The contractor shall obtain and submit necessary clearances/permissions from the concerned authorities for the borrow areas/materials acquired to the engineer.

If specified, the back filling shall be done with clean well-graded sand from approved quarries free from harmful and deleterious materials.

2.03.00 Quality Control

All works shall confirm to the lines, levels, grades, cross sections and dimensions shown on the approved drawings and/or as directed by the engineer. The contractor shall establish and maintain quality control for the various aspects of the work, method of construction, materials and equipments used etc. The quality control operation shall include but not be limited to the following.

Sl. No.	Activity	Check
1	Lines, levels & grades	a) By periodic surveys b) By establishing markers, boards etc
2	Back filling	(a) On quality of fill material (b) On moisture content of back fill (c) On degree of compaction achieved

3.00.00 EXECUTION

The contractor shall prepare and submit the detailed drawings/schemes for excavation and back filling works as proposed to be executed by him showing the dimensions as per the construction drawings and specification adding his proposal of slopes, shoring, approaches, dewatering, drainage, berms and compaction etc within 15 days of award of the contract to the engineer for approval.

3.01.00 Setting out

On receiving the approval from the engineer with modifications and corrections if any, the contractor shall set out the work from the control points furnished by the engineer and fix permanent points and markers for ease of periodic checking as the work proceeds. These permanent points and markers shall be fixed at the interval as prescribed by the engineer and shall be got checked and certified by the engineer after whom the contractor shall proceed with the work. It should be noted that this checking by the engineer prior to the start of the work will in no way relieve the contractor of his responsibilities of carrying out the work to true lines, levels and grades as per the drawings and specification. If any errors are noticed in the contractor's work at any stage, the same shall be rectified by the contractor at his own risk and

cost.

3.02.00 Clearing and Grubbing etc

The area to be excavated shall be cleared out of fences, trees, logs, stumps, bushes, vegetation, rubbish, slush etc. Trees upto 300mm girth shall be uprooted. Trees above 300mm girth to be cut shall be approved by the engineer and marked. Cutting of trees shall include removing roots as well. After the tree is cut and roots taken out, the pot holes formed shall be filled with good earth in 250mm layers and compacted unless directed otherwise by the engineer. The trees shall be cut in to suitable pieces as instructed by the engineer. Before earthwork is started, all the spoils, unserviceable materials and rubbish shall be burnt or removed and disposed to the approved disposal area(s) as specified by the engineer. Useful materials, saleable timber, fire woods etc shall be the property of the owner and shall be stacked properly at the worksite in a manner as directed by the engineer.

3.03.00 Excavation for Foundations and Trenches

3.03.01 General

All excavation shall be done to the minimum dimensions as required for the safety and working facility. In each individual case, the contractor shall obtain prior approval of the engineer for the method he proposes to adopt for the excavation including dimensions, side slopes, shoring, dewatering, drainage and disposal etc. This approval however shall not in any way make the engineer responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. All excavation in open cuts shall be made true to the line, slopes and grades as shown on the drawings or as directed by the engineer. No material shall project within the dimension of minimum excavation lines marked. Boulders (if any) projecting out of the excavated surfaces shall be removed if they are likely to be a hindrance to the work/workers in the opinion of the engineer.

Method of excavation shall in every case be subject to the approval of the engineer. The contractor shall ensure the stability and safety of the excavation, adjacent structures, services and works etc including the safety of the workmen. If any slip occurs, the contractor shall remove all the slipped materials from the excavated pit without any extra cost to the engineer/owner. All loose boulders and semi detached rocks which are not inside but so close to the area to be excavated and may liable to fall or otherwise endanger the workmen, equipment of the work etc during excavation in the opinion of the engineer shall be stripped off and removed away from the area of excavation. The method to be used for removal shall be such that it should not shatter or render unstable or unsafe the portion, which was originally sound and safe. In case any material not required to be removed initially but later to become loose or unstable in the opinion of the engineer shall also be promptly and satisfactorily removed.

The rough excavation may be carried out upto a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. If directed by the engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up as instructed by the engineer. If the excavation (in all types of soil and rock) is done to a depth greater than that shown on the drawing or as directed by the engineer, the excess depth up to the required level shall be filled with cement concrete not leaner than 1:4:8 or richer as directed by the engineer at the own risk and cost of the contractor. In case where excavation in soil, soft rock (including weathered rock) and hard rock are involved, the excavation in each stratum shall be carried out separately with the approved methodology and as per the

instructions of the engineer.

All excavated materials such as rock, boulders, bricks, dismantled concrete blocks etc shall be the property of the owner and shall be stacked separately as directed by the engineer. All gold, silver, oil, minerals, archeological and other findings of importance, trees cut or other materials of any description and all precious stones, coins, treasures, relics, antiquities and other similar things which may be found in or upon the site shall be the property of the owner and the contractor shall duly preserve the same to the satisfaction of the engineer/owner. The contractor shall deliver the same to such person or persons as may be authorized or appointed from time to time by the owner to receive the same.

Prior to starting the excavation, the ground level at the location shall be checked jointly with the engineer.

3.03.02 Excavation in All Type of Soil and in Soft Rock

The excavation in all type of soil, soft rock including decomposed rock etc shall be carried out as per the approved proposal and as directed by the engineer. The work shall be carried out in a workmanlike manner without endangering the safety of nearby structures/services or works and without causing hindrance to any other activities in the area. Foundation pits shall not be excavated to the full depth unless construction is imminent. The last 150mm depth shall be excavated once concreting work is imminent. At the discretion of the engineer, the full depth may be excavated and the bed be covered with lean concrete as specified after watering and compacting the bed. As the excavation reaches the required dimensions, lines, levels and grades etc, the work shall be got checked and approved by the engineer. In cases where deterioration of the ground, upheaval, slips etc are expected, the engineer may order to suspend the work at any stage and instruct the contractor to carry out the protection works before the excavation will be restarted.

3.03.03 Excavation in Hard Rock

Hard rocks shall normally be excavated by means of blasting. In case where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other approved method as directed by the engineer. Personnel deployed for rock excavation shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces. Where the excavated surface is not stable against sliding, necessary supports such as props, bracings or bulkheads shall be provided and maintained during the period of construction. Where the danger of falling loose rock/boulder from the excavated surfaces deeper than 2m exist, steel mesh anchored to the lower edge of the excavation and extending over and above the rock face adequate to retain the dislodged material shall be provided and maintained.

3.03.04 Blasting

a) General

Storage, handing and use of explosives shall be governed by the current explosive rules/regulations laid down by the Central and the State Governments. The contractor shall ensure that these rules/regulations are strictly adhere to. The following instructions are also to be strictly followed and the instructions wherever found in variance with the

above said rules/regulations, the former (instructions) shall be superseded with the later (above said rules/regulations).

No child under the age of 16 and no person who is in a state of intoxication shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives. The contractor shall obtain licence from the District Authorities for undertaking the blasting work as well as for obtaining and storing the explosives as per Explosives Rules, 1940 corrected upto date. The contractor shall purchase the explosives, fuses, detonators etc only from a licensed dealer and shall be responsible for the safe custody and proper accounting of the explosive materials. The engineer or his authorized representative shall have the access to check the contractor's store of explosives and his accounts at any time. It is the full responsibility of the contractor to transport the explosives as and when required for the work in a safe manner to the work spot.

Further, the engineer may issue modifications, alterations and new instructions from time to time. The contractor shall comply with the same without these being made a cause for any extra claim.

b) Materials

All materials such as explosives, detonators, fuses, tamping materials etc proposed to be used in the blasting operation shall have the prior approval of the engineer. Only explosives of approved make and strength are to be used. The fuses known as instantaneous fuse must not be used. The issue of fuse with only one protective coat is prohibited. The fuse shall be sufficiently water resistant as to be unaffected when immersed in water for 30 minutes. The rate of burning of the fuse shall be uniform and shall be not less than 4 seconds per inch of length with 10% tolerance on either side. Before use, the fuse shall be inspected. Moist, damaged or broken ones shall be discarded. When the fuses are in stock for long, the rate of burning of fuses shall be tested before use. The detonators shall be capable of giving an effective blasting of the explosives. Moist and damaged detonators shall be discarded.

c) Storage of Explosives

The current Explosive Rules shall govern the storage of explosives. Explosives shall be stored in a clean, dry and well-ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400m of the actual work site or any source of fire. The space surrounding the magazine shall be fenced and the ground inside shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be through a single gate only and no person shall be allowed without the permission of the officer-in-charge. The clear space between the fence and the magazine shall not be less than 90m. The magazine shall be well drained. Two lightning conductors, one at each end shall be provided to the magazine. The lightning conductors shall be tested once in every year.

Explosives, fuses and detonators shall each be separately stored. Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides. Special care shall be taken to keep the floor free from any grains of explosives. Cases containing explosives shall not be opened inside the magazine and the explosives in open cases shall not be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine but must be removed without delay to a safe distance and be destroyed.

Artificial light, matches, inflammable materials, oily cotton, rag waste and articles liable to spontaneous ignition shall not be allowed inside the magazine. Illumination shall be obtained from an electric storage battery lantern. No smoking shall be allowed within 100m distance from any magazine.

Magazine shoes without nails shall be used while entering the magazine. The persons entering the magazine must put on the magazine shoes, which shall be provided at the magazine for this purpose and should be careful

- * not to put their feet on the clean floor unless the magazine shoes on.

- * not to touch the magazine shoes on ground outside the clean floor.

- * not to allow any dirt or grit to fall on the clean floor.

Persons with bare feet shall dip their feet in water before entering the magazine and then step directly from the tub to the clean floor. No person having article of steel or iron with/on him shall be allowed to enter the magazine. Workmen shall be examined before entering the magazine to check none of the prohibited articles are with them. A brush broom shall be kept in the lobby of the magazine for cleaning the magazine. Cleaning shall be done immediately after each occasion whenever the magazine is opened for receipt, delivery or inspection of the explosives.

The mallets, levers, wedges etc for opening the barrels or cases shall be of wood. The cases of explosives are to be carried by hand and shall not be rolled or dragged inside the magazine. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been stored long in the store are to be issued first. Neither the magazine shall be opened nor any person shall be allowed in the vicinity of the magazine during any dust storm or thunderstorm. All magazines shall be officially inspected at definite intervals and a record of such inspections shall be kept.

d) Carriage of Explosives

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from the direct rays of the sun, artificial lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each case or package shall be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on the vehicle conveying explosives. No explosive shall be transported in a carriage or vessel unless all iron or steel therein the carriage or vessel which are likely to contact the package containing explosives are effectually covered with lead, leather, wood, cloth or any other suitable material. No light shall be carried on the vehicle carrying explosives and no operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

e) Use of Explosives

The contractor shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The contractor shall satisfy himself that the person so appointed is fully acquainted with his responsibilities.

Holes for charging the explosives shall be drilled with pneumatic drills and the drilling pattern shall be so planned that the rock pieces after blasting will be suitable for handling. The hole diameter shall be of such a size that the cartridges can easily pass down through them and any undue force is not required during charging. Charging operation shall be carried out by or under the personal supervision of the shot firer. Wrappings shall never be removed from the explosive cartridges. Only one cartridge at a time shall be inserted in a hole and wooden rods shall only be used for loading and stemming the shot holes. Only such quantities of explosives as are required for a particular work shall be brought to the work site. Should any surplus remain when all the holes have been charged shall be carefully removed to a point at least 300m away from the firing point.

The authorized shot firer himself shall make all the connections. The shot firing cable shall not be dragged along the ground to avoid any damage to the insulation. The shot firing cable shall be tested each time for its continuity and possible short-circuiting. The shot firer shall always carry the exploder handle with him until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits. Before any blasting is carried out it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300m radius from the firing point or as required by the statutory regulations at least 10 minutes before the time of firing by sounding a warning siren and the area shall be encircled by red flags.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges, the electric detonators shall be connected with the exploder through the shot firing cable in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current etc and keep the lead wires short circuited until it is ready to fire. Any kink in the detonator leading wire shall be avoided. For simultaneous firing of a large number of shot holes, use of cordtex may be done. An electric detonator attached to its side with adhesive tape shall initiate cordtex connecting wire or string. Blasting shall only be carried out at certain specified times to be agreed jointly by the contractor and the engineer.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations, the authorized shot firer shall return to the blast area and inspect carefully the work and satisfy himself that all the charged holes have exploded. Cases of misfired unexploded charges shall be exploded by drilling a parallel fresh hole at a distance of not less than 600mm from the misfired hole and by exploding a new charge.

The authorized shot firer shall be present during the removal of debris as it may contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until at least half an hour after firing.

Where blasting is to be carried out in proximity of other structures, controlled blasting by drilling shallow shot holes and proper muffling arrangements with steel plates loaded with sand bags etc shall be used on top of the blast holes to prevent the rock fragments from causing any damage to the adjacent structures and other properties. Adequate safety precautions as per building byelaws, safety codes, statutory regulations etc shall be taken during blasting operations.

f) Restrictions in Blasting

- a) Blasting which may disturb or endanger the stability, safety or quality of the adjacent structures/foundations shall not be permitted.
- b) Blasting within 200m of a permanent structure or construction work in progress shall not be permitted.
- c) Progressive blasting shall be limited to two third of the total remaining depth of excavation.
- d) No large scale blasting operations will be resorted to when the excavation reaches the last one metre and only small charge preferably black powder may be allowed so as not to shatter the parent rock
- e) The last blast shall not be more than 0.50 m in depth.
- f) In rocky formations, at locations where specifically indicated or ordered in writing by the engineer, the use of explosives shall be discontinued and chiselling shall complete excavation or any other suitable method as approved by the engineer.

3.03.05

Disposal

The excavated spoils shall be disposed of in any (or all) of the following manner as directed by the engineer.

- a) By using it straightway for backfilling.
- b) By stacking it temporarily to use for backfilling at a later date during execution of the contract.
- c)
 - i) By either spreading
 - or
 - ii) By spreading and compacting at designated disposal areas.
- d) By selecting the useful material and stacking it neatly in designated areas as indicated by the engineer for use in backfilling by some other agency.

3.03.06

Disposal of Surplus Materials

All surplus material from excavation shall be removed and disposed of from the excavation site to the designated disposal area indicated by the engineer. All good and sound rocks obtained from excavations and all assorted materials of dismantled structures are the property of the owner and if the contractor wants to use it, he shall have to obtain it from the engineer at a mutually agreed rate. All sound rocks and other assorted materials like excavated bricks etc

shall be stacked separately.

3.03.07 Protection

The contractor shall notify the engineer as soon as the excavation is expected to be completed within a day so that he shall inspect it at the earliest. Immediately after approval of the engineer, the excavation must be covered up in a shortest possible time. But in no case the excavation shall be covered up or worked on before approval by the engineer. Excavated material shall be placed 1.5m or half the depth (of excavation) whichever is more from the edge of the excavation or further away if directed by the engineer. Excavation shall not be carried out below the foundation level of the structure close by until the required precautions are taken. Adequate fencing is to be made enclosing the excavation. The contractor shall protect all the underground services exposed during excavation. All existing surface drains in the work area shall be suitably diverted by the contractor before taking up excavation to maintain the working area neat and clean.

3.03.08 Dewatering

All excavation shall be kept free of water and slush. Grading in the vicinity shall be controlled to prevent the surface water running into the excavations. The contractor shall remove any water inclusive of rain water and subsoil water etc accumulated in the excavation by pumping or other means as approved by the engineer and keep the excavations dewatered and/or lower the subsoil water level to 300mm below the founding level until the construction of foundation and backfilling are completed in all respects.

Sumps made for dewatering must be kept clear of the foundations. The engineer's prior approval on the method of pumping to be adopted shall be taken; but in any case, the pumping arrangement shall be such that there shall be no movement or blowing in of subsoil due to the differential head of water during pumping.

3.03.09 Timber Shoring

Close or open type timber shoring as approved by the engineer depending on the nature of sub-soil, depth of pit or trench and the type of timbering shall be adopted. Timbers made out of approved quality shall only be used. It shall be the responsibility of the contractor to take all necessary steps to prevent the sides of trenches and pits from collapsing.

a) Close Timbering

Close timbering shall be done by completely covering the sides of the trenches and pits generally with short, upright members called "polling boards". These shall be of 250mm wide (min.) and 40mm thick (min.) sections as directed by the engineer. The boards shall generally be placed vertically in pairs, one on each side of the cut and shall be kept apart (maximum spacing is limited to 1.20m) by horizontal walers of strong wood cross strutted with wooden struts or as directed by the engineer. The length of wooden struts shall depend on the width of the trench or pit.

In case where the soil is very soft and loose, the boards shall be placed horizontally against the sides of excavation and supported by vertical walers, which shall be strutted to similar timber pieces on the opposite face of the trench or pit. The lowest board supporting the

sides shall be taken into the ground. No portion of the vertical side of the trench or pit shall remain exposed to avoid any slipping out of earth.

The withdrawal of the timber shall be done very carefully to prevent the collapse of the pit or trench. It shall be started from one end and preceded systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber. No claim shall be entertained for any timber, which cannot be withdrawn and is lost or buried.

b) Open Timbering

In case of open timbering, vertical board of 250mm wide (min.) and 40mm thick (min.) shall be spaced sufficiently apart to leave unsupported strips of maximum 500mm average width. The detailed arrangement, size of timber and the spacing etc shall be subjected to the approval of the engineer. In all other respects, the specification for close timbering shall apply to open timbering as well.

3.03.10 Treatment of Slips

The contractor shall take all precautions to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides of the excavations. These precautions along with proper slopes, berms, shoring and control of ground water should cause no slips to occur. If however slips still occur, the same shall be removed by the contractor with his own risk and cost.

3.04.00 Backfilling

3.04.01 General

The material to be used for backfilling shall be approved by the engineer which shall be obtained directly from the excavation, from the nearby areas where excavation work by the same agency is in progress, from the temporary stacks of excavated spoils or from the borrow pits as directed by the engineer. The material shall be free from lumps and clods, roots and vegetations, harmful salts and chemicals, organic materials etc.

In locations where sand filling is required, the sand used should be clean, well graded and be of the quality normally acceptable for use in concrete.

3.04.02 Filling and Compaction in Pits and Trenches all Around the Structures

As soon as the work in foundation has been accepted, the spaces around the foundation in pits and trenches shall be cleared of all debris, brick bats, mortar droppings etc and filled with approved earth in layers not exceeding 250mm (in loose thickness). Each layer (loose) shall be watered, rammed and properly compacted to the required degree to the satisfaction of the engineer. Earth shall be compacted with approved mechanized compaction machine. Usually, no manual compaction shall be allowed unless specifically permitted by the engineer. The moisture content of the fill material during compaction shall be controlled near to its optimum moisture content so as to obtain the required degree of compaction. The final surface shall be trimmed and levelled to proper profile as desired by the engineer.

3.04.03 Plinth Filling

The plinth shall be filled with earth in layers not exceeding 250mm (in loose thickness) and each layer shall be watered and compacted to the required degree with approved compaction machine or manually if specifically permitted by the engineer. When the filling reaches the finished level, the surface shall be flooded with water for at least 24 hours, allowed to dry and then rammed and compacted in order to avoid any settlement at a later stage. The finished surface of fill shall be trimmed to the slope intended to be provided for the floor.

3.04.04 Filling in Trenches for Water Pipes and Drains

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed. Where the trenches are excavated in soil, the filling shall be done with earth on the sides and top of pipes in layers not exceeding 150mm, watered, rammed and compacted taking care that no damage is caused to the pipe below.

In case of trenches excavated in rock, the filling upto a height of 300mm or the diameter of the pipe whichever is more above the crown of the pipe or barrel shall be done with fine material such as earth, moorum, disintegrated rock or ash as per the availability at site and shall be filled in compacted layers not exceeding 150mm. The remaining filling shall be done in layers with the mixture of boulders (of size not exceeding 150mm) and fine material as specified elsewhere in the specification. Each layer shall be watered, rammed and compacted to the required degree and to the satisfaction of the engineer.

3.04.05 Filling in Disposal Area

Surplus materials from excavation which are not required for backfilling shall be disposed of in the designated disposal areas. The spoils shall not be dumped haphazardly but should be spread in layers approximately 250mm thick when loose, watered and compacted with the help of compacting equipment as per the directions of the engineer. In wide areas, rollers shall be employed and compaction shall be done to the satisfaction of the engineer at the optimum moisture content, which shall be checked and controlled by the contractor. In certain cases the engineer may direct the contractor to dispose the surplus materials without compaction, which can be done by tipping the spoils from a high bench neatly maintaining a proper level and grade of the bench.

3.05.00 Approaches and Fencing

The contractor should provide and maintain proper approaches for the workmen and inspection. The roads and approaches around the excavation should be kept clear at all times so that there is no hindrance to the movement of men, material and equipment of various agencies connected with the project. Sturdy and elegant fencing is to be provided around the top edge of the excavation as well as around the bottom of the fill at the surplus disposal area where dumping from a high bench is in progress.

3.06.00 Lighting

Full-scale area lighting is to be provided if night work is permitted or directed by the engineer. If no night work is in progress, red warning lights should be provided at the corners of the excavated pit and the edges of the fill.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 Excavation

On completion of excavation, the dimension of the pits will be checked as per the drawings after the pits are completely dewatered. The work will be accepted after all undercuts have been set right and all over excavations are filled back to the required lines, levels and grades by placing ordinary cement concrete of 1:4:8 proportion and/or richer and/or by compacted earth as directed by the engineer. The choice of the grade of concrete will be a matter of unfettered discretion of the engineer. Over excavation of the sides shall be made good by the contractor while carrying out the backfilling. The excavation work will be accepted after the above requirements are fulfilled and all the temporary approaches encroaching inside the excavation have been removed.

4.02.00 Backfilling

The degree of compaction required will be as per the stipulation laid down in IS: 4701 and the actual method of measuring the degree of compaction will be as decided by the engineer. The work of back filling will be accepted after the engineer is satisfied with the degree of compaction achieved.

5.00.00 RATES AND MEASUREMENTS

5.01.00 Rates

- a) The item of work in the schedule of quantities describes the work very briefly. The various items of the schedule of quantities shall be read in conjunction with the corresponding section in the technical specification including amendments and additions if any. For each item in the schedule of quantities, the bidder's rate shall include all the activities covered in the description of the items as well as for all necessary operations in detail as described in the technical specification.
- b) No claims shall be entertained if the details shown on the released for construction drawings differ in any way from those shown on the tender drawings.
- c) The unit rate quoted shall include minor details which are obviously and fairly intended and which may not have been included in these documents but are essential for the satisfactory completion of the work.
- d) The bidder's quoted rate shall be inclusive of supplying and providing all labour, men, materials, equipments, tools and plants, supervision, services, approaches, schemes etc.
- e) In case blasting in hard rock is envisaged, the unit rate quoted for earthwork shall include the cost of storage and safety arrangements for the materials required for blasting. No separate payment will be made on this account.

5.02.00 Measurements

Method of measurements are specified in the proceeding sections. Where not so specified, the latest version of IS: 1200, Part-1 shall be applicable.

- a) The length, breadth and depth shall be measured correct to the nearest centimetre if measurements are taken by tape. Rounding of numerical shall be as per relevant IS Codes. If the measurements are taken with staff and level, the levels shall be recorded correct to 5mm. The area and volume shall be worked out in square meter and cubic meter respectively correct to the nearest of two decimal places.
- b) For earthwork in excavation, the ground levels shall be taken before and after completion of the work in the actually excavated area. The quantity of earthwork in excavation shall be computed from these levels in cubic meter.
- c) Where soft rock and hard rock are mixed, the measurement shall be done as follows. The two types of rock shall be stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in the stacks. If the sum of net quantity of the two types of rock so arrived exceeds the total quantity of the excavation, then the quantity of each type of rock shall be worked out from the total quantity (from excavation) in the ratio of net quantities in stack measurements of the two types of rock. If stacking is not feasible, the method as suggested by the engineer shall be followed.
- d) Where soil, soft rock and hard rock are mixed, the measurement shall be done as follows. The soft and hard rock shall be removed from the excavated material and stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in stacks. The difference between the entire excavation and the sum of the quantities of soft and hard rock so arrived shall be taken as soil.

6.00.00 INFORMATION TO BE SUBMITTED BY THE BIDDER

6.01.00 With Tender

Detail of equipments and machineries proposed to be used for excavation, backfilling and compaction shall be submitted along with the tender.

6.02.00 After Award

After award of the contract the successful bidder shall submit the following for approval.

- a) Within 30 days of the award of contract, the contractor shall submit a detailed programme of the work as proposed to be executed giving completion dates of excavation for the various foundations and the time required for backfilling and compaction after completion of foundation for the structures. The earthwork programme shall be planned in accordance with the foundation programme. The programme should also show how the excavation and backfilling quantities will be balanced minimizing the temporary stacking of spoils. It is to be noted that the engineer even after initial approval of the programme may instruct the contractor to enhance or to retard the progress of work during the actual execution in order to match with the progress of foundations. The initial programme being submitted by the contractor should have sufficient flexibility to take care of such reasonable variations.
- b) Within 15 days of the award of contract, the contractor shall submit the drawings for earth work in excavation and backfilling showing detail of slopes, shoring, approaches, sump pits, dewatering lines, fencing etc for the approval of the engineer.

SUB-SECTION – D2

CEMENT CONCRETE (PLAIN & REINFORCED)

C O N T E N T

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	GENERAL
3.00.00	INSTALLATION
4.00.00	SAMPLING AND TESTING
5.00.00	ACCEPTANCE CRITERIA
6.00.00	RATES AND MEASUREMENTS
7.00.00	LIST OF I.S.: CODES AND STANDARDS FOR REFERENCE

SUB-SECTION – D II**CEMENT CONCRETE (PLAIN & REINFORCED)****1.00.00 SCOPE****1.01.00 General**

This specification covers all the requirements, described hereinafter for general use of Plain and Reinforced Cement Concrete work in Structures and locations, cast-in-situ or precast, and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work. Special requirements for structures such as reinforced concrete chimney, cooling towers, etc. have been covered under the respective specifications. Those specifications shall be used in conjunction with this specification.

1.02.00 IS: 456 shall form a part of this specification and shall be complied with unless permitted otherwise. For any particular aspect not covered by this Code, appropriate Code, specifications and/or replacement by any International code of practice as may be specified by the Engineer shall be followed. All codes and Standards shall conform to its latest revisions. A list of IS codes and Standards is enclosed hereinafter for reference. However, should the list be not exhaustive and does not cover any aspect of the work, then relevant Indian and, in its absence, relevant International code shall apply.

2.00.00 General**2.01.00 Work to be provided for by the Contractor**

The work to be provided for by the Contractor, unless otherwise specified shall include but not be limited to the following

- a) Furnish all labour, supervision, services including facilities as may be required under statutory labour regulations, materials, forms, templates, supports, scaffolds, approaches, aids, construction equipment, tools and plants, transportations, etc. required for the work.
- b) Prepare Bar bending Schedules for reinforcement bars showing the positions and details of spacers, supports, chairs, hangers etc.
- c) Prepare working drawings of formworks, scaffolds, supports, etc.
- d) Prepare shop drawings for various inserts, anchors, anchor bolts, pipe sleeves, embedments, hangers, openings, frames etc.
- e) Prepare detailed drawings of supports, templates, hangers, etc. required for installation of various embedments like inserts, anchor bolts, pipe sleeves, frames, joint seals, frames, openings etc.

As decided by the Engineer some or all of the drawings & schedules prepared under item (b) to (e) above will have to be submitted for approval.

- f) Submit for approval detailed schemes of all operations required for executing the work, e.g. material handling, Concrete mixing, Placement of concrete, Compaction, curing, services, Approaches, etc.

- g) Design and submit for approval concrete mix designs required to be adopted on the job.
- h) Furnish samples and submit for approval results of tests of various properties of the following:
 - i) The various ingredients of concrete
 - ii) Concrete
 - iii) Embedments
 - iv) Joint seals
- i) Provide all incidental items not shown or specified in particular but reasonably implied or necessary for successful completion of the work in accordance with the drawings and specifications.
- j) For supply of certain materials normally manufactured by specialist firms, the Contractor may have to produce, if directed by the Engineer, a guarantee in approved Performa for satisfactory performance for a reasonable period as may be specified, binding both the manufacturers and the Contractor, jointly and severally.

2.02.00 Work by others

No work under this specification will be provided by any agency other than the Contractor unless specifically mentioned elsewhere in the contract.

2.03.00 Information to be submitted by the Tenderer

2.03.01 With Tender

The following technical information's are required with the tender:

- a) Source and arrangement of processing of aggregates proposed to be adopted.
- b) Type of plant and equipment proposed to be used.
- c) Names of firms with which association is sought for to execute the special items of work in the contract.
- d) Types of formwork proposed to be used.

2.03.02 After Award

The Contractor shall submit the following information and data including samples where necessary, progressively during the execution of the contract.

- a) Programme of Execution

Within 30 days of the award of contract, the Contractor will submit a Master Programme for completion of the work.

This Master Programme may have to be reviewed and updated by the Contractor, quarterly

or at more frequent intervals as may be directed by the Engineer depending on the exigencies of the work.

Detailed day-to-day Programme of every month is to be submitted by the Contractor before the end of the previous month.

b) Samples

Samples of the following materials and any other materials proposed to be used shall be submitted as directed by the Engineer, in sufficient quantities free of cost, for approval. The Engineer for future reference will preserve approved samples. The approval of the Engineer shall not, in any way, relieve the Contractor of his responsibility of supplying materials of specified qualities:

- i) Coarse and fine aggregates.
- ii) Admixtures.
- iii) Plywood for Formwork.
- iv) Embedded and anchorage materials as may be desired by the Engineer.
- v) Joint sealing strips and other*waterproofing materials.
- vi) Joint filling compounds.
- vii) Foundation quality Rubber Pads.

c) Design Mix

Design mix as per specification giving proportions of the ingredients, sources of aggregates and cement, along with test results of trial mixes as per relevant I.S., is to be submitted to the Engineer for his approval before it can be used on the works.

d) Bar Bending Schedules

Bar Bending Schedules in accordance with Clause 2.01.00 (b) and 3.16.01 of this specification.

e) Detailed Drawings and Designs of Formworks to be used

Detailed design data and drawings of standard formworks to be used as per clause 2.01.00 (c).

f) Detailed Drawings for Templates & Temporary Supports for embedment As per Clause 2.01.00 (e).

g) Mill Test Reports for Cement & Reinforcing Steel.

h) Inspection Reports

The Engineer in accordance with Clause 2.04.00 of this specification may desire inspection Reports in respect of Formwork and Reinforcement and any other item of work as.

i) Test Reports

Reports of tests of various materials and concrete as required under Clause 4.0: SAMPLING & TESTING of this specification or as directed by the Engineer.

j) Any other data, which may be required as per this specification or as directed by the Engineer.

2.04.00 Conformity with Design

The Contractor will prepare checklists in approved Performa, which will be called "Pour Cards". These Pour Cards will list out all items of work involved. The Contractor will inform the Engineer, sufficiently in advance, whenever any particular pour is ready for concreting. He shall accord all necessary help and assistance to the Engineer for all checking required in the pour. On satisfying himself that all details are in accordance to the drawings and specifications, the engineer will give written permission on the same Pour Cards allowing the contractor to commence placement of concrete. Details of all instructions issued by the Engineer and the records of compliance by the Contractor, deviations allowed by the Engineer and any other relevant information will be written on accompanying sheets attached to the Pour Cards. The Pour Cards along with accompaniments will be handed over to the Engineer before starting placement of concrete. One of the mix designs developed by the Contractor as per the I.S. Specifications and established to the satisfaction of the Engineer by trial mixes shall be permitted to be used by the Engineer, the choice being dictated by the requirements of designs and workability. The methods of mixing, conveyance, placement, vibration, finishing, curing, protection and testing of concrete will be as approved or directed by the Engineer.

2.05.00 Materials to be used

2.05.01 General Requirement

All materials whether to be incorporated in the work or used temporarily for the construction shall conform to the relevant IS Specifications unless-stated otherwise and be of best approved quality.

2.05.02 Cement

Ordinary Portland cement of grade-43 as per IS:8112/fly ash based Portland puzzolona cement conforming to IS:1489 (Part-1) shall preferably be used in reinforced/plain cement concrete works for all areas other than for the critical structures identified below. However, other types of cement such as ordinary Portland cement conforming to IS:269, Portland slag cement conforming to IS:455 respectively can be used under special circumstances. Cement used in all concrete mixes shall be in general of grade 33/43 unless design requires a higher grade. Ordinary Portland cement shall be used for following structure.

- a) TG foundation top deck and sub structures including raft.
- b) Spring Supporting decks of all machine foundations.
- c) Structures requiring grade of concrete of M30 and above.

In special cases, Rapid Hardening Portland Cement, Low Heat Cement, Sulphate resistant cement, high strength Ordinary Portland Cement etc. may be permitted or directed to be used by the Engineer.

For Brickwork, plaster, flooring and other finishing works, ordinary Portland cement of 33/43 grade shall be used.

2.05.03 Coarse Aggregate

Aggregate of sizes ranging between 4.75 mm and 150 mm will be termed as Coarse Aggregate. Coarse aggregate for concrete shall be chemically inert, hard, strong durable against weathering, of limited porosity, and free from deleterious materials. It shall be properly graded. Coarse aggregates shall be either crushed gravel or stone. All aggregates shall meet the requirement of IS:383:1970. Only Coarse Aggregate from, approved quarries and conforming to IS-383 will be allowed to be used on the works. Petrographic test shall be carried out by the contractor free of cost for checking the quality of rock from quarry. This test shall be repeated by the Contractor free of cost for change in quarry or as directed by the Engineer. The results shall be checked for reactivity of silica in aggregate with alkalis of cement.

2.05.04 Fine Aggregate

Aggregate smaller than 4.75 mm and within the grading limits and other requirements set in IS: 383 are termed as Fine Aggregate or Sand. Only Fine Aggregate from approved sources and conforming to the above IS Specification will be allowed to be used in works. Sand shall be hard, durable, clean and free from adherent coatings or organic matter and clay balls or pellets. Sand when used as fine aggregate in concrete shall conform to IS:383. For plaster, it shall conform to IS:1542 and for masonry work to IS:2116.

2.05.05 Water

Water for use in Concrete shall be clear and free from injurious oils, acids, alkalis, organic matter, salt, silts, or other impurities. Generally, IS: 3550 will be followed for routine tests. Acceptance of water shall be as per IS: 456.

2.05.06 Admixture

Only admixtures of approved quality will be used when directed or permitted by the Engineer. The different types of admixtures, which may be necessary to satisfy the concrete mix and the design requirement, shall be as per IS-9103 and may be one of the followings:

- a) Accelerating admixture
- b) Retarding admixture
- c) Water reducing admixture
- d) Air entraining admixture

The contractor shall inform the Engineer about the type of admixture which he is planning to use in different areas within the scope of work for the approval of the Engineer. The admixture shall be of proven make and from a reputed manufacturer. It should not have any adverse effect on strength, durability of concrete and reinforcement. Super plasticizers conforming to IS: 9103

or ASTM C-494 shall only be used as admixture having the above properties either individually or in a combination as per the direction of the Engineer.

2.05.07 Reinforcement

Reinforcement shall be as per relevant IS Specification as mentioned in the Contract/Drawing/Instructions. All bars above 10 mm dia. shall be of tested quality.

2.06.00 Storage of Materials

2.06.01 General

All materials shall be so stored as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged or is otherwise considered defective by the Engineer, shall not be used for concrete and shall be removed from site immediately, failing which, the Engineer shall be at liberty to get the materials removed and the cost incurred thereof shall be realised from the Contractor's dues. The Contractor shall maintain upto-date accounts of receipt, issue and balance (stack wise) of all materials. Storage of materials shall conform to IS: 4082.

2.06.02 Cement

Sufficient space for storage, with open passages between stacks, shall be arranged by the Contractor to the satisfaction of the Engineer.

Cement shall be stored off the ground in dry, leak proof, well-ventilated warehouses at the works in such a manner as to prevent deterioration due to moisture or intrusion of foreign matter.

Cement shall be stored in easily countable stacks with consignment identification marks. Consignments shall be used in the order of their receipts at site. Sub-standard or partly set cement shall not be used and shall be removed from the site, with the knowledge of the Engineer, as soon as it is detected.

2.06.03 Aggregates

Aggregates shall be stored on raised surface constructed by providing planks or steel plates or on concrete or brick masonry pavement. Each size shall be kept separated with wooden or steel or concrete or masonry bulkheads or in separate stacks and sufficient care shall be taken to prevent the material at the edges of the stock piles from getting intermixed. Stacks of fine and coarse aggregates shall be kept sufficiently apart with proper arrangement of drainage. The aggregates shall be stored in easily measurable stacks of suitable depths as may be directed by the Engineer.

2.06.04 Reinforcement

Reinforcing steel shall be stored consignment-wise and size-wise off the ground and under cover, if desired by the Engineer. It shall be protected from rusting, oil, grease, and distortions.

If necessary, the reinforcing steel may be coated with cement wash before stacking to prevent scale and rust at no extra cost to the Owner. The stacks shall be easily measurable. Steel needed for immediate use shall only be removed from storage.

2.07.00 Quality Control

Contractor shall establish and maintain quality control for different items of work and materials as may be directed by the Engineer to assure compliance with contract requirements and maintain and submit to the Engineer records of the same. The quality control operation shall include but not be limited to the following items of work:

- a) Admixture: Type, quantity, physical, and chemical properties that affects strength, workability, and durability of concrete.

For air entraining admixtures, dosage to be adjusted to maintain air contents within desirable limits.
- b) Aggregate: Physical, chemical and mineralogical qualities. Grading, moisture content and impurities.
- c) Water: Impurities tests.
- d) Cement: Tests to satisfy relevant IS Specifications.
- e) Formwork: Material, shapes, dimensions, lines, elevations, surface finish, adequacy of form, ties, bracing and shoring and coating.
- f) Reinforcement: Shapes, dimensions, length of splices, clearances, ties and supports. Quality and requirement of welded splices.

Material tests or Certificates to satisfy relevant IS Specification.
- g) Grades of Concrete: Usage and mix design, testing of all properties.
- h) Batching & Mixing: Types and capacity of plant, concrete mixers and transportation equipment.
- i) Joints: Locations of joints, water stops and filler materials. Dimension of joints, quality, and shape of joint material and splices.
- j) Embedded and Anchorage Items: Material, shape, location, setting.
- k) Placing: Preparation, rate of pouring, weather limitations, time intervals between mixing and placing and between two successive lifts, covering over dry or wet surfaces, cleaning and preparation of surfaces on which concrete is to be placed, application of mortar/slurry for proper bond,

- prevention of cold joint, types of chutes or conveyors.
- l) Compaction: Number of vibrators, their prime mover, frequency and amplitude of vibration, diameter and weight of vibrators, duration of vibration, hand-spreading, rodding and tamping.
- m) Setting of base & Bearing plates: Lines, elevations, and bedding mortar.
- n) Concrete Finishes: Repairs of surface defects, screening, floating, steel trowelling and brooming, special finishes.
- o) Curing: Methods and length of time.

Copies of records and tests for the items noted above, as well as, records of corrective action taken shall be submitted to the Engineer for approval as may be desired.

3.00.00 INSTALLATION

All installation requirements shall be in accordance with IS: 456 and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification do not cover all the aspects to the full satisfaction of the Engineer.

3.01.00 Washing and Screening of Aggregates

Washing and screening of coarse and fine aggregates to remove fines, dirt, or other deleterious materials shall be carried out by approved means as desired by the Engineer.

3.02.00 Admixture

All concrete shall be designed for normal rate of setting and hardening at normal temperature. Variations in temperature and humidity under different climatic conditions will affect the rate of setting and hardening, which will, in turn, affect the workability and quality of the concrete. Admixtures including plasticisers of approved make may be used with the Engineer's approval in accordance with IS-456 to modify the rate of hardening, to improve workability or as an aid to control concrete quality. The Engineer reserves the right to require laboratory test or use test data, or owner satisfactory reference before granting approval. The admixture shall be used strictly in accordance with the manufacturer's directions and/or as directed by the Engineer.

3.03.00 Grades of Concrete

Concrete shall be in one of the grades designated in IS: 456. Grade of concrete to be used in different parts of work shall be as shown on the drawing. In case of liquid retaining structures, IS: 3370 will be followed. Minimum cement content shall be as per IS: 456.

3.04.00 Proportioning and Works Control

3.04.01 General

“Design Mix Concrete” and “Nominal Mix Design” is defined as follows for use in this specification:

- a) Proportioning of ingredients of concrete made with preliminary tests by designing the concrete mix. Such concrete shall be called "Design Mix Concrete".
- b) Proportioning of ingredients of concrete made without preliminary tests adopting nominal concrete mix. Such concrete shall be called "Nominal Mix Concrete".

As far as possible, design mix concrete shall be used on all concrete works. Nominal mix concrete, in grades M-15 or lower only may be used if shown on drawings or approved by the Engineer. In all cases the Proportioning of ingredients and works control shall be in accordance with IS: 456 and shall be adopted for use after the Engineer is satisfied regarding its adequacy and after obtaining his approval in writing.

3.04.02 Mix Design Criteria

Concrete mixes will be designed by the Contractor to achieve the strength, durability, and workability necessary for the job, by the most economical use of the various ingredients. In general, the design will keep in view the following considerations

- a) Consistent with the various other requirements of the mix, the quantity of water should be kept at the lowest possible level.
- b) The nominal maximum size of coarse aggregate shall be as large as possible within the limits specified.

- c) The various fractions of coarse and fine aggregates should be mixed in such a proportion as to produce the best possible combined internal grading giving the densest and most workable mix.
- d) The finished concrete should have adequate durability in all condition, to withstand satisfactorily the weather and other destruction agencies, which it is expected to be subjected to in actual service.
- e) The mix design shall have required workability and characteristic strength as per IS: 456. The quantity of cement, aggregates, and admixtures shall be determined by mass.

The requirement of adequate structural strength is catered for by the choice of proper grade of concrete in structural design. The Contractor will strictly abide by the same in his design of concrete mix installation. Various trials shall be given by the contractor with specific cement content on each trial. In some cases, plasticizers and other admixtures may be necessary to achieve the desired results.

3.05.00 Strength Requirements

The strength requirements of both design mix and nominal mix concrete where ordinary Portland Cement or Portland Blast furnace slag cement is used, shall be as per IS: 456. All other relevant clauses of IS: 456 shall also apply.

3.06.00 Minimum Cement Content

The minimum cement content for each grade of concrete shall be as per IS: 456. Contractor has to consider actual environmental exposure condition at site. Based on various tests results and as per Engineer, the environment condition shall be adopted for which minimum cement content shall be considered. No extra payment shall be made on account of any variation in environment condition.

- a) Sufficient number of trial mixes (to be decided by the Engineer) will be taken at the laboratory for the various designs and graphs of w/c ratio Vs crushing strengths at various ages will be plotted.
- b) All tests will be done in presence of the Engineer who shall be the final authority to decide upon the adoption of any revised minimum cement content. The Contractor will always be responsible to produce quality concrete of the required grade as per the acceptance criteria of IS: 456.
- c) The Engineer will always have the unquestionable right to revise the minimum cement content as decided above, if, in his opinion, there is any chance of deterioration of quality on account of use of lower cement content or any other reason.

3.07.00 Water-Cement Ratio

The choice of water-cement ratio in designing a concrete mix will depend on:-

- a) The requirement of strength.

- b) The requirement of durability.

3.07.01 Strength Requirement

In case of "Design Mix Concrete" the water-cement ratio of such value as to give acceptable test results as per IS: 456, will be selected by trial and error. The values of water-cement ratios for different grade and mix designs will have to be established after conducting sufficiently large number of preliminary tests in the laboratory to the satisfaction of the Engineer. Frequent checks on test will have to be carried out and the water-cement ratios will be revised if the tests produce unsatisfactory results. Notwithstanding anything stated above the Contractor's responsibility to produce satisfactory test results and to bear all the consequences in case of default remains unaltered.

In case of nominal mix concrete, the maximum water-cement ratio for different grades of concrete is specified in Table-5 of IS: 456 and no tests are necessary. The acceptance test criterion for nominal mix concrete shall be as per IS: 456.

3.07.02 Durability Requirement

Tables 4 & 5 of IS: 456 give the maximum water-cement ratio permissible from the point of view of durability of concrete subjected to adverse exposure to weather, sulphate attacks, and contact with harmful chemicals. Impermeability may also be an important consideration.

Whenever the water-cement ratio dictated by Durability consideration is lower than that required from strength criteria, the former should be adopted.

In general the water cement ratio between 0.4 and 0.45 will be desirable to satisfy the durability requirement and from the consideration of impermeability of concrete. The contractor may propose lower water cement ratio as mentioned above by addition of a suitable plasticizer/super-plasticizer. Trial mix shall be carried out accordingly. However, the contractor has to propose specifically along with field trials in the event of lower cement content if found suitable along with a plasticizer.

3.08.00 Workability

The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of formwork and around the reinforcement and embedments and to give the required surface finish shall depend*on the type and nature of structure and shall be based on experience and tests. The usual limits of consistency for various types of structures are given below:

TABLE-V

LIMITS OF CONSISTENCY

Degree of workability	Slump in mm with Standard Cone as per IS: 1199		Use for which concrete is suitable
	Min.	Max.	

Very low	0	25	Large Mass concrete structure with heavy compaction equipments, roads
Low	25	50	Uncongested wide and shallow R.C.C. structures
Medium	50	100	Deep but wide R.C.C. structures with congestion of reinforcement and inserts
High	100	150	Very narrow and deep R.C.C. structures with congestion due to reinforcement and inserts.

Note: Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer.

With the permission of the Engineer, for any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete. No extra payment will be made for this additional cement.

The workability of concrete shall be checked at frequent intervals by slump tests.

3.09.00 Size of coarse Aggregates

The maximum size of coarse aggregates for different locations shall be as follows unless otherwise directed by the Engineer

Very narrow space	- 12 mm
Reinforced concrete Except foundation	- 20 mm
Ordinary Plain concrete and Reinforced concrete foundations	- 40 mm
Mass concrete	- 80 mm
Lean concrete	- 40 mm

Grading of coarse aggregates for a particular size shall conform to relevant I.S. Codes and shall also be such as to produce a dense concrete of the specified proportions, strength and consistency that will work readily into position without segregation.

Coarse aggregate will normally be separated into the following sizes and stacked separately in properly designed stockpiles

80 mm to 40 mm, 40 mm to 20 mm and 20 mm to 5 mm. In certain cases it may be necessary to further split the 20 mm to 5 mm fraction into 20 mm to 10 mm and 10 mm to 5 mm fractions.

This separation of aggregates in different size fractions is necessary so that they may be remixed

in the desired proportion to arrive at a correct internal grading to produce the best mix.

- 3.09.01** Temperature control of concrete in top decks of machine foundations (i.e. of TGs, BFPs, Fans and Mills):

The temperature of fresh concrete shall not exceed 25°C when placed. A suitable measuring device for measuring the temperature of concrete as approved by the Engineer shall be used. For maintaining the limiting temperature of the 25°C, crushed ice shall be used as mixing water. The ice shall be formed of water conforming IS: 456. The Contractor shall establish the quantity of crushed ice to be mixed in order to achieve the limiting temperature of 25°C.

- 3.09.02** Base raft of Turbo Generator foundations and top decks of all machine foundations shall be cast in a continuous operation without any construction joint.

3.10.00 Mixing of Concrete

Ingredients of the concrete mix shall be measured by weight. Concrete shall always be mixed in mechanical mixer. Water shall not normally be charged into the drum of the mixer until all the cement and aggregates constituting the batch are already in the drum and mixed for at least one minute. Mixing of each batch shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour and consistency, but in no case shall mixing be done for less than 2 (two) minutes and at least 40 (forty) revolutions after all the materials and water are in the drum. When absorbent Aggregates are used or when the mix is very dry, the mixing time shall be extended as may be directed by the Engineer. Mixers shall not be loaded above their rated capacity as this prevents thorough mixing.

The entire contents of the drum shall be discharged before the ingredients for the next batch are fed into the drum. No partly set or remixed or excessively wet concrete shall be used. Such concrete shall be immediately removed from site. Each time the work stops, the mixer shall be thoroughly cleaned & when the next mixing commences, the first batch shall have 10% additional cement at no extra cost to the Owner to allow for loss in the drum.

Regular checks on mixer efficiency shall be carried out as directed by the Engineer as per IS: 4634 on all mixers employed at site only those mixers whose efficiencies are within the tolerances specified in IS: 1791 will be allowed to be employed.

Batching Plant shall conform to IS: 4925. The measuring gauges of batching plant shall be periodically calibrated for which the contractor shall provide standard weights. The accuracy of all gauges shall be within limits prescribed by the Engineer.

When hand mixing is permitted by the Engineer, for unimportant out of the way locations in small quantities, it shall be carried out on a water-tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. In case of hand-mixing, 10% extra cement shall be added to each batch at no extra cost to the owner.

3.11.00 Conveying Concrete

Concrete shall be handled and conveyed from the place of mixing to the place of laying as rapidly as practicable by approved means and placed and compacted in the final position before the initial setting of the cement starts. Concrete should be conveyed in such a way as will prevent segregation or loss of any of the ingredients. For long distance haulage, agitator cars of approved design will be used. If, in spite of all precautions, segregations does occur during transport, the concrete shall be properly re-mixed before placement. During very hot

or cold weather, if directed by the Engineer, concrete shall be transported in deep containers, which will reduce the rate of loss of water, by evaporation or loss of heat. If necessary, the container may have to be covered and insulated. Conveying equipments for concrete shall be well maintained and thoroughly cleaned before, commencement of concrete mixing. Such equipments shall be kept free from set concrete.

3.12.00 Placing and Compacting Concrete

Where specifically covered, the relevant I.S. Code will be followed for the procedure of surface preparation, placement, consolidation, curing, finishes, repairs and maintenance of concrete. If, however, there is no specific provision in relevant I.S. code for any particular aspect of work, any other standard code of practice, as may be specified by the Engineer, will be adopted. Concrete may have to be placed against the following types of surfaces:

- a) Earth foundation
- b) Rock foundation
- c) Formwork
- d) Construction joint in concrete or masonry

The surface on or against which concrete is to be placed has to be cleaned thoroughly. Rock or old construction joint has to be roughened by wire brushing, chipping, sand blasting or any other approved means for proper bond. All cuttings, dirt, oil, foreign and deleterious material, laitance, etc. are to be removed by air water jetting or water at high pressure. Earth foundation on which direct placement of concrete is allowed, will be consolidated as directed by the Engineer such that it does not crumble and get mixed up with the concrete during or after placement, before it has sufficiently set and hardened.

Formwork, reinforcement, preparation of surface, embedments, joint seals etc., shall be approved in writing by the Engineer before concrete is placed. As far as possible, concrete shall be placed in the formwork by means approved by the Engineer and shall not be dropped from a height or handled in a manner which may cause segregation. Any drop over 1500 mm shall have to be approved by the Engineer.

Rock foundation or construction joint will be kept moist for at least 72 hours prior to placement. Concrete will be placed always against moist surface but never on pools of water. In case the foundation cannot be dewatered completely, special procedure and precaution, as directed by the Engineer will have to be adopted.

Formwork will be cleaned thoroughly and smeared lightly with form oil or grease of approved quality just prior to placement.

A layer of mortar of thickness 12 mm of the same or less w/c ratio and the same proportion as that of the concrete being placed or cement slurry will be spread thoroughly on the rock Foundation or construction joint just prior to placement of concrete.

After concrete has been placed, it shall be spread, if necessary & thoroughly compacted by approved mechanical vibration to maximum, subsidence without segregation and thoroughly worked around shape. Vibrators shall not be used for pushing concrete into adjoining areas. Vibrators must be operated by experienced workmen and the work carried out as per relevant

IS Code of Practice: In thin members with heavy congestion of reinforcement or other embedments, where effective use of internal vibrator is, in the opinion of the Engineer, doubtful, in addition to immersion vibrators the contractor may have to employ form vibrators conforming to IS: 4656. For slabs and other similar structures, the contractor will additionally employ screed vibrator as per IS: 2506. Hand tamping may be allowed in rare cases, subject to the approval of the Engineer. Care must be taken to ensure that the inserts, fixtures, reinforcement, and formwork are not displaced or distorted during placing & consolidation of concrete.

The rate of placement of concrete shall be such that no cold joint is formed and fresh concrete is placed always against green Concrete, which is still plastic and workable. No concrete shall be placed in open, during rains. During rainy season, no placement in the open is to be attempted unless sufficient tarpaulins or other similar protective arrangement for completely covering the still green concrete from rain is kept at the site of placement. If there has been any sign of washing of cement and sand, the entire affected concrete shall be removed immediately. Suitable precautions shall be taken in advance to guard against rains before leaving the fresh concrete unattended. No accumulation of water shall be permitted on or around freshly laid concrete.

Slabs, beams, and similar members shall be poured in one operation, unless otherwise instructed by the Engineer. Mouldings, throating, drip course, etc., shall be poured as shown on the drawings or as directed by the Engineer. Holes shall be provided and bolts, sleeves, anchors, fastenings, or other fixtures shall be embedded in concrete as shown on the drawings or as directed by the Engineer. Any deviation there from shall be set right by the Contractor at his own expense as instructed by the Engineer.

In case the forms or supports get displaced during or immediately after the placement and bring the concrete surface out of alignment beyond tolerance limits, the Engineer may direct to remove the portion and reconstruct or repair the same -at the Contractor's expense.

The Engineer shall decide upon the time interval between two placements of concrete of different ages coming in contact with each other, taking in consideration the degree of maturity of the older concrete, shrinkage, heat dissipation and the ability of the older concrete to withstand the load imposed upon it by the fresh placement.

Once the concrete is deposited, consolidated and finished in its final position, it shall not be distributed.

3.13.00 Construction Joints and Cold Joints

3.13.01 Construction Joints

It is always desirable to complete any concrete structure by continuous pouring in one operation. However, due to practical limitation of methods and equipment and certain design considerations, construction joints are formed by discontinuing concrete certain predetermined stages. These joints will be formed in a manner specified in the drawings/Instruction.

Vertical construction joints will be made with rigid stop-board forms having slots for allowing passage of reinforcement rods and any other embedments and fixtures that may be shown. Next stage concrete shall be placed against construction joint as per clause 3.12.

Where the location of the joints are not specified, it will be in accordance with the following:

- a) In a column, the joint shall be formed 75 mm below the lowest soffit of the beam framing into it.
- b) Concrete in a beam shall preferably be placed without a joint, but if Provision of a joint is unavoidable, the joint shall be vertical and at the middle of the span.
- c) A joint in a suspended floor slab shall be vertical and at the middle of the span and at right angles to the principal reinforcement.
- d) Feather-edges in concrete shall be avoided while forming a joint.
- e) A construction joint should preferably be placed in a low-stress zone and at right angles to the direction of the principal stress.
- f) In case the Contractor proposes to have a construction joint anywhere to facilitate his work, the proposal should be submitted well in advance to the Engineer for study and approval without which no construction joint will be allowed.

3.13.02

Cold Joint

An advancing face of a concrete pour, which could not be covered by fresh concrete before expiry of initial setting time (due to an unscheduled stoppage or delay on account of breakdown in plant, inclement weather, low rate of placement or any other reason), is called a cold joint. The Contractor should always remain vigilant to avoid cold joints.

If, however, a cold joint is formed due to unavoidable reasons, the following procedure shall be adopted for treating it:

- a) If the concrete is so green that it can be removed manually and if vibrators can penetrate the surface without much effort, fresh concrete can be placed directly against the old surface. The old concrete should be covered by fresh concrete as quickly as possible and the joint thoroughly and systematically vibrated.
- b) In case concrete has hardened a bit more than (a) but can still be easily removed by a light hand pick, the surface will be raked thoroughly and the loose concrete removed completely without disturbing the rest of the concrete in depth. A rich mortar layer 12 mm in thickness, will be placed on the cold joint fresh concrete shall be placed on the mortar layer and the joint will be thoroughly and systematically vibrated penetrating the vibrator deep into the old layer of concrete.
- c) In case the concrete at the joint has become so stiff that it cannot be remoulded and mortar or slurry does not raise inspite of extensive vibration, the joint, will be left to harden for at least 12 - 24 hrs. It Will then be treated as a regular construction joint, after cutting the concrete to required shape and preparing the surface as described under clause 3.12.

3.14.00

Repairs, Finishes, and Treatment of Concrete surfaces

- 3.14.01** Adequate and sound concrete surfaces, whether formed or unformed, can be obtained by employing a concrete mix of proper design, competent formwork, appropriate methods of handling, placing, and consolidation by experienced workmen.

Unsound concrete resulting from improper mix design, incompetent methods, equipment and formwork, poor workmanship and protection will not be accepted and will have to be dismantled, removed and replaced by sound concrete at the Contractor's cost. The Engineer may, at his sole discretion, allow to retain concrete with minor defects provided the Contractor is able to repair it by approved methods at no extra cost to the Owner. All concrete work shall be inspected by the Contractor immediately after the forms are removed & he will promptly report occurrence of any defects to the Engineer. All repair works will be carried out as per the instructions and in the presence of the Engineer or his representative. Generally, repair work will consist of any or all of the following operations:

- a) Sack rubbing with mortar and stoning with carborundum stone.
- b) Cutting away the defective concrete to the required depth shape.
- c) Cleaning of reinforcement & embedments. It may be necessary to provide an anti-corrosive coating on the reinforcement.
- d) Roughening by sand blasting or chipping.
- e) Installing additional reinforcement/welded mesh fabric.
- f) Dry packing with stiff mortar.
- 9) Plastering, guniting, shotcreting etc.
- h) Placing and compacting concrete in the void left by cutting out defective concrete.
- i) Grouting with cement sand slurry of 1:1 mix.
- j) Repairing with a suitable mortar either cement or resin modified mortars.
- k) Polymer modified patching and adhesive repair& mortar for beams & columns.

3.14.02 Finishing unformed Surface

The contractor shall provide normal finishes in unformed surfaces which can be achieved by screeding, floating, trowelling etc. A few typical and common cases of treatment of concrete surface are cited below

a) Floor

Whenever a non-integral floor finish is indicated, the surface of reinforced concrete slab shall be struck off at the specified levels and slopes and shall be finished with a wooden float fairly smooth removing all laitance. No over trowelling, to obtain a very smooth surface, shall be done, as it will prevent adequate bond with the subsequent finish. If desired by the Engineer, the surface shall be scored and marked to provide better bond.

Where monolithic finish is specified or required, concrete shall be compacted and struck off at the specified levels and slopes with a screed, preferably a vibrating type and then floated with a wooden float. Steel trowelling is then started after the moisture film and shine have disappeared from the surface and after the concrete has hardened enough to prevent excess of fines and water to rise to the surface but not hard enough to prevent proper finishing of aberrations. Steel trowelling properly done will flatten and smoothen sandy surface left by wooden floats and produce a dense surface free from blemishes, ripples, and trowel marks.

A fine textured surface that is not slick and can be used where there is likelihood of spillage of oil or water can be obtained by trowelling the surface lightly with a circular motion after initial trowelling keeping the steel trowel flat on the surface.

To provide a better grip the Engineer may instruct marking the floor in a regular geometric pattern after initial trowelling.

b) Beams, Columns & Walls

If on such or any other concrete structure it is intended to apply plaster or such concrete surfaces against which brickwork or other allied works are to be built, the Contractor shall hack the surface adequately as soon as the form is stripped off so that proper bond can develop. Pattern, adequacy, and details of such hacking shall meet with the approval of the Engineer, who shall be informed to inspect such surfaces before they are covered up.

3.15.00 Protection and Curing of concrete

Newly placed concrete shall be protected by approved means from rain, sun, and wind. Concrete placed below the ground level shall be protected against contamination from falling earth during and after placing. Concrete placed in ground containing deleterious substances, shall be protected from contact with such ground, or with water draining from such ground, during placing of concrete and for a period of at least three days, or as otherwise instructed by the Engineer. The ground water around newly poured concrete shall be kept to an approved level by pumping out or other adequate means of drainage to prevent floatation or flooding. Steps, as approved by the Engineer, shall be taken to protect immature concrete from damage by debris, excessive loadings, vibration, abrasion, mixing with earth or other deleterious materials, etc. that may impair the strength and durability of the concrete.

As soon as the concrete has hardened sufficiently, it shall be covered either with sand, hessian, canvas, or similar materials and kept continuously wet for at least 14 (fourteen) days after

final setting. Curing by continuous sprinkling of water will be allowed if the Engineer is satisfied with the adequacy of the arrangements made by the Contractor. Quality of water for curing shall be as per IS: 456.

If permitted by the Engineer, liquid curing compound may be used for prevention of premature water loss in concrete and thereby effecting curing of concrete. This type of curing compound shall be sprayed on newly laid concrete surfaces to form a thin film barrier against premature water loss without disturbances to normal setting action. The curing compound shall be emulsified paraffin based and shall comply with ASTM requirements for acceptance.

The curing compound shall be applied following the final finishing operation and immediately after disappearance of water from concrete surface. It is important not to apply the curing compound when standing water is still present on concrete.

The contractor shall arrange for the manufacturer's supervision at no extra cost.

The Contractor shall remain extremely vigilant and employ proper equipment and workmen under able supervision for curing. The Engineer's decision regarding the adequacy of curing is final. In case the Engineer notices any lapse on the part of the Contractor, he will inform the Contractor or his supervisor verbally or in writing to correct the deficiency in curing. If no satisfactory action is taken by the Contractor within 3 (three) hours of issuance of such instruction, the Engineer will be at liberty either to employ sufficient means through any agency to make good the deficiency and recover the cost thereof from the Contractor, or deduct certain amount from contractor's payment for the part where inadequate curing was noticed entirely at the discretion of the Engineer.

3.16.00 Reinforcement

Mild steel round bars, TMT bars, Hot rolled deformed bars or cold twisted deformed bars as medium tensile or high yield strength steel, plain hard drawn steel wire fabric etc, will be used as reinforcement as per drawings and directions. In an aggressive environment an anti-corrosive coating on the reinforcement may be provided as per IS: 9077, as shown on the drawing or as directed by the Engineer.

3.16.01 Bar Bending Schedules

The Contractor shall prepare Bar Bending Schedules showing clearly the arrangements proposed by the Contractor to match available stock of reinforcing steel, progressively, starting within one week of receipt of approval on corresponding design of RCC structure. As decided by the Engineer, some or all the detailed drawings and schedules will have to be submitted for approval. Approval of such detailed drawings by the Engineer shall not relieve the Contractor of his responsibility for correctness nor of any of his obligations to meet the other requirements of the contract. The contractor for record and distribution shall submit six prints of the final drawings & schedules with one reproducible print.

3.16.02 Cleaning

All steel for reinforcement shall be free from loose scales, oil, grease, paint or other harmful matters immediately before placing the concrete.

3.16.03

Bending

Unless otherwise specified, reinforcing steel shall be bent in accordance with the procedure specified in IS: 2502 or as approved by the Engineer. Bends and shapes shall comply strictly with the dimensions corresponding with the final Bar Bending Schedules. Bar Bending Schedules shall be rechecked by the Contractor before any cutting, bending is done.

No reinforcement shall be bent when already in position in the work, without approval of the Engineer, whether or not it is partially embedded in concrete. Bars shall not be straightened in a manner that will injure the material. Rebending can be done only if approved by the Engineer. Reinforcing bars shall be bent by machine or other approved means producing a gradual and even motion. All the bars shall be cold bent unless otherwise approved. Bending hot at a cherry-red heat (not exceeding 845°C) may be allowed under very exceptional circumstances except for bars whose strength depends on cold working. Bars bent hot shall not be cooled by quenching.

3.16.04 Placing in Position

All reinforcements shall be accurately fixed and maintained in position as shown on the drawings by such approved and adequate means like mild steel chairs and/or concrete spacer blocks. Bars intended to be in contact at crossing points, shall be securely tied together at all such points by No. 20 G annealed soft iron wire or by tack welding in case of Bar larger than 25 mm dia., as may be directed by the Engineer. Binders shall tightly embrace the bars with which they are intended to be in contact and shall be securely held. The vertical distance between successive layers of bars shall be maintained by provision of mild steel spacer bars. They should be spaced such that the main bars do not sag perceptibly between adjacent spacers. Before actual placing, the Contractor shall study the drawings thoroughly and inform the Engineer in case he feels that placement of certain bars is not possible due to congestion. In such cases he should not start placing any bar before obtaining clearance from the Engineer.

3.16.05 Welding

Lapping shall normally do splicing of reinforcement. For M.S. reinforcement bars, butt-welding may be done, if permitted by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian Standards for welding of mild steel bars used in reinforced concrete construction as per IS: 2751 and IS: 456. Welded mesh fabrics conforming to IS: 1566 may also be used if specified in the Drawings. Welding of cold twisted High yield strength deformed bar shall not be allowed.

3.16.06 Control

The placing of reinforcements shall be completed well in advance of concrete pouring. Immediately before pouring, the reinforcement shall be examined by the Engineer for accuracy of placement and cleanliness. Necessary corrections as directed by him shall be carried out. Laps and anchorage lengths of reinforcing bars shall be in accordance with IS: 456, unless otherwise specified. The laps shall be staggered as far as practicable and as directed by the Engineer. Arrangements for placing concrete shall be such that reinforcement in position does not have to bear extra load and get disturbed. The cover for concrete over the reinforcements shall be as shown on the approved drawings unless otherwise directed by the Engineer. Where concrete blocks are used for ensuring the cover and positioning reinforcement, they shall be made of mortar not leaner than 1 (one) part cement to 2 (two) parts sand by –volume and cured in a pond for at least 14 (fourteen) days. The type, shape, size and location of the concrete blocks shall be as approved by the Engineer.

3.17.00 Cold Weather Concreting

When conditions are such that the ambient temperature may be expected to be 5°C or below during the placing and curing period, the work shall conform to the requirement of IS: 456 and IS: 7861.

3.18.00 Hot Weather Concreting

When depositing concrete in very hot weather, the Contractor shall take all precautions as per IS: 7861 and stagger the work to the cooler parts of the day to ensure that the temperature of wet concrete used in massive structures does not exceed 38°C while placing. Positive temperature control by precooling, post cooling or any other method, if required, will have to be done by the contractor at no extra cost.

3.19.00 Concreting under water

When it is necessary to deposit concrete under water it shall be done in accordance with the requirements of IS: 456.

3.20.00 Form Work

3.20.01 General

If it is so desired by the Engineer, the contractor shall prepare, before commencement of actual work, designs and working drawings for formwork and centring and get them approved by the Engineer. The formwork shall conform to the shape, grade, lines, levels and dimensions as shown on the drawings.

Materials used for the formwork inclusive of the supports and centring shall be capable of withstanding the working load and remain undistorted throughout the period it is left in service. All supports and scaffolds should be manufactured from structural or tubular steel except when specifically permitted otherwise by the Engineer.

The centring shall be true to vertical, rigid and thoroughly braced both horizontally and diagonally. Rakers are to be used where forms are to support inclined members. The forms shall be sufficiently strong to carry without undue deformation, the dead weight and horizontal pressure of the concrete as a liquid as well as the working load. In case the contractor wishes to adopt any other design criteria, he has to convince the Engineer about its acceptability before adopting it. Where the concrete is vibrated, the formwork shall be strong enough to withstand the effects of vibration without appreciable deflection, bulging, distortion or loosening of its components. The joints in the formwork shall be sufficiently tight to prevent any leakage of slurry or mortar.

To achieve the desired rigidity, tie bolts, spacer blocks, tie wires and clamps as approved by the Engineer shall be used but they must in no way impair the strength of concrete or cause stains or marks on the finished surface. Where there are chances of these fixtures being embedded, only mild steel and concrete of adequate strength shall be used. Bolts passing completely through liquid retaining walls/slabs for the purpose of securing and aligning the formwork shall not be used.

The formwork shall be such as to ensure a smooth uniform surface free from honeycombs, air bubbles, bulges, fins and other blemishes. Any blemish or defect found on the surface of the concrete must be brought to the notice of the Engineer immediately and rectified as directed by

him.

For exposed interior and exterior concrete surfaces of beams, columns and wall, plywood or other approved form shall be thoroughly cleaned and tied together with approved corrosion-resistant devices. Rigid care shall be exercised in ensuring that all column forms are in true plumb and thoroughly cross-braced to keep them so. All floor and beam centring shall be crowned not less than 8 mm in all directions for every 5 metres span. The formwork should lap and be secured sufficiently at the lift joints to prevent bulges and offsets.

Temporary openings for cleaning, inspection and for pouring concrete shall be provided at the base vertical forms and at other places, where they are necessary and as may be directed by the Engineer. The temporary openings shall be so formed that they can be conveniently closed when required, during pouring operations without leaving any mark on the concrete.

3.20.02 Cleaning and Treatment of Forms

All parts of the forms shall be thoroughly cleaned of old concrete, wood shavings, saw dust, dirt and dust sticking to them before they are fixed in position. All rubbish, loose concrete, chippings, shavings, sawdust etc. shall be scrupulously removed from the interior of the forms before concrete is poured. Compressed air jet and/or water jet along with wire brushes brooms etc. shall be used for cleaning. The inside surface of the formwork shall be treated with approved non-staining oil or other compound before it is placed in position. Care shall be taken that oil or other compound does not come in contact with reinforcing steel or construction joint surfaces. They shall not be allowed to accumulate at the bottom of the formwork. The oiling of the formwork will be inspected just prior to placement of concrete and redone wherever necessary.

3.20.03 Design

The formwork shall be so designed and erected that the forms for slabs and the sides of beams, columns, and walls are independent of the soffits of beams and can be removed without any strain to the concrete already placed or affecting the remaining formwork.

Removing any props or repropping shall not be done except with the specific approval of the Engineer. If formwork for column is erected for the full height of the column, one side shall be left open and built up in sections, as placing of concrete progress. Wedges, spacer bolts, clamps or other suitable means shall be provided to allow accurate adjustment and alignment of the formwork and to allow it to be removed gradually without jarring the concrete.

3.20.04 Inspection of Forms

Casting of Concrete shall start only after the formwork has been inspected and approved by the Engineer. The concreting shall start as early as possible within 3 (three) days after the approval of the formwork and during this period the formwork shall be kept under constant vigilance against any interference. In case of delay beyond three days, a fresh approval from the Engineer shall be obtained.

3.20.05 Removal of Forms

Formwork shall be kept in position after casting of concrete for a minimum period as mentioned in IS: 456, however the period of retaining form in position can be extended as per drawing, instruction of Engineer or as required for satisfactory completion of work without any extra cost. Before removing any formwork, the Contractor must notify the Engineer well in advance to enable him to inspect the concrete if the Engineer so desires.

The Contractor shall record on the drawing or in any other approved manner, the date on which concrete is placed in each part of the work and the date on which the formwork is removed there from and have this record checked and countersigned by the Engineer regularly. The Contractor shall be responsible for the safe removal of the formwork and any work showing signs of damage through premature removal of formwork or loading shall be rejected and entirely reconstructed by him without any extra cost to the Owner, The Engineer may, however, instruct to postpone the removal of formwork if he considers it necessary.

If any other type of cement other than ordinary Portland cement and Rapid hardening cement is used, the time of removal of forms shall be revised such that the strength of this cement at the time of removal of forms match with strength of Portland cement at the time of removal of form.

3.20.06 Tolerance

The formwork shall be so made as to produce a finished concrete, true to shape, lines, levels, plumb and dimensions as shown on the drawings subject to the following tolerances unless otherwise specified in this specification or drawings or directed by the Engineer:-

For -	a) Sectional dimension -	± 5 mm
	b) Plumb	- 1 in 1000 of height
	c) Levels	- ± 3 mm before any deflection has taken place

The tolerance given above are specified for local aberrations in the finished concrete surface & should not be taken as tolerances for the entire structure taken as a whole or for the setting and alignment of formwork, which should be as accurate as possible to the entire satisfaction of the Engineer. Any error, within the above tolerance limits or any other as may be specially set up by the Engineer, if noticed in any lift of the structure after stripping of forms, shall be corrected in the subsequent work to bring back the surface of the structure to its true alignment.

3.20.07 Re-use of Forms

Before re-use, all forms shall be thoroughly scraped, cleaned, joints and planes examined and when necessary repaired, and inside surface treated as specified hereinbefore. Formwork shall not be used/re-used if declared unfit or unserviceable by the Engineer.

3.20.08 Classification

Generally, the "ordinary" class formwork shall be used unless otherwise specified.

- a) **Ordinary:** These shall be used in places where ordinary surface finish is required and shall be composed of steel and/or approved good quality partially seasoned timber.
- b) **Plywood:** These shall be used in exposed surfaces, where specially good finish is required and shall be made of approved brand of heavy quality plywood to produce a perfectly uniform and smooth surface conforming to the shape described in the drawing with required grain texture on the concrete. Re-use may only be permitted after special inspection and approval by the Engineer. He may also permit utilization of used plywood for the "ordinary" class, if it is still in good condition.
- c) **Ornamental:** These shall be used where ornamental and curved surface are required and

shall be made of selected best quality well seasoned timbers or of plywood, which can be shaped correctly.

3.21.00 Opening, Chases, Grooves, Rebates, Blockouts etc.

The Contractor shall leave all openings, grooves, chases, etc. in concrete work as shown on the drawings or as specified by the Engineer.

3.22.00 Anchor Bolts, Anchors, Sleeves, Inserts, Hangers/Conduits/Pipe and other misc. Embedded Fixtures

The Contractor shall build into concrete work all the items noted below and shall embed them partly or fully as shown on drawings and secure the same as may be required. The materials shall be as specified and be of best quality available according to relevant Indian Standards of approved manufacture and to the satisfaction of the Engineer. Exposed surfaces of embedded materials are to paint with one coat of approved anti- corrosive paint and/or bituminous paint without any extra cost to the Owner. If welding is to be done subsequently on the exposed surface of embedded material, the paint shall be cleaned off the member to a minimum length of 50 mm beyond each side of the weld line.

Necessary templates, jigs, fixtures, supports etc. shall be used as may be required or directed by the Engineer.

Items to be embedded

- a) Inserts, hangers, anchors, frame around openings, manhole covers, frames, floor clips, sleeves conduits and pipes.
- b) Anchor bolts and plates for machinery, equipment and for structural steel work.
- c) Steel structurals to be left embedded for future extension, special connection etc.
- d) Dowel bars, etc. for concrete work falling under the scope of other contractors.
- e) Lugs or plugs for door and window frames occurring in concrete work.
- f) Flashing and jointing in concrete work.
- g) Any misc. embedments and fixture as may be required.

Correct location and alignment, as per drawings/instruction of all these embedded items shall be entirely the responsibility of the Contractor.

3.23.00 Expansion and Isolation Joints

3.23.01 General

Expansion and isolation joints in concrete structures shall be provided at specific places as per details indicated on the drawings. The materials and types of joints shall be as specified hereinafter. In case of liquid retaining structures, additional precautions shall be taken to prevent leakage of liquids as may be specified on the drawings or as directed by the Engineer. All materials are to be procured from reliable manufacturers and must have the approval of the Engineer. Where it is the responsibility of the Contractor to supply the material, the Engineer may demand test certificates for the materials and/or instruct the Contractor to get them tested in an approved laboratory free of cost to the Owner. Joints shall be formed true to line, level, shape, dimension, and quality as per drawings and specifications. Prior approval of the method of forming the joints should be obtained from the Engineer before starting the work.

3.23.02 Bitumen Board/ Expanded Polystyrene Board

a) Bitumen Board

Bitumen impregnated fibreboard of approved manufacturer as per IS: 1838 may be used as fillers for expansion joints. It must be durable and waterproof. It shall be compressible and possess a high degree of rebound. The dimensions of the board should be equal to that of the joint being formed. It should, preferably be manufactured in one piece, matching the dimension of the joint and not prepared by cutting to size smaller pieces from larger boards at site. At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25 mm after application of an approved primer. The sealing compound and the primer shall be applied as specified by the manufacturer.

b) Expanded Polystyrene Boards

If required, commercial quality of expanded polystyrene products commonly used for thermal insulations may also be used as filler material in expansion joints. The thickness may vary from 12 mm to 50 mm. The material will have to be procured from reliable manufacturers as approved by the Engineer. The method of installations will be similar to that recommended by the manufacturers for fixing on cold storage walls. A coat of Bitumen paint may have to be applied on the board against which concrete will be placed.

3.23.03 Joint sealing strips

Joint sealing strips may be provided at the construction, expansion, and isolation joints as a continuous diaphragm to contain the filler material and/or to exclude passage of water or any other material into or out of the structure. The sealing strips will be either metallic like G.I., Aluminums, or Copper, or non-metallic like rubber or P.V.C.

Sealing strips will not have any longitudinal joint and will be procured and installed in largest practicable lengths having a minimum number of transverse joints. The material is to be procured from reputed manufacturers having proven records of satisfactory supply of joint strips of similar make and shape for other jobs. The jointing procedure shall be as per the manufacturer's recommendations, revised if necessary, by the Engineer. The Contractor is to supply all labour and material for installation -including the material and tools required for jointing, testing, protection, etc. If desired by the Engineer, joints in rubber seals may have to be vulcanized.

a) Metal Sealing Strips

Metal sealing strips shall be either G.I., Aluminium or Copper and formed straight, U shaped, Z shaped or any other shape and of thickness as indicated in the drawing. The transverse joints will be gas welded using brass rods and approved flux and will be tested by an approved method to establish that it is leak proof. If required, longer lap lengths and different method of brazing which will render it leak proof, will be adopted by the Contractor. The edges shall be neatly crimped and bent to ensure proper bond with the concrete.

i) G.I. Strips

G.I. strips shall be minimum 1.5 mm thick and 150 mm in width unless specified otherwise. The standard of Galvanizing shall be as per relevant Indian Standards for heavy-duty work. At the joints, the overlapping should be for a minimum length of 50 mm.

ii) Aluminium Strips

Aluminium strips shall be minimum 18 SWG thick and 300 mm wide unless specified otherwise and shall conform to IS: 737 of 19000 grades or 31000 grade (Designation as per IS: 6051). A minimum lap of 50 mm length is required at the joints.

iii) Copper Strips

The Copper strips shall be minimum 18 SWC in thickness and 300 mm width unless specified otherwise and shall conform to the relevant Indian Standards. It should be cleaned thoroughly before use to expose fresh surface, without any reduction in gauge. A minimum lap of 50 mm in length is required at the joints.

b) Non-metallic Sealing Strips

These will be normally in Rubber or P.V.C. Rubber or P.V.C. joint seals can be of shape having any combination of the following features:

- i) Plain
- ii) Central bulb
- iii) Dumb-bell or flattened ends
- iv) Ribbed and Corrugated Wings
- v) V shaped

As these types of seals can be easily handled in very large lengths unlike metal strips, transverse joints will be allowed only under unavoidable circumstances and with the specific approval of the Engineer. The method of forming these joints, laps etc. shall be as specified by the Manufacturer and/or as approved by the Engineer taking particular care to match the central bulbs & the edges accurately.

c) Rubber Sealing Strips

The minimum thickness of Rubber sealing strips shall be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings or as directed by the Engineer. The material will be natural rubber and be resistant to corrosion, abrasion, and tear and also to attacks from the acids, alkalis and chemicals normally encountered in service. The physical properties will be generally as follows. The actual requirements may be slightly different as decided by the Engineer:

Specific Gravity	:	1.1 to 1.15
Shore Hardness	:	65A to 75A
Tensile Strength	:	25 - 30 N/Sq.mm
Maximum Safe Continuous Temperature	:	75°C
Ultimate Elongation	:	Not less than 350%

b) P.V.C., Sealing Strips

The minimum thickness of P.V.C. sealing strips will be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings or as directed by the Engineer. The material should be of good quality Polyvinyl Chloride highly resistant to tearing, abrasion, and corrosion as well as to chemicals likely to come in contact with during use. The physical properties will generally be as follows. The actual requirements, which will be directed by the Engineer, may vary slightly

Specific Gravity	:	1.3 to 1.35
Shore Hardness	:	60A to SOA
Tensile Strength	:	10 - 15 N/Sq.mm
Maximum Safe Continuous Temperature	:	70 Deg.C

Ultimate Elongation : Not less than 275%

3.23.04 Bitumen Compound

When shown in drawing or directed, the gap in expansion joints shall be thoroughly cleaned and bitumen compound laid as per manufacturer's specifications. The compound to be used shall be of approved manufacture and shall conform to the requirements of IS: 1834.

3.23.05 Isolation Joints

Strong and tough alkathene sheet or equivalent, about 1 mm in thickness and as approved by the Engineer shall be used in isolation joints. It shall be fixed by an approved adhesive compound on the cleaned surface of the already set concrete to cover it fully. Fresh concrete shall be laid against the sheet, care being taken not to damage the sheet in any way.

3.23.06 Pad

Hard foundation quality rubber pads of required thickness and shapes shall be put below machine or other foundations as shown on the drawings. The rubber shall have a unit weight of 1500 Kg/Cu.m, a shore hardness - 65A to 70A and be of best quality of approved manufacture, durable, capable of absorbing vibration and must be chemically inert in contact with moist or dry earth or any other deleterious material expected under normal conditions.

3.24.00 Grouting under Machinery or Structural Steel Bases

If required, grouting under base plates of machines or structural steel etc. shall be carried out by the Contractor. In general, the mix shall be 1 (one) part cement and 1 (one) part sand and just enough water to make it flow as required. The areas to be grouted shall be cleaned thoroughly with compressed air jet and/or with water in locations where accumulated surplus water can be removed. Where directed by the Engineer, 6 mm down stone chips may have to be used in the mix. Surface to be grouted shall be kept moist for at least 24 hours in advance. The grout shall be placed under expert supervision, so that there is no locked up air. Edges shall be finished properly. If specified on drawings, admixtures like Aluminium powder, "Ironite" etc. may have to be added with the grout in required proportions. Premixed non-shrink grout of approved manufacture having proper strength shall be used with Engineer's approval for important machineries.

3.25.00 Precast Concrete

The Specification for precast concrete will be similar as for the cast-in-place concrete described herein and as supplemented in this section. All precast 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 soffit former of the units, it 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 M.S. sheeting. Where directed by the Engineer, casting will have to be done on suitable vibrating table. 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, where necessary or as directed by the Engineer, shall be embedded in correct position of the units to facilitate erection, even though they may not be shown on the drawings, and shall be burnt off and finished after erection.

Precast concrete units, when ready, shall be transported to site by suitable means approved by the Engineer. Care shall be taken to ensure that no damage occurs during transportation. All adjustments, leveling, and plumbing shall be done as per instructions of the Engineer. The Contractor shall render all help with instruments, materials, and men to the Engineer for checking the proper erection of the precast units.

After erection and alignment, the joints shall be filled with grout or concrete as per drawings. If centrings have to be used for supporting the precast units, they shall not be removed until the joints have attained sufficient strength and in no case before 14 (fourteen) days. The joint between precast roof planks shall be pointed with 1:2 cement: sand mortar where called for in the drawings.

3.26.00 Waterproofing of Concrete Structure**3.26.01 General**

Where required, waterproofing of concrete structures shall be ensured internally by suitable design of the concrete mix, addition of suitable admixtures in the concrete or mortar at the time of mixing and/or installing water bars at the joints. In addition to the above measures, the structures shall be made watertight by adopting "structural waterproofing" as per specification. The design, material, and workmanship shall conform to the relevant I.S. Codes where

applicable. The Engineer's approval of the materials shall be obtained by the Contractor before procurement. If desired by the Engineer, test certificates for the materials and samples shall be submitted by the Contractor free of charge. The materials shall be of best quality available indigenously, fresh clean and suitable for the duties called upon.

3.26.02 Water Bar/Seal/Special Treatment of Construction Joint

Water bearing structures and underground structures may have water bar/seals installed at the joints. They may be metallic, rubber, or P.V.C. The materials and installation will be as described under Clause 3.23.3. Construction joint shall be provided as per clause 3.13.1 with or without water bar/seal as shown on the drawing. In case of water bars being used at the construction joint, fixing of the same has to be done carefully, so that the water bar is not disturbed during concreting. The construction joint shall also be treated by any one of the following methods.

Method 1: A surface retarder in the form of a thixotropic gel shall be applied on the joint surface of the previous pour in case of joint on the wall and in case of floor the same shall be applied on the formwork against which previous pour of concreting shall be done. The retarder may be liquid or paste form depending on the type of formwork. The formwork shall be removed within 24 hours after concreting. Within 2 hours of striking of the formwork the retarder shall be washed off with strong water jet to make surface rough and clean. Then a rich cement mortar using cement, sand and aggregates (maximum size 8 mm) along with synthetic rubber emulsion type water resistant bonding agent shall be applied for a depth of 50 mm just before pouring the next stage of concreting. In case of walls, the above bonding agent will be mixed with water, which will be used for making the cement mortar. The proportion of mixing of this bonding agent with water shall be as per manufacturer's specification. In case of floor joint, however, after washing of retarder a solvent free two-component epoxy resin-bonding agent will be used at the joint before the next pour of concrete. The above bonding agent shall have the following properties after 28 days

Compressive strength	-	55 to 60 N/Sq.mm
Flexural strength	-	5 to 30 N/sq.mm
Tensile strength	-	15 N/Sq.mm (approx.)
Bonding strength to concrete	-	3 N/Sq.mm (approx.)
Bonding strength to steel	-	20 N/Sq.m (approx.)

The whole operation shall be done as per manufacturers specification. The contractor shall provide manufacturer's supervision at no extra cost to the owner.

Method 2: One row of threaded nozzles at regular intervals not exceeding 1.5 m centre to centre shall be placed in concrete along the construction joint during casting. Injection of cement water together with a suitable waterproof expanding grouting admixture of approved quality shall be done through the nozzles after the concrete has set to seal the voids in concrete near the construction joint in walls and slabs. The injection shall be done under pressure of approximately 2 to 4 kg/sq.cm. The nozzles shall be sealed off with suitable admixture after the injection is over. The whole operation shall be carried out as per manufacturer's specification and supervision. The cost of such manufacturer's supervision shall be borne by the contractor.

3.26.03 Waterproofing Admixtures

The waterproofing admixture for concrete and cement mortar/plaster shall conform to IS: 2645. The admixture shall not cause decrease of strength of concrete/plaster at any stage and it shall be free from chlorides and sulphates. The admixture shall not affect the setting time by more than 5%. The maximum permissible dosage of admixture will be 3% (three percent) by weight of cement, but a lower dosage will always be preferred. The product shall be stored in strong moisture proof packings. However, in case of important structures where M25 or higher grade concrete is specified, the use of melamine based, high range water reducing concrete admixture shall be used to provide a waterproof concrete, For achieving high strength concrete having cement content around 400 kg/cu.m. a melamine based super plasticizer will be preferable.

- a) In concrete: The admixtures shall be procured from reliable and reputed manufacturers and approved by the Engineer. The method of application and other details shall conform to the manufacturer's specification and/or as instructed by the Engineer. The Contractor shall have the services of the manufacturer's supervisor at no extra cost to supervise the work, if desired by the Engineer.
- b) In Plaster: The concrete surface, to be plastered, shall be hacked to Engineer's satisfaction, cleaned thoroughly and kept wetted for 24 hours. The plaster shall be in cement sand mortar mixed in proportion varying from 1:1 to 1:4 by volume along with the approved waterproofing admixture and laid in appropriate thickness and in layers not exceeding 15 mm/layer or as per manufacturer's specification. The additive shall be of quality and type approved by the Engineer. If desired by the Engineer, the Contractor shall have the work supervised by the manufacturer's supervisor at no extra cost. On completion, the Plastered surface shall be cured continuously for a minimum period of 14 days like concrete.

3.26.04 Structural waterproofing

- a) Nozzles spaced as required after the concrete is completed shall be drilled into surfaces to be rendered watertight. Non-shrink cement grout with waterproofing compound as per manufacturers specifications shall be injected under pressure to seal all voids. Special care shall be taken at joints by providing additional nozzles. The pressure grouting shall be done on the internal surface.

- b) External Treatment

Two layers of (1 : 4) plaster of 12 mm thick each with waterproofing compound as per manufacturer's specification shall be provided on outer surface of concrete underground structures.

3.26.05 Protective coating on Inside Surface.

Two coats of cement based two components polymer modified flexible protective and waterproofing slurry having 1 mm thick for each coat shall be applied on the walls/floor after proper surface preparation as mentioned above. The slurry shall be applied by brush.

3.26.06 Bitumen Felt: Application for Tanking

This specification shall cover laying the waterproof course on the outside and inside of the walls and bases of structures.

The materials shall conform to IS: 1322, and the workmanship to IS: 1609. The bitumen felt should be hessian base and/or fibre base as specified in Drawing. If required by the Engineer, tests as specified in relevant IS Codes shall be arranged by the Contractor without charging any extra to the Owner.

The Contractor shall execute this work in direct collaboration with one of the well known specialized firm approved by the Engineer.

Cleaning the surface, keeping it dry, providing, necessary corner fillets and cement rendering and cutting chases, etc. shall be done as per drawings and/or instructions. If any protective brickwork on/against concrete sub-bases or walls are required, the same shall be provided. A twenty (20) years guarantee for satisfactory performances shall be given by the Contractor as well as his specialist sub-contractor jointly and severally, for this work. Free rectification of any defects noted in the work within this guarantee period will be carried out by the Contractor even if it is beyond the specified maintenance period of the contract as a whole.

3.26.07 Polyethylene Films: Application in Walls or base of structures

Waterproof treatment shall be applied as outlined and as per sequence given hereunder

- i) the concrete surface shall be made smooth with 12 mm cement plaster 1:6.
- ii) apply hot bitumen 80/100 grade (IS: 73-1961) at the rate of 1.0 Kg/Sq.m minimum
- iii) lay black polyethylene film 250-micron (IS: 2508-1977) with cut back bitumen adhesive in overlaps over hot bitumen surface, gently pressed, taking care not to puncture the film.

Alternatively, the overlaps shall be heat sealed by an electric iron having three parallel sealing bars. A long piece of plywood is to be placed below the polyethylene film to be heat-sealed. On the plywood a rubber gasket is to be laid to provide a cushion for better welding of the film. On the rubber padding, a cellophane tape is to be spread and on this the LDPE film, with 100 mm overlap, is to be stretched. On the overlapped film another cellophane tape is to be placed to prevent the heat sealer from sticking to the LDPE film. After this, the electric iron is to be pressed on the overlap joint for sufficient time so as to allow perfect welding. The operation is to be repeated for subsequent lengths of joints. After heat-sealing, the cellophane tape is to be removed and the joints are to be tested for leaks.

- iv) Lay 100 gm brown craft paper laminated with a layer of straight run bitumen,
- v) Lay hot bitumen 80/100 grade (IS: 73-1961) at 1.0 Kg/Sq.m minimum.
- vi) Lay 250-micron polyethylene film as second layer similar to
- vii) above.
- viii) Lay second layer of 100 gm. brown craft paper laminated similar to (iv) above.
- ix) Apply hot bitumen (straight run grade) to IS: 73-1961 at 1.0 Kg/Sq.m dusted with fine sand.
- x) Protecting with a layer of 75 mm plain cement concrete M-10, or a layer of brick laid in cement mortar 1:6 in case of wall apply a 12 mm thick plaster as shown on the drawing or a protective brick wall in 1:6 cement mortar as shown on the drawing.

3.27.00 Protective Coating on Concrete Surface

3.27.01 On Foundation

The outside faces of foundation of important structures will be protected from adverse effect of soil/underground water, if shown on drawing by using rubber/bitumen emulsion protective coating of approved manufacturer.

4.00.00 SAMPLING AND TESTING

4.01.00 General

The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost unless otherwise specified in this specification. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.

4.02.00 Cement

Representative samples will be taken from each consignment of cement received from the manufacturer/supplier for carrying out the tests for fineness (by hand sieving), setting time and compressive strengths as per guidelines of IS: 269. Soundness Tests may also be required to be carried out if required by the Engineer. The Contractor shall carry out the tests without any expense to BHEL. No cement from a particular consignment/batch will be used on the works unless satisfactory 3 (three) days and 7 (seven) days test results for compressive strength are known. The Engineer and Contractor will jointly associate themselves with the tests irrespective of whether they are carried out by the BHEL or the Contractor. These tests are of great importance, as their results will have a bearing on the acceptance of concrete or otherwise as per the terms and conditions of the Contract.

4.03.00 Aggregates

The contractor shall carry out any or all the tests on aggregates as may be required by the Engineer in accordance with IS: 2386 PARTS-I to VIII. The acceptance criteria of the samples tested shall be in accordance with the requirements of the relevant Indian Standards.

4.04.00 Water

Sampling and Testing of water being used for concrete works as per IS: 3550 will be carried out by the Contractor at regular intervals and whenever directed by the Engineer. The acceptance criteria will be as per IS: 456.

4.05.00 Admixture

4.05.01 Air Entraining Agents

Initially, before starting to use A.E.A., relationship between the percentage of air entrained and the cylinder cube crushing strength vis-a-vis quantity of A.E.A. used for all types of concrete will be established by the Contractor by carrying out sufficiently large number of tests. After that, at regular intervals and whenever directed by the Engineer, the Contractor will check up

the actual percentages of air entrained and corresponding crushing strengths to correlate with the earlier test results.

4.05.02 Other Admixtures

Tests for establishing the various properties of any other admixtures, which may be required to be added, shall be carried out by the Contractor.

4.06.00 Concrete

The sampling of concrete, making the test specimens, curing and testing procedure etc. shall be in accordance with IS: 516 and IS: 1199, the size of specimen being 15 cm cubes. Normally, only compression tests shall be performed but under special circumstances the Engineer may require other tests to be performed in accordance with IS: 516. Sampling procedure, frequency of sampling and test specimen shall conform to IS: 456. To control the consistency of concrete from every mixing plant, slump tests shall be carried out by the Contractor every two hours or as directed by the Engineer. Slumps corresponding to the test specimens shall be recorded for reference. The acceptance criteria of concrete shall be in accordance with IS: 456. Concrete work found unsuitable for acceptance shall have to be dismantled and replacement is to be done as per specification by the Contractor at his own cost. In the course of dismantling, if any damage is done to the embedded items or adjacent structures, the same shall be made good, free of charge by the Contractor, to the satisfaction of the Engineer.

5.00.00 ACCEPTANCE CRITERIA

5.01.00 Standard Deviation

Standard deviation shall be based on test results and determination of Standard deviation shall conform to IS: 456.

5.02.00 Acceptance Criteria

The strength requirements and acceptance criteria shall conform to IS: 456.

5.03.00 Inspection and Core Tests

Inspection of concrete work immediately after stripping the formwork and core test of structures shall conform to IS: 456.

5.04.00 Load Test

Load tests of structural members as per IS: 456 may be required by the Engineer, when the strength of test specimen results falls below the required strength. If the member shows evident failure, the Contractor shall make the structure adequately strong free of cost to BHEL.

The entire cost of load testing shall be borne by the Contractor. If a portion of the structure is found to be unacceptable, it shall be dismantled and replaced by a new structure as per specification. The entire cost of dismantling and replacement and restoration of the site being borne by the Contractor.

If, in the course of dismantling, any damage is done to the embedded items and or other adjacent

structures, the same will be made good, free of charge by the Contractor to the satisfaction of the Engineer.

6.00.00 RATES AND MEASUREMENTS

6.01.00 Cast-in-situ Concrete

6.01.01 Rates

- a) The unit rates shall include the cost of labour, materials, equipment, handling, transporting, botching, mixing, placing in position, vibrating, compacting, finishing, curing, testing, etc. at all elevations. This shall also include the cost of using curing compound, whenever used.
- b) The unit rates shall include for all working conditions including in or under water, liquid, mud, in or under foul positions, under tides, and extreme weather conditions.
- c) The unit rates for exposed concrete works (including machine foundations) shall include all incidentals, rendering, smoothening with carborandum stone, finishing with a paste of cement sand mortar, curing, etc.
- d) The unit rates shall include for maintaining stability of structure during execution.
- e) Nothing extra shall be payable for the handling/mixing of extra cement on account of any reason or pouring of second stage concrete.
- f) Nothing shall be payable to the Contractor on account of facilities and arrangement provided by him for conducting ultrasonic pulse velocity tests or other relevant tests to ascertain grade and quality, etc. of the concrete, if required. In case of any defects, the Contractor shall rectify the same by cement/epoxy grout at his own cost.
- g) The unit rates for controlling of the temperature of concrete shall include storing and mixing of ice, water, cooling of aggregate etc.
- h) The quoted rate shall include the cost of making additional trial mixes, using the superplasticizer and mixing in concrete etc.

6.01.02 Measurements

- a) Actual volume of concrete work as executed or as per drawings issued, whichever is less shall be measured in cubic metres.

- b) No deductions shall be made for the following:
 - i) Opening upto 0.1 sq.m.
 - ii) Volume occupied by reinforcement, sleeves, anchor bolts, and similar items.
 - iii) Volume occupied by pipes, conduits, sheathing, etc. not exceeding 100 sq.cm. each in cross sectional area.
- c) The concrete works of different grades; below and above ground floor finished level shall be measured separately, unless otherwise specified in the schedule of items. Accordingly rates shall be applied for concrete in foundation for concrete below ground floor finished level and concrete in superstructure for concrete above ground floor finished level.
- d) For temperature control measures, measurement shall be done in terms of quantity of concrete in cum. in concreting of which the ice have been used or cooling of aggregates has been done to keep the temperature of freshly laid concrete to less than 25⁰C.

6.02.00 Reinforcement

6.02.01 Rates

- a) The unit rates shall include for cover block, providing binding wire, welding, separator pieces between two or more layers of reinforcement required for keeping the steel in position, etc. at all elevations.
- b) No extra will be paid for transportation from stores, cleaning, straightening of steel, cutting, bending, binding with annealed wire, welding, tack welding, placing the reinforcement modification of already embedded reinforcement, if required, due to faulty fabrication or placement and other cost of tools and plants, materials, labours, return of unused steel to the store, etc.
- c) No extra shall be paid for preparing and getting approved bar bending schedules (including all revisions).
- d) Generally members are straight and have straight edges. However, for bending, binding, placing of reinforcement in any curved member in length or cross section or both, no extra payment shall be made.

6.02.02 Measurements

- a) Bar or any other type of reinforcement used like hard drawn steel wire fabric etc. for reinforced concrete shall be measured by weight in tonnes. The weight shall be arrived at by multiplying the actual or theoretical length measured along with standard hooks, cranks, bends, authorized laps, etc. whichever is less by the sectional weights. Claims for payment for this item shall be submitted with supporting documents giving the schedule of bars with sketches. The sectional weight to be adopted shall be IS Section weight. Nothing extra will be payable to the Contractor on account of, difference in weight, if any, due to different methods adopted for issue and measurement.
- b) Standard hooks, cranks, bends, authorised laps, supports, hangers and chairs which are covered in approved bar bending schedule shall be measured in tonnes.

6.03.00 Formwork and Staging

6.03.01 Rates

- a) The unit rates shall be inclusive of all staging, scaffolding, making the formwork watertight, etc. for all elevations and in all types of works.
- b) No separate payment shall be made for providing fillets, for rounding or chamfering at junctions, comers, etc.
- c) The unit rates shall include the cost of labour, materials etc. and the extra time, which shall be required for the removal of shuttering/ support for satisfactory completion of work.

- d) No extra payment shall be made on account of difficulty, wastage etc. for placement/removal of formwork between the network of closely placed steel beams or for the lacing/bracing portions and ribbed slab constructions.
- e) Payment for curved shuttering shall be made for curved members/wall whose centerline radius in plan is less than 6m.
- f) If the contact surface area in pockets is less than or equal to 0.1 sq.m. in each case, payment shall be done under item for providing formwork in pockets.

6.03.02 Measurements

- a) Formwork for different classes (types) shall be measured separately as the actual surface in contact with the concrete and paid on area basis unless included in the rate for concrete. The unit of measurement shall be in sq.m.
- b) Openings upto 0.1 sq.m or boxing left for inserts etc. for facility of Contractor's work, shall be neglected as if nonexistent for the purpose of formwork measurement of surface in which the openings occur.

For suspended floor, no deduction shall be made for flange area of secondary steel beams.

- c) No measurement shall be taken for the formwork in pockets, openings, chases, blockouts, etc. in concrete, the contact surface area is less than or equal to 0.1 sq.m. in each case.
- d) For pockets, if the contact surface area is less than or equal to 0.1 sq.m. in each case, measurement shall be done under item for providing formwork in pockets.
- e) Formwork, if required, for joints shown on drawing or instructed by the Engineer, shall be paid for the 'leading side' only.

6.04.00 Embedded Parts

6.04.01 Rates

- a) The unit rate for erection of embedded steel parts, supplied by Engineer shall include transportation from Owner's store to the place of work, erection & installation including setting material in concrete, etc. complete.
- b) The unit rate for MS pipe embedments and PVC pipe embedments shall include cutting, welding, fabrication, erection, embedding, and transportation to site. Unit rate shall also include the cost of the pipes.
- c) Rate for expansion fasteners shall include cost of fasteners, installation, and fixing including cost of washers and nuts.

6.04.02 Measurements

- a) The measurement of the embedded steel parts fabricated and installed by the Contractor shall be based on the calculated weight of steel sections in tonne corrected to second place of decimal.
- b) Embedded steel parts supplied by Owner and installed by Contractor Measurement shall be done for the net weight of the embedments installed in tonnes correct to second place of decimal.
- c) For PVC pipes/conduits, measurements shall be in quintals correct to second place of decimal for the net weight.
- d) For mild steel pipes, measurement shall be in quintals, correct to second place of decimal, for the net weight of the steel pipe supplied, fabricated, and installed.
- e) The lugs shall be measured in Kg. correct to second place decimal for the net weight.
- f) The expansion fasteners shall be measured in number according to tension capacity.
- g) The rails shall not be treated as embedded steel part and the track shall be measured in running metres along the centre line and paid for under separate item of work as specified in schedule of items. Other related civil items associated with the laying of track shall be measured separately and paid under respective items of works.

6.05.00 Groutings

6.05.01 Rates

Rate shall include the cost of surface preparation, admixtures, and curing.

6.05.02 Measurements:

- a) Measurement shall be in cubic decimeters.
- b) Measurement for grouting shall be by volume of the block out, pockets or bolt hole upto the top surface of foundation concrete and shall be calculated from the dimensions shown on the drawings.
- c) Measurement for underpinning shall be by volume between the top surface of the foundation concrete and the underside of the base plate, the plan dimensions being as indicated on the drawings.
- d) No deduction shall be made for shims, bolts, shear keys and such other embedments.

6.06.00 Joints

6.06.01 Rates

The unit rate shall include all the activities described in the schedule of items.

6.06.02 Measurements

- a) Bitumen Board/Expanded polystyrene.

The measurement for bitumen board shall be based on actual finished surface area in square meters nearest to second decimal, for the specified thickness.

- b) Water Stops

The measurement for water stops shall be in running metres of actual length of the joint covered, for specified thickness, width, and shapes. No separate measurement shall be made for laps/splices for cross-joints and mitered joints.

- c) Metal Cover Strips

The measurement for Metal Cover Strips shall be based on actual finished surface area in square metres for the specified thickness.

- d) Vibration Damping Resilient Pads

The measurement for this item shall be in square metres for the specified thickness, measured correct to the second place of decimal, of the actual finished surface area.

6.07.00 Dismantling/Demolishing Work – RCC and PCC and Chipping of Concrete

6.07.01 Rates

The unit rates shall include the cost of all necessary propping, shoring, underpinning scaffolding, safety measures, temporary enclosures, disposal/ stacking of serviceable/unserviceable materials, etc. for all types of work and for all grades of concrete.

In the case of dismantling/demolishing work, the cutting of reinforcement shall also be included in the rate.

In the case of chipping work, the cutting of reinforcement shall be paid separately.

6.07.02 Measurements

- a) Dismantling of PCC and RCC work shall be measured in cu.m separately. Measurement of all work, except hidden work shall be taken before execution of work and no allowance for increase in bulk shall be allowed. Specifications for deductions of voids, openings etc, shall be on the same basis as that employed for construction work.
- b) Chipping of concrete, making holes/pockets etc. shall be measured in cubic decimeters (i.e. 0.001 cu.m.).
- c) Cutting of reinforcement in chipping work for making of pockets and openings shall be measured in sq. cm. of cross-sectional area.

6.08.00 Precast Concrete

This clause shall be read in conjunction with relevant provisions specified elsewhere for cast in-situ Concrete.

6.08.01 Rates

- a) The unit rate shall include cost of preparation of casting yard, formwork, concrete and its casting, finishing as specified, setting filling of gaps between adjacent pre-cast concrete units with concrete, or cement mortar, curing, handling, erection, grouting, welding, preparation of supporting surface, etc.

6.08.02 Measurements

The measurement of pre-cast concrete members shall be on the basis of volume of concrete in cubic metres nearest to second place of decimal. No deduction shall be made for volume occupied by reinforcement/inserts/sleeves and for openings up to 0.1 sq.m. The setting of element with cement mortar shall not be measured separately The filling of concrete cement

mortar between the gaps of adjacent precast units shall be considered while computing the volume of pre-cast concrete work and shall be paid for under this item itself.

7.00.00 LIST OF IS CODES AND STANDARDS FOR REFERENCE

All work under this specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not specifically covered by Indian standard Specifications, any other standard practice, as may be specified by the Engineer, shall be followed:-

IS: 73 -	Indian Standard Specification for Paving Bitumen
IS: 216 -	Indian Standard Specification for Coal Tar Pitch
IS: 383 -	Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete
IS: 432 -	Indian Standard Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for concrete Reinforcement
IS: 455 -	Indian Standard Specification for Slag Cement
IS: 456 -	Indian Standard Code of Practice for Plain and Reinforced Concrete
IS: 457 -	Indian Standard Code of Practice for General Construction of Plain and Reinforced Concrete for Dams and other Massive Structures
IS: 516 -	Indian Standard Specification for Methods of Test for Strength of Concrete
IS: 702 -	Indian Standard specification for industrial bitumen.
IS: 1199 -	Indian Standard Specification for Methods of Sampling and Analysis of Concrete
IS: 1322 -	Indian Standard Specification for Bitumen Felts for Waterproofing and Damp-proofing
IS: 1489 -	Indian Standard Specification for Portland Pozzolona Cement
IS: 1566 -	Indian Standard Specification for hard drawn steel wire fabric for concrete reinforcement.
IS: 1609 -	Code of Practice for Laying Damp-proof Treatment using Bitumen Felts

IS: 1786 -	Indian Standard Specification for High Strength Deformed Steel Bars and Wires for Concrete Reinforcement.
IS: 1791 -	Indian Standard Specification for Batch Type Concrete Mixers.
IS: 1838 -	Indian Standard Specification for preformed fillers for expansion joints in concrete pavements and structures (non-extruding and resilient type.
IS: 2185 -	Indian Standard Specification for Hollow Cement Concrete Blocks
IS: 2210 -	Indian Standard Specification for Design of Reinforced Concrete shell Structures and Folded Plates
IS: 2386 -	Indian Standard Specification for Methods of Test for Aggregates for Concrete - Part-I to VIII
IS: 2502 -	Indian Standard Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement
IS: 2505 -	Indian Standard Specification for Concrete Vibrators, Immersion Type
IS: 2506 -	Indian Standard Specification for Screed Board Concrete Vibrators
IS: 2514 -	Indian Standard Specification for Concrete Vibrating Tables
IS: 2571 -	Code of practice for laying in-situ cement concrete floors.
IS: 2645 -	Integral cement water proofing compound
IS: 2722 -	Indian Standard Specification for Portable Swing Weigh Batchers for Concrete (Single and Double Bucket type)
IS: 2750 -	Indian Standard Specification for steel scaffoldings.
IS: 2751 -	Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction
IS: 2770 -	Indian Standard Specification for Method of Testing Bond in Reinforced Concrete
IS: 3025 -	Indian Standard specification for Methods of Sampling and Test (Physical and Chemical) for Water used in Industry
IS: 3067 -	Code of practice for general design details and preparatory work for damp proofing and water proofing of building.
IS: 3201 -	Indian Standard Specification for Design and Construction of Precast Concrete Trusses

IS: 3370 -	Indian Standard Specification for Code of Practice for Concrete Structures for Storage of Liquids
IS: 3414 -	Code of practice for design and installation of joints in buildings.
IS: 3550 -	Indian Standard Specification for Method of Test for Routine Control for Water used in Industry
IS: 3558 -	Code of Practice for use of Immersion vibrators for Consolidating Concrete
IS: 3696 -	Safety Code for Scaffolding and Ladders
IS: 3812 -	Indian Standard Specification for Fly Ash for Use as Admixture for Concrete
IS: 4014 -	Code of practice for steel tubular scaffolding.
IS: 4031 -	Indian Standard Specification for Method of Tests for Hydraulic Cement
IS: 4082 -	Indian Standard Specification for Recommendation on Stacking and Storage of Construction Materials at site
IS: 4090 -	Indian Standard Specification for Design of Reinforced Concrete Arches
IS: 4634 -	Indian Standard Specification for Method of Testing Performance of Batch-type Concrete Mixes
IS: 4656 -	Indian Standard Specification for Form Vibrators for Concrete
IS: 4925 -	Indian Standard Specification for Concrete Batching and Mixing Plant
IS: 4926 -	Indian Standard Specification for Ready Mixed Concrete
IS: 4990 -	Indian Standard Specification for Plywood for Concrete Shuttering work
IS: 4991 -	Indian Standard Specification for Blast Resistant Design of structure for Explosion above ground
IS: 4995 -	Indian Standard Specification for Design of Reinforced Part-I & II Reinforced Concrete Bins for the Storage of Granular and Powdery Materials
IS: 4998 -	Indian Standard Specification for Design of Reinforced Concrete Chimneys.
IS: 5256 -	Code of practice for sealing joints in concrete lining on canals.
IS: 5512 -	Indian Standard Specification for Flow Table for use in Tests of Cement

and Pozzolanic materials

IS: 5513 - Indian Standard Specification for vacate Apparatus.

IS: 5515 - Indian Standard Specification for Compaction Factor Apparatus.

IS: 5525 - Recommendation for detailing of reinforcement in reinforced concrete works.

IS: 5624 - Indian Standard Specification for foundation bolts.

IS: 5751 - Indian Standard Specification for Precast Concrete Coping Blocks.

IS: 5816 - Indian Standard Specification for Method of Test for Splitting Tensile strength of Concrete Cylinders.

IS: 5891 - Indian Standard Specification for Hand operated Concrete Mixers.

IS: 5892 - Indian Standard Specification for transit mixer and agitators.

IS: 6452 - Indian Standard Specification for High Alumina Cement for Structural Use

IS: 6909 - Indian Standard Specification for Super sulphated Cement

IS: 6923 - Indian Standard Specification for Method of Test for Performance of Screed Board Concrete Vibrators.

IS: 6925 - Indian Standard Specification for Method of Test for Determination of Water Soluble Chloride in Concrete Admixtures.

IS: 7242 - Indian Standard Specification for Concrete Spreaders.

IS: 7246 - Indian Standard Specification for Table Vibrators for Consolidating Concrete.

IS: 7251 - Indian Standard Specification for Concrete Finishers.

IS: 7293 - Safety code for working with construction machinery.

IS: 7320 - Indian Standard Specification for Concrete Slump Test Apparatus.

IS: 7861 - Indian Standard Specification for Recommended Practice Part-I&II for Extreme Weather Concreting.

IS: 7969 - Safety Code for Storage and Handling of Building Materials.

IS: 8041 - Indian Standard Specification for Rapid Hardening Portland cement.

IS: 8112 - Indian Standard Specification for high strength Ordinary Portland Cement.

- IS: 8142 - Indian Standard Specification for Determining Setting time of concrete by Penetration Resistance.
- IS: 8989 - Safety Code for Erection of Concrete Framed Structures.
- IS: 9012 - Recommended method for shotcreting.
- IS: 9013 - Indian Standard Specification for Method of Making, Curing, and determining compressive Strength of Accelerated-cured Concrete Test Specimens.
- IS: 9077 - Code of Practice for Corrosion Protection of Steel Reinforcement in RB and RCC Construction.
- IS: 9103 - Indian Standard Specification for Admixtures for Concrete.
- IS: 10262 - Recommended Guidelines for Concrete Mix Design.
- IS: 13311 - Non-destructive testing of concrete.
- SP: 34 - Handbook of concrete, reinforcement and detailing.

SUB-SECTION – D3

CARPENTRY AND JOINERY

C O N T E N T

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODES
5.00.00	RATES AND MEASUREMENTS

CARPENTRY AND JOINERY

1.00.00 SCOPE

This section covers supply, fitting and fixing of timber frames to doors and windows with M S holdfasts, flush doors, windows, shutters, partitions, wall panelling, pelmets, shelves, furniture, etc. as shown in drawings, including a prime coat of approved paint, varnish, or fixing of decorative plastic laminate where called for. This shall also include the supply and fixing of all hardware and fixtures shown in drawing or specified.

2.00.00 INSTALLATION

2.00.01 Materials

a) Timber

Unless otherwise specified, all timber shall be best quality well seasoned CP teakwood free from large or loose knots, cracks or any other defects. All timber shall be treated with approved wood preservative before use, unless specified otherwise. The rough timber shall be approved by the Engineer before incorporating in the works and starting the carpenter's work.

b) Plywood

Plywood shall be of commercial quality or with decorative surface veneer. Unless specifically permitted otherwise, the adhesive used in plywood shall be phenol formaldehyde synthetic resin of BWP grade conforming to IS: 848.

c) Decorative Laminated Plastic Sheets

The colour, pattern, finish and texture shall be approved by the Engineer. The bulk supply shall be procured in full sheet sizes which will ensure the least number of joints in one surface.

d) Flush Doors

Flush doors shall be solid core doors with commercial or decorative faces and hardwood edges conforming to IS: 2202 (Part-1). The core for solid core doors shall be of block board or wood particle board. Manufacturer's literature and test certificates shall be submitted for the approval of the Engineer. The Contractor shall give a guarantee that the adhesive used is BWP grade phenol formaldehyde synthetic resin conforming to IS: 848. The thickness shall be as specified.

e) Panel Doors

Panel door shall be of teakwood shutter frame, unless otherwise noted and panels with teakwood/commercial ply/teakwood particle board. Other considerations shall be as mentioned in item (d) above.

f) Windows, Ventilators

Windows and ventilators shall be made of teakwood shutter frame, unless specified otherwise and glazing of specified thickness shall be fixed with wooden beadings.

g) Fixtures

Fixtures for doors, windows, furniture etc. shall be as shown on drawing or specified.

2.02.00 Workmanship

2.02.01 General

The work shall be done by skilled carpenters as per details shown on drawing or instructed by the Engineer.

Framing timber and other work shall be close - fitting with proper wood joinery, accurately set to required lines or levels and rigidly secured in place. The surface of frames etc., which will come in contact with masonry after fixing, shall be given two coats of approved paint before fixing. Mastic caulking shall be done after fixing external door and window frames. Special care shall be taken to match the grain of timber or plywood, which will be subsequently polished. Screwing or nailing will not be permitted to the edge of plywood and particle board. The edge of all plywood, blackboard and particle board shall be finished with teakwood lipping unless otherwise shown on drawings.

Fixing to frames and partitions shall generally be with 40 mm x 6 mm x 300 mm long M S holdfasts bifurcated at end and grouted with 1:2:4 cement concrete. The gap between masonry and external door and window frame shall be caulked with polysulphide mastic. M.S. grills or guard bars shall be provided to windows where called for in the drawings.

2.02.02 Finish

All carpentry work after finishing shall be sand papered smooth. A prime coat paint shall be given after inspection of the Engineer to all surfaces other than those, which shall be subsequently polished or covered with laminated plastic sheet.

2.02.03 Surface Treatment

When shown on drawings or called for, decorative ply or laminated plastic sheets shall be bonded under pressure to the surface to be finished. The adhesive used shall be of brand and brought to site in sealed containers. The rate of application and the length of time for which the pressure is to be applied shall be as per the manufacturer's instructions. The edge of sheets shall be protected by teak lipping or bevelled as shown on drawings.

3.00.00 ACCEPTANCE CRITERIA

3.00.01 Door and Window Frames

All frames shall be square and flat at the time of delivery and shall be checked for dimensions and corner angles. After fixing they shall be on a fine vertical plane. All external door and window frames shall be caulked with mastic.

3.02.00 Door and Window Shutters

All doors and window shutters shall be of proper size, shape, and design and free of warp. When fixed to frames, these shall operate smoothly without jamming and all latching or locking devices shall engage properly without undue pressure.

3.03.00 Partitions, Paneling, Pelmet, Furniture, etc.

3.03.01 General

These shall conform to drawings in all details. No unsightly nail marks etc. shall be permitted. Plywood grains shall be matched to give a uniform and pleasing appearance.

3.03.02 Partition

Shall be checked for rigidity of fixing, plumb and horizontal as well as vertical alignment.

3.03.03 Pelmet

Shall be checked for rigidity of fixing and adequate clearance of fixture.

3.03.04 Cupboard Shutters

Shall operate smoothly without jamming and locks, bolts and double ball catches shall engage securely. Single ball catches shall not be used.

3.03.05 Drawers

Shall operate smoothly and have backstops to prevent them from being pushed too far. Locks shall engage securely.

3.03.06 Loose Furniture

When placed on a level surface, tables tops etc. shall be horizontal and the pieces stand stably on legs or supports.

4.00.00 IS CODES

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 848	-	Synthetic resin adhesives for plywood (Phenolic and Aminoplastic)
IS: 1003	-	Timber panelled and glazed shutters.
IS: 2191	-	Wooden flush door shutter (Cellular and hollow core type).
IS: 2202	-	Wooden flush door shutters (solid core type).
IS: 4021	-	Timber door, window, and ventilator frames.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall include of all activities mentioned in “Schedule of Item” for completion of the work. No separate payment shall be made for fixing, caulking, application of primer coat, polishing, providing of butt hinges, holdfasts, sliding/tower bolts, door stoppers, door closers and other fittings and fixtures.

5.02.00 Measurement

Measurement shall be done in Sqm for doors, windows, ventilators, shutters, partitions etc.

Measurement for wooden frame shall be in CuM.

Pelmets shall be measured in RM.

SUB-SECTION – D4

ROOF AND UNDERGROUND STRUCTURES WATER PROOFING, INSULATION AND ALLIED WORKS

C O N T E N T

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA AND GUARANTEE
4.00.00	I.S. CODES AND STANDARDS
5.00.00	RATES AND MEASUREMENTS

**ROOF AND UNDERGROUND WATER PROOFING, INSULATION AND
ALLIED WORKS**

1.00.00 SCOPE

This section covers furnishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of roof and underground water-proofing, insulation and allied works for buildings and at locations covered under the scope of this package.

2.00.00 INSTALLATION

2.01.00 Grading Underbed

The surface to receive the underbed shall be roughened and thoroughly cleaned with wire brush and water. Oil patches if any shall be removed with detergent. The surface shall be soaked with water and all excess water removed just before laying of the underbed.

The underbed shall not be laid under direct hot sun and shall be kept in shade immediately after laying so as to avoid quick loss of water from the mix and separation from the roof surface. The underbed shall be cured under water for at least 7 days.

The underbed shall be laid to provide an ultimate run off gradient not less than 1 in 120 and as directed by the Engineer. Upto an average thickness of 25mm the underbed shall usually be composed of cement and sand plaster. For higher thickness the underbed shall be made with cement concrete. The underbed shall be finished to receive the waterproofing treatment direct or insulation as the case may be.

2.01.01 Plaster

The grading plaster shall be average 25 mm thick maximum. It shall consist of cement and coarse sand in the ratio 1:4 nominal by volume. The sand and cement shall be thoroughly mixed dry and then water added. Each batch of mix shall be consumed before the initial set starts.

The plaster shall be fully compacted to the desired grade in continuous operation. The surface shall be even and reasonably smooth.

2.01.02 Concrete

The concrete shall be used where the subgrade is more than average 25 mm thick. It shall consist of cement concrete 1:2:4 nominal mix by volume with 12 mm down stone chips and coarse sand. The aggregate shall be mixed dry and minimum quantity of water shall be added to make the mix workable.

The mix shall be laid to proper grade, fully consolidated and surface shall be smooth and even.

2.02.00 Insulation

The Tendered shall along with the tender send specifications of insulating materials he proposes to use and the proposed method of laying. Before bulk supply, the contractor shall send samples of insulating material to the Engineer, and after approval of the samples, the Contractor shall procure and transport the bulk material to the site. Whenever asked by the Engineer, the Contractor shall furnish test certificates from testing laboratory on the insulating and other properties of the materials.

After laying the insulation the surface shall be made ready as required to receive the waterproofing treatment. If any plastering is used it shall be not leaner than 1:4 cement sand by volume and not thinner than 12 mm and it shall be cured for seven days.

2.02.01 Foam Concrete

This shall be of lightweight foam concrete of average 50 mm thickness or as specified or as shown on drawings. This may be laid in situ in suitable panels or precast blocks. The insulating properties shall be such that the thermal conductivity shall not exceed 0.125 Kcl/sq.m. h degree C. Before starting the laying of foam concrete samples shall be prepared at site and got tested for approval of the Engineer.

The foam concrete laid shall be sufficiently strong to make the usual workload and standard loads expected on the roof. Any damaged portion shall be removed and replaced forthwith. Approval of the Engineer shall be taken before laying the waterproofing over the insulation.

While laying the foam concrete, samples from each batch of the mix shall be kept for test if so desired by the Engineer.

2.02.02 Expanded Polystyrene Blocks

The expanded polystyrene block Insulation shall be fire retardant quality and shall have a maximum thermal conductivity of 0.026 Kcl m/sq.m h °C. It must be strong enough to withstand without any deformation under the workload and standard loads expected on the roof.

The Contractor shall lay the expanded polystyrene block as per manufacturer's approved specification. Only specifically experienced workers shall be used for this work. If the Engineer is not satisfied about the efficiency of the workers the Contractor shall secure manufacturers supervision at no extra cost to the Owner.

2.03.00 Fillets

Fillets at Junction of roofs and vertical walls shall be provided with the same insulating material as provided for the main roof insulation. The fillets shall be 150 mm x 150 mm in size unless otherwise shown on drawings or instructed by the Engineer.

Where there is no insulation over roof slab, fillets shall be cast-in-situ cement concrete (1:2:4) nominal mix volume.

2.04.00 Waterproofing

Waterproofing treatment shall be laid by a specialist firm with long experience in the particular trade.

2.04.01 Water proofing with bitumen felt

The waterproofing treatment for roofs with bitumen felts shall be done following relevant IS: 1346. Bitumen felt shall conform to IS: 1322 and Bitumen primer to IS: 3384.

The bonding materials shall consist of blown type conforming to IS: 702 or residual bitumen to IS: 73 or a mixture of the two to withstand local conditions of prevailing temperature or gradient of roof surface. The Contractor shall convince the Engineer that the bonding material proposed

to be used is suitable for the particular job.

The Contractor shall state the source from where he proposed to procure the materials. Samples of the self-finished felt shall be submitted in advance to the Engineer along with test certificates for his review. Test certificates for the bonding materials shall also be submitted and samples, if desired by the Engineer, shall be provided for confirmatory tests. Samples shall be submitted if instructed by the Engineer.

Minimum overlaps of 100 and 75 mm shall be given at the end and sides of strips of felt and properly bonded with bitumen. Joints in successive layers of felt shall be staggered.

Normal treatment with one layer of felt, heavy treatment with two layers of felt or Extra Heavy treatment with three layers of felt shall be indicated. Brief details of the various treatments shall be as follows:

a) Normal Treatment - Five courses

- 1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.
- 2) Hot applied bitumen at the rate of 1.2 kg/sq.m. (min.)
- 3) Hessian base self finished felt, type 3, grade 1.
- 4) Hot applied bitumen at the rate of 1.2 kg/sq.m. (min.)
- 5) 20 mm thick pressed precast concrete tiles with 15 mm, thick 1:4 cement-sand mortar underbed.

b) Heavy Treatment - Seven Courses

With Hessian base felt

- 1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.
- 2) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 3) Hessian base self-finished felt, type 3, grade 1.
- 4) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 5) Hessian base self-finished felt, type 3, grade I.
- 6) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 7) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

or

With fiber base felt

- 1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.
- 2) Not applied bitumen at the rate of 1.2 kg/sq.m (Min.)

- 3) Fiber base self-finished felt, type 2, grade 2.
- 4) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 5) Fiber base self-finished felt, type 2, grade 2.
- 6) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 7) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

c) Extra Heavy Treatment – Nine courses

With fiber based felt

- 1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.
- 2) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)
- 3) Fiber-base self-finished felt type 2, grade 1.
- 4) Hot applied bitumen at the rate of 1.2 kg/sq.m (min.)
- 5) Fibre base self-finished felt type 2, grade 1.
- 6) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)
- 7) Fibre base self-finished felt type 2, grade 1.
- 8) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)
- 9) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

or

With Hessian base felt

- 1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.
- 2) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)
- 3) Hessian base self-finished felt, type 3, grade 1.
- 4) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)
- 5) Hessian base self-finished felt, type 3, grade 1.
- 6) Hot applied bitumen at the rate of 1.2 kg/sqm. min.
- 7) Hessian base self-finished felt, type 3, grade 1.

8) Hot applied bitumen at the rate of 1.2 kg/sqm. min.

9) 20 mm thick pressed precast concrete tiles with 15 thick 1:4 cement: sand mortar underbed.

However, in special cases, more courses, or a combination of fibre base and hessian base felts may be asked for.

The surface to receive the waterproofing treatment must be cleaned and dried satisfactorily and the Engineer's approval taken before starting the work. If any existing waterproofing treatment is being augmented the existing top course shall be completely removed and all damaged felts or other defects repaired.

The Engineer may instruct the Contractor to lay part of the stipulated courses at the first instant to be followed later on with the balance courses. This interim finish shall be done with a course of hot applied bitumen. While doing the balance again hot bitumen shall be applied to start with after repair of all damages to the already laid course.

After completion the surface shall be cleaned taking care that felt cuttings etc. do not find their way into rainwater down comers.

2.05.02 Elastomeric Membrane

a) Material

The material shall consist of high solid content Polyurethane based cold liquid applied coatings as per ASTM C836 & C898 comprising of urethane pre-polymers extended with flexible material, which cure by reaction with atmospheric moisture to give a continuous film which is rubbery and elastic or any other equivalent material permitted as per ASTM and approved by the Engineer. The material shall consist of high solid coating designed to give a high-build film. The material shall not be diluted. The coating shall have physical feature like high viscosity, 90% solids, high resistance to impact, abrasion and cracking, superior tensile strength, application limit of 70°C minimum, 300% elongation and forming a perfectly smooth permanently flexible seamless membrane which should have good adhesion to roof substrates (RCC, tiles, brick, and metals), having a minimum life of 10 years. It should also be resistant to acid (mild concentrated), alkalies and have a very low water absorption rate (0.5%) max. at ambient temp. after 7 days.

The pack shall not be older than 9 months after the date of manufacture and packing.

b) Primer coat

It shall consists of polyurethane (P.U.) or any other equivalent material. Primer coat shall be a special blend of moisture curing urethane pre-polymers in solvent. A single coat of this primer shall be applied by brush over the prepared bed as an adhesion coat of an application rate of minimum 6 sq.m per litre.

The primer shall be allowed to dry for minimum of 2hrs. time before the successive finishing coats of P.U. liquid membrane are applied.

c) Finishing coats :

The finishing coats shall consist of two successive liquid coatings of high solids content urethane pre-polymers or equivalent material to form an elastomeric membrane. The overall dry film thickness shall be 1.5mm subject to minimum 500 gm per sq.m per coat application rate.

Each coat shall be allowed to dry for minimum 12 hours before applying the next coat. The surface should be dry and smooth before application.

The coating shall be continued up the parapets/walls for a minimum of 150mm over the finished roof surface. It shall be continued into rain water pipes by atleast 100mm.

The final coat of P.U. liquid when tacky shall be sprinkled with the sand.

For edges, expansion joints and any vulnerable points a later of polyscrim cloth /fabric to be embedded between 2 finishing coats.

d) Surface Finish :

Areas of roof treatment which are vulnerable to accidental damage shall be provided with wearing course consist of minimum 20 mm thick PCC of Grade M15 (using 12.5mm size aggregate) cast in panel of maximum size of 1.20m x 1.20m and reinforced with 0.56mm diameter galvanised chicken wire mesh and sealing of joints using sealant or elastomeric compound.

When the roof surface is subjected to foot traffic or used as a working area, a cement mortar (1:4) shall be applied over the top most layer of roofing treatment. Over this, a layer of chequered cement concrete flooring tiles conforming to IS:13801 and shall be provided in place of stone grit and cement painted. The tiles shall be laid as per IS:1443.

2.04.03 Waterproofing By Epoxy Resin Based Application

Exposed surfaces of cement concrete, lime concrete or brickwork to be treated for waterproofing by the resin-based application shall be thoroughly cleaned and the epoxy resin based material to be applied as directed by the manufacturer. The material shall not have any adverse effect on the surface on which it is applied and must stick to it uniformly to make a strong durable bond. It shall not be affected by short duration fire, sun exposure, and light duty traffic. The application shall be resistant to growth of fungus and proof against saltpetre action. If desired by the Engineer, a sample shall be prepared in advance and tested for waterproofness for 48 hours under 300 mm depth of standing water. The Contractor shall arrange the demonstration by providing free the materials and labour for the application as free of cost to Owner. This item shall carry a guarantee as specified.

2.04.04 Flashing

Unless otherwise stated flashing shall be done in the same way as the waterproofing except that the last layer shall be finished with two coats of bituminous primer. The flashing shall be extended up the vertical surfaces as shown on drawing. The flashing shall end in grooves in vertical walls. The grooves shall be at least 65 mm deep and caulked with waterproof mastic cement. The minimum overlap with horizontal roofing felt shall be 100 mm.

Where specified or directed by the Engineer, metal flashing shall be provided. The materials shall be 18 Gage or 22 G G.I. sheets, as specified or as directed by the Engineer.

2.05.00 WATER-PROOFING OF UNDERGROUND STRUCTURES

Basements, ducts, pits, tunnels etc below the ground water table and in contact with soil are covered under this. Bonding material shall be blown bitumen of 65/25 grade conforming to IS: 702.

Waterproofing shall be provided on the outside of walls and top of floors and shall be carried 150mm above ground level. The number of layers of bitumen felt to be used for walls and floor unless otherwise shown in the drawing shall be:

- a) For depths up to 5m below ground level 2 layers
- b) For depths beyond 5m below ground level 3 layers

2.05.01 Method of laying the bitumen felts and workmanship shall be as per IS: 1609 and IS: 3067. Water proofing work shall be taken in hand only when the sub-soil water level is at its lowest; the site shall be kept dry by adequate arrangements for pumping out water till the work has been completed.

For this purpose drains shall be formed along the edges of the excavation but beyond the building line, with suitable collecting sumps.

In case of large excavation areas where it is necessary to dewater under the floor, additional land drains shall be formed across the excavation, to adequately drain the area.

Adequate arrangement shall be made to protect the sides of excavation from slipping while the work is in progress.

The base concrete or mud-mat shall be rendered smooth by a 20mm thick sand-cement plaster (6:1). Any sharp edges/corners, over which the waterproofing course is to be laid, shall be eased out by means of cement.

The surface must be dry before the next operation is carried out.

Water proofing/damp proofing treatment:

- A) Heavy Treatment (Two layers of felt)
 - i) Primer (For vertical faces only), as per I.S. 3384.
 - ii) Hot applied blown bitumen at the rate of 1.2 Kg/m²
 - iii) Hessian base, bitumen felt type 3 grades 2

- iv) Hot applied blown bitumen @ 1.2 Kg/m²
- v) Hessian base, bitumen felt type 3 grade 2
- vi) Hot applied blown bitumen @ 1.2 Kg/m²
- B) Extra Heavy treatment (Three layers of felt)
 - i) Primer (for vertical faces only) as per I.S. 3384
 - ii) Hot applied bitumen at the rate of 1.2 Kg/m²
 - iii) Hessian base bitumen felt type 3 grades 2
 - iv) Hot applied bitumen at the rate 1.2 Kg/m²
 - v) Hessian base bitumen felt type 3 grades 2
 - vi) Hot applied bitumen at the rate of 1.2 Kg/m²
 - vii) Hessian base bitumen felt type 3 grades 2
 - viii) Hot applied bitumen at the rate of 1.2 Kg/m²

The surface must be dry before the next operation is carried out at each stage said above.

The laying of felt over the bitumen so applied, shall always commence on the floor, and shall be carried over to the walls only after treatment of the floor is complete. The minimum over lapping at sides and ends of strips shall be 10cm. Point for subsequent layers completely sealed by blow lamp.

A protective flooring of either brick flat in cement mortar (1:3) or 6cm thick cement concrete (M 15) or a coat of cement plaster (1:3) 4 cm thick shall be constructed over the bitumen layers to prevent damage to the latter during subsequent construction of the structural floor.

The walls shall be treated in a similar way; the bitumen felts joining at the base with the projecting felt laid over the mud-mat. The wall surface shall be made smooth where necessary with a coat of cement plaster (1:3), the felts laid as for the floor, ensuring that the surface to be treated is dry and then a protective brick wall, 12.5 cm nominal thickness shall be built in cement mortar (1:3) over the projecting mud-mat, the space between the wall and felt being grouted with cement.

3.00.00 ACCEPTANCE CRITERIA AND GUARANTEE

The surface level shall be such as to allow quick draining of rains without leaving any pool anywhere. The finishing course shall be fully secured and shall have an even density. There shall not be any bubble formation or crushed or squeezed insulation or underbed.

The contractor shall give a guarantee in writing for all works executed under this specification supplemented by a separate and unilateral guarantee from the specified agency for the roof waterproofing treatment work. The guarantee shall be for materials and workmanship for 5 years in case of normal treatment, 10 years for heavy treatment and 20 years for extra heavy treatment. The mode of execution of the guarantee shall be acceptable to the Owner.

4.00.00 I.S. CODES AND STANDARDS

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

- a) IS: 73 - Paving Bitumen
- b) IS: 702 - Industrial Bitumen
- c) IS: 1203 - Methods of testing tar and bitumen
- d) IS: 1322 - Bitumen felts for waterproofing and damp proofing.
- e) IS: 1346 - Code of practice for waterproofing of roofs with bitumen felts.
- f) IS: 3384 - Bitumen primer for use in waterproofing and damp proofing.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be for complete work, including the cost of all materials and labour, as detailed in the specification unless any portion is specifically excluded in the "Schedule of Items".

No extra shall be paid for finishing around opening, sleeves, pipes, ducts, inserts, etc.

No separate payments shall be made for cleaning of surface, treating of cracks and surface preparation.

5.02.00 Measurement

The finished work shall be measured in Sqm of actual surface area for the purpose of payment.

No deduction shall be made and no extra shall be paid for openings upto 0.4 sqm.

SUB-SECTION – D5

METAL DOORS, WINDOWS, VENTILATORS, LOUVERS ETC.

C O N T E N T

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	INFORMATION TO BE SUBMITTED
5.00.00	I.S. CODES
6.00.00	RATES AND MEASUREMENTS
ATTACHMENT	
ANNEXURE – A	SCHEDULE OF FIXTURES

METAL DOORS, WINDOWS, VENTILATORS, LOUVERS ETC.

1.00.00 SCOPE

This section covers supplying and/or erecting and installing of all metal doors, windows, ventilators, louvers, glazed partitions, etc. The scope of work shall also include the assembly and erection of all doors, windows, louvers, glazed partitions, etc. Supplying and/or fixing of all door and window accessories and hardware are also included in the scope.

2.00.00 INSTALLATION

2.01.00 Materials

Steel sections used for fabrication of doors, windows etc. shall be standard rolled steel sections specified in IS: 1038 and IS: 1361 or as specified.

Steel sheets for frames, shutters, louver blades etc. shall be of gauge mentioned in drawings and schedules.

Aluminium sections for fabricating doors, windows, partitions etc. shall be extruded sections conforming to IS:733 or IS:1285 or as manufactured by Indian Aluminium Company Limited or approved equivalent. Aluminium door, windows and ventilator shall be fabricated as per IS:1948 and IS:1949. The alloy used shall conform to IS Designation HE 9-WP of IS: 733.

Hardware and fixtures shall be as specified and the best quality from approved manufacturers shall only be used. The tenderer shall specifically state the particular manufacturer's materials he proposes to use. Improper alignment or faulty operation due to inadequate strength of hardware or fixture shall entirely be the Contractor's responsibility.

All hardware and fixtures shall be able to withstand repeated use. Door closures shall conform to IS: 3564 and shall be suitable for doors weighing 61-80 Kg. unless otherwise stated. Each closer shall be guaranteed against manufacturing defect for one year and any defect found within this period shall be rectified or shall be replaced free of charge. Concealed door closers shall be either floor mounted or transom mounted, suitable for installation with metal doors. It shall conform to the performance Requirements and endurance test stated in IS: 3564 - Appendix-A. The Contractor shall submit samples of each type of hardware to the Engineer. The approved samples shall be retained by the Engineer for comparison of bulk supply. The samples shall be returned to the Contractor towards end for incorporation in the job. The mastic for caulking shall be of best quality from a manufacturer approved by, the Engineer. In general, mastic for fixing of metals frames shall be as per IS: 1081 or as approved by the Engineer.

2.02.00 Fabrication

2.02.01 Steel Doors, Windows, Ventilators, louvers etc.

a) Door Frames

Frames shall be fabricated from 16 gage(G) sheets. They shall, be mortised, reinforced, drilled, and tapped for hinge lock and bolt strikes. Where necessary, frames shall be reinforced for door closers. Welded construction with mitered Corners shall be used. Rubber door silencers shall be furnished for the striking jamb. Loose "T" masonry anchors shall be provided. Frames shall finish flush with floor and adjustable floor

anchors shall be installed. Frames shall be brought to site with floor ties/weather bars installed in, place.

b) Double Plate Flush Door Shutters

Door shutters shall be 45 mm thick, completely flush design and shall comprise of the outer sheets or 18 G steel sheets, rigidly connected and reinforced inside with continuous vertical 20 G stiffeners, spot welded in position at not more than 150 mm on centres.

Both edges of doors shall be joined and reinforced full height by steel channels placed immediately inside and welded to the door faces. Top and bottom of doors shall be reinforced horizontally as shown on drawing by steel channels running full width of door. Doors shall not have more than 2.5 mm clearance at jambs and heads, shall have proper level on lock stiles and rails to operate without binding, and shall be reinforced at corners to prevent sagging or twisting. Pairs or double doors shall have meeting-stile edges bevelled or rebated. Where shown on drawing, or called for in the schedule of items, the doors shall be sound deadened by filling the inside voids with mineral wool or other suitable approved materials.

Doors shall be mortised, reinforced, drilled, and tapped in shop for hinges, locks, and bolts. They shall also be reinforced for closers, push-plates, and other surface hardware where necessary. Any drilling and tapping required for surface hardware shall be done at site. Where shown drawing, provision shall be made for fixing glazing, vision panels, louvers etc. glazing mouldings shall be of 18 G steel or extruded aluminium sections and suitable for fixing 6 mm. glass. Louvers blades shall be V or Z shaped and made out of 16 G sheets.

c) Single Sheet Door Shutters

Single sheet doors shall be made from best quality 18 G mild steel sheets, and shall present a flush surface on the outside. The inside shall be stiffened with semi tubular edge and central stiffening rail, which shall convey the lock and other fixture. The frames shall be made from best quality, 16 G mild steel sheets.

Wherever required, provisions for fixing glass panes, louvers etc. shall be made.

The manufacturing shall be done as specified in 2.02.01 (b) "Double Plate Flush Door Shutters."

d) Sliding Door

Sliding doors shall be either double plate or single plate Construction made out of 18 gauge steel sheets with adequate stiffeners. The contractor shall specify the weight of the door in his shop and submit the manufacturer's catalogue of the sliding gear he proposes to use. Where called for the Contractor shall make provision for openings to the door for monorail beams. Doors shall close positively to exclude rainwater from seeping in. When called for, sliding doors shall withstand specified wind loads without buckling or jamming. The door shall slide freely under all ambient conditions.

e) Door Threshold

Door threshold shall be provided. Doors without threshold shall have bottom tie of approved type.

f) Steel Windows, Sashes, and Ventilators etc.

These shall conform in all respects to IS: 1038 and IS: 1361 latest editions. The details as called for in the above codes shall be applicable for coupling mullions, transoms, weather bars, and pivot arrangements for ventilators, etc. or as called for. All welds shall be dressed flush on all exposed and contact surfaces. Where composite unit openings are required the individual window units shall be joined together with requisite transoms and mullions. All windows shall be outside glazed, fixed with putty or metal glazing beads as specified. Where aluminium glazing beads are specified, they shall be extruded aluminium channel 9.5 mm x 9.5 mm x 1.6 mm (Indal Section No. 2209) unless otherwise shown on drawings. Aluminium beads shall be given one coat of zinc chromate primer before fixing to windows.

2.02.02 Aluminium Door, Windows, and Frames

Extruded sections shall have a minimum 3 mm wall thickness. All sections shall be approved by the Engineer before fabrication is taken up. Doors frames, mullions, transom etc. shall be anodized in a bath of sulphuric acid to provide a clear coating of minimum 15 micron thickness. The anodized materials shall then be sealed by immersing in boiling water for 15 minutes. A protective transparent Coating shall be applied to the sections before shipment from the factory.

All work shall be fitted and shop assembled to a first class job, and ready for erection. Shop joints shall be made to hair lines and then welded or braced by such method as will produce an

uniform colour throughout the work. Work on the above, other than described, shall be carefully fitted and assembled with neat joints with concealed fasteners. Wherever possible, joints shall be made in concealed locations and on edges of doors. Field connections of all work may be made with concealed screws or other approved type of fasteners. Glazing beads shall be snap fit type without visible screws and shall be of sizes to accommodate 6 mm thick glazing. All work shall be adequately braced and reinforced as necessary for strength and rigidity.

2.03.00 Shop Coat or Paint

The shop Paint for steel doors, windows etc. shall be best lead or zinc chromate primer paint from, approved manufacturer. All surfaces shall be thoroughly cleaned of rust, grease, loose mill scales etc. and given one coat of shop paint. Portions like mullions, transoms etc. that will be inaccessible after assembly of units shall be given an extra coat of paint before assembly.

Where called for, all steel doors, windows, etc. shall be hot dip galvanized to give a coating weight of 1½ - 2 oz. per sqft. One coat zinc chromate primer coat shall then be applied as shop paint.

Portions of aluminium frame, which come in contact with masonry construction shall be (before shipment from workshop) protected with a heavy coat of alkali resistant paint. Aluminium coming in contact with other incompatible metals shall be coated with zinc chromate primer.

2.04.00 Handling & Storage of Fabricated Material

All metal doors, windows, etc. shall be packed and crated properly before dispatch, to ensure that there will be no damage to the fabricated materials. Loading into wagons and trucks shall be done with all care to ensure safe arrival of materials at site in undamaged condition.

When taking delivery of items supplied by Owner, the Contractor shall satisfy himself that the items supplied are up to the specified standard. Any defect detected shall promptly be brought to the notice of the Engineer.

All metal doors, windows etc. shall be stored under cover in a way to prevent damage or distortion. Special care shall be taken to prevent staining of aluminium products by rust, mortar etc.

2.05.00 Assembly & Erection at Site

In general, the fixing of steel doors, windows, ventilators, louvers, etc. shall conform to IS: 1081. The Contractor shall assemble and install all steel doors, windows, sashes, fixed metal louvers, etc. including transoms and mullions for composite units in respective places, keening proper "Lines and levels", and in approved workmanlike manner, to give trouble free and leak-proof installations. Installation shall be done according to instructions of the manufacturer, and/or as approved by the Engineer. If required by the Engineer, the installation shall have to be carried out under the supervision of the manufacturer's staff. The Contractor shall take all precaution against damage of the components during installation. Necessary holes, chases, etc. required for fixing shall be made by the Contractor and made good again as per original, after installation, without any extra charge.

After installation of steel doors, windows, etc. all abrasions to shop-coat of paint shall be retouched and made good the same quality of paint used in shop coat.

All coupling mullions, transoms, frames, etc. in contact with adjacent steel and other members, shall be well bedded in mastic. The Contractor shall bring to the site the cement in original sealed containers of manufacturer and shall apply it as per the instruction. For all frames supplied by either the owner or the Contractor, mastic shall be supplied by the Contractor and caulking done properly as per drawings, specifications and as per instructions of the Engineer.

Door shutters, partitions hardware fixtures etc. shall be fixed only after major equipments have been installed in rooms.

Wherever required, nylon cords of approved quality shall be supplied along with pivoted sashes and shall be of adequate length to terminate one metres from the floor. Loose ends of cords shall end in metal or plastic pull as approved by the Engineer.

2.06.0 Fire proof Door

Fire proof doors shall be provided at all fire exit points as specified and also to restrict the spread of fire within buildings whether from internal fire or from external fire. The construction details of door shall conform to the requirements stipulated in IS:3614(Part-1). Doors shall comply with the testing requirement mentioned in IS:3614 (Part-2). The doors shall be approved by Tariff Advisory Committee and shall have minimum 2 hrs. fire rating.

Metal covered (on both sides) Doors having insulating core filled up with mineral wool shall be used at all fire exit points and shall open out side.

All necessary accessories and hardware shall also be supplied along with doors. Fire proof door shall be provided with zinc silicate primer (minimum DFT 75 micron) after blast cleaning the surface to near white metal surface and shall be finished painted with epoxy based painting.

3.00.00 ACCEPTANCE CRITERIA

3.01.00 For fabricated Items

- a) Overall dimensions shall be within ± 1.5 mm of the size shown on drawings.
- b) Mullions, transoms etc. shall be in one length and permissible deviations from straightness shall be limited to ± 1.5 mm from the axis of the member.
- c) Door and window shutters shall operate without jamming. The clearance at head and jamb for door shutters shall not exceed 1.5 mm for double leaf doors; the gap at the meeting stiles shall not be more than 1.5 mm.
- d) Door leaves shall be undercut where shown on drawings.
- e) Doors, windows, frames, etc. shall be on a true planes, free from warp or buckle.
- f) All welds shall be dressed flush on exposed and contact surfaces.
- g) Correctness of location and smoothness of operations of all shop installed hardware and fixtures

- h) Provision for hardware and fixtures to be installed at site.
- i) Glazing beads shall be cut with mitered corners.
- j) Glazing clips, fixing devices etc. shall be supplied in adequate numbers.
- k) Shop coats shall be properly applied.
- l) Exposed aluminum surfaces shall be free from scratches, stains, and discoloration. Anodized surfaces shall present a uniform and pleasing look.

3.02.00 For installed Items

- a) Installations shall be at correct location, elevation and in general, on a true vertical plane.
- b) Fixing details shall be strictly as shown on drawings.
- c) Assembly of composite units shall be strictly, as per drawings with mastic caulking of transoms and mullions, gaskets, weather strips etc. complete.
- d) All frames on external walls shall be mastic caulked to prevent leakage through joint between frames and masonry.
- e) All openable section shall operate smoothly without jamming.
- f) Locks, fasteners etc. shall be engage positively. Key shall, be non-interchangeable.
- g) Cutting to concrete or masonry shall be made good and all abrasions to shop paint shall be touched up with paint of same quality as shop paint.
- h) Aluminium doors, windows, etc. shall be free from scratches stain or discoloration.

4.00.00 INFORMATION TO BE SUBMITTED

4.01.00 With Tender

- a) Names of manufacturers for Doors, windows etc.
- b) Manufacturer's catalogue for all hardware and fixtures proposed to be used.

4.02.00 After Award

- a) Before starting fabrication of all metal doors, windows, etc. the Contractor shall submit detailed fabrication drawings to the Engineer for approval. The fabrication shall be started only after approval of drawings.
- b) He shall submit a programme of work to be done for the approval of the Engineer.
- c) Before bulk supply, he shall submit for the approval of the Engineer samples of all bought out items and samples of each type of fabricated items. The samples shall be retained by

the Engineer for comparison of bulk supply and returned to the Contractor towards the end for final incorporation in the job.

5.00.00**IS CODES**

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

Specification for Wrought Aluminium and Aluminium Alloy bars, rods and sections (for general engineering purpose)	-	IS: 733
Specification for Wrought Aluminium and Aluminium Alloy, extruded round tube, hollow section (for general engineering purpose)	-	IS: 1285
Steel doors, windows, and ventilators	-	IS: 1038
Steel windows for industrial, building	-	IS: 1361
Aluminium doors windows, and ventilators	-	IS: 1948
Aluminium windows for industrial buildings	-	IS: 1949
Steel doorframes	-	IS: 4351
Code of practice for fixing and glazing of Metal (steel and aluminium) doors, windows and Ventilators.	-	IS: 1081
Specification for Fire-check Doors – Part 1: Plate, Metal covered and Rolling type	-	IS: 3614
Hot Rolled Steel Sections for Doors, Windows and Ventilators – Specification	-	IS: 7452

6.00.00 RATES AND MEASUREMENT**6.01.00 Rates**

Rates shall be applicable of all elevation. Rates shall include preparation of working drawings (if required), supply of material, fixtures, gaskets, erection of unit, caulking and jamming of frames, including cutting/drilling/welding, grouting, grinding, making good of the structure for installing the unit etc. complete as per “Schedule of Items”.

Rates shall also include cost of surface preparation, application of primer, enamel painting or anodizing as applicable.

Rate for fire proof door is inclusive of providing insulation core, primer, shop painting (epoxy based), all hardware as specified in Schedule of items.

6.02.00 Measurement

Supply and installation of doors, windows, and ventilators shall be measured in Sqm in net outer to outer (excluding frame) area of doors, windows, and ventilators of each type used as described in "Schedule of Items". Frame for steel or aluminium shall be measured in Kgs. Wooden frames shall be measured in Cum. Measurement for aluminium partition shall be from net outer to outer area of frames i.e., frames are part of partition.

Measurement for fire proof door shall be in SqM in net area outer to outer of the door.

ANNEXURE-A

SCHEDULE OF FIXTURES

A. TIMBER DOORS

1. For single leaf panel/flush doors
 - i) 100 mm brass butt hinges with screws - 3 Nos.
 - ii) 150 mm brass tower bolts with screws - 1 No.
 - iii) 100 mm x 225 mm clear plastic push Plate with counter sunk brass screws - 1 No.
 - iv) 30 mm brass ring pull handle with Plates and screws - 1 No.
 - v) 150 mm brass coat hook with screws - 1 No.
 - vi) Heavy duty, cylinder looks on active leaf - for flush door. For door-closure, see "Door Schedule".

B. ALUMINIUM DOORS

1. For double leaf door
 - i) Concealed hanging arrangement for door leaves.
 - ii) Concealed two points bolt encasing simultaneously at head and threshold on inactive leaf, operable from inside.
 - iii) Heavy duty, cylinder look on active leaf.
 - iv) Pull handle of approved design on both leaves.
 - v) Doors stops for both leaves.
 - vi) Overhead door closure for both leaves.

ANNEXURE-A

C. STEEL DOORS AND WINDOWS

1. Doors

a) Double leaf doors

- i) 100 mm butt hinges - 3 Nos. on each leaf.
- ii) 300 mm aluminum tower bolt - 2 Nos. (top and bottom)
On inside of inactive
Leaf. 1. No. (Top only)
On inside active leaf.
- iii) 200 mm anodized aluminum pull handle - 1 No. of each leaf.
- iv) Door stop of approved design - 1 No. of each leaf.

NOTE: For locks, door closure and threshold, see "Door Schedule".

b) Single leaf doors

- i) 100 mm butt hinges - 3 Nos.
- ii) 300 mm aluminum tower bolt - 2 Nos. top & bottom of Inside face
- iii) 200mm anodised aluminum Pull handle - 1 No.
- iv) Door stop of approved design - 1 No.

NOTE: For locks, door closures and threshold, sec "Door Schedule".

2. Windows, Ventilators, etc.

a) Side Hung Windows

- i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.
- ii) 12" peg stays - 1 No. per leaf

ANNEXURE-A

- iii) 2 point handles - 1 No. per leaf

b) Top Hung Ventilators (Projecting Out)

- i) Hinges - As per standard Practice of the

- Manufacturer, but minimum two
hinges Per leaf.
- ii) Adjustable sliding fabrication
assembles - 2 Nos. per leaf.
- iii) 2 point handles -1 No. per leaf.
- c) Bottom Hung Ventilators (Projecting in)
 - i) Hinges - As per standard Practice of the
Manufacturer, but minimum two
hinges Per leaf.
 - ii) Concealed side arms for
opening adjustment. - 2 Nos. per leaf.
 - iii) Spring Catch - 1 No. per leaf.

ANNEXURE-A

D. ALUMINIUM WINDOW, VENTILATORS, ETC.
(As per I.S-1948 latest editions)

a) Side Hung Windows

- i) Hinges - As per standard Practice of the
Manufacturer, but minimum two
hinges Per leaf.
- ii) 300 mm peg stays - 1 No per leaf
- iii) 2 point handles - 1 No per leaf

b) Top Hung Ventilators (Projecting out)

- i) Hinges - As per standard Practice of the
Manufacturer, but minimum two
hinges Per leaf.
- ii) Adjustable sliding
fabrication assemblies - 2 Nos. per leaf
- iii) 2 Point handles -1 No. per leaf

c) Bottom Hung Ventilation&(Projecting In)

- i) Hinges - As per standard Practice of the
Manufacturer, but minimum two
hinges Per leaf.
- ii) Concealed side arms for
opening adjustment - 2 Nos. per leaf
- iii) Spring Catch - 1 No. per leaf

SUB-SECTION – D6

GLASS AND GLAZING

C O N T E N T

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODES
5.00.00	RATES

GLASS AND GLAZING

1.00.00 SCOPE

This section covers supplying and fixing of all glass and glazing including all clips, putty, mastic cement etc. wherever required as per specifications.

2.00.00 INSTALLATION

2.01.00 General

The Contractor shall supply and install all glass and glazing as required for various doors, windows, sashes, ventilators and fixed louvers, miscellaneous glazing and partitions, from approved manufacturer like Hindustan Pilkinton or equivalent, having uniform refractive index and free from flaws, specks, and bubbles. The glass shall be brought to site in the original packing from the manufacturer and cut to size at site.

Materials

- a) Glare reducing or heat absorbing glass shall be "Calorex" of Hindustan Pilkinton or approved equivalent and special care shall be taken to grind smooth and round off the edges before fixing.
- b) Clear glass shall be flat draw sheet glass and shall be at least 4 mm thick. Sheet glass for doors shall be minimum 5.5 mm thick.
- c) Wired glass shall be thick-rolled glass with centrally embedded 42g wire mesh of Georgian type. This may be of clear or coloured glass, as required.
- d) Obscure glasses shall have a cast surface in one side.
- e) Coloured and figured glass shall be as per approved sample.
- f) In general, the putty shall conform to IS: 400 and be of best quality from approved manufacturer. It shall be brought to site in the manufacturer's original packing.
- g) Neoprene gaskets with snap-fit glazing beads shall be fixed as per manufacturer's instructions and shall sit snugly against glass to give a leak proof installation.

2.03.00 Glazing, Setting, and Finish

All glazing clips, bolts, nuts, putty, mastic cement etc. as required shall be supplied by the Contractor.

All glass shall be thoroughly cleaned before putting in position. Each glass pane shall be held in place by special glazing clips of approved type. As specified in relevant I.S. Codes, four glazing chips shall be provided per glass pane, except for large panes where six or more clips shall be used as per engineer's instructions. All holes that may be necessary for holding the clips glazing heads and all other attachments shall be drilled by, the Contractor.

Glass panes shall be set without springing, and shall be bedded in putty and back puttied, except where mouldings or gasket are specified, putty, mastic cement etc. shall be smoothly finished to the even line and figured glass shall be set with smooth side out.

Where owner will supply glass, the Contractor shall cut it to size and fix them in the same as specified above.

The Contractor shall supply necessary glazing clips, putty, mastic cement etc.

After completion of glazing, the Contractor shall remove all dirt stains, excess putty etc. clean glass panes and leave the work in perfectly acceptable condition. All broken cracked or damaged glass shall be replaced by new ones at the contractor's own cost.

3.00.00

ACCEPTANCE CRITERIA

- a) All installation shall be free from cracked, broken, or damaged glass. Edges of large panes of thicker glass and heat absorbing glass shall be inspected carefully for chipped, cracked, or underground edges.
- b) Glazing shall be carefully done to avoid direct contact with metal frames.
- c) All glass shall be embedded in mastic or fixed by neoprene gaskets to give a leak proof installation.
- d) At completion, the panes shall be free from dirt, stains, excess putty etc. to the complete satisfaction of the Engineer.

4.00.00

I.S. CODES

Following are some of the important I.S.Codes relevant to this Section:

IS: 3548 - Code of practice for glazing in building.

IS: 1081 - Code of practice' for fixing and glazing metal doors, windows ventilators.

5.00.00 RATES

Rates of glass and glazing are included in respective items for supply and installation of window, ventilator, and partitions. No separate payment shall be made for glazing clips, mastic cement, putty, screws; rails, etc. nor for drilling holes in frames for inserting glazing clips.

SUB-SECTION – D7

ROLLING STEEL SHUTTERS AND GRILLS

C O N T E N T

CLAUSE NO. DESCRIPTION

1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA & GUARANTEE
4.00.00	I.S. CODES
5.00.00	RATES AND MEASUREMENTS

ROLLING STEEL SHUTTERS AND GRILLS

1.00.00 SCOPE

This Section covers the design and supply of materials, fabrication, delivery and erection of Rolling Shutters/Grills with motor drive and/or manual operation including all accessories as hereinafter specified.

2.00.00 INSTALLATION

2.01.00 Components

- a) Slats for rolling shutters shall be made from tested bright cold rolled, annealed M.S. strips, not less than 0.9 mm thick for shutters upto 4.5 M wide and not less than 1.25 mm thick for shutters having width more than 4.5 M, wide and above, machine rolled at 75 mm rolling centers, interlocking with each other. The profile will be such as to prevent excessive deflection under specified wind load.
- b) Rolling grills shall be constructed out of 6mm rods at 35 mm on centers running horizontally flexible connected with vertical links spaced not more than 200 centers. Alternatively, rolling grills shall be made from perforated slats of approved design reinforced with 6mm dia rods.
- c) End locks shall be heavy type M.C.I./C.I. and shall be provided at each end of alternate slats unless specified otherwise.
- d) Bottom bars shall be finished with two angles not less than 6 mm thick for external shutters. When shown on drawings, a flexible weather strip shall be applied to make tight contact with the floor.
- e) Guides shall be of such depth as to retain the shutter under a wind pressure of 100 Kg/Sq.m.
- f) Shafts shall be of steel pipe of sufficient size to carry the tensional load with a maximum deflection of 1/360th of span. Grease packed ball bearings or bushings shall be provided for smooth trouble free operation.
- g) Hoods shall be formed of not less than 20 gauge steel, suitable reinforced to prevent sag.
- h) Locks shall be slide bolt and hasp, or cylinder lock operable from one or both sides. Provision securing hand chain with pad-lock, provision for removable handle for hand cranks etc. shall be made as prescribed by the Engineer.
- i) Power unit shall be suitable for 3 phase, 50 cycles, 400-volt A.C. power supply and be either floor or wall mounted unit. The motor shall be of sufficient capacity, to move the shutter in either direction at a speed of 0.3 metres per second. In addition to the gear motor each standard power unit shall include a magnetic brake, a reversing starter with built-in overload protection, a geared limit switch and one push button station located inside the building unless otherwise stated in drawing.

It is desirable that the bottom bar of motor operated doors shall be provided with a sensitive edge, electrically connected to stop the travel of the door on meeting an obstruction.

- j) Operating chains shall be of tested quality, heavily galvanized and with all ends rounded to

assure smooth operation and hand protection.

- k) Reduction gears shall be high strength grey cast iron, machine moulded from machine out patterns.

2.02.00 Manually Operated Shutters/Grills

Manually operated shutters shall be easily operable by one person. The speed of operation shall be about 1.3 metres per second. In general, manually operated shutters shall be push pull type for opening up to 9 Sq. metre in area. Larger shutters shall, be either chain and gear operated or crank and gear operated. The crank handle shall be removable. All shutters shall be lockable from one or both sides as desired by the Engineer.

2.03.00 Power operated Shutters/Grills

These shall be operable from a push button station conveniently located beside the door. One emergency hand chain/crank operation shall also be provided for use in case of failure of the electric system. Where called for, externally mounted shutters shall be operated by control mechanism located inside the building.

2.04.00 Shop Coat

Shutters shall be painted with one coat of red lead or zinc chromate primer. Where specified, doors shall be galvanized and subsequently painted one coat of zinc chromate for adhesion of field coat.

2.05.00 Erection

Door shall be installed by the manufacturer or his authorized representative and all work shall be as per manufacturer's instructions. Any drilling or cutting to concrete, masonry etc. shall be made good after erection of shutters and all abrasion to shop coat shall be touched up. All electrical work shall be in strict accordance with the latest Indian Electricity Rules.

3.00.00 ACCEPTANCE CRITERIA AND GUARANTEE

3.01.00 Shop Inspection

After completing the manufacture of the different components of the rolling shutter, an arrangement for shop inspection by the Engineer shall be made to check the conformity with approved shop drawings.

3.02.00 Field Inspection

After installing the shutters, the Contractor shall test the performance of the shutter in the presence of the Engineer. The doors shall be smoothly operable under all ambient conditions. All control and locking devices shall give fault free performance.

3.03.00 Guarantee

The Contractor shall give one year's guarantee for the successful operation of the shutters. This shall be supported by a separate and unilateral guarantee from the manufacturer of the shutters.

4.00.00 I.S. CODE

IS: 6248 - Metal rolling shutters and rolling grills.

5.00.00 RATES AND MEASUREMENT**5.01.00 Rates**

Rates for rolling shutters and grill shall include the cost of the locks, guide channels, cost of drive as specified. In case of electrically operated rolling shutters, the rate shall also include the mounting of controls, wire and wiring from the nearest junction box, conduit and other electrical connections and cost of electric motor.

5.02.00 Measurement

Supply and installation of rolling shutter and grill shall be measured in Sqm in net outer to outer (including frame) area of each type used as described in "Schedule of Items".

SUB-SECTION – D8**MISCELLANEOUS METAL****C O N T E N T****CLAUSE NO. DESCRIPTION**

1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	IS CODES
5.00.00	RATES AND MEASUREMENTS

MISCELLANEOUS METAL**1.00.00 SCOPE**

This section covers supply, fabrication and erection of miscellaneous metal items of light nature in gates, balcony and stair hand rails, structural works, ladders, hangers, masonry anchors, anchor bolts, fasteners, chain link fencing, barbed wire fencing etc. as specified or shown on drawing or as instructed by the Engineer. The above items shall be of fabricated or cast of mild steel, aluminium, brass, cast iron, M.S.& galvanized M.S. sheets, aluminium sheets, expanded

metal, wire mesh as shown on drawings or specified.

2.00.00 INSTALLATION

2.01.00 Fabrication/casting

2.01.01 General

All work shall be done according to approved shop drawings. All workmanship shall be equal to the best practice in modern structural or foundry shop.

2.01.02 Shop Connections

- a) All shop connections shall be riveted or welded except when noted otherwise on drawings.
- b) Welding of steel shall be done in accordance with IS: 816.
- c) Welding of aluminium shall be done accordance with IS: 2812, "Arc welding of Aluminium and Alloys." Special care shall be taken to grind smooth all welded surface that shall remain exposed to view. Welds shall be electrically continuous if so required by the Engineer.

2.01.03 Shop Coat

Before leaving the shop, all metal work shall be thoroughly cleaned by effective means of all loose mill seals, rust and foreign matter. Except where encased in concrete, all steelwork shall be given one coat of approved metal protective paint, applied by brush thoroughly and evenly, well worked into joints and other open spaces. All paint shall be applied to dry surfaces. When specified steel work shall be galvanised or painted with a coat of zinc chromate primer. Aluminium surfaces, which shall come in contact with masonry, shall be given one coat of bituminous paint.

2.02.00 Erection

2.02.01 Bracing

The Contractor shall provide all necessary temporary guys and braces to ensure alignment and stability of the members and to take care of all loads to which the structure may be subjected, including erection of equipment and operation of the same.

2.02.02 Temporary Bolting-Up

As erection proceeds the Contractor shall plum up and level all members and shall securely bolt up to take care of all dead load, wind load and erection stresses. Wherever erection equipment or other loads are carried by members during erection, proper provision shall be made to take care of the stresses resulting from the same.

2.02.03 Turned Bolt

For field connections where bolting is specified, holes for the turned bolts may be reamed in the field, if required. All drilling or reaming for turned bolts shall be done after the parts to be connected are assembled.

2.02.04 Welding

Where specified on drawings, welding shall be done in accordance with IS: 816 for steel and IS: 2812 for Aluminium & Alloys.

2.02.05 Cutting and Fitting

No cutting of sections, flanges, webs of angles shall be done without the approval of the Engineer. Where indicated on the drawings holes, cuttings, etc. shall be provided as required for installation, to the work by the other Contractors. No additional holes or cuttings, than those shown on drawings, shall be made without the approval of the Engineer.

2.02.06 Drifting

Correction minor misfits and a reasonable amount of reaming and cutting of excess stock from rivets may be permitted. For this, light drifting may be allowed to draw holes together. Twist drills shall be used to enlarge as necessary to make connections, reaming that weakness the members or make it impossible to fill the holes properly or to adjust accurately after reaming shall not be allowed.

Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins or a moderate amount of reaming and slight chipping and cutting shall immediately be called to the attention of the Engineer-and approval of the method of correction obtained. The use of cutting torches to enlarge or alter rivet holes shall not be permitted.

2.02.07 Spot Painting

All field rivets and bolts and also any serious abrasion to shop paint shall be spot painted with the same materials and used for the shop paint or equivalent.

2.02.08 Good

All cutting to concrete or masonry shall be made good to the satisfaction of the Engineer.

2.02.09 Grouting

All bearing plates, loose, lintels and beams, etc. shall be set to proper grade and level by the Contractor and the Engineer's approval obtained before proceeding with the grouting. Grouting shall be done in 1:1½:3 concrete with 6 mm down stone chips or as specified in schedule of items.

2.02.10 Anchor Fasteners

The anchor fasteners shall be of two type viz. light duty for carrying tensile load upto 0.5MT per fasteners and heavy duty for carrying tensile load of 0.5MT to 5.0MT per fasteners. These anchor fasteners shall be fixed into concrete. The Contractor shall submit the Manufacture's literature showing the average pull out and average shear value for anchor of various sizes. Anchors shall be fixed in position strictly as per the manufacturers instructions and as approved by the Engineer.

Heavy Duty Anchor Fasteners

The safe tensile load carrying capacity of the anchors shall be arrived by providing the minimum factor of capacity of 2.5 for the characteristic load of the anchor. Minimum size of anchor shall be M8 (8mm). All anchors shall be from the approved manufacturers like HILTI or equivalent.

- a) Anchor fasteners shall be supplied and fixed in position by the contractor. Anchor fasteners can be of mechanical bonding or chemical bonding.
- b) Capacity of the anchor shall be established after considering the effect of concrete grade, embedment depth, concrete thickness, anchor spacing and edge distance from the concrete edge.
- c) The selection for the particular type of bonding for the anchors shall be made after considering the concrete grade, available embedment depth, load to be transferred, space available for installing anchors.
- d) The mechanical bonding anchor are torque controlled anchors made from carbon steel of grade 8.8 as per IS:1367 part 3. Anchors in bolt as well as nut version are acceptable. The bolt version anchors consists of bolt washer, sleeves, plastic section, expansion sleeves and a cone. Nuts version anchor consists of nuts, threaded rod, washer, sleeves, plastic section, expansion sleeves and a cone. All steel component of anchor shall be electro galvanised to minimum 5 micron coating thickness. The plastic section shall be of polyacetal Derlin 100 or equivalent.
- e) Chemical bonding anchor shall consist of foil capsule and threaded rod. The foil capsule shall contain the resin and hardener. The threaded rod shall have chiselled tip. The behaviour of anchors under fire shall conform the heating curves as per ISO:834. Anchors of size M8 to M24 shall conform to grade 5.8 and anchors of size M27 to M39 shall conform to grade 8.8 as per IS:1367 part 3. All steel components of the anchors shall be electro-galvanised to minimum 5 micron thickness.

Light Duty Anchors

This anchor shall comprise of stud, nut, washers, expansion sleeve. The one end of the stud shall have thread and the other end shall have cold formed conical head. All steel components of the anchors shall be electro-galvanised to minimum 5 micron thickness. The expansion sleeve shall preferably be of stainless steel of SS316. The anchors shall conform to minimum grade 5.8 as per IS:1367 part 3.

2.02.11 Pipe Joints

MS pipes or GI pipes shall be joined by threaded sockets or by welding. Cast iron pipes shall be socket and spigot joined and caulked with hemp and molten head.

2.03.0 FENCING

2.03.01 Chain Link Fencing

The material requirement shall conform to IS: 2721 latest edition. The chain link fencing shall be woven from 3.15mm dia. wire with mesh size of 50mm. The mesh wire shall not vary from specified dia. by more than ± 0.05 mm. all steel wire shall be hot dipped galvanised wire. The dia shall be measured over the galvanised coating. The line wire shall be 4.0mm dia. mild steel. The stirrup wire for securing the line wire to the intermediate post (RCC/structural steel) shall be 2.5 mm diameter mild steel. The tying wire for securing the chain link fencing to the line

wire shall be 1.6mm diameter mild steel. Hair pin chain staples for fastening down the bottom of galvanised chain line fencing to the concrete sill shall be 3.15mm wire. The ends shall be bent outwards for securing anchorage.

Cleat for eye bolts shall be of uniform size and shall consist of mild steel angle of 75 x 50 x 8 mm. The eye bolts strainer shall consist of bolt with welded eye sufficiently threaded and fitted with a nut and washer. Two-way eye bolt strainer shall have suitable ring nuts fitted after the wires have been strained on one side. Stretcher bar shall consist of mild steel flats 25 x 4.75 mm. They shall be secured to the cleats by steel bolts.

The chain link fencing shall be strained between each pair of straining posts and secured to each straining posts by means of a stretcher bar. One of top line wire shall be threaded through appropriate adjacent row of mesh, care being taken that no meshes in the row are bypassed by the line wire except where deviation is necessary at the straining posts. The second top line wire shall be strained in front of the fencing. The fencing shall be attached to the top and bottom line wire by wire ties spaced at 150mm apart and to the other middle line wire by wire ties spaced at 450mm apart.

The bottom of fencing shall be treated as follows:

Continuous concrete sill 125mm wide x 225mm high for full length between posts shall be cast with the top 25mm above GL and 25mm below the chain link fencing. Hair pin staples shall be threaded through the bottom row of mesh at 750mm c/c and set in the sill to a depth of 150mm.

2.03.02

Barbed Wire Fencing

The barbed wire shall conform to IS:278 latest edition. The barbed wire shall be galvanised and galvanising shall conform to the requirement laid down for 'light-coated wire' of IS:4826 and it shall be smooth and relatively free of lumps etc. Wire with excessive roughness blisters, salammoniac spots shall be rejected. The barbed wire shall be made from two line wire and two point wire of 2.5 mm thickness each. The barbs shall have four point and shall be formed by twisting two point wires, each two turns, tightly around both or one line wire (Type A - around both line wire, Type B - around one line wire) making altogether four complete turns. The barbs shall be so finished that four points are set and located or locked as far as possible at right angle to each other. The barbs shall have a length of not less than 13mm and not more than 18mm. The distance between two barbs shall be 75 ± 12 mm.

Straining posts shall be provided at all ends and corners of fences or at changes in direction or acute variation in level and at intervals not exceeding 66 M on straight lengths of fence. Intermediate posts shall be spaced at regular intervals not exceeding 3.0m. Struts shall be fitted to all straining posts behind the chain link fabric in the direction of line of fence. There shall be four evenly spaced row of line wire in all. The top line wire shall be doubled, making five line wire in all. The bottom wire shall be closed to the ground. Each line wire shall be strained tightly by means of eyebolts strainers or winders at each straining points. Each line wire shall be secured to each intermediate post by a wire stirrup passed through a hold in the post and secured to the line wire by three complete turns on each sides of the post. The barbed wire shall be fitted with one dropper at the centre of each bay, secured to the wire so that they could not be bunched together. Droppers for barbed wire shall be of mild steel of not less than 25 x 4.75 mm thick with 38 x 4.85 mm half round staples for fastening the barbed wire to them. Bracing for the rows of barbed wire shall be approved by the Engineer.

3.00.00 ACCEPTANCE CRITERIA

- a) All items shall be correct shape, size, weight etc. shown on drawings and schedule of items.
- b) For installed items, the tolerances shall be as follows
 - i) Permissible deviation from, straightness – 1 in 1000.
 - ii) Seats, stiffener connections etc. shall be as per approved drawings and shall not interfere with architectural clearances.
- c) All castings shall be free from blowholes, cracks, and other blemishes.
- d) All MS wire fencing shall be in true vertical plain, and shall not bulge.

4.00.00 IS CODES

IS:278	Specification for Galvanised Steel Barbed wire for fencing.
IS:816	Code of practice for use of Metal Arc welding for general construction in mild steel.
IS:1367	Industrial Fasteners – Threaded steel fasteners - Technical supply condition.
IS:2721	Specification for Galvanised Steel Chain Link fence fabric.
IS:2812	Arc welding of Aluminum and Alloy

5.00.00 RATES AND MEASUREMENTS

5.01.0 Rates

Rates shall include supply, fabrication and installation for misc. metals works as required for completion of works like gates, fencing, handrails, ladders, hangers, anchors etc., unless otherwise specified in Schedule of Items.

Rate for fencing shall also include excavation, concreting and supply, erection & fabrication of post (post made of either structural steel or reinforced cement concrete), unless any specific item is excluded.

5.02.0 Measurements

Measurement for MS gates shall be in MT.

Measurement for galvanised MS wire fencing shall be in Sqm.

Measurement for Anchors shall be in nos. for the type as specified in schedule of items.

Measurement of other misc. metals shall be done in MT unless otherwise specified in schedule of items.

SUB-SECTION – D9

MASONRY AND ALLIED WORKS

C O N T E N T

CLAUSE NO. DESCRIPTION

1.00.00	SCOPE
2.00.00	MATERIALS
3.00.00	INSTALLATION
4.00.00	I.S. CODES
5.00.00	RATES AND MEASUREMENTS

MASONRY AND ALLIED WORKS

1.00.00 SCOPE

This section covers furnishing, installation including handling, transporting, batching, mixing, laying scaffolding, centering, shuttering, finishing, curing, protection, maintenance and repair of common building materials till handing over of masonry and allied works for use in structures and locations covered under the scope of this package.

2.00.00 MATERIALS

a)

b) a) Brick (Fly Ash Cement Bricks with min 75kg/sq cm strength)

Bricks for general masonry work shall be of class designation 7.5 of nominal dimensions as per Indian standard specification, well burnt, of uniform size, shape and colour, free from cracks, flaws or modules of free lime and emit clear ringing sound when struck. Fractured surface shall show uniform texture free from grits, lumps holes etc. Water absorption after 24 hours immersion shall not exceed 20% by weight for bricks. Dimensional tolerance shall not exceed 8% of the size shown in drawings for bricks. All bricks shall have rectangular faces and sharp straight edges. The bricks shall show no efflorescence after soaking in water and drying in shade.

Each brick shall have the manufacturer's identification marks clearly marked on the frog.

Representative samples shall be submitted and approved samples shall be retained by the Engineer for further comparisons and reference. Any brick not found up to the specification shall be removed immediately from site at the Contractor's own cost.

Bricks shall not be dumped at site. They shall be stacked in regular tiers, even as they are unloaded; to minimize breakage and defacement of bricks. Bricks selected for different situation of use in the work shall be stacked separately.

c)

d) b) Stone

All stones shall be obtained from approved quarries, hard, tough, durable compact grained, uniform in texture and colour and free from decay, flaws, veins, cracks and sand holes. The surface of a freshly broken stone shall be bright, clean, and sharp and shall show uniformity of texture, without loose grains and free from any dull, chalky, or earthly appearance. Stone showing mottled colours shall not be used for face work. A stone shall not absorb more than 5 per cent of its weight of water after 24 hours immersion. The type of stone shall be as specified on drawings and/or instructed by the Engineer. Samples shall be submitted by the Contractor and approved samples shall be retained by the Engineer for comparison of bulk supply.

c) Cement

Cement used shall be Ordinarily Portland Cement or Portland Slag Cement or Portland Pozzolana Cement conforming to IS Codes and shall be fresh when delivered. In special cases, Rapid Hardening Portland Cement, Low Heat Cement etc. may be permitted or directed to be used by the Engineer. The Contractor shall submit the manufacturer's certificate for each consignment of cement procured to the Engineer. If at any time, the Engineer feels that the cement being used by the Contractor is not up to specification, he may stop the work and send the samples of the cement to a testing laboratory for standard tests and all expenses incurred thus shall be borne by the Contractor. The Contractor shall also have no claim for this type of suspension of work.

The cement shall be stored above the ground level in perfectly dry and watertight sheds. The bags shall be stacked in a manner so as to facilitate removal or first in first out basis. Any material considered defective by the Engineer shall not be used by the Contractor and shall be removed from the site immediately.

d) Coarse Aggregate

Coarse aggregates shall be as per IS: 383 latest editions, consisting of hard, strong and durable pieces of crushed stone and shall be free from organic or clay coatings and other impurities like disintegrated stones, soft flaky particles etc. and any other material liable to affect the strength, durability or appearance of concrete.

Aggregates other than crushed stone conforming to the provisions of specification may be used if permitted by the Engineer.

Washing of aggregates by approved means shall be carried out, if desired by the Engineer.

Grading of coarse aggregates shall generally conform to IS: 383 and shall be such as to produce a dense concrete or the specified proportions and strength and of consistence that will work readily into position without segregation.

Aggregates shall be stored on brick soling or an equivalent platform so that they do not come in contact with dirt, clay, grass, or any other injurious substances at any stage.

Aggregate of different size shall be kept in separate stacks. If so desired by the Engineer aggregate from different sources shall be stacked separately with proper care to prevent intermixing.

e) Sand

Sand shall be hard, durable, clean, and free from adherent coatings or organic matter and shall not contain clay balls or pellets. The sand shall be free from impurities such as iron pyrites, alkalis, salts, coal, mica, shale or other laminated materials in such forms or quantities as to affect adversely the hardening, strength, durability or appearance of mortar, plaster or concrete or to cause corrosion to any metal in contact with such mortar, plaster or concrete. All sand shall be properly graded and shall be as per relevant IS Code. Sand for concrete shall conform to IS: 383.

f) Water

Water shall be clean, fresh and free from organic matters, acids or soluble salts and other deleterious substances which may cause corrosion, discoloration, efflorescence etc.

e)

f) g) Reinforcement

Reinforcement steel shall be clean and free from loose mill scales, dust, loose rust, oil and grease or other coatings, which may impair proper bond. Structural steel shall conform to IS: 2062. Mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement shall conform to IS: 432. Cold twisted steel bars shall conform to IS: 1786. Hand drawn steel wire fabric shall conform to IS: 1566. Hexagonal wire netting shall conform to IS: 3150. All steel bars including and above 10 mm diameter shall be of tested quality. All wire netting shall be galvanized.

Reinforcement bars shall be stored off the ground and under cover if so desired by the Engineer. If necessary, a coat of cement wash shall be given to the bars to guard against rusting.

3.00.00 INSTALLATION

3:01.00 Soling

3.01.01 Brick Soling

The ground shall be dressed, consolidated by ramming, or by light rolling and a 12 mm thick cushion of sand laid. On the sand cushion the bricks shall be laid with fine joints and placed firmly in position by hammering with wooden mallet. The surface shall be free from undulations. The 'frog' side shall be on the underside. The joints shall be broken the in all direction and bricks cut as required. The pattern of laying and number of layers shall be as per Schedule of item. Orientation shall be as desired by the Engineer. After laying of each layer of bricks sand shall be spread over and worked into the joints to pack the bricks tight.

3.01.02 Stone Soling

The stones for soling shall be selected on the basis of thickness of soling specified in the Schedule of Items. The larger stones shall be laid and the gaps filled by smaller stones. The interstices shall then be firmly packed with sand by flooding with water.

3.02.00 Brick-on-Edge

Excavation shall be done close to the brick dimensions and in perfect alignment. Bricks shall be firmly placed by hammering with wooden mallets and sides and joints packed firmly with

earth so that the edging is not disturbed easily. Alignment and level shall be acceptable to the Engineer.

3.03.00 Masonry

3.03.01 General

All masonry work shall be true to lines and levels as shown on drawings. All masonry shall be tightly built against structural members and bonded with dowels, inserts etc. as shown on drawings.

3.03.02 Cement Mortar

Cement mortar shall be prepared with materials specified in clause 2.00.00. Sand for masonry mortar shall conform to IS: 2116. Cement and sand in the specified proportion shall be mixed dry thoroughly and minimum water added to attain required workability.

Surplus mortar droppings from masonry, if received on surface free from dirt may be mixed with fresh mortar if permitted by the Engineer who may direct addition of additional cement without any extra payment. No mortar, which has stood for more than half an hour, shall be used.

3.03.03 Brick Masonry

Bricks shall be soaked by submergence in clean water for at least two hours in approved vats before use. Bricks shall be laid in English bond unless specified otherwise. Broken bricks shall not be used. Cut bricks shall be used if necessary to complete bond or as closers. Bricks shall be laid with frogs upwards over full mortar beds. Bricks shall be pressed into mortar and tapped into final position so as to embed fully in mortar. Inside faces shall be buttered with mortar before the next bricks is placed and pressed against it. Thus all joints between bricks shall be fully filled with mortar.

Mortar joints shall be kept uniformly 10 mm thick. All joints on face shall be raked to minimum 10 mm depth using raking tool while the mortar is still green to provide bond for plaster or pointing.

Where plaster or pointing is not provided, the joints shall be struck flush and finished immediately. Brickworks two bricks thick or more shall have both faces in true plane. Brickwork of lesser thickness shall have one selected face in true plane.

3.03.04 Exposed Brickwork

Brickwork in superstructures, which is not covered by plaster, shall be as shown on drawing and executed by specially skilled mason. Courses shall be truly horizontal and vertical joints truly vertical. Wooden straight edges with brick course graduations and position of window sills and lintels shall be used to control uniformity of brick courses. Masons must check workmanship frequently with plumb, spirit level, rule, and string. All brickwork shall be cleaned at the end of days work. If face bricks are specified, the brickwork shall be in composite bricks, with face bricks on the exposed face and balance in routine bricks, but maintaining the bond fully. Where face bricks are not specified, bricks for the exposed face shall be specially selected from routine bricks. All exposed brickwork on completion of work shall be rubbed down, washed clean, and pointed as specified. Where face bricks are used carborandum stone shall be used for rubbing down.

3.03.05 Reinforced Brickworks

Reinforcements shall be as specified. All reinforcements shall be thoroughly cleaned and fully embedded in mortar. Where M.S. bars are used as reinforcement, these shall be lapped with dowels if left in R.C. columns or welded to steel stanchions.

3.03.06 Stone Masonry

Stones shall be thoroughly soaked before laying. Stones shall be laid on their natural quarry beds. Individual stones shall be fitted with mallet and properly wedged to reduce thickness of mortar joints. Thickness of joint shall be not less than 8 mm and not greater than 25 mm. At least two stones shall run the full width of the wall for every square meter of surface area.

3.03.07 Exposed Stone work

Stonework, which is to be kept exposed, shall be as shown on approved drawing. It shall be executed by specially skilled mason. Stones used for exposed face shall be specially selected. All exposed stone faces shall be kept clean and free from mortar and pointed up neatly as the work proceeds in a manner called for in the drawings or instructions. A sample wall, 10 Sq.M. area shall be built and approved by the Engineer and all works shall match with this sample.

3.03.08 Composite Masonry

Where stonework facing with brick masonry backing is specified the bond between them shall be achieved by bond stones of dimensions and frequency as desired by the Engineer.

3.03.09 Expansion & Separation Joints

Location of joints shall strictly be as shown on drawings or as instructed by the Engineer.

Expansion joints shall be as shown on drawings and specified. Expansion joint filler boards and sealing strips shall have minimum transverse joints. Transverse joints shall meet the approval of the Engineer.

Separation joints shall be with standard waterproof paper or with alkathene sheets about 1 mm in thickness. Length and sealing of laps shall be to the satisfaction of the Engineer.

3.03.10 Mouldings, Cornices, Drip Course

These shall be made as shown in drawings. Bricks or stone shall be cut and dressed as required. If no subsequent finish is envisaged, these shall be rubbed to correct profile with Carborundum stone.

3.03.11 Curing

Masonry shall be cured by keeping it wet for seven days from the date of laying. In dry weather at the end of days work top surface of masonry shall be kept wet by ponding.

3.03.12 Embedding of fixtures

All fixtures shall generally be embedded in mortar and masonry units shall be cut as required.

3.03.13 Encasing of Structural Steel

This shall be done by building masonry work round flanges, webs etc., and filling the gap between steel and masonry by minimum 12 mm thick mortar. Encased members shall be wrapped with chicken wire mesh when shown on drawings or instructed by the Engineer. The minimum lap in chicken wire mesh shall be 50 mm.

3.04.00 Damp Proof Course (DPC)

Unless otherwise specified Damp-proof course shall be 40 mm thick 'artificial stone' in proportion 1:1½:3 cement sand stone-chips (10 mm down) with admixture of a waterproofing compound as approved by the Engineer. The percentage of admixture shall be as per manufacturer's specifications but not less than 2% by weight of cement. The top surface shall be double chequered and cured by ponding for seven days.

3.05.00 Damp Proof Membrane

Damp proof treatment using fibre or hessian base bitumen felt shall be 6, 8 or 10 course treatment as specified in IS: 1609. The number of courses shall be as shown as drawings or as specified. Sequence of work shall be as directed by the Engineer. Extreme care shall be taken to prevent damage to felt during and after laying. The Contractor shall be obliged, at his own expense, to rectify any leakage appearing within 5 years of installation by removing and renewing the coats at the point of leakage.

Where shown on drawing, damp proof membrane with one layer bitumen paper or one layer alkathene sheet shall be laid with minimum 150 mm lap under slabs on grade.

3.05.00 Plinth Protection

Plinth of buildings shall be protected with brick-on-edge paving of minimum 750mm width unless otherwise shown on the drawings. The treatment shall consist of laying bricks in cement mortar 1:6 (1 cement: 6 sand) over a 75mm thick bed of dry graded brick aggregate, 40mm nominal size, grouted with sand. The top shall be finished with 1:2 cement mortar pointing (1 cement: 2 sand). Plinth protection shall be laid with a minimum outward slope of 1 in 50. The brick aggregate shall be well graded, broken from well burnt or slightly overburnt and dense brickbats. It shall be homogeneous in texture, roughly cubical in shape, clean and free from dirt or any other foreign matter.

The ground shall first be prepared to the required slope around the building. The high portions of the ground should be cut down; hollows and depressions filled up to the required level from the excavated earth and rammed so as to give uniform outward slope. The bed shall be watered and rammed with heavy iron square rammers. Surplus earth, if any, shall be disposed off beyond a lead of 50m or as directed by the Engineer.

Over this, 75mm thick bed of aggregate of 40mm nominal size, shall be laid with a minimum outward slope of 1 in 50. Aggregates shall be carefully laid and packed, bigger sized being placed at the bottom. The brick aggregates shall be consolidated dry with heavy iron rammers.

The aggregates shall then be grouted evenly with sand at the rate of 0.6 cubic metre per square metre area, adequately watered to ensure filling of voids by sand and again rammed with heavy iron rammers. The finished surface shall give uniform appearance. After the subgrade has been compacted thoroughly, brick flooring with bricks of specified strength in cement mortar 1:6 (1 cement: 6 sand) shall be laid.

The bricks shall be laid on edge in Diagonal/Herring Bone Bond or other pattern as specified or as directed by the Engineer. Bricks shall be laid on 12mm thick mortar bed and each brick shall be properly bedded and set home by gentle tapping with handle of trowel or wooden mallet. Its inside face shall be buttered with mortar before the next brick is laid and pressed against it. On completion of the portion of flooring, the vertical joints shall be fully filled from the top with mortar. The surface shall present a true plain surface with the required slope.

The pointing shall be done in cement mortar 1:2 (1 cement: 2 sand). The mortar shall be pressed into the joints and shall be finished off flush and level with the edges of the bricks so as give a smooth appearance. The edges shall be neatly trimmed with a trowel and a straight edge. The mortar shall not spread over surface of the masonry.

Brick flooring & pointing shall be kept wet for a minimum period of seven days. These shall be

protected from rain by suitable covering when the mortar is green.

4.00.00 I.S. CODES

Some of the important relevant codes for this section are:

IS: 1127: Recommendations for dimensions and workmanship of natural building stones for masonry work.

IS: 1597: Code of Practice for Construction of stone Masonry.

IS: 1609: Code of Practice for laying Damp proof treatment using bitumen felts.
IS: 2212: Code of Practice for Brickwork.

IS: 2250: Code of Practice for preparation and use of masonry Mortar.

IS: 5134: Bitumen Impregnated Paper & Board.

5.00.00 RATES AND MEASUREMENTS

5.01.00 Rates

Unit rate for masonry work shall include the following:

- a) Raking out joints for plastering or pointing or finishing the joint flush as the work proceeds.
- b) Preparing top sand sides of existing wall for joining old with new work.
- c) Providing, dismantling and removing the scaffolding.

Unit rate for DPC shall be inclusive of formwork and bitumen painting.

5.02.00 Measurement

Brickwork in wall of half brick thickness shall be measured separately in Sqm stating the wall thickness and more than half brick thickness shall be measured by volume. Plaster thickness shall not be considered for computation of volume.

Masonry work in sub structure and super structure shall be measured separately, unless otherwise specified in the Schedule of items.

No deductions shall be made and no extra payment shall be made for following:

- a) Opening upto 0.1 Sqm each in area. In calculating the area of the opening lintels or sills shall be included along with the size of the opening.
- b) Drainage holes and recesses for cement blocks to embed holdfasts for doors, windows etc.
- c) Pipe and fixtures upto 300mm dia. and nothing extra shall be paid for the mortar used for fixing.

Reinforcement in masonry work shall be paid separately under respective items.

Damp proof course shall be measured in Sqm. No deduction shall be made and no extra shall be paid for opening upto 0.1 Sqm in area.

Plinth protection shall be measured under respective item of works executed required for completion of the work as specified.

SECTION - D

SUB-SECTION – D10

FINISH TO MASONRY AND CONCRETE

C O N T E N T

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE
5.00.0	<u>RATES AND MEASUREMENTS</u>

FINISH TO MASONRY AND CONCRETE

1.00.00 SCOPE

This Section covers finishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of finishing items for masonry and concrete. This shall also include the work to be done to make the surface suitable for receiving the finishing treatment.

Before commencing finishing items the Contractor shall obtain the approval of the Engineer regarding the scheduling of work to minimize damage by other trades. He shall also undertake normal precaution to prevent damage or disfiguration to work of other trades or other installation.

2.00.01 INSTALLATION

2.01.00 Preparation of Surface

All joints in masonry walls shall be raked out to a depth of at least 10 mm with a hooked tool made for the purpose while the mortar is still green. Walls shall be rushed down with stiff wire brush to remove all loose dust from joints and thoroughly, washed with water. All laitance shall be removed from concrete to be plastered.

For all types of flooring, skirting and dado work, the base cement concrete slab or masonry surface shall be roughened by chipping and cleaned of all dirt, grease or loose particles by hard brush and water. The surface shall be thoroughly moist to prevent absorption of water from the base course. Any excess of water shall be mopped up.

g) At any point, the level of base shall be lower than the theoretical finished floor level by the thickness of floor finish. Any chipping or filling to be done to bring the base in the required level shall be brought to the notice of the Engineer and his approval shall be taken regarding the method and extent of rectification work required.

h)

Prior to commencement of actual finishing work, the approval of the Engineer shall be taken as to the acceptability of the base.

2.02.00 PLASTERING

2.02.01 Mortar

Mortar for plastering shall be as specified.

For sand cement plaster, sand and cement in the specified proportion shall be mixed dry, on a watertight platform and minimum water added to achieve working consistency. The sand for plaster shall conform to IS: 1542.

No plaster, which has stood for more than half an hour, shall be used; plaster that shows tendency to become dry before this time shall have water added to it.

2.02.02 Application of Plaster

Plaster, when more than 12 mm thick, shall be applied in two coats a base coat followed by the finishing coat. Thickness of the base coat shall be sufficient to fill up all unevenness in the surface; no single coat, however, shall exceed 12 mm in thickness. The lower coat shall be thicker than the upper coat; the overall thickness of the coats shall not be less than the minimum thickness shown on the drawings. The undercoat shall be allowed to dry and shrink before applying the second coat of plaster. The undercoat shall be scratched or roughened before it is fully hardened to form a mechanical key. The method of application shall be 'thrown on' rather than 'applied by trowel'.

To ensure even thickness and true surface, patches of plaster about 100 mm to 150 mm square or wooden screed 75 mm wide and of the thickness of the plaster, shall be fixed vertically about 2000 mm to 3000 mm apart, to act as gauges. The finished wall surface shall be true to plumb, and the Contractor shall, without any extra cost to the Owner, make up any irregularity in the brickwork with plaster.

All vertical edges of brick pillars, doorjambs etc. shall be chamfered or rounded off as directed by the Engineer. All drips, grooves, mouldings and cornices as shown on drawing or instructed by the Engineer shall be done with special care to maintain true lines, levels and profiles. After the plastering work is completed, all debris shall be removed and the area left clean. Any plastering that is damaged shall be repaired and left in good condition at the completion of the job.

2.02.03 Finish

Generally, the standard finish shall be used unless otherwise Shown on drawing or directed by the engineer. Wherever any special treatment to the plastered surface is indicated, the work shall be done exactly as shown on the drawings, to the entire satisfaction of the engineer regarding the texture, color and finish.

a) Standard Finish

Wherever punning is indicated, the interior plaster shall be finished rough; otherwise the interior plaster shall generally be finished to a smooth surface. The exterior surface shall generally be finished with a wooden float.

b) Neat Cement Finish

Immediately after achieving a true plastered surface with the help of a wooden straight edge, the entire area shall be uniformly treated with a paste of neat cement at the rate of one (1) kg. per Sq.M. and rubbed smooth with a trowel.

c) Coloured Plaster Finish

This shall be done in the same way as specified in Clause 2.02.02 but using Coloured cement in place of ordinary cement. When coloured plastering is specified in more than one coat, the topcoat only shall be made with coloured cement.

Coloured cement shall be either ready mixed material or may be obtained by mixing pigments and cement at site, as approved by the Engineer. The pigments to be mixed with cement shall conform to Appendix-A of IS: 2114 latest editions.

Samples of colouring material shall be submitted to the engineer for approval and material procured, shall conform in all respects to the approved samples, which shall remain with the Engineer. All coloured cement and/or pigments shall be stored in an approved manner in order to prevent deteriorations.

d) Pebble-dash Finish

Mortar of required thickness consisting of 1 part cement and 4 parts sand by volume shall be applied in the usual manner as described under plastering Clause 2.02.02. While the mortar is still plastic small pebbles or crushed stone of size generally from 10mm to 20mm as approved by the Engineer shall be thrown on the plastered surface. The aggregate shall be lightly tapped into the mortar with a wood float or the flat end of oil a trowel, in order to ensure satisfactory bond between the dashing and the mortar.

e) Rough-cast Finish

A wet plastic mix of 3 parts coloured cement 6 parts sand and 4 parts aggregate by volume (gravel or crushed stone of size from 6 mm to 12 as approved by the Engineer) shall be thrown on to the wall by means of a plaster's trowel and left in the rough condition.

f) Scraped Finish

Ordinary plaster as described under Clause 2.02.02 after being leveled and allowed to stiffen for a few hours, shall be scraped with a steel straight edge to remove the surface skin. The pattern shall be as approved by the Engineer.

g) Textured Finish

Mortar consisting of 1 part cement and 3 parts sand by volume shall be applied in a manner as specified under "Plastering" Clause 2.2.2 Ornamental treatments in the form of horizontal or vertical rib texture fan texture etc. shall be applied by means of suitable tools to the freshly applied plastered surface, as approved by the Engineer.

h) Sand Faced Plaster

The plaster shall be applied in 2 coats. The first coat or the scratch coat should be approximately 14mm and shall be continuously carried out without break to the full length

of wall or natural breaking points such as doors, windows, etc. The scratch coat shall be dashed on the prepared surface with heavy pressure, brought to true and even surface and then lightly roughened by cross scratch lines, to provide bond for the finishing coat. The mortar proportion for this scratch coat shall be as specified in the respective item or work. The scratch coat shall be cured for at least 7 days & then allowed to dry. The second coat shall be 6mm thick and it shall not be applied until at least 10 days have elapsed after the application of scratch coat. Before application of the second coat, the scratch coat shall be evenly damped. This coat shall be applied from top to bottom in one operation & without joints; finish shall be straight, true, & even. The mortar of this coat shall be as specified under the respective item of work. White sand for finish shall be used for the second coat & for finishing work. Sand for finish shall be of even coarse size & shall be dashed on the surface & sponged.

2.02.04 Curing

All plastered surfaces after laying shall be watered, for a minimum period of seven days, by an approved method, and shall be protected from excessive heat and sunlight by suitable approved means. Moistening shall commence, as soon as the plaster has hardened sufficiently and not susceptible to damage. Each individual coat of plaster shall be kept damp continuously, for at least two days, and then dried thoroughly, before applying the next coat.

2.03.00 Pointing to masonry

All Joints of brickwork shall be raked out to a depth of 10 mm with a hooked tool made for the purpose while the mortar is still green. The brickwork shall then be brushed down with a stiff wire brush, so as to remove all loose dust from the joints and thoroughly washed with water. Mortar consisting of 1 part cement and 3 parts clean, sharp, well graded sand by volume shall be pressed carefully into the joints and finishes with suitably tools to shape as shown on the drawings. Any surplus mortar shall be scalped off the wall face leaving the surface clean.

The pointed surface shall be kept wet for at least three days for curing.

2.04.00 Plaster with Metal Lath

The supports, hangers, brackets, cleats etc. shall be as shown on drawings and/or as approved by the Engineer. These shall have a coat of prime paint before and another coat of approved paint after erection.

The metal lath shall be expanded metal, with 12 mm x 38 mm mesh, 16 thick and 3 mm wide strands. Side laps shall be minimum 12 mm and end laps 25 mm minimum. The plastering shall be minimum 20 mm thick measured from the back of lath and applied in two-layers. The mortar for plastering shall consist of 1 part cement and 4 parts sand by volume mixed as specified in plastering, Clause 2.02.01. The application, finish etc. shall be as specified under relevant clause above. Where called for a 2 mm Plaster of Paris punting shall be applied over plaster as a finishing coat to give perfectly smooth and even finish.

2.05.00 Lime Punning

For plastered surfaces, where an even smooth surface is specified, lime punning with 5 parts of shell lime properly slaked, strained and aged, mixed with 1 part clean, washed, sieved, fine sand by volume shall be done. The thickness of lime punning shall be not less than 2 mm and more than 3 mm. The plastered surface shall be saturated with water before application of the lime punning. The punting shall be applied by skilled workman and given a smooth and even finish free from undulations, cracks etc. and to the satisfaction of the Engineer.

2.06.00 Plaster of Paris Punning

Plastered surfaces, where specified shall be finished with Plaster-of-Paris punning. The material shall be from approved manufacturers and approved by the Engineer. The thickness of the punning shall be 2 mm and shall be applied by skilled workmen. The finish shall be smooth, even and free from undulation, cracks etc.

Before bulk work is taken in hand, a sample of punning shall be done on roughly 10 Sq.M. areas and approval of the Engineer taken. The work shall then be taken in hand as per approved sample.

2.07.00 Stone Facing

Stone facing where specified shall be done as shown on design drawings and approved shop drawings. The stone shall be as specified on drawings. Samples of stone shall be submitted to the Engineer for approval and then bulk purchase made. The Contractor shall submit three copies of shop drawings for the Engineer's approval before commencing the work.

The thickness of facing stone shall be not less than 25 mm unless otherwise specified on drawings.

The stone slabs shall be cut and finished to sizes as per pattern shown on drawings.

They shall be fastened to wall with suitable non-corrodible anchorage as approved by the Engineer. Where mild steel clamps, stays etc. are used for anchorage, they shall be galvanized (weight of zinc coating shall not be less than 700 gms per square meter of surface) to prevent rust stains developing on the finished surface. There shall be at least 12 mm gap between the stone and masonry, which shall be filled up and packed by a mortar of 1 part cement and 3 parts of sand by volume. After the mortar is set and cured for at least four days, the exposed surface shall be rubbed and polished as approved by the Engineer.

The completed surface shall be neat, or uniform texture and acceptable to the Engineer.

Where pointing is specified on drawings it shall be done by mortar as specified on drawings.

3.00.00 ACCEPTANCE CRITERIA

Finish to masonry and concrete shall fully comply with the Specifications, approved samples and instructions of the Engineer with respect to lines, levels, thickness, colour, texture, pattern and any other special criteria as mentioned in the body of the specification or as shown on drawings.

4.00.00 I.S. CODE

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

i)

j) IS: 1661: Code practice for cement and cement-lime plaster finish on wall & ceilings.

k)

l) IS: 4101: code of practice for external facings and veneers.

m)

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall also include providing, dismantling and removing of scaffolding, surface preparation, curing and all type of surface, shapes/ profiles and at all elevations.

5.02.00 Measurement

All plastering shall be measured net (on surface area on which it is applied) in Sqm. Plaster work shall be classified according to the type used and shall be measured separately. Plaster on ceiling and walls shall be measured separately. Soffits of stairs shall measured as plastering on ceiling.

No deduction shall be made for opening not exceeding 0.5 Sqm and for ends of beams, joints, etc. also no payment shall be made for reveals, jams, soffits, sills of these openings.

50% deduction shall be made for opening exceeding 0.5 Sqm but not exceeding 3.0 Sqm each and no addition shall be made for reveals, jams, soffits, sills etc.

In case of opening exceeding 3.0 Sqm each, deduction shall be made for opening but jams, soffits, and reveals shall be measured and paid for.

SUB-SECTION – D11
PAINTING, WHITEWASHING, POLISHING

C O N T E N T

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA AND TESTING
4.00.00	I.S. CODES AND STANDARDS
5.00.00	RATES AND MEASUREMENTS

PAINTING, WHITE WASHING, POLISHING, ETC.

1.00.00 SCOPE

This section covers painting, white washing, varnishing, polishing etc. of both interior and exterior surfaces of wood work, masonry, concrete plastering, plaster of paris, false ceiling, structural and other miscellaneous steel items, rain water down comer, floor and roof drains, soil, waste and service water pipes, and other ferrous and non-ferrous metal items.

Copper, bronze, chromium plate, Nickel, stainless steel and aluminium shall generally not be painted or finished except if otherwise specified.

Before commencing painting, the Contractor shall obtain the approval of the Engineer in writing regarding the schedule of work to minimize damage; disfiguration or staining to work of other trades or other installations.

2.00.00 Installation

2.00.01 Materials

Materials shall be highest grade products or well-known approved manufacture and shall be delivered to the site in original sealed containers, bearing brand name, manufacturer's name and colour shade, with labels intact and seals unbroken. All materials shall be subject to inspection, analysis and approved by the Engineer. It is desired that materials of one manufacturer only shall be used as far as possible and paint of one shade is obtained from the same manufacturing batch. Each and every supply of primer, finish paint etc. shall be accompanied by manufacturer's test certificate. All paint shall be subject to analysis from random samples taken at site from painters bucket, if so desired by the Engineer.

All prime coats shall be compatible to the material of the surface to be finished as well as to the finished coats to be applied.

All unspecified materials such as snellac, turpentine or linseed oil shall be of the highest quality available and shall conform to the latest IS standards. All such materials shall be made by reputable recognized manufacturers and shall be approved by the Engineer.

All colours shall be as per painting schedule and tinting and matching shall be done to the satisfaction of the Engineer. In such cases, where samples are required, they shall be executed in advance with the specified materials for the approval of the Engineer.

a) White Wash/Colour Wash

Shall be done from pure shell lime or fat lime, or a mixture of both as instructed by the engineer, and shall conform to IS: 712 latest editions. Samples of lime shall be submitted to the Engineer for approval, and lime as per approved sample shall be brought to site in unslaked condition. After slaking, it shall be allowed to remain in a tank for two days and then stirred up with a pole, until it attains the consistency of thin cream. 100 grams of gum to 6 liters of white wash water and a little of indigo or synthetic ultramarine blue shall be added to the lime. Mineral colour not affected by lime shall be added to white wash to get the required tint/shade approved by the Engineer.

b) Dry distemper

Shall be made from suitable pigments, extenders, lime proof tinters, water-soluble binders etc. and shall conform to IS: 427. The distemper shall be diluted with prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for a day's work shall be prepared.

c) Oil Bound Washable Distemper

Shall be of oil emulsion type containing suitable preservatives and shall conform to IS: 428. The distemper shall be diluted with prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for a day's work shall be prepared.

d) Waterproof Cement Paint

Shall be made from best quality white cement and lime resistant colours with accelerators, waterproofing agents and fungicides. The paint shall conform to IS: 5410.

e) Acrylic Emulsion Paint

Shall be water-based acrylic copolymer emulsion with rutile titanium dioxide and other selected pigments and fungicide conforming to IS: 5411 (Part-1). It shall exhibit excellent adhesion to plaster and cement surface and shall resist deterioration by alkali salts. The paint film shall allow the moisture in wall to escape without peeling or blistering. The paint, after it is dried, shall be able to withstand washing with mild soap and water without any deterioration in colour, or without showing flaking, blistering, or peeling.

f) Synthetic Enamel Paint

Shall be made from synthetic resins and drying oil with rutile titanium dioxide and other selected pigments to give a smooth, hard, durable and glossy finish to all exterior and resist interior surfaces. White and pastel shades shall not yellowing and darkening with aging. The paint shall conform to IS: 2932 and IS: 2933.

g) Aluminium Paint

Shall be in two pack containers and shall resist weathering. The paint shall conform to IS: 2339.

h) Varnishing

Shall be best quality alkyd varnish suitable for brushing over the tint of paint or light natural wood and shall not darken or yellow with age.

i) French Polish

Shall be made from best quality shellac, denatured spirit and other suitable alcohol soluble ingredients and made by a well known approved manufacturer. The material shall conform to IS: 348.

French polish shall not be used on bare wood it shall only be used as finishing coat on wood after the woods pretreated with a liquid wood filler conforming to IS: 345 is applied and rubbed out.

j) Bitumen paint (black bituminous anti-corrosive paint)

Bitumen based anti-corrosive paint conforming to IS: 158 shall be used.

2.00.02 Storage

The Contractor shall arrange for safe and proper storage of all materials and tools. The storage space if allotted within the building shall be adequately protected from damage, disfigurement, & stains. Paint shall be kept covered at all times and mixing shall be done in suitable containers. All necessary precautions shall be taken by the contractor to prevent fire.

2.01.00 Preparation of surface

Before starting the work the Contractor shall obtain the approval of the Engineer regarding the soundness & readiness of the surface to be painted on.

2.01.02 Wood

All surfaces shall be free from, dirt and loose or peeling paints. The surface shall be rubbed down smooth. All nails & screws shall be sunk below the surface and filled with putty after applying an under coat. Small knots that do not justify cutting and sap streaks shall be covered with minimum 2 coats of pure shellace coating applied thinly & extended 25 mm beyond the area. All large, loose, or resinous knots shall be removed and filled with sound wood. All work shall be done as per IS: 2338.

2.01.02 Masonry, Concrete, and Plastered Surface

Surface shall be free from all oil, grease, efflorescence, mildew, loose paint, or other foreign and loose materials. Masonry cracks shall be cleaned out and patch filled with mortar similar to the original surface and uniformly textured. Where this type of resurfacing may lead to the finishing paint being different in shade from, the original surfaces, the resurfaces area shall be treated with minimum one coat of cement primer, which should be continued to the surrounding area for a distance of minimum 100 mm.

Surface with **Mildew or Efflorescence** shall be treated as below:

All mildewed surfaces shall be treated with an approved fungicide such as ammoniacal wash consisting of 7g of copper carbonate dissolved in 80ml liquor ammonia and diluted to water, or 2.5 percent magnesium silicofluoride solution and allowed to dry thoroughly before paint is applied.

2.01.03 Metal

The surface preparation shall be done in accordance with IS:1477(Part-1) 'Code of practice for painting of ferrous metals in building' and as directed by Engineer. All metal surfaces shall be absolutely clean, dry, and free from rust, scales, weld slag, flux deposit, wax, grease, dried soap films, foreign matters like cement mortar etc and free from existing loose red oxide zinc chromate primer and should be removed by means of wire brushes, hand scrappers, sand paper, emery cloth, emery papers, or by mechanical power tools etc. or as directed by Engineer. For exposed chemical resistant paints, surfaces shall be blast cleaned to near white metal. All galvanized iron surfaces shall be pretreated with a compatible primer according to the manufacturer's direction. Any abrasion in shop coat shall be touched up with the same quality of paint as the original coat. The actual painting work should be commenced only after obtaining clearance from the Engineer regarding proper cleaning of the surface.

2.02.00 Application

2.02.01 General

The method of application shall be as recommended by the manufacturer. In case of selection of special shades and colour (not available in standard shades) the Contractor shall mix different shades and prepare test panels of minimum size 1 meter square as per instruction of the Engineer and obtain his approval prior of application of finishing paints.

Proper tools and implements shall be used. Scaffoldings used shall be independent of the surface to be painted to avoid shade differences of the freshly repaired anchor notes.

Painting shall be done by skilled labours in a workmanlike manner. All materials shall be evenly applied so as to free of sags, runs, crawls, or other defects. All coats shall be of proper consistency. In case of application by brush, no brush marks shall be visible. The brushes shall be clean and in good condition before application of paint.

All priming undercoat for painting shall be applied by brush only, and rollers spray equipments etc. shall not be used.

No work shall be done under conditions that are unsuitable production of good results. No painting shall be done when plastering is in progress or is drying. Application of paint, which seals the surfaces to moisture shall only be done after the moisture on and below the surface has dried out.

All coats shall be thoroughly dry before succeeding coat is applied. Coats of painting as specified are intended to cover surfaces perfectly. In case the surface is not covered properly by applying the specified number of coats, further coats shall be applied by the Contractor when so desired by the Engineer.

All primers and undercoats shall be tinted to approximate the colour of the finishing coats. Finished coats shall be of exact colour and shade as per approved samples and all finish shall be uniform in colour and texture. All parts of mouldings and ornaments shall be left clean and true to finish.

Painting on ferrous metal surface shall, be done as per IS: 1477 (Part I & 2). The total dry thickness of film should not be less than 120 Micron.

2.02.02 White Washing

The surface where white washing is to be applied shall be cleared of all loose materials and dirt. All holes and irregularities of the surface shall be filled up with lime putty and shall be allowed to dry up before white washing.

One coat of whitewash shall consist of one stroke from top downwards, another from bottom upwards over the first stroke and another from left to right before the previous one dries up. Second coat shall be applied and in case the Engineer feels that one or more coats are required the Contractor shall do so without any extra cost to the Owner. No brush marks shall show on the finished surface.

2.02.03 Dry Distemper

New plastered surface shall be allowed to dry for at least two months. New lime or lime cement

plastered surface shall be washed with a solution of 1 part Vinegar to 12 parts water or 1:50 sulphuric acid solution and for 24 hours after which the wall shall be thoroughly washed with clean water. For cement-plastered surface, the surface shall be washed with solution of 100 gms. of zinc sulphate to 1 litre of water and allowed to dry.

Dry distempering shall be done as per manufacturers instruction. In applying the distempers the brush, should first be applied horizontally and immediately crossed off perpendicularly. Brushing shall not be continued too long, otherwise brush marks may result.

2.02.04 Oil bound washable distemper

The distemper shall be applied after surface is primed with an alkali resistant primer, and followed by minimum two coats of oil bound washable distemper all as per manufacturer's instruction.

2.02.05 Waterproof Cement Paint

Surface to be coated with cement paint shall be washed and brushed down. As soon as the moisture has disappeared, the surface shall be given one coat of paint. Care shall be taken so that the paint does not dry out too rapidly. After 4 to 6 hours, the water shall be sprinkled over the surface to assist curing and prevent cracking. After the first coat has dried (24 to 48 hours) the second coat shall be applied in a similar manner. The finished surface shall be kept moist by occasional sprinkling with water for seven days after painting.

2.02.06 Acrylic Emulsion Paint

Paint shall be applied after providing one coat of cement primer solvent of approved quality and primer shall be conform to IS: 109. Lime gauged cement plastered surfaces shall not be painted for at least one month after plastering. A sample patch shall be painted to check alkali reaction if so desired by the Engineer. Painting shall be done strictly as per manufacturer's specification.

2.02.07 Synthetic Enamel Paint

Shall be applied on properly primed surface. Subsequential coat shall not be applied till the previous coat is dry. The previous shall be lightly sand papered for better adhesion of subsequent coats.

2.02.08 Aluminium Paint

The paint, supplied in two pack containers shall be mixed and applied strictly as per manufacturer's direction. When more than one coat of paint is required or indicated, the next coat shall only be applied after the previous coat become hard dry.

2.02.09 Clear Synthetic Varnish

The Varnish shall be applied on wood surface after (a) filling, (b) staining & (c) sealing operations are carried out. The application of a combination of filler and stain shall not be permitted.

For the finishing coats of varnish, the surface shall be allowed to dry and be rubbed down lightly, wiped off and allowed to dry. Careful attention to cleanliness is required for varnishing. All dust and dirt shall be removed from the surface as well as from the neighbourhood. Damp atmosphere and draughts shall be avoided, and exposure to extreme heat or cold & dampness shall not be allowed.

The varnish shall be applied liberally with a brush and spread evenly over a portion of the surface with light strokes to avoid frothing. It shall be allowed to flow on white the next section is being laid on excess varnish shall then be scrapped off the brush and the first section be crossed, recrossed and then laid off lightly. The varnish once it has begun to set shall not be retouched. In case of any mistake in application, the varnish shall be removed and the work started afresh.

The varnish shall be minimum of two coats, with the first coat being a flatting varnish. This shall be allowed to dry hard and be flatted down, before applying the next coat. Sufficient time must be allowed between coats to get a hard dry surface before next coat is applied. All work shall be as per relevant IS Code.

2.02.10 French polish

All unevenness of the surface shall be rubbed down to smoothness with sand paper and the surface shall well dusted .The pores in the shall be filled up with a paste of whitening in water or methylated spirit with a suitable pigment like burnt siemme or umber.

After application of the filler paste, the French polish shall be applied with a pad of woollen cloth covered by a fine cloth. The pad shall be moistened with polish and rubbed hard on the surface in a series of overlapping circles so that the polish is sparingly but uniformly applied over the entire area to give an even surface. A trace of linseed oil may be used on the pad for case of application. The surface shall be allowed to dry before further coats are applied in the same manner. To finish off, the pad shall be covered with a fresh piece of clean fine cloth, slightly damped with methylated spirit, and rubbed lightly and quickly with circular motions to leave the finished surface with a uniform texture and high gloss.

2.02.11 Chemical Resistant Paint

For chemical resistant paints, epoxy, chlorinated rubber, or vinyl butryl paint system shall be used. Manufacturer's recommendation shall be followed regarding the paint system, exposed to moderately to severe corrosive condition and subject to acid/alkali spillage & fumes, shall be followed.

2.03.00 Protection

Furniture and other movable objects, equipment, fittings and accessories shall be moved, protected and replaced upon completion of work. All stationary equipment shall be well covered so that no paint can fall on them. Work finished by other agencies shall be well protected. All protections shall be done as per instructions of the Engineer.

2.04.00 Cleaning up

In addition to provisions in general conditions the Contractor shall, upon completion of painting etc. remove all marks and make good surfaces, where paint has been splashed or splattered, including all equipment, fixtures, glass, furniture, fittings etc. to the satisfaction of the Engineer.

3.00.00 ACCEPTANCE CRITERIA AND TESTING

- a) All painted surfaces shall be uniform and pleasing in appearance.
- b) All varnished surfaces shall be of uniform texture and high glossy finish.

- c) The colour, texture etc. shall match exactly with those of approved samples.
- d) All stains, splashes, and splatters of paints and varnishes shall be removed from surrounding surfaces.

Testing

- a) As, each part of the work is under progress, i.e. preparation of surface, providing primer, providing different coats of finishing paints, it shall be passed by the Engineer. Variation from the drawings or specification or standard etc. shall not be accepted. The Contractor shall ascertain from the Engineer as to which parts will be inspected and passed from time to time. The Contractor shall provide all necessary arrangement for inspection of the painting work during its different working phase. The Contractor shall provide necessary scaffolding, approach for inspection of the above as per direction and satisfaction of the Engineer. All the necessary cost for scaffolding, approach, platform, lighting arrangement testing and inspection shall be borne by the Contractor. Such inspection and testing will not, however, exonerate the Contractor from his responsibilities for proper workmanship, material etc.
- b) The Contractor shall carry out all sampling and necessary testing in accordance with the relevant Indian Standards and shall conduct such tests as called for by the Engineer. Where no specific testing procedure is mentioned in the relevant codes, the tests shall be carried out as per the prevalent accepted Engineering practice as per the direction of the Engineer. Tests shall be done in a laboratory, approved by the Engineer, and cost of testing shall be borne by the contractor.
- c) Material/workmanship unsuitable for acceptance shall be removed and replaced by the Contractor. The work shall be redone as per Specification of the contract and direction of the Engineer without extra cost to owner.

4.00.00**I.S. CODE**

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 348	Specification for French polish
IS: 427	Specification for Distemper, dry colour as required.
IS: 428	Specification for Distemper oil emulsion, colour as required.
IS: 1477 (I & II)	Code of Practice for painting of ferrous metal in buildings.
IS: 2338 (I & II)	Code of Practice for finishing of wood and wood based materials.
IS: 2339	Specification for Aluminium, Paints for general purposes in dual containers.
IS: 2395	Code of Practice for painting concrete, masonry, and Plaster surface.
IS: 2932	Specification for enamel, exterior type-1.
IS: 5410	Specification for cement paint, colour as required.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be unit rates for complete items described in the “Schedule of Items”.

Rate shall include cleaning, preparation of surface, supply and application of primer, painting and providing all protection and scaffolding required at site.

5.02.00 Measurements

Painting over the concrete/masonry/wooden surface shall be measured net (on the surface area on which it is applied) in Sqm.

No deduction shall be made for opening not exceeding 0.5 Sqm and ends of beams, joints, etc. also no payment shall be made for reveals, jams, soffits, sill of these openings.

50% deduction shall be made for opening exceeding 0.5 Sqm but not exceeding 3.0 Sqm each and no addition shall be made for reveals, jams, soffits, sills etc.

In case of opening exceeding 3.0 Sqm each, deduction shall be made for opening but jams, soffits, and reveals shall be measured and paid for.

Corrugated surfaces shall be measured flat and measured area shall be increased by 15%.

Painting of structural steel works shall be measured in M.T. unless specified otherwise.

SUB-SECTION – D12

FLOOR FINISH AND ALLIED WORKS

C O N T E N T

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODES

5.00.00 RATES AND MEASUREMENTS
 FLOOR FINISH AND ALLIED WORKS

1.00.0 SCOPE

This section covers furnishing, installation, finishing, curing, testing, protection, maintenance till handing over various types of floor finishes, and allied items of work as listed below

a) In Situ Finishes

- n) i) Integral finish to concrete base
- o)
 - p) ii) Terrazzo finish
 - q)
 - r) iii) Granolithic finishes
- iv) Patent Stone
- v) Metallic Hardener like “Ironte”/Hardonate Finish
- vi) Mastic Asphalt finishes
- vii) Chemical Resistant finish

b) Tiled Finishes

- i) Terrazzo tile
- ii) Chequered tile
- iii) Glazed tile
- iv) Tesse rae (Mosaic etc.)
- v) Chemical Resistant
- vi) Rubber, Vinyl etc.
- vii) Stone Slab including Kota Stone.

1.01.00 Base

The base to receive the finish is covered under other relevant specifications.

1.01.01 Sequence

Commencement, scheduling and sequence of the finishing works shall be planned in detail and must be specifically approved by the Engineer in view the activities of other agencies working

in that area. However, the Contractor for the finishing items shall remain fully responsible for all normal precautions and vigilance to prevent any damages whatsoever till handing over.

2.00.00 INSTALLATION

2.00.01 Special Materials

Basic materials are covered elsewhere under the Specification. In general, all such materials shall be as per relevant Codes where available. In all cases these materials shall be of the best quality available indigenously unless specified otherwise.

The materials for finishing items must be procured from well-reputed specialized manufacturers and on the basis of approval of samples by the Engineer. The materials shall be ordered, procured and stored well in advance to avoid compulsion to use substandard items to maintain in the construction schedule.

2.00.02 Workmanship

Only workers specially experienced in particular items of finishing work shall be engaged, where such workers are not readily available, with the Engineer's permission, experienced supervisors recommended by the manufacturer shall be engaged. In particular cases where the Engineer so desires the Contractor shall get the finishing items installed by the manufacturer.

2.00.03 Preparation of the Base Surface

The surface to be treated shall be thoroughly examined by the Contractor. Any rectification necessary shall be brought to the notice of the Engineer and his approval shall be taken regarding method and extent of such rectification work.

For all types of flooring, skirting, dado and similar locations, the base to receive the finish shall be adequately roughened by chipping, raking out joints and cleaning thoroughly all dirt, grease etc. with water and hard brush and detergent if required, unless otherwise directed by the manufacturer of any special finishing materials or specifically indicated in this specification.

To prevent of water from the finishing treatment the base shall be thoroughly soaked with water and all excess water mopped up.

The surface shall be bone dry where adhesives are used for fixing the finishes.

Prior to commencement of actual finishing work the approval of the Engineer shall be taken as per the acceptability of the surface.

2.01.00 In Situ Finishes

2.01.01 Integral Finish To Concrete Base

While the surface of the concrete laid as per specification for 'Cement Concrete' has been fully compacted and levelled but the concrete is still 'green' thick slurry, made with neat cement shall be applied evenly and worked in with iron floats. When the slurry starts to set it shall be pressed with iron floats to have a firm compact smooth surface without trowel mark or undulations. This finish shall be as thin as possible by using 2.2 kg. of cement per Sq.M. of area.

The surface shall be kept in shade for 24 hours and then cured for at least 7 days continuously by flooding with water. The surface shall not be subjected to any load or abrasion till 21 days after lying.

As desired by the Engineer the surface, while still 'green' shall be indented by pressing strings, the marking shall be of even depth, in straight lines and the panels shall be of uniform and symmetrical patterns.

2.01.02 Terrazzo Finish in Situ

It shall consist of an underbed and a topping laid over an already laid and matured concrete base.

a) Thickness

Unless otherwise specified the total thickness of the 'finish shall be minimum 40 mm for horizontal and 25 mm for vertical surface of which the topping shall be not less than 10 mm. While the topping shall be of uniform thickness the underbed may vary in thickness to provide necessary slopes. The vertical surface shall project out 6 mm from the adjacent plaster or other finish. Necessary cutting into the surface receiving the finish shall be done to acc ate the specified thickness. All junctions of vertical with horizontal shall be rounded neatly to uniform radius of 25 mm.

b) Mix

i) Underbed

The underbed for floors and similar horizontal surfaces shall consist of a mix of 1 parts cement, 1½ parts sand and 3 parts stone chips by volume. For vertical surfaces the mix shall consist of 1 part cement to 3 parts sand by volume. The sand shall be coarse. The stone chips shall be 10 mm down well graded. Only sufficient water to be added to give a workable consistency.

ii) Topping

The mix for the topping shall be composed of cement, colour Pigment, marble dust and marble chips. Proportions of the ingredients shall be such as to produce the terrazzo of colour texture and pattern approved by the Engineer. The cement shall be white or gray or a mixture of the two to which pigment shall be added to achieve the desired colour. To 3 parts of this mixture 1 part marble powder by volume shall be added and thoroughly mixed dry. To 1 part of this mix 1 to 1½ parts of marble chips by volume shall be added and thoroughly mixed dry again.

The pigment must be stable and nonfading. It must be very finely ground. The marble powder shall be from White marble and shall be finer than IS Sieve No.: 30. The size of marble chips shall be between 1 mm to 20 mm. Sufficient quantity to cover each visible area shall be prepared in one lot to ensure uniform colour. Water to make it just workable shall be added to a quantity that can be used up immediately before it starts to set.

c) Laying

The underbed shall be laid in panels. The panels shall not be more than 5 Sq.M. in area of which no side shall be more than 2.5 M. long. For exposed locations the maximum area of a panel shall be 2.0 Sq.M. The panel shall be laid in alternate bays or chequered board pattern. No panel shall be cast in contact with another already laid until the latter has contracted to the full extent.

Dividing strips made of aluminium or glass shall be used for forming the panels. The strips shall exactly match the total depth of underbeds plus topping.

After laying, the underbed shall be levelled compacted and brought to proper grade with a screed or float. The topping shall be laid after about 24 hours while the underbed is still somewhat "green" but firm enough to receive the topping. A slurry of the mixture of cement and pigment already made shall be spread evenly and brushed in just before laying the topping. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water and to achieve a compact dense mass fully bonded with the underbed. The surface of the topping shall be trowelled over, pressed and brought to a smooth dense surface showing a minimum 75% area covered by marble chips in a even pattern of distribution.

d) Curing

The surface shall be left for curing for about 12 to 18 hours and then cured by allowing water to stand on the surface or by covering with wet sack for four days.

e) Grinding and Polish

When the surface has sufficiently hardened it shall be watered and ground evenly with rapid cutting coarse grade (no.80) grit blocks, till the marble chips are exposed and the surface is smooth. Then the surface shall be thoroughly washed and cleaned. A grout with already prepared mixture of cement and pigment shall be applied to fill up all pinholes. The surface shall be cured for 7 days by keeping it moist and then ground with fine grit blocks (no.: 120). It shall again be cleaned with water, the slurry applied again to fill up any pinholes that might have appeared and allowed to be cured again for 5 days. Finally, the surface is ground a third time with very fine grit blocks (no.: 320) to get smooth surface without any pinhole. A suitable machine shall do the grinding. Where grinding machine can not be used hand grinding may be allowed when the first rubbing shall be with carborundum stone of coarse grade (no.:60), second rubbing with medium grade (no.: 80) and final rubbing and polishing with fine grade (no.: 120). The surface shall be cleaned with water, dried, and covered with soil free, clean sawdust if directed by the Engineer. The final polishing shall be postponed till before handing over if desired by the Engineer. Just before handing over the surface shall be dusted with oxalic acid at the rate of 0.33 gm. per. Sq.M., water sprinkled on to it and finished by buffing with felt or hessian bobs. The floor shall be cleaned with soft moist rag and dried. However, all excess wax polish to be wiped off and the surface to be left glossy, but not slippery.

2.01.03 Granolithic Finish

Granolithic finish shall either be laid monolithically over base concrete or separately over hardened base concrete.

a) Thickness

The finish shall be average 20 mm and minimum 12 mm thick, unless specified otherwise.

b) Mix

The mix shall consist of 1 part cement: 1 part coarse sand 2 parts coarse aggregate by volume. The coarse aggregate shall be very hard like granite and well graded between 6 mm and 12 mm. Minimum quantity of water to get workability shall be added.

c) Laying of Monolithic Topping

The concrete base shall be laid as per specification "Cement Concrete" and levelled upto the required grade. The form shall remain sufficiently protruding to take the finish.

Within about 3 hours of laying the base while it is still fully -green- the topping shall be laid evenly to proper thickness and grade. If considered necessary the surface of the base shall roughened by wire brushing. Unless manual operation is permitted by the Engineer, mechanical vibrators of suitable design shall be used to press the topping firmly and work vigorously and quickly secure full bond with concrete base.

The laitance brought to the surface during compression shall be removed carefully without disturbing the stone chips. The surface shall then be lightly trowelled to remove all marks. When sufficiently set, hand trowelling shall be done to secure a smooth surface without disturbing the stone chips.

For large areas the laying shall be in panels of maximum 25 Sq.M. area. The panels shall be laid in chequered board pattern.

d) Laying of Topping Separately on Hardened Base

The base concrete shall be prepared as stated in clause 2.00.03 and a slurry of neat cement applied just prior to laying the granolithic concrete mix (1:1:2). The method of compaction etc. shall be same as for monolithic topping.

e) Curing

Immediately after laying, the finish shall be protected against rapid drying. As soon as the surface had hardened sufficiently, it shall be kept continuously moist for at least 10 days by means of wet gunny bags or ponding of water on the surface. The floor shall not be exposed to heavy traffic during this period.

f) Grinding

If grinding is specified, it shall start only after the finish has fully set. Clause 2.01.02 (e) shall be followed. However, the Engineer shall decide upon the ultimate polish required.

g) Finishing

Where specified, sodium, silicate or magnesium or zinc silico fluoride treatment shall be done. The number of coats to be applied shall be as per approved drawings or as instructed. The concentration and method of application of the solutions shall be as specified in IS: 5491.

2.01.04 Patent Stone

It shall consist of an underbed and a topping laid on an already laid and matured concrete base.

a) Thickness

The patent stone finish shall have thickness as stipulated under clause 2.01.02 (a) except that the topping shall be 12 mm thick.

b) Mix

i) Underbed

The mix shall be as stipulated under clause 2.01.02 (b).

ii) Topping

The mix for the topping shall consist of 1 part cement and 2 part stone aggregate 6mm nominal size by volume.

c) Laying

The Patent Stone finish including the underbed shall be laid in alternate bays or in Chequered board pattern. No panel shall be cast in contact with another already laid till the contraction of the latter has already taken place.

The maximum area of each panel shall be 3 Sq.M. of which no side shall be more than 2 M. long.

A cement grout shall be applied and worked into the surface to receive the finish; the underbed then laid, compacted, and leveled to proper grade with a screed or float. The topping shall be applied evenly on the underbed while it is not fully set but firm enough and rolled and pressed to get full bond. The topping shall be trowelled to a dense finish to the satisfaction of the Engineer. All trowel marks shall be mopped out with a soft cloth to give a clean smooth surface.

After the surface is sufficiently set, the finished floor shall be kept moist for 7 days for curing. If desired the finish shall be polished as directed by the Engineer.

2.01.05 Metallic Hardener Like 'Ironite'/'Hardonate' Finish

This will consist of a topping (incorporating iron particles) to bond with concrete base while the latter is 'green'.

a) Thickness

Unless otherwise specified the metallic hardener finish shall be of 12 mm depth.

b) Material

The hardening compound shall be uniformly graded iron particles free from non-ferrous metal impurities, oil, grease, sand soluble alkaline compounds or other injurious materials when desired by the engineer, actual samples shall be tested.

c) Mix

Proportion of the metallic hardener shall be as specified or as indicated by the manufacturer. However, in absence of any such direction 1 part metallic hardener shall be mixed dry, with 4 parts cement, by weight. To this mixture 6 mm nominal size stone chips shall be added in proportion of 1 part cement (mixed with hardener) to 2 parts of stone chips by volume and uniformly mixed. Minimum quantity of water shall be added to make it workable.

d) Laying

The concrete floor shall be laid as per specification 'Cement Concrete' and levelled upto required grade. The forms, if any, shall remain sufficiently projecting to make the finish. The surface shall be roughened by wire brush as soon as possible.

The finish shall be laid while the concrete underbed is still very 'green' within about 3 hours of laying of the latter. The finish shall be of uniform thickness and even dense surface without trowel marks, pin holes etc. This topping layer shall be pressed firmly and worked vigorously and quickly to secure full bond with the concrete base. Just when the initial set starts the surface shall be finished smoothed with steel trowel.

The finished floor shall be cured for 7 days by keeping it wet.

2.01.06 Mastic Asphalt Finish

This is a one-layer treatment on concrete or brick base.

a) Thickness

The thickness shall be as specified in the drawing.

b) Materials

Bitumen shall be industrial Bitumen of the grade 90/15 and 75/15 conforming to IS: 702.

Mineral filler shall be dry stone dust passing through 75 micron IS Sieve.

Fine aggregate shall be crushed and graded natural limestone or other hard work.

Coarse aggregate shall be crushed siliceous stone or other approved aggregate 6 mm stone chips shall be used for finish upto 20 mm thick & 10 mm chips for thicker finish.

c) Composition

Bitumen mastic shall conform IS: 1195 and shall be either brought to site in blocks weighing about 25 Kg or prepared at site. If brought in blocks, these shall be remelted in mechanically agitated mastic cookers and coarse aggregate, preferably preheated fed in successive portions until the complete change is thoroughly, incorporated. At no stage during the remelting and mixing process, shall the temperature exceed 205°C.

d) Laying

The hot mastic shall be laid on dry base surface cleaned thoroughly by wire brushing and sweeping. The mastic shall be leveled and when cooled to some extent shall be finished with a wooden float with addition of small quantity of fine sand if required. No load shall be allowed till the finish has cooled to normal temperature.

The mastic shall be laid in suitable panels of about 1.5 Sq.M. in area each formed by formers. Succeeding panels shall be laid overlapping the finish panel so as to melt its edges and form a continuous finish without joint.

2.01.07 Chemical Resistant in Situ Finish

Chemical resistant in situ finish shall be as epoxy resin with suitable filler material over a primer. The minimum thickness shall be 6 mm. About its performance the Engineer shall have to be fully satisfied by test results and examination of similar treatment already in existence. The contractor shall get it done by a specialized Manufacturer and get guarantee of performance from the organization and pass it on to the Owner in addition to his own guarantee.

2.02.00 Tiled Finish

These shall include finish tiles, stone slabs, and similar manufactured or natural items over already laid and matured base of concrete or masonry by means of an underbed or an adhesive layer.

2.02.01 Terrazzo Tile Finish

The finish will consist of manufacture terrazzo and an underbed.

a) Thickness

The total thickness including the underbed shall be minimum 40 mm for floors 30 mm for walls unless otherwise specified.

The skirting, dado and similar vertical surfaces shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the tiled finish, to accommodate the specified thickness shall be done.

b) Tiles: Terrazzo

The tiles shall, unless specifically permitted in special cases be machine made under quality control in a shop. The tile shall be pressed hydraulically to a minimum of 140 Kg. per Sq.cm.

Each tile shall bear on its back permanent and legible trademark of the manufacturer. All angles of the tiles shall be right angles all arises sharp and true, colour and texture of the wearing face uniform throughout. Maximum tolerance allowance length and breadth shall

be ± 1 mm and the thickness ± 3 mm. Face of the tile shall be plane, free from pinholes and other blemishes.

The tiles shall be composed of a backing and topping. The topping shall be of uniform thickness not less than 10 mm.

The total thickness including the topping shall be as specified but not less than 20 mm in any case.

The backing shall be composed of 1 part ordinary gray cement and 3 parts of stone chips by weight mixed with water.

The topping shall be as specified under clause 2.01.02 (b).

The tile shall be cured at the shop for at least 14 days before delivery to the site. First grinding shall be given to the tiles at the shop before delivery. Tiles shall be packed properly to prevent damage during transit and storage. The tiles must be carefully stored to prevent staining by damp, rust, oil, and grease or other chemicals.

Tiles made in each batch shall be kept and used separately so that colour of each area of the floor may remain uniform.

The manufacturer shall supply along with the tiles the grout mix containing cement and pigment in exact proportions as used in topping of the tiles. The containers for the grout mix shall be suitably marked to relate it to the particular type and batch of tiles.

c) Mix: Underbed

The underbed for floor and similar horizontal surfaces shall be 1 part lime putty: 1 part surkhi: 2 parts coarse sand by weight mixed with sufficient water to form a stiff workable mass. For skirting and dado and all vertical surfaces it shall be about 12 mm thick and composed of 1 part cement and 3 parts coarse sand by weight.

d) Laying

The underbed mortar shall be evenly spread and brought to proper grade and consolidated to a smooth surface. The surface shall be roughened for better bond. Before the underbed had time to set and while it is still fairly moist but firm, cement shall be hand dusted over it or a cement slurry applied and the tiles shall immediately be placed upon and firmly pressed by wooden mallet on to the underbed until it achieves the desired level. The tiles shall be kept soaked for about 10 minutes just before laying. The joints between tiles shall be as close as possible and not more than 1.5 mm wide.

Special care shall be taken to check the level of the surface and the lines of the joints frequently so that they are perfect.

When tiles are required to be cut to match the dimensions these shall be sawn and edges rubbed smooth. The location of cut tiles shall be planned in advance and approval of the Engineer taken.

At the junction of horizontal surface with vertical surface the tiles on the former shall enter at least 12 mm under the latter.

After fixing, the floor shall be kept moist and allowed to mature undisturbed for 7 days. Heavy traffic shall not be allowed.

If desired dividing strips as specified under Clause 2.01.02(c) may be used for dividing the work into suitable panels.

e) Grinding and Polishing

Procedure shall be same as Clause 2.01.02(e). Grinding shall not commence earlier than 14 days after laying of tiles.

2.02.02 Chequered Tile Finish

The finish shall consist of manufactured gray or coloured cement tiles or terrazzo tiles with chequered face and an underbed laid over concrete or brick surface.

a) Thickness

Thickness shall be same as in clause 2.02.01 (a).

b) Tiles: Chequered

The tiles shall have chequers not less than 2.5 cm. c/c and not more than 5 cm. c/c. Depth of grooves shall be not less than 5 mm. The grooves shall be uniform and straight.

The tiles shall conform to clause 2.02.01 (b) except that these may have the topping in terrazzo or plain gray cement or colour pigment added to cement.

c) Under-bed

As per clause 2.02.01 (c).

d) Laying

As per clause 2.02.01 (d).

e) Grinding and Polishing

As per clause 2.02.01 (e) except that the tiles shall be ground and polished by hand and after laying taking special care in polishing the grooves properly and uniformly.

2.02.03 Glazed Tiles Finish

This finish shall be composed of glazed earthenware tiles with an underbed laid over a concrete or masonry base.

a) Thickness

The total thickness shall be between 20mm and 25mm including the underbed.

The tile finish on vertical surface shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the finish, to accommodate the specified thickness shall be done.

b) Tiles: Glazed

The tiles shall be of earthenware, covered with glaze white or coloured, plain or with designs, of 150 mm x 150 mm nominal sizes and 5.5 mm to 6 mm on thick unless otherwise specified. The tolerance shall be ± 1.5 mm for length and breadth and ± 0.5 mm for thickness specials like internal and external angles; beads, covers, cornices, corner pieces etc. shall match. The top surface of the tiles shall be glazed with a gloss or matt, unfading stable finish as desired by the Engineer. The tiles shall be flat and true to shape. The colour shall be uniform and fractured section shall be fine grained in textures, dense and homogeneous. The tiles shall be strong and free from flaws like cracks, craze, specks, crawlings, etc. and other imperfections. The edge and the underside of the tiles shall be completely free from glaze and the underside shall have ribs or indentations for better anchorage with the fixing mortar.

The coloured tiles, when supplied, shall preferably come from one batch to avoid difference in colour.

c) Mix: Underbed

The mix for the underbed shall consist of 1 part cement and 3 parts coarse sand by weight mixed with sufficient water or any other mix if specified.

d) Laying

Same as clause 2.02.01 (d).

e) Finishing

The joints shall be cleaned and flush pointed with white cement and cured for 7 days by keeping it wet. The surface shall be cleaned with soap or suitable detergent, washed fully, and wiped with soft cloth to prevent scratching before handing over.

2.02.04 Tesserae Finish (Mosaic etc.)

This finish consists of manufactured vitreous, glass, ceramic or similar hard small pieces set in an underbed over a concrete or masonry surface, already laid.

a) Thickness

The total thickness including the underbed shall be between 16 mm & 25 mm.

b) Tesserae Finish

These shall usually be 6 mm thick small piece of ceramic vitreous china, tinted glass, or similar hard wearing, strong, and durable material in desired shapes and sizes and patterns.

The supply shall come in the desired pattern in full or sections conveniently for handling, stuck to pieces of strong thick paper on the surface to be exposed. The gum used for this purpose must be water soluble and non-staining. The sections shall be properly marked to avoid mistakes and master drawing shall be available at the site for guidance.

- c) Mix: Underbed
Same as clause 2.02.03 (c)

- d) Laying

The specification for laying if given by the manufacturer of the item shall be followed provided it is approved by the Engineer. Otherwise clause 2.02.03 (d) shall generally be followed. However, instead of gray cement the slurry shall be made with white cement to fix the panels. The paper-mounted patterns in sections shall be carefully placed and pressed in position true to lines and levels. Earliest possible the paper shall be peeled off and surface examined and cleaned, joints flush pointed with white cement and cured for 7 days by keeping it wet.

2.02.05 Chemical Resistant Tiled Finish

This shall include all varieties of special tiles used for specific chemical resistance function and an underbed over already laid concrete or masonry.

- a) Tiles

The chemical resistant tiles shall be of the best indigenous Manufacture unless otherwise specified and shall be resistant to the chemical (both acid and alkali). The tiles shall have straight edges, uniform thickness, plain surface, uniform nonfading colour, and textures.

Usually the chemical resistant tiles shall not absorb water more than 2% by weight. The tiles shall have at least compression strength of 700 Kg/cm². The surface shall be abrasion resistant and durable.

- b) Laying

The mortar used for setting or for underbed these tiles shall be durable, strong and chemical resistant epoxy mortar. The grout, which shall be to the full depth of tile, shall have equal chemical resistant properties. Joints shall be pointed if so desired. The setting and fixing shall be according to the manufacturer's specification approved by the Engineer.

2.02.06 Rubber, Vinyl, or Vinyl Asbestos Tiles Finish

This shall include various types of tiles manufactured from rubber, vinyl etc. set with an adhesive on concrete or masonry base. An underbed may be required to secure desirable surface and grade.

- a) Thickness

The thickness of the tiles shall be as incorporated in drawing.

- b) Tiles

Unless otherwise desired the tiles shall be squares of approved dimensions. The tolerance in dimensions shall be ± 1.5 mm.

The face of the tiles shall be free from porosity, blisters, cracks, embedded foreign matters or either physical defects which affect appearance or serviceability. All edges shall be cut

true and square. The colour shall be nonfading and uniform in appearance, insoluble in water and resistant to alkalies, cleaning agents and usual floor polishes.

Each tile shall be marked on the back legibly and indelibly with manufacturer's trademark, the thickness, sizes, batch number, and date of manufacturer.

Tiles shall be delivered securely packed and stored in clean, dry well ventilated place at a temperature near about to that the tiles shall be called upon to stand ultimately.

Adhesive to be used for sticking the tiles shall be approved by the tile manufacturer. The adhesive shall have a short drying time and long life in addition to toughness.

c) Mix: Underbed

The underbed where required to make up the specified thickness or to give the required grade or to get the right type of surface shall be composed of 1 part like putty:1 part cement: 3 parts coarse sand mixed with just sufficient water to make it workable.

d) Laying

The tiles shall be kept in the room to be tiled for at least 24 hours to bring them to the same temperature as the room. For air-conditioned space, the air-conditioning shall be completed before tiling is taken up.

The surface to receive this finish shall be firm even textured but not too smooth, without undulations and other deficiencies. If an underbed is laid the same shall be cured for at least 7 days by keeping it moist and then fully dried.

The surface shall be thoroughly cleaned. All loose dust particles shall be removed. Oil and grease if any shall be completely cleaned by use of detergent.

The adhesive shall be applied to fully dry surface in desired thickness uniformly. The adhesive shall also be applied to the backs and edges of the tiles and allowed to surface dry. The tiles shall be placed neatly on the surface exactly to the approved pattern and set with a suitable tool. If the edges tend to curl, weights are to be used to keep the edges down. Special care shall be taken to avoid formation of air pockets under the tiles. The joints shall be very fine. Any adhesive squeezed out through the joints shall be removed immediately.

e) Finishing

If any adhesive mark is there on the surface a soft cloth soaked in solvent shall be used to wipe it off. The surface shall be cleaned with soft soap, dried, and polished with an approved type of polish just before handing over.

2.02.07 Stone Slab Finish: Marble, Stone, and Similar Fine Grained Stone including Kota stone

a) Thickness

The underbed shall be minimum 12 mm and average 20 mm thick. The slabs will be 20 mm thick.

b) Stone Slab

The stone slabs shall be made from selected stock, which is hard, sound, homogeneous and dense in texture and free from flaws. Angles and edges shall be true, square, and free from chipping and surface shall be plane. The slabs shall preferably be machine cut to the required dimensions. Tolerance of ± 5 mm in dimensions and ± 2 mm in thickness will be allowed. Unless specified the slabs shall be minimum 300 mm x 300 mm.

The stone slabs shall come from specific regions and in specified quality with top surface fine chisel dressed. All sides shall also be fine chisel dressed to the full depth to allow finest possible joints.

The slabs shall be delivered to the site well protected against damages and stored in dry place under cover.

c) Mix: Underbed
Same as clause 2.02.01 (c).

d) Laying

The sides and top surface of the slabs shall be machine rubbed or table rubbed with coarse sand stone and washed before laying.

The underbed mortar shall be evenly spread and brought to proper level on the area under each slab. The slab shall be laid over the underbed, pressed, and tapped down with wooden mallet to the proper level. The slab shall then be lifted and the underbed corrected as necessary and allowed to stiffen a little. Next, thick cement slurry shall be spread over the surface. The edges of the slab shall be buttered with slurry of cement, gray / white / mixed with pigment matching the colour of the stone slabs. The slab shall be gently laid and tapped with wooden mallet to bed properly to a very fine joint and to the required level. All surplus cement slurry shall be removed and the surface mopped clean with wet soft cloth. The laid finish shall be cured for 7 days by keeping it wet.

e) Polishing, Finishing

Fine chiselling shall be done to remove the slight undulations that usually exist at the joints. The polishing and finishing shall be done as specified under clause 2.02.01 (e). However, the joints shall be so fine in the case of stone slabs that grouting shall not be called for.

2.02.08 Stone Slab Finish: Sand Stone and Similar Coarse Grained Stone Finish

Generally clause 2.02.07 shall be followed except that the workmanship and finish shall not be fine as which are explained hereunder.

The slabs shall be rough chiselled or fine chiselled as specified. Tolerance may be allowed upto ± 6 mm for rough finish, but no sharp unevenness and shall be allowed. For fine chiselling the unevenness shall be limited to ± 2 mm. The sides shall be chisel dressed at least to half slab depth so that the maximum deviation from straight line shall be within 25 mm. Beyond this depth the edge may be slightly splayed.

The joint thickness shall be kept limited to 5 mm in case of rough finish and 3 mm in case of

fine finish unless wider joints are specified. The joints shall be grouted with white or coloured cement. If fine joints in the flooring are specified, the edges of slabs shall be cut in such a way that it shall form a inverted 'Y'.

3.00.00 ACCEPTANCE CRITERIA

The finish shall be checked specially for:

- a) Level, Slope, Plumb as the case may be
- b) Pattern and Symmetry
- c) Alignment of joints, dividing strip etc.
- d) Colour, texture
- e) Surface finish
- f) Thickness of joints
- g) Details at edges, junctions etc.
- h) Performance
- i) Precautions specified for durability

4.00.00 I.S. CODES

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 777	:	Glazed earthenware tiles
IS: 1196	:	Code of practice for laying bitumen mastic flooring.
IS: 1197	:	Code of practice for laying of rubber floors
IS: 1237	:	Cement concrete flooring tiles
IS: 1443	:	Code of practice for laying and finishing of cement concrete flooring tiles.
IS: 2114	:	Code of practice for laying in situ terrazzo floor.
IS: 3461	:	PVC asbestos floor tiles
IS: 4860	:	Specification for acid resistant bricks
IS: 5518	:	Code of practice for laying of flexible PVC Sheet and tile flooring.
IS: 5491	:	Code of practice for laying in situ granolithic floor topping.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be for the complete work (including dividing strips, ironite, metals, tiles etc. if any) as per the schedule of items. Rates shall be applicable for application on horizontal and vertical surfaces at all elevations and for all types of work including stairs tread and riser, laying in desired pattern and panels, cost of specials (if any) rounding of corners, mouldings etc.

Rates shall be including provision of side shuttering (if required) for casting of floor in alternate panels and or without dividing strips.

5.02.00 Measurement

The finished surface shall be measured in Sqm for area unless otherwise specified. Deduction shall not be made for opening or embedded articles having area not exceeding 0.1 Sqm.

SUB-SECTION – D13

SHEET WORK IN ROOF AND SIDING

C O N T E N T

CLAUSE NO. DESCRIPTION

1.00.0	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODES
5.00.00	RATES AND MEASUREMENTS

SHEET WORK IN ROOF AND SIDING

1.00.00 SCOPE

This section covers supply, cutting & fabrication and erection of corrugated/plain asbestos, corrugated galvanized iron, aluminum, permanently colour coated troughed zinc-aluminium alloy coated M.S. sheet or other sheet for covering to roof and sides at various elevations as specified.

2.00.00 INSTALLATION

2.01.00 Storage of Materials

All materials shall be stored by the Contractor in proper way to prevent all damage.

2.02.00 Workmanship

The workmanship shall be according to best construction practice to give a watertight finish to the satisfaction of the Engineer. Fixing of gutters and down pipes shall be according to IS: 2527.

2.02.01 Asbestos Sheeting

Asbestos sheets of profiles as specified shall be fixed with minimum 150 mm end lap and side laps as per manufacturer's specification. Hook bolts or J-bolts shall be 8 mm dia. at 305 mm centres. Six (6) mm dia. galvanized iron seam bolt and nut with G.I. flat washers and bitumen washers shall be used for stitching ridge cappings, corner pieces, ventilators, north light curves etc.

2.02.02 C.G.I. Sheeting and Aluminium Sheeting

Side laps shall be 2 corrugations for roof and one corrugation for side sheeting. End laps shall be minimum 150 mm for roof and 100 mm for side sheeting. In ridges and hips where plain sheets are used, the end laps shall be minimum 100 mm. Holes in C.G.I. sheets shall preferably be made on the ground. The sheets should be placed on purlins/trestles and holes punched in the ridge of the corrugation from the outside inward for obtaining proper seating of limpet washers. Sheets shall be secured to sheet framing by 8 mm dia. galvanised iron hooks or J-bolts and maximum spacing of the bolts shall be 305 mm. The length of the hook or J-bolts shall be to suit the sections of the bearers. Sheets shall also be bolted at the ends at every third corrugation with 6 mm dia. galvanized iron seam bolts and G.I. flat washers and bituminous washers.

2.02.03 Fibre Glass Reinforced Plastic Sheeting

This shall be of thickness and profile as specified. Colour and light transmittance shall be as mentioned. Where used in conjunction with C.G.I. or asbestos sheeting, the end and side laps and fixing device shall be same as used for general sheeting. Where used in lieu of glass, the fixing shall be by means of timber or metal glazing beads. In all cases, the installation shall be completely watertight and able to withstand the designed wind-pressure.

2.02.04 PERMANENT COLOUR COATED SANDWICHED INSULATED METAL CLADDING SYSTEM

- i. Troughed zinc-aluminium alloy coated (both sides) M.S. sheet having 0.6mm minimum thickness (or high tensile steel sheet having minimum yield strength of 350 Mpa of 0.5mm minimum thickness) shall be used on external face (outer face) of cladding system. Weight of coating shall not be less than 150 gm/sq.m. The outer side (exposed face) shall be permanently colour coated with Polyfluro Vinyl Coating (PVF₂) of Dry Film Thickness (DFT) 20 microns (minimum) over primer. Inner side of external sheet shall be provided with suitable pre-coating of minimum 7 microns.
- ii. Galvanised M.S. sheets of minimum 0.6mm thickness shall be used as inner liner (internal face) of cladding system. The exposed face shall be permanently colour coated with silicon modified polyester paint of DFT 20 microns (minimum) over primer. Inner face of external sheet shall be provided with suitable pre-coating of minimum 7 microns. The rate of galvanization shall not be less than 275 gm/sqm.
- iii. The permanent colour coated sheet shall meet the general requirements of IS:14246 and shall conform to class 3 for the durability.
- iv. Inner sheet shall be fixed directly to side runners and Z spacers made out of at least 2 mm thick galvanized steel sheet of grade 375 as per IS:277. Inner sheet shall be fixed at the rate not more than 1.50M centre to centre to hold the insulation and external sheeting. The fasteners shall be of high quality corrosion resistant grade of self tapping / self drilling type provided with suitable cap.
- v. The insulation shall be of bonded mineral wool of minimum thickness 50mm conforming to IS:8183, having a density of 32 Kg/cu.m. for glass wool & 48 Kg/cu.m. for rock wool.

2.02.05 PERMANENT COLOUR COATED (NON-INSULATED) METAL CLADDING SYSTEM

- i. Troughed zinc-aluminium alloy coated not less than 150 gm/sq.m M.S. sheets having 0.6 mm minimum thickness (or High tensile steel sheet having minimum yield strength of 350 Mpa of 0.5mm minimum thickness) shall be used for the cladding system. The outer side (exposed face) shall be permanently colour coated with PVF₂ paint of minimum DFT 20 microns over primer and the inner side (internal face) shall be coated with same paint of minimum DFT 12 microns over primer. These shall be fixed directly to runners. The sheets shall meet the general requirement of IS:14246 and shall conform to class 3 for the durability.
- ii. **FLASHING, CAPS, TRIM CLOSURES ETC.**

All flashings, trim closures caps etc. required for the metal cladding system shall be made out of plain sheets having same material and coating specification as mentioned above for the outer face of the sandwiched metal cladding.

3.00.00 ACCEPTANCE CRITERIA

The installations shall present a neat appearance and shall be checked for water tightness. The following shall be checked:

- a) Side and end laps
- b) Absence of cracks, holes or damages in sheet
- c) Spacing of bolts
- d) Provision of double washers (G.I. and asbestos or bituminous washers)
- e) Proper installation of flashing.

4.00.00 I.S. CODE

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 3007 :	Code of practice for laying of asbestos cement sheets.
IS: 2527 :	Code of practice for fixing rainwater gutters and down pipes for roof drainage.
IS: 1626 :	Specification for asbestos cement building pipes, gutters and fittings.
IS: 277 :	Specification for galvanized steel sheets (plain and corrugated).

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be unit rate for complete item described in “Schedule of Items” and shall include all wastage.

5.02.00 Measurement

Sheeting work in roof & sides shall be measured in Sq.M. for net area of the work done. Profiled sheeting shall be measured flat and not girthed. Opening less than 0.40 Sqm shall not be deducted. No extra shall be paid for extra labour in cutting and for wastage etc. No payment shall be made for laps in sheeting works.

SUB-SECTION – D14

SUSPENDED CEILING

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	SAMPLES
4.00.00	SHOP DRAWINGS
5.00.00	ACCEPTANCE CRITERIA
6.00.00	RATES AND MEASUREMENTS

SUSPENDED CEILING

1.00.00 SCOPE

This section covers supply and installation of suspended ceiling together with the suspension system as shown on drawing or specified in schedule of item with all materials, labour and equipments. The work shall also include providing of openings in the ceiling for lighting, air-conditioning diffusers etc. as shown on drawings or as instructed by the Engineer.

2.00.00 INSTALLATION

2.01.00 Suspension System

2.01.01 General

Suspension system shall consist of the grid supporting the ceiling panels, intermediate runner supports for the grid if any and hangers, wall angles etc. required to suspend the grid or the runners from structural works, slabs and beams.

All members of the suspension system shall be of sufficient strength and rigidity to carry, the ceiling boards or sheets in a true and level plane without exceeding a deflection of 1/360th of their span. All joints in ceiling panels shall run straight and cross joint shall be at perfect right angles. Angle moulds where shown on drawings shall be securely fixed to walls. All drillings of structural concrete and installation of suitable anchoring device for installation including welding of the suspension system shall be included in the rate. All M.S. sections used for supports etc. shall be given one coat of synthetic enamel paint over a coat of red lead primer.

2.01.02 Metal Grid Suspension System

Aluminium grid ceiling system shall be "Bead lock" as manufactured by W A Beard shell and Co. Pvt. Ltd. or Ajit India Limited or approved equal. Steel grid ceiling system shall be 'Jolly Snap Grid' as manufactured by Jolly Board Limited or approved equal.

Steel tees as intermediate members and steel channels, as end pieces will be assembled in the form of grid. Size of tees and channels shall be as required.

The cross-tees shall intersect main tee runners in pattern shown on drawing and positively locked together with intersection members. All perimeter areas shall have tee runners fixed to vertical wall surfaces and end channels shall be fixed to runners leaving return air space between vertical wall and channels, unless otherwise shown on drawings. Angle cleats or other suitable fixing device shall be fixed to the structural beams above for fixing of hangers. Main runners shall be hung by M.S. flats, angles, rods or 12G or heavier galvanized tie wire hangers at maximum 1.2 metre centres. Extra hangers shall be provided at light fixtures that are supported from the ceiling system. The spacing of main and cross runners shall be as shown on drawings. Turnbuckles shall be provided in M.S. rods for adjustment in levels.

2.02.00 Ceiling Panels

2.02.01 Material

Ceiling panels shall be best quality material in thickness and properties called for in the "Schedule of items". The Contractor shall submit test certificates to the Engineer for approval before bulk supply. The ceiling panels may be of following type:

- a) Plaster of Paris board (decorative)
- b) Expanded polystyrene insulation board with plastic fascia.
- c) Fibre Insulation board.
- d) Bonded wooden particle board (Plain and decorative)
- e) Glass fibre reinforced polystyrene sheets.
- f) Flat asbestos sheets (with plastic fascia).

2.02.02 Installation of Ceiling Panels

Installation of Ceiling panels shall be strictly as per manufacturer's instruction.

For concealed grid system, tiles shall be fixed to the supporting grid in manner shown on drawing or as specified by the manufacturer. Where V joints in tiles are called for in drawings, these shall be in true lines. Where flush surface is required, the joints shall be filled with approved filler material and finished to give a neat uniform surface. Special care shall be taken to neatly finish the ceiling at junctions with walls, light fixtures, diffusers etc.

2.02.03 Aluminium Lineal Ceiling System

Aluminium lineal ceiling system shall be "Luxalon 84C" or approved equal and the installation shall be strictly as per manufacturer's instruction/ specification subject to approval of the Engineer.

Aluminium lineal ceiling shall comprise of plain panels, 84 mm wide and 12.5 mm deep with a 23.9 mm recessed flange, roll formed out of 0.5 mm thick aluminium alloy panels stove enamelled on both sides, fixed on roll-formed carriers made of enamelled 0.95 mm thick aluminium, 32 mm wide and 39 mm deep with prongs to hold panels in the module of 100mm, at maximum spacing 1.2 M centre to centre. The carriers shall be suspended from roof by 4 mm dia galvanised steel wire hangers with special height adjustment clips made out of spring steel at maximum spacing of 1.2 M c/c. Hangers shall be fixed to roof by 'J' hooks and nylon inserts. 25 mm thick resin bonded mineral wool (spintex 300 or equivalent) insulation bound in polythene shall be laid on top of panels. Lineal ceiling shall be fixed in pattern as per detailed drawings.

3.00.00 SAMPLES

Samples of Ceiling panels and metal suspension system components as noted below shall be submitted for Engineer's approval:

- Panels : 3 samples approximately 300 mm square/long each
- Suspension System : 3 samples of short length : each of main and secondary system

4.00.00 SHOP DRAWINGS

Shop drawings shall be submitted for approval as required and approval shall be obtained prior

to delivery of suspended ceiling components. Shop drawings shall be co-coordinated with all related work and shall show the following information:

- a) A reflected ceiling plan of areas indicated to receive the ceiling showing electrical and mechanical features.
- b) Typical Intermediate framing for support where required.
- c) Hanger fastening details.
- d) Panels - unit support at ceiling penetrations.
- e) Details of splicing method for main and cross runners.
- f) A table indicating load bearing capacity of main and cross runner
- g) A note stating that the suspension system member furnished will not deflect more than $1/360$ of the span under the indicated loading.

5.00.00 ACCEPTANCE CRITERIA

Finished ceiling shall be at the correct plane and present a pleasing and uniform appearance, free from, sags, warps, disfigured, or damaged board. Cutouts for light fixtures, diffusers etc. shall be of exact dimensions and in exact locations.

6.00.00 RATES AND MEASUREMENT**6.01.00 Rates**

Rates shall be for the complete item called for in the "Schedule of Items". No extra payment will be made for alignment and adjustment of lighting fixtures, air-conditioning diffusers, access panels etc. The rate shall include all cutting and wastage from standard size sheets, runners/carries etc.

6.02.00 Measurement

Actual area of work shall be measured in Sqm correct to second place of decimal. However, no deduction will be made for opening upto 0.25 Sqm. each in area.

SUB-SECTION – D15**WATER SUPPLY, DRAINAGE
AND SANITATION****C O N T E N T****CLAUSE NO. DESCRIPTION**

1.00.00	SCOPE
2.00.00	MATERIAL
3.00.00	INSTALLATION
4.00.00	TESTING AND ACCEPTANCE CRITERIA
5.00.00	I.S. CODES
6.00.00	RATE AND MEASUREMENT

WATER SUPPLY, DRAINAGE AND SANITATION**1.00.00 SCOPE**

This section covers supply of all materials labour and incidentals required for supply, laying and installation of under/over ground pipes for water supply, drainage and sanitation with all fittings, fixtures and jointing, construction of ancillary works like manholes, drop connections, gully chambers, septic tank, soak pits, surface drain etc.

The supply and installation of water supply/sanitation fixtures and accessories like water closets, urinals, wash basins, sinks, mirrors, shelves, towel rail, soap container etc. with all fittings, fixtures, water supply/sanitation pipes and water storage tanks etc.

2.00.00 MATERIAL

All materials, fittings, fixtures, and appliances shall be of the best quality conforming to relevant Indian Standard and shall be procured from approved manufacturers. Unless specifically allowed by the Engineer, the Contractor shall submit samples of fittings and fixtures, which will be retained by him for comparison when bulk supplies are received at the site. Ultimate choice of type, model, and manufacturer lies completely with the Engineer.

It shall be the responsibility of the Contractor to procure the materials selected by the Engineer. Hence orders are to be placed with the manufacturers in time, so that the materials are available at the site well ahead of their requirement.

The materials brought to the site, shall be stored in a separate secured enclosure away from the building materials. Pipe threads, sockets, and similar items shall be specially protected till final installation. Brass and other expansive items shall be kept under lock and key. Fragile items shall be checked thoroughly when received at the site and items found damaged shall not be retained at the site.

2.01.01 Pipes and Pipe Fittings

For water supply, galvanised mild steel pipe of medium grade confirming to IS: 1239 shall be used. The galvanising shall not be less than 400gm/sqm of pipe surface area. Galvanising shall be smooth and shall be subjected to testing as per IS: 2633 for uniformity of coating. The zinc coating shall be free from defects.

For Roof drainage and building sanitation works following type of pipe are covered in this Section:

- a) Cast Iron pipe
- b) Steel pipe (lined, coated with bituminous composition, out coated with cement concrete or mortar or galvanized)
- c) Concrete pipe
- d) Asbestos cement pipe
- e) PVC pipe
- f) Stoneware pipe

- g) Vitrified pipe
- h) Lead pipe (not to be used for portable water)

2.02.01 Fixtures

All material, fittings, fixtures, appliances, accessories shall be of approved quality and shall be procured from reputed brands like Hindustan/Pasriware/ Cera or equivalent or as approved by Engineer. The bidder shall procure the fixtures from the above named reputed manufacturers and shall mention in his bid the type & make of the fixtures he intends to use.

All items brought to the site must bear the manufacturer's identification mark. Procurements shall be made well in advance and should get inspected & approved immediately by the Engineer. All fixtures shall be adequately protected, covered, and plugged till handing over.

All fittings, gratings, fasteners, unless specified otherwise, shall be chromium plated. The chromium plating shall be of grade-2 (10micron thickness) confirming to IS: 4827. Powder coating shall be of approved colour and shall have minimum thickness (DFT) of 20micron. Stainless steel accessories shall be of grade SS-304 and from reputed manufacturer (like Salem Steel) and shall be polished bright finish.

Unless specified in the contract the fixtures shall be as specified hereinafter.

Water closet

a) European type

It shall consist of European type glazed vitreous china basin (confirming to IS: 2556, part-II), with siphon open front solid plastic seat and plastic cover, low level glazed stoneware flushing cistern with valve less fittings, supply connections and necessary fittings. All fittings shall be chromium plated. Colour of basin, cistern, seat and cover shall be as approved by the Engineer.

b) Squatting type

It shall consist of Orissa pattern glazed vitreous china squatting pan with integral foot rests (confirming to IS:2556, part-III) and high level cast iron flushing cistern with valve less fittings, supply connections and necessary fittings. All fittings shall be chromium plated. The flushing cistern shall be painted as specified by the Engineer.

Urinals

It shall consist of wall type glazed vitreous china urinals (conforming to IS:2556), cast iron automatic flushing cistern complete with supply connections, flush pipe, lead pipes, gratings, traps and all other

necessary fittings. Frequency of automatic flushing shall be approximately once every five minutes. For every four urinals (maximum) located together may be served by one cistern of adequately capacity. All fittings shall be chromium plated.

Wash Basin

It shall be made of glazed vitreous china conforming to IS:2556, part-IV. The basin shall be flat back, wall hung by painted cast-iron brackets and complete with hot and cold CP brass faucets with nylon washers, PVC connection pipe with CP brass nuts, CP brass chain with rubber plug, 32mm dia. Chromium plated brass waste of standard pattern, 32mm dia. CP brass trap union complete with necessary fittings.

Sink

It shall be made of glazed vitreous china conforming to IS:2556, part-V. It shall be wall hung by painted cast iron brackets and complete with one CP brass faucet with nylon washers, PVC connection pipe with CP brass nuts, CP brass chain with rubber plug, 40mm dia. chromium plated brass waste of standard pattern, 40mm dia. CP brass trap union complete with necessary fittings.

Bathroom mirror

It shall be made of the best quality 6 mm thick glass and produced by a reputed mirror manufacturer. It shall be wall mounted with adjustable revolving brackets. The brackets, screws, and other fittings shall be chromium plated.

Glass shelves

Glass shelves shall consist of 6 mm thick clear glass with guardrails and shall be wall mounted with brackets. All brackets, guardrails, and screws shall be chromium plated.

Towel rail

Towel rails shall be 20 mm dia chromium plated MS pipes wall mounted with steel brackets. The brackets, screws etc. shall also be chromium plated.

Soap holder

It shall be made of chromium plated strong members. The holders shall be wall mounted with chromium-plated screws.

Liquid Soap Dispenser

It shall be round and easily revolving with removable threaded nozzle. The body, bracket for wall mounting and screws shall be chromium plated.

Toilet roll holder

It shall be made of glazed vitreous china with suitable cover cum cutter. Wall mounting screw shall be chromium plated.

Valve, cocks, Taps

All valves, stop cocks, taps etc. shall conform to relevant Indian standard specification and shall be of best quality from approved manufacturers. These shall be suitable for normal working pressures. Nominal size and material shall be as required / specified.

2.03.00 Water Storage Tank

Water storage tank shall be PVC of approved brand and make (Syntex or equivalent). Reservoirs made of concrete masonry or fabricated steel shall be covered by respective work specifications.

3.00.00 INSTALLATION

3.01.00 General

Basic layouts may be available in the drawings provided, the details might have to be supplemented by the Contractor and get the approval of the Engineer before installation. Special attention shall be given to economise the layout. Symmetry of layout is very important. Fittings meant for operation shall be located and oriented to allow easy reach and operation. Maintenance, repairs, and replacements of pipes, fittings, and fixtures must be conveniently possible. All pipe lines, locations of fittings and fixtures, etc. shall be as per drawings or as directed by the Engineer. Correctness of lines, plumb, orientation, symmetry, and levels shall be strictly ensured. All items shall be fully secured against movement in any direction and so located as to allow easy maintenance.

All pipelines, fittings, and fixtures shall be installed leak proof. When the works under scope of this specification linked up with works executed by others, the connections shall be such as to prevent any splashing or spilling or emission of foul odour and gases.

3.02.00 Portable water supply Pipe Lines

3.02.01 Laying

In addition to fulfilling the functional requirements all pipelines shall be laid true to line, plumb and level and shall run on the surface of the walls, ceiling or in chases. Any deviation shall need approval of the Engineer. Meticulous care shall be taken to avoid chances of airlock and water hammer.

Pipes shall be laid on continuous unyielding surface or on reliable supports at least one near each joint and spacing as directed by the Engineer. The support must be strong, neat and shall have provisions for securing the pipes in every direction and easy maintenance. All pipes used for water supply should be thoroughly and efficiently disinfected before taken in to use.

3.02.02 Back Flow

The layout of pipe work shall be such that there is no possibility of back flow towards the source of supply from any cistern or appliances, whether by siphonage or otherwise. All pipe works shall be so laid or fixed and maintained as to be and to remain completely watertight, thereby avoiding waste of water, damage of property and the risk of contamination of the water conveyed.

3.02.03 Contamination

There shall be no cross connection whatsoever between a pipe/fitting for conveying or containing wholesome water and a pipe/fitting for containing impure water or water liable to contamination or of uncertain quality of water which has been used for any other purpose. No piping shall be laid or fixed so as to pass into or through any sewer, scour outlet or drain or any manhole connected therewith.

3.02.04 Underground Piping

Underground piping shall be laid at such a depth that it is not likely to be damaged by traffic and other loads and frost, where applicable. The size and depth of the trench shall be as approved by the Engineer. Back filling shall be done with selected fine earth, unless otherwise permitted, in 150 mm layers and carefully consolidated. Special care shall be taken while filling in the vicinity of the pipe to avoid damage. Before backfilling, the laid pipe shall be fully tested and approved.

Where the pipe rests on rock it may be bedded on a layer of fine selected material or concrete to avoid local point support. The trench shall be so treated by gradient and filling in the area that it does not act as a drainage channel.

3.02.05 Concealed Piping

Where desired by the Engineer or shown on the drawings the pipes shall be concealed in masonry or concrete of the structure. The Contractor may co-ordinate with the building Contractor for leaving the chases, openings, and conduits as necessary. However, the Contractor will rectify if required the chases, openings, and conduits, supplement and make good after laying and testing of the concealed pipelines.

3.02.06 Jointing of Pipes

All G.I. pipes shall be properly thread/weld jointed and made completely water tight and durable. Burr from the joints shall be removed after screwing. Union joints shall be provided for all required location to facilitate maintenance.

3.02.07 Painting

Where required, underground G.I. pipes shall be given 2 coats of bituminous paint on the outside after laying. When painting is to be done above ground G.I. pipes shall be given one coat of red lead or zinc chromate primer and top coats shall be minimum 2 coats of best quality paint as specified.

3.03.00 RAINWATER DOWN COMERS

3.03.01 Pipes

Rainwater down comers shall be standard Cast Iron or Heavy duty PVC/GI. In case where specifically desired, M.S. pipes may also be used. M.S. pipes shall be painted outside with two coats of anticorrosive paints under a coat of primer.

Rainwater down comers shall run along and be secured to walls, columns etc. Where desired by the Engineer these may have to be installed in chases cut in the structure. All pipes shall be well secured and supported by adequately strong brackets. The brackets may be wrought iron clevis type, split ring type, or perforated strap iron type as approved by the Engineer. For vertical runs each pipe shall hang freely on its brackets fixed just below the socket. Suitable spacer blocks shall be provided against the vertical surface to which the pipe is fixed.

All bends and junctions shall be supplied with watertight cleanouts.

Roof and floor drains and yard gullies shall be installed, if required, by cutting into the structure and grouted with 1:2:4 cement concrete. All gutters shall be provided with removable gratings.

All horizontal pipes shall have a minimum fall of 1 in 100.

3.03.02 Khurras

The khurras shall be constructed before the work in parapet wall is taken up and it shall be 45x45 cm in size, unless otherwise specified and shall be formed of cement concrete of M-20 grade.

3.03.03 Gutters

The gutters shall be made of G.I. or A.C and procured from reputed specialised manufacturers. Each section shall be sufficiently rigid, edges and corners straight and the slopes perfectly

uniform. G.I. gutters shall have the edges strengthened by suitable means.

Unless noted otherwise the gutters shall have a minimum fall of 1 in 120. Adequate number of string supports shall be provided so that there is no sagging even when the gutter is full. Each joint must have a support. Unless otherwise specified the supports shall be fabricated M.S. brackets. All junctions shall be thoroughly watertight. The joints may be made by riveting, bolting or soldering. All joints between successive lengths of gutters shall have an overlap of at least 5 cm. The drop in the overlap shall always be in the direction of the fall of the gutter. Ends of gutters shall be closed watertight. Junction with rainwater down comers shall be made fully watertight and secured.

3.04.00 SOIL AND DRAINAGE PIPES

3.04.01 Gradients

If not specified the minimum gradients of soil and drainage pipeline shall be as follows:

100 mm nominal dia	:	1 in 35
150 mm nominal dia	:	1 in 65
230 mm nominal dia	:	1 in 120
300 mm nominal dia	:	1 in 200

3.04.02 Relation with water supply pipelines

Unless specifically cleared by the Engineer, under no circumstances shall drainage and sewer pipes be allowed to come close to water supply pipelines.

3.04.03 Laying

Each separate pipe shall be individually set for line and for level. Where lengths of sewer or drain pipes are laid in trench, properly painted sight rails shall be fixed across the trench at a height, equal to length of the boning rod to be used, above the required invert level of the drain or sewer at the point where the sight is fixed. More sight rails shall be required at manholes, change of gradient and intermediate positions if the distance for sighting is more than 50 ft. apart. The excavation shall be boned in at least once in every 6 ft. The foot of the boning rod shall be set on a block of wood of the exact, thickness of the wall of the pipe. Each pipe shall be separately and accurately boned between sight rails.

3.03.04 Support and Protection of Pipelines

All pipes shall be laid with sockets leading uphill. Preferably the pipe shall rest on solid and even foundations for the full length of the barrel. However, the pipe manufacturer's instruction as approved by the Engineer shall be followed in the matter of support and jointing.

To achieve full and continuous support, concrete for bedding and packing is the best. Where pipes are not bedded on concrete, the floor shall be left slightly high and carefully placed so that the pipe barrels rest on undisturbed ground. If anywhere the excavation has been carried too low packing shall be done in concrete. Where laid on rock or very hard ground which cannot be easily excavated to a smooth surface, the pipes shall be laid on a cradle of fine concrete floor of gravel and crushed stone over laid with concrete or on a well consolidated gravel and crushed stone bed as desired by the Engineer. PVC or similar pipes shall be laid directly on stable soil and packed with selected soil.

The minimum support and protection for glazed stoneware pipes shall be as follows:

- a) When cover is less than 2 metre below ground level and where pipes are unavoidably exposed above ground surface, the pipes shall be completely encased or surrounded with concrete.
- b) Where pipes are laid on soft soil with the maximum water table laying at the invert of the pipe, the sewer shall be bedded on concrete.
- c) Where the pipes have to be laid on soft soil with the maximum water table rising above the invert of the pipe, but below the top of the barrel, the pipe sewer shall be haunched.
- d) Where maximum water table is likely to rise above the top of the barrel or wherever the pipe is laid on soft soil the pipe sewers shall be completely encased or surrounded with concrete.

Vitrified clay pipes shall be laid on a bed of 150 mm thick cement concrete (1:3:6) nominal mix by volume.

Cast iron pipes and concrete pipes may be supported on suitable concrete or brick support, where specified. The supports shall be unyielding and strong enough. At least one support shall be located close to ends. Spacing of intermediate supports shall be as decided by the Engineer. Pipes shall be secured to the supports by approved means.

Anchoring of pipes where necessary shall be achieved by suitable concrete encasing designed for the expected thrust.

3.03.05 Entry into structures

For entry of the pipe lines into any building of structure suitable conduits under the structure or sleeves shall be used. The conduits and sleeves shall be such as to allow easy repairs and replacement of the pipes. When openings or chases are required to be made in the structure for entry of pipelines, locations and sizes shall be marked and checked by the Engineer. After laying of the pipeline the openings and chases shall be mended.

3.03.06 Ducts

Where solid, waste and ventilating pipes are accommodated in ducts, access to cleaning areas shall be provided. Connection to drain shall be through a gully with sealed cover to guard against ingress of sewer gas, vermin, or backflow.

3.03.07 Traps and Ventilating Pipes

Pipes are carrying off the waste from water closets and waste water and overflow water from baths, wash basins, sinks to drains shall be trapped immediately beneath such fixtures. Traps shall have minimum water seal of 50 mm and shall be ventilated whenever such ventilation is necessary to maintain water seal of the trap. Ventilating pipes shall be carried up vertically from the drain to a height of at least 600 mm above the outer covering of the roof of the building or as shown on drawings. All vertical ventilating, anti-syphonage and similar pipe shall be covered on top with a cowl. The cowl shall be made of C. I. unless desired otherwise by the Engineer.

3.03.08 Manhole & Inspection Chambers

At every change of alignment, gradient or diameter there shall be a manhole or inspection chamber. The maximum distance between manholes shall be 30 meter unless specially permitted otherwise. However, for truck route (for pipes above 900 mm dia.) this distance can be increased to 45 M. The distance between manhole or inspection chamber and gully chamber shall not exceed 6 metres unless desired otherwise provision of IS: 4111 (Part-1) shall be followed for construction of a manhole. Manhole shall be constructed so as to be watertight under test. The change in alignment shall be carried out in such a manner as to provide no lodgement for any splashing in case of accidental flashing of the chamber. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement, sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide smooth flow.

Unless otherwise specified, 560 mm dia. circular cast iron manhole cover with frame, heavy-duty, conforming to IS: 1726 shall be provided. The covers shall be close fittings so as to prevent gases from coming out.

3.03.09 Cutting of Pipes

Manufacturer's instructions shall be followed for cutting of pipes where necessary. Suitable and approved tools shall be used for the cutting so as to leave surface clean and square to the axis of the pipe.

3.03.10 Jointing

Jointing of pipes shall be so planned as to avoid completely any movement or strain to the joints already made. If any joint is suspected to be damaged it shall be opened out and redone.

All joints between pipes, pipes and fittings and manholes shall be gas-tight when above ground and watertight when underground. Method of jointing shall be as per instructions of the pipe and fittings manufacturer and as approved by the Engineer. However, in the absence of any instruction available from the manufacturer the methods as detailed hereunder shall be used.

a) Cast Iron Pipes

Socket and spigot pipes shall be jointed by the cast lead joints. The spigot shall be centred in the socket of the pipe by tightly caulking in sufficient turns of tarred gasket or hemp yarn to have unfilled half the depth of socket. When the gasket or hemp yarn has been caulked tightly a jointing shall be placed round the barrel and tightened against the face of the socket to prevent airlock. Molten lead shall then be poured in to fill the remainder of the socket and caulked with suitable tools right round the joint to make up for shrinkage of the molten metal on cooling and shall be finished 3 mm behind the socket face.

Joints in cast iron pipes with special jointing arrangements like 'Tyton' Joints etc. shall follow the instructions of the manufactures.

In special cases if flanged joints are accepted by the Engineer the joints shall be made leak proof by inserting approved type of rubber gaskets. The bolts shall be secured in stages to avoid uneven strain.

b) Concrete Pipes

Jointing of concrete pipes shall be generally of rigid type. Unless otherwise stated collar type joint shall be provided. IS: 783 shall be followed for general guidance.

The two adjoining pipes shall be butted against each other and adjoined in correct position. The collar shall then be slipped over the joint, covering equally both the pipes. The angular space shall be filled with stiff mixture of cement mortar 1:2 (1 cement : 2 sand) which shall be rammed with caulking tool. After a day's work, any extraneous material shall be removed from the inside of the pipe and the newly made joint shall be cured for 7 days.

c) Glazed Stoneware Pipes

Tarred gasket or hemp yarn soaked in thick cement slurry shall first be placed round the spigot of each pipe and the spigot shall then be placed into the socket of the pipe previously laid. The pipe shall then be adjusted and fixed in the correct position and the gasket caulked tightly so as not to fill more than 1/4 of the total depth of the socket. The remainder of the socket shall be filled with a stiff mixture of cement mortar 1:1 (1 cement : 1 sand). A fillet shall be formed round the joint with a trowel, forming an angle of 45 deg. with the barrel of the pipe. The newly made joints shall be protected, until set and shall be cured by covering with damp cloth or other suitable materials.

d) Vitrified clay pipes

The vitrified clay pipe shall be made from refractory clay mixed with crushed pottery and stone and burnt at a high temperature. These shall be hard, compact, and glazed to make them acid resistant and impervious, and shall be obtained from approved manufacturer.

Special care shall be taken in handling these pipes. The pipes shall not be jointed until the earth has been partly refilled over the portion of the pipe between the joint holes. Before laying the second pipe, the socket of the first pipe laid shall be thinly painted all round on the inside with cement slurry (1 part of cement and 2 parts of clean, sharp sand). A ring of rope yarn (closely twisted hemp or jute) dipped in neat cement paste or tar or bitumen, shall be inserted in the socket of pipe and driven home with caulking tools. The rope shall fully encircle the spigot with a slight overlap and shall not occupy more than one-fourth of the total depth of the socket. Where the spigot end of the pipe is made for receiving the gasket,

it shall be wrapped with two or three turns of tarred spun, as close to the end as possible, before inserting into the socket. The joint shall then be completely filled with cement mortar (1:1), which shall have very little water. A fillet shall be formed round the joint with trowel, forming an angle of 45 degrees with the outside pipe. Special care shall be taken so that any excess mortar etc. left inside the pipe joints is neatly cleaned off immediately after each joint is made. A semi-circular wooden scrapper or a rubber disc to which a long handle is fixed could be used for this purpose.

e) Lead Pipes

The joints in lead pipes shall be made as wiped solder joint. The minimum and the maximum length of the wiped solder joints shall be 8 cm. and 9 cm. respectively. The solders shall generally consist of two parts of lead and one part of tin.

f) Polyethylene Pipes

The joints shall be thermo welded or bolted as per manufacturer's instructions.

g) Jointing Cast Iron Pipes with Stoneware Pipes

Where any cast iron drain pipe, ventilating pipe or trap is connected with a stoneware or semi-vitrified waste pipe, the beaded spigot end of such cast iron drain pipe, waste or ventilating pipe or trap shall be inserted into a socket of such stoneware pipe and the joint made with mortar consisting of one part of cement and one part of clean sand after placing a ratted gasket or hemp yarn soaked in neat cement slurry round the joint and inserted in it by means of a caulking tool.

h) Jointing Stoneware with Cast Iron Pipes

Where any water closet pan or earthware trap connected to such a pan is to be jointed with a cast iron soil pipe, the joint between the stoneware spigot and the cast iron socket shall always be of a flexible nature. Such joint shall be made with a mixture of bitumen and chopped asbestos fibre.

3.04.11 Trenches and other excavations

Width of the trench at the bottom shall be such as to provide 200 mm clearance on either side of the pipe for facility of laying and jointing.

Excavated material shall be stacked sufficiently away from the edge of the trench and the side of the spoil bank shall not be allowed to endanger the stability of the excavation. Spoil may be carted away and used for filling the trench behind the work.

Turf, top soil or other surface material shall be set aside, turf being carefully rolled and stacked for use in reinstatement.

All excavation shall be properly timbered, where necessary.

Efficient arrangements for dewatering during excavation and keeping it dry till backfilling shall

be made to the satisfaction of the Engineer. Sumps for dewatering shall be located away from the pipe layout.

Where the excavation proceeds through roads necessary permissions shall be secured by the Contractors from the appropriate authorities.

Special care shall be taken not to damage underground services, cables etc. These when exposed shall be kept adequately supported till the trench is backfilled.

The backfilling shall be done only after the pipeline has been tested and approved by the Engineer. Special care shall be taken under and sides of the pipe during hand packing with selected material. At least 300 mm over the pipe shall also be filled with soft earth or sand. Consolidation shall be done in 150 mm layers. The surface water shall be prevented from getting into the filled up trench. Traffic shall not be inconvenienced by heaping up unduly the backfilling material to compensate future settlement. All future settlements shall be made good regularly to minimize inconvenience of traffic where applicable.

3.04.12 Protection

Open end of each pipe shall be protected during installation by suitable covers or plugs so that the ends, threads, sockets, or spigot are not damaged and no foreign material can find its way into the pipeline. Fittings and fixtures liable to be misused or stolen during the construction phase shall be fitted only before testing and handing over.

3.05.00 Water Storage Tanks

Overhead/loft type water storage tank shall be made of PVC. These tanks shall be provided for each toilet block and placed on the roof/loft of the building. Tank shall be installed with proper supports and anchorage for applicable wind and seismic condition. Installation of tank shall be carried out according to the recommendation of IS: 12701. These tanks shall rest preferable on flat surface so as to distribute the load evenly. The tank shall be leakproof and water tight.

The outlet pipe shall be 50 mm above the bottom of the tank and provided preferably with strainers. The wash out or draining pipe shall be connected at the lowest point and flush with bottom of tank.

Tank shall be provided with all fittings for inlet, outlet, overflow pipes and ball valves.

3.06.00 SEPTIC TANK AND EFFLUENT DISPOSAL

3.06.01 Septic tank

Septic tank shall consist of the tank itself with inlet and outlets there from complete with all necessary earthwork and backfilling. The details of septic tank shall be as shown on drawings. This item shall also include ventilating pipe of at least 100 mm dia whose top shall be provided with a suitable mosquito proof wiremesh and cowl. Ventilating pipe shall extend to a height of about 2 meter when the septic tank is at least 15 meter away from the nearest building and to a height of 2 meter above the top of building when it is located closer than 15 meter. Ventilating pipes can be connected to the normal soil ventilating system of the building where allowed.

3.06.02 Effluent Disposal

The effluent from the septic tank shall be disposed by allowing it into an open channel or a body of water if the concerned authority approves or into a soak pit for absorption by soil or shall be allowed to be absorbed by soil through open jointed SW pipes laid in a trench filled with broken bricks.

3.06.03 Soak pit

The soak pit shall be complete. It shall consist of a 900 mm dia pit 1000 mm in depth below the invert level of the inlet pipe. The pit shall be lined with stone; brick or concrete blocks set in cement mortar (1:6) and filled with brickbats. Inlet pipe shall be taken down to a depth of 900 mm from the top as an anti-mosquito measure.

3.06.04 Open jointed SW Pipe/dispersion trenches

Minimum dia of the SW pipes shall be 150 mm nominal. The trench for laying the pipes shall be a minimum 600 x 600 mm. The joints of the pipes shall be left unsealed. The entire length of the pipe within the trench shall be buried in a 250 mm layer gravel or crushed stone of uniform size. On top of gravel/crushed stone layer is a 150 mm bed of well-graded coarse aggregate. Ordinary soil is used for filling the top of trench.

3.06.05 Commissioning septic tank

After the septic tank has been proved watertight and the sewage system is checked the tank shall be filled with water to its outlet level before the sewage is let into the tank. It shall be seeded with well digested sludge obtained from septic tank or sludge digestion tank. In the absence of digested sludge a small quantity of decaying organic matter such as digested cow-dung may be introduced.

3.07.00 Related Works

All works, like earthwork, masonry, concrete, steelwork, cutting holes, chases, repairs and rectification associated directly with installation of water supply and sanitation systems shall come under scope of the Contractor unless specifically excluded. These works are not detailed out in this Section.

3.08.00 Regulation

The work which is required to be carried out under this section, shall be executed by a licensed Plumber only (engaged by the Contractor) and he shall obtain all necessary sanctions, permissions, certificates etc., from Municipal and/or other Local Authorities and shall abide by all the rules of such Authorities.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 Inspection Before installation

All pipes, fittings, and appliance shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes and fittings shall be inspected on site before laying and

shall be sounded to disclose cracks. Any defective items shall be clearly marked as rejected and forthwith removed from the site.

4.02.00 Testing of Water Supply pipe line

4.02.01 Testing of Mains After Laying

After laying and jointing, the main shall be slowly and carefully charged with water, so that all air is expelled from the main by providing a 25 mm inlet with a stop-cock, allowed to stand full of water for a few days if time permits, and then tested under pressure. The test pressure shall be 5 Kg/sq.cm or double the maximum working pressure, whichever is greater. The pressure shall be applied by means of a manually operated test pump, or in the case of long mains or mains of a large diameter, by a power driven test pump, provided that the pump is not left unattached. In either case due precaution shall be taken to ensure that the required test pressure is not exceeded. Pressure gauges shall be accurate and shall preferably have been recalibrated before the test. The pump having been stopped, the test pressure shall maintain itself without measurable less for at least five minutes. The end of the main shall be closed by fitting a watertight expanding plug and the plug shall be secured by struts to resist the end thrust of the water pressure in the mains.

4.02.02 Testing of Service Pipes and Fittings

The service pipes shall be slowly and carefully charged with water allowing all air to escape avoiding all shock or water hammer. The service pipe shall then be inspected under working conditions of pressure and flow. When all draw-off taps are closed, the service pipes shall be absolutely watertight. All piping, fittings, and appliances shall be checked for satisfactory support and protection from damage, corrosion, and frost.

4.03.00 Testing of Drain and Sewerage Pipelines

All soil pipes, waste pipes, ventilating pipes and all other pipes, when above ground, shall be gas tight. All sewers and drainpipes laid below ground shall be tested water tight. The method of actual tests shall be decided by the Engineer. All test data shall be recorded and submitted to the Engineer for review and instruction. The Engineer's discretion regarding tolerance shall be final.

General guidance for the tests are given below:

a) Smoke test

All soil pipes, waste pipes and vent pipes and all other pipes when above ground shall be approved gastight by a smoke test conducted under a pressure of 25 mm of water and maintained for 15 minutes after all trap seals have been filled with water. The smoke is produced by burning oily waste or tarpaper or similar material in the combustion chamber of a smoke machine. Chemical smokes shall not be used.

b) Water test

The pipes shall be subjected to a test pressure of at least 1.5 m head of water at the highest point of the section under tests. The tolerance figure of two litres per centimetre of diameter per kilometre may be allowed during a period of 10 (ten) minutes. The test shall be carried out by suitably plugging the low end of the drain and the ends of connections, if any, and filling the system, with water. A knuckle bend shall be temporarily jointed in at the top end and a sufficient length of the vertical pipe jointed to it so as to provide the required test head or the top end may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitably for observation.

Subsidence of test water may be due to one or more of the following cases:

- a) Absorption by pipes and joints
- b) Sweating of pipes or joints
- c) Leakage at joints or from defective pipes
- d) Trapped air.

Allowance shall be made for (a) by adding water until absorption has ceased and after which the test proper should commence. Any leakage and the defective part of the work shall be cut out and made good.

c) For straightness

- i) By inserting at the high end of the sewer or drain a smooth ball of a diameter 13 mm less than the pipe bore. In the absence of obstruction, such as yarn or mortar projecting through the joints, the ball will roll down the invert of the pipe and emerge at the lower end; and
- ii) By means of a mirror at one end of the line and lamp at the other. If the pipeline is straight, the full circle of light may be observed. The mirror will also indicate obstruction in the barrel if the pipeline is not straight.

4.04.00 Fittings and Fixtures etc.

All fittings and fixtures shall be connected by water tight joints. No dripping of water shall be acceptable.

4.05.00 Testing Septic Tank

The septic tank shall be tested for water tightness. It shall be filled up with water and allowed to soak for 24 hours. Then, it shall be topped up and allowed to stand again for 24 hours and loss of level recorded. The fall shall not be more than 15 mm in 24 hrs.

5.00.00**I.S. CODES**

Important relevant IS Codes for this specification are listed below:

Latest editions shall always be consulted.

IS: 404	:	Lead pipes.
IS: 407	:	Brass tubes for general purposes.
IS: 458	:	Concrete pipes (with or without reinforcement)
IS: 783	:	Code of Practice for laying of concrete pipes.
IS: 1172	:	Code of basic requirements for water supply, drainage and sanitation.
IS: 1200	:	Laying of water and sewer lines, including appurtenant (Pt.XVI) items.
IS: 1230	:	Cast iron rain water pipes and fittings.
IS: 1239 (Pt.I & III)	:	Specification for Mild Steel Tubes and Mild Steel Tubulars and other wrought steel pipe fittings (10 mm to 15 mm nominal diameter).
IS: 1536	:	Specification for centrifugally cast (Spun) iron pressure pipes for water gas and sewage.
IS: 1537	:	Specification for vertically cast iron pressure pipes for water, gas and sewage.
IS: 1592	:	Asbestos cement pressure pipes,
IS: 1626	:	Asbestos cement pressure pipes, gutters and fittings (Spigot and Socket types).
IS: 2065	:	Code of Practice for Water Supply in buildings.
IS: 2501	:	Copper tubes for general engineering purposes.
IS: 2556	:	Specification for vitreous sanitary appliances (vitreous china) Part – I - General requirement
IS: 2633	:	Method of testing, uniformity of coating on zinc coated articles.
IS: 3076	:	Low density polyethylene pipes for portable water supplies.
IS: 3486	:	Specification for Cast iron spigot and socket drain pipes (80 mm to

250 mm nominal diameter).

- IS: 3589 : Specification for Electrically welded steel pipe for water, gas and sewage (200 mm to 2000 mm nominal diameter).
- IS: 4827 : Specification for electro plated coatings of nickel and chromium on copper and copper alloy.
- IS: 4964 : High-density polyethylene pipes for portable water supplies.
- IS: 12701 : Rotational moulded polyethylene water storage tanks

6.00.00 RATE AND MEASUREMENT

6.01.00 RATE

6.01.01 G.I. Pipes For Water Supply

Rate shall include providing and fixing of the pipes including all specials and fittings, such as tees, bands, elbows, clamps, drain heads, cleanouts etc. with cutting, making chases and jointing of pipes, making good the walls.

6.01.02 Rainwater Down-comers

Rate shall include providing and fixing of the pipes including all specials and fittings, such as tees, bands, elbows, clamps, drain heads, cleanouts etc. The rate also include cost of jointing and making good the opening in structure.

6.01.03 Sanitary Fixtures

Rate shall include providing and fixing of sanitary appliances & fixtures and at all elevation, including all accessories and fittings, connections pipes, waste trap and pipes all complete as per description of "Schedule of Items". Rate shall also include the jointing of waste & traps to drain pipes.

6.01.04 Drainage and Sewer Pipes

Rate shall be inclusive of providing, laying and jointing of pipes as specified. Rate also include cost of lead joints or other joint as specified, cost for painting and cutting and making good walls, floors etc.

6.01.05 Floor and Gully Traps

Rate of traps is inclusive of all excavation, filling, repair, making good of opening in floor and walls, grating, painting etc. complete as described in "Schedule of Items".

6.01.06 Manholes, Septic Tank, Soak Pit and Cover

Rate of manholes, septic tank, soak pit shall be paid under respective items of work executed like brick work, plastering, concrete, reinforcement steel etc. provided for completion of the

structure as per drawing and specifications. Manhole cover shall be paid separately as per description of item.

6.01.07 Water Storage Tank

The rate for water storage tank is inclusive of supply and installation of tank with all fittings, inlets, outlets, valves etc. complete.

6.02.00 Measurements

6.02.01 Pipe for Water Supply and Drainage

For G.I.Pipe of water supply line, rainwater down comers, drainage and sewer pipe, the measurements shall be in running metres and shall be taken along centre line of pipe or specials.

The pipe shall be measured separately according to dia. and class of pipe.

Fixtures like bibcock, stopcocks, valves etc. shall be measured in numbers.

6.02.02 Sanitary Appliances & Fixtures and Allied Works

All sanitary appliances & fixtures like sink, washbasin, WC, shall be measured in numbers for the complete work as described in schedule of items.

Floor and gully traps shall be measured in numbers unless otherwise specified.

Water storage tank shall be measured in numbers for the capacity as specified in “Schedule of Items”.

The item of work executed for completion of manholes, septic tank & soak pit shall be measured in respective items of work like brick work, RCC, plastering etc. CI cover shall be measured in numbers as specified in “Schedule of Items”.

SUB-SECTION – D16

ROADS AND DRAINAGE

CONTENT

CLAUSE NO.	DESCRIPTION

1.00.00	SCOPE
2.00.00	CODES AND STANDARDS
3.00.0	EXECUTION
4.00.00	TESTING AND ACCEPTANCE CRITERIA

Road And Drainage

1.00.00 Scope

The scope include all works required for the construction of road including construction of embankment, sub-base course, base course, tack coat, bituminous macadam, wearing course, liquid seal coat, shoulder and all incidental items of work specified or not shown but reasonably implied or necessary for the completion of the work etc.

The scope also include all works required for the construction of drainage including construction of road side drains, RCC culverts, pipe culverts, drainage pipes, manholes and all other incidental items necessary for the completion of the work etc.

1.01.00 Works To Be Provided By The Contractor

The works to be provided by the contractor unless specified otherwise shall include but not be limited to the following.

- a) Construction of roads including providing all materials, labour, supervision, services, equipments, tools and plants, transportation etc all required for the completion of the work.
- b) Submission of detailed scheme of all operations required for executing the work (e.g. material handling, placement, services, approaches etc) to the engineer for approval.
- c) Carrying out tests whenever required by the engineer to assess the quality of work and submission of the test results to the engineer after completion of the same etc.

1.02.00 Work To Be Provided By Others

No work under this specification will be provided for by any agency other than the contractor unless specifically mentioned elsewhere in the contract.

1.03.00 Conformity With Designs

The contractor shall carryout the work as per the construction drawings, specification and as directed by the engineer.

1.04.00 Materials To Be Used

All materials required for the work shall be the best commercial variety and as approved by the engineer.

2.00.00 Codes and Standards

All works under this specification shall conform to the latest revision and/or replacement of the following or any other IRC/IS Codes and Standard Practices unless specified otherwise.

- a) Specification for road and bridge works of Ministry of Shipping & Transport
(Road Wing) Published by the IRC
- b) IRC: 19 - Standard specification and code of practice for Water bound
Macadam
- c) IRC :SP 11 - Hand Book of Quality Control for Construction of Roads and Runways
- d) IS:456 - Indian Standard Code of Practice for Plain and Reinforced
Concrete.
- e) IS:2212 - Code of Practice for Brick work
- f) IS: 783 - Code of Practice for Laying of Concrete Pipes
- g) IS: 1201 - Methods of testing tar and bituminous materials
to 1220
- h) IS: 73 - Specification for paving bitumen
- i) IS: 215 - Specification for Road tar
- j) IS: 216 - Coal tar pitch
- k) IS: 217 - Specification for cut-back bitumen
- l) IS: 454 - Specification for cut-back bitumen from waxy crude
- m) IS: 1834 - Specification for hot applied sealing compound for joint in concrete
- n) IS: 1838 - Specification for performed fillers for expansion joints in concrete, non
extruding and resilient type
- Part I Bitumen impregnated fibre
- Part II CNSL Aldehyde resin and coconut pith
- o) IS : 334 - Glossary of terms relating to bitumen and tar
- p) IS: 1077 - Common burnt clay building bricks.
- q) IS : 3117 - Specification for bitumen emulsion roads (anionic type).
- r) Other specifications mentioned elsewhere in this specification.

In case any particular aspect of work is not covered specifically by the specification/Indian Standard Code of practices, any other standard practice as may be specified by the engineer shall be followed.

2.01.00**Quality Control**

The Contractor shall establish and maintain quality control for all materials, procedures, workmanship and equipments used. All works shall conform to the lines, grades, cross sections and dimensions shown on the drawings, specification and as directed by the engineer. Permitted tolerances for road works are described hereinafter.

a) Horizontal Alignment

Horizontal alignment shall be reckoned with respect to the centre line of the carriageway as shown on the drawings. The edges of the carriageway as constructed shall be correct within a tolerance of $\pm 25\text{mm}$ therefrom. The corresponding tolerance for edges of the roadway and lower layers of the pavement shall be $\pm 40\text{mm}$.

b) Longitudinal Profile

The finished levels of the sub-grade and different pavement courses as constructed shall not vary from those calculated with reference to the longitudinal and cross-profile of the road shown on the drawings or as directed by the engineer and shall not exceed the tolerances as mentioned below.

Sub-grade	$\pm 25 \text{ mm}$
Sub-base	$\pm 20 \text{ mm}$
Base course	$\pm 15 \text{ mm}$
Wearing course	$\pm 10 \text{ mm}$

Tolerance in wearing course shall not be permitted in conjunction with the positive tolerance on base course if the thickness of the wearing course is thereby reduced by more than 6 mm.

c) Surface Regularity of Sub-grade and Pavement Courses

The surface regularity of the completed sub-base, base course and wearing surfaces in the longitudinal and transverse directions shall be within the tolerances indicated in Table - I. The longitudinal profile shall be checked with a 3m long straight edge at the middle of each traffic lane along a line parallel to the centre of the road. The transverse profile shall be checked with a set of three camber boards at intervals of 10m.

TABLE –I

PERMITTED TOLERANCE OF SURFACE REGULARITY FOR PAVEMENT COURSES

Sl. No.	Type of Construction	Longitudinal profile with 3m straight edge					Cross Profile
		Maximum permissible Undulation (mm)	Maximum number of undulations permitted in any 300m length with undulation exceeding (mm)				Maximum permissible variation from specified profile under camber template (mm)
			18	12	10	6	
1	2	3	4	5	6	7	8
1.	Earthen sub-grade	25	30	-	-	-	15
2.	Granular sub-base	15	-	30	-	-	12
3.	Water Bound Macadam with oversize metal (40-90 mm size)	15	-	30	-	-	12
4.	Water Bound Macadam with normal size metal (20-50 mm and 40-63 mm size), Bituminous Penetration Macadam	12	-	-	30	-	8
5.	Surface dressing** (two coat) over WBM (20-50 mm or 40-63 mm size metal), Bituminous penetration macadam	12	-	-	20	-	8
6.	Open graded premix carpet, mix seal Surfacing	10	-	-	-	30	6
7.	Bituminous macadam	10	-	-	-	20***	6
8.	Semi-dense carpet	10	-	-	-	20***	6
9.	Asphaltic Concrete	8	-	-	-	10***	4

Notes:

1. ** For surface dressing in all other cases, the standards of surface evenness will be the same as those for the surface receiving the surface dressing.
2. *** These are for machine laid surfaces. If laid manually due to unavoidable reasons, tolerance upto 50 percent above these values in this column may be permitted at the discretion of the Engineer. However this relaxation does not apply to the values of maximum undulation for longitudinal and cross profiles mentioned in columns 3 and 8 on the table.
3. Surface evenness requirements in respect of both the longitudinal and cross profiles should be simultaneously satisfied.

3.00.00 Execution

3.01.00 Setting Out

Within 15 days of the award of contract, the contractor shall prepare and submit to the Engineer, detailed drawings/schemes of embankment filling and excavation works as proposed to be executed by him showing the dimensions as per construction drawings and specification adding his proposals of drainage and dewatering of pits, watering and compacting the embankment fill etc. On receiving the approval from the Engineer with modifications and corrections if any, the contractor shall set out the work from the control points furnished by the Engineer and fix permanent points and markers for ease of future checking. These permanent points and markers will be checked by the Engineer and certified by him after which the contractor shall proceed with the work. It should be noted that this checking by the Engineer prior to the start of the work will in no way absolve the contractor of his responsibility of carrying out the work to true lines and levels as per the approved drawings. If any errors are noticed in the Contractor's work at any stage, the same shall be rectified by the contractor at his own risk and cost. Profiles of the embankment made by Bamboo, earth or other convenient materials and strings shall be set up at suitable intervals for the guidance of the workmen.

3.02.00 Clearing and Grubbing etc

Before commencement of earthwork, the surface area of ground to be occupied shall be cleared of all fences, trees, logs, stumps, bush, vegetation, rubbish, slush etc. Cutting of trees shall include trees having girth of any size and removing roots upto a depth of 600mm below ground level or 300mm below formation level whichever is deeper. After the removal of roots of trees, the pot holes formed shall be filled with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the Engineer. The trees shall be cut into suitable pieces as instructed by the Engineer. Before earthwork is started, all the spoils and unserviceable materials and rubbish shall be burnt or removed from the site to the approved disposal areas as may be specified. Useful materials, saleable timbers, firewood, etc shall be the property of the Owner and shall be stacked properly at the worksite in a manner as directed by the Engineer.

3.03.00 Filling in Embankment

3.03.01 General

The material used for constructing the embankment shall be earth, moorum, gravel or a mixture of the above or any other material approved by the Engineer. The material shall be free from lumps & clods, boulders and rock pieces, roots and vegetation, harmful salts and chemicals, organic materials, loose silts, fine sands and expansive clays in order to provide a stable embankment. The filling and compaction operation should be such that the best available materials are saved for the top portion and will result in an acceptable and uniform gradation of material and provide impermeability and stability to the embankment when compacted. The size of the coarse material in the mixture of earth shall ordinarily not exceed 75mm. However, the Engineer may at his discretion permit the use of material coarser than the specified if he is

satisfied that the same will not present any difficulty as regard to the placement and compaction of the fill material are concerned. Ordinarily, only the materials satisfying the density requirements as given below in Table-II shall be employed for embankment construction.

Table - II**Density Requirements of Embankment Materials**

Sl. No.	Type of Work	Maximum laboratory dry density when tested as per IS: 2720 (Part - VII)
1.	Embankment upto 3m height	Not less than 1.44 gm/cc
2.	Embankment exceeding 3m height and embankment of any height subject to long period of inundation	Not less than 1.52 gm/cc
3.	Top 0.5m of the embankment below sub-base and shoulders (where earth shoulders are specified)	Not less than 1.65 gm/cc

Expansive clays exhibiting marked swell and shrinkage properties shall not be used for embankment construction.

The material for embankment construction shall be obtained from approved sources with preference given to the materials available from nearby road excavation or any other excavation under the same contract.

3.03.02 Setting Out

After the site clearance, the work shall be set out true to lines, curves, slopes, grades and sections as shown on the approved drawings or as directed by the Engineer. The contractor shall provide all labour, survey instruments and materials such as strings, pegs, nails, bamboo, stones, lime, mortar, concrete etc required in connection with the setting out of the works and establishment of the bench marks. The limits of the embankment shall be marked by fixing batter pegs on both sides at regular intervals as guides before commencing the earthwork. To ensure the safety, the pegs should normally be fixed about 500mm away from the actual limits of the fill and to be painted in a distinct colour. The centreline of the embankment shall be pegged at regular intervals of 25/30m and at all skew/curves. The actual profile of the embankment shall be made at every third centreline peg with bamboo posts and strings. Preferably prototype profiles developed with wooden planks need to be fixed at every 200m and at the intersection points at curves. The profile shall be about 3m long.

3.03.03 Stripping and Storing top soil

The construction of the earthen embankment by filling shall conform to the dimensions, slopes and other details shown in the approved drawings. Before commencement of the embankment construction, the surface area of ground to be occupied after clearing and grubbing shall be stripped off to a minimum depth of 150mm or more as directed by the Engineer in order to remove all perishable material and any soil which may become unstable on saturation or may interfere with the development or proper bonding between the foundation and embankment. It is not necessary to remove all the soil containing fine hair like roots but only the rather heavy mats are to be removed. In localities where most of the available embankment fill materials are not conducive to plant growth or when so directed by the Engineer, the top soil shall be stripped to specified depths not exceeding 150mm.

3.03.04 Compacting Original Ground

In all cases, the original ground after stripping shall be compacted by rolling with a minimum of six passes of 8-10 tonne roller and as directed by the Engineer. Where the height of the proposed embankment is less than 0.5m and the original ground does not already have a relative compaction of atleast 95 percent, the same shall be loosened upto a depth of 0.5m and filled in layers not exceeding 250mm in loose thickness and each layer shall be watered and compacted to 100% maximum dry density of the fill material determined in accordance with IS:2720, Part-VII. However, before relaying and compacting the loosened material, the surface below this level shall be suitably compacted as directed by the Engineer with a minimum of six passes of a 8 - 10 tonne roller.

Where so directed by the Engineer, any unsuitable material occurring in the embankment foundation shall be removed and replaced with approved materials suitably compacted. Embankment work shall not proceed until the foundation soil of the embankment is inspected by the Engineer and approved.

3.03.05 Filling

The embankment material shall be spread uniformly over the entire width of the embankment in layers not exceeding 250mm in loose thickness. Successive layers of embankment shall not be placed until the layer under construction has been thoroughly compacted to the requirements set down hereunder. Moisture content of the fill material shall be checked at the source of supply and if found less than that specified for compaction, the same shall be made good either at the source or after spreading the soil in loose thickness for compaction. In the latter case water shall be sprinkled directly from a hose line or from a truck mounted water tank and flooding shall not be permitted under any circumstances. After adding required amount of water, the soil shall be processed by means of harrows, rotary mixers or by any other approved methods until the layer is uniformly wet.

If the material delivered to the road bed is too wet, it shall be dried by aeration and exposure to the sun till the moisture content is acceptable for compaction. Should circumstances arise

where owing to wet weather, the moisture content cannot be reduced to the required amount by the above procedure, the work on compaction shall be suspended.

Moisture content of each layer shall be checked in accordance with IS:2720, Part-II and unless otherwise specified shall be so maintained making due allowance for evaporation losses that during compaction, the moisture content shall be in the range of 1 percent above to 2 percent below the optimum moisture content as determined in accordance with IS:2720, Part-VII.

Clods or hard lumps of earth shall be broken to have a maximum size of 150mm when being placed in the lower layers of the embankment and a maximum size of 60mm when being placed in the top 0.5m portion of the embankment below sub-base.

Hauling equipment shall be dispersed uniformly over the entire surface of the previously constructed layer to minimise rutting or uneven compaction.

Where the embankment is to be constructed across a low swampy ground that will not support the weight of trucks or other hauling equipments, the lower part of the fill shall be constructed by dumping successive loads in a uniformly distributed layer to a thickness not greater than that necessary to support the hauling equipment while placing subsequent layers.

3.03.06**Compaction**

Compaction equipment approved by the Engineer shall only be employed for construction. If directed by the Engineer, the Contractor shall demonstrate the efficiency of the plant he intends to use by carrying out compaction trials.

Each layer shall be thoroughly compacted to the density as specified in Table-III. Subsequent layers shall be placed only after the finished layer has been tested and accepted by the Engineer.

Table - III**Compaction Requirements For Embankment**

Sl. No.	Type of work/material	Field dry density as a percentage of maximum laboratory dry density as per IS : 2720, Part-VII
1.	Top 0.5m portion of embankment below sub-base and shoulders	Not less than 100
2.	Other portions of embankment	Not less than 95

When density measurement reveal any soft area in the embankment, further compaction shall be carried out as directed by the Engineer. If in spite of that the specified compaction is not achieved, the material in the soft area shall be removed and replaced with approved material, compacted to the density requirements and satisfaction of the Engineer.

3.03.07**Drainage**

The surface of the embankment at all times during construction shall be maintained at such a cross fall as will shed water and prevent ponding.

3.03.08 Finishing Operations

Finishing operations shall include the work of shaping and dressing the shoulders, road bed and side slopes to conform the alignment, levels, cross sections and dimensions as shown on the drawings or as directed by the Engineer. Both the upper and lower ends of the side slopes shall be rounded off to improve appearance and merge the embankment with the adjacent terrain.

3.04.00 Turfing With Sods

3.04.01 General

This work shall consist of furnishing and laying of live sod of perennial turf forming grass on embankment slopes, shoulders or other locations as shown on the drawings or as directed by the Engineer. Unless otherwise specified the work shall be taken up following the construction of embankment provided the season is favourable for establishment of the sod.

3.04.02 Materials

The sod shall consist of dense, well rooted growth of permanent and desirable grasses, indigenous to the locality where it is to be used and shall be practically free from weeds or other undesirable matter. At the time the sod is cut, the grass shall have a length of approximately 50mm and the sod shall be free from any debris.

Thickness of the sod shall be as uniform as possible with some 50 to 80mm of soil covering the grass roots depending on the nature of the sod so that practically all the dense root system of the grass are retained in the sod strip. The sods shall be cut in rectangular strips of uniform width not less than 250mm x 300mm in size but not so large so that it is convenient to handle and transport without damage. During wet weather the sod shall be allowed to dry sufficiently to prevent rearing during handling and during dry weather it shall be watered before lifting to ensure its vitality and prevent dropping of soil during handling.

3.04.03 Placing The Sods

The area to be sodded shall be previously constructed to the required slope and cross section. Soil on the area shall be loosened, freed from all stones larger than 50mm size, sticks, stumps and any other undesirable foreign matter etc and brought to a reasonably granular texture to a depth not less than 25mm for receiving the sod. Following soil preparation, fertilizer and ground limestone when specified shall be spread uniformly. After spreading, the materials shall be incorporated in the soil by discing or other means. The prepared sod bed shall be moistened if not already sufficiently moist and the sod shall be placed thereon within approximately 24 hours after the same has been cut. Each sod strip shall be laid in close contact with each other and shall be lightly tamped with suitable wooden or metal tampers so as to eliminate air pockets and to press it into the underlying soil. At points where water may flow over the sod, the upper edges of the sod strips shall be turned into the soil below the adjacent area and a layer of earth shall be placed over it followed by thorough compaction.

3.04.04 Staking the Sods

Where the side slope is 2 to 1 or steeper and the distance along the slope is more than 2m, the sods shall be staked with pegs or nails spaced approximately 500 to 1000mm along the longitudinal axis of the sod strips. Stakes shall be driven approximately plumb through the sods and to be almost flushed with them.

3.04.05 Top Dressing

After the sods have been laid in position, the surface shall be cleaned of loose sod, excess soil and other foreign materials. Thereafter a thin layer of top soil shall be scattered over the top dressed surface and the area shall be thoroughly moistened by sprinkling water.

3.04.06 Watering and Maintenance

The turfing so laid shall be well watered and protected until final acceptance. Watering shall be done in such a way that no erosion or damage to the sodded areas/embankment occur. The Contractor shall erect necessary warning signs and barriers, repair or replace the sods which are failing to show uniform growth of grass or damaged by his operation and shall maintain the sod at his own cost until final acceptance.

3.05.00 Shoulder Construction

3.05.01 Description

This work shall consist of constructing shoulder on either side of the pavement in accordance with the requirements of this specification and in conformity with the lines, grades and cross sections shown on the approved drawings and as directed by the Engineer.

3.05.02 Materials

Shoulder shall be made of selected earth or granular material as specified conforming to relevant IRC standards.

3.05.03 Construction Operations

Except in the case of bituminous pavements, the shoulders shall be constructed in advance to the laying of pavement courses. The compacted thickness of each layer of shoulder shall correspond to the compacted layer of pavement course to be laid adjacent to it. After compaction, the inside edges of shoulders shall be trimmed vertical and the area enclosed between the shoulders shall be cleaned of all spilled material before proceeding with the construction of the pavement layer.

In the case of bituminous pavements, shoulder shall be constructed only after the pavement courses have been laid and compacted.

Regardless of the method of laying, all shoulder construction material shall be placed directly on the shoulder. Any spilled material dragged on to the pavement surface shall be immediately removed without any damage to the pavement and the area so affected shall be thoroughly cleaned. During all stages of shoulder construction, the required crossfall shall be maintained to drain off surface water.

3.06.00 Kerb

3.06.01 Material

Kerb if required for the construction of footpath shall consist of precast concrete blocks with concrete grade of M-20. The blocks shall be of 100mm thick and of suitable length. The depth of blocks unless otherwise mentioned elsewhere shall be 375mm considering 225mm height of footpath above the road level.

3.06.02 Laying

The kerb shall be laid by cutting trenches of 150mm deep. The width of the trench shall be minimum and just sufficient to insert the kerbs. The inside faces of the kerbs shall be in plumb and the gap between the block shall not be more than 10mm. The gap shall be filled with cement mortar as specified.

The kerbs shall be thoroughly packed with a mixture of stone chips (50%) and moorum (50%) at the outside face. The laying and packing shall be done in a proper workmanlike manner acceptable to the Engineer.

3.07.00 Sub-base (Granular Sub-base)**3.07.01 Description**

This work shall consist of laying and compacting well graded material on the prepared sub-grade in accordance with the specification. The material shall be laid in one or more layers as shown on the drawings and shall conform to the lines, grades and cross sections shown on the drawings and as directed by the Engineer.

3.07.02 Materials

The materials to be used for the work shall be natural sand, moorum, gravel, crushed stone, crushed slag, crushed concrete, brick metal, laterite, kankar etc or combinations thereof depending upon the grading required. The mixed materials shall be free from organic or other deleterious constituents and conform to one of the three grading given in Table - IV below.

Table - IV**Grading for Granular Sub-base Material**

Sieve designation	Percent by weight passing the sieve		
	Grading 1	Grading 2	Grading 3
80 mm	100	100	100
63 mm	90 - 100	90 - 100	90 - 100
4.75 mm	35 - 70	40 - 90	50 - 100
75 micron	0 - 20	0 - 25	0 - 30
Minimum CBR value for the fraction of material passing 20 mm sieve.	30 %	25%	20%

Note : The materials passing 425micron sieve for all the three gradings when tested according to IS : 2720, Part V shall have liquid limit and plasticity index not more than 25 percent and 6 percent respectively.

3.07.03 Physical Requirements

The fraction of materials passing 20 mm sieve shall give a CBR value as specified in Table – IV when tested in accordance with IS : 2720, Part XVI after preparing the samples at maximum dry density and optimum moisture content corresponding to IS : 2720, Part VII and soaking the same in water for 4 days.

3.07.04 Spreading and Compacting

Immediately prior to laying of sub-base, the sub-grade already finished shall be prepared by removing all vegetations and other extraneous matter, lightly sprinkled with water if necessary and rolled with one pass of 8 - 10 tonne smooth wheeled roller.

The sub-base material shall be spread on the sub-grade with the help of a drag spreader, motor grader or other approved means. The thickness of loose layers shall be so regulated that the maximum thickness of each layer after compaction shall not exceed 150mm.

Moisture content of the loose material shall be checked in accordance with IS : 2720, Part II and shall be suitably adjusted by sprinkling additional water from a hose line, truck mounted water tank or other approved means so that at the time of compaction it shall be from 1 percent above to 2 percent below the optimum moisture content. While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means if so directed by the Engineer until the layer is uniformly wet.

Immediately thereafter, rolling shall be done with 8 to 10 tonne smooth wheeled rollers or with any other approved plant. Rolling shall commence from the edges and progress towards the centre longitudinally except that on super elevated portions it shall progress from the lower to the upper edge parallel to the centre line of the pavement. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade and camber shall be checked and any high spots or depressions which become apparent shall be corrected by removing or adding fresh material.

Rolling shall be continued till the density achieved is at least 100% of the maximum dry density of the material determined as per IS : 2720, Part VII. The surface of any layer of material on completion of compaction shall be well closed free from movement under compaction plant and from compaction planes, ridges, cracks or loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and recompacted.

3.08.00 Water Bound Macadam Sub-base/Base Course

3.08.01 Description

Water bound macadam shall consist of clean crushed aggregates mechanically interlocked by rolling and bonded together with screenings, binding material wherever necessary and water laid on the prepared sub-grade or sub-base as the case may be and finished in accordance with

the specification and in conformity with the lines, grades and cross-sections shown on the approved drawings.

3.08.02 Materials

a) Coarse Aggregates - General Requirements

Coarse aggregates shall be either crushed or broken stone. The aggregates shall conform to the physical requirements set forth in Table - V.

Table - V

Physical Requirements of Coarse Aggregates for water Bound Macadam

Sl.No.	Type of Construction	Test	Test method	Requirements
1.	Sub-base	Los Angeles Abrasion Value *	IS : 2386 (Part IV)	50 percent maximum
		or Aggregate Impact Value	IS : 2386 (Part IV) or IS : 5640**	40 percent maximum
2.	Base	a) Loss Angeles Abrasion value*	IS : 2386 (Part IV)	50 percent maximum
		or Aggregate Impact Value	IS : 2386 (Part IV) or IS : 5640 **	40 percent maximum
		b) Flakiness Index ***	IS : 2386 (Part I)	15 percent maximum

* Aggregates may satisfy requirements of either of the two tests.

** Aggregates like brick metal, kankar and laterite which get softened in presence of water shall be tested for impact value under conditions in accordance with IS : 5640.

*** The requirements of Flakiness Index shall be enforced only in case of crushed or broken stone and crushed slag.

b) Crushed or Broken Stone

Crushed or broken stone shall be hard, durable and free from excess flat, elongated, soft and disintegrated particles, dirt and other objectionable matters.

c) Grading Requirements of Coarse Aggregates

The coarse aggregates shall conform to one of the gradings given in Table – VI. However the use of Grading No.1 shall be restricted to sub-base courses only.

Table - VI
Grading Requirements of Coarse Aggregates

Grading No.	Size range	Sieve designation	Percent by weight passing the sieve
1.	90mm to 40 mm	100 mm 80 mm 63 mm 40 mm 20 mm	100 65 - 85 25 - 60 0 - 15 0 - 5
2.	63 mm to 40 mm	80 mm 63 mm 50 mm 40 mm 20 mm	100 90 - 100 35 - 70 0 - 15 0 - 5
3.	50 mm to 20 mm	63 mm 50 mm 40 mm 20 mm 10 mm	100 95 - 100 35 - 70 0 - 10 0 - 5

d) Screenings

Screenings to fill voids in the coarse aggregate shall generally consist of the same material as the coarse aggregates. However, where permitted, predominantly non-plastic material such as moorum or gravel (other than rounded river borne material) may be used for this purpose provided liquid limit and plasticity index of such material is below 20 and 6 respectively and fraction passing 75 micron sieve does not exceed 10 percent.

As far as possible, screenings shall conform to the grading set forth in Table-VII. Screenings of Type A in Table-VII shall be used with coarse aggregates of Grading No.1 in Table-VI. Screenings of Type-A or B shall be used with coarse aggregates of Grading No.2. Type-B screenings shall be used with coarse aggregates of Grading No. 3.

Table - VII

Gradings For Screenings

Grading classification	Size of screenings	Sieve designation	Percent by weight passing the sieve
A	12.5 mm	12.5 mm 10.0 mm 4.75 mm 150 micron	100 90 - 100 10 - 30 0 - 8
B	10 mm	10 mm 4.75 mm 150 micron	100 85 - 100 10 - 30

e) Binding Material

Binding material to be used for water bound macadam construction shall comprise of a suitable material approved by the Engineer having plasticity index value of less than 6 as determined in accordance with IS : 2720, Part V. Application of binding material may not be necessary when the screenings used are of crushable type such as moorum or gravel.

3.08.03 Construction Operations

- a) The sub-grade/sub-base to receive the water bound macadam coarse shall be prepared to the specified grade and camber and made free of dust and other extraneous material. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm. Where water bound macadam is to be laid over an existing black topped surface, 50mm x 50mm furrows shall be cut at an angle of 45 degrees to the centre line of the road at 1m intervals in the latter before laying the coarse aggregates.

b) Inverted Choke

If water bound macadam is to be laid directly over the sub-grade without any other intervening pavement course, a 25mm course of screenings (Grading B) shall be spread on the prepared sub-grade before application of the coarse aggregates is taken up.

c) Spreading Coarse Aggregates

The coarse aggregates shall be spread uniformly over the prepared surface in such quantities that the thickness of each compacted layer is limited to 100mm for Grading No.1 and 75 - 100mm for Grading No. 2 and 3.

The spreading shall be done from stockpiles along the side of the roadway or directly from the vehicles. In no case shall the aggregate be dumped in heaps directly on the surface prepared to receive the aggregate nor shall hauling over permitted.

The surface of the aggregates spread shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregate as may be required. No segregation of large or fine particles

shall be allowed and the coarse aggregate as spread shall be of uniform gradation with no pockets of fine material.

The coarse aggregate shall not normally be spread more than 3 days in advance of the subsequent construction operations.

d) Rolling

Immediately following the spreading of the coarse aggregates, rolling shall be started with three wheeled power rollers of 8 to 10 tonne capacity or tandem or Vibratory rollers of approved type. The weight of the roller shall depend upon the type of the aggregate and be indicated by the Engineer.

Except on super elevated portions where the rolling shall proceed from inner edge to the outer, rolling shall begin from the edges gradually progressing towards the centre. First the edge/edges shall be compacted with roller running forward and backward. The roller shall then move inwards parallel to the centre line of the road. Each pass of the roller shall uniformly overlap not less than one half the width of the track made in the preceding pass.

Rolling shall continue until the aggregates are thoroughly keyed and the creeping of aggregates ahead of the roller is no longer visible. During rolling slight sprinkling of water may be done if necessary. Rolling shall not be done when the sub-grade is soft or yielding or when it causes a wavelike motion in the sub-grade or sub-base course.

The rolled surface shall be checked transversely and longitudinally with templates and any irregularities found shall be corrected by loosening the surface, adding or removing necessary amount of aggregates and rerolled until the entire surface conform to the desired camber and grade. In no case shall the use of screenings be permitted to make up the depressions.

e) Application of Screenings

After the coarse aggregate has been rolled, screenings to completely fill the interstices shall be applied gradually over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done while the screenings are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregates. The screenings shall not be dumped in piles but be spread uniformly in successive thin layers either by the spreading motion of hand shovels or by mechanical spreader or directly from trucks. Trucks operating for spreading the screenings shall be so driven as not to disturb the coarse aggregates.

The screenings shall be applied at a slow and uniform rate (in three or more applications) so as to ensure filling of all voids. This shall be accompanied by dry rolling and brooming with mechanical brooms or hand brooms or with both. In no case shall the screenings be applied so fast and thick as to form cakes or ridges on the surface in such a manner as would prevent filling of voids or prevent the direct bearing of the roller on the coarse aggregate. These operations shall continue until no more screenings can be forced into the voids in the coarse aggregates.

The spreading, rolling and brooming of screenings shall be carried out in only such lengths of the road which could be completed within one day's operation.

f) Sprinkling and Grouting

After the screenings have been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to seep the wet screenings into the voids and to distribute them evenly. The sprinkling, sweeping and rolling operations shall be continued with additional screenings applied as necessary until the coarse aggregate has been thoroughly keyed, well-bonded and firmly set to its full depth and a grout has been formed of screenings. Care shall be taken to see that the base or sub-grade does not get damaged due to the addition of excess quantity of water during construction.

g) Application of Binding Material

After the application of screenings, the binding material where it is required to be used shall be applied successively in two or more thin layers at a slow and uniform rate. After each application the surface shall be copiously sprinkled with water and the resulting slurry shall be swept in with hand brooms or mechanical brooms to fill the voids properly and rolled during which water shall be applied to the wheels of the rollers if necessary to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling the voids form a wave ahead of the wheels of the moving roller.

h) Setting and Drying

After the final compaction of water bound macadam course, the road shall be allowed to dry overnight. Next morning hungry spots shall be filled with screenings or binding material as directed, lightly sprinkled with water if necessary and rolled. No traffic shall be allowed on the road until the macadam has set. The Engineer shall have the discretion to stop hauling traffic from using the complete water bound macadam course if in his opinion it would cause excessive damage to the surface.

3.09.00 Tack Coat

3.09.01 Description

The work shall consist of application of a single coat of low viscosity liquid bituminous material to an existing road surface preparatory to another bituminous construction.

3.09.02 Materials

The binder used for tack coat shall be bitumen of a suitable grade as approved by the Engineer and conforming to IS-73, IS-217 or IS-454 as applicable or any other approved cutback.

3.09.03 Construction Operations

a) Preparation of Base

The surface on which the tack coat is to be applied shall be thoroughly swept and scraped clean of dust and any other extraneous materials before the application of the binder.

b) Application of Binder

Binder shall be heated to the temperature appropriate to the grade of bitumen used and approved by the Engineer and sprayed on the base at the rate specified below. The rate

of spread in terms of straight run bitumen shall be 5 kg per 10 square metre area for an untreated water bound macadam surface. The binder shall be supplied uniformly with the aid of sprayers.

The tack coat shall be applied just ahead of the oncoming bituminous construction.

3.10.00 Bituminous Macadam Binder Course

3.10.01 Description

This work shall consist of construction in a single course of 50mm/75mm thickness of compacted crushed aggregates premixed with a bituminous binder laid immediately after mixing on a base prepared previously in accordance with the specification and in conformity with the lines, grades and cross sections shown on the approved drawings.

3.10.02 Materials

a) Binder

The Binder shall be straight run bitumen of a suitable grade as directed by the Engineer complying with IS : 73.

b) Aggregates

The aggregates shall consist of crushed stone, crushed gravel (shingle) or other stones. They shall be clean, strong, durable, fairly cubical shape and free of disintegrated pieces, organic and other deleterious matter and adherent coats. The aggregates shall preferably be hydrophobic and of low porosity.

The aggregates shall satisfy the physical requirements set forth in Table - VIII.

Table - VIII

Physical Requirements of Aggregates For Bituminous Macadam

Sl. No.	Test	Test method	Requirements
1.	Los Angeles Abrasion Value *	IS : 2386 (Part IV)	35 percent maximum
2.	Aggregate Impact Value *	IS : 2386 (Part IV)	30 percent maximum
3.	Flakiness Index	IS : 2386 (Part I)	35 percent maximum
4.	Stripping Value	IS : 6241 (Part IV)	25 percent maximum
5.	Water Absorption	IS : 2386 (Part III)	2 percent maximum

*Aggregates may satisfy requirements of either of the two tests.

The Aggregates for bituminous macadam for different thickness shall conform to the grading A or B given in Table IX or X.

Table-IX

Aggregates Grading For 75mm Compacted Thickness Of Bituminous Macadam

Sieve Designation	Percent by weight passing the sieve	
	Grading A	Grading B
63 mm	100	
50 mm	90 - 100	
40 mm	35 - 65	100
25 mm	20 - 40	70 - 100
20 mm	-	50 - 80
12.5 mm	5 - 20	-
4.75 mm	-	10 - 30
2.36 mm	-	5 - 20
75 micron	0 - 5	0 - 4

Table-X

Aggregates Grading For 50mm Compacted Thickness Of Bituminous Macadam

Sieve Designation	Percent by weight passing the sieve	
	Grading A	<u>Grading B</u>
50 mm	100	
40 mm	90 - 100	
25 mm	50 - 80	100
20 mm	-	70 -100
12.5 mm	10 - 30	-
10 mm	-	35 - 60
4.75 mm	-	15 - 35
2.36 mm	-	5 - 20
75 micron	0 - 5	0 - 4

c) Proportioning of Materials

The binder content for premixing shall be 3.5 and 4.0 percent by weight of the total mix for aggregate grading- A and B respectively unless directed otherwise by the Engineer.

The quantity of aggregates to be used shall be sufficient to yield the specified thickness after compaction.

d) Variation in Proportioning of Materials

The Contractor shall have the responsibility for ensuring proper proportioning of materials and producing a uniform mix. Variation in binder content upto ± 0.3 percent by weight of total mix shall however be permissible for individual specimens taken for quality control tests.

3.10.03 Construction Operations

a) Weather and Seasonal Limitations

Bituminous macadam shall not be laid during rainy weather or when the base course is damp or wet.

b) Preparation of Base

The base on which the bituminous macadam is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross sections as shown on drawings and as directed by the Engineer. The surface shall be thoroughly swept and scraped clean and free from dust and foreign matter.

c) Tack Coat

A tack coat shall be applied over the base.

d) Preparation and Transport of Mix

Hot mix plant of adequate capacity shall be used for preparing the mix. The temperature of binder at the time of mixing shall be in the range 150 Deg. - 165 Deg. C and to that of aggregates shall be in the range 125 Deg. - 150 Deg. C provided the temperature difference between the binder and the aggregate at no time exceeds 25 Deg. C. Mixing shall be thorough to ensure that a homogenous mixture is obtained in which all particles of the aggregates are coated uniformly. The mixture shall be transported from the mixing plant to the point of use in a suitable vehicle. The vehicle employed for transport shall be clean and be covered over in transit if so directed by the Engineer.

e) Spreading

After mixing, the mix shall be spread immediately by means of a self propelled mechanical paver with suitable screeds capable of spreading, tamping and finishing the mix to the specified lines, grade and cross sections. However in restricted locations and in narrow widths where the available plants cannot operate in the opinion of the Engineer may permit manual laying of the mix.

The temperature of mix at the time of laying shall be in the range 110 Deg. - 135 Deg. C.

In multilayer construction, the longitudinal joint in one layer shall offset that into the layer below by about 150mm. However, the joint in the topmost layer shall be at the centre line of the pavement.

Longitudinal joints and edges shall be constructed true to the delineating lines parallel to the centre line of the road. All joints shall be cut vertical to the full thickness of the previously laid mix and the surface painted with hot bitumen before placing fresh material.

f) Rolling

After spreading of mix, rolling shall be done with 8 to 10 tonne power rollers or other approved plant. Rolling should start as soon as possible after the material has been spread. Rolling shall be done with care to avoid any undulation in the pavement surface.

Rolling on the longitudinal joint shall be done immediately after the paving operation. After this, the rolling shall commence at the edges and progress towards the centre longitudinally except on superelevated portions where it shall progress from the lower to the upper edge parallel to the centre line of the pavement.

The initial or breakdown rolling shall be done as soon as it is possible to roll the mixture without cracking the surface and no mix pick up on the roller wheels. The second or intermediate rolling shall follow the break down rolling as closely as possible and be done while the paving mix is still at a temperature that will result in maximum density. The final rolling shall be done while the material is still workable enough for removal of roller marks.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding fresh materials. The rolling shall then be continued till the entire surface has been rolled to compaction and there is no crushing of aggregates and till all the roller marks are eliminated. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. The roller wheels shall be kept damp if necessary to avoid the bituminous material from sticking to the wheels and being picked up. In no case shall fuel/lubricating oil be used for this purpose.

Rolling operation shall be completed in every respect before the temperature of the mix fall below 80 Deg. C.

Rollers shall not stand on the newly laid material as it may lead to undue deformation. The edges along and transverse of the bituminous macadam laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of appropriate binder before the new mix is placed against it.

The bituminous macadam shall be provided with a final surfacing without any delay. If there is to be any delay the course shall be covered by seal coat before allowing any traffic over it.

3.11.00 Open Graded Premix Carpet

3.11.01 Description

This work shall consist of laying and compacting open graded carpet of specified thickness in a single course of suitable small sized aggregates premixed with bituminous binder on a previously prepared base to form wearing course in accordance with the specification.

3.11.02 Materials

a) Binder

The binder shall be bitumen of a suitable grade, as approved by the Engineer and satisfying the requirements of IS: 73, 217, 454 or any other approved cutback as applicable.

b) Aggregates

The aggregates shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be obtained by crushing rock, gravel or river shingle and be free of elongated and flaky pieces, soft and disintegrated materials, vegetable and any other deleterious matter etc. They shall preferably be hydrophobic type.

The aggregates shall satisfy the quality requirements set forth in Table VIII except that the Flakiness Index shall be limited to a maximum of 30.

c) Proportioning of Materials

The materials shall be proportioned in the ratio of its thickness based upon quantities given in Table XI.

Table - XI

Quantity of Materials Required For 10 Sq. M of Road Surface For 20mm Thick Open Graded Premix Carpet

<u>Aggregates for Carpet</u>		
i)	Stone Chippings - 12mm size ; passing 20 mm sieve and retained on 10 mm sieve	0.18 Cu.m
ii)	Stone Chippings - 10 mm size; passing 12.5 mm sieve and retained on 6.3 mm sieve	0.09 Cu.m
Total		0.27 Cu.m

Binder for premixing (quantities in terms of straight run bitumen)

i)	For 0.18 Cu.m of 12 mm size stone Chippings at 52 Kg per Cu.m	9.5 Kg
ii)	For 0.09 Cu. M of 10mm size stone Chippings at 56 Kg per Cu.m	5.1 Kg
Total		14.6 Kg

3.11.03 Construction Operation

a) Weather and Seasonal Limitations

Open graded premix carpet shall not be laid during rainy weather or when the base course is damp or wet or when the atmospheric temperature in shade is 16 Deg. C or below.

b) Preparation of Base

The underlying base on which the bituminous carpet is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross section in accordance with the drawing, specification and as directed by the Engineer. The surface shall be well cleaned by removing caked earth and other foreign matters with wire brushes, sweeping with brooms and finally dusting with sacks as necessary.

c) Tack Coat

A tack coat complying with clause 3.09.00 shall be applied over the base preparatory to laying of the carpet. However application of tack coat shall not be necessary when the laying of carpet follows soon after laying the bituminous course.

d) Preparation of Premix

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder.

The binder shall be heated to the temperature appropriate to the grade of bitumen approved by the Engineer in boilers of suitable design avoiding local overheating and ensuring a continuous supply.

The aggregates shall be dry and suitably heated to a temperature as directed by the Engineer before these are placed in the mixer. After about 15 seconds of dry mixing, the heated binder shall be distributed over the aggregates at the rate specified.

The mixing of binder with chipping shall be continued until the chippings are thoroughly coated with the binder. The mix shall be immediately transported from the mixer to the point of use in suitable vehicles or wheel barrows. The vehicles employed for transport shall be clean and be covered over in transit if so directed.

e) Spreading and Rolling

The premixed material shall be spread on the road surface with rakes to the required thickness and camber or distributed evenly with the help of a drag spreader without any undue loss of time. The camber shall be checked by means of camber boards and inequalities evened out. As soon as sufficient length of bituminous material has been laid rolling shall be commenced with 6 to 8 tonne power rollers preferably with smooth wheel tandem type or with any other approved plant. Rolling shall begin at the edges and progress toward the centre longitudinally except on the superelevated portions where it shall progress from the lower to upper edge parallel to the centre line of the pavement.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding premixed materials. Rolling shall then be continued until the entire surface has been rolled to compaction and all the roller marks have been eliminated. In each pass of the roller, preceding track shall be overlapped uniformly by at least 1/3 width. The roller wheels shall be kept damp to prevent the premix from adhering to the wheels and being picked up. In no case shall fuel/lubricating oil be used for this purpose. Rollers shall not stand on newly laid material as it may lead to undue deformations.

The edges along and transverse of the carpet laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of approved binder before the new mix is placed against it.

f) Seal Coat

A seal coat conforming to clause 3.12.00 shall be applied to the surface immediately after laying the carpet. No traffic shall be allowed on the road till the seal coat has been placed.

3.12.00 Seal Coat

3.12.01 Description

This work shall consist of application of a seal coat as specified for sealing the voids in the bituminous surface laid to the specified levels, grade and camber.

Type A : Liquid seal coat comprising of an application of a layer of bituminous binder followed by a cover of stone chippings.

Type B : Premixed seal coat comprising of a thin application of fine aggregate premixed with bituminous binder.

3.12.02 Materials

a) Binder

The binder shall be bitumen of suitable grade as directed by the Engineer and conforming to the requirements of IS : 73, 217 or 454 as applicable or any other approved cutback.

The quantity of binder to be adopted in terms of straight run bitumen shall be 9.8 Kg and 6.8 Kg per 10 square metre area for Type A and Type B seal coat respectively.

b) Stone Chippings for Type A Seal Coat

The stone chippings shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be free of elongated or flaky pieces, soft or disintegrated stone, vegetable or other deleterious matters etc. Stone chippings shall be of 6mm size defined as 100 percent passing through 10mm sieve and retained on 2.36mm sieve. The quantity used for spreading shall be 0.09 cu.m per 10 sq.m area. The chippings shall satisfy the quality requirements spelled out in Table- VIII except that the upper limit for flakiness Index shall be 30.

c) Fine Aggregate for Type B Seal Coat

The fine aggregate shall be sand or fine grit and shall consist of clean, hard, durable, uncoated dry particles and shall be free from dust, soft or flaky material, organic matter or other deleterious substances. The aggregate shall pass 1.7 mm sieve and be retained on 180 micron sieve. The quantity used for premixing shall be 0.06 cubic metre per 10 square metre area.

3.12.03 Construction Operations

a) Preparation of Base

The seal coat shall be applied immediately after laying the bituminous course which is required to be sealed. Before application of seal coat, the surface shall be cleaned free of any dust or other extraneous matters.

b) Construction of Type- A Seal Coat

The binder shall be heated in boilers of suitable design to the temperature appropriate to the grade of bitumen approved by the Engineer and sprayed on the dry surface in a uniform manner preferably with the help of mechanical sprayers. Excessive deposits of binder caused by stopping or starting of the sprayer or through leakage or due to any other reason shall be suitably corrected before the stone chippings are spread.

Immediately after the application of binder, stone chippings in a dry and clean state shall be spread uniformly on the surface preferably by means of a mechanical grittier or otherwise manually so as to cover the surface completely. If necessary the surface shall be broomed to ensure uniform spread of chippings.

Immediately after the application of the cover material, the entire surface shall be rolled with a 8 - 10 tonne smooth wheeled roller. Rolling shall commence at the edges and progress towards the centre except in superelevated portions where it shall proceed from the inner edge to the outer. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. While rolling is in progress additional chippings shall be spread by hand in whatever quantities required to make up the irregularities. Rolling shall continue until all aggregate particles are firmly bedded in the binder and present a uniform closed surface.

c) Construction of Type-B Seal Coat

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder.

The binder shall be heated in boilers of suitable design to the temperature appropriate to the grade of bitumen approved by the Engineer. Also the aggregates shall be dry and suitably heated to a temperature as directed by the Engineer before the same are placed in the mixer. Mixing of binder with aggregates to the specified proportions shall be continued till the latter is thoroughly coated with the former.

The mix shall be immediately transported from the mixing plant to the point of use and spread uniformly on the bituminous surface to be sealed.

As soon as sufficient length has been covered with the premixed material, the surface shall be rolled with 6 - 8 tonne smooth wheeled power rollers. Rolling shall be continued till the premixed material completely seals the voids in the bituminous course and a smooth uniform surface is obtained.

3.12.04 Opening to Traffic

In case of Type-B Seal coat, traffic may be allowed soon after the final rolling when the premixed materials are cooled down to the surrounding temperature. However in case of Type-A seal coat, the traffic shall not be permitted until the following day.

3.13.00 Repair of Existing Water Bound Macadam Surfaces

Pot holes or patches and ruts in the water bound macadam base or surface course which is to be surface treated shall be repaired by removing all loose materials by cutting in rectangular patches and replacing with suitable materials. The repair shall be done as under.

Pot holes, patches and ruts shall be drained of water and cut to regular shape with vertical sides and then be filled either with i) Coarse aggregate and screenings conforming to the specification for water bound macadam and compacted with rollers or other approved rammer etc or ii) premixed material conforming to the specification for open graded premix carpet and compacted with rollers or other approved means after painting the sides and bottom of the holes with a thin application of bitumen or a combination of both as directed by the Engineer.

3.14.00 Road Side Drains

3.14.01 Drains

The road side drains shall be made in sizes and slopes as shown on approved drawings. The sides and bottom shall be neatly dressed after excavation. Proper connections shall be made to the culverts outside the plant area as per drawings and instructions of the Engineer.

The excavated spoils other than that required for backfilling shall be transported and filled in low areas within the plant area or in embankments as instructed by the Engineer. The lining for the drains shall be as per drawing. Lining of drains may be of bricks or cement concrete blocks of M15 grade concrete as shown on approved drawing or as directed by the Engineer. If shown on approved drawing, drains may be of R.C.C. construction with necessary slopes.

3.15.00 Culverts

Excavation in trenches for foundation of culverts and wing walls shall be done with side slopes as per the drawings and instructions of the Engineer after clearing the site etc. As per the specification of earthwork, backfilling in layers with watering and compaction shall be done after the construction of foundations. The construction of culverts shall be done true to the lines and levels as shown on the drawings. The specification for Masonry and/or Plain and Reinforced Cement concrete shall be followed as applicable.

3.16.00 Pipe Culverts and Drainage Pipes

3.16.01 Materials

The drainage pipes shall be made of R.C.C and shall be either class NP-2 or NP-3 as shown on the approved drawings.

Pipe culverts shall be made of reinforced concrete pipe and shall be of class NP4 or of RDSO class for railway as shown in the drawing. All pipes shall meet the requirements of IS : 458 and shall be procured from approved manufacturers with collars as per manufacturer's specification. The tenderer shall specifically mention the particular manufacturer's product he proposes to use.

Cement shall be ordinary Portland Cement as per IS : 269.

Aggregates shall be as per IS : 383. Maximum size shall not exceed one third the thickness of the pipe or 20 mm whichever is smaller.

Fine aggregates for concrete shall be as per IS : 383.

3.16.02 Laying of Pipes

Laying of concrete pipes shall correspond to IS : 783 and as per the specification given below.

- a) The foundation bed for pipe shall be excavated true to lines and grades shown on the drawings and as directed by the Engineer. When trenching is involved, its width on either side of the pipe shall not be less than 150mm and not more than one third the diameter of pipe unless otherwise instructed/permitted by the Engineer. The sides of the trench shall be as nearly vertical as possible. Side slope, shoring, bailing out water etc as required shall be done by the Contractor.

Side slips if there be any shall be removed by the Contractor. After laying of the pipes are completed, backfilling of the trenches shall be done as per the specification of earth work to the satisfaction of the Engineer. The surplus spoils shall be transported and filled in low areas within the plant area as instructed by the Engineer.

When bedrock or boulder stratum is encountered during excavation, the excavation shall be taken down to at least 200mm below the bottom of the pipe with prior permission of the Engineer and all rock/boulders in the area shall be removed and space filled with approved earth free from stone or fragmented materials, shaped to the requirements and thoroughly compacted to provide adequate support for the pipe.

Filling of trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur and shall be done as per the specification of earth work.

When two or more pipes are to be laid adjacent to each other, they shall be separated by a distance equal to at least half the diameter of the pipe subject to a minimum of 450 mm.

Laying of pipes shall start from the outlet and proceed towards inlet.

All pipes and fittings shall be gradually lowered into the trench or placed on the supports by approved means taking due care not to damage them. Under no circumstances the pipes shall be dropped into the trench or on supports from the height.

- b) Pipe bedding shall be first class projection bedding for positive projecting pipes as per IS : 783 having a projection ratio not greater than 0.70. The pipe shall be carefully laid on bedding made up of fine granular materials in an earth foundation; the bedding shall be carefully shaped to fit the lower part of the pipe exterior for at least ten percent of its overall height and in which the fill material is thoroughly compacted in layers not exceeding 150mm in depth around the pipe for the remainder of the pipe laid in trench.

When indicated on the drawings or directed by the Engineer, the pipe shall be bedded on a cradle constructed of concrete having a mix not leaner than M15. The shape and dimension of the cradle shall be as indicated on the drawing or as directed by the Engineer. The pipe shall be laid on the concrete bedding before the concrete is set.

- c) The drop walls shall be made with first class brickwork in 1:4 cement mortar.
- d) The pipe culverts shall be made with proper care with respect to the invert of the pipe, gradient if any etc as specified on drawings and as instructed by the Engineer.
- e) Where R.C.C pipes are encased in concrete at road crossings or at other places the pipes need be suitably supported avoiding reinforcements of concrete blocks, joints properly done before concreting is taken up. Concreting of total height of block may be done in a single operation or may be done upto some height for pipes to be properly laid in position and the balance height of the block shall be concreted subsequently.
- f) The R.C.C. pipes shall be joined with cement mortar. Cement mortar shall consist of 1 part cement and 2 part of clean sand with only enough water for workability. Procedure of jointing shall be as per IS : 783.

3.16.03 Relation With Water Supply Pipeline

Unless specifically cleared by the Engineer, under no circumstances shall the drainage pipes be allowed to come close to water supply pipelines.

3.17.00 Manholes and Inspection Chambers

The maximum distance between the manholes shall be 30m unless specifically permitted otherwise. In addition, at every change of alignment, gradient or diameter there shall be a manhole or inspection chamber. The distance between the manhole or inspection chamber and gully chamber shall not exceed 6 meters unless permitted otherwise. Manhole shall be constructed so as to be water tight under test. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide smooth flow.

Connection to existing pipelines shall be through a manhole.

Manholes shall be provided with standard covers usually of C.I. or as directed by the Engineer. The cover shall be closely fitted so as to prevent gases from coming out.

4.00.00 Testing And Acceptance Criteria

All testing as mentioned in the specification and as mentioned in Clause No. 900 of the “Specification for Roads and Bridge Works, 1983” published by IRC on behalf of Ministry of Shipping and Transport (Roads Wing) shall be carried out by the Contractor as per the direction of the Engineer.

SUB-SECTION – D17

FABRICATION OF STRUCTURAL STEEL WORK

C O N T E N T

CLAUSE NO.	DESCRIPTION
1.00.0	SCOPE
2.00.00	GENERAL
3.00.00	WORKMANSHIP
4.00.00	INSPECTION, TESTING, ACCEPTANCE <u>CRITERIA AND DELIVERY</u>
5.00.00	INFORMATION TO BE SUBMITTED
6.00.00	RATES AND MEASUREMENTS

FABRICATION OF STRUCTURAL STEEL WORK

1.00.00 SCOPE

This specification covers supply, fabrication, testing, painting and delivery to site of structural steelwork including supply of all consumable stores and rivets, bolts, nuts, washers, electrodes and other materials required for fabrication and field connections of all structural steelwork covered under the scope of the contract.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified elsewhere in the contract, shall include, but not be limited to the following

- a) Preparation of complete detailed fabrication drawings and erection marking drawings required for all the structures covered under the scope of the contract based on the approved design drawings. As decided by the Engineer, some or all of these detailed drawings will have to be submitted for approval.
- b) To submit revised design with calculations and detailed fabrication drawings in case any substitution of the designed sections are to be made.
- c) To submit design calculations for joints and connections developed by the contractor along with detailed fabrication drawings.
- d) Furnish all materials, labour, tools and plant and all consumables required for fabrication and supply, all necessary rivets, bolts, nuts, washers, tie rods and welding electrodes for field connections,
- e) Furnish shop painting of all fabricated steelwork as per requirements of this Specification.
- f) Suitably mark, bundle, and pack for transport all fabricated materials.
- g) Prepare and furnish detailed Bill of Materials, Drawing Office Dispatch lists, Rivet and Bolt List and any other list of bought out items required in connection with the fabrication and erection of the structural steelwork.
- h) Insure, load and transport all fabricated steelwork field connection materials to site.
- i) Maintain a fully equipped workshop at site for fabrication, modification and repairs of steelwork at site as may be required to complete the works in accordance with the Contract.
- j) Specific technical requirements are given in Section –C of this document. In case of any contradiction between Section –D and Section –C, requirements as given in Section –C shall prevail.

2.02.00 Work by others

No work under this specification will be provided for by any agency other than the contractor, unless specifically mentioned otherwise elsewhere in the contract.

2.03.00 Codes and standards

All work under this specification shall, unless otherwise specified in the contract, conform to the requirements of the latest revision and/or replacements of the following or any other relevant Indian Standard specifications and codes of practice. In case any particular aspect of the work is not specifically covered by any Indian Standard specification, any other standard practice, as may be specified by the Engineer shall be followed:

IS : 226 -	Structural steel (Standard Quality)
IS : 800 -	Code of Practice for general construction in steel.
IS : 806 -	Code of practice for use of steel tubes in general building construction.
IS : 808 -	Rolled steel beams, channels, and angle sections
IS : 813 -	Scheme of symbols for welding
IS : 814 -	Covered electrodes for metal arc welding of structural steel
IS : 815 -	Classification and coding of covered electrodes for metal arc welding of structural steels.
IS : 816 -	Code of practice for use of metal arc welding for general construction in mild steel
IS : 817 -	Code of practice for training and testing metal arc welders
IS : 818 -	Code of practice for safety and health requirements in electric and gas welding and cutting operations
IS : 822 -	Code of practice for inspection of welds
IS : 919 -	Recommendations for limits and fits for Engineering
IS : 961 -	Structural Steel (High Tensile)
IS : 1148 -	Rivet bars for structural purposes
IS : 1149 -	High tensile rivet bars for structural purposes
IS : 1161 -	Steel Tubes for structural purposes
IS : 1200 -	Method of measurement of steelwork and ironwork (Part 8)
IS : 1239 -	Mild Steel Tubes
IS : 1363 -	Black hexagon bolts, nuts and lock nuts (dia. 6 to 30 mm) and black hexagon

screws (dia 6 to 24 mm)

IS : 1364 -	Precision and semi-precision hexagon bolts, screws, nuts and locknuts (dia, range 6 to 39 mm)
IS : 1367 -	Technical supply conditions for threaded fasteners
IS : 1442 -	Covered electrodes for the metal arc welding of high tensile structural steel
IS : 1608 -	Method for tensile testing of steel products other than sheet strip, wire and tube
IS : 1730 -	Dimensions for steel plate, sheet, and strip for structural and general engineering purposes.
IS : 1731 -	Dimensions for steel flats for structural and general engineering purposes
IS : 1852 -	Rolling and cutting tolerances for hot-rolled steel products
IS : 1977 -	Structural steel (ordinary quality) St-42-0
IS : 2062 -	Steel for General Structural Purposes
IS : 2074 -	Ready mixed paint, red oxide Zinc chromate priming
IS : 2595 -	Code of Practice for Radiographic Testing
IS : 2629 -	Recommended practice for Hot-Dip Galvanizing of Iron and Steel
IS : 2633 -	Method for testing uniformity of coating on Zinc Coated Articles
IS : 3757 -	High strength structural bolts
IS : 4759 -	Specifications for Hot-Dip Zinc Coatings on Structural Steel and other allied products
IS : 7205 -	Safety Code for Erection of Structural Steelwork
IS : 7215 -	Tolerances for fabrication of steel structures
IS : 7280 -	Bare wire electrodes for submerged arc welding of structural steels.
IS : 9595 -	Recommendations for metal arc welding of carbon and carbon manganese steels.

2.04.00 Conformity with Designs

The contractor shall design all connections, supply and fabricate all steelwork and furnish all connection materials in accordance with the approved drawings and/or as instructed by the Engineer keeping in view the maximum Utilization of the available sizes and sections of steel materials. The methods of painting, marking, packing and delivery of all fabricated materials shall be in accordance with the provisions of the contract and/or as approved by the Engineer. Provision of all relevant Indian Standard Specifications and Codes of Practice shall be followed unless otherwise specified in the contract.

2.05.00 Materials to be used

2.05.01 General

All steel materials required for the work will be supplied by the contractor unless otherwise specified elsewhere in the contract. The materials shall be free from all imperfections, mill scales, slag intrusions, laminations, fittings, rusts etc. that may impair their strength, durability, and appearance. All materials shall be of tested quality only unless otherwise permitted by the Engineer and/or Consultant. If desired by the Engineer, Test Certificates in respect of each consignment shall be submitted in triplicate. Whenever the materials are required to be used from unidentified stocks, if permitted by the Engineer, a random sample shall be tested at an approved laboratory from each lot of 50 tones or less of any particular section.

The arc welding electrodes shall be of approved reputed manufacture and conforming to the relevant Indian Standard Codes of Practice and Specifications and shall be of heavily coated type and the thickness of the coating shall be uniform and concentric. With each container of electrodes, the manufacturer shall furnish instructions giving recommended voltage and amperage (Polarity in case of D.C. supply) for which the electrodes are suitable.

2.05.02 Steel

All steel materials to be used in construction within the purview of this specification shall comply with any of the following Indian Standard Specifications as may be applicable:

- a) IS : 2062 - Steel for general structural purposes
- b) IS : 961 - Structural steel High Tensile
- c) IS : 1977 - Structural steel (Ordinary quality) St-42-0

In case of imported steel materials being used, these shall conform to specifications equivalent to any of the above as may be applicable.

2.05.03 Rivet Steel

All rivet steel used in construction within the purview of this Specification shall comply with one of the following Indian Standard Specifications as may be applicable:

- a) IS : 1148 - Rivet Bars for structural purpose
- b) IS : 1149 - High tensile rivet bars for structural purposes. Where high tensile steel is specified for rivets, steps shall be taken to ensure that the rivets are so manufactured that they can be driven and heads formed satisfactorily without the physical properties of steel being impaired.

2.05.04 Electrodes

All electrodes to be used under the Contract shall be of approved reputed manufacture and shall comply with any of the following Indian Standard Specifications as may be applicable

- a) IS : 814 - Covered electrodes for metal arc welding of structural steel
- b) IS : 815 - Classification and coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel
- c) IS : 1442 - Covered electrodes for the metal arc welding of high tensile structural steel
- d) IS : 7280 - Bare wire electrodes for submerged arc welding of structural steels

2.05.05 Bolts and Nuts

All bolts and nuts shall conform to the requirements of Indian Standard Specification IS: 1367 - Technical Supply Conditions for Threaded Fasteners.

Materials for Bolts and nuts under the purview of this contract shall comply with any of the following Indian Standard Specifications as may be applicable.

a) Mild Steel

All mild steel for bolts and nuts when tested in accordance with the following Indian Standard Specification shall have a tensile strength of not less than 44 Kg/mm² and a minimum elongation of 23 per cent on a gauge length of 5.6 _/A, where "A" is the cross sectional area of the test specimen

i) IS: 1367: Technical supply conditions for threaded fasteners

ii) IS: 1608: Method for tensile testing of steel products other than sheet, strip, wire and tube

b) High Tensile Steel

The material used for the manufacture of high tensile steel bolts and nuts shall have the mechanical properties appropriate to the particular class of steel as set out in IS: 1367 or as approved by the Engineer.

2.05.06 Washers

Washers shall be made of steel conforming to any of the following Indian Standard Specifications as may be applicable under the provisions of the Contract:

- a) IS : 2062 - Steel for general structural purposes
- b) IS : 961 - Structural Steel (High Tensile Quality)

c) IS : 1977 - Structural steel (Ordinary Quality) St-42-0

2.05.07 d) IS : 6649 - Hardened washers
Paints

Paints to be used for shop coat of fabricated steel under the purview of this contract shall conform to the Indian Standard Specification IS: 2074 - Ready mixed Paint, Red oxide Zinc Chromate Priming.

2.06.00 Coal Bin

2.06.01 Shape of bins shall be circular, polygonal, square, or rectangular in plan. Bottom hopper portion may have be conical-cum-hyperbolic or any other profile shape as shown in the drawing. Bin shall be termed as bunkers or silos according to their shape and plane of rupture of coal.

2.06.02 For general requirements, fabrication and construction details IS: 9178 (Pt.I & 11) shall be followed as general guidance. The bins shall be fabricated and erected in segments.

2.06.03 The Coal bins shall be made of mild steel plates joined together with full strength butt weld and provided with stiffeners at regular interval. Stiffeners shall be provided on the external face and it may be welded with external face.

2.06.04 Bending of plates and rolled sections to the required shape for fabrication shall be done by plate bending machine or cold bending process Without resorting to heating, hammering, angle smithy and black smithy process.

2.06.05 Poking hole (manual or pneumatic) and striking plate shall be provided to facilitate coal flow. Poking holes shall have circular MS pipe and cover cap as detailed in the drawing.

2.07.00 New Erection Marks

2.07.01 Additional structures involving new erection marks may be required to be added at any stage of work.

2.07.02 All such new erection marks shall be detailed and included in marking schemes and fabrication carded out thereafter.

2.07.03 All such new erection marks shall be considered under item of original fabrication work. As a result of additional structures becoming necessary if the work is delayed beyond the time schedule stipulated, the Engineer shall give suitable extension of time provided he is satisfied about the reasonableness of the delay involved. However, no claim for extra payments or revision of rates due to delay shall be entertained.

2.08.00 ELECTRO FORGED STEEL GRATINGS

- 2.08.01** Factory made fabricated electro forged gratings unit with steel conforming to IS: 2062 shall be supplied, fabricated, transported, erected and aligned in floorings, platforms, drain and trench covers, walkways, passages, staircases with edge binding strips and anti skid nosing in treads etc.
- 2.08.02** All grating units shall be rectangular in pattern and electro forged. The size and the spacing of the bearing bars and cross bars shall be as detailed in fabrication drawings. The contractor shall submit the grating design for different spans and load intensities along with fabrication drawings. The depth of the grating unit shall be 40 mm, unless specified otherwise.
- 2.08.03** The gratings shall be made up in panel units designed to coincide with the span of the structural steel framing or openings as indicated in the design/ scope drawings. Maximum possible standardization of the grating panel sizes shall be tried and designed.
- 2.08.04** The grating unit shall be accurately fabricated and finished, free from wraps, twists, or any defects that would impair their strength, serviceability, and appearance.
- 2.08.05** Grating work shall include cut outs and clearance opening for all columns, pipes, ducts, conduits or any other installation penetrating through the grating work. Such cut outs and clearances shall be treated as specified in subsequent clauses.
- 2.08.06** The gratings shall be notched, trimmed and neatly finished around flanges and webs of the columns, moment connections, cap plates, and such other components of the steel structures encountered during the placement of the gratings. In all such cases, the trimming shall be done to follow the profile of the components encountered. After trimming, the binding strip shall be provided on the grating to suit the profile so obtained.
- 2.08.07** Opening in gratings for pipes or ducts that are 150mm in size or diameter or larger shall be provided with steel bar toe plates of not less than 5mm thickness and appropriate width, set flush with the bottom of the bearing bars.
- 2.08.08** Penetrations in gratings that are more than 50mm but less than 150mm in size or diameter shall be welded with plates of size shown in the detailed drawings set flush with the bottom of the grating panel.
- 2.08.09** Unless otherwise indicated on the drawings, grating units at all penetrations shall be made up in split section, accurately fitted and neatly finished to provide for proper assembly and erection at the job site.
- 2.08.10** Grating units shall be provided with all necessary clips, bolts, nuts and lock washers required for proper assembly and rigid installation and fastening to abutting units supporting structural steel framing members.
- 2.08.11** The gratings shall be of reputed make and manufacturer, as approved by Engineer. The unit rate quoted by him for this item shall be inclusive of transport of gratings to the project site, all taxes, duties etc. He shall also provide all facilities and access to the Engineer or his representative to carry out inspection during all stages of manufacturing of gratings.
- 2.08.12** Maximum deviation in linear dimension from the approved dimension shall not exceed 12mm.
- 2.08.13** All fabricated grating section and accessories shall be blast cleaned to near white metal surface

(Sa 2½) followed by either of the following two:

- (a) Two coats of red lead primer and two coats of black enamel finish paint.
- (b) Hot dipped galvanization at 610 gm/sq.m.

in the shop prior to erection at site, as the approved drawing.

2.08.14 Prior to finishing all surfaces shall be cleaned, free from rust, mill scale, grease, oil, or any other foreign matter by blast cleaning. BS: 4232 shall be followed for blast cleaning.

2.08.15 Primer can be applied by spray guns or by brushes, however the finish paint shall necessarily be applied by means of spray guns. The applied coatings shall be uniform, free from voids and streaks; drilled or punched holes shall be touched up prior to erection or assembly.

2.09.00 GALVANIZATION OF GRATINGS

2.09.01 Purity of Zinc to be used-for galvanizing shall be 99.5% as per IS: 2 15

2.09.02 After the shop work is complete, the structural material shall be punched with erection mark and be hot double dip galvanized. Before galvanizing the steel section shall be thoroughly blast cleaned to near white metal surface (Sa 2½).

2.09.03 The weight of the zinc coating shall be at least 610 gm/m² - unless noted otherwise.

2.09.04 The galvanized surface shall consist of a continuous and uniformly thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be cleaned and smooth and shall be free from defects like discoloured patches, bare spots, unevenness of coating, spelter that is loosely attached to the steel, blistered surface, flaking or peeling off etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.

2.09.05 There shall be no flaking or loosening when struck squarely with a chisel faced hammer. The galvanized steel member shall withstand minimum four one minute dips in copper sulphate solution as per IS: 2633.

2.09.06 When the steel section is removed from the galvanizing kettle, excess spelter shall be removed by 'bumping'. The processes known as 'wiping' or 'scrapping' shall not be used for this purpose.

2.09.07 Defects in certain members indicating presence of impurities in the galvanizing bath in quantities larger than that permitted by the specifications or lack of quality control in any manner in the galvanizing plant, shall render the entire, production in the relevant shift liable to rejection.

2.09.08 All structural steel shall be treated with sodium dichromate or an approved equivalent solution after galvanizing; so as to prevent white storage stains.

2.09.09 If the galvanizing of any member is damaged, the Engineer shall be shown of the extent of damage, if so directed the galvanizing may have to be redone in the similar manner as stated above at no extra cost to the Owner.

2.10.00 STAINLESS STEEL HOPPERS

2.10.01 Material

Stainless steel hopper of grade SS 4 15M as manufactured by SAIL or equivalent shall be provided in the lower portion of bunker hopper. SS 4 15M having the following chemical composition shall be used.

Material	%	Remarks
Carbon	10.03%	Max.
Silicon	1.60%	Max.
Manganese	0.80% to 1.50%	
Phosphorous	0.03%	Max.
Sulphur	0.03%	Max.
Chromium	10.80% to 12.50%	
Nickel	1.50%	Max.
Titanium	0.75%	Max.
Nitrogen	0.03%	Max.

The mechanical properties shall be as follows:

Description	Value	Remarks
Hardness Rock Well B Scale	90	Max.
Tensile Strength	450 MPa	Min.
Yield Strength	300 MPa	Min.
Elongation	25%	Min.

2.10.02 Fabrication

The fabrication, erection, alignment and welding shall be carried out as per the accepted practice and in accordance with relevant I.S. and international specification as well as stipulations contained herein. Fabrication drawings shall be prepared by the contractor on the basis of the design / scope drawings furnished by Engineer. The fabrication and erection works shall be done as per the approved fabrication drawings.

2.10.03 Fabrication Drawings

- a) Fabrication drawing shall give the cutting plan for each hopper plate. Such, cutting plan shall be based on the size of the Stainless Steel plate available at store. In order to reduce the wastage and ensure the maximum utilization of stainless steel plate, the cutting plan

shall take in the consideration of the reverse curvature and place the various elements of hopper plate in opposite fashion to reduce the end wastage. Similarly the hopper plate element having different radii shall be placed one inside the other, to optimize the stainless steel plate use. Such optimization may also required adjustment in the size of the each element of hopper plate and also additional weld joints.

- b) The bill of material of hopper plate shall indicate the inner surface area of the hopper, weight of the hopper based on the inner surface area, weight of each of the cut plate of hopper fabrication, weight of cut and scrap pieces generated. Contractor shall return to the Owner's store all unutilized (surplus) stainless steel plates and all waste and cut pieces generated. Non return of any part of the surplus/waste steel pieces to the Owner's store will call for the penal recovery at three (03) times the maximum procurement rate for the weight of stainless steel pieces not returned to the store.
- c) In case the contractor does the cutting of the stainless steel without approved cutting plan then all the wastage (i.e. the difference between the weight of stainless steel plate cuts and the actual finished weight considered for the measurement for payment) shall be subjected to the penal recovery at the rate mentioned above.

2.10.04 Cuffing

Cutting may be affected by shearing, or by using plasma. The cut edges of all plates shall be perfectly straight and uniform through out. Cutting shall be done as per the cutting plan shown in the fabrication drawing. Should the Engineer find it necessary, the edges shall be ground smooth afterwards by contractor within the unit rates quoted by him. All the edge s shall be ground smooth before they are welded.

2.10.05 Jointing

Welding shall join stainless steel. All weld joints (along the inclined plane) shall be staggered. Any common welding process can weld stainless steel viz. MIG, metal arc or plasma using the covered compatible electrodes as per IS: 5206 or by inert gas arc welding as per IS: 2811. Shielding gas shall be Argon + Hydrogen mixture or Argon + Oxygen mixture. However, Argon + Oxygen mixture shall be preferred. Carbon-di-oxide mixture shall be avoided. 308L and 315L electrodes/fillers shall be used for the welding of Stainless Steel to Stainless Steel and Stainless Steel to Mild Steel respectively. However, the welding process and the type of the electrodes to be used for welding shall be as per welding procedure, as approved by the Engineer. On the basis of the welding procedure, the Contractor shall conduct qualification test.

2.10.06 Bending

The stainless steel plates shall be subjected to cold forming and bending in order to get the desired shape and profile.

2.10.07 Welding sequence

The type of electrodes, welding sequence, preheat and interpass temperature and post weld heat treatment shall be as approved by the Engineer.

2.10.08 Acceptance Criteria of Fabricated Structures

The acceptance of the fabricated structure work shall depend upon correct dimensions and alignment, absence of distortion in the structure, satisfactory results from the inspection and testing of the welded structure joints and the test specimens, general workmanship being good meeting the tolerance requirements given in IS: 7215.

2.11.00 BEARINGS

2.11.01 PTFE (Poly tetra fluorethylene) slide bearing

a) General

The bearings shall consist of upper and lower units. The upper unit shall include a sole plate with mirror finish stainless steel facing bonded to the bottom surface of the sole plate. The lower unit shall consist of a relevant laminated elastomers pad surfaced with PTFE. A rigid confining medium substructure bonds the PTFE to the pad. When the upper and lower units are mated the stainless steel slides on the PTFE surface with an extremely low coefficient of friction. These bearings shall be designed as per the performance requirements. The bearing shall be of reputed make and manufacturer as approved by Engineer, for required vertical loads, as per the construction drawings and for a maximum displacement of ± 50 mm.

b) Material

PTFE bearing shall be sliding against highly polished stainless steel and the coefficient of friction between them shall be less than 0.06 at 55 kg/cm². In order to prevent cold flow in the PTFE surface it shall be rigidly bonded by a special high temperature resistant adhesive to the stainless steel sub-strata. The stainless steel surface, which slides against the PTFE, is mirror polished. The stainless steel shall be bonded to the top plate by special high strength adhesive. The thickness of the stainless steel shall be between 1.0 to 1.5mm.

The resilient bearing pad shall consist of multiple layers of lightweight fabric impregnated with a high quality elastomer compound vulcanized into slabs of uniform standard thickness as per the requirement. This shall withstand vertical (compressive) load not less than 500 kg/cm² and shear loads upto 40 kg/cm².

c) Installation

The seating area for PTFE bearing shall be prepared accurately level and furnished with a thin layer of epoxy resin mortar. The bearing will be placed on this layer while it is still

workable and the bearing is levelled. The bearing should not be displaced as the beam is lowered into position. When the mortar and adhesive are fully set and the beam slightly above the top of the bearing. The upper surface of the bearing shall then be coated with sufficient thickness of epoxy resin mortar so that when the beam is lowered on to the temporary supports it comes into full contact with the mortar and some is squeezed out. The surplus shall be troweled off and after the mortar is fully set the temporary supports removed.

2.12.00 Storage of material

2.12.01 General

All materials shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged, shall be removed from the contractor's yard immediately, failing which, the Engineer shall be at liberty to get the material removed and the cost incurred thereof shall be realised from the Contractor. The Contractor shall maintain upto date accounts in respect of receipt, use, and balance of all sizes and sections of steel and other materials. In case the fabrication is carried out in contractor's fabrication shop outside the plant site where other fabrication works are also carried out, all materials meant for use in this contract shall be stacked separately with easily identifiable marks.

2.12.02 Steel

The steel to be used in fabrication and the resulting cut-pieces shall be stored in separate stacks off the ground section wise and lengthwise so that they can be easily inspected, measured, and accounted for at any time. If required by the Engineer, the materials may have to be stored under cover and suitably painted for protection against weather.

2.12.03 Electrodes

The electrodes for electric arc welding shall be stored in properly designed racks, separating different types of electrodes in distinctly marked compartments. The electrodes shall be kept in a dry and warm condition if necessary by resorting to heating.

2.12.04 Bolts, Nuts and Washers

Bolts, nuts and washers and other fastening materials shall be stored on racks off the ground with a coating of suitable protective oil. These shall be stored in separate gunny bags or compartments according to diameter, length, and quality.

2.12.05 Paints

Paints shall be stored under cover in air tight containers. Paints supplied in sealed containers shall be used up as soon as possible once the container is opened.

2.13.00 Quality Control

The Contractor shall establish and maintain quality control procedures for different items of work and materials to the extent he deems necessary to ensure that all work is performed in accordance with this specification. In addition to the Contractor's quality control procedures, materials and workmanship at all times shall be subjected to inspection by the Engineer or Engineer's representative. As far as possible, all inspection by the Engineer or

Engineer's representative shall be made at the Contractor's fabrication shop whether located at Site or elsewhere. The Contractor shall co-operate with the Engineer or Engineer's representative in permitting access for inspection to all places where work is being done and in providing free of cost all necessary help in respect of tools and plants, instrument, labour and materials required to carry out the inspection. The inspection shall be so scheduled as to provide the minimum interruption to the work of the Contractor.

Materials or workmanship not in reasonable conformance with the provisions of this Specification may be rejected at any time during the progress of the work.

The quality control procedure shall cover but not be limited to the following items of work

- a) Steel: Quality manufacturer's test certificates, test reports of representative samples of materials from unidentified stocks if permitted to be used.
- b) Rivets, Bolts, : Manufacturer's certificate, dimension checks, Nuts & Washers material testing.
- c) Electrodes : Manufacturer's certificate, thickness and quality of flux coating.
- d) Welders : Qualifying Tests
- e) Welding sets : Performance Tests
- f) Welds : Inspection, X-ray, Ultrasonic tests
- g) Paints : Manufacturer's certificate, physical inspection reports
- h) Galvanizing : Tests in accordance with IS 2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS : 4759 - Specification for Hot-Dip Zinc coatings on Structural Steel and other allied products.

2.14.00 Standard dimensions, forms and weights

The dimensions, forms, weights and tolerances of all rolled shapes rivets, bolts, nuts, studs, washers etc. and other members used in the fabrication of any structure shall, wherever applicable, conform to the requirements of the latest relevant Indian Standards, wherever they exist, or, in the absence of Indian Standards, to other equivalent standards.

2.15.00 Fabrication Drawings

The contractor shall within thirty (30) days after the award of the Contract submit to the Engineer the Schedule of Fabrication and erection of structural Steelworks, for approval. Within one week after receipt of approval on design of any steel structure (part or full) based on the approved design. As decided by the

Engineer, six (6) copies each of some or all of the detailed fabrication drawings will have to be submitted for approval.

The sequence of preparation of fabrication drawings shall match with the approved fabrication and erection schedule. The above-mentioned approval for fabrication drawings will be accorded only towards the general conformity with the design requirements as well as specifications. The approval of drawing however shall not relieve the contractor of his sole responsibility in carrying out the work correctly and fulfilling the complete requirements of contract documents.

The fabrication drawings shall include but not limited to the following:

- a) Assembly drawings giving exact sizes of the sections to be used and identification marks of the various sections.
- b) Dimensional drawings of base plates, foundation bolts location etc.
- c) Comparison sheets to show that the proposed alternative section, if any, is as strong as the original sections shown on the Design Drawings.
- d) Complete Bill of Materials and detailed drawings of all sections as also their billing weights.
- e) Any other drawings or calculations that may be required for the clarification of the works or substituted parts thereof.

These drawings shall give all the necessary information for the fabrication, erection, and painting of the steelwork in accordance with the provisions of this Specification. Fabrication drawings shall be made in accordance with the best modern practice and with due regard to sequence, speed and economy in fabrication and erection. Fabrication drawings shall give complete information necessary for fabrication of the various components of the steelwork, including the location, type, size, and extent of welds. These shall also clearly distinguish between shop and field rivets, bolts, and welds and specify the class of bolts and nuts. The drawings shall be drawn to a scale large enough to convey all the necessary information adequately. Notes on the fabrication drawings shall indicate those joints or groups of joints in which it is particularly important that the welding sequence and technique of welding shall be carefully controlled to minimize the locked up stresses and distortion. Welding symbols used shall be in accordance with the requirements of the Indian Standard Specification. IS: 813 - Scheme of symbols for Welding, and shall be consistent throughout. Weld lengths called for on the drawings shall mean the net effective length.

The Contractor shall be responsible for and shall carry out at his cost any alterations of the work due to any discrepancies, errors or omissions on the drawings or other particulars supplied by him, whether such drawings or other particulars have been duly approved or not in accordance with the Contract.

3.00.00 WORKMANSHIP

3.01.00 Fabrication

3.01.01 General

All workmanship shall be equal to the best practice in modern structural shops, and shall conform to the provisions of the Indian Standard IS: 800 - Code of Practice for general construction in steel and other relevant Indian Standards or equivalent.

3.01.02 Straightening Material

Rolled materials before being laid off or worked, must be clean, free from sharp kinks, bends or twists and straight within the tolerances allowed by the Indian Standard Specification on IS: 1552 - Specification for rolling and cutting tolerance for hot-rolled steel products. If straightening is necessary, it may be done by mechanical means or by the application of a limited amount of localized heat. The temperature of heated areas, as measured by approved methods, shall not exceed 600°C.

3.01.03 Cutting

Shearing, cropping, or sawing shall affect cutting. Use of a mechanically controlled gas-cutting torch may be permitted for mild steel only. Gas cutting of high tensile steel may also be permitted provided special care is taken to leave sufficient metal to be removed by machining, so that all metal that has been hardened by flame is removed. Gas cutting without a mechanically controlled torch may be permitted if special care is taken and done under expert hand, subject to the approval of the Engineer.

To determine the effective size of members cut by gas, 3 mm shall be deducted from each cut edge. Gas cut edges, which will be subjected to substantial stress or which are to have weld metal deposited on them, shall be reasonably free from gouges, occasional notches or gouges not more than 4 mm deep will be permitted. Gouges greater than 4 mm that remain from cutting shall be removed by grinding. All re-entrant corners shall be shaped notch free to a radius of at least 12 mm. Shearing, cropping and gas cutting shall be clean, reasonably square and free from any distortion.

3.01.04 Planning of edges

Planning or finishing of sheared or cropped edges of plates or shapes or of edges gas-cut with a mechanically controlled torch shall not be required, unless specifically required by design and called for on the drawings, included in a stipulation for edge preparation for welding or as may be required after the inspection of the cut surface. Surface cut with hand-flame shall generally be ground, unless specifically instructed otherwise by the Engineer.

3.01.05 Clearances

The erection clearance for cleated ends of members connecting steel to steel shall preferably be not greater than 2 mm at each end. The erection clearance at ends of beams web shall be not more than 3 mm at each end, but where for practical reasons greater clearance is necessary, suitably designed cheatings shall be provided.

3.02.00 Riveted and bolted construction

3.02.01 Holes

Holes through more than one thickness of material for members, such as compound stanchions and girder flanges, shall be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly, if the thickness of the material is

not greater than the nominal diameter of rivet or bolt plus 3 mm subject to a maximum thickness of 16 mm provided that the holes are punched 3 mm less in diameter than the required size and reamed after assembly to the full diameter.

Holes for rivets or black bolts shall be not more than 1.5 mm or 2.0 mm (depending on whether the diameter of the rivet or bolt is less or more than or equal to 25 mm) larger in diameter than the nominal diameter of the rivet or black bolt passing through them.

Holes for turned and fitted bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to a tolerance grade of BS as specified in IS: 919. Parts to be connected shall be firmly held together by tacking welds or clamps and the holes drilled through all the thicknesses in one operation and subsequently reamed to size. Holes not drilled through all thickness in one operation shall be drilled to a smaller size and reamed out after assembly.

Holes for rivets or bolts shall not be formed by gas cutting process.

3.02.02 Assembly

All parts of riveted members shall be well pinned or bolted and rigidly held together while riveting. Drifting to enlarge unmatching holes shall not generally be permitted. In case drifting is permitted to a slight extent during assembly, it shall not distort the metal or enlarge the holes. Holes that must be enlarged to admit the rivets or bolts shall be reamed. Poor matching of holes shall be cause for rejection. The component parts shall be so assembled that they are neither twisted nor otherwise damaged, and shall be so prepared that the specified cambers, if any, are maintained.

Rivets shall ordinarily be hot driven, in which case their finished heads shall be approximately hemispherical in shape and shall be of uniform size throughout the work for rivets of the same size full, neatly finished and concentric with the holes. Rivets shall be heated uniformly to a temperature not exceeding 1125°C they shall not be driven after their temperature has fallen below 540°C.

Rivets shall be driven by power riveters, of either compression or manually operated type, employing pneumatic, hydraulic or electric power. Hand driven rivets shall not be allowed unless in exceptional cases specifically approved by the Engineer. After driving, rivets shall be tight, shall completely fill the holes and their heads shall be in full contact with the surface. In case of countersunk rivets, the countersinking shall be fully filled by the rivet, any proudness of the countersunk head being dressed off flush, if required.

Riveted members shall have all parts firmly drawn and held together before and during riveting and special care shall be taken in this respect for all single riveted connections. For multiple riveted connections, a service bolt shall be provided in every third or fourth hole.

All loose, burnt, or otherwise defective rivets shall be cut out and replaced and special care shall be taken to inspect all single riveted connections. Special care shall also be taken in heating and driving long rivets. The Contractor shall prove the quality of riveting by cutting some rivets chosen at random by the Engineer. No extra payment will be made to the Contractor for such cutting and replacing. Riveting work, for any particular section or group, will be considered satisfactory when at least 90% of the corresponding cut rivets is found to be sound. If the ratio

is below 75%, all the rivets in the particular section or group shall be cut, removed and replaced and tested again at the Contractor's expense. For cases between 75% and 90% the engineer shall have the option to instruct cutting and replacing any number of further rivets at the Contractor's cost as he deems necessary.

Bolted construction shall be permitted only in case of field connections if called for on the Drawings and is subjected to the limitation of particular connections as may be specified. In special cases, however, shop bolt connections may be allowed if shown on drawing or directed by the Engineer.

Washers shall be tapered or otherwise suitably shaped, where necessary, to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project through the nut at least one thread. In all cases the bolt shall be provided with a washer of sufficient thickness under the nut to avoid any threaded portion of the bolt being within the thickness of the parts bolted together. In addition to the normal washer one spring washer or lock nut shall be provided for each bolt for connections subjected to vibrating forces or otherwise as may be specified on the Drawings.

3.03.00 Welded Construction

3.03.01 General

Welding shall be in accordance with relevant Indian Standards and as supplemented in the Specification. Welding shall be done by experienced and good welders who have been qualified by tests in accordance with IS: 817.

3.03.02 Preparation of material

Surface to be welded shall be free from loose scale, slag, rust, grease, paint, and any other foreign material except that mill scale, which withstands vigorous wire brushing, may remain. Joint surfaces shall be free from fins and tears. Preparation of edges by gas cutting shall, wherever practicable, be done by a mechanically guided torch.

3.03.03 Assembling

Parts to be fillet welded shall be brought in, as close contact as practicable and in no event shall be separated by more than 4 mm. If the separation is 1.5 mm or greater, the size of the fillet welds shall be increased by the amount of the separation. The fit of joints at contact surfaces, which are not completely sealed by, welds, shall be close enough to exclude water after painting. Abutting parts to be butt-welded shall be carefully aligned. Misalignments greater than 3 mm shall be corrected and in making the correction the parts shall not be drawn into a sharper slope than two degrees (2°).

The work shall be positioned for flat welding whenever practicable.

3.03.04 Welding Sequence

In assembling and joining parts of a structure or of built-up members, the procedure and sequence of welding shall be such as will avoid needless distortion and minimize shrinkage stresses in the closing welds of a rigid assembly, such closing welds shall be made in compression elements.

In the fabrication of cover-plated beams and built-up members, all shop splices in each

component part shall be made before such component part is welded to other parts of the member. Long girders or girder sections may be made by shop splicing not more than three sub-sections, each made in accordance with this paragraph.

When required by the Engineer, welded assemblies shall be stress relieved by heat-treating in accordance with the provisions of the relevant Indian Standard or any other Standard approved by the Engineer.

3.03.05 Welding technique

Submerged-Arc-Welding/ process employing semi-automatic welding (GMAW/SAW) shall be used for welding longitudinal fillet welds (connecting flange with web) and longitudinal butt joints for fabrication of columns, framing beams and crane girders, unless manual arc welding is specifically approved by the Engineer. Necessary jigs and fixtures and rotation of structures shall be so arranged that vertically down-hand position of welding become possible. 'Open-Arc-Welding' process employing coated electrodes shall be employed for fabrication of other welded connections and field welding.

All complete penetration groove welds made by manual welding, except when produced with the aid of backing material not more than 8 mm thick with root opening not less than one-half the thickness of the thinner part joined, shall have the root of the initial layer gouged out on the back side before welding is started from that side, and shall be so welded as to secure sound metal and complete fusion throughout the entire cross-section. Groove welds made with the use of the backing of the same material, as the base metal shall have the weld metal thoroughly fused with the backing material. Backing strips need not be removed. If required, they may be removed by gouging or gas cutting after welding is completed, provided no injury is done to the base metal and weld metal and the weld metal surface is left flush or slightly convex with full throat thickness.

Groove welds shall be terminated at the ends of a joint in a manner that will ensure their soundness. Where possible, this should be done by use of extension bars or run-off plates. Extension bars or run-off plates need not be removed upon completion of the weld unless otherwise specified elsewhere in the contract.

3.03.06 Temperature

No welding shall normally be done on parent material at a temperature below (-) 5°C. However, if welding is to undertaken at low temperature, adequate precautions as recommended in relevant Indian Standard shall be taken. When the parent material is less than 40 mm thick and the temperature is between (-) 5°C and 0°C, the surface around the joint to a distance of 100 mm or 4 times the thickness of the material, whichever is greater, shall be preheated till it is hand warm. When the parent material is more than 40 mm thick, the temperature of the area mentioned above shall be in no case be less than 20°C. All requirements regarding preheating of the parent material shall be in accordance with the relevant Indian Standard.

3.03.07 Peening

Where required, intermediate layers of multiple-layer welds may be peened with light blows from a power hammer, using a round-nose tool, peening shall be done after the weld has cooled to a temperature warm to the hand. Care shall be exercised to prevent scaling or flaking of weld and base metal from over peening.

3.03.08 Equipment

These shall be capable of producing proper current so that the operator may produce satisfactory welds. The welding machine shall be of a type and capacity as recommended by the manufacturers of electrodes or as may be approved by the engineer.

3.04.00 Finish

Column splices and butt joints of compression members depending on contact for stress transmission shall be accurately machined and close-buttressed over the whole section with a clearance not exceeding 0.1 mm locally at any place. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc; after welding/riveting together, should be accurately machined so that the parts connected butt over the entire surfaces of contact. Care should be taken that those connecting angles of channels are fixed with such accuracy that they are not reduced in thickness by machining by more than 1.0 mm.

3.05.00 Slab bases and caps

Bases and caps fabricated out of steel slabs, except when cut material with true surface, shall be accurately machined over the bearing surface and shall be in effective contact with the end of the stanchion. A bearing face, which is to be grouted direct to a foundation, need not be machined if such face is true and parallel to the upper face.

To facilitate grouting, holes shall be provided, where necessary, in stanchion bases for the escape of air.

3. 12.00 Lacing bars

The ends of lacing bars shall be neat and free from burns.

3. 13.00 Separators

Rolled section or built-up steel separators or diaphragms shall be required for all double beams except where encased in concrete, in which case, pipe separators shall be used.

3.14.00 Bearing Plates

Provision shall be made for all necessary steel bearing plates to take up reaction of beams and columns and the required stiffeners and gussets whether or not specified in Drawings.

3.15.00 Floor Grating

All grating units shall be rectangular in pattern and of pressure locked assembly. The size and spacing of bearing bars and cross bars shall be as approved in detailed drawings. Alternatively diamond pattern grating if approved may be used.

The grating shall be made in panel units designed to span as indicated in structural steel framing drawing or as directed by the Engineer.

The grating units shall be finished free from warps, twists, or any other defects. Grating work shall include cutouts and clearance openings for all columns, pipes, ducts, conduits etc. The gratings shall be notched, trimmed, and neatly finished around components of the steel structures encountered. Binding strip shall be provided on the grating to suit the profile. Openings in gratings shall be provided with steel bar toe plates of not less than 5 mm thickness and 100 mm width.

Unless otherwise indicated on drawings, all penetrations of grating units shall be made up in split section, accurately fitted, and neatly finished. Grating units shall be provided with all necessary clips, bolts, lock washers etc. for proper assembly and installation on supporting steel members. Maximum deviation in linear dimension shall not exceed 12 mm.

3.10.00 Chequered Plates

Minimum thickness of chequered plate floorings, covers etc. shall be 6 mm O/P. Chequered plate shall be accurately cut to the required sizes and shapes and the cut edges properly ground. Stiffeners shall be provided wherever required from design consideration.

3.11.00 Architectural Clearances

Bearing plates and stiffener connections shall not be permitted to encroach on the designed architectural clearances.

3.11.00 Shop connections

- a) All shop connections shall be otherwise riveted or welded as specified on the Drawings.
- b) Heads of rivets on surfaces carrying brick walls shall be flattened to 10 mm thick projection.
- c) Certain connections, specified to be shop connections, may be changed to field connections if desired by the Engineer for convenience of erection and the contractor will have to make the desired changes at no extra cost to the exchequer.

3.13.00 Castings

Steel castings shall be annealed.

3.14.00 Shop erection

The steelwork shall be temporarily shop-erected complete or as directed by the Engineer so that accuracy of fit may be checked before dispatch. The parts shall be shop-erected with a sufficient number of parallel drifts to bring and keep the parts in place. In case of parts drilled or punched using steel jigs to make all similar parts interchangeable, the steelwork shall be shop erected in such a way as will facilitate the check of interchange ability.

3.15.00 Shop painting

3.15.01 General

Unless otherwise specified, steelwork, which will be concealed by interior building finish, need not be painted; steelwork to be encased in concrete shall not be painted. Unless specifically exempted, all other steelwork shall be given one coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned, in accordance with the following paragraph, by brush, spray, roller coating, flow-coating or dipping as may be approved by the Engineer.

After inspection and approval and before leaving the shop, all steelwork specified to be painted shall be cleaned by hand-wire brushing or by other methods of loose mill scale, loose rust, weld slag or flux deposit, dirt and other foreign matter. Oil and grease deposits shall be removed by the solvent. Steelwork specified to have no shop paint shall, after fabrication, be cleaned of oil

or grease by solvent cleaners and be cleaned of dirt and other foreign material by thorough sweeping with a fibre brush.

3.15.02 Inaccessible parts

Surfaces not in contact, but inaccessible after assembly, shall receive two coats of shop paint, Positively of different colours to prove application of two coats before assembly. This does not apply to the interior of sealed hollow sections.

3.15.03 Contact surfaces

Contact surface shall be cleaned in accordance with sub-clause 3.13.1 before assembly.

3.15.04 Finished surfaces

Machine finished surfaces shall be protected against corrosion by a rust inhibiting coating that can be easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection.

3.15.05 Surfaces adjacent to field welds

Unless otherwise provided for, surfaces within 50 of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.

3.16.00 Galvanizing

3.16.01 General

Structural steelwork for switchyard or other structures as may be specified in the contract shall be hot dip galvanized in accordance with the American Society for Testing and Materials Specification ASTM-A 123 or IS: 2629 - Recommended practice for Hot-Dip Galvanizing of Iron and steel. Where the steel structures are required to be galvanized the field connection materials like bolts, nuts and washers shall also be galvanized.

3.16.02 Surface Preparation

All members to be galvanized shall be cleaned, by the process of pickling of rust, loose scale, oil, grease, slag and spatter of welded areas and other foreign substances prior to galvanizing. Pickling shall be carried out by immersing the steel in an acid bath containing either sulphuric or hydrochloric acid at a suitable concentration and temperature. The concentration of the acid and the temperature of the bath can be varied, provided that the pickling time is adjusted accordingly.

The pickling process shall be completed by thoroughly rinsing with water, which should preferably be warm, so as to remove the residual acid.

3.16.03 Procedure

Galvanizing shall be carried out by hot dip process in a proper and uniformly heated bath. It shall meet all the requirements when tested in accordance with IS: 2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS: 4759 - Specification for Hot-dip zinc coatings on Structural Steel & other allied products.

After finishing the threads of bolts, galvanizing shall be applied over the entire surface uniformly. The threads of bolts shall not be machined after galvanizing and shall not be clogged with zinc. The threads of nuts may be tapped after galvanizing but care shall be taken to use oil in the threads of nuts during erection.

The surface preparation for galvanizing and the process of galvanizing itself, shall not adversely affect the mechanical properties of the materials to be galvanized. Where members are of such lengths as to prevent complete dipping in one operation, great care shall be taken to prevent warping.

Materials on which galvanizing has been damaged shall be acid stripped and re-galvanized unless otherwise directed, but if any member becomes damaged after leaving been dipped twice, it shall be rejected. Special care shall be taken not to injure the skin on galvanized surfaces during transport, handling, and erection. Damages, if occur, shall be made good in accordance or as directed by the Engineer.

4.00.00 INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY

4.01.00 Inspection

Unless specified otherwise, inspection to all, work shall be made by the or Engineer's representative at the place of manufacture prior to delivery. The Engineer or his representative shall have free access at all reasonable times to those parts of the manufacturer's works which are concerned with the fabrication of the steelwork under this Contract and he shall be afforded all reasonable facilities for satisfying himself that the fabrication is being done in accordance with the provisions of this Specification.

The Contractor shall provide free of charge, such labour, materials, electricity, fuel, water, stores, tools and plant, apparatus and instruments as may be required by the Engineer to carry out inspection and/or tests in accordance with the Contract. The Contractor shall guarantee compliance with the provisions of this Specification.

4.02.00 Testing and Acceptance Criteria

4.02.01 General

The Contractor shall carry out sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own Cost. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.

4.02.02 Steel

All steel supplied by, the Contractor shall conform, to the relevant Indian Standards. Except otherwise mentioned in the contract, only tested quality steel having mill test reports shall be used. In case unidentified steel materials are permitted to be used by the Engineer, random samples of materials will be taken from each unidentified lot of 50 M.T or less of any particular section for tests to conform to relevant Indian Standards. Cost of all tests shall be born by the contractor.

All material shall be free from all imperfections, mill scales, slag intrusions, laminations, fittings, rusts etc. that may impair their strength, durability, and appearance.

4.02.02 Welding

- a) The weld surface shall be cleaned with steel wire brush to remove spatter metal, slag etc. and 100% of welds shall be inspected visually for size, length of weldment and external defects. Weld gauges shall be used for checking weld sizes. The surface shall be clean with regular beads and free from slags, cracks, blow-holes etc.
- b) Non-destructive examination shall be carried out to determine soundness of weldments as follows:
 - i) 10% at random on fillet-joints.
 - ii) 100% on all butt-joints.
- c) Should the ND tests indicate defects like improper root penetration, extensive blowholes, slag intrusion etc., such welds shall be back gauged, joints prepared again and rewelded.

All defects shall be rectified by the Contractor at no extra costs.
- d) All electrodes shall be procured from approved reputed manufacturers with test certificates. The correct grade and size of electrode, which has not deteriorated in storage, shall be used. The inspection and testing of welding shall be performed in accordance with the provisions of the relevant Indian Standards or other equivalents. For every 50 tones of welded fabrication, the Engineer may ask for 1(one) test-destructive or non-destructive including X -ray, ultrasonic test or similar, the cost of which shall be borne by the Contractor.

4.02.04 Rivets, bolts, nuts and washers

All rivets, bolts, nuts, and washers shall be procured from M/s. Guest Keen William Ltd. or equivalent and shall confirm to the relevant Indian Standards. If desired by the Engineer, representative samples of these materials may have to be tested in an approved laboratory and in accordance with the procedures described in relevant Indian Standards. Cost of all such testing shall have to be borne by the Contractor. In addition to testing the rivets by hammer, 2% (two per cent) of the rivets done shall have to be cut off by chisels to ascertain the fit, quality of material and workmanship. The removal of the cut rivets and re-installing new rivets shall be done by the Contractor at his own cost.

4.02.05 Shop painting

All paints and primers shall be of standard quality and procured from approved manufacturers and shall conform to the provisions of the relevant Indian Standards.

4.02. 12 Galvanizing

All galvanizing shall be uniform and of standard quality when tested in accordance with IS: 2633 - Method for testing uniformity of coating on Zinc Coated Articles and 15: 4759 - specification for Hot-Dip Zinc Coatings on Structural Steel & other allied products.

4.03.00 Tolerance

The tolerances on the dimensions of individual rolled steel components shall be as specified in IS: 1852 - specification for rolling and Cutting Tolerances for Hot-rolled Steel Products. The tolerances on straightness, length etc. of various fabricated components (such as beams and girders, columns, crane gantry girder etc.) of the steel structures shall be as specified in IS: 721 - Tolerances for Fabrication of Steel Structures.

4.04.00 Acceptance

Should any structure or part of a structure be found not to comply with any of the provisions of this specification, the same shall be liable to rejection. No Structure or part of the structure once rejected, shall be offered again for test, except in cases where the Engineer considers the defects rectifiable. The Engineer may, at his discretion, check some of the tests at an appropriate laboratory at the contractors cost.

When all tests to be performed in the Contractor's shop under the terms of this contract have been successfully carried out, the steelwork will be accepted forthwith and the Engineer will issue acceptance certificate, upon receipt of which, the items will be shop painted, packed and dispatched. No item to be delivered unless an acceptance certificate for the same has been issued. The satisfactory completion of these tests or the issue of the certificates shall not bind the Owner to accept the work, should it, on further tests before or after erection, be found not in compliance with the Contract.

4.05.00 Delivery of materials

4.05.01 General

The Contractor will deliver the fabricated structural steel materials to site with all necessary field connection materials in such sequence as will permit the most efficient and economical performance of the erection work. The Owner may prescribe or control the sequence of delivery of materials, at his own discretion.

4.05.02 Marking

Each separate piece of fabricated steelwork shall be distinctly marked on all surfaces before delivery in accordance with the markings shown on approved erection drawings and shall bear such other marks as will further facilitate identification and erection.

4.05.03 Shipping

Shipping shall be strictly in accordance with the sequence stipulated in the agreed Programme. Contractor shall dispatch the materials to the e worksite securely protecting and packing the materials to avoid loss or damage during transport by rail, road or water. All parts shall be adequately braced to prevent damage in transit.

Each bundle, bale or package delivered under this contract shall be marked on as many sides as possible and such distinct marking (all previous irrelevant markings being carefully obliterated) shall show the following:

- a) Name and address of the consignee
- b) Name and address of the consignor

- c) Gross weight of the package in tonnes and its dimensions
- d) Identification marks and/or number of the package
- e) Custom registration number, if required

All markings shall be carried out with such materials as would ensure quick drying and indelibility.

Each component or part or piece of material when shipped, shall be indelibly marked and/or tagged with reference to assembly drawings and corresponding piece numbers.

Each packing case shall contain in duplicate in English a packing list pasted on to the inside of the cover in a water-proof envelope, quoting especially -

- a) Name of the Contractor
- b) Number and date of the Contract
- c) Name of the office placing the contract
- d) Nomenclature of stores
- e) A schedule of parts or pieces, giving the parts or piece number with reference to assembly drawings and the quantity of each.

The shipping dimensions of each packing shall not exceed the maximum dimensions permissible for transport over the Indian Railways/Roads.

After delivery of the materials at site, all packing materials shall automatically become the property of the Owner.

Notwithstanding anything stated hereinbefore, any loss or damage resulting from inadequate packing shall be made good by the Contractor at no additional cost to the Owner. When facilities exist, all shipments shall be covered by approved Insurance Policy for transit at the cost of the Contractor.

The contractor shall ship the complete materials or part on board a vessel belonging to an agency approved by the Owner or on rail and/or road transport as directed. The Contractor shall take all reasonable steps to ensure correct appraisal of freight rates, weights and volumes and in no case will the Owner be liable to pay any warehouse, wharfage, demurrage and other charges.

If, however, the Owner has to make payment of any of the above-mentioned charges, the amount paid will be deducted from the bills of the Contractor.

Necessary advise regarding the shipment with relevant details shall reach the Engineer at least a week in advance.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 With Tender

The following information is required to be submitted with the Tender:

a) Progress Schedule

The Contractor shall quote in his Tender a detailed schedule of progress of work and total time of completion, itemizing the time required for each of the following aspects of work.

- i) Preparation and approval of fabrication drawing
- ii) Procurement of Materials
- iii) Fabrication and shipping of all anchor bolts
- iv) Fabrication and shipping of main steelwork.
- v) Fabrication and shipping of steelwork for bunkers, tanks and/or silos as applicable.
- vi) Fabrication and shipping of all other remaining steelwork including miscellaneous steelwork.
- vii) Final date of completion of all shipments.

b) Shop

Location of the Tenderer's fabrication workshop giving details of equipment, manpower, the total capacity, and the capacity that will be available exclusively for this contract shall be submitted.

5.02.00 After Award

After award of the Contract the successful Tenderer is to submit the following:

- a) Complete fabrication drawings, material lists, cutting lists, rive and bolt lists, field welding schedules based on the approved design drawings prepared by him in accordance with the approved schedule.
- b) Monthly Progress Report with necessary photographs in six (6) copies to reach the Engineer on or before the 7th day o. each month, giving the up-to-date status of preparation of detailed shop drawings, bill of materials, procurement of materials, actual fabrication done, shipping and all other relevant information.
- c) Detailed monthly material reconciliation statements relevant to the Work done and reported in the Progress Report, giving the stock at hand of raw steel, work in progress, finished materials.
- d) Results of any test as and when conducted and as require by the engineer.
- e) Manufacturer's mill test report in respect of steel materials, rivets, bolts, nuts, and electrodes as may be applicable.

6.00.00 RATES AND MEASUREMENT

6.01.00 Rates

- 6.01.01** The items of work in the Schedule of items describe the work in brief. The various items of the Schedule of items shall be read in conjunction with these specifications including amendments and additions, general conditions of contract, special conditions of contracts, and other tender documents, if any. For each item of Schedule of Items, the bidder's rates shall include the activities covered in the description of the item as well as all necessary operations described in the Specifications.
- 6.01.02** The bidder's rates shall include cost of all minor details which are obviously and fairly intended and which may not have been included in the description in these documents but are essential for the satisfactory completion of the work. Rates shall also include for taking all safety measures.
- 6.01.03** The bidder's -rates for all items of schedule of items shall include complete cost towards plant, equipment, erection and dismantling of scaffolding, men, materials and consumables, skilled and unskilled labour, levies, taxes, royalties, duties, transport, storage, repair/rectification/maintenance until handing over, contingencies, overhead and all incidental items not specifically mentioned but reasonably implied and necessary to complete the work.
- 6.01.04** No claims shall be entertained, if the details shown on the 'Released for Construction' drawings differ from those shown on the bid/tender drawings.
- 6.01.05** Rates shall be inclusive of all leads and lifts/elevation.
- 6.01.06** The bidder's rates for Structural Steel shall include for fabrication and erection, transportation to site, preparation checking collecting and distributing of the fabrication drawings and design calculations, erection scheme, alignment, welding, including preheating and post heating, testing of welders, inspection of welds, visual inspection, non destructive and special testing, rectification and correction of defective welding works, production test plate, inspection and testing, erection scheme, protection against damage in transit, stability of structures, etc. The rates shall also be inclusive of providing and installing temporary structures, transport of Owner issue material from store, return of surplus/waste steel materials including cut pieces/waste steel, provision of additional butt/weld joint to reduce the wastage and all other general, special, such requirements as may be required, for the successful completion of the work.
- 6.01.07** The bidder's rates for foundation bolts assembly shall include fabrication erection, installation, and alignment of complete bolt assembly with nuts, locknuts, anchor plates, stiffener plates, protective tape, etc. This shall also include the cost of materials not issued by the Owner.
- 6.01.08** The bidders rates for application of inorganic primer shall include surface preparation to near white metal surface by blast cleaning, abrasives, touch up painting, suitable enclosure to avoid contamination and the necessary statutory approval from the factory inspector/pollution control board etc. regarding the method of blast cleaning and abrasives used, and getting approval of the specialized agency supplying the zinc silicate primer.
- 6.01.09** The bidder's rates for application of finish painting system shall include surface preparation, application of intermediate (under) coat, finish coat and final finish coat, and getting approval of the specialized agency supplying the finish paint.
- 6.01.10** The bidder's rates for electro-forged gratings (if specified) shall include supply, fabrication, transportation to the site, erection and alignment of factory made electro-forged gratings, all taxes, duties thereon etc. The rates shall also include preparation of grating design for different spans and load intensifies, preparation of design and fabrication drawings, edge preparation,

blast cleaning followed by finish paint.

- 6.01.11** The bidder's rates for galvanization of factory made electro-forged gratings (if specified) shall include the application of hot dipped galvanization as finish over the fabricated gratings and the treatment to be given for prevention of white storage stains, as per the technical Aspiration.
- 6.01.12** The bidder's rates for permanent mild steel bolts, nuts and washers shall include the supply and fixing of such bolts, nuts and washers in position, for various types of Structural Steel works, as per the technical specification.
- 6.01.13** The bidder's rates for high strength structural bolts, nuts and washers shall include the supply and fixing of such bolts, nuts and washers in position, for various types, of Structural Steel works, as per the technical specification.
- 6.01.14** The bidder's rates for dismantling, additions to, alterations in and/or modifications shall be inclusive of all operations such as lowering of material, carriage etc., as mentioned in the technical specification. Unutilised steel pieces cut/removed shall be returned to the project stores free of charge. Non-return of unutilized steel pieces to the Owner's store would be considered as wastage and recovery would be affected as per the provision of contract for structural steel consumption. This shall not include the weight of temporarily dismantled/supported members, connected member.
- 6.01.15** The bidder's rates for re-erection of erection marks after additions to, alterations in and/or modifications shall be inclusive of all operations mentioned in technical specification for the calculated weight of the rectified/modified erection mark rejected at site. This shall not include the weight of temporarily dismantled/supported members, connected member. All the operations mentioned above for restoring such members shall be carried out at no extra cost. The work of erection of any erection mark which has not been dismantled but have been modified/rectified before erection shall not be paid under this item but shall be paid under relevant item of fabrication and erection of steel work of Schedule of items for the modified weight.
- 6.01.16** The bidder's rates for PTFE shall include design, supply, transportation of the complete assembly with guides and dust protection cover and installation of bearings in position drilling, bolting, erecting aligning etc. along with any taxes, duties thereon etc.
- 6.01.17** The bidder's rates for Stainless Steel hopper (if specified) shall include fabrication and erection, transportation to site, preparation checking collecting and distributing of the fabrication drawings and design calculations, all other operations mentioned in the technical specification. The rates shall also include for erection scheme, alignment, making cutting plan, cutting, jointing, bending, rolling, grinding, drilling, bolting, assembly, edge preparation, welding including pre-heating, post-heating, testing of welders, inspection of welds, inspection and testing, protection against damage in transit, stability of structures, installation of temporary structures etc. The rates shall also be inclusive of providing and installing temporary structures, transport of Owner issue material from store, return of surplus / waste steel materials including cut pieces/waste steel, provision of additional butt / weld joint to reduce the wastage and all other general, special, such requirements as may be required, for the successful completion of the work.
- 6.01.18** The bidders rates for preformed flexible open ended bellow strap of neoprene (if specified) shall include supply and transportation, installation in position, drilling, bolting, aligning etc. complete along with any taxes, duties thereon etc.

- 6.01.19** The bidder's rates for Stainless Steel Hand Rail (if specified) shall include complete Hand Rail including, stainless steel beading, stainless steel cleats, stainless steel fasteners, neoprene gaskets, preparation of shop drawing but excluding the cost of glazing. The Owner for this item of work shall supply no material.

6.02.00 MODE OF MEASUREMENT

- 6.02.01** The measurement for the item of foundation bolts assembly including that of nuts; locknuts shall be based on the calculated weight of steel installed in Metric Tonne, corrected to second place of decimal. The weight of the foundation bolt shall be calculated in the same way as that done for the item of fabrication, erection, alignment of structural steel. The weight of the nut / locknut shall be taken as per actual weight supplied by the contractor and accepted by the Engineer.
- 6.02.02** The measurement for the item of fabrication, erection, alignment, welding, etc. of structural steel work shall be based on the approved weight of steel nearest to a Kg, by applying the unit weight as adopted at the time of issue of structural steel on the measurements worked out as given below.
- 6.02.03** For ISMB, ISMC, ISA, flats, round bars, square bars and pipes, length shall be taken as per distance between planes normal to the axis of the member passing through the extreme points of the section.
- 6.02.04** Gussets plates in trusses, and bracings, brackets plates, stiffeners, and skew cuts if any in plates for butt welds the area shall be assumed as the minimum circumscribed rectangle.
- 6.02.05** For bunker wall plates the minimum-circumscribing rectangle of the individual plate/pieces out of which these wall plates are assembled by butt-welding, shall be measured. Care shall be taken to ensure maximum utilization of cut-pieces generated by providing extra butt joints (for which no extra payment shall be made).
- 6.02.06** For all other plates, where the area of any notch/skew cut in the plate is less than 0.2 sq.m. the area of the plate shall be assumed as that of the minimum circumscribing rectangle for the purpose of measurement and calculation of area for the purpose of payment. However, if the area of any notch/skew cuts in a plate is more than 0.2 sq.m. the actual profile of the plate shall be considered for the purpose of payment.
- 6.02.07** No deduction shall be made for the hole in the members, if the area of individual hole is less than 0.2 sq.m. The weight shall be calculated by deducting the area of holes, if area of individual hole is more than 0.2 sq.m.
- 6.02.08** All cut-pieces and scrap generated due to cutting of holes, skew-cuts of plates, gussets, brackets, stiffeners, etc. shall be stacked separately and handed over to the project stores without being considered for material accounting as the circumscribing rectangle has been considered for payment.
- 6.02.09** The splice plate shown in the fabrication drawing or approved by the Engineer shall only be measured for payment.
- 6.02.10** The weight of permanent bolts, washers and nuts and welds shall not be included in the weights of the members. No extra payment shall be made for welding/bolting.
- 6.02.11** The bolts and nuts required for erection purpose shall not be paid for and may be taken away

by the Contractor after final welding for members. Erection boltholes left after removal of erection bolts shall be suitably plugged with welds.

- 6.02.12** The measurement for the item of application of inorganic primer including blast cleaning of steel surfaces shall be based on the weight on which the zinc silicate primer is applied, after blast cleaning in Metric Tonne, corrected to third place of decimal. The weight shall be the weight as approved, for erection mark/element of the mark painted, for payment of the item of fabrication and erection of structural steel works.
- 6.02.13** The measurement for the item of application of finish primer system shall be based on the weight on which the epoxy based finish primer is applied in Metric Tonne, corrected to third place of decimal. The weight shall be the weight as approved, for erection mark/element of the mark painted, for payment of the item of fabrication and erection of structural steel works.
- 6.02.14** The measurement for the item of gratings shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor, and accepted by the Engineer. Nothing extra shall be payable for making cutouts, notches, openings of any profile, trimming profiles etc. in the grating units.
- 6.02.15** The measurement for the item of hot dipped galvanization of gratings shall be based on the actual weight in Kgs, corrected to second place of decimal of gratings galvanized by the Contractor and accepted by the Engineer.
- 6.02.16** The measurement for the item of permanent bolts with nuts and washers shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor and accepted by the Engineer, and as per the approved bolts and nuts schedules.
- 6.02.17** The measurement for the item of High Strength Structural bolts with nuts and washers shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor and accepted by the Engineer, and as per the approved bolts and nuts schedules.
- 6.02.18** The measurement for the item of the work of dismantling, additions, alterations, reerection etc. shall be as given below
- 6.02.19** For dismantling, the unmodified weight of the actually dismantled erection marks shall only be measured.
- 6.02.20** For the work of addition to, alteration in and / or modification of 'erection marks' either in erected position or in the fabrication yard, measurement of weight for payment purpose shall be calculated as the arithmetic sum of weight of steel cut and removed from the erection mark, weight of steel reutilised out of such cut and removed pieces and weight of additional new steel pieces added to the erection mark.
- 6.02.21** For re-erection the weight of the modified erection mark shall only be measured.
- 6.02.22** The weight shall be measured nearest to kg. and shall be arrived in a manner similar to the measurement for the item of fabrication, erection, alignment and welding of structural steel.
- 6.02.23** The measurement for the item of PTFE bearings shall be based on the actual weight in MT, corrected to third place of decimal, supplied by the contractor and as accepted by the Engineer and as per the approved bearing schedule, for the total vertical load carrying capacity, for all bearings.

- 6.02.24** The measurement for the item of stainless steel hopper shall be based on the actual finished weight of hopper weight in Kgs, corrected to second place of decimal. The hopper weight shall be arrived by multiplying of the inner surface area of the hopper with the unit weight of the hopper plate.
- 6.02.25** The measurement for the item of flexible open-ended bellows straps of neoprene shall be based in running meter, corrected to second place of decimal. Bellow Straps shall be supplied as per the requirement of the approved drawings. The measurement shall be done for the inner circumference of the bunker on which neoprene has been fixed and for the length supplied by the Contractor 'and as accepted by the Engineer.
- 6.02.26** The measurement for the item of Stainless Steel Hand Railing shall be based in Kgs corrected to second place of decimal. The weight shall also include the weight of Stainless Steel fasteners, Stainless Steel beading, Stainless Steel cleats etc. The weight shall be the finished weight of Hand Rail, as accepted by the Engineer.

SUB-SECTION – D18

ERECTION OF STRUCTURAL STEELWORK

C O N T E N T

CLAUSE NO. DESCRIPTION

1.00.00	SCOPE
2.00.00	GENERAL
3.00.00	WORKMANSHIP
4.00.00	TESTING AND ACCEPTANCE CRITERIA
5.00.00	INFORMATION TO BE SUBMITTED

ERECTION OF STRUCTURAL STEELWORK

1.00.00 SCOPE

This specification covers the erection of structural steelwork including receiving and taking delivery of fabricated structural steel materials arriving at site, installing the same in position, painting and grouting the stanchion bases all complete as per Drawings, this Specification and other provision of the Contract.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor, unless otherwise specified in the Contract, shall include but not be limited to the following:

- a) The Contractor shall provide all construction and transport equipment, tools, tackle, consumables, materials, labour, and supervision required for erection of the structural steelwork.
- b) Receiving, unloading, checking, and moving to storage yard at Site including prompt attendance to all insurance matters as necessary for all fabricated steel materials arriving at Site. The Contractor shall pay all demurrage and/or wharfage charges etc. on account of default on his part.
- c) Transportation of all fabricated structural steel materials from Site storage yard, handling, rigging, assembling, riveting, bolting, welding and satisfactory installation of all fabricated structural steel materials in proper location according to approved erection drawings and/or as directed by the Engineer. If necessary suitable temporary approach roads to be built for transportation of fabricated steel structures.
- d) Checking center lines, levels of all foundation blocks including checking line, level, position and plumb of all bolts and pockets. Any defect observed in the foundation shall be rectified with Engineer's approval. The Contractor shall fully satisfy himself regarding the correctness of the foundations before installing the fabricated steel structures on the foundation blocks.
- e) Aligning, plumbing, levelling, riveting, bolting, welding and securely fixing the fabricated steel structures including floor gratings, chequered plates etc. in accordance with the Drawings or as directed by the Engineer.
- f) Painting of the erected steel structures.

g) All minor modifications of the fabricated steel structures as directed by the Engineer including but not limited to the following:

- i) Removal of bends, kinks, twists etc. for parts damaged during transport and handling.
- ii) Cutting, chipping, filling, grinding, etc. if required for preparation and finishing of site connections.
- iii) Reaming of holes for use of higher size rivet or bolt if required.
- iv) Refabrication of parts damaged beyond repair during transport and handling or refabrication of parts, which are incorrectly fabricated.
- v) Fabrication of parts omitted during fabrication by error, or subsequently found necessary.
- vi) Drilling of holes which are either not drilled at all or are drilled in incorrect location during fabrication.
- vii) Carry out tests in accordance with this specification.

2.02.00 Work by Others

No work under this Specification will be provided for by any agency other than the Contractor unless specifically mentioned elsewhere in the contract.

2.03.00 Codes and Standards

All work under this Specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specification and codes of Practice of equivalent:

IS: 800 - Code of practice for general construction in steel.

IS: 456 - Code of practice for main or reinforced concrete.

2.04.00 Conformity with Designs

The Contractor will erect the entire fabricated steel structure, align all the members, complete all field connections and grout the foundations all as per the provisions of this specification and the sequence and the design criteria laid down by the Engineer. All work shall conform to the provisions of this specification and /or instructions of the engineer. The testing and acceptance of the erected structures shall be in accordance with the provisions of this Specifications and/or the instructions o the Engineer.

2.05.00 Material

2.05.01 General

All fabricated steel structures and connection materials shall be supplied by the Contractor to the site. The Contractor shall take delivery from railway wagons or trucks at site, and unload the materials and perform all formalities like checking of materials and attend to insurance matters in accordance with Sub-Clause 2.01.00 and as specified hereinbefore.

2.05.02 Materials to conform to Indian standards

All materials required to be supplied by the Contractor under this contract shall conform to the relevant Indian Standard specifications.

2.06.00 Storage of Materials

2.06.01 General

All material shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for use in the works. Any material which has been deteriorated or damaged beyond repairs and has become unfit for use shall be removed immediately from the site, failing which, the engineer shall be at liberty to get the materials removed by agency and the cost incurred thereof shall be realised from the Contractor's dues.

2.06.02 Yard

The Contractor will have to establish a suitable yard in an approved location at site for storing the fabricated steel structures and other raw steel materials such as structural sections and plates as required. The yard shall have facilities like drainage, lighting, and suitable access for large cranes, trailers, and other heavy equipments. The yard shall be fenced all around with security arrangement and shall be of sufficiently large area to permit systematic storage of the fabricated steel structures without overcrowding and with suitable access for cranes, trailers and other equipment for use in erection work in proper sequence in accordance with the approved Programme of work.

The Tenderer must visit the site prior to submission of his tender to acquaint himself with the availability of land and the development necessary by way of filling, drainage, access roads, fences, sheds etc. all of which shall be carried out by the Contractor at his own cost as directed by the Engineer.

2.06.03 Covered Store

All field connection materials, paints, cement etc. shall be stored on well designed racks and platforms off the ground in a properly covered store building to be built at the cost of the Contractor.

2.07.00 Quality Control

The contractor shall establish and maintain quality control procedures for different items of work and materials as may be directed by the Engineer to assure compliance with the provisions of the Contract and shall submit the records of the same to the Engineer. The quality control operation shall include but not be limited to the Following items of work :

- i) Erection: Lines, levels, grades, plumbs, joint characteristics including tightness of bolts.
- ii) Grouting: Cleaning and roughness of foundation, quality of materials used for grouting, admixtures, consistency, and strength of grout.
- iii) Painting: Preparation of surface for painting, quality of primers and paints, thinners, application and uniformity of coats.

2.08.00 Taking Delivery

The Contractor shall take delivery of fabricated structural steel and necessary connection materials from railhead/trucks as may be necessary and as directed by the Engineer. He shall check, unload; transport the materials to his stores for proper storing at his own cost. The Contractor shall submit claims to insurance or other authorities and pursue the same in case of loss or damage during transit and handling and all loss thereof shall be borne by him.

The Contractor shall also take all precautions against damage of the materials in his custody after taking delivery and till the same are erected in place and accepted. The Contractor shall salvage, collect, and deliver all the packing materials to the Owner free of charge.

3.00.00 WORKMANSHIP

3.01.00 Erection

3.01.01 Plant and Equipment

The suitability and adequacy of all erection tools and plant and equipment proposed to be used shall be thoroughly verified. They shall be efficient, dependable, in good working condition and shall have the approval of the Engineer.

3.01.02 Method and sequence of erection

The method and sequence of erection shall have the prior approval of the Engineer. The Contractor shall arrange for most economical method and sequence available to him consistent with the drawings and specifications and other relevant stipulations of the contract.

3.01.03 Temporary Bracing

Unless adequate bracing is included as a part of the permanent framing, the erector during erection shall install, free of cost to the Owner, temporary guys and bracings where needed to secure the framing against loads such as wind or seismic forces comparable in intensity to that for which the structure has been designed, acting upon exposed framing as well as loads due to erection equipment and erection operations.

If additional temporary guys are required to resist wind or seismic forces acting upon components of the finished structure installed by others during the course of the erection of the steel framing, arrangement for their installation by the erector shall be made free of cost to the Owner.

The requirement of temporary bracings and guys shall cease when the structural steel is once located, plumbed, levelled, aligned, and grouted within the tolerances permitted under the specification and guyed and braced to the satisfaction of the Engineer.

The temporary guys, braces, false work, and cribbing shall not be the property of the Owner and they may be removed immediately upon completion of the steel erection.

3.01.04 Temporary Floors for Buildings

It shall be the responsibility of the Contractor to provide free of cost planking and to cover such floors during the work in progress as may be required by any Act of Parliament and/or bylaws of state, Municipal or other local authorities.

3.01.05 Setting Out

Positioning and levelling of all steelwork, plumbing of stanchions and placing of every part of the structure with accuracy shall be in accordance with the approved Drawings and to the satisfaction of the Engineer. For heavy columns, etc. the Contractor shall set proper screed bars to maintain proper level. No extra payment shall be made for this.

Each tier of column shall be plumbed and maintained in a true vertical position subject to the limits of tolerance under this Specification.
No permanent field connections by riveting, bolting or shall be carried out until proper alignment and plumbing has been attained.

3.01.06 Field Riveting

All rivets shall be heated and driven with pneumatic tools. Hand passing or "throwing" of rivets are desirable. Any other method of conveying hot rivets from the furnace to the driving point must be approved by the engineer. No-cold rivets shall be driven. All other requirements of riveting including quality and acceptance criteria shall be in accordance with the relevant portions of the Specification for Fabrication of Structural Steelwork of the Project.

3.01.07 Field Bolting

All relevant Portions in respect of bolted construction of the Specification for Fabrication of Structural Steelwork applicable to the Project shall also be applicable for field bolting in addition to the following:

Bolts shall be inserted in such a way so that they may remain in position under gravity even before fixing the nut. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible materials. When assembled, all joint surfaces, including those adjacent to the washers shall be free of scales except tight mill scales. They shall be free of dirt, loose scales, burns, and other, defects that would prevent solid seating of the parts. Contact surfaces within friction type joints shall be free of oil, paint, lacquer, or galvanizing.

All high tensile bolts shall be tightened to provide, when all fasteners in the joint are tight, the required minimum bolt tension by any of the following methods.

a) Turn-of-nut Method

When the turn-of-nut method is used to provide the bolt tension, there shall first be enough bolts brought to a "snug tight" condition to ensure that the parts of the Joint are brought into good contact with each other. 'Snug tight' is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation specified in Table-I with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation there shall be no rotation of the part not turned by the wrench.

TABLE-I

Bolts length not exceeding 8 times dia or 200 mm	Bolt length exceeding 8 times dia or 200 mm	Remarks
1/2 turn	2/3 turn	Nut rotation is relative to bolt regardless of the element (nut or bolt) being turned. Tolerance on rotation-30° over or under.

Bolts may be installed without hardened washers when tightening is done by the turn -of-nut - method. However, normal washers shall be used.

Bolts tightened by the turn-of-nut method may have the outer face of the match-marked with the protruding bolt point before final tightening, thus affording the inspector visual means of noting the actual nut rotation. Such marks can be made by the wrench operator by suitable means after the bolts have been brought up snug tight.

b) Torque Wrench Tightening

When torque wrenches are used to provide the bolt tensions, the bolts shall be tightened to the torques specified in TABLE-II (See Note below the Table). Nuts shall be in tightening motion when torque is measured. When using torque wrenches to install several bolts in a single joint, the wrench shall be returned to touch up bolts previously tightened, which may have been loosened by the tightening of subsequent bolts, until all are tightened to the required tension.

TABLE-II

Nominal Bolt Diameter (mm) for bolt class 8.8 of IS:1367	Torque to be applied (Kg.M)
20	59.94
22	81.63
24	103.73

Note: The above torque values are approximate for providing tensions of 14. 7 T for 20 mm dia.; and 21.2 T for 24 mm dia. bolts under moderately lubricated condition. The torque wrench shall be calibrated at least once daily to find out the actual torque required to produce the above required tension in the bolt by placing it in a tension indicating device. These torques shall be applied for tightening the bolts on that day with the particular wrench.

In either of the above two methods, if required, for bolt entering and wrench operation clearances, tightening may be done by turning the bolt while the nut is prevented from rotating.

Impact wrenches if used shall be of adequate capacity and sufficiently supplied with air to

perform the required tightening of each bolt in approximately ten seconds. Holes for turned bolts to be inserted in the field shall be reamed in the field. All drilling and reaming for turned bolts shall be done only after the parts to be connected are assembled. Tolerances applicable in the fit of the bolts shall be in accordance with relevant Indian Standard Specifications. All other requirements regarding assembly and bolt tightening shall be in accordance with this sub clause.

3.01.08 Field Welding

All field assembly and welding shall be carried out in accordance with the requirements of the specification for fabrication work applicable to the project, excepting such provisions therein which manifestly apply to shop conditions only. Where the fabricated structural steel members have been delivered painted, the paint shall be removed before field welding for a distance of at least 50 mm on either side of the joints.

3.01.09 Holes, Cutting and Fitting

No cutting of sections, flanges, webs, cleats, rivets, bolts, welds etc. shall be done unless specifically approved and /or instructed by the Engineer.

The erector shall not cut, drill, or otherwise alter the work of other trades, unless such work is clearly specified in the Contract or directed by the Engineer. Wherever such work is obtain specified the Contractor shall obtain complete information as to size, location and number of alterations prior to carrying out any work. The Contractor shall not be entitled for any payment on account of any such work.

3.02.00 Drifting

Correction of minor misfits and reasonable amount of reaming and cutting of excess stock from rivets will be considered as permissible. For this, light drifting may be used to draw holes together and drills shall be used to enlarge holes as necessary to make connections. Reaming, that weakens the member or makes it impossible to fill the holes properly or to adjust accurately after reaming, shall not be allowed.

Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins and reamers shall immediately be called to the attention of the Engineer and approval of the method of correction obtained. The use of gas cutting torches at erection site is prohibited.

3.03.00 Grouting of stanchion bases and bearings of beams and girders on stone, brick or concrete (Plain or reinforced)

Grouting shall be carried out with Ordinary Cement grout as described below:

The mix shall be one (1) part cement and one (1) part sand and just enough water to make it workable. The positions to be grouted shall be cleaned thoroughly with compressed air jet and wetted with water and any accumulated water shall be removed. These shall be placed under expert supervision, taking care to avoid air locks. Edges shall be finished properly. If the thickness of grout is 25 mm or more, two (2) parts of 6 mm down graded stone chips may be added to the above noted cement-sand grout mix, if required, by the Engineer or shown on the drawings.

No grouting shall be carried out until a sufficient number of bottom lengths of stanchions have been properly lined, leveled, and plumbed and sufficient floor beams are tied in position.

Whatever method of grouting is employed, the operation shall not be carried out until the steelwork has been finally levelled and plumbed, the stanchion bases being supported meanwhile by steel wedges, and immediately before grouting, the space under steel shall be thoroughly cleaned.

If required by the Engineer, certain admixtures like aluminium powder, "ironite" or equivalent, may be required to be added to the grout to enhance certain desirable properties of the grout. Approved non-shrink pre-mixed grout having required flowability and compressive strength may also be used with Engineer's approval.

3.04.00 Painting after Erection

Field painting shall only be done after the structure is erected, levelled, plumbed, aligned and grouted in its final position, tested and accepted by the Engineer. Normally, final painting shall be done only after the floor slabs are concreted and masonry walls are built. However, touch up painting, making good any damaged shop painting and completing any unfinished portion of the shop coat shall be carried out by the Contractor free of cost to the Owner. The materials and specification for such painting in the field shall be in accordance with the requirements of the specification for fabrication of structural steelwork applicable for the project.

Painting shall not be done in frosty or foggy weather or when humidity is such as to cause condensation on the surfaces to be painted. Before painting of steel, which is delivered unpainted, is commenced, all surfaces to be painted shall be dried and thoroughly cleaned from all loose scale and rust.

All field rivets, bolts, welds, and abrasions to the shop coat shall be spot painted with the same paint used for the shop coat. Where specified, surfaces, which will be in contact after site assembling, shall receive a coat of paint (in addition to the shop coat, if any) and shall be brought together while the paint is still wet.

Surface, which will be inaccessible after field assembly shall receive the full, specified protective treatment before Bolts and fabricated steel members who are galvanized or otherwise treated and steel members to be encased shall not be painted.

The final painting shall be of tow coats of Synthetics Enamel painting or Aluminium paint of approved manufacture as per the approved "Schedule of Painting". The shades shall also be as per the approved schedule. Synthetic enamel paint shall conform to IS: 2932.

3.05.00 Final cleaning up

Upon completion of erection and before final acceptance of the work by the Engineer, the contractor shall remove free of cost all false work, rubbish and all Temporary Works resulting in connection with the performance of his work.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 General

Loading tests shall be carried out on erected structures, if required by the Engineer, to check adequacy of fabrication and/or erection. Any structure or a part thereof found to be unsuitable for acceptance as a result of the test shall have to be dismantled and replaced with suitable member as per the Contract and no payment towards the cost of the dismantled portion and any connected work shall be made to the contractor. In course of dismantling, if any damage is done to any other parts of the structure or to any fixtures, the same shall be made good free of cost by the Contractor, to the satisfaction of the Engineer. The Cost of the tests specified hereinafter shall be borne by the Owner; but if the structure fails to pass the tests, the cost of the tests shall be recovered from the Contractor. Any extra claim due to loss of time, idle labour, etc. arising out of these testing operations shall not be entertained, however, only reasonable and appropriate time extensions will be allowed.

The structure or structural member under consideration shall be loaded with its actual dead load for as long a time as possible before testing and the tests shall be conducted as indicated in the following sub-clauses 4.01.01, 4.01.02 and 4.01.03. The method of testing and application of loading shall be as approved by the Engineer.

4.01.01 Stiffness Test

In this test, the structure or member shall be subjected, addition to its actual dead load, to a test load equal to 1.5 times the specified superimposed load, and this loading shall be maintained for 24 hours. The maximum deflection attained during the test shall be within the permissible limit. If, after removal of the test load, the member or structure does not show a recovery of at least 80 per cent of the maximum strain or deflection shown during 24 hours under load, the test shall be repeated. The structure or member shall be considered to have sufficient stiffness, provided that the recovery after this second test is not less than 90 per cent of the maximum increase in strain or deflection recorded during the second test.

4.01.02 Strength Test

The structure or structural member under consideration shall be subjected, in addition to its actual dead load, to a test load equal to the sum of the dead load and twice the specified superimposed load, and this load shall be maintained for 24 hours.

In the case of wind load, a load corresponding to twice the specified wind load shall be applied and maintained for 24 hours, either with or without the vertical test load for more severe condition in the member under consideration or the structure as a whole. Complete tests under both conditions may be necessary to verify the strength of the structure. The structure shall be deemed to have adequate strength if, during the test, no part fails and if on the removal of the test load, the structure shows a recovery of at least 20 per cent of the maximum deflection or strain recorded during the 24 hours under load.

4.01.03 Structure of same design

Where several structures are built to the same design and it is considered unnecessary to test all of them, one structure, as a prototype, shall be fully tested, as described in previous Sub-clauses, but in addition, during the first application of the test load, particular note shall be taken of the strain or deflection when the test load 1.5 times the specified superimposed load has been maintained for 24 hours. This information is required as a basis of comparison in any check test carried out on samples of the structure.

When a structure of the same type is selected for a check test, it shall be subjected, in addition to its actual dead load, to a superimposed test load, equal to 1.5 time the specified live load, in a manner and to an extent prescribed by the Engineer. This load shall be maintained for 24 hours, during which time, the maximum deflection shall be recorded. The check test shall be considered satisfactory, provided that the maximum strain or deflection recorded in the check test does not exceed by more than 20% of the maximum strain or deflection recorded at similar load in the test on the prototype.

4.01.04 Repair for subsequent test and use after strength tests

An actual structure which has passed the "Strength Test" as specified in Sub-clause 4.1.2 hereinbefore and is subsequently to be erected for use, shall be considered satisfactory for use after it has been strengthened by replacing any distorted members and has subsequently satisfied the 'Stiffness Test' as specified in Sub-clause 4.01.01 hereinbefore.

4.02.00 Tolerances

Some variation is to be expected in the finished dimensions of structural steel frames. Unless otherwise specified, such variations are deemed to be within the limits of good practice when they are not in excess of the cumulative effect of detailed erection clearances, fabricating tolerances for the finished parts and the rolling tolerances for the profile dimensions permitted under the Specifications for fabrication of structural steel work applicable to this Project and as specified below:

I. For Buildings Containing Cranes

Component	Description	Variation Allowed
1.	2.	3.
Main columns	a) shifting of column axis at foundation level with respect to building line	
	i) In longitudinal direction	i) ± 3.0 mm
	ii) In lateral direction	ii) ± 3.0 mm
	b) Deviation of both major column axis from vertical between foundation and other member connection levels:	
	i) For a column upto and	i) ± 3.5 mm from true

		including 10M height	vertical
	ii) For a column greater than 10M but less than 40M height	ii) ± 3.5 mm from true vertical for any 10 M length measured between connection levels, but not more than ± 7 mm per 30m length.	
	c) For adjacent pairs of columns across the width of the building prior to placing of truss	± 9.0 mm on true span.	
	d) For any individual column deviation of any bearing or resting level from levels shown on drawings.	± 3.0 mm	
	e) For adjacent pairs of columns either across the width of building or longitudinally level difference allowed between bearing or seating	3.0 mm	
Trusses	a) Deviation at centre of span or greater than 10mm vertical plane running through centre of bottom chord.	1/1500 of the of upper chord member from whichever is the least.	
Trusses	b) Lateral displacement of top chord at center of span from vertical plane running through center of supports.	1/250 of depth of truss or 20 mm which ever is the - least.	
Crane Cirders	a) Difference in levels of crane rail measured between adjacent columns.	2.0 mm.	
	b) Deviation to crane rail-gauge	± 3.0 mm	
	c) Relative shifting of ends of adjacent crane rail in plan and elevation after thermite welding.	1.0 mm.	
	d) Deviation of crane rail axis from centre line of web.	± 3.5 mm	
Setting of Expansion	At the time of setting of the expansion gaps, due		

gaps regard shall be taken of the ambient temperature above or below 30°C. The coefficient of expansion or contraction shall be taken as 0.000012 per °C per unit length.

iv) For Building without Cranes

The maximum tolerances for line and level of the steel work shall be ± 3.0 mm on any part of the structure. The structure shall not be Out of Plumb more than 3.5 mm on each lox section of height and not more than 7.0 mm per 30 m section.

These tolerances shall apply to all parts of the structure unless the drawings issued for erection purposes state otherwise.

4.03.00 Acceptance

Structures and members have passed the tests and conform to all requirements specified in the foregoing Sub-clause 4.01.00, 4.01.01, 4.01.02, 4.01.03 and 4.01.04 and other applicable provisions of this specification and are within the limits of tolerances specified in Sub-clause 4.02.00 and/or otherwise approved by the Engineer shall be treated as approved and accepted for the purpose of fulfillment of the provisions of this contract.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 Before Tender

5.01.01 Tentative Programme

The Tenderer shall submit a tentative programme based on the information available in the Tender Document and visit to site indicating the structure-wise erection schedule proposed to be maintained by the Contractor to complete the job in time in accordance with the Contract.

5.01.02 Constructional Plant and Equipment, Tools, Temporary works & manpower A detailed list Of all constructional plant and equipment like cranes, derricks, winches, welding sets, erection tools etc. along with their make, model, present condition and location available with the Tenderer which he will be able to employ on the job to maintain the progress of work in accordance with the Contract shall be submitted along with the Tender. The total number of each category of experienced personnel like fitters, welders, riggers etc. that he will be able to employ on the job shall also be indicated.

5.01.03 Erection Yard

A site plan showing the layout and location of the erection yard proposed to be established by the tenderer shall also be attached with the tender indicating the storage space for fabricated steel materials, site-fabrication and repair shop, covered stores, offices, locations of erection equipments and other facilities.

The Engineer shall have the right to modify the arrangement and location of the proposed yard to suit site conditions and the Contractor shall comply with the same without any claim whatsoever.

5.02.00 After award of the Contract

After award of the contract, the Contractor shall submit the following:

5.02.01 Detailed Programme

The Contractor shall submit a detailed erection programme within a month of the award of the Contract for completion of the work in time in accordance with the Contract. This will show the target programme, with details of erection proposed to be carried out in each fortnight, details of major equipment required, and an assessment of required strength of various categories of workers in a proforma approved by the Engineer.

5.02.02 Fortnightly Progress Report

The Contractor shall submit fortnightly progress reports in triplicate to the Engineer showing along with necessary photographs, 125 mm x 90 mm size, and all details of actual achievements against the target programme specified in Sub-clause 5.02.01 above. Any shortfall in the achievement in a particular fortnight must be made up within the next fortnight. Along with this report, the Contractor shall also furnish details of fabricated materials in hand at site and the strength of his workers.

SUB-SECTION – D19

ROOF DECKING

C O N T E N T**CLAUSE NO. DESCRIPTION**

1.00.00	SCOPE
2.00.00	MATERIALS
3.00.00	INSTALLATION
4.00.00	ACCEPTANCE CRITERIA
5.00.00	IS CODES
6.00.00	RATES AND MEASUREMENTS

ROOF DECKING**1.00.00 Scope**

This section of the specification covers the supply, fabrication and erection of profiled light gauge Metal Decks (coated and painted) as roof decking to the main plant building and any other area as indicated in the drawings.

2.00.00 Material

2.01.01 Roof of main plant TG and Deareator bay and bunker building consists of permanently colour coated (on exposed face) galvanized MS trough metal sheet decking plate of approved colour over roof purlins for cast-in-situ roof slab as per IS: 14246 and conform to class 3. Thickness of deck plate shall be minimum 0.8mm and minimum trough depth of 44 mm and centre to centre of the valley shall be 130mm with minimum yield strength of 250 Mpa. Silicon modified polyester paint shall be used for permanent coating over galvanized surface with minimum rate of galvanization 275 gm/sqm. DFT of permanent colour coating shall be 20 microns. It shall serve as permanent shuttering for cast-in-situ roof slab. It should have adequate strength to support weight of green concrete and imposed load during construction. The thickness of the deck plate shall however be designed suitably according to the spacing of roof purlins.

3.00.00 INSTALLATION

The Contractor shall furnish all labour, equipment and materials as required for the design, fabrication, coating, erection and fixing of the decking over purlins, painting and for the complete performance of the work in accordance with the construction drawings and as described herein.

The description, which follows, gives a general indication of the nature and extent of the work but is not necessarily exhaustive and does not purport to cover all the details/operations which will be necessary in order to carry out the work.

3.01.00 Detailed Design of Roof Decking

The Contractor, in conjunction with the manufacturer, shall be responsible for the detailing of the profiled decking, fittings and fixtures and shall submit with his tender particulars of the proposed manufacturer and of the particular product proposed for use. The detailing is to be based on typical details furnished by the Engineer. The Contractor shall submit to the Engineer, two copies of the general arrangement and detailed working drawings for the proposed design, together with all calculations necessary to verify the adequacy and completeness of the design & detailing of decking sheets, fixtures, flashings and trims. After approval he shall supply further eight copies.

The Engineer will verify the correct interpretation of his requirements but may not necessarily check the design and details, and the Contractor shall be entirely responsible for the accuracy of the drawings and the correctness of the design and the suitability of the details. Manufacture of roof decking sheets shall not commence until the necessary approval of the Engineer has been obtained.

3.02.00 Erection & Fixing

3.02.01 Sequence of Manufacture/Erection

Cutting Schedules, delivery to site and stacking arrangements in store shall ensure that sheets are erected in a sequence which follows that for the manufacture. The decking sheets shall be erected using an arrangement of sheets and joints to conform with the requirements of this specification. Decking erection for each elevation or feature shall commence at one end only and proceed towards the other end, in order to ensure tight fitting laps.

3.02.02 Position and Location of Laps

Side and end laps of roof decking sheets shall be located and positioned in such a manner as to provide the maximum weather protection taking into account the direction of the prevailing wind.

The lines formed by horizontal laps and fixing shall where possible, be continuous and coincide with the edges of large openings in the roof.

3.02.03 Alignment of Sheets and Fixings

All roof decking sheets shall be fixed plumb and level with all fixings evenly spaced and accurately lined. All dirt and grease shall be removed from the surfaces of the sheets as the work proceeds.

3.02.04 Site Cutting

Approval must be obtained before the roof decking sheets are cut at site. Generally cutting of sheets to length will not be permitted, only special cutting and trimming for small openings shall allowed. Where possible, site cut edges shall be concealed at laps.

3.02.05 Damaged Sheets

Distorted, blemished or water stained sheets and any other fittings shall not be used.

3.02.06 Laps

End laps and side laps to roof decking sheets shall be sufficiently large to ensure that the decking complies with the weather tightness and other requirements of this specification. The length of each decking sheet shall be adjusted so that the end laps shall bear on the purlins. In no case end laps shall not be less than 150 mm and side laps shall not be less than 53 mm.

3.02.07 End Lap Fixings

End lap fixings shall be located at least 25 mm from the end of each sheet.

3.02.08 Side Lap Fixings

The spacing of side lap fixings shall ensure compliance with this specification regarding tightness. The spacing of these fixing screws shall not exceed 500mm. The fixing shall be located in the bottom flat of the corrugation.

3.02.09 Holes

Holes in MS decking sheets shall be punched. In case holes are drilled holes, it is to be ensured that the holes do not go oversize due to the small thickness of the sheeting. All drilling swarf shall be removed from the surfaces of decking, supporting steel work, purlins etc.

3.02.10 Location and Spacing of Fixings

Fixings shall be accurately located in position in the centre of the corrugations to ensure that the heads of bolts, nuts and washers bear squarely down on the surface of the sheeting and are not located at the edge or on the joints in supporting purlins.

3.02.11 Fixings

The tenderer shall submit with his tender details of the proposed method for securing the roofing sheets to the metal purlins. The roof decking sheets are to be fixed to the roof purlins with hex washer head white zinc plated heat treated carbon steel self drilling / self tapping screws of minimum thread diameter of 5.6mm. These self drilling screws shall be drilled through the roofing sheets and purlins supporting the roofing sheets. These purlins shall be suitably spaced as per the requirement of roofing sheets and the roofing sheets shall not sag more than span/250 for the loads likely to be imposed during concreting and in future. The self-drilling screws are to be spaced at a maximum distance of 390mm centre to centre along the length of the purlins and top chord of truss. The screws are to be located preferably in the valley only and shall be installed in accordance with the manufacturer's recommendations using tools approved by the manufacturer which do not damage the coating of the decking sheets.

3.03.00 Protection during Construction

Precautions shall be taken during the erection of the roof decking to ensure that partially erected decking are protected during inclement weather and damage at all times.

3.04.00 Damage

Any damage to coating & primer during transportation is to redone with the similar type of coating as per the manufacturer's specification at no extra cost to the Owner.

4.00.00 Acceptance Criteria

The installation shall present a neat appearance and shall be checked for water tightness. The following shall be checked :

- a) Side and end laps
- b) Absence of damage in the sheeting.
- c) Conformity of fixings with the approved design.

5.00.00 IS Codes

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS : 513 - Specification for cold rolled carbon steel sheets.

IS : 3618 - Specification for phosphate treatment of iron and steel for protection against corrosion.

IS : 4431 - Specification for carbon & carbon manganese free cutting steel.

IS : 1573 - Electroplated Coatings of zinc on iron and steel.

6.00.0 RATES AND MEASUREMENTS

6.01.00 Rates

Rates shall be unit rate for complete item described in the Schedule of Items and shall include all wastage.

6.02.00 Method of Measurement

Roofing shall be measured for net area of the work done. Profiled sheeting (coated & painted) shall be measured in plan area of sheets and not girthed. No deduction shall be made for openings measuring up to 0.1 sq.m. in area. No extra shall be paid for extra labour in cutting and for wastage etc. in making opening and cutting to size.

No payments shall be made for laps.

SUB-SECTION – D20

FALSE FLOORING

C O N T E N T

CLAUSE NO.	DESCRIPTION
1.00.00	GENERAL
2.00.00	MATERIALS
3.00.00	INSTALLATION
4.00.00	ACCEPTANCE CRITERIA
5.00.00	IS CODES
6.00.00	RATES AND MEASUREMENTS

FALSE FLOORING

1.00.00 General

This section of the specification covers the supply, fabrication and installation of false flooring system having PVC top finish particle board, GI supporting system, painting etc. as per schedule of items in the main plant building and any other area as indicated in the drawings.

The scope of contractor covers supply of all materials, fabrication & installation works required to be carried out for completion of false flooring in the area specified in the drawings.

2.00.00 MATERIAL

2.01.00 Supporting structure

Supporting pedestals shall be made of steel and will be of height as required. Supporting pedestal shall be truly vertical and located at distances to conform with size of floor panels and shall be equipped with locking devices to prevent disturbances of finished elevation. Base of pedestal shall have integral load dispersion plate of size 100x100x8mm to transmit the load evenly to the base floor. Adjustment of pedestal shall be provided by threaded vertical rod of 25mm diameter and elevating nut. The pedestal head shall provide positive interlocking of the steel grid channels supporting system and shall prevent lateral shifting.

The grid channels shall be made of galvanised steel of 40mm x 40mm x 3.15mm thick and shall be placed at 610mm centre to centre both ways to support floor panels in uniform levelled elevations. Nominal height of the false flooring system shall be 600 mm unless otherwise indicated. Pedestal head shall be equipped with conducting grounding pad if so desired by the Engineer

2.02.00 Floor Panels

The floor panels shall be made of fire resistant particle board, phenol formaldehyde bonded. Size of each panel shall be 610mm x 610mm with all panel edges finished to a tolerance of ± 0.2 mm. Floor panel shall have 2mm thick non-static PVC on top, 2mm thick hard PVC strip lipping on four edges and 26 G aluminium sheet fixed with araldite at bottom. Minimum thickness of the panel shall be 35mm, unless otherwise noted. All panels shall be completely interchangeable and easily removable with a suction lift tool. Panels shall be square within a tolerance of ± 0.25 mm on the diagonal. The floor panels shall be cut, wherever required for providing suitable outlets for cables and edges shall be lipped with hard PVC sheets.

2.02.01 Strength

Each 610mm x 610 mm floor panel must be capable of withstanding the designed service load. The ultimate strength shall provide a safety factor of 3. The false flooring shall be capable of carrying a axial load of 800 kg and uniform load of 2000 kg/sq.m with maximum deflection of 1/350. If required by the Engineer, the samples shall be accepted only after carrying out load tests. The Engineer may relax the test requirements with concentrated load in case cabinets are not handled with castor fitting arrangement.

One additional pedestal shall be provided under floor stringer along front panel area of each control board for taking possible additional load that may occur from time to time.

2.02.02 Surface finish

All removable panels shall have the top surface finished with 2 mm thick flexible PVC flooring conforming to IS:3462 and shall be fixed to the surface with compatible high-creep resistant adhesive. The PVC floor tile shall be in single piece for each floor panel. Under side of panels shall also be painted with suitable epoxy or oil based paint.

2.02.03 Damaged Floor Panels

Distorted, blemished or stained floor panels shall not be used.

2.03.00 Skirting

Skirting shall be 150 mm high and 2 mm thick, completely matching with false flooring surface finish materials and shall be fixed to the wall surface as per manufacturer's installation instructions.

3.00.00 INSTALLATION

3.01.00 Base

The system shall be placed over a base of RCC floor slab and beams. Any grouting etc. that is necessary to fix the supporting structure shall be done.

The concrete sub floor shall be sealed with two coats of polyurethane paint to prevent moisture from coming in contact with cables and to minimise dust problem.

The floor panels and channels shall be completely interchangeable and remain in position without screwing or bolting under working/imposed loadings.

Any damage to the sub floor during installation of the false flooring system shall be made good by the contractor without any extra cost to the Owner. All steel surfaces are to be protected by two coats of polyurethane paint over a compatible primer and any damage to the paint during installation shall be made good. In case the loads exerted by the weight of machines are above the stated characteristics of floor finish material, the floor shall be protected by overlaying hard board during installation of machine or equipment.

All installation work of the false flooring system shall be supervised by the manufacturer's authorised representative.

3.03.00 Painting

After fixing the false flooring supporting system the sub floor shall be given a coat of polyurethane paint.

3.04.00 Protection during Construction

All precautions shall be taken during the erection of the false flooring to ensure that partially erected flooring are protected and shall not be damaged before handing over to owner.

3.05.00 Damage

Any damage of coating to supporting system caused during transportation is to be redone with the similar type of coating as per the manufacturer's specification at no extra cost to the Owner.

4.00.00 ACCEPTANCE CRITERIA

The false flooring system shall only be accepted after completion of following checks :

- a. Level
- b. Alignment of joints
- c. Thickness of joints
- d. Surface finish
- e. Colour and texture
- f. Details of edges, junctions etc.
- g. Performance
- h. Criteria specified for strength.

5.00.00 IS CODES

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS:5318 Laying of flexible sheet and flooring.

IS:3462 Flexible PVC flooring

IS:3087 Wood particle boards (medium density) for general purposes.

6.01.0 RATES AND MEASUREMENTS**6.01.00 Rates**

Rates shall be unit rate for complete item described in the Schedule of Items and shall include, but not limited to, supply & installation of floor panels, supporting systems, paintings etc.

6.02.00 Method of Measurement

False flooring shall be measured in Sq.M for net area of the work done. No deduction shall be made for openings measuring up to 0.4 sq.m. in area. No extra shall be paid for extra labour in cutting and for wastage etc. in making opening and cutting to size.

SUB-SECTION – D21**BORED CAST-IN-SITU RCC PILES****CONTENTS****CLAUSE NO. DESCRIPTION**

1.00.00	SCOPE
2.00.00	GENERAL REQUIREMENTS
3.00.00	MATERIALS
4.00.00	PILE INSTALLATION
5.00.0	SAMPLING, TESTING, AND QUALITY ASSURANCE
6.00.00	PILE TESTING

7.00.00	CODES AND STANDARDS		
8.00.00	RATES AND MEASUREMENT		
	ANNEXURE-A		
	ANNEXURE-B		
	ANNEXURE-C		
	ANNEXURE-D		
	TABLE	-	1

TECHNICAL SPECIFICATION FOR INSTALLATION OF BORED CAST-IN-SITU PILES

1.00.00 SCOPE

This specification covers the installation of bored cast-in-situ reinforced concrete vertical piles of specified load carrying capacity and diameter for various structures. This specification also covers carrying out initial and routine load tests on piles to assess their vertical, horizontal and pull out load carrying capacities.

2.00.00 GENERAL REQUIREMENT

2.01.00 This specification along with specific requirements under Annexure-A covers the technical requirements for piling work.

2.02.00 The work shall include supplying and providing necessary materials, mobilization of all necessary equipments (Annexure-B), providing necessary engineering supervision through qualified and technical personnel, skilled and unskilled labour, etc. as required to carryout the complete piling work, and submission of records as per schedule.

2.03.00 The Contractor shall carryout all works as mentioned in Scope above. All works shall be executed to the satisfaction of the Engineer.

2.04.00 Pile capacities in vertical compression, horizontal, pullout loads for various pile diameters are given in Annexure-A.

2.05.00 The Contractor shall confirm and guarantee the "Safe Load" capacities by conducting both initial and working load test on piles as mentioned in the specific requirements.

2.06.00 The Contractor shall submit along with tender documents his tender design of piles based on soil data furnished by the Owner along with this specification. The ultimate load capacity of a pile may be estimated using suitable static formula and the minimum factor of safety shall be 2.5. However, safe load carrying capacity shall be conformed and guaranteed by conducting initial and routine load tests.

2.07.00 In case of initial or routine load test piles, if the Contractor fails to establish the safe load capacity as per his design, the Owner has the right to either derate the pile capacity on prorata basis or insist the Contractor to modify the pile design, to achieve the desired safe load capacity at no extra cost to the Owner.

2.08.00 Derating is acceptable up to 90 percent. In such case, additional piles shall be installed as per the design requirements.

2.09.00 The Owner shall decide whether to derate or modify the design based on the design considerations such as providing additional piles in the designed pile cap, provision for extending the pile cap size, etc.

2.10.00 In case the Owner decides to modify the design instead of derating the pile, the contractor shall carry out the same and install separate test piles and test the same to guarantee the safe load at no extra cost to the Owner. However no extra shall be charged for the additional test piles as well as testing of these piles as per agreed contract conditions.

2.11.00 In case of working piles, if the pile does not meet the guaranteed capacity or rejected due to any other reason, the Contractor shall install extra piles at no extra cost to the Owner. 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 Contractor.

- 2.12.00 It is essential that all equipment and instruments are properly calibrated both at commencement and immediately after the completion of tests so that they represent true values. Certificates to this effect from an approved institution shall be furnished to the Engineer. If the Engineer so desires the Contractor shall arrange for having the instruments tested at an approved laboratory at no extra cost to the Owner and the test report shall be submitted to the Engineer. If the Engineer desires to witness such tests Contractor shall arrange to conduct the test in his presence.
- 2.13.00 The Contractor shall make his own arrangements for locating the coordinates and position of piles as per drawings supplied to him and for determining the Reduced Levels (RL) of these locations with respect to the benchmark indicated by the Engineer. 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 so that the work can be carried out accurately according to specifications and drawings.
- 2.14.00 The contractor shall assure the quality of piling work including cleaning of pile bore, quality of concrete, integrity of piles, etc.
- 2.15.00 **AVAILABLE SUB-SOIL DATA**
An abstract of the sub soil data is furnished in the tender document. However, the detailed soil investigation report shall be made available for reference of the bidder, if so required, at the office of the Owner. The soil data furnished is in good faith and only for the guidance of the Bidder, to arrive at design parameters and construction methods.

3.00.00 MATERIALS

3.01.00 General

All materials viz cement, steel, aggregates, water, etc. which are to be used for pile construction shall conform to relevant IS codes for properties, storage and handling of common building materials. However, aggregates more than 20 mm size shall not be used.

3.02.00 CONCRETE

Concrete shall be manufactured either by central batching plant or Ready Mix concrete. However, for initial test piles suitable method as approved by the Engineer may be used. Concrete shall conform to IS: 10262 & IS: 456.

- 3.02.01 Technical Specification for Cement Concrete (Plain and Reinforced) works along with IS: 2911 Part I/Sec 2 shall be followed for concrete works of piles. Use of plasticiser to control the water cement ratio shall be permitted on specific approval from the Engineer. Water cement ratio shall not be greater than 0.5.

- 3.02.02 Grade and minimum cement content

Minimum grade of concrete shall be as per Annexure-A conforming to IS: 456. Minimum cement content of 400 Kg/M³ of concrete shall be used for M-20 grade concrete.

- 3.02.03 Slump of concrete
The slump of concrete shall vary between 150 to 180 mm.

3.03.00 REINFORCEMENT

- 3.03.01 Longitudinal reinforcement in pile shall be high strength deformed steel bars conforming to IS: 1786 unless specified otherwise. Lateral reinforcement in pile shall be of mild steel conforming to IS: 432 Part-1 or HYSD bars as per IS: 1786.
- 3.03.02 The longitudinal reinforcement shall be provided considering the combination of vertical (compression and tension) and horizontal loads. However, the minimum longitudinal reinforcement shall be 0.4 percent of the sectional area calculated on the basis of nominal pile diameter. Minimum six numbers of bars shall be provided for longitudinal reinforcement. The diameter of longitudinal reinforcement bars shall not be less than 12mm. The stipulated minimum reinforcement shall be provided for the full length of pile.
- 3.03.03 The longitudinal reinforcement shall project 50 times its diameter above cut off level unless otherwise indicated.
- 3.03.04 The laterals shall be tied to the longitudinal reinforcement to maintain its shape and spacing. The laterals may in the form of links or spirals. The minimum diameter of the links or spirals shall be 6 mm and the spacing of the links or spiral shall not be less than 150 mm and in no case more than 250 mm.
- 3.03.05 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.
- 3.03.06 The minimum clear distance between the two adjacent main reinforcement bars shall normally be 100 mm for the full depth of cage.
- 3.03.07 The laps in the reinforcement shall be such that the full strength of the bar is effective across the joint and the reinforcement cage is of sound construction.
- 3.03.08 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).
- 3.03.09 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.
- 3.03.10 Minimum clear cover to the longitudinal reinforcement shall be 50 mm, unless otherwise mentioned.
- 3.03.11 Bundling of bars is not permitted.

4.00.00 PILE INSTALLATION

Installation of piles shall be carried out as per pile layout drawings, installation criteria, and the direction of the Engineer.

4.01.00 Equipment and Accessories

- 4.01.01 The equipment and 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.
- 4.01.02 List and details of equipment and accessories proposed to be used for the job shall be submitted along with the bid.
- 4.01.03 The capacity of the rig shall be adequate so as to reach the specified founding level.
- 4.01.04 Provision shall be kept for chiselling within the pilebore, as specified elsewhere in this specification. Chiselling shall be carried out only with the approval of Engineer.

4.02.00 Installation Criteria

- 4.02.01 For determining the founding level of piles in soil as specified elsewhere, the Contractor shall have to perform Standard penetration test (SPT) as per IS: 2131 in a separate bore hole. The SPT shall be conducted at 1.0 m interval between the depths covering 5 metres each above and below the specified founding level. The bore shall be 100 mm diameter and method of boring shall conform to IS: 1892.
- 4.02.02 For determining founding level of piles in rock, as specified elsewhere socketing horizon shall be established by the Contractor by collecting rock cores of Nx size in a separate borehole, and testing the same for uniaxial compressive strength (UCS). Cores shall be collected by double tube core barrel attached with diamond bit. Coring shall be done upto a depth as indicated in the "specific requirements." Coring in rock shall conform to IS: 6926.
- 4.02.03 In case it is not possible to test the cores so obtained for uniaxial compressive strength, cores shall be tested for point load strength index and correlated to obtain uniaxial compressive strength.
- 4.02.04 Number of boreholes for carrying out SPT in soil or uniaxial compressive strength in rock, shall vary from one in 100 to 150 piles or pile group of 150 Sqm depending on the site condition and as decided by the Engineer. However, at the location of initial load test piles, one such borehole shall be done.
- 4.02.05 A protocol between contractor and BHEL site shall be maintained regarding the strata at founding level. SPT value and UCS from the nearest borehole shall be indicated therein.
- 4.02.06 The founding level of the pile shall be decided based on the criteria elaborated in the specific requirements under Annexure-A. Concreting shall not be done until the above conditions for founding level are satisfied.
- 4.02.07 Approval of founding level by the Engineer shall in no way absolve the Contractor of his responsibility to guarantee the Safe load capacity of the piles as indicated in this document.

4.03.00 Control of position and alignment

- 4.03.01 Piles shall be installed as accurately vertical as possible. The permissible limits for deviation with respect to position and (inclination) alignment shall conform to IS: 2911 Part I/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/4 whichever is less (75mm or D/10 whichever is more in case of piles having diameter more than 750mm) from their designed position at the working level.

4.04.00 Boring

- 4.04.01 Boring operations shall be done by rotary or percussion type drilling rigs using reverse mud circulation (RMC) method. Rotary hydraulic pulley shall be preferred.
- 4.04.02 The Contractor shall satisfy himself about the suitability of the method to be adopted for site. If DMC (direct mud circulation) 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 mobilisation, 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 at no extra cost to the Owner.
- 4.04.03 Working level shall be above the cut off level. After the initial boring of about 1.0m a temporary guide casing of suitable length shall be lowered in the pile bore. The diameter of guide casing shall be of such diameter, so as to give the necessary finished diameter of the concrete pile. The centre line of guide casing shall be checked before continuing further boring. Guide casing shall be minimum of 1.0m length. Additional length of casing may be used depending on the condition of the strata, ground water level etc.
- 4.04.04 Use of drilling mud (bentonite slurry) for stabilizing the sides of the pile bore is necessary wherever subsoil is likely to collapse in the pile bore. Drilling mud to be used shall meet the requirement as given in Annexure-C.
- 4.04.05 The bentonite slurry and the cuttings, which are carried to the surface by the rising flow of the slurry, shall pass through settling tanks of adequate size to remove the sand and spoils from the slurry before the slurry is recirculated to the boring. The bentonite slurry mixing and recirculation plant shall be suitably designed and installed.
- 4.04.06 The bentonite slurry shall be maintained at 1.5m above the ground water level during boring operations and till the pile is concreted. When DMC or RMC method is used the bentonite slurry shall be under constant circulation till start of concreting.
- 4.04.07 The size of cutting tools shall not be less than the diameter of the pile by more than 75mm. However, the pile bore shall be of the specified size.

4.05.00 Chiselling

- 4.05.01 Chiselling may be resorted to with the permission of the Engineer below the socketing horizon. The chiselling tool or bit shall be of adequate size and weight so as to reach the desired depth.

4.06.00 Cleaning of Pile bore

- 4.06.01 On completion of the pile bore upto the required depth, the bottom of the hole shall be cleaned very carefully before concreting work is taken up. Cleaning shall ensure that the pile bore is completely

free from sludge/bored materials, debris of rock/boulder etc. Necessary checks shall be made as given in clause 5.0 to confirm the thorough cleaning of the pile bore.

4.06.02 Pile bore shall be cleaned by fresh drilling mud through tremie pipe after placing reinforcement and just before start of concreting.

4.06.03 Pile bore spoil along with used drilling mud shall be disposed off from site as directed by the Engineer.

4.06.04 Pile bore bottom shall be thoroughly cleaned to make it free from sludge or any foreign matter before and after placing the reinforcement cage.

4.07.00 Adjacent Structures

4.07.01 When working near existing structures care shall be taken to avoid any damage to such structures.

4.08.00 Concreting

4.08.01 The Contractor shall carry out concrete mix design in accordance with IS: 10262 and submit mix design calculations and get them approved from the Engineer well in advance for installation of piles. Adequate number of tests on cubes, etc. shall be carried out as mentioned in clause 5.0 to ensure concrete of the minimum specified strength in accordance with IS: 456 at requisite workability (slump).

4.08.02 Concreting shall not be done until the Engineer is satisfied that the bearing strata (soil/rock) met with at the termination level of pile.

4.08.03 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.

4.08.04 Proper placement of the reinforcement cage to its full length shall be ensured before concreting.

4.08.05 Concreting shall be done by tremie method as specified by IS: 2911 (Part I /Sec.2). The level of drilling mud shall be maintained sufficiently above the ground water level.

4.08.06 The concreting operations shall not be taken up when the specific gravity of bottom slurry is more than 1.2 and sand content more than 7%. The drilling mud sample shall be collected from the bottom of pilebore as mentioned in clause 5.

4.08.07 Consistency of the drilling mud suspension shall be controlled throughout the 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.

4.08.08 It shall be ensured that volume of concrete poured is at least equal to the theoretically computed volume of pile shaft being cast.

4.08.09 The temporary guide casing shall be withdrawn cautiously, after concreting is done upto the required level. While withdrawing the casing concrete shall not be disturbed.

4.09.00 Cut off level (COL)

- 4.09.01 Cut off level of piles shall be as indicated in drawings released for construction or as indicated by the Engineer.
- 4.09.02 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.
- 4.09.03 When the pile cut off level is less than 1.0 metre below the working level, concrete shall be cast to the piling platform level to permit overflow of concrete for visual inspection. In case COL of pile is more than 1.0 metre below working level then concrete shall be cast to a minimum of one metre above COL.

4.10.00 Sequence of Piling

- 4.10.01 Each pile shall be identified with a reference number.
- 4.10.02 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.

4.11.00 Building up of Piles

- 4.11.01 If any pile, already cast as per construction drawing, requires any extra casting due to any change in cut off level or the cast pile top level is less than the specified level or for any other reason, then the pile shall be built-up by using atleast one grade higher concrete than that used for concreting of the same pile, ensuring proper continuity with the existing concrete and to the satisfaction of the Engineer. Necessary reinforcement as per design requirement and suitable shuttering shall be provided before casting the concrete. Surrounding soil shall also be built up to the required level by proper compaction to ensure lateral capacity of the pile.

4.12.00 Breaking off of Piles

- 4.12.01 If any pile already cast, requires breaking due to lowering in cut off level or for any other reason, then the same shall be carried out, not before seven days of casting without affecting the quality of existing pile such as loosening, cracking etc. and to the satisfaction of the Engineer.

4.13.00 Preparation of Pile head

- 4.13.01 The soil surrounding the piles shall be excavated upto the bottom of the lean concrete below the pile cap, with provision for working space, sufficient enough to place shuttering, reinforcement, concreting and any other related operations.
- 4.13.02 The exposed part of concrete above the COL shall be removed/chipped off and made to a uniform level at COL, but not before seven days of casting of pile.
- 4.13.03 The projected reinforcement above COL shall be properly cleaned and bent to the required shape and level to be anchored into the pile cap.
- 4.13.04 The pile top shall be embedded into the pile cap by 50mm or clear cover to reinforcement, whichever is higher.
- 4.13.05 All loose material, like debris due to chipping/breaking of pile head to the desired level, shall be removed and disposed off as directed by the Engineer.

4.14.00 Rejection and Replacement of Defective Piles

- 4.14.01 The Engineer 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, 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, at no extra cost to the Owner.

4.15.00 Recording of Piling Data

- 4.15.01 The Contractor shall record all the information during installation of piles. Typical data sheet for recording pile data shall be as shown in Appendix D of IS: 2911 Part I/Sec.2. The pile data shall also include all the details as in Annexure-D. On completion of each pile installation, pile record in triplicate shall be submitted to Engineer within two days of completion of concreting of the pile.

5.00.00 SAMPLING, TESTING AND QUALITY ASSURANCE

- 5.01.00 Facilities required for sampling and testing of materials, concrete, etc. in field and in laboratory should 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 tests shall be carried out as per the prevalent accepted engineering practice and as per the directions of the Engineer. Tests shall be done in the presence 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.

- 5.02.00 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.

- 5.03.00 Materials found unsuitable for acceptance shall be removed and replaced by the Contractor. The work done by this unsuitable material shall be redone as per specification requirements & and to the satisfaction of the Engineer at no extra cost to the Owner.

5.04.00 Quality Assurance Programme

- a) The Contractor shall submit and finalize a detailed Field Quality Assurance Programme within 30 days from the date of award of the 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 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.
- b) 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. 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 meet all the specified requirements before acceptance at manufacturers premises or at independent government approved laboratory. Tests indicated in the table are for cross checking at site the conformity of the materials to some of the specifications.

5.05.00 Testing of Concrete

- 5.05.01 Concrete and other materials shall be tested for quality, strength and other properties. Details of testing shall be as specified under technical specification for Cement concrete (Plain and Reinforced).
- 5.05.02 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.
- 5.05.03 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 three test cubes for every 10 piles shall be tested for the 7-days & 28-days cube strength.
- 5.05.04 In preparation of test cubes or specimens vibrators shall not be used.
- 5.05.05 Concrete shall be tested for slump at every 1-hour interval during concreting of piles.
- 5.05.06 The frequency of sampling and testing of concrete and materials shall be done as per technical specification for cement concrete (Plain & Reinforced).
- 5.05.07 The acceptance criteria shall be as mentioned in Table-1.

5.06.00 Testing for position and alignment

- 5.06.01 Each pile shall be checked for its position with respect to specified location. Each pile bore shall be checked for its alignment.
- 5.06.02 Permissible limits for deviation shall be as specified under clause no. 4.03.

5.07.00 Properties of Drilling mud

- 5.07.01 Properties of drilling mud shall be checked as per requirement under Annexure C. Prior to the commencement of piling work and thereafter minimum once in a week or as found necessary by the Engineer, one sample consisting of 3 specimens shall be tested. Acceptance criteria applicable are as specified else where with 5% variation. This relaxation is not applicable for properties of drilling mud before concreting.
- 5.07.02 Density of the drilling mud shall be checked in each pile before concreting.

5.08.00 Check for Pile bore

- 5.08.01 On completion of boring and cleaning the bottom of each pilebore shall be checked from the sample collected from near the bottom of pile bore or by any other methods as approved by the Engineer, to ensure that it is free from pilebore spoil/debris and any other loose material, before concreting. Concreting shall be done only after the approval of the Engineer.
- 5.08.02 For sampling of drilling mud from the pilebore the following method or any other suitable method shall be adopted.
- a) A solid cone shall be lowered by a string to the bottom of pilebore. A sampler tube closed at top with a central hole (hollow cylinder) is lowered over the cone, and 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.

- b) Use of borehole camera for checking the pile bore spoil and strata is acceptable on approval of the Engineer.

5.09.00 Pile Integrity test

5.09.01 Low strain integrity test shall be conducted on 50% of the jobs piles and on all test piles or as directed by Engineer. The system shall have the computer readout facility and report on the findings of this shall be furnished to the Owner. This test shall be used to identify the job piles for routine load test.

Piles shall be trimmed to cut off level or sound concrete level. No pile cap blindage work should be undertaken prior to this test. The cast in-situ piles should not be tested before 14 days of casting.

5.09.02 The test shall be undertaken by persons trained and experienced and capable of interpreting the results with specific regard to piling. This test is limited to testing the integrity of the shaft and is not intended to replace the use of static load testing.

5.09.03 Low Strain Integrity Test Methodology:

- a) In this test, a low stress wave is set up in the pile shaft and is also known as Sonic Integrity or Sonic Echo test.
- b) A small metal/hard rubber hammer is used to produce a light blow on top of the pile. The shock wave travelling down the length of the pile is reflected back from the toe of the pile and recorded through a suitable transducer/ accelerometer in a computer for subsequent analysis.
- c) The primary shockwave, which travels down the length of the shaft, is reflected from the toe by the change in density between the concrete and sub strata. However, if the pile has any imperfections or discontinuities within its length these will set up secondary reflections, which will be added to the return signal.
- d) By analysis of the captured signal and knowledge of the conditions of the ground, age of concrete, etc. a picture of the locations of pile shaft defects can be built up. The observed signals are amplified into digital display as velocity versus length records providing information on structural integrity of piles.
- e) The stress wave velocity and approximate pile lengths are provided as input for the integrity testing. The stress wave velocity is dependent on the Young's Modulus and mass density of pile concrete.
- f) More than one recording of signals shall be done until repeatability of signals is achieved on the same pile.
- g) The tests shall be conducted at 3-6 locations to cover the entire cross section of the pile.

6.00.00 PILE TESTING

Pile load test shall be carried out as per IS:2911 Part-4 (latest edition) or as directed by Engineer.

6.01.00 INITIAL LOAD TEST

Initial load test shall be carried out on separately cast piles for confirmation of estimated pile capacities and to fix a more accurate driving criteria viz. set/bow, total number of blows and approximate depth etc. of founding level. At least 2 nos. of tests shall be conducted for each mode (vertical compression, pull out and lateral). The maximum test load shall be as mentioned in bill of quantities.

6.02.00 ROUTINE LOAD TEST

Routine load tests shall be carried out on job (working) piles for 0.5% of total no. of piles (for each mode and type). Maximum test load shall be 1.5 times the design safe load capacity. Piles showing unsatisfactory results as per load test results shall be treated as defective piles. Defective piles shall be removed or left in place and replaced by additional piles as directed by Engineer at no extra cost to the owner. Any additional cost towards design implications, if any, due to above shall be born by the contractor.

7.00.00 CODES AND STANDARDS

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 432 (Part 1 & 11)	-	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: 1200 - (Part 23)	Measurement of Building and Civil Engineering works Piling.	
IS: 1786 -	Code of practice for twisted steel high strength deformed bars for concrete reinforcement.	
IS: 1892 -	Code of practice for Subsurface Investigation for foundation.	
IS: 2131 -	Method of Standard Penetration Test for Soils	
IS: 2911 - Part I/Sec 2	Code of practice for design and construction of pile foundations - Bored cast-in-situ concrete piles.	
IS: 2911 - Part IV	Code of practice for design and construction of pile foundation - Load test on piles.	
IS: 6926 -	Code of practice for Diamond core Drilling for Site Investigation for River Valley Projects.	

IS: 10262 - Recommended guidelines for concrete mix design.

8.00.00 RATES AND MEASUREMENTS

The clauses below shall apply for item rate contracts only. They shall not be applicable to turnkey/lump sum Contracts.

8.01.00 Rates

- 8.01.01 The items of work in the schedule of items, describe the work in brief. The various items in schedule of items shall be read in conjunction with the corresponding sections in the Technical Specifications, including amendments, and additions, if any. For each item in schedule of items, the unit rate shall include for the activities covered in the description of the item as well as for all necessary operations described in the specification and specific requirements.
- 8.01.02 The unit rates shall include for minor details which are obviously and fairly intended, and which may not have been included in the description in these documents, but are essential for the satisfactory completion of the work. Unit rates shall also include for all safety measures as required by codal provisions, local regulations, acts, bye-laws, etc. and for execution of work to the satisfaction of the Engineer.
- 8.01.03 The quoted rate for each item shall be inclusive of mobilization of all plant, equipment, scaffolding, labour, materials, skilled and unskilled labour, and demobilization after completion of work, supervision, establishing the level and coordinates at each work.
- 8.01.04 The quoted rate for piling for a particular diameter and capacity of pile shall remain valid for the actual lengths provided /to be provided irrespective of the minimum length specified elsewhere in this specification.
- 8.01.05 The quoted rate for piling as per description of item works shall be inclusive of providing all plant equipment, labour, materials, skilled and unskilled labour, making observations, establishing the ground level and coordinates at each location of pile by carrying levels from one established bench mark and distances from one set of grid lines furnished by the owner.
- 8.01.06 The quoted rate for piling shall be inclusive of bailing out all the pile bore spoil from the pilebore, keeping the borehole free from bored material/debris etc. and disposing the bored/chiselled material along with the drilling mud upto 2 Km. beyond plant boundary or as directed by Engineer, flushing the pile bore by fresh bentonite before concreting, collection of samples from bottom of pilebore, transporting to laboratory, testing and reporting of results.
- 8.01.07 The quoted rate for piling shall include shifting of plant and equipment from one pile location to another pile locations, providing temporary casing pipe and removal of the same after completing, concreting, supply of necessary materials, equipment and manpower, cost of boring by approved method as specified, circulation of bentonite slurry and cleaning of borehole free from sludge, as specified, etc.
- 8.01.08 The quoted rate for piling shall also include chiselling, if any, required for socketing the pile in rock.
- 8.01.09 The quoted rate for the piling shall include concreting by termite method, length of pile above COL, withdrawal of guide casing, cost for preparation of pile head and disposal of debris etc.,

resulting from breaking off of pile upto COL, upto a distance of 2 Km from the plant boundary or as directed by Engineer.

- 8.01.10 The quoted rate for piling shall also include providing reinforcement and its cleaning, straightening, cutting, bending, binding with annealed wire, welding, tackwelding, providing concrete cover blocks, spacers, placing the reinforcement cage in pile casing/bore and other cost of tools and plants, materials, labours, carting the steel from store to piling site and return of unused steel to the Owners storage point, etc.
- 8.02.11 Plasticiser/Admixture when used as directed by the Engineer shall be included in piling rates.
- 8.01.12 The quoted rate for piling shall include for all quality assurance requirements, but not limited to providing for technical inspection, transportation of samples to laboratory, testing samples, maintaining and submitting all test records, etc.
- 8.01.13 The quoted rate for boring in separate borehole shall be inclusive of performing of SPT at regular intervals as specified and collecting rock cores from boreholes, upto the depth as specified shall be inclusive of transporting to laboratory, testing and reporting of the results.
- 8.01.14 Unit rate for low integrity test shall be inclusive of mobilization of the entire set of equipment, computer readout, printer, and equipment which may not have been included in the description but are essential for the satisfactory completion of the work as per internationally accepted practice. The rate quoted shall be inclusive of repeatability of test, preparation of pile top surface etc.
- 8.02.00 Measurement**
- 8.02.01 Piling length shall be measurement by linear measurement from pile cut-off level to the tip of pile in meters upto second place of decimal separately for each diameter and capacity of pile. The length of pile to be cast above cut off level, as per specification, and as approved by Engineer, shall be considered for cement reconciliation only. Theoretical diameter of piles shall be considered for reconciliation of cement consumption. No extra payment shall be made for the length from existing ground to cut-off level.
- 8.02.02 Reinforcement steel shall be measured for reconciliation purpose only and the measurement shall be done for providing and placing reinforcement in piles, by weight in tones, up to third place of decimal in the following manner:
- i) The weight shall be arrived at by multiplying the actual length measured alongwith standard hooks, rings or spirals, spacers, cranks, bends, authorized laps, etc. by sectional weight. These shall be submitted with supporting documents giving the schedule of bars with sketches. The sectional weight to be adopted shall be IS code's sectional weight. Nothing extra shall be payable to the contractor on account of difference in weight, if any, due to different methods adopted for issue and measurement.
 - ii) Standard hooks, cranks, bend, authorized laps, supports, hangers and chairs which are covered in approved bar bending schedule shall be measured in tones.
 - iii) Dowels, neither shown on the drawings nor instructed by the Engineer, but required for construction facilities shall not be measured.
- 8.02.03 Breaking off of piles, due to subsequent change in design cut off level, shall be measured separately. This shall be measured in cubic metres upto second place of decimal. This will be payable only when the pile is cast and on the basis of written instruction of the Engineer for lowering of COL.

- 8.02.04 Measurements for the item of boring in a separate borehole shall be measured in metres from ground level upto the depth as specified, upto second place of decimal. Item of work of boring in soil and coring in rock shall be measured separately for the actual length of boring in soil and coring in rock.
- 8.02.05 The item for pile integrity test shall be measured in terms of no. of piles tested.

ANNEXURE-A

Specific Requirements for Bored Cast-in-situ RCC Piles

- A1.0 Minimum cement concrete grade M-25
- Minimum cement content 400 Kg/M³

- A1.1 Safe load

Diameter of Pile

Diameter of Pile (mm)	Vertical/ Compression (MT)	Horizontal/ Lateral (MX)	Pull out/Tension (MT)
*	*	*	*
*	*	*	*

- A2. Installation criteria

The installed pile(s) shall satisfy the following criteria.

- A2.1 In Soil/weathered Rock

- a) Minimum length of the pile shall be _____ * m below COL.
- b) The pile shall be terminated after penetrating through the strata having SPT penetration less than ____ * cm for ____ * blows, for a minimum length of _____ * times the diameter of the pile.

- A2.2 In Rock

- a) Piles shall be installed and socketed into the rocks for a length (socketing length) equal to _____ * times the pile diameter subject to a minimum of _____ * meter below the socketing horizon.
- b) Socketing horizon shall consist of rock strata having minimum uniaxial compressive strength of _____ * kg/sq.cm.

- A3. Average cut-off level for tender design and initial load test can be assumed as _____ * m below ground level.

- A4. A protocol shall be signed between BHEL site and contractor regarding,

Strata at the founding depth

Installation criteria

Socketing depth

Density of bentonite before concreting

Slump of concrete.

Time interval between end of boring and start of concreting,

* Values shall be indicated separately depending upon subsoil strata of the site.

ANNEXURE-B

List of Equipments

SI.No	Description	Capacity No.
1.	Piling Rigs	
2.	Chisel	3 T min 6 T max
3.	High pressure Mud Pumps	10 HP min 25 HP max
4.	Bentonite mixing plants	
5.	Concrete batching plant	
6.	Soil testing equipments	

Note:

1. The no. and capacity of the piling equipment varies for each work.
2. Additional equipments shall be mobilized if required as per the directions of the Engineer to match the work schedule at no extra cost to the Owner.

ANNEXURE-C

Bentonite suspension used for piling work shall satisfy the following requirements

- 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 installed. However, the density of bentonite suspension after mixing with deleterious materials in the pilebore may be upto 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.

ANNEXURE-D
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:
 - i) Freshly supplied mud
 - Liquid limit -
 - Sand content -
 - Density -
 - Marsh viscosity -
 - Swelling index -
 - pH value -
 - ii) 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).

* Standard penetration Test

** Unconfined compression strength

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
No. _____
Dia. _____
Depth _____

Stirrups: Type
No. _____
Dia. _____
Spacing _____

23. Any other information regarding obstructions, delay and other interruption to the sequence of work.

TABLE -1
FREQUENCY OF SAMPLING AND TESTING

Sl. No	Type of material work	Nature of Test/ characteristics	Method of Test & frequency	No. of test	Acceptance Criteria
1.	Pilebore size a) diameter b) length		Physical measurement	each pile	as per specification
2.	Founding level	to establish socketing horizon/ and or founding level & upto depth 5m below founding level.	in separate borehole meant for the purpose a) SPT in soils/ weathered rock b) Core & UCS value of rock	1 borehole for 100-150 piles or group of 150 Sqm	Annexure - B
3.	Bentonite (Mud) properties. a) Basic properties of bentonite before use. b) Contaminated mud from pile bore bottom before concreting	Liquid Limit, Marsh Viscosity, Specific gravity, sand content, swelling index, pH value. Density, sand content	in lab in lab	As per Cl. 5.7 Each Pile	As per Annexure C As per annexure C
4.	Position and Alignment	-	Physical or any Approved method	Each Pile	As per Cl. 4.3
5.	Cleaning of pilebore	-	As per Cl. 5.8	Each Pile	Pilebore be free from bored material cuttings/ debris/sludge
6.	Reinforcement (R/F) Spacing of longitudinal R/F cover laps binding of laterals		Physical inspection and measurement	each cage	As per approved design
7.	Concrete a) Workability b) Cubes	Slump cone test Compressive Strength test	Each pile As per spec.	As per Cl. 5.5 As per Cl. 5.5	As per specification. As per IS: 456
8.	Materials like aggregate, sand etc.	As per technical specification for concrete and relevant IS codes			
9.	Pile head		Physical	each pile	

SECTION - D

SUB-SECTION – D22

SITE LEVELLING AND GRADING

C O N T E N T

CLAUSE NO. DESCRIPTION

1.00.00	GENERAL
2.00.00	SCOPE
3.00.00	MATERIALS
4.00.00	QUALITY CONTROL
5.00.00	EXECUTION
6.00.00	RATES AND MEASUREMENTS

STANDARD TECHNICAL SPECIFICATION

FOR

SITE LEVELLING AND GRADING

1.00 GENERAL

This specification cover the works to be carried out for “**Site Levelling and Grading Works including Slope Protection**” etc for the entire plant and associated areas. The specified formation level(s) shall be achieved either by excavation or by raising with controlled fill with excavated/borrowed earth as the case may be.

2.00 SCOPE

2.01 The scope include all works involved in levelling the site to the lines, grades, cross sections and dimensions as shown on the approved drawings and/or as directed by the engineer including site clearance, setting out, earth work in excavation, stacking, loading, transportation, unloading, dewatering, drainage, filling, watering, compaction, turfing on slopes (if required), lighting, disposal of residual/surplus earth etc. It also include supplying and providing all labour, materials, supervision, services, equipments, tools and plants, testing and all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work etc.

2.02 All tools and plants, equipments and machineries to be used in this work shall be of standard quality and manufactured by reputed concerns conforming to Indian Standard (IS) codes or equivalent thereof.

2.03 Work to be provided by the Contractor

The works to be provided by the contractor unless specified otherwise shall include but not be limited to the following.

- a) Supplying and providing all labour, supervision, services including as required under statutory labour regulations, materials, equipments, tools and plants, approaches, transportation etc required for the completion of the work.

b) Preparation and submission of detailed scheme of all operations required for executing the work (material handling, placement, services, approaches etc) to the engineer for approval.

c) Carrying out sampling and testing on fill materials/fills to assess the quality/moisture content/degree of compaction and submission of the test results whenever required by the engineer.

d) Design, construction and maintenance of Magazine of proper capacity for storage of explosives for blasting work and removal of the same after completion of the work etc.

2.04 Work to be provided by others

No work under this specification will be provided for by any agency other than the contractor unless specifically mentioned elsewhere in the contract.

2.05 Codes and Standards

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) codes unless specified otherwise.

IS: 1200	Methods of measurement of building and civil engineering works, Part-1: Earthwork
IS: 2720	Method of test for soils (Relevant parts)
IS: 3764	Excavation work- Code of safety
IS: 4081	Safety code for blasting and related drilling operations
IS: 4701	Code of practice for earthwork on canals
IS: 6922	Criteria for safety and design of structures subject to underground blasts

In case of conflict between this specification and those (IS codes) referred to herein, the former shall prevail. In case any particular aspect of work is not covered specifically by the specification or/and by the IS codes, any other standard practice as may be specified by the engineer shall be followed.

2.06 Conformity with Designs

The contractor shall carry out the work as per the approved drawings, specification and as directed by the engineer.

3.00 MATERIALS

All materials required for the work shall be of best variety and approved by the engineer.

3.01 Materials for Excavation

For the purpose of identifying the various strata met during the course of excavation, the following classification is to be followed.

a) Soil

It include all type of soil including laterite, moorum etc with/without any percentage of kankars which can be excavated by normal means such as shovel, pick axe, crow bar, spade etc and those which do not fall under **clause 3.01 (b) and (c)** etc.

b) Soft Rock

It include the rocks (including weathered rock) which are removable by splitting with the help of crow bar, pick axe, wedges, pavement breakers, pneumatic tools, hammers or such implements etc and not requiring blasting (for excavation) in the opinion of the engineer.

c) Hard Rock

It includes the rocks, which require blasting for excavation in the opinion of the engineer. Where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other method as approved by the engineer. The mere fact that the contractor resorts to blasting shall not classify the soft rock under hard rock.

However, the engineer's decision on the type of strata encountered during excavation shall be the final and binding on the contractor.

3.02 Materials for Filling

Any coarse grained or fine grained low plastic soil free from vegetation, roots, shingle, salts, organic matters, sod and any other harmful chemicals shall be used for filling. The contractor shall test the fill material to establish its suitability and submit the results to the engineer for approval. Fill material shall be got approved by the engineer. The following type of materials shall not be used for filling.

- a) Materials from swamps, marshes and bogs
- b) Expansive clays
- c) Peat, logs, sod and perishable materials
- d) Materials susceptible to combustion

e) Any material or industrial and domestic produce which will adversely affect other materials of work

f) Materials from prohibited areas

The earth available by cutting the high grounds within the project site and the materials (if) available from the road excavation or any other excavation under the same contract shall be used for filling depending upon its suitability as fill material. Filling with excavated rock (in the project site) shall be done only with the written permission of the engineer in the following manner. The boulders shall be broken into pieces not exceeding 150mm size in any direction and mixed with fine materials consisting of decomposed rock, moorum or any approved earth to fill the voids as far as possible and the mixture shall then be used for filling. In case the earth required for filling is over and above the earth available from the compulsory excavations within the project area, then borrow areas for obtaining suitable fill material shall be arranged by the contractor himself from outside the plant boundary limits and all expenses including royalties, taxes, duties etc shall be borne by him. He shall obtain and submit the necessary clearances/permissions from the concerned authorities to the engineer for the borrow areas/materials acquired.

4.00 QUALITY CONTROL

All works shall conform to the lines, levels, grades, cross sections and dimensions shown on the approved drawings and/or as directed by the engineer. The contractor shall establish and maintain quality control for the various aspects of the work, method of construction, materials and equipments used etc. The quality control operation shall include but not be limited to the following.

Sl. No.	Activity	Check
1	Lines, levels & grades	a) By periodic surveys b) By establishing markers, boards etc
2	Filling	(a) On quality of fill material (b) On moisture content of fill material (c) On degree of compaction achieved

5.00 EXECUTION

The contractor shall prepare and submit the detailed drawings/schemes for excavation and filling works as proposed to be executed by him showing the dimensions as per the construction drawings and specification adding his proposal of approaches, dewatering (if any), drainage and compaction etc within 15 days of award of the contract to the engineer for approval.

5.01 Site Clearance

Before the commencement of earthwork, the entire area of cutting and filling shall be cleared of all trees, stumps, bushes, grasses, vegetation etc with their roots, fences, logs, rubbish, water, slush etc. It is not necessary to remove all the soil containing fine hair like roots but only the rather heavy mats are to be removed. Cutting of trees shall include trees having girth of any size and removing roots upto a depth of 600mm below the existing ground level or 300mm below the formation level whichever is deeper. After the removal of roots of trees, the pot holes formed shall be filled with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the engineer. The trees shall be cut in to suitable pieces as instructed by the engineer. Before earthwork is started, all the spoils, unserviceable materials and rubbish shall be burnt or removed and disposed off to the approved disposal area(s) as specified by the engineer. Useful materials, saleable timbers, fire woods etc shall be the property of owner and shall be stacked properly at the worksite in a manner as directed by the engineer.

5.02 Setting Out

On receiving the approval from the engineer with modifications and corrections if any, the contractor shall set out the work from the control points furnished by the engineer and fix permanent points and markers for the ease of periodic checking as the work proceeds. These permanent points and markers shall be fixed at the interval as prescribed by the engineer and shall be got checked and certified by the engineer after whom the contractor shall proceed with the work. It should be noted that this checking by the engineer prior to the start of the work will in no way relieve the contractor of his responsibility of carrying out the work to true lines, levels and grades as per the drawings and specification. If any errors are noticed in the contractor's work at any stage, the contractor at his own risk and cost shall rectify the same. The contractor shall take spot levels of the area (with respect to the bench mark/ available source as provided by the engineer) to be excavated or to be filled at an interval of not more than 10m or as directed by the engineer before starting any earth work and shall be submitted to the engineer for prior approval.

5.03 Excavation

Levelling by excavation shall be carried out where the existing ground levels are higher than the specified formation level. Excavation shall include removal of all materials whatever nature as may be and whether wet or dry shall be carried out exactly in accordance with the line, levels, grades and curves shown on the approved drawings and/or as directed by the engineer. All excavations shall be done to the minimum dimensions as required. The contractor shall obtain prior approval of the engineer for the method he proposes to adopt for excavation in different types of strata including dimensions, side slopes and dewatering if any, stacking or disposal etc. This approval however shall not in any way make the engineer responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. The work shall be carried out in a workmanlike manner without endangering the safety of nearby structures/services or works and without causing hindrance to any other activities in the area. **Prior to starting the excavation, the ground level at the location shall be checked jointly with the engineer.**

The rough excavation may be carried up to a maximum depth of 150mm above the final formation level. The balance shall be excavated with special care and the final surface shall be compacted by rolling with 6 passes of 8 to 10 tonne roller. If directed by the engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the engineer. The contractor shall be paid for the extra excavation and filling at the appropriate items of work.

If the excavation is done to a depth greater than that shown on the drawing or as directed by the engineer due to the contractor's fault, the excess depth shall be filled up to the required level with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the engineer at the own risk and cost of the contractor.

Suitable slope in cutting as per the requirements and as directed by the engineer shall be adopted to withhold the face of earth. The contractor shall be held responsible for any damage to any part of the work caused by the collapse of the side of excavations.

5.03.01 Excavation in Hard Rock

Excavation in hard rock shall normally be done with blasting. In case where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other approved method as directed by the engineer. Personnel deployed for rock excavation shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces.

5.03.02 Blasting

a) General

Storage, handing and use of explosives shall be governed by the current explosive rules/regulations laid down by the Central and the State Governments. The contractor shall ensure that these rules/regulations are strictly adhere to. The following instructions are also to be strictly followed and the instructions wherever found in variance with the above said rules/regulations, the former (instructions) shall be superseded with the later (above said rules/regulations).

No child under the age of 16 and no person who is in a state of intoxication shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives. The contractor shall obtain licence from the District Authorities for undertaking the blasting work as well as for obtaining and storing the explosives as per Explosives Rules, 1940 corrected upto date. The contractor shall purchase the explosives, fuses, detonators etc only from a licensed dealer and shall be responsible for the safe custody and proper accounting of the explosive materials. The engineer or his authorized representative shall have the access to check the contractor's store of explosives and his accounts at any time. It is the full responsibility of the contractor to transport the explosives as and when required for the work in a safe manner to the work spot.

Further, the engineer may issue modifications, alterations and new instructions to the contractor from time to time. The contractor shall comply with the same without these being made a cause for any extra claim.

b) Materials

All materials such as explosives, detonators, fuses, tamping materials etc proposed to be used in the blasting operation shall have the prior approval of the engineer. Only explosives of approved make and strength are to be used. The fuses known as instantaneous fuse must not be used. The issue of fuse with only one protective coat is prohibited. The fuse shall be sufficiently water resistant as to be unaffected when immersed in water for 30 minutes. The rate of burning of the fuse shall be uniform and shall be not less than 4 seconds per inch of length with 10% tolerance on either side. Before use, the fuse shall be inspected. Moist, damaged or broken ones shall be discarded. When the fuses are in stock for long, the rate of burning of fuses shall be tested before use. The detonators shall be capable of giving an effective blasting of the explosives. Moist and damaged detonators shall be discarded.

c) Storage of Explosives

The current Explosive Rules shall govern the storage of explosives. Explosives shall be stored in a clean, dry and well-ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400m of the actual work site or any source of fire. The space surrounding the magazine shall be fenced and the ground inside shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be through a single gate only and no person shall be allowed without the permission of the officer-in-charge. The clear space between the fence and the magazine shall not be less than 90m. The magazine

shall be well drained. Two lightning conductors, one at each end shall be provided to the magazine. The lightning conductors shall be tested once in every year.

Explosives, fuses and detonators shall each be separately stored. Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides. Special care shall be taken to keep the floor free from any grains of explosives. Cases containing explosives shall not be opened inside the magazine and the explosives in open cases shall not be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine but must be removed without delay to a safe distance and be destroyed.

Artificial light, matches, inflammable materials, oily cotton, rag waste and articles liable to spontaneous ignition shall not be allowed inside the magazine. Illumination shall be obtained from an electric storage battery lantern. No smoking shall be allowed within 100m distance from any magazine.

Magazine shoes without nails shall be used while entering the magazine. The persons entering the magazine must put on the magazine shoes which shall be provided at the magazine for this purpose and should be careful

- * not to put their feet on the clean floor unless the magazine shoes on.

- * not to touch the magazine shoes on ground outside the clean floor.

- * not to allow any dirt or grit to fall on the clean floor.

Persons with bare feet shall dip their feet in water before entering the magazine and then step directly from the tub to the clean floor. No person having article of steel or iron with/on him shall be allowed to enter the magazine. Workmen shall be examined before entering the magazine to check none of the prohibited articles are with them. A brush broom shall be kept in the lobby of the magazine for cleaning the magazine. Cleaning shall be done immediately after each occasion whenever the magazine is opened for receipt, delivery or inspection of the explosives.

The mallets, levers, wedges etc for opening the barrels or cases shall be of wood. The cases of explosives are to be carried by hand and shall not be rolled or dragged inside the magazine. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been stored long in the store are to be issued first. Neither the magazine shall be opened nor any person shall be allowed in the vicinity of the magazine during any dust storm or thunderstorm. All magazines shall be officially inspected at definite intervals and a record of such inspections shall be kept.

d) Carriage of Explosives

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from direct rays of the sun, artificial lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each case or package shall be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on the vehicle conveying explosives. No explosive shall be transported in a carriage or vessel unless all iron or steel therein the carriage or vessel which are likely to contact the package containing explosives are effectually covered with

lead, leather, wood, cloth or any other suitable material. No light shall be carried on the vehicle carrying explosives and no operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

e) Use of Explosives

The contractor shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The contractor shall satisfy himself that the person so appointed is fully acquainted with his responsibilities.

Holes for charging the explosives shall be drilled with pneumatic drills and the drilling pattern shall be so planned that the rock pieces after blasting will be suitable for handling. The hole diameter shall be of such a size that the cartridges can easily pass down through them and any undue force is not required during charging. Charging operation shall be carried out by or under the personal supervision of the shot firer. Wrappings shall never be removed from the explosive cartridges. Only one cartridge at a time shall be inserted in a hole and wooden rods shall only be used for loading and stemming the shot holes. Only such quantities of explosives as are required for a particular work shall be brought to the work site. Should any surplus remain when all the holes have been charged shall be carefully removed to a point at least 300m away from the firing point.

The authorized shot firer himself shall make all the connections. The shot firing cable shall not be dragged along the ground to avoid any damage to the insulation. The shot firing cable shall be tested each time for its continuity and possible short circuiting. The shot firer shall always carry the exploder handle with him until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits. Before any blasting is carried out it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300m radius from the firing point or as required by the statutory regulations at least 10 minutes before the time of firing by sounding a warning siren and the area shall be encircled by red flags.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges, the electric detonators shall be connected with the exploder through the shot firing cable in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current etc and keep the lead wires short circuited until it is ready to fire. Any kink in the detonator leading wire shall be avoided. For simultaneous firing of a large number of shot holes, use of cordtex may be done. An electric detonator attached to its side with adhesive tape shall initiate cordtex connecting wire or string. Blasting shall only be carried out at certain specified times to be agreed jointly by the contractor and the engineer.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations, the authorized shot firer shall return to the blast area and inspect carefully the work and satisfy himself that all the charged holes have exploded. Cases of misfired unexploded charges shall be exploded by drilling a parallel fresh hole at a distance of not less than 600mm from the misfired hole and by exploding a new charge. The authorized shot firer shall be present

during the removal of debris as it may contain unexploded explosives near the misfired hole.

The workmen shall not return to the site of firing until at least half an hour after firing.

Where blasting is to be carried out in proximity of other structures, controlled blasting by drilling shallow shot holes and proper muffling arrangements with steel plates loaded with sand bags etc shall be used on top of the blast holes to prevent the rock fragments from causing any damage to the adjacent structures and other properties. Adequate safety precautions as per building byelaws, safety codes, statutory regulations etc shall be taken during blasting operations.

5.03.04 Restrictions on Blasting

- a) Blasting which may disturb or endanger the stability, safety or quality of the adjacent structures/foundations shall not be permitted.
- b) Blasting within 200m of a permanent structure or construction work in progress shall not be permitted.
- c) Progressive blasting shall be limited to two third of the total remaining depth of excavation.
- d) No large scale blasting operations will be resorted to when the excavation reaches the last one metre and only small charge preferably black powder may be allowed so as not to shatter the parent rock.
- e) The last blast shall not be more than 0.50 m in depth.
- f) In rocky formations, at locations where specifically indicated or ordered in writing by the engineer, the use of explosives shall be discontinued and excavation shall be completed by chiselling or any other suitable method as approved by the engineer.

5.04 Sorting of Excavated Materials

The excavated material shall be carefully sorted for use in filling the areas in the project site by removing roots, grasses, organic matters and other objectionable materials and be sorted out into different types of materials for use and as directed by the engineer. The excavated material which is not considered fit for filling purpose shall be immediately removed and disposed at such a place and in such a manner as will be directed by the engineer. The material found unusable should be got approved by the engineer before actually disposing it off. The useful materials that cannot be used directly shall be heaped in separate area as stock piles. Stockpiles shall be of regular size as far as possible for ease of measurement. The materials heaped shall be utilised as and when required and as directed by the engineer. The cost of complete item of earthwork includes the cost of rehandling of the materials and temporarily heaped and reused.

5.05 Disposal of Surplus/ Waste Materials

Surplus and other waste materials shall be removed and disposed of from the construction site to the area demarcated by the engineer. No material shall be wasted unless approved by the engineer.

5.06 Earth Work in Filling

Levelling by raising with controlled fill of approved excavated/borrowed earth shall be carried out where the existing ground levels are lower than the specified formation level. After clearing site as per clause 5.01, the original ground shall be compacted by rolling subject to a minimum 6 passes of 8 to 10 tonne roller. The approved earth/fill material shall then be spread in horizontal layers not exceeding 300mm in compacted thickness. Each layer shall be watered and thoroughly compacted with proper moisture content and such equipments as may be required to obtain a minimum of 95% of its maximum dry density as determined by standard Proctor's test as per IS: 2720, part-VII. Moisture content of the fill material shall be controlled near optimum moisture content during compaction

The fill material shall be tested for its optimum moisture content and maximum dry density as per IS: 2720, part-VII. Moisture content shall be checked at the source of supply in accordance with IS:2720 part- II and if found less than that required for proper compaction, the same shall be made good either at the source or after spreading the soil in loose thickness for compaction. In the latter case, water shall be sprinkled directly from the hose line or from the truck-mounted water tank etc making due allowance for evaporation losses and the fill material be thoroughly mixed by means of harrows, rotary mixers or by any other suitable approved method until the layer is uniformly wet. **Flooding shall not be permitted for watering purpose under any circumstances.** If the material delivered is too wet, it shall then be dried by aeration and exposure to the sun till the moisture content is suitable for compaction. Should circumstances arise owing to wet weather the moisture content cannot be reduced to the required amount by the above procedure, the work on compaction shall be suspended. Clods or hard lumps of earth shall be broken to have a maximum size of 150mm when being placed in the layers before compaction. For each of the above tests on the fill material, one sample for every 10,000cu.m shall be tested. Additional samples shall be tested whenever there is a change of source or type of material.

Before start of filling, the contractor shall submit the engineer his proposal for the methodology to be adopted for compaction. The compaction equipments as approved by the engineer shall only be employed to compact the different type materials encountered during construction. If directed by the engineer, the contractor shall demonstrate the efficacy of the plant he intends to use by carrying out compaction trials. Moisture content of the fill material shall be controlled near optimum moisture content during compaction.

The compacted layer shall be tested for its dry density as per IS:2720, part-XXVIII or XXIX as directed by the engineer. Samples shall be taken at the rate of one sample for every 10,000sq.m area of each compacted layer. In addition random checks shall be carried out in compacted layers by means of Proctor needle penetration test. Contractor shall submit all the test results to the engineer immediately after completion of the tests. A sample shall be deemed to have passed the test when the dry density of the compacted fill is equal to or more than 95% of its maximum dry density. When field density measurements reveal any soft areas in the fills, further compaction shall be carried out as directed by the engineer. If in spite of that, the specified compaction is not achieved, the material in the soft areas shall be replaced with approved material compacted to the density requirements and satisfaction of the engineer.

Subsequent layers shall be placed only after the finished layer has been tested and accepted by the engineer.

Where the filling is to be done across low swampy ground that will not support the weight of trucks or other hauling equipments, the lower part of the fill shall be constructed by dumping

successive loads in a uniformly distributed layer of a thickness not greater than that necessary to support the hauling equipment while placing subsequent layers.

5.07 Dewatering and Drainage

It shall be ensured that the area to be excavated/filled shall be free from water. The contractor shall remove the water (if any) by pumping or by any other means as approved by the engineer. At all times, the surface of cutting/filling during execution shall be maintained at such a cross fall as will shed water and prevent ponding. All existing drains/channels (if any) in the work area shall be suitably diverted by the contractor before taking up any excavation or filling. These diversions shall be such that it shall ensure effective disposal of water without any accumulation or flooding within the project site and in adjoining areas.

5.08 Finishing Operations

Finishing operation shall include the work of shaping and dressing the excavated/filled ground to the required grades, levels, lines, side slopes, cross-sections and dimensions as shown on the approved drawings or as directed by the engineer.

5.09 Turfing

Turfing shall be provided at the slopes and other locations as shown on the drawings or as directed by the engineer. The turf shall be of approved quality of grass. The sod shall consist of dense, well rooted growth of permanent and desirable grasses indigenous to the locality where it is to be used and shall be practically free from weeds or other undesirable matter. The grass on the sod shall have a length of approximately 50mm and the sod shall be free of any debris. Thickness of the sod shall be as uniform as possible with 50 to 80mm of soil covering the grass roots depending on the nature of the sod so that all the dense root system of the grasses are retained in the sod strip. The sods shall be cut in rectangular strips of uniform width not less than

about 300mm x 250mm size but not so large so that it is convenient to handle and transport without damage.

The area to be sodded shall be previously constructed to the required slope and cross section. Prior to placing the sods, the slopes shall be **roughned** and wetted in order to have a satisfactory bond. The strips of sod shall be laid in close contact with each other and be tamped firmly in place so as to fill and close the joints between them. The turfing so laid shall be well watered and protected until final acceptance.

5.10 Approaches

The contractor shall provide proper approaches for workmen and inspection.

5.11 Lighting

Full scale lighting are to be provided if night work is permitted or directed by the engineer. If no night work is in progress, red warning lights should be provided at the edges of excavations and fills.

6.00 RATES AND MEASUREMENTS

6.01 Rates

a) The item of work in the schedule of quantities describe the work very briefly. The various items of the schedule of quantities shall be read in conjunction with the corresponding sections in the technical specification including amendments and additions if any. For each item in the schedule of quantities, the bidder's rate shall include all the activities covered in the description

of the items as well as for all necessary operations in detail as described in the technical specification.

b) No claims shall be entertained if the details shown on the released for construction drawings differ in any way from those shown on the tender drawings.

c) The unit rate quoted shall include minor details which are obviously and fairly intended and which may not have been included in these documents but are essential for the satisfactory completion of the work.

a) The bidder's quoted rate shall be inclusive of supplying and providing all labour, men, materials, equipments, tools and plants, supervision, services, approaches, schemes etc.

6.02 Measurements

Method of measurements are specified in the proceeding sections. Where not so specified, the latest version of IS:1200, Part-1 shall be applicable.

a) The length, breadth and depth shall be measured correct to the nearest centimetre if measurements are taken by tape. Rounding of numericals shall be as per relevant IS Codes. If the measurements are taken with staff and level, the levels shall be recorded correct to 5mm. The area and volume shall be worked out in square meter and cubic meter correct to the nearest of two decimal places.

b) For earth work in excavation, the ground levels shall be taken before and after completion of the work in the actually excavated area. The quantity of earth work in cutting shall be computed from these levels in cubic meter.

c) Where soft rock and hard rock are mixed, the measurement shall be done as follows. The two types of rock shall be stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in the stacks. If the sum of net quantity of the two types of rock so arrived exceeds the total quantity of excavation then the quantity of each type of rock shall be worked out from the total quantity (from excavation) in the ratio of net quantities in stack measurements of the two types of rock. If stacking is not feasible, the method as suggested by the engineer shall be followed.

d) Where soil, soft rock and hard rock are mixed, the measurement shall be done as follows. The soft and hard rock shall be removed from the excavated material and stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in stacks. The difference between the entire excavation and the sum of the quantities of soft and hard rocks so arrived shall be taken as soil.

e) For earth work in filling, the actual measurements of fill shall be calculated by taking levels of the original ground before start of the work but after site clearance and after compaction of fills. The quantity of earth work in filling shall be computed from these levels in cubic meter.

f) For turfing, the measurement shall be made on the finished work in square meter.

 BHEL Maharatna Company	4x270 MW BHADRADRI TPS– SPECIFIC TECHNICAL REQUIREMENTS FOR PRE TREATMENT (PT) PLANT	SPECIFICATION NO.	
		VOLUME – II B	
		SECTION - C	SUB-SECTION -
		REV.0	DATE 02.04.2015
		SHEET 1 OF 4	

3.00.00	GEO-TECHNICAL INVESTIGATION & FOUNDATION SYSTEM
3.01.01	Detailed Geo-technical Investigation is being carried out by BHEL. The laboratory investigation is in progress. The report will be available after completion of laboratory test results. However, the bore log details of boreholes drilled in and near PT plant area (BH-115 & 113) are enclosed as Annexure- 1. The data shall be solely for the purpose of guidance to the bidder. BHEL/owner does not take any responsibility about the accuracy and applicability of the geo-technical data furnished herewith. The onus of correct assessment/ interpretation and understanding of the existing sub-strata conditions is on the bidder. Any variation in the data between the one furnished and to that found during execution of the work at site/ additional geo-technical investigation (if carried out by the bidder) at proposed pretreatment Plant area shall not constitute a valid reason in affecting the terms & conditions of this bid and the bidder should note that nothing extra will be payable on this account. The bidder shall fully satisfy himself about the nature of the sub-strata expected to be encountered including the type of foundation, ground water table and construction methodology to be adopted etc prior to the submission of the bid. If the bidder desires to carry out additional geo-technical investigation he/she may do so with prior information/permission of BHEL/owner at no extra cost to BHEL/owner. No extension in time schedule shall be permitted on this account. However, the net safe bearing capacity (SBC) of shallow/open foundations to be adopted for the design during detailed engineering shall be limited to the values as mentioned in Clause-3.02.02 and any value of net SBC higher than the one indicated will not be accepted. However, bidder shall note that the net safe bearing capacity and foundation depth to be adopted for design during detailed engineering stage shall be got approved by BHEL/owner.
3.01.02	In case of non-availability of any geo-technical investigation data, the bidder shall carry out his/her own detailed geo-technical investigation in the work area(s) under bidder’s scope for establishing the sub-strata conditions and to decide the type of foundation for the structures envisaged, construction methods to be adopted, any special requirements/treatment called for/remedial measures for sub soil/foundations etc. prior to the commencement of detailed design/drawings. The bidder shall obtain approval on the agency for conducting geo-technical investigation work, field and laboratory testing schedule proposed by the bidder etc. from BHEL/owner before undertaking the geo-technical investigation work.
3.02.00	Foundation System
3.02.01	General Requirements a. All equipments/structures shall be supported on suitable open foundation along with any special requirements/remedial measures/treatment called for subsoil/foundations as approved by BHEL/owner.



**4x270 MW BHADRADRI TPS– SPECIFIC
TECHNICAL REQUIREMENTS FOR PRE
TREATMENT (PT) PLANT**

SPECIFICATION NO.

VOLUME – II B

SECTION - C

SUB-SECTION -

REV.0

DATE 02.04.2015

SHEET 2 OF 4

- b. All foundations shall be designed in accordance with the provisions of relevant part of latest revision of Indian Standards or as per the technical specification whichever is stringent.
- c. The foundation shall be rested on virgin soil/soft rock/rock.
- d. No foundation shall rest on filled up soil /Loose soil.
- e. A combination of open and pile foundations shall not be permitted under the same structure.
- f. Foundations shall be designed to resist loading derived from environmental loads including loads due to wave, current, wind or seismic, gravity loads, construction loads, static and moving loads and any other loads as applicable and as specified elsewhere in the specification.
- g. Foundation shall be designed for worst combination of loads as described elsewhere in the specification.
- h. Ground water table shall be considered at finished ground level for design purposes unless specified elsewhere in the specification.

3.02.02 Open foundations

In case shallow/open foundations are adopted then the following shall be strictly adhered to.

- i. Minimum width of foundation shall be 1m.
- ii. Minimum founding level shall be as mentioned in Table-1.
- iii. The net safe bearing capacity (SBC) of shallow/open foundations at different founding level shall be limited to the values as mentioned in the following Table-1 and any value of net SBC higher than the one indicated shall not be accepted. However, bidder shall note that the net safe bearing capacity and depth of foundation to be adopted for design during detailed engineering stage shall be got approved by BHEL/owner.



**4x270 MW BHADRADRI TPS– SPECIFIC
TECHNICAL REQUIREMENTS FOR PRE
TREATMENT (PT) PLANT**

SPECIFICATION NO.

VOLUME – II B

SECTION - C

SUB-SECTION -

REV.0

DATE 02.04.2015

SHEET 3 OF 4

Table-1

Unit	Type of Foundation	Founding Level (m)	Net Safe Bearing capacity (T/sq.m)	Finished* Ground Level (FGL) (m)	Remarks
1	Isolated/Raft	(+)65.000	12	R.L (+)67.000M	Minimum founding level shall be RL(+)65.000M
2	Isolated/Raft	(+)64.000	18		
3	Isolated/Raft	(+)63.000	22		
4	Isolated/Raft	(+)62.000	30		
5	Isolated/Raft	(+)61.000	40		

*** FGL mentioned in the above table is indicative only, in case any change in FGL the same shall be intimated accordingly.**

- iv. The founding stratum shall be soil/weathered rock/rock. In case any loose stratum/cavity is met with at founding level or below during execution , the same shall be completely removed and filled back with PCC 1(cement):3(sand):6(stone aggregates up to desired foundation level.
- v. It shall be ensured that all foundations of a particular structure/building/equipment shall rest on one bearing stratum.
- vi. The permissible settlement as mentioned under para “permissible settlement of foundations” or permissible settlement



**4x270 MW BHADRADRI TPS– SPECIFIC
TECHNICAL REQUIREMENTS FOR PRE
TREATMENT (PT) PLANT**

SPECIFICATION NO.

VOLUME – II B

SECTION - C

SUB-SECTION -

REV.0

DATE 02.04.2015

SHEET 4 OF 4

from functional requirement whichever is more stringent shall be adopted for the design.

vii. Permissible settlement of foundations:

The permissible differential settlement of foundation resting on soil mass shall be governed by IS: 1904 and from functional requirements whichever is more stringent. Unless otherwise mentioned, the total settlement of foundation resting on soil shall be restricted to 40mm in case of isolated foundation and 75mm in case of raft foundation.

viii. Total permissible settlement of foundation resting on weathered rock/rock shall be 12mm

ix. Analysis and proportioning of footings to minimize differential settlements shall be carried out for all major foundations and the same shall be submitted for BHEL/owner's approval.

x. Expansive soil shall not be used for filling/back filling around foundations. Filling/back filling around foundations /structures shall be done with good non-expansive soils.

xi. No foundation shall be rested on expansive soil.



NAGADI CONSULTANTS PRIVATE LIMITED

DELHI - BANGALORE - CHENNAI - SECUNDERABAD

Job No. : 1658

B.H. No. : 115

Term. Depth : 15.00M

RECORD OF BORING

Project UX 270 MW AT S. GENCO, Manuguru, T.P.S.
 Started 14/03/15 Time 9.30 A.M. Completed 15/03/15 Time 6.15 P.M.
 B.H. Co-ordinates 1998633N, 472316E Size of B.H. _____ Water Table _____
 Equipment Velli-35 (S) Nearest Location : P.T. Plant, D.M. Plant

Soil Description	Depth (m)	SPT / Sample Q	N - Value	Remarks
Brownish clay silt with gravels	0.50	D.S.		
do	1.00	SPT ✓	3 3 3 3 3 3 3 3 6 7 9 10	32
Brownish clay silt with gravels	1.50	D.S.		
do	2.00	UDS ✓		
do	2.50	D.S.		
do	3.00	SPT ✓	3 3 3 3 3 3 5 6 6 6 8 9	29
do	3.50	D.S.		
do	4.00	UDS ✓		
Brownish clay silt	4.50	8PS		
Brownish clay silt with gravels	5.00	SPT ✓	2 3 3 3 3 3 3 4 4 5 6 8	23
Reddish weathered Rock	6.00	D.S.		
do	6.50	UDS.		
do	7.50	D.S.		
do	8.00	SPT ✓	3 3 3 3 3 3 9 12 30 32 35	38 Refusal
do	9.00	D.S.		
Greyish + Reddish Soft Rock	9.50	UDS		
Reddish Soft Rock	11.00	140min.	27	CR - 0.40M
do	12.50	130min.	29	CR - 0.43M
do	14.00	D.S.		
do	15.00	60min.	35	CR - 0.35M

* DS. Disturbed ; UDS, Undisturbed

Client

J.S. Rana
 Nagadi Consultants
 Site-in-Charge

67.50

PT Plant, DM Plant clarified PH4

	NAGADI CONSULTANTS PRIVATE LIMITED DELHI - BANGALORE - CHENNAI - SECUNDERABAD		Doc. No.: FD/G/09/01	
			Job No.: 1652	
			B.H. No.: 113	
			Term. Depth: 15.0M	
RECORD OF BORING				
Project <u>UX270 MW T.S. GENCO, Mangur, T.P.S</u>				
Started <u>28/01/15</u> Time <u>11:00 A.M</u> Completed <u>30/01/15</u> Time <u>1:00 P.M</u>				
B.H. Co-ordinates <u>1993630N, 472214E</u> Size of B.H. <u>100mm/12</u> Water Table <u>not encountered</u>				
Equipment <u>Volt 35(S)</u> Nearest Location: <u>clarified water storage tank</u>				
Soil Description	Depth (m)	SPT / Sample Q	N - Value	Remarks
D. Brownish silt-with clay	0.50	D.S.		
do	1.00	SPT	6" 6" 6" 41 8 10	N = 16
Brownish silty clay with gravel.	1.50	D.S.		
Greyish Reddish silty clay with gravel	2.00	UDS		
Reddish weathered Rock (Shale)	2.50	D.S.		
do	3.00	SPT	6" 6" 6" 31 53 80	N > 100
do	3.50	D.S.		
Reddish weathered Rock	4.00	UDS		
Greyish Reddish weathered Rock	5.00	SPT	3 3 3 3 3 3 8 9 14 20 25 28	87
Reddish weathered Rock (Shale)	6.00	D.S.		
do	6.50	UDS		
do	7.50	D.S.		
do	8.00	SPT	2 1 1 40 50	N > 100
do	9.00	D.S.		
do	9.50	UDS		
do	10.00	D.S.		
Reddish Soft Rock (Shale)	11.00			CR-0.55M 37
do	12.50			CR-0.28M 19
do weathered Rock	13.00	D.S.		
do	14.00	D.S.		
Greyish Red Soft Rock (Shale)	15.00			CR-0.32M 32
*DS. Disturbed ; UDS, Undisturbed				
Client	J.S. Rana Nagadi Consultants Site-in-Charge			

**TITLE**

**4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: III

REV 00

SHEET 1 of 4

VOLUME III

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT****SPECIFICATION NO.**

PE-TS-411-158A-A001

VOLUME: III

REV 00

SHEET 2 of 4

LIST OF DOCUMENTS TO BE SUBMITTED ALONG WITH BID

- Technical pre-bid clarification if any strictly in the enclosed Schedule of pre bid clarification s only with mention of specification clause for which clarification is being asked. (Stamped & Signed).
- Technical Deviation if any strictly in the enclosed Schedule of deviation with cost of withdrawal only with mention of specification clause for which deviation is being asked. (Stamped & Signed).
- Compliance cum confirmation certificate (Stamped & Signed).
- Un Price Schedule duly filled in (Stamped & Signed).
- Electrical Load List in BHEL format (Stamped & Signed).
- List of Start-up & commissioning spares if any (Stamped & signed).
- List of tools & tackles (Stamped & signed).
- Duly filled signed and stamped Aux Power consumption format in sealed envelope.

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT****SPECIFICATION NO.**

PE-TS-411-158A-A001

VOLUME: III

REV 00

SHEET 3 of 4

COMPLIANCE CUM CONFIRMATION CERTIFICATE

The bidder shall confirm compliance with following by signing/ stamping this compliance certificate and furnishing same with the offer:

1. The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusions/ deviations with regard to same.
2. QP/ test procedures shall be submitted in the event of order based on the guidelines given in the specification & QP enclosed therein.
3. QP will be subject to BHEL/Customer approval in the event of order & customer hold points for inspection/ testing shall be marked in the QP at the contract stage. Inspection/ testing shall be witnessed as per same apart from review of various test certificates/ Inspection records etc. The charges for 3rd party inspection (Lloyds, TUV or equivalent) for imported components shall be included in the base price of the equipment by the bidder.
4. All drawings/data – sheets etc. to be submitted during contract shall be subject to BHEL/Customer review/ approval. GA drawings, as submitted with offer at tender stage are for reference purpose only and shall be subject to approval during contract stage.
5. There are no other deviations with respect to specification other than those furnished in the 'Schedule of Deviations'.
6. The offered materials shall be either equivalent or superior to those specified. Also for components where material is not specified it shall be suitable for intended duty, materials shall be subject to approval in the event of order.
7. The commissioning spares (if any) are supplied on 'As Required Basis' & prices for same included in the base price (If bidders reply to this is "No commissioning spares are required" and if some spares are actually required during commissioning same shall be supplied by bidder without any cost to BHEL).
8. All sub vendors shall be subject to BHEL/CUSTOMER approval.
9. Any special tools & tackles, if required, shall be in bidder's scope.
10. Demonstration test parameters shall stand valid till the satisfactory completion of Demonstration test and its acceptance by BHEL/Customer.

PARTICULARS OF BIDDER / AUTHORISED REPRESENTATIVE				
NAME	DESIGNATION	SIGNATURE	DATE	

**TITLE****4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR
PRE- TREATMENT PLANT**

SPECIFICATION NO.

PE-TS-411-158A-A001

VOLUME: III

REV 00

SHEET 4 of 4

PRE BID CLARIFICATION SCHEDULE

All clarification from the Technical Specification shall be filled in by the BIDDER clause by clause in this format only.

VOLUME	SECTION	CLAUSE NO.	PAGE NO.	SPECIFICATION REQUIREMENT	CLARIFICATION	REASONS FOR CLARIFICATION

PARTICULARS OF BIDDER / AUTHORISED REPRESENTATIVE					
NAME	DESIGNATION	SIGNATURE	DATE	COMPANY SEAL	

THIS IS A PART OF TENDER TECHNICAL SPECIFICATION PE-TS-411-158-11000-A001

SCHEDULE OF DEVIATIONS WITH COST OF WITHDRAWAL



PROJECT:-4 X 270 MW BHADRADRI TPS

PRE- TREATMENT PACKAGES

TENDER ENQUIRY REFERENCE:-

NAME OF VENDOR:-

SL NO	VOULME/ SECTION	PAGE NO.	CLAUSE NO.	TECHNICAL SPECIFICATION/ TENDER DOCUMENT	COMPLETE DESCRIPTION OF DEVIATION	COST OF withdrawal OF DEVIATION	REFERENCE OF PRICE SCHEDULE ON WHICH COST OF withdrawal OF DEVIATION IS APPLICABLE	NATURE OF COST OF withdrawal OF DEVIATION (POSITIVE/ NEGATIVE)	REASON FOR QUOTING DEVIATION

TECHNICAL DEVIATIONS

COMMERCIAL DEVIATIONS

PARTICULARS OF BIDDERS/ AUTHORISED REPRESENTATIVE

NAME	DESIGNATIONS	SIGN & DATE

NOTES:

1. For self manufactured items of bidder, cost of withdrawal of deviation will be applicable on the basic price (i.e. excluding taxes, duties & freight) only.
2. For directly dispatchable items, cost of withdrawal of deviation will be applicable on the basic price including taxes, duties & freight.
3. All the bidders have to list out all their Technical & Commercial Deviations (if any) in detail in the above format.
4. Any deviation not mentioned above and shown separately or found hidden in offer, will not be taken cognizance of.
5. Bidder shall submit duly filled unpriced copy of above format indicating "quoted" in "cost of withdrawal of deviation" column of the schedule above along with their Techno-commercial offer, wherever applicable.
6. Bidder shall furnish price copy of above format along with price bid.
7. The final decision of acceptance/ rejection of the deviations quoted by the bidder shall be at discretion of the Purchaser.
8. Bidders to note that any deviation (technical/commercial) not listed in above and asked after Part-I opening shall not be considered.
9. For deviations w.r.t. Payment terms, Liquidated damages, Firm prices and submission of E1/ E2 forms before claiming 10% payment, if a bidder chooses not to give any cost of withdrawal of deviation loading as per Annexure-VIII of GCC, Rev-06 will apply. For any other deviation mentioned in un-priced copy of this format submitted with Part-I bid but not mentioned in priced copy of this format submitted with Priced bid, the cost of withdrawal of deviation shall be taken as NIL.
10. Any deviation mentioned in priced copy of this format, but not mentioned in the un-priced copy, shall not be accepted.
11. All techno-commercial terms and conditions of NIT shall be deemed to have been accepted by the bidder, other than those listed in unpriced copy of this format.
12. Cost of withdrawal is to be given separately for each deviation. In no event bidder should club cost of withdrawal of more than one deviation else cost of withdrawal of such deviations which have been clubbed together shall be considered as NIL.
13. In case nature of cost of withdrawal (positive/negative) is not specified it shall be assumed as positive.
14. In case of discrepancy in the nature of impact (positive/ negative), positive will be considered for evaluation and negative for ordering.

PROJECT: 4X270 MW BHADRADRI TPS**SUGGESTIVE PRICE SCHEDULE****PRE- TREATMENT PACKAGES**

THE PRICES SHOULD BE SUBMITTED IN THE ENCLOSED PRICE SCHEDULE FORMAT ONLY. FOLLOWING PRICE SCHEDULE FORMATS ARE ENCLOSED

ANNEXURE 'A' : LUMP SUM PRICES AND MAJOR BREAK-UP OF PRICES

Bidder shall furnish this price schedule in his offer only

Particulars of bidder / authorised representative

Name	Designation	Signature	Date	Company seal

ANNEXURE -A

1	Total lump sum firm price on FOR site basis to cover design, engineering, manufacture, fabrication, assembly, inspection & testing at vendor's & sub-vendor's works, painting, forwarding, supply and delivery at site including start up and commissioning spares, mandatory spares, properly packed for transportation, loading/unloading / handling and storage at site, in site transportation, assembly, erection and commissioning, trail run, preparation and submission of "As Built" drawings, site testing, carrying out demonstration / performance guarantee tests at site and handover in flawless operating condition to end customer as per the details elaborated in different sections / volumes of technical specification (PE-TS-411-158A-A001) for 4X270 MW BHADRADRI TPS for following package: PT plant including civil construction and structural works at site (except Chemical House building and centrifuge shed/building)	
a)	Bidder to note that total price indicated above at 1 shall be considered for evaluation and hence should be complete in all respect for the full scope defined and considering all terms and conditions agreed.	
b)	In case, price indicated above does not match with item wise break-up given at 2, the highest price so calculated shall be considered for evaluation but in case of order, the same shall be placed at the lowest price.	

2 MAJOR BREAK-UP OF PRICES GIVEN IN 1 ABOVE

2.1	Total lumpsum firm price for EQUIPMENT (SUPPLY, DESIGN & ENGINEERING) i.e.manufacture, fabrication, assembly, inspection and testing at vendor's & sub-vendor's works, painting, startup and commissioning as required, forwarding, proper packing, shipment and delivery at site, inclusive of all taxes & duties for the complete scope of supply of entire of Pre Treatment Plant as per the details in different sections / volumes of technical specification (PE-TS-411-158A-A001) for 4X270 MW BHADRADRI TPS.	
2.2	Total lump sum firm price for all services including loading/unloading / handling and storage at site, in site transportation, assembly, erection and commissioning, trail run, preparation and submission of "As Built" drawings, site testing etc. required for completion of entire Pre Treatment Plant including supervision of PT plant civil structurals and construction work at site (except Chemical House building and centrifuge shed/building) as per the details in different sections / volumes of technical specification (PE-TS-411-158A-A001) for 4X270 MW BHADRADRI TPS.	
2.3	Price for Performance Guarantee / demonstration test and handing over the plant to the customer.	
2.4	Price for Mandatory spares (as per list indicated in Section C1 of tender technical specification) inclusive of all taxes, duties and other levies as applicable.	
3.0	Break-up (%) of prices given at SI No-2.1 above (To be used during contract execution for payment).	
3.1	Lumpsum firm price for supply of Atmospheric tanks & Pressure Vessels inclusive of all taxes, duties and other levies as applicable.	20% of sl no 2.1 above.
3.2	Lumpsum firm price for supply of centrifuge inclusive of all taxes, duties and other levies as applicable.	5% of sl no 2.1 above.
3.3	Lumpsum firm price for supply of Valves inclusive of all taxes, duties and other levies as applicable.	15% of sl no 2.1 above.
3.4	Lumpsum firm price for supply of Instruments and control systems inclusive of all taxes, duties and other levies as applicable.	20% of sl no 2.1 above.
3.5	Lumpsum firm price for supply of Pumps & Blowers with motor inclusive of all taxes, duties and other levies as applicable.	10% of sl no 2.1 above.
3.6	Lumpsum firm price for supply of Piping & Fittings inclusive of all taxes, duties and other levies as applicable.	10% of sl no 2.1 above.
3.8	Lumpsum firm price for supply of agitators, strainers inclusive of all taxes, duties and other levies as applicable.	5% of sl no 2.1 above.
3.9	Lumpsum firm price for supply of mechanism for clarifiers and thickener inclusive of all taxes, duties and other levies as applicable.	5% of sl no 2.1 above.
3.11	Lumpsum firm price for supply of Balance items inclusive of all taxes, duties and other levies as applicable.	5% of sl no 2.1 above.
3.12	Submission & approval of all basic documents P&ID, process sizing calculation, Equipment layout, control philosophy, sub-vendor list and PLC documents	5% of sl no 2.1 above.

Bidder shall furnish this price schedule in his offer only

Particulars of bidder / authorised representative

Name	Designation	Signature	Date	Company seal

4x270 MW Bhadradi TPS - PRE- TREATMENT PACKAGES					
ANNEXURE B					
GUARANTEED AUXILIARY POWER CONSUMPTION					
Sl.No.	Description / Item	Working	Standby	Power Consumption (KW) (at motor input terminal)	Total Power Consumption (KW)
1	2	3	4	5	6 = 3 x 5
1.1	Total power consumption for station of PT plant				
Notes					
1	If the actual power consumption exceeds the guaranteed power consumption, liquidated damages shall be payable by the bidder at the rate of ₹ 2,52,000/- per KW (Rupees Two lacs and fifty two thousand per Kilowatt) excess power consumption, over the base guaranteed figure indicated by him in his bid. Such liquidated damages may be recovered by the BHEL by deduction from the contract price or by enforcing the contract performance guarantee or in any other manner deemed fit by the BHEL For this purpose, the drives of standby equipment shall not be considered.				
2	Power consumption (KW) of motors shall be measured at motor input terminals when operating at the rated capacity and pressure and performed on test rig at the vendor's works and actual motor shall be used for this				
3	For bid evaluation purpose on account of guaranteed auxiliary power consumption, the same shall be loaded at the rate of ₹ 2,52,000/- per KW (Rupees Two lacs and fifty two thousand per Kilowatt) for the differential power consumption.				
4	Base aux power figure is given in SECTION C1-C of the technical specification of pre- treatment packages.				
5	Power consumption to be provided by bidder in sealed envelope.				