

TD-201 Rev No. 00	Form No. 	BHARAT HEAVY ELECTRICALS LIMITED RC PURAM, HYDERABAD - 32 PROJECT ENGINEERING & SYSTEMS DIVISION		PEMC-05255 Rev No. 01 Page 1 of 70	
COPYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED, It must not be used directly or indirectly in any way detrimental to the interest of the company. JOB SPECIFICATION OF RCC COOLING TOWER PROJECT : 1 x 51MW COMBINED CYCLE CAPTIVE POWER PLANT PROJECT, HAZIRA, GUJARAT. CUSTOMER: OIL AND NATURAL GAS CORPORATION LTD. HAZIRA, GUJARAT. CONSULTANT: FICHTNER CONSULTING ENGINEERS (INDIA) PVT. LTD., BANGALORE					
Ref. Doc	Prepared : Pradeepa	Checked : Amit Kumar Sinha	Approved : Radhika Sista	Date : 25.11.14	

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SECTION-I

BRIEF SYSTEM DESCRIPTION, SCOPE OF WORK AND GENERAL INFORMATION

1.1.0 BRIEF SYSTEM DESCRIPTION

1.1.1

The cooling tower shall cool continuously, throughout the year, the hot water returning from the main condenser and auxiliary cooling equipment of the Power Plant. The normal flow of hot water to each cell shall be as mentioned in data sheets of this specification.

1.1.2

The cold water from the tower basin outlet channel will flow by gravity to the cooling water pumps sump by RCC channel. Bidders scope includes Sluice Gates, Coarse and fine mesh Screens and Channel length of 2 metres from the edge of the Cooling tower basin. For details of terminal point refer to Annexure (Drawing of CW and ACW Pump House Area Layout Drg. No. 1-381-01-06543 Rev.00).

1.1.3

Each cell shall be identified and so designed that each one of them could be operated independently of the rest of the other cells and can also be repaired / maintained and cleaned while other cells are in service.

1.1.4

A suitable sump in each cell shall be provided in the basin to facilitate draining of the basin with the use of a permanent dewatering pump.

1.1.5

Fill shall be of film type fills, supported on RCC beams. Recycled PVC shall not be used for the fill material. PVC shall be made fire resistant by suitable treatment. Material of construction for all the items shall be selected considering the corrosion effect.

1.1.6

Hot water from condenser and from auxiliary cooling equipment shall be taken to the hot water distributors by means of common hot water risers and distributed through a distribution system.

1.2.0 BRIEF SCOPE OF WORK

This specification is intended to cover the design, engineering, manufacture, fabrication, assembly, testing at manufacturer’s works, delivery properly packed for transport, inland transportation up to site, unloading, storage at site, in-plant transportation, civil works (excluding piling of cooling tower, if required), complete services of erection, testing (including performance test of cooling tower) and commissioning, complete with all accessories as specified hereinafter and as required for safe and trouble free operation and maintenance of Induced Draft RCC counter flow cooling tower with 3 (2W+1S) cells as per this Job specification and its annexures.

This Job specification and its Annexures shall be read in conjunction with Standard Technical specification PY-51016 Rev.01.

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1.3.0 ORDER OF PRECEDENCE

This specification shall be read in conjunction with all other specifications and documents enclosed to it. Any conflict between referenced documents shall be identified and indicated. When resolving conflicts the following order of precedence shall govern.

- (1) Job specifications (PEMC-05255 Rev.01)
- (2) Standard specifications (PY-51016 R1)
- (3) P&ID's referred
- (4) Annexures
- (5) Standards and codes as applicable

1.4.0 SPECIAL CLEANING, PROTECTION & PAINTING

Refer Annexure- 1 (Volume III Section 2.15) for surface preparation and painting attached with this specification. Painting on concrete structures shall be done as per Annexure-2 (Volume III Section 5).

1.5.0 PROJECT INFORMATION

Project	: 1 x 51MW Combined cycle captive power plant at ONGC HAZIRA plant
Site Location	
State	: GUJARAT
Nearest town	: SURAT
Nearest Railway Station	: SURAT
Nearest Airport	: SURAT
Nearest Harbour	: Magdalla, 20 KM
Access Road	: NH-8 (30 KM)

METEOROLOGICAL DATA :

1.	Barometric pressure	1.013 bar (Average)
2.	Ambient Temperature - Max. average dry bulb temperature - Min. average dry bulb temperature - Temperature for electrical equipment /Device	45.6°C 4.4°C 50°C
3.	Relative Humidity - Maximum - Minimum - Average	70% 18% 64%
4.	Rain fall - Average in a year - Heaviest in a day - Period – Monsoon showers	1203.5 mm 459.2 mm

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5.	Wind	June to September
	• Wind code • Max wind speed • 20-61 kmph for 20 days in a year • Average wind speed for remaining period • Most predominant wind direction	IS-875 62 kmph <20 kmph South west
	6. Class of seismic area	Zone-III (IS-1893)

Site Elevation Data:

Elevation above mean sea level : RL 7.5 above, MSL

1.6.0 MAKE -UP WATER ANALYSIS

Sl. No.	Characters	Unit	Filtered water Analysis
1	pH	Mg/l as CaCO ₃	8.3
2	Total Hardness	Mg/l as CaCO ₃	138
3	Ca Hardness	Mg/l as CaCO ₃	72
4	Sodium	As Fe	94
5	Iron	Mg/l as CaCO ₃	Traces
6	Total Cation	NTU	232
7	Turbidity	Mg/l as CaCO ₃	<2.4
8	Total Alkalinity	Mg/l as CaCO ₃	156
9	Sulphate	Mg/l as CaCO ₃	7.2
10	Chloride	Mg/l as CaCO ₃	68.4
11	EMA	Mg/l as CaCO ₃	75.6
12	Total Anion	Mg/l as CaCO ₃	231.6
13	Silica	Mg/l as SiO ₂	24
14	KMnO ₄ Value	Mg/l as CaCO ₃	18

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1.7.0 DRAWING/DOCUMENTS TO BE SUBMITTED WITH THE OFFER

- a) Thermal analysis of cooling tower, Power consumption calculations
- b) Technical details of the Cooling tower offer and detailed specification, drawings, calculation's, cross plots, brochures, catalogues etc for all components of the system, including mechanical and thermal capacity of reducing gear, its rating data and selection calculations.
- c) Fill characteristic curves and pressure drop curves duly certified by the manufacturer of fill.
- d) The manufacturer's design performance curves as per ATC 105 of CTI for 90%, 100%, 110% water flow rate and range of 40^o F, 36^o F, 32^o F are to be used for extrapolating the test data. These curves shall be submitted along with the offer and should be in ^o F only.
- e) Detailed design calculations to be filled in data sheet enclosed elsewhere, tower sizing format and drawings etc. to explain all salient features of the offer shall be submitted along with the offer, failing which the offer shall be liable for rejection.
- f) Technical data sheet for cooling tower
- g) Tower sizing data for cooling tower
- h) All civil GA, RCC details and piling etc. drawings and design calculations including design files.

1.8.0 SUB VENDOR LIST

Sl. No.	Item Description	VENDOR NAME
1	Waste water pump (Sludge cum Dewatering Pump)	Goulds (Submersible) / Gusher (Monoblock)
2	Gate, Globe, Check valves	Flosteer Engineering (I)Pvt.Ltd / Skilt Fabricators Pvt.Ltd / Steel Strong Valves (I) Pvt. Ltd./ A.V.Valves Limited / Ampo S Co Op Poyam Valves / Fouress Engineering (I)Pvt.Ltd / L & T Valves Limited / Valvitalia S.P.A / B.F.E.Srl Bonney Forge / Weir BDK Valves / NSSL Limited / Micon Valves (I) Pvt. Ltd. / Niton Valve Industries Ltd / Shalimar Valves Pvt. Ltd. / Leader Valves Limited / K.S.B Pumps Ltd.

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OPyright AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED . It must not be used directly or indirectly in any way detrimental to the interest of the company.	3	Travelling water screen	US filter / General Mechanical Works, India / Macmet India Limited ,India / Brackett green, USA	
	4	Butterfly valves	Durga Valves Private Limited / L & T Valves Limited / Boteli Valve Group Company Ltd./ Ashwathi Controls Pvt. Ltd. / Instrumentation Ltd / Fouress Engineers (India) / Weir Bdk Valves / Unique Valves Limited, / Inter Valve (India) Ltd. / Dembla Valves Ltd./ Dynamic Valves Pvt. Ltd. / Hi-Tech Butterfly Valves India / Leader Valves Limited / Galaxy Controls Pvt Ltd., / Advance Valves Pvt.Ltd./ Kamala Valves & Engineering / Venus Pump & Engineering Works	
	5	Pressure Gauges	Pyro electric / General instruments/ Altop / Precision Instrument / Waaree / WIKA	
	6	Temperature Gauges	WIKI/GIC / Pyroelectric / Waaree / H GURU Instruments/ ASHCROFT / AN Instruments	
	7	LT Motor	ABB / Siemens / Alstom / Bharat Bijlee / CGL	
	8	LPBS/ LCS(Local control stations)	Flexpro Electricals Pvt. Ltd./ FCG Power Industries./ Prompt Engineering Works, Mumbai / Flameproof Equipments Pvt.Ltd. / Fcg Flameproof Control Gears / Baliga Lighting Equipment Pvt. Ltd.	
	9	Illumination Fittings	Bajaj / Philips / Baliga (flame proof) / Square A Enterprises / Iec Electricals / Spaceage Switchgears Limited / Crompton Greaves / Wipro Limited / Mika Engineers	
	10	LT Power Cables	Universal / RPG / FGI / Nicco / Torrent / KEI / Poly Cab	
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	11	Control Cables	RPG / FGI / Torrent / Universal Cables Ltd / KEC International Limited / Nicco Corporation Ltd Hyd / KEI Industries Limited / Delton Cables Limited / Sriram Cables Pvt. Ltd. / Polycab Wires Pvt.Ltd / Torrent Cables Ltd / Apar Industries Limited / Ravin Cables Ltd
	12	Cable trays	Indiana / Parekh / Vatco / Jamnametal / AV / Sadhna Steelmite Engineering / Patny Systems Pvt. Ltd / Jamna Metal Company / Parmar Metals Pvt. Ltd / Metalemms Bombay Pvt. Ltd./ Vinfab Engineers India Private / Premier Power Products / India Electricals Syndicate
	13	Cable Glands	United Agro Engineering Pvt. Ltd./ Flexpro Electricals Pvt. Ltd./ Fcg Power Industries./ Prompt Engineering Works, Mumbai / Flameproof Equipments Pvt.Ltd./ Fcg Flameproof Control Gears / Electromac Industries
	14	Instrumentation Cables	Thermo Cables Limited / Middle East Specialized Cables Co. / Cords Cable Industries Ltd./ Kei Industries Limited / Delton Cables Limited / Paramount Communications Ltd / Special Cables Pvt. Ltd./ Polycab Wires Pvt.Ltd / Suyog Electricals Ltd / Elkay Telelinks Limited / Lapp India Pvt. Ltd. / Associated Cables Pvt Ltd. / Leoni Cable Solutions (India)
	15	Pipes – Carbon Steel	Sumitomo / Koba steel / Maharashtra Steel Tubes / Jindal / SAIL (WTP -Duplex imported)
16	Liquid Level Float Switch	Magnetrol International Inc / V Automat And Instruments Pvt Ltd. / Scientific Devices (Bombay) Pvt. Ltd. / Chemtrols Industris Ltd, Pune Techtrol Pvt Ltd./ Levcon Instruments (P) Ltd. / D.K. Instruments (P) Ltd.	

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SECTION-II

DETAILED MECHANICAL SPECIFICATION –MECHANICAL

2.1.0 SCOPE

This Specification covers the design, performance, manufacturing, construction features, shop & site testing and delivery to site of induced draft cooling towers complete with all accessories, properly packed for transportation, supervision, erection & commissioning, testing at site of all materials and equipment, as specified and as required for completion of the cooling tower(s) in all respects.

If any portion of this specification conflicts with any specific provisions contained in the data sheets, the later shall govern.

2.2.0 REFERENCE

The cooling tower and its accessories shall comply with the stipulations laid down in the latest editions of the following codes and documents and the relevant specifications mentioned in these specifications :

- i AGMA American Gear Manufacturers Association
- ii ASME American Society of Mechanical Engineering
- iii CTI Cooling Towers Institute, USA
- iv ATP Acceptance Test Procedure

2.3.0 DESIGN BASIS

The cooling tower shall be mechanical induced draft type having 3 nos. of cells (2W+1S) with fans, motors, gear reducers, piping distribution system, nozzles, valves, etc. The water-air relationship shall be "Counter Flow" designed to meet the best performance requirements given in the attached data sheet. Where a tower is divided into cells, each cell shall be identified and so designed that each one of them could be operated independently of the rest of the cells and can also be repaired, maintained and cleaned while the other cells are in service.

The basin and channel shall be so designed that full flow conditions can be attained even at minimum water level in the basin. The sluice gates should be able to discharge full cell capacity at minimum water level and levels of gates shall be fixed accordingly. The fill shall be of film type fills, supported on RCC beams. Recycled PVC shall not be used for the fill material. PVC shall be made fire resistant by suitable treatment.

The design of the cooling tower shall generally be as per this specification and as per relevant Indian and International standards to meet the performance requirements given in the attached data sheet.

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The information for structural design of the cooling tower furnished herein is for general guidance of the bidder. Bidder shall verify this information at site before taking up the design of the cooling tower. The cooling towers design shall provide towers suitable for reliable operation in the climatic conditions prevailing at the site. In addition, the tower design shall include the following features for reliable operation and fog reduction under varying seasonal conditions: (i) Water Distribution a. Structural elements within the spray chamber should be minimum. b. In the design of the water distribution system 90% of the plan area should receive water loading within $\pm 5\%$ of the average. No portions of the plan area should deviate by more than 10% from the average. c. Fill manufacturer's performance data should not be used except with the exact spray system used to develop the data. (ii) Air Distribution a. Horizontal structural elements in the air inlet plane should be minimized. b. Appropriate air inlet guiding geometry should be used. c. Velocity pressure ratio shall be greater than 5 (as per CTI paper no.:TP87-04) d. Fan coverage percentage should be greater than or equal to 80% (i.e; if a circle is projected on the eliminator plan area at a 45° angle from the fan cylinder opening, the % of the eliminator area covered by the projected circle is the % fan coverage which should be $\geq 80\%$ as specified in CTI paper no.:TP87-04) (iii) Air Velocity a. At tower inlet 4.5 m/s (max.) b. At fill minimum 1.8 m/s (average) c. The exit air velocity at top of fan stack shall be min 6.1 m/s (as per CTI paper no.:TP87-04) (iv) Tower capability which is defined as the percentage of water the tower can cool under design thermal conditions, shall be minimum 100% (Bidder shall submit the thermal calculations) (v) The air entry is only from sides and not from ends, as there will not be any air opening at the ends. (vi) Maximum efficiency to be considered for fan and gear reducer shall be 78% and 97.5% respectively. (vii) Structural interference near the fill and air inlet shall be minimized to circumvent the loss of effectiveness of fill near the air inlet.			
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OPYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED . It must not be used directly or indirectly in any way detrimental to the interest of the company.	2.4.16 Maximum pumping head available at ground level at terminal point of CT : 12 mwc			
	2.4.17 Maximum permissible velocity for sizing of hot water piping : 2.0 m/s			
	2.4.18 Minimum water level in the cooling tower basin : 100 mm above bottom			
	2.4.19 Cooling tower basin depth : 2300mm			
	2.4.20 Cooling tower Channel area depth : 2450mm			
	2.4.21 Maximum plan area available : 48m x 16m			
	2.5.0 MATERIAL OF CONSTRUCTION AND FEATURES:			
	2.5.1 Tower Casing / Tower basin : Cast – in situ concrete / RCC			
	2.5.2 Fills : PVC			
	2.5.3 Fill support : RCC			
	2.5.4 Drift eliminator : PVC UV Stabilised			
	2.5.5 Water distribution nozzles : Polypropylene			
	2.5.6 Water distribution system : PVC/ FRP/ GRP			
	2.5.7 Fan stack : GRP / RCC			
	2.5.8 Fan blades : FRP / GRP			
	2.5.9 Fan hub : MS HDG			
	2.5.10 Fan drive shaft : Carbon Fibre / SS 304			
	2.5.11 Sluice gates : CI			
	2.5.12 Coarse Screens : MS HDG with SS mesh			
	2.5.13 Fine Screens : MS HDG with SS mesh			
	2.5.14 Codes and standards : CTI code – standard III : BS 4485			
	2.5.15 Operation of CT fans : through plant DCS			
	2.5.16 Following Signals are to be provided for indication in DCS			
	a) Gear box oil level : Low alarm			
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	2.5.17 Whether space heater required for each drive motor : Yes		
	2.5.18 Whether fan blades to have adjustable pitch : Yes		
	2.6.0 COLD WATER BASIN DETAILS		
	2.6.1 Finished Graded level (FGL(E)) : EL 99.7m (FGL of existing plant)		
	2.6.2 Finished Graded level (FGL(N)) : EL 101.2m (FGL of new CCCPP area)		
	2.6.3 Top of paved area (TOP) : EL 101.4m		
	2.6.4 Elevation of basin kerb top : EL 103.575 m		
	2.6.5 Normal water level : EL 102.975 m		
	2.6.6 Storage capacity between normal to minimum water level : Minimum 6 minutes.		
2.6.7 Minimum water level : EL 101.575 m			
2.7.0 STRUCTURAL COMPONENTS AND ACCESSORIES			
The cooling tower shall be of following construction: a. Reinforced cement concrete structure with PVC fill.			
The bidder shall provide metal inserts of approved design on the tower structure for fixing cable trays, pipe supports, lightning arrestors etc.			
2.7.1 Frame Work			
The frame work shall be of RCC construction. For details refer to SECTION-V - DETAILED TECHNICAL SPECIFICATION-CIVIL which is part of this specification.			
2.7.2 Casing			
The casing walls shall be of reinforced cement concrete construction . For details refer to SECTION-V -DETAILED TECHNICAL SPECIFICATION-CIVIL which is part of this specification.			
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OPRYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED . It must not be used directly or indirectly in any way detrimental to the interest of the company. 2.7.3 Filling Fill shall be pure film type made of PVC supported on RCC grid. 2.7.4 Drift Eliminators Drift Eliminator shall be of blade type and blades shall be of PVC-UV stabilized. Drift eliminator blades shall limit the drift losses to a value not greater than 0.005% of the design water circulation rate. 2.7.5 Partition Wall Partition wall shall be provided from basin top to the bottom of fan deck to permit each cell to be taken out of service without affecting the operations of the other cell. RCC partition wall shall be provided for concrete tower. 2.7.6 Fan Deck Fan deck for supporting the fan cylinder and for access to mechanical equipment and distribution system shall be of adequate section to support any reasonable combination of live and dead loads. Fan deck shall be of RCC of adequate thickness for RCC tower. Access doors shall be provided into each cell through the fan deck and drift eliminators for easy access to the cooling tower interior for inspection and repairs. 2.7.7 Access doors All parts subjected to periodical maintenance and inspection such as filling, drift eliminators, fans etc. shall readily be accessible and easily removable. Access door shall be provided in each fan stack. The door shall have easily operable shutter of leak-proof design and MS construction (For painting refer Annexure 1) 2.7.8 Fan Cylinder (Fan Stack) Fan cylinder shall have an extended stack of venturi shape to attain conversion of velocity pressure to static pressure. The height of stack shall be such that the recirculation effects of air shall be reduced to minimum possible. Fan stack shall be of GRP/RCC construction for concrete tower. Rings for fan stacks shall be of the same material as that of fan stack and shall be concentric with the fan. 2.7.9 Stairways RCC staircase one each at both the ends of the cooling tower from ground level to fan deck shall be provided. For details refer to SECTION-V -DETAILED TECHNICAL SPECIFICATION-CIVIL which is part of this specification.			
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Owner or his authorized representative will have the right to inspect at any stage of manufacture and construction, all materials, components and workmanship and testing of material. The bidder shall provide all facilities for inspection and testing without any extra cost to the owner. It shall be clearly understood that the bidder shall be responsible to complete and commission the entire work in all respects including the work not specifically mentioned in the scope of work or specifications or in drawings, but are necessary to achieve completions. 2.12.0 PERFORMANCE, GUARANTEE AND TESTS The completed cooling tower performance test shall be carried out by the bidder to demonstrate the design parameters specified under Design data Section 2.4.0. The Performance guarantee test shall be carried out in accordance with the cooling tower Institute Acceptance Test Procedure ATP-105. If the performance test shows a deficiency, the bidder shall rectify the defects without any additional cost and demonstrate the design parameters. The bidder shall furnish performance curves based on constant L/G ratio for the following conditions: a. For water rate at design condition and +10% variation. b. For cooling range at design condition +20% variation. c. For wet bulb temperature +3.0⁰F(ie. +1.67⁰C) and -7⁰F (ie. -3.9⁰C) of design wet bulb temperature. The completed cooling tower operation shall also be guaranteed to meet the following requirements. - The approach shall not be greater than that specified in the cooling tower data sheet. - Motors driving the fans shall be amply sized for total BHP required including gear losses. - The power consumption for running the fan should not exceed the rated BHP. - There shall be no leakage of water through sides or ends of the tower. - Motors, speed reduction gears and fans shall be of adequate design and construction and properly protected for operation in all adverse climatic conditions. - Water tightness of basin, piping, valves, sluice gates, etc. is to be ensured. - Test for cooling capacity to meet design parameters. - Test for tripping level of vibration switch. - Drift losses and power consumption shall be within the guaranteed limit mentioned in data sheets. - Motors and fans shall operate satisfactorily in continuous operation with no injurious vibrations and the sound intensity shall not exceed 85 decibels above threshold level when measured at a horizontal distance of 1.5M from the nearest face of the tower and 1.5 M above ground level.			
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- Return water header in bidder's scope shall be hydraulically tested for a pressure of 10.5 kg/cm².

Failing to meet the guaranteed parameters shall make cooling tower liable for rejection.

2.13.0 SPECIFIC REQUIREMENTS

a) Bidder shall provide one spare screen to facilitate maintenance and repairs.

b) Bidder shall specify the type of resin for all G.R.P. materials. The Bidder shall also indicate the tensile strength of GRP materials used and it shall be noted that the materials shall be tested for strength.

2.14.0 Mandatory Spares

The following mandatory spares shall be supplied

Sl.No.	Description	Quantity required
1	Coupling with all fasteners	10% or 1 no. of each type and size
2	Bearings complete	20% or 2 sets of each type and size
3	Complete fan and hub assembly matched and balanced	10% or 1 set of each type and size
4	Complete gear box	10% or 1 no. of each type and size
5	Bearings for gear box	20% or 2 sets of each type and size
6	Oil seals, 'O' rings and Gaskets for gear box	10% or 2 sets of each type and size
7	All Couplings (Fan end, Gearbox end and motor end) along with all fasteners)	10% or 1 set of each type and size
8	Cell Isolation Valve	10% or 1 no. of each type and size
9	Tower Internals – Water spray nozzle	10% of total population of one tower
10	Towers Internals-Film Type Fills Packs	10% of total population of one tower
11	Towers Internals – Drift eliminator	10% of total population of one tower
12	Bearing of each motor type and rating (set)	Min. 10% of installed capacity
13	Local Gauges (pressure, temperature, level, flow)	5% for each type and range subject to minimum 1nos.
14	Field switches	5% for each type and range subject to minimum 1nos.
15	Junction boxes (Terminal Blocks, Cable glands, Lug)	5% for each type and range subject to minimum 1nos.

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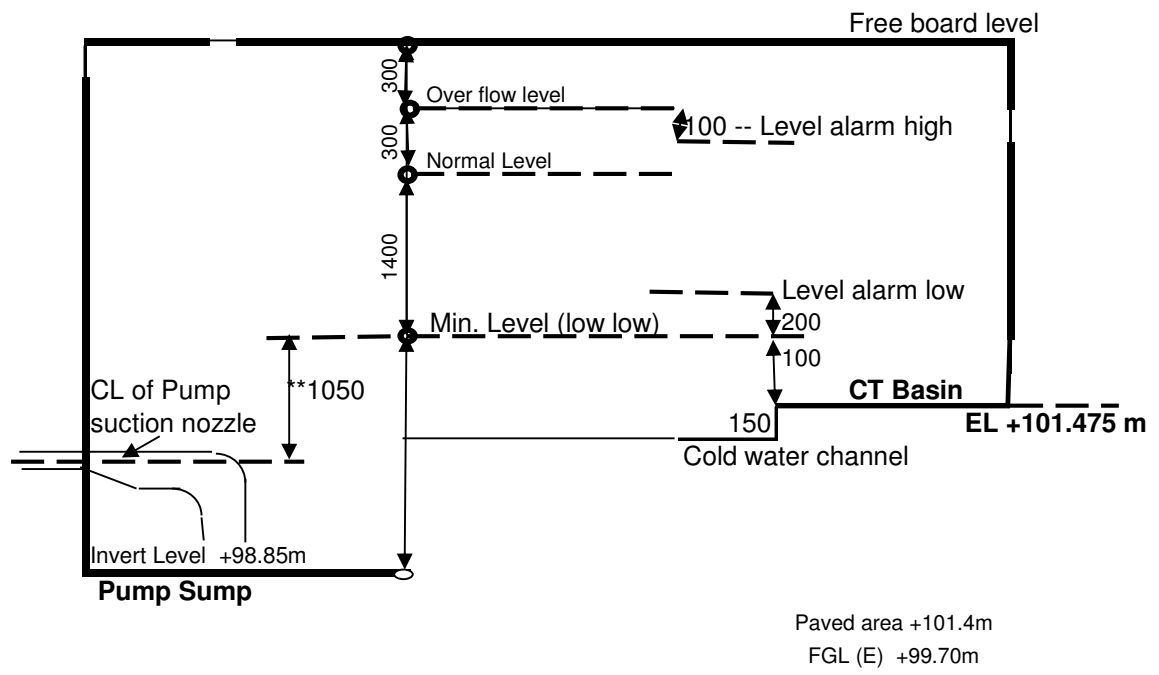
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2.15.0 WATER LEVELS IN CT BASIN & CW PUMP SUMP



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OPRYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED . It must not be used directly or indirectly in any way detrimental to the interest of the company. STRUCTURAL STEEL IS : 800 -Code of Practice for General Construction in Steel IS : 808 -Dimensions for Rolled Steel Beam Channel and Angle Sections 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 : 9595 -Recommendations for Metal Arc Welding of Carbon Manganese steels. IS: 801 - Code of practice for use of cold-formed light gauge steel structural members in general building construction. IS: 802 - Code of practice for use of structural steel in overhead transmission line towers. IS: 806 - Code of practice for use of steel tubes in general building construction. IS: 814 - Covered electrodes for manual metal arc q welding of carbon and carbon manganese Steel. IS: 2629 - Recommended practice for hot dipped galvanizing on iron and steel. MISCELLANEOUS IS : 1905-Code of Practice for structural use of un-reinforced masonry IS: 1597- Code of practice for construction of stone masonry IS: 1838- Fillers for expansion joints IS:2633- Methods for testing uniformity of coating of zinc coated articles IS: 4091- Code of practice for design and construction of foundation for transmission line towers and poles IS: 4991- Criteria for blast resistant design of structures for explosions above ground IS: 6313-Code of practice for anti-termite measures in buildings IS: 6533- Code of practice for design & construction of steel chimney IS: 6745- Method for determination of mass of zinc coating IS: 8944- Chloropyrifos emulsifiable concentrates IS: 9178- Criteria for design of steel bins for storage of bulk materials IS: 12118- Two parts polysulphide based sealants IS: 5249- Determination of dynamic properties of soil IS:5410- Code of practice for cement and colored paints IS:9862- Ready mixed paint, brushing, bituminous, black, lead –free, acid, alkali, water and chlorine resisting Note: The above list is suggestive and not exhaustive. Apart from these basic codes any other code referred-to in this document and/or any other related code shall also be followed wherever required. STANDARDS SP 6 -ISI Handbook for structural engineers SP (7) -1972-Simple welded girders SP : 16-Design aids for reinforced concrete to IS:456-1978 SP (20) -Hand book on masonry design and construction			
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SP 22 -Explanatory handbook on codes for earthquake engineering (IS:1893 & IS:4326). SP : 24-Explanatory handbook on Indian Standard code for plain and reinforced concrete (IS:456-1978) SP : 34-Hand book of concrete reinforcement and detailing Also, the standards mentioned in Annexure 2 of this specification are applicable: 3.4.0 Loads & Load Combinations 3.4.1 Design loads shall comply in general with the requirements of IS:875 and IS:1893 as a minimum, unless more stringent requirements are specified herein. The following type of loads shall be considered in general for the analysis and design of structures and foundations. i) Dead Loads (DL) Dead loads shall include the weight of all structural and architectural components. It shall also include the self-weight of equipment and any other permanently applied external load. Self-weight of materials may be calculated on the basis of unit weights as per IS:875 ii) Live Loads (LL) Live loads noted below are the general equivalent uniformly distributed loads to account for equipment/piping/cable tray/erection loads etc. Where the actual loads of the equipment exceeds in specific areas due to concentration of facilities, the same shall be substituted in lieu of the above loads. For areas not covered below, the relevant loading furnished in IS:875 shall govern. Fan deck : 500 kg/m² Staircases & Platforms : 500 kg/m² Side walls & partitions of basin a) From inside : Hydrostatic loading (with no passive pressure from soil outside) b) From outside : Earth pressure (with no water/ hydrostatic pressure inside) iii) Equipment Loads (EQL) : Equipment causing heavy concentrated loads shall be considered separately. Where both concentrated and uniform loads cannot act simultaneously the			
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OPRYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED . It must not be used directly or indirectly in any way detrimental to the interest of the company. structure shall be checked for each condition of loading separately and shall be designed for the most critical conditions iv) Wind Loads (WL) Wind load shall be in accordance with IS:875 (Part - 3) - 1987. However basic wind speed shall be 44m/s. Design life of structure shall be taken as 100 yrs. To account for surface area of piping, platform and other attachments fixed to equipment, the surface area exposed to wind shall be increased by 20% or as specified in the mechanical data sheet of equipment. v) Seismic Load (SL) Seismic loads shall be in accordance with “CONTRACT specification Annexure 2 (volume III section-5) : which are CONTRACT Specifications and attached with this specification. vi) Equipment Loads (EQL) Equipment loads are self-weight of the structure of permanent or semi-permanent equipment acting on the structure. Such loads will be supplied by the equipment manufacturer. Only major equipment loads will be considered separately. The minor equipment loads will be included in live loads. vii) Dynamic Loads (DNL) Dynamic Loads due to ID fan and motor etc. shall be considered to check resonant condition. 3.4.2 Load Combinations All possible load combinations as suggested by IS codes/DCPL specs. shall be considered in analysis. Wind and earthquake shall be assumed to act separately. 3.4.3 Design Details a. Concrete Structures : (Follow sheet 690 of volume III section 5 attached as annexure 2 & IS:3370) The following grades of concrete shall be adopted for the type of structures noted against each: M30 : All structural elements like basins, partition walls, columns, beams, foundations etc. with minimum cement content of 400kg/m³ of concrete. M30 : For all piling and pile caps with minimum cement content of 420kg/m³ of concrete . M20 : PCC in pavement, plinth protection. 1:3:6 : PCC below base slab etc. The minimum thickness of PCC below base slab shall be 100mm.			
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ii.

Design of structural concrete for liquid retaining structures such as basin, partition wall in basin etc. shall be designed as uncracked section in accordance with IS:3370. Reinforcing steel shall be arranged to control shrinkage cracks. Concrete partition wall in basin, if any, shall be designed considering water on one side only.

iii.

Design of all other structural elements such as fan deck slab, outside staircase, frame columns etc. shall be carried out as per limit state method as per IS:456-2000.

iv.

Base slab/rafts of all liquid retaining structure shall be designed to withstand the uplift pressure.

v.

Factor of safety shall not be less than those specified under clause 20 of IS:456-2000 against overturning and sliding.

vi.

Factor of safety against uplift shall be as per IS 3370 (Part-I).

vii.

The base slab shall be monolithic with the wall and uniform thickness.

viii.

Liquid retaining structure shall be checked for water tightness as per IS codes.

ix.

All stairs shall have maximum rise of 150 mm and minimum tread of 300 mm & shall be minimum 1200 mm wide (RCC stairs) .

x.

The cover adopted shall be as follows in accordance with IS:3370:-

Grade beams

Floor beams

Slabs

Column

Footings

:

:

:

:

:

Follow spec. volume III section 5 attached as annexure 2

xi.

TMT/High Yield Strength Deformed steel bars of grade Fe-500 bars conforming to IS-1786. Painted with fusion bonded epoxy coating as per IS: 13620 shall be used for reinforcement. Binding wire shall be PVC coated binding wire.

xii.

For structural concrete items, Cement to be used shall be either Portland slag cement with minimum 50 % slag or Portland pozzolana cement since the site is exposed to severe environmental condition due to marine environment. Follow spec. volume III section 5 attached as Annexure 2.

b.

Steel Structures

Design of steel structures shall be carried out by working stress method of IS:800.

c.

Foundations

The soil parameters used for the design of underground structures shall be as per the detailed Soil Investigation Report which is attached separately with the specification. If

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piling is envisaged in this project, the same shall be of bored cast-in-situ type. Bidder to note that final soil report is to be followed without any cost and time implications.

d. **Cement content:**
Follow spec. volume III section 5 attached as **annexure 2**.

3.5.0 GENERAL DESIGN SPECIFICATION

3.5.1 General :

The design specification herein below establish the minimum basic requirements for all Civil & Structural works. However, all structures shall be designed for the satisfactory performance of the function for which the same are to be constructed.

With regard to soil and other hydrographic data furnished, it shall be clearly understood that the same are given to the bidders in good faith and as such no claim for extra payment shall be entertained by the Owner, if the actual condition met with during execution are at variance with the data given in tender. The bidder shall fully satisfy himself about the site conditions, nature of soil, ground water, contour levels etc. prior to the submission of the bid. The bidder shall conduct his own investigations to ascertain the correctness of the data furnished.

3.5.2 Design Calculations and Drawings

Detailed design calculations / design drawings shall be commenced by Contractor only after approval is obtained from the Owner to the basic design criteria submitted by the Contractor. No later deviation from the approved design criteria will be permitted unless specifically approved again by the Owner in writing, prior to its adoption.

Civil scope drawings for structural system showing all equipment loads, cutouts, embedments etc. based on approved mechanical General Arrangement (GA) drawings shall be submitted by the Contractor and these shall be accompanied by detailed design calculations. Drawings and design calculations submitted without prior approval of relevant mechanical GA drawings will not be considered for review.

Designs and drawings shall be submitted sequentially in a phased manner and Contractor shall ensure that design calculations / drawings for several structures are not submitted at one time. For this purpose, design / drawing submission schedule shall be furnished by the Contractor for Engineer's review and approval. Owner will review and furnish comments / approval to the designs and drawings, generally within a period of four weeks from the date of receipt of the same in the Owner's office. Timely submission of designs / drawings to the Owner for review / approval is the sole responsibility of the Contractor and postal or other delays as reasons for late / non-submission will not be entertained by the Owner.

Designs and drawings submitted by the Contractor shall be thoroughly checked and approved by the Contractor's authorised engineers before submission for approval. Any

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unchecked / unsigned documents will not be reviewed by the Owner. No claim from the Contractor for extension of time or extra cost on this account shall be entertained by the Owner under any circumstances. No check will be specifically carried out by the Owner to verify arithmetical / numerical accuracy of the calculations, which shall remain entirely the Contractor's responsibility. All design calculations and drawings shall be in English and shall be in SI units. All modification suggested by the Owner to meet specification requirements and sound engineering practice shall be incorporated by the Contractor at no extra cost to the Owner. In this respect, the decision of the Owner shall be binding on the Contractor. Should there be a requirement for preparation of separate drawings to show enlarged details to facilitate construction / erection, then such drawings shall also be prepared by the Contractor at no extra cost. Design drawings showing typical connections and details conforming to design assumptions shall be submitted for approval of the Owner by the Contractor. Design drawings for steel structures shall include structural arrangement, member size, member forces, splice location, details of base plate, anchor bolts, typical connection details etc. so that the drawing indicates clearly all the necessary information brought out in relevant design calculations. Proposed bracing patterns shall be subject to approval by Owner duly considering system requirement point of view. Changes in structural sections on approved drawings shall be got ratified with necessary supporting calculations and reasons for the change. Contractor shall note that all values / dimensions / elevations etc. without supporting break up of data adopted / assumed in his calculations / drawings shall be taken by Owner to be correct unless these have been specifically indicated in the specification. Any problems later met in this regard shall be made good by the Contractor at his own cost and no extension of time on this ground shall be granted by the Owner. The designs shall clearly spell out the erection scheme for various structures envisaged by the Contractor and resulting additional loadings, if any, shall be duly accounted for. Before taking up actual erection work, detailed erection scheme proposed to be followed by the Contractor shall be submitted for Engineer's approval. Detailed civil construction drawings including Bar Bending Schedule for all concrete works shall be prepared by the Contractor and submitted to the Engineer / Owner for their review and approval Construction work at site shall commence only after obtaining written approval to the drawings by the Owner. For framed structures, computer analysis shall be adopted and the computer output listing should include all input data covering the design loads and other particulars as specified. Computer package used shall be a proven and widely used software.			
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Internationally accepted commercial software viz. STAAD, STAADPRO, COSMOS, GT STRUDEL, NISA only shall be permitted for analysis and design. In case software packages other than listed above are intended to be used for analysis and design, the same shall be informed in writing to Owner/Owner's representative. Calculations and relevant computer files containing input and detailed output shall be submitted by the Contractor for checking and validation of the software package. Only after getting written approval from Owner/Owner's representative, to this effect such intended software be put to use for detailed analysis and design. Contractor shall submit typical hand calculations for a few important structural elements to validate the computer programme used for the designs. The design and drawings of this Cooling Tower needs to be approved by M/s BHEL before starting of the construction. A detailed list of drawings/documents ((including design calculations, design drawings, bar bending schedules (for RCC works) and fabrication drawings(for structural steel works)) & structure wise quantity statement(showing anticipated, released and balance quantities of concrete, structural steel and piles) shall be submitted in post order stage to Owner/Owner's representative for review. The drawing list and quantity statement shall be updated every month and submitted to Owner/Owner's representative. General philosophy of designs of all the structures and equipment foundations along with explanatory sketches and basis of design/analysis shall be submitted and got reviewed by Owner/Owner's representative before the contractor proceeds with the final design and construction drawings. Structural design and drawings for any structure/building/equipment foundation shall be submitted only after the reference Architectural drawings/equipment data sheets and G.A.drawings/vendor drgs have been reviewed in at least code-2*, by concerned specialist of Owner/Owner's representative. Copies of these reviewed reference documents shall also be submitted along with structural design and drawings while submitting them to Owner/Owner's representative for review. *Code-2: Proceed with manufacture/fabrication as per commented document, revised document required. Apart from fulfillment of functional and safety requirement, aesthetic requirement of the cooling tower shall be taken care in the design. As specific guidelines for achieving required aesthetics are difficult to establish, preliminary drawings indicating architectural treatment shall be submitted to BHEL/CONTRACT for approval. Elements like canopies, overhangs, shading devices, gutters door window/ventilators, external appearance, colour scheme etc. shall be considered as contributory to aesthetics and the design shall be subject to BHEL/ONGC's approval. Painting on Cooling tower building shall be done as per contract specification- C-1.8 Cooling tower civil work shall be as per CONTRACT spec "volume III section 5 attached as annexure 2" in addition to above mentioned clauses.			
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<u>SECTION-IV</u> <u>DETAILED TECHNICAL SPECIFICATION-ELECTRICAL</u>			
OPRYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED . It must not be used directly or indirectly in any way detrimental to the interest of the company. 4.1.0 INTENT OF SPECIFICATION This specification is intended to cover the design, manufacture, assembly, testing at manufacturer's works, supply and delivery properly packed for transport of all electrical equipment and accessories required for effective and trouble free operation cooling tower. The specification also includes receiving, unloading, storage, insurance, in-plant transportation and handling, complete erection, final check-up and testing of all equipment and accessories covered under this specification including their trial run and commissioning ensuring safe and trouble free continuous operation of the specified electrical power supply, distribution and evacuation systems to the complete satisfaction of the Purchaser. 4.2.0 CODES AND STANDARD All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable IS/IEC except where modified and/or supplemented by this specification. Equipment and materials conforming to any other standard which ensures equal or better quality may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid. The electrical installation shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS Codes of Practice. In addition, other rules or regulations applicable to the work shall be followed. In case of any discrepancy, the more restrictive rule shall be binding. 4.3.0 SCOPE OF SUPPLY - Motors for fans & other drives with specified cable glands & lugs - Local push button stations for motors - Cable trays from bottom of the cooling tower up to motor terminal box. - Earthing of all electrical & electronic equipment installed on cooling tower - Lightning protection of cooling tower - Lighting system complete with required lighting panel, lighting fixtures, wiring and switched sockets for the cooling tower. - Two numbers 63A, 415V industrial type welding receptacle 4.4.0 COMPLETENESS OF SUPPLY It is not the intent to specify completely herein all details of the equipment. Nevertheless, the equipment shall be complete and operative in all aspects and shall conform to highest standard of engineering, design and workmanship. Any material or accessory which may not have specifically mentioned but which is necessary or usual for satisfactory and trouble-free operation and maintenance of the equipment shall be furnished without any extra charge.			
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	4.5.0 DEVIATION Should the Bidder wish to deviate from this specification in any way, he shall draw specific attention to such deviation. All such deviations shall be clearly mentioned on the Deviation sheet enclosed, with reference to the respective clause of the specification. Unless such deviations are recorded in the Deviation sheets and submitted with the offer, it will be taken for granted that the offer is made in conformity with this specification in all respects.
	4.6.0 SYSTEM CONFIGURATION
	4.6.1 System Voltages with variations a) Main Power Circuits : i) 415 Volts : ±6% b) Control Circuits : i) 110 Volts DC : (±)10% to (-)15% c) Lighting Circuits : i) 240 Volts AC : ± 6% ii) 110 Volts DC : (+)10% to (-) 10% d) Frequency with variations : 50 Hz, ±3% e) Combined voltage & Frequency : ±10% (absolute sum) Variation
	4.6.2 Fault Level(For LV system) (a) 415 Volts System : 50KA for one (1) Second. (b) DC system : 20 KA for one (1) Second. (c) Lighting System: 15kA for 1 sec
	4.6.3 No. of Phases & System of grounding a) 415 volts Supply : 3 phase and neutral solidly grounded
	4.7.0 TROPICAL PROTECTION AND PAINTING All electrical equipment, accessories and wiring shall have fungus protection involving special treatment of insulation and metal against fungus, insect and corrosion. Screens of corrosion resistant material shall be furnished on ventilating louvers to prevent entrance of insects.
	All steel surfaces shall be thoroughly cleaned by sand blasting or chemical process as required to produce smooth surface free of scale, grease, rust and foreign adhering

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OPYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED . It must not be used directly or indirectly in any way detrimental to the interest of the company. 4.8.1.12 Grounding The frame of each motor and its TB shall be provided with two separate and distinct grounding pads complete with tapped hole, GS bolts and washer. The cable terminal box shall have a separate grounding pad. 4.8.1.13 Rating Plate In addition to the minimum information required by IS, the following information shall be shown on motor rating plate : a) Temperature rise in °C under rated condition and method of measurement. b) Degree of protection c) Bearing identification no. and recommended lubricant. d) Location of insulated bearings. 4.8.1.14 Accessories Accessories shall be furnished, as listed below, or if otherwise required by driven equipment specification or application- Space Heater a) Motor of rating 30 KW and above shall be provided with space heaters, suitably located for easy removal or replacement. b) The space heater shall be rated 230 V, 1 phase, 50 Hz and sized to maintain the motor internal temperature above dew point when the motor is idle. c) Space heater shall be provided with thermistor element. Indicator/Switch a) Dial type local indicator with alarm contacts shall be provided for the following : - i) 6600 V motor bearing temperature. ii) Hot and cold air temperature of the closed air circuit for CACA and CACW motor. b) Flow switches shall be provided for monitoring cooling water flow of CACW motor and oil flow of forced lubrication bearing, if used. c) Alarm switch contact rating shall be rated suitably at operating voltage. Current Transformer for Differential Protection a) Motor >= 1000 KW shall be provided with three differential current transformers mounted over the neutral side leads within the TB. b) The arrangement shall be such as to permit easy access for C.T. testing and replacement. Accessory Terminal Box a) All accessory equipment such as space heater, temperature detector, current transformers etc., shall be wired to and terminated in terminal boxes, separate from motor (power) terminal box. b) Accessory terminal box shall be completed with double compression nickel plated brass glands, tin coated Cu lugs and pressure type terminals to suit cable connections.			
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Drain Plug
Motor shall have drain plugs so located that they will drain the water, resulting from the condensation or other causes from all pockets of the motor casing.

Lifting Provisions
Motor weighing 25 kg. or more shall be provided with eye bolt or other adequate provision of lifting.

Dowel Pins
The motor shall be designed to permit easy access for drilling holes through motor feet or mounting flange for installation of dowel pins after assembling the motor and driven equipment.

Painting
Motor including fan shall be painted with corrosion proof paints.

4.8.1.15 Test (at manufacture works)
Upon completion, each motor shall be subjected to standard routine tests as per relevant standards. In addition, any special test called for in the driven equipment specification shall be performed. The following type tests shall be performed on a representative sample of 6600V motor of each type & rating, even if type test certificates of these tests are submitted by the Bidder for Purchaser's approval.

a) Measurement of stator resistance and rotor resistance. (slip ring motors)

b) No load running of motor and reading of voltage, current, power input and speed.

c) Locked rotor reading of voltage, current, power input and values of torque of motor.

d) Full load reading of voltage, current, power input and slip.

e) Temperature rise test.

4.8.1.16 Drawings, Data & Manuals
Drawings, data & manuals for the motors shall be submitted as indicated below:

To be submitted with the Bid

a) List of the motors

b) Individual motor data sheet

c) Scheme & write up on forced lubrication system, if any.

d) Type test certificates on similar motors of comparable ratings.

To be furnished for Approval and Distribution

a) Dimensional General Arrangement drawing

b) Foundation Plan & Loading

c) Cable end box details.

d) Space requirement for rotor removal

e) Thermal withstand curves hot & cold.

f) Starting Time Vs Current and speed torque characteristics at 80% & 100% voltage

g) Complete motor data.

h) Any other relevant drawings, documents or data necessary for satisfactory installation, operation and maintenance.

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OPYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED . It must not be used directly or indirectly in any way detrimental to the interest of the company. Instruction Manuals for Motors The manuals shall clearly indicate method of installation, check-ups, tests to be carried out before commissioning and operation cum maintenance of the equipment. The Bidder may note that the drawings, data and manuals listed herein are minimum requirements only. The Bidder shall ensure that all other necessary write-ups, curves, calculations and information required to fully describe the equipment are submitted with his bid. 4.8.1.17 Tests on motor during commissioning The erection tests the pre-commissioning tests shall cover: • High voltage tests (for HT motors only) • Trip tests • Equipment Functional Test • Tests on Motors as per IS • Insulation test of winding by megger, drying out and, if necessary, high potential test. ○ Winding resistance measurement on all 3 phases for motors. ○ Testing the motor for proper direction of rotation and reconnection, if necessary. ○ No load test run of the motor for a minimum of eight (8) hours to check out bearing or other associated parts. ○ During test run, hourly record of currents on all the three phases shall be maintained and careful watch shall be maintained on the equipment for any abnormal sound, temperature of bearing, vibrations. ○ After no load test run of the motor each rotary equipment shall be coupled and shall be subjected to a test run. The duration of this test run shall be mutually agreed with customer (minimum 4 hours). ○ The objective of the test run shall be to ascertain that the following are within the permissible limits and the operation is satisfactory. ▪ Vibration and noise level ▪ Bearing vibration and temperature ▪ Performance of the lube oil systems ▪ Motor winding temperature ▪ Performance of various control, interlocks and protective elements, wherever applicable. ▪ Performance of annunciation system and indication, wherever applicable. All above tests shall be carried out in presence of BHEL/end customer as per the agreed protocol at site with customer. 4.8.2 LIGHTING SYSTEM 4.8.2.1 Design feature Cooling tower platforms and stair cases shall be suitably illuminated. Lighting fixtures shall be provided through out cooling tower platform and staircase with suitably mounting. The lux level shall be 80 lux at platform and staircase landing. The minimum illumination level at any point should not be less than 75% of average lux level. While designing illumination layout different design factors i.e. lamp aging			
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factor, utilization factor and maintenance factor etc. shall be suitably considered. Maintenance factors shall not be more than 0.7.

The illumination level as specified shall be guaranteed. While measuring illumination level for this purpose ageing factor and maintenance factor considered in the illumination design will be applied, i.e. the illumination level measured for new installation have to be much higher than specified lux level.

Lighting fixtures shall be fed from outdoor type lighting panel of suitably rated & sized. Lighting panel shall be suitably located at easy accessible location. Lighting fixtures shall be group controlled through outgoing MCB of lighting panel. Circuit load for MCB shall be limited to 1200W(Max) or 10 nos. of lighting fixture whichever is minimum.

Lighting package shall include lighting fixtures, lighting & Power panels, 1ph & 3ph receptacles, lighting JB's, copper armoured XLPE insulated cable of required sizes as mentioned elsewhere in this document. Mounting and illumination installation accessories like poles, clamps, anchoring fastener, cable glands, cable trays etc. which are required for successful erection & commissioning of lighting package shall be included.

All the equipment in the lighting package shall be of approved make, necessary approval shall be obtained before installation of any equipment.

All equipment i.e. Lighting fixtures, Receptacles, Panels, Junction boxes, Cable glands etc. installed in hazardous area shall be of flame proof type suitable for respective classified area zone and gas group. All flame proof equipment shall be test certified from approved test house like CMRI/ERTL etc. as applicable. The equipment shall in addition bear the valid approval from Chief Controller Of Explosives (CCOE)-Nagpur, Directorate General of Factory Advice service & Labour institutes (DGFASCI), Mumbai and a valid BIS license.

4.8.2.2 Fixture & Lamps

Lighting fixtures shall be designed for an operating voltage 240V +/- 10%, 50Hz +/- 5%, 1ph AC supply. Fixtures shall be of weather proof type with a minimum of IP55 protection class and shall be designed for minimum glare. The surface finish shall be smooth, unobtrusive and scratch resistant.

Well glass fixture, non-integral type suitable for HPSV lamp shall be considered. Fixture should have neoprene gasketed toughened glass cover and wire guard. Provision of external reflector shall be considered and supplied if asked specifically during detail engineering. Flame proof fixtures shall be considered for installation in hazardous area.

Fixture shall have provision of cable entry from side only, top cable entry shall be avoided. Fixture shall be furnished complete with lamps and separately mounted control gear and accessories as applicable.

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OPYPRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED . It must not be used directly or indirectly in any way detrimental to the interest of the company. shall be 25 X 6 mm. Busbar support shall be FRR or approved equal, Bakelite support will not be acceptable. Bus bars shall be supported and braced to withstand the stresses due to maximum short circuit current and also to take care of any thermal expansion. All bus connections shall be silver plated. Adequate contact pressure shall be ensured by means of two bolt connection with plain and spring washers and lock nuts. Bimetallic connectors shall be furnished for connection between dissimilar metals. The 4-wire system shall have fully insulated neutral bus of minimum cross-section half of the phase buses. Bus bars shall be colour coded for easy identification and so located that the sequence R-Y-B shall be from left to right, top to bottom or front to rear when viewed from the front of the assembly. Board/Panel shall be fitted with phase barriers such that it is not readily possible for personnel to touch the phase busbars. Insulation barriers shall be provided around the circuit breakers such that only the dollies of the circuit breaker is accessible after opening the door. Incomer to each Lighting panels shall be provided with one triple pole 63A MCB(without release) with neutral isolating facilities and one earth leakage circuit breaker of sensitivity 100mA. Combined type triple pole MCB with earth leakage circuit breaker also acceptable for incomer. Lighting panels shall have outgoing 20A , DP MCBs having thermal elements for overload protection and an instantaneous magnetic trip to protect against severe faults. All MCBs provided shall be suitable for breaking capacity of 10kA(Minimum) at 240V AC. ELCB of suitable sensitivity shall be provided. Incoming and outgoing circuit shall be terminated in suitable terminal blocks. Each Lighting panel shall have sufficient number of spare outgoing feeders (at least 20%). Panel shall be standardized to have 6 way, 12 way & 18 way. Panel incomer shall be suitable for 4Cx16 sqmm, Cu. Cond. XLPE Ar. Cable and outgoing shall be suitable for 3Cx2.5sqmm cu. Armoured XLPE cable. Double compression nickel plated brass cable gland with FRP shroud of suitable size equal in no. to the incoming and outgoing circuit shall be supplied. 4.8.2.4 Receptacles Following type of receptacles shall be provided : a) Type RB-15A (industrial metal type along with controlling switch and plug), 240V, 2 pole, 3 pin with third pin earthed. No. of receptacle shall be provided sufficient to ensure accessibility with a 15m length of trailing cable from any point in the cooling tower area. Flame proof socket shall have interlocking facility between plug and socket.			
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b) Type RC-63A, 415V, 3 phase, 5 pin interlocked plug and switch with earthing contact. Rotary switch with interlocking arrangement ensures that Plug cannot be removed when switch is ON. Qty. of receptacle shall be sufficient to ensure accessibility with a 50m length of trailing cable from any point in the cooling tower area and shall be fed from AC Distribution Board/MCC (ACDB/MCC is in BHEL scope). Maximum two nos. receptacle shall be fed from one feeder with a condition that at a time only one will be in use.

Receptacles shall be heavy duty, complete with individual plug and switch. Receptacle boxes shall be, metal clad gasket construction with 2mm CRCA sheet steel and neoprene gasket cover, weather proof and shall have minimum IP55 protection with external canopy. Receptacles shall have spring loaded shutter or cap with metallic chain to cover the socket when not in use. Plug suitable for socket unit shall be supplied along with each receptacle.

Receptacles shall be suitable for either wall/column mounting on brackets and shall have loop in/out provision. Each receptacle box shall be epoxy painted through 7 tank process with color shade of 631 as per IS5.

The receptacle shall be provided with earthing screws with washer and nuts welded on the surface for grounding. Arrangement shall be provided inside the receptacle for grounding of third pin. Shrouded type plug shall be provided with corresponding matching arrangement at sockets to prevent accidental contact with finger during plug insertion.

All 15A sockets shall feed through power panel only. Maximum three nos. 15A, 1ph, receptacle shall be fed from one circuit. Each outgoing feeder of power panel shall be suitable for 3Cx4 sqmm, XLPE Ar. Cu.Cable. Other constructional details of power panel shall be as per lighting panels.

Cable terminating to the receptacle from bottom only and should be through double compression nickel plated brass cable gland of appropriate sizes and PVC shroud. Unused entries should be sealed by Al. blanking plug.

4.8.2.5 Lighting Cables & Wires

Lighting cables shall conform to clause no-1.7.5 – “LT Power and Control Cables”. Lighting fixtures shall be wired through 3Cx2.5sqmm cu. Armoured XLPE cable. 1ph, 15A, 240V sockets shall be wired through 3Cx4sqmm cu. Armoured XLPE Cable. 3ph, 63A socket shall be wired through 4Cx16sqmm cu. Armoured XLPE cable..

4.8.2.6 Junction Box

Junction boxes shall be of 16 SWG sheet steel hot-dip galvanised, dust and damp proof, generally conforming to IP-55.

Junction boxes shall be complete with gasket inspection cover, terminal blocks, cable glands etc.

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			Junction boxes for outdoor use shall be weatherproof type IPW-55 with external canopy and those for hazardous location shall be flame-proof type. Junction boxes shall have following indelible markings : Circuit nos. on top Circuit nos. with ferrules (inside) as per drawing DANGER sign in case of 415V circuit. 4.8.2.7 Lighting poles (2Mtr & 3 Mtr pole for Hand rail and skid mounting) i) Lighting pole shall be of medium grade GI pipe with 100mm internal diameter for 3.0 mtr and above height pole and 50mm internal dia for 2.0 meter height pole. ii) The 3.0 mtr. and above lighting pole shall be completed with fixing base plate for mounting of pole in concrete foundation up to 750mm height. iii) The poles shall have swan neck made of medium grade 50mm GI pipe with radius of 250mm. iv) All poles should have required size holes for routing of cable to the fixture. v) All the accessories like reducer, coupler, bend pipe, U bolt etc. which are required for successful installation of poles should be provided. 4.8.2.8 Nameplate Nameplates shall be furnished for identification of devices and circuits. All switches, controls and indications shall be permanently and legibly marked in English as to their functions. All lighting fixtures, receptacles, junction boxes etc. shall be properly marked up indelibly with corresponding circuit nos. 4.8.2.9 Codes & Standards i) IS:6665 - Code of practice for industrial lighting. ii) IS:3646 – Code of practice for interior lighting. iii) IS:1944 – Lighting for roads with special requirements. iv) IS: 1777- Industrial luminaire with metal reflectors v) IS: 1293- Plug and socket outlets of rated voltage upto and including 250V and rated current upto 16A. vi) IS:1913- General and safety requirements for luminaires. vii) IS:4012-Specification for dust proof electric lighting fitting. viii) IS:4013-Dust tight electric lighting fittings. ix) IS:6616-Ballast for high pressure mercury vapour lamps. x) IS:9974-High pressure sodium vapour lamps. xi) IS:13947-Low voltage switchgear and control gear. xii) IS:694-PVC insulated cables for working voltage upto and including 1100V 4.8.2.10 Tests i) Shop Tests All equipment shall be completely assembled, wired, adjusted and routine tested as per relevant Standards at manufacturer's works. Tests on lighting distribution boards/panels shall include : a. Wiring continuity tests. b. High voltage and insulation tests. c. Operational tests.	
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ii) Site Test

The Bidder shall thoroughly test and meggar all cables, wires and equipment to prove the same are free from ground and short circuit. If any ground or short circuit is found, the fault shall be rectified or the cable and/or equipment replaced.
All equipment shall be demonstrated to operate in accordance with the requirements of this specification. Illumination in different areas shall be measured and demonstrate that it is as per designed lux level as per requirement.

4.8.2.11 Drawings, Data & Manuals

i) To be submitted with the Bid

Make, type and catalogue number of lighting fixtures, Control gears, lamps and accessories along with technical leaflets, data sheets, polar curves etc.

Typical outline drawings, showing constructional features, cable/ conduit entry, fixing arrangements etc. of :

a. Lighting/Power panel.

b. 1ph & 3 ph receptacles .

c. Junction boxes

Technical leaflets and data sheet on each piece of equipment/ device such as M.C.B., ELCB, switch fuse, receptacle etc.

ii) To be submitted for Approval and Distribution

Detail dimensional drawing showing constructional features & Datasheet, cable/conduit entry, grounding, fixing arrangement etc. of :

a) Lighting Panels

b) Receptacles and junction boxes.

c) Lighting fixture complete with lamps and accessories.

d) Non-integral/separate type control gear box for lighting fixtures, as applicable.

e) Lighting poles

Data sheets for lighting fixtures, Control gear, lamps, accessories indicating constructional details, light distribution curves, lumen output, co-efficient of utilization factor, Power consumption etc.

Technical leaflets and data sheet on each piece of equipment/ device such as MCB, switch, fuse, receptacle etc.

Detail Illumination Layout drawing showing the disposition of fixtures, lighting panel/boards, receptacles, details of routing/wiring etc.

Detail lighting design calculation for different areas to provide minimum lighting levels as specified.

Any other relevant drawings, documents and data necessary for satisfactory installation, operation and maintenance.

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All metallic structures, hand rails etc., shall be earthed at one point. For equipment earthing Purchaser shall provide earthing riser (two nos.) near the cooling tower (300 mm above ground level). The Contractor shall provide earthing ring around cooling tower area for connecting to individual equipment. Cooling tower contractor shall connect their earthing system to purchaser earth raiser at 2 points.

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Detailed of earthing & lightening erection procedure shall be handover to successful bidder during detail engineering. 4.8.3.3 Lightning Protection System Air Terminations a) The vertical air terminal rods shall be installed at the roof of buildings at the top of cooling towers to protect these objects from lightning strokes. b) The vertical air terminal shall be made of 32 mm dia, 2.5m long galvanised steel rod. The projected length of the rod shall be as required to protect the object (on which the rod is fixed from lightning stroke). c) All the vertical air terminal rods shall be electrically connected together by means of horizontal conductors of minimum size 25 mm x 6 mm galvanized steel flats. d) The shielding angle for one vertical air termination shall be 30 degrees. Between two or more vertical conductors of equal height spaced at a distance not exceeding twice their height, the equivalent protective angle within the space bounded by the conductors may be taken as 60 deg. to the vertical, while the protective angle away from the conductors is still taken as 30 deg. to the vertical. e) Horizontal air termination of conductor shall be so laid out that no part of the roof will be more than nine (9) meters from the nearest roof conductor. Down Conductors a) The down conductors shall be 25 mm x 6 mm(min) galvanised steel flats. One end of this shall be connected with air terminal rod/horizontal conductor at the top of roof/structure and other end connected to the nearest ground electrode in earth pit. b) Each down conductor shall have an independent earth pit. In no case conductors of the lightning protection system shall be connected with the conductor of grounding system above ground level.] c) The connection between each down conductor and rod electrode shall be made via test link located at approximately 1500 mm above ground level. d) The down conductor shall be laid straight and sharp bends shall be avoided as far as practicable. These shall be cleated on outside of the building wall and/or column/structure at about 600 mm interval unless stated otherwise in the drawing. e) At all supports for down conductor along the column/wall of the structure the portion embedded inside the building concrete should not touch the reinforcement bars. f) All exposed metallic parts of the buildings shall be bonded to the down conductors. Such parts shall include ladders, balconies, conduits etc.			
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g) The down conductors shall be protected at the ground level against mechanical injury by means of non-metallic pipes, viz., PVC pipes filled with bituminous compound.

Electrodes

a) The pipe electrodes shall be minimum 40mm dia, 3m long mild steel. These shall be driven into the ground. GI earth electrode rod drawing shall be provided to supplier during detailed engineering stage.

b) All the electrodes shall be interconnected by means of one (1) 40mm dia rod which will be laid underground at a minimum depth of 600 mm below finished grade level unless stated otherwise. This ground mats/electrode in turn shall be connected to main grounding grid.

Riser

All risers connected to grounding mat shall be minimum 75 x 10 mm GI strip and shall be projected 300 mm above grade level unless stated otherwise.

Grounding Leads

Each grounding lead shall be connected to the equipment at one end by bolting connection and to the riser/ground bus at the other end by arc welding. The sizes, no. and material of the grounding leads shall be of galvanized steel flats of standard sizes of 50mm x 6mm, 35mmx6mm, 25mmx 3mm or 8 SWG G.I wire. The size and no. of the grounding leads shall be decided as per relevant standards.

Jointing & Connection

a) All ground conductor connections below ground level shall be done by electric arc welding with low Hydrogen content electrode.

b) The projected portion of riser above ground shall be coated with two (2) coats of anti-corrosive paints with a minimum thickness of 1 mm after connection.

c) The projected portion of riser above ground shall be coated with two (2) coats of anti-corrosive paints with a minimum thickness of 1 mm after connection.

d) The joints in the lightning conductors shall be kept to a minimum and there shall be no joint in the underground portions of conductors.

e) All the joints shall be done by arc welding process. Overlapping of the conductors at straight joints shall not be less than 150 mm. The contact surface shall be cleaned properly before jointing.

f) The portion of galvanised steel flats, which undergoes welding at site, shall be coated with two (2) coats of cold galvanising anti-corrosive paint after welding.

g) The bolted joint of the test link shall be covered with thick coating of bitumen paint after successful testing.

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load per meter of cable tray of various width shall be 75kg/mtr. All cable trays shall be sized to allow 20% future cables.

Cable Tray Sections
A cable tray section shall be single length of cable tray, either straight or formed as an elbow, tee, cross etc. Horizontal and vertical elbows shall be used in cable tray system for changing the direction of cable tray in the horizontal plane and vertical plane respectively. Horizontal tee shall be used in cable tray system for joining cable tray sections in three directions at 90 degree angle in the same plane.

Horizontal cross shall be used in cable tray system for joining cable tray sections in four direction at 90 degree angle in the same plane.

Reducer shall be used in cable tray system for joining cable tray sections of different widths in the same plane.

Barrier strip shall be used in trays where tray divider is needed for segregating cables of different voltage grades in the same tray. The height of the barrier strip shall be equal to the full inside clear depth of the cable tray. The vertical gap between two cable tray sections and between cable tray section and bottom of soffit / structural member shall be minimum 300mm.

Splice Plates and Hold-down Clamps
Splice plates shall be located on the outer surface of cable tray side rail. The plates shall be attached by round-head bolts with nuts and washers on the outside of the tray.
Hold-down clamps shall provide a positive mechanical lock with the bracket against displacement of the tray in a lateral or vertical direction when the tray is in a normal (horizontal) position.

Cable Tray Support
Concrete inserts, brackets, hangers, supports shall be used for supporting the ladder type cable trays @ 1.5m interval.

Cable Tray Cover
Cable tray cover shall be used to protect the cables, when laid on outdoor overhead cable trays, from direct sun rays. Necessary clamps, nuts, bolts etc. shall be provided for fixing the same on cable tray sections. Minimum thickness is 2.5mm and stiffeners to be provide to avoid sagging. The cable risers or vertical raceways shall be covered by 2.5 mm thick sheet steel, hot dip galvanized cable tray covers with suitable stiffeners. The sheet cover shall be of removable type.

Cable Strap
Cable strap shall be suitable for binding cables with cable tray rung individually or in group. Cable strap shall be made of GI flat.

Tests

All the materials supplied by the Bidder shall be tested as per relevant standards and manufacturer's standard practice.

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OPRYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED . It must not be used directly or indirectly in any way detrimental to the interest of the company.	Drawings, Data and Manuals to be submitted with the Bid a) Typical general arrangement drawings of the materials to be supplied. b) Technical leaflets of each type of materials. To be furnished for Approval and Distribution a) Dimensional outline drawings of each type of materials. b) Technical leaflets of each type of materials. c) Any other relevant drawings, documents or data necessary for satisfactory installation, operation and maintenance. Instruction Manuals for Cable Trays and Accessories The manuals shall clearly indicate method of installation, check-ups and tests to be carried out before commissioning of the equipment. The Bidder may note that the drawings, data and manuals listed herein are minimum requirements only. The Bidder shall ensure that all other necessary write-ups, curves, calculations and information required to fully describe the equipment offered are submitted with the bid. 4.8.5 LT POWER AND CONTROL CABLES Scope of LT power cables and control cables shall be as per terminal points mentioned in cl no1.7.6.0 4.8.5.1 Design Criteria The cables will be used for connection of power and control circuits of the electrical system. Cables will be generally laid on ladder type trays or drawn through rigid steel conduits. For interplant connection cables may be directly buried in ground. For continuous operation at specified rating, maximum conductor temperature shall be limited to the permissible value as per relevant standard and/or this specification. The insulation and sheath materials shall be resistant to oil, acid and alkali and shall be tough enough to withstand mechanical stresses during handling. Cable shall be as per followings- 1. LV Power cables shall be of 1.1 kV grade, XLPE insulated, PVC inner sheathed (extruded),armoured, FRLS PVC outer sheathed, compacted Copper conductor upto 10 sq.mm and above 10 sq.mm aluminium conductor. LT XLPE cables shall be conforming to IS 7098-Part-1, 1988. 2. Control cables shall be of 1.1 kV grade, multicore, XLPE insulated, PVC inner sheathed, armoured, FRLS PVC outer sheathed stranded copper conductor conforming to IS 7098-Part-1, 1988. 3. XLPE insulation shall be suitable for continuous conductor temperature of 90 C and short circuit conductor temperature of 250 C. 4. For single core armoured cables, armouring shall be of aluminium wire. For multicore armoured cables, armouring shall be of galvanised steel strip/wire as per applicable IS.		
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	5. The cable cores shall be laid up with fillers between the cores wherever necessary. All the cables shall have distinct extruded PVC inner sheath. 6. Conductor of Copper cables shall have plain annealed copper. All the conductors shall be multi-stranded. 7. Cables shall be suitable for laying on racks, in ducts, trenches with chances of flooding by water and shall also be suitable for directly buried installation. All the cables shall be flame retardant low smoke (FRLS) type designed to withstand mechanical, electrical and thermal stresses developed under steady state and transient operating conditions. 8. Outer sheath shall be of PVC black in colour having following FRLS properties. • Oxygen index of not less than 29. • Acid gas emission of max. 20%. • Smoke density of not more than 60%. 9. All the cables shall be protected against rodent and termite attack. Necessary chemicals shall be added in to the PVC compound of the outer sheath. 10. TESTS: Cables offered shall be of type tested and proven type. Type test certificates for test conducted earlier on similar rating shall be furnished. Routine tests, Acceptance tests and all special tests for FRLS properties shall be carried out for all the cables as per applicable standards. The sample shall be drawn at the rate of one per type and size for every lot offered for inspection. 4.8.5.2 Joints and Terminations All power and control cables shall be in continuous lengths without any splices or intermediate joints. ❖ Glands and lugs for the power, control and signal cables being terminated at motor end/J.B end/vendor any equipment shall be supplied by vendor. ❖ The weatherproof/Explosion proof cable gland shall be of double compression type with armour clamping arrangement suitable for armoured cables. The gland consists of a gland body, polychloroprene seal, skid washer and a gland nut. The armour is sealed by tightening the gland nut. The risk of torque being induced into the cable is eliminated by using a skid washer. Back nut should be supplied. Glands shall have a screwed nipple with conduit electrical threads, check nut and PVC Shroud. ❖ Lugs shall be heavy duty tinned copper. 4.8.5.3 Selection Criteria In cable sizing the following are to be taken into consideration : a) Short circuit current and duration b) Continuos current c) Installation conditions. d) Voltage drop under normal running and starting condition. e) To limit the cable to some standard sizes instead of using too many sizes. The standard cable sizes, amp capacities, derating factors. as given in IS will be generally followed.			
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Basis for selection of power cables considering voltage drop criteria shall be as follows:

- a) Voltage drop at motor terminal during starting not to exceed 15% of rated voltage.
- b) Voltage drop during normal operation at full load not to exceed 3% of rated voltage.
- c) Voltage drop in cable from MLDB to any lighting fixture shall not exceed 3% under steady state.

All control cables shall be 2.5 Sq.mm copper cable.

Multicore control cables will generally have spare conductor (s) in accordance with the following chart :

Conductors Required Cables

- 1 or 2 1-3/C
- 3 or 4 1-5/C
- 5 or 6 1-7/C
- 7 or 8 10C
- 9 or 10 1-12/C
- 11, 12 or 13 1-16/C
- 14 to 18 1-20/C
- above 19 Two or more of above cables.

Separate cables for each type of following services/functions as applicable shall be used for each feeder. Same multicore cable using different services shall not be acceptable.

- a) Power.
- b) Control, interlock and indication.
- c) Metering and measuring.
- d) Alarm and annunciation.
- e) C.T. Cables.
- f) P.T. Cables

4.8.5.4 Cable Identification

Cable identification shall be provided by embossing on the outer sheath the following:

- a) Manufacturer's name or trade mark
- b) Voltage grade
- c) Year of manufacture
- d) Type of insulation, e.g. XLPE etc.
- e) Type of outer sheath e.g. "FRLS" etc.
- f) Nominal cross sectional area of the conductor & no of cores.

4.8.5.5 TESTS

Shop Tests

The Cables shall be subject to shop tests in accordance with relevant standards to prove the design and general qualities of the Cables as below:

- a) Routine tests on each drum of cables. All Routine tests on each size of cable as per IS 7098-I, & approved data sheet (as applicable) shall be conducted.
- b) Acceptance tests on drums chosen at random for acceptance of the lot as per IS-7098-I.

Ref.

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c) Type tests on each type of cable, inclusive of measurement of armour D.C. resistance of power cables etc shall be as per IS-7098-I.

Type Tests and Special tests to be conducted/Valid Certificates to be submitted shall be governed by below clauses. If Type tests certificates and Special Tests Certificates (applicable for UV test, Accelerated water absorption test) are not available for any size of cable, same shall be conducted by vendor at his own cost in any recognized laboratory. If in-house test facilities are to be used then the testing equipments shall be calibrated (valid calibration certificates shall be produced during inspection) and traced back to National Calibration standards. The reports shall be submitted for BHEL’s approval before dispatch of the cables. There shall not be any delivery and commercial implications on account of this.

SPECIAL TESTS:

Ultra Violet radiation Test: Test for Resistance to Ultra Violet Radiation should be carried as per DIN 53387(latest) or ASTM-G-154(latest) on outer sheath.

Accelerated water absorption test: Accelerated water absorption test for insulation as per NEMAWC-53(latest)

Oxygen Index Test: The test shall be carried out as per IS-10810(Part-58). Sampling to be done for every offered lot/size as per sampling plan.

Flammability test: The outer sheath of cables shall possess flame propagation properties meeting requirements as per IEC – 60332 Part-1 and Part-3 (Category A). Sampling for these tests to be done randomly once for each order. The acceptance criteria for tests shall be as mentioned in IEC standard.

Rodent and Termite repulsion test: Test for rodent and termite repulsion property shall be carried out. The vendors shall furnish the test details to analyze the property by chemical method for review/information. Sampling to be done for every offered lot/size as per sampling plan.

FRLS Tests:

Each type of cable shall also be subject to the following additional type tests at works. Following FRLS tests on each size (minimum one sample per size) of cable shall be conducted in the presence of BHEL’s representative & reports shall be annexed to Inspection report.

a) Oxygen index test as per ASTM D-2863 and minimum oxygen index shall be 29 at 27+/-2degC.

b) Temperature index test as per ASTM D-2863 and minimum temp index shall be 250degC.

c) Acid gas generation test as per IEC-60754(1) and Maximum acid gas generation shall be 20% by weight.

d) Smoke generation test as per ASTM D-2843 and Maximum smoke density rating shall be 60%.

e) Flammability Test:

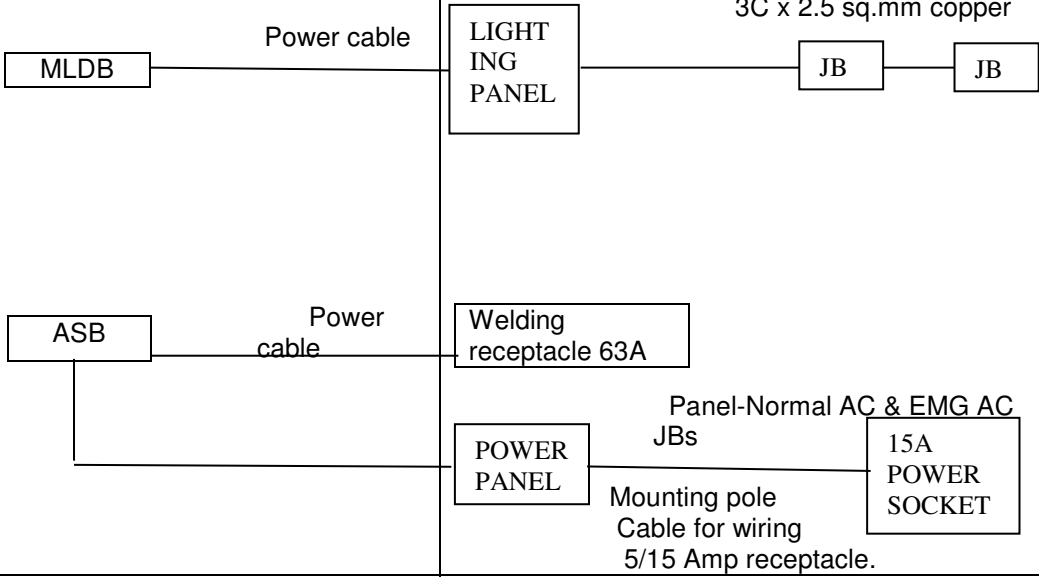
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OPYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED . It must not be used directly or indirectly in any way detrimental to the interest of the company.	For Cables with OD >35: as per IEEE-383. For Cables with OD <=35: as per Clause F3 of SS: 4241475/88.		
	4.8.5.6 Drawings, Data & Manuals		
	To be submitted with the Bid		
	a) Manufacturer's catalogues giving cable construction details and characteristics. b) Cable current ratings for different types of installation, inclusive of derating factors for ambient temperature, grouping etc. c) Write-up on Manufacturer's recommended method of splicing, jointing, termination etc. of the cables. d) Type test certificates on all specified cables(Cables offered shall have valid Type test certificates of recognized testing house such as CPRI, CMRI, PTB, BASEEFA, UL or equivalent.		
	To be submitted for Approval and Distribution		
	a) Guaranteed cable datasheet.		
	Instruction Manuals for Power and Control Cables		
	The manuals shall clearly indicate method of installation, check-ups and tests to be carried out before commissioning of the equipment. The Bidder may note that the drawings, data and manuals listed herein are minimum requirements only. The Bidder shall ensure that all other necessary write-ups, curves, calculations and information required to Fully describe the equipment offered are submitted with the bid.		
	4.8.5.7 RATINGS AND REQUIREMENT		
	L.T. Power Cables		
Ref. Doc	1100V XLPE power cable conforming to following requirement and in line with IS-7098-1, IS-5831, IS-8130 and IS-3975.		
	Conductor : Stranded compacted Copper conductor upto 10 sq.mm and above 10 sq.mm aluminium conductor of grade H4 and class-2. LT XLPE cables shall be conforming to IS 7098-Part-1, 1988.		
	Insulation : Extruded XLPE compound conforming to IS-7098-I.		
	Inner Sheath : Extruded PVC compound conforming to type ST2 for multicore cable. Single core cables shall have no inner sheath.		
	Armour : Galvanized single steel wire/Strip armour for multicore cables and round wire for single core cable.		
Overall Sheath : Extruded FRLS PVC compound conforming to type ST-2.			
Control Cables (Not applicable)			
1100 V grade, 90 Deg.C rating ,XLPE Control cables conforming to following requirement and in line with IS:7098-I, IS:8130, IS:5831 and IS:3975.			
Conductor : Stranded, non-compacted & circular, high conductivity annealed copper.			
Insulation : Extruded XLPE compound conforming to IS-7098-I.			

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OPYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED . It must not be used directly or indirectly in any way detrimental to the interest of the company. Inner Sheath : Extruded PVC compound conforming to type ST1 for multicore cables. Single core cables shall have no inner sheath. Armour : Galvanised single round steel wire for twin and multicore cables. Overall Sheath : Extruded FRLS PVC compound conforming to type ST1. HR : Heat Resistant FRLS : Flame Retardant Low Smoke 4.8.5.8 CABLE SIZES L.T. POWER CABLES Power Cables sizes shall be furnished during detail engineering. CONTROL CABLE (Not applicable) Cables sizes shall be furnished during detail engineering. CABLES FOR ELECTRONIC EQUIPMENT GROUNDING Cables sizes shall be 1Cx10Sq.mm Cu. Un-armoured cable or OEM recommendations whichever is higher. Outer sheet color shall be GREEN as per IS.			
Ref. Doc			

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	TP'S OF BHEL A. <u>CABLE TRAYS</u> (1) At two points below ground. (Cable trench)	<u>BIDDER SCOPE (SUPPLY, ERECTION & COMMISSIONING)</u> Further cable trays including risers up to individual equipment. Cable trays shall be procured as per BHEL specification which will be furnished during detailed Engineering.
	2) <u>GROUNDING</u> - Underground main earth mat with risers at two points.	Further grounding system for all the equipment including provide earthing ring around cooling tower area cable trays, JBs, lighting poles/fixtures, LPBs etc.
	(3). <u>LIGHTNING PROTECTION</u> Under ground earth grid	-Earth pits with test electrodes for each down conductor (drawing during detailed engineering by BHEL) -Earth pits interconnection with underground earth mat 50x60mm strip. -All above ground lightning protection system.
	(4). <u>CABLES + CABLING</u> BHEL ←	

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OPYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED . It must not be used directly or indirectly in any way detrimental to the interest of the company.			(5). <u>LIGHTING</u> 	Note:- 1. Lugs and glands are in vendor scope. Glands will be double compression type nickel plated brass with PVC shrouds and lugs shall be tinned copper lugs. 2. Power cables upto lighting panel, 3ph receptacles and power panel(for 1-pd distribution) are in BHEL scope further distribution is in vendor scope. 3. All cable terminations at vendor supplied equipments are in contractor scope including termination accessories. 4. Cable laying upto BHEL's and contractor terminal point is in BHEL scope further cable laying, dressing and termination at equipment side is in contractor scope
Ref.	Doc			

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SECTION-V

DETAILED TECHNICAL SPECIFICATION- C & I

5.1.0 GENERAL

The Cooling Tower (CT) shall be provided with adequate number of instruments and controls for ensuring safe, smooth and efficient operation of the plant. The instrumentation and control systems provided shall be sufficient to control and monitor all significant process parameters continuously and provide necessary safety controls and interlocks including alarms for abnormal conditions to ensure adequate safety to man, machine and environment.

5.2.0 TYPE OF INSTRUMENTATION AND CONTROL

The instrumentation and Control system envisages control of Cooling Tower from DCS supplied by others. All signals to be made available in local junction box. All the safety interlocks shall be through a DCS supplied by others. All instruments and control equipments supplied under this contract shall be compatible with the DCS systems procured under a separate contract.

5.3.0 SCOPE OF SUPPLY:

Level switch mounted on lube oil sump of each Fan gearbox for alarm & interlocks.

Two (2) nos. of vibration cut off switches mounted on each cooling tower fan for alarm and trip & interlocks wired to a junction box at ground level.

Sight glass assembly for oil level indicator for each gear reducer.

Temperature gauges and pressure gauges for local indication at the riser pipes of each cooling tower.

Cabling including cable glands from vibration cutoff switch and level switches up to junction box and including the junction box.

Provision shall be made for mounting of Pitot tube at each hot water inlet piping header to measure the flow.

Any other necessary equipment/service required for the effective operation/functioning of the cooling tower shall be in the bidder's scope.

5.4.0 CABLING AND ACCESSORIES

All necessary cabling and accessories including junction boxes, structural supports, cable glands, lugs, ferrules, cable ties, etc. up to the local junction box shall be supplied by the bidder and from local junction box to marshalling cabinets shall be supplied by others.

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5.5.0 ERECTION, CALIBRATION, TESTING AND COMMISSIONING

All instruments supplied under the contract shall be erected, calibrated, tested and commissioned by the Bidder. All necessary erection hardware as required shall be supplied by the Bidder. This includes items like cable glands, junction boxes, instrument valves, mounting accessories, conduits, name plates, structural steel requirement, instrument/instrument tray supports, etc. and any other erection hardware / accessory required for successful erection, calibration, testing and commissioning of instruments supplied under this package.

5.6.0 DESIGN REQUIREMENTS

5.6.1 SCOPE

This general specification together with enclosures if any cover the design of Control and Instrumentation system, complete with all accessories and materials along with special test equipment where the supply of such instruments is a part of a larger plant.

The detailed scope of work, specific requirements, exclusions, deviations, additions etc. if any, will be indicated elsewhere in this specification.

Bidder shall be fully responsible for design, materials selection, sizing and selection of the proper instruments for their system. All equipments supplied shall be of proven quality both with respect to design and materials. No prototype instrument or instrument of an experimental nature shall be offered or supplied.

Bidder shall prepare and submit a P&I diagram for the system within the scope of his supply, showing all the instruments and interlock/trip operations. Each instrument shall be given individual tag numbers from blocks of numbers allotted by the Purchaser/Consultant appearing in the Bidder's scope of supply but are an integral part for the control of this package.

Bidder shall clearly define the operational philosophy suggested by him, which should be in line with requirements specified in the main package/equipment specification.

5.6.2 Electrical Power

The power source for Control & Instrumentation shall be 110 V AC $\pm 2\%$, 50 Hz $\pm 3\%$. Any repeat relays used for alarm/interlock purpose shall be working on 24V DC. Normal power supply of 230V, 50 Hz shall be used for illumination.

5.6.3 Wiring Details

Open terminals shall generally be avoided. Terminal strips shall be of "Klippon" or equivalent type and shall be mounted in an enclosure.

1.5 sq.mm multi stranded PVC insulated copper conductor shall be used in general. These shall be laid in PVC troughs as far as possible.

5.6.4 GENERAL SPECIFICATIONS OF INSTRUMENTS

Ref.	Doc

Level measuring devices may be of the direct measurement, differential pressure or electrical/electronic type as appropriate to the application. For local indication of level, direct measuring devices shall be used. Unless otherwise approved by the Customer/Consultant, each measuring equipment shall be capable of being removed without the vessel or other instruments being taken out of service. Level gauges shall be of the reflex/transparent type made from stainless steel bar and fitted with toughened borosilicate glass and marked with their safe working pressure and temperature, except on low temperature and pressure application when transparent types may be used. Gauge glasses for boiler applications shall be in accordance with

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IBR Code. Each gauge shall be fitted with top and bottom isolating valves with full bore drain valve at the bottom and plugged vent at the top. Flanged connections, rated same as the vessel, shall be used. Gauges shall be arranged so that the visible length is in excess of the maximum operating range. Differential pressure transmitting devices shall preferably be used on all services. Displacement type instruments shall be mounted in external cages with flanged connections, rating same as the vessel. This type of instrument shall not be used for applications involving viscous, corrosive or flashing liquids. Direct measurement of level by means of internally mounted floats, etc, shall only be used when the switch point is either well defined in advance or is adjustable in service, and the vessel can be emptied and/or de-pressurised for the removal of the switch without effect to the normal operation of the plant, or where choking of extended connections is likely to occur. Float switches shall be glandless with magnetic coupling.

5.6.4.5 Pressure Instruments

Pressure Gauges

Local Pressure Gauges shall operate on Bourdon tube principles. Pressure gauge dial shall be white, non rusting plastic with black figures. Pointers shall have external micrometer adjustment for gauge zero adjustment. Pressure gauges shall be weatherproof with dial size of 150 mm and shall have features like screwed bezels, externally adjustable zero, over range protection and blowout discs. Pressure gauge sensing element shall be of SS316 and movement of SS304, as a minimum. The design of pressure gauges shall confirm to IS-3624. Pressure gauges shall have an accuracy of $\pm 1\%$ of URV as a minimum. Differential pressures gauges may have an accuracy of $\pm 2\%$ of URV.

Overrange protector and pulsation dampener, whenever used, shall be of SS304, as a minimum. Pulsation dampeners shall be used for all pulsating services. These shall be floating pin type, externally mounted and externally adjustable. All pressure gauges with maximum operating pressure exceeding 60 kg/cm2 and gauges in toxic service shall be solid front type. Process connection shall normally be 1/2" NPTM bottom. Cases shall be SS 304 and weatherproof to IP-65 as per IEC-529/IS-2147. Blow-out discs shall be provided for all gauges. Ranges shall be so specified that the gauge normally operates in the middle third of the scale and shall conform to IS-3624 standard dials, wherever possible. Shatterproof glass shall be provided for pressure, receiver or draft gauges.

5.6.4.6 Temperature Instruments

Thermowells

All temperature elements shall be provided with Thermowells fabricated out of bar stock of minimum SS 304, in general. Thermowell flange material shall be selected as per piping specifications, in general. Thermowell design shall be as per standard 7-52-0035 upto ANSI 600# including for packages/sub-packages. For thermowells above ANSI 600# rating, bidder may use their own proven design(s) recommended by various manufacturers suitable for the specified pressure-temperature conditions. The

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RTD (Resistance Temperature Detector) shall be platinum element 3 wire type with 100 resistance at 0 DegC calibrated as per IEC 751/DIN 43760. RTD shall be used

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within a temperature range of -200 to 650 DegC. RTD shall generally be selected for applications requiring low temperature measurement with comparatively shorter temperature span requiring accuracies of the order of 0.25% or better.

5.6.5 INSTALLATION

All the instrumentation shall be installed so that it complies with the prevailing standards and the recommendations of the manufacturer. Only one instrument shall be fitted to each tapping point.

5.7.0 INSTRUMENT MOUNTING

All indicating instruments and controls shall be readable and accessible from floor level or permanent platforms. Gauge glasses shall be visible from any control valve that controls the vessel level. Clearance shall be allowed for servicing and access to all items. Items shall be positioned so that exits are not obstructed. Open type transmitter racks as required and with suitable canopy shall be provided to group and mount all pressure, flow and level transmitters. Junction boxes/field termination cabinets shall be provided for termination of field switches like pressure, temperature and also for the transmitters. Post or bracket mounts for instruments shall not be attached to pipe work, removable flooring, handrails or be directly affixed to machinery and equipment subject to vibration.

5.7.0 CABLES

Individual/pair shielded and overall shielded twisted pair cables shall be used for analog and overall shielded cables shall be used for digital signals. All these cables shall be with FR PVC for inner and outer sheath. The size of the wire shall be 2.5 sq.mm.

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	SL. NO	DESCRIPTION	QTY.	UNIT PRICE (Rs)	TOTAL PRICE (Rs)
	1.	DESIGN, ENGINEERING, MANUFACTURE AND SUPPLY			
	1.1	Design, Engineering, Manufacture and Supply of Cooling Tower as per BHEL specification PEMC-05255, Rev01 and its enclosures • Complete mechanical equipment • Complete electrical and C&I equipment	1		
	1.2	Special Tools & Tackles			
	1.2.1	Mechanical Hub puller for fan	1		
	1.2.2	Bevel protractor with spirit level (For blade pitch angle adjustment)	1		
	1.2.3	Drive shift alignment kit with dial indicator	1		
	1.2.4	Torque wrench	1 set		
	1.3	Commissioning and erection spares [Item wise list of commissioning and erection spares with unit rate and quantity to be furnished by bidder)	1		
	2.	CIVIL WORKS			
	2a.	CIVIL WORKS of Cooling Tower as per BHEL specification PEMC-05255, Rev01 and its enclosures Attention : 1) Price of piling (if envisaged in bidders design) should not be included. 2) Bidder to indicate quantities of piles (if envisaged in design) in sl. No. 2b) below.	1		
	2b.	Bidder to indicate total number of Piles in Nos. (if required based on vendor civil design) (Ø 500mm, Pile capacity, Vertical – 65T, Horizontal, fixed head – 4.5T, free head – 2.0T, Uplift – 20T)	Qty. (To be specified by bidder)	70312	

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	3	Erection & Commissioning of Cooling Tower				
	3a	Erection and commissioning of Cooling Tower as per BHEL specification PEMC-05255, Rev01 and its enclosures • Complete mechanical equipment • Complete electrical and C&I equipment	1			
	3b	Performance guarantee testing of Cooling Tower as per cooling tower Institute Acceptance Test Procedure ATP-105.	1			
	4	Mandatory Spares for Cooling Tower				
	4.1	Coupling with all fasteners	10% or 1 no. of each type and size			
	4.2	Bearings complete	20% or 2 sets of each type and size			
	4.3	Complete fan and hub assembly matched and balanced	10% or 1 set of each type and size			
	4.4	Complete gear box	10% or 1 no. of each type and size			
	4.5	Bearings for gear box	20% or 2 sets of each type and size			
	4.6	Oil seals, 'O' rings and Gaskets for gear box	10% or 2 sets of each type and size			
	4.7	All Couplings (Fan end, Gearbox end and motor end) along with all fasteners)	10% or 1 set of each type and size			
	4.8	Cell Isolation Valve	10% or 1 no. of each type and size			
	4.9	Tower Internals – Water spray nozzle	10% of total population of one tower			
	4.10	Towers Internals-Film Type Fills Packs	10% of total population of one tower			
	4.11	Towers Internals – Drift eliminator	10% of total population of one tower			
	4.12	Bearing of each motor type and rating (set)	Min. 10% of installed capacity			
	4.13	Local Gauges (pressure, temperature, level, flow)	5% for each type and range subject to minimum 1no.			
	4.14	Field switches	5% for each type and range subject to minimum 1no.			
	4.15	Junction boxes (Terminal Blocks, Cable glands, Lug)	5% for each type and range subject to minimum 1no.			
	TOTAL PRICE (1+2+3+4)				(Rs)	

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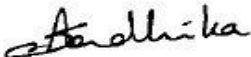
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	5	Optional Price			
	5.1	2 years recommended spares along with their quantities and unit rate for normal trouble free operation of Cooling Tower based on bidders' experience. [List for recommended spares and it's unit rate to be furnished by bidder)	RO		
	RO= Rate Only NA= Not Applicable				
	NOTES:- A. Bidder to quote strictly as per BHEL's NIT requirements. B. Bidder to note that this is a LUMP SUM Turn-Key Order. Any additional claim after placement of order will not be entertained under any circumstances. C. Offer will be evaluated based on total price for Supply, Civil, Erection & commissioning and Supply of Mandatory Spares (i.e. Sl. Nos. 1+2+3+4 of price format). Prices of Optional Item shall not be considered for Price bid evaluation. D. Piling is not in scope of bidder. However, for optimizing the overall cost of cooling tower, cost of piling will also be considered for evaluation of L1 price. The cost of Rs 70,312/- per pile will be considered for evaluation of prices. The total cost of piling will be product of quantity of piles indicated by bidder multiplied with cost of one pile i.e Rs. 70312. E. During execution of project if excess piles beyond the number indicated by bidder in his offer under Sl. No. 2b are required as per bidders final civil design, then amount based on penal rate of Rs. 85000/- per pile multiplied by the total nos. of excess piles will be deducted from bidders bills. F. Separate Purchase Orders will be issued for Supply portion, Civil portion and for Erection & Commissioning works of this project. The Purchase Order for Supply portion including Mandatory Spares will be issued by BHEL-PE&SD whereas the Purchase Order for Civil, E&C portion will be issued by BHEL-PSWR (BHEL's Construction Management Division). G. Bidder to quote the base rates only. All Applicable taxes and duties to be indicated shall be indicated separately for the Supply Portion, Civil Portion, Erection & Commissioning Portion and Mandatory spares Portion as follows: i. All Applicable Taxes and duties for Supply Portion ii. All Applicable Taxes and duties for Civil Portion iii. All Applicable Taxes and duties for Erection & commissioning iv. All Applicable Taxes and duties for Supply of Mandatory Spares H. The above items shall be quoted as per tender specification PEMC-05255, Rev01 & all its enclosures. Responsibility of ensuring correctness & completeness of scope of supply as per specification requirement solely lies with bidder. I. Bidder to quote separately, in an identical format, 2 years operational spares with recommended quantity and unit rate. However ordering of the same shall be at the sole discretion of BHEL.				
	BIDDER'S SIGNATURE NAME: DATE : COMPANY SEAL				

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No.	Page No.	1	Technical Purchase Specification for Cooling Tower	PY51016 rev 01	71	2	General Conditions of Contract		102	3	General scope of supply and services		196	4	Detail Technical specification- Civil, Structural and Architectural works (Vol III, section 5)	Annexure 2	202	5	Cranes and hoists (Vol III sub-sec 2.6)	Annexure 3	395	6	Inspection testing at manufacturer works (Vol III sub-sec 2.13)	Annexure 4	405	7	General Plant design requirement		419	8	Quality assurance, shop inspection and testing		438	9	Equipment erection, site testing, commissioning & performance test		442	10	Surface preparation and painting (Vol III, sub-sec.-2.15)	Annexure 1	459	11	color code for piping (Vol IV sec 8)	Annexure A	477	12	Special tools, tackles and equipment		486	13	Consumables		487	14	Documentation		488	15	Plant and Equipment identification, Labelling		490	16	Contract drawings, documents for approval, Liaison meeting		490	17	Environmental protection		496	18	Soil Investigation Report (Vol IV sec 8)		498	19	Progress report		542	20	Data sheet for level switch		543	21	Data sheet for pressure gauge		544	22	Data sheet for temperature gauge		545	23	Data sheet for vibration switch		546	24	P&ID of Cooling water system	2-381-01-04546-R00	547	25	Plot Plan	0-381-01-01570-R01	549	26	CW & ACW Pump House area layout	1-381-01-06543 R00	551	27	Check list	Annexure B	553	28	Master Document List (MDL)		556	29	Technical suitability check list for civil design of CT	Annexure 5	563	30	Technical suitability for civil design		564	31	Manufacturing quality plan		567	32	Data sheet to be filled up by Bidder	Annexure C	568	Ref. 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	Rev. No.	Date	Revision Details	Prepared By	Approved By	
	00	03.03.15	First issue	Amit	Radhika	
	01	16.07.15	Revised in line with E&C input to PSWR	Amit	MSSN	
	Ref. Doc.					

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COPYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED, It must not be used directly or indirectly in any way detrimental to the interest of the company.			TECHNICAL PURCHASE SPECIFICATION FOR RCC COOLING TOWER		
Ref. Doc	Prepared By:  MURALIDHAR		Reviewed By:  RADHIKA SISTA		Date: 26.06.2013

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OPRYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED . It must not be used directly or indirectly in any way detrimental to the interest of the company. 1.1.0 INTENT OF SPECIFICATION : 1.1.1 This specification is intended to cover the design, engineering, manufacture, fabrication, assembly, testing at manufacturer's works, delivery properly packed for transport, inland transportation up to site, inland transit insurance, unloading, storage at site, in-plant transportation, complete services of erection, testing and commissioning, complete with all accessories as specified hereinafter and as required for safe and trouble free operation and maintenance of the Cooling Tower. 1.1.2 This specification shall be read in conjunction with its enclosures. In case of any discrepancy arising between this job specification & its enclosures, wherein more than one level (i.e. both less stringent level and more stringent levels) of same requirement have been indicated for a particular item, the most stringent of all shall be followed and shall relevantly over-ride others. Otherwise, the requirements indicated in this job specification shall be considered as additional requirements to the ones indicated in the enclosures. Further, if a requirement in this specification or its enclosures, calls for decision of owner/BHEL, it shall be bidder's sole responsibility to clearly bring out the same before submitting his technical tender offer, so as to enable owner/BHEL to furnish their decision. If such a requirement is not duly addressed by bidder during tender stage and same comes out during order execution stage, it shall be binding on the bidder to comply with the decision furnished by owner/BHEL then, without any cost, delivery, or any other commercial implications. Bidder shall get all his technical queries/doubts clarified before technical bid submission. 1.1.3 Any additional equipment, material, etc., which are not specifically mentioned here, but are required to make the supplied equipment complete in all respect, in accordance with the intent of this technical specification, contractual agreement, statutory requirements, relevant/applicable codes/standards, good engineering practices, and for safe and trouble-free operation, shall be deemed to be covered under the scope of this specification. 1.2.0 GENERAL REQUIREMENTS : 1.2.1 This specification also includes the supply of commissioning spares as required, special tools & tackles(if any) for necessary operation & maintenance. These shall form an integral part of the supply for the above package irrespective of being separately or explicitly indicated in this-specification/tender-correspondence /purchase-order. However, recommended spares for two (2) years operation shall be quoted separately and shall not form an integral part of the supply for the above package. If required to be ordered, requirement of 2 years operational spares shall be explicitly indicated in this-specification/tender-correspondence/purchase-order.			
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OPYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED . It must not be used directly or indirectly in any way detrimental to the interest of the company. 1.2.2 The design, manufacture, inspection, erection, commissioning, testing and performance of the cooling tower and its accessories shall comply with latest edition of all currently applicable statutes, standards, regulations and safety codes. Nothing in this specification shall be construed to relieve the vendor of this responsibility. 1.2.3 All materials supplied under this contract shall be new and unused. All indigenous equipment/materials offered should be with ISI mark. Any special approvals that may be applicable for certain items, like for explosion-proof items from CMERI-Dhanbad, etc., shall be have to be duly considered and ensured. All imported equipment/materials should have an approval of ASME / API / BS / LPC / FM / UL / BASEEFA / NEC / IEC / NFPA / AWWA /other-applicable-authority, as the case may be. 1.2.4 All equipment/items supplied shall conform to the provisions of statutory & other regulations in force in India and the State/Province where the project is executed, such as the Indian Factories Act, Indian Electricity (Supply) Act, Indian Electricity Act, Indian Electricity Rules, International Electric Technical Commission (IEC) Publication, Environmental Rules, etc. 1.2.5 Supplies shall be rendered in conformity with proven design principles. The purpose of this contract must be fulfilled in its entirety and the maximum of reliability and economy guaranteed. 1.2.6 All the components shall be so designed that repairs and overhauling is minimum and can be carried out easily in the shortest possible time. 1.3.0 DESCRIPTION OF SYSTEM Please refer the Job Specification. 1.4.0 REFERENCE The cooling tower and its accessories shall comply with stipulations laid down in the latest editions of the following codes and their relevant specifications mentioned in the specifications. <table border="0"> <tr> <td>1</td> <td>AGMA</td> <td>:</td> <td>AMERICAN GEAR MANUFACTURERS ASSOCIATION</td> </tr> <tr> <td>2</td> <td>ASME</td> <td>:</td> <td>AMERICAN SOCIETY OF MECHANICAL ENGINEERING</td> </tr> <tr> <td>3</td> <td>CTI</td> <td>:</td> <td>COOLING TOWER INSTITUTE, USA</td> </tr> <tr> <td>4</td> <td>ATC</td> <td>:</td> <td>ACCEPTANCE CODE</td> </tr> </table> 1.5.0 SCOPE OF SUPPLY Cooling Tower Basin, outlet channels/sumps and sludge pits : Yes/As applicable				1	AGMA	:	AMERICAN GEAR MANUFACTURERS ASSOCIATION	2	ASME	:	AMERICAN SOCIETY OF MECHANICAL ENGINEERING	3	CTI	:	COOLING TOWER INSTITUTE, USA	4	ATC	:	ACCEPTANCE CODE
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OPYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED . It must not be used directly or indirectly in any way detrimental to the interest of the company. - Staircases and cage ladder : As specified in the Job Specification - Fans with Drives & Motors : Yes - Guards for rotating parts : NA - Hot water piping upto distribution basin including pipe supports for ground level piping and any other piping in CT area. : Yes - Flow control valves on hot water distribution lines for each cell : Yes - Companion flanges with bolts, nuts & gaskets for piping terminals : NA (as a butt welded joint is envisaged at all the piping terminal points) - One no. Coarse Screen & guide and One no. fine screen & guide for each cold Water outlet. : Yes - Sluice gate with guides and sealing device for each cold water outlet sump/channel. : Yes - Cooling Tower Cells draining arrangement Including drain pumps/Isolating valves and drain pipe spool in sludge pit : As specified in the Job Spec. - Suitable lifting and handling arrangement for handling fan hub, gear reducer and motor upto one end of cooling tower top deck and for lowering from there to ground level : Yes 2 nos chain pulley blocks(one for handling screens and one for handling mechanical components at Fan deck level) : Yes			
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COPYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED . It must not be used directly or indirectly in any way detrimental to the interest of the company.	and including the junction box at ground level		
	• Provision, for installation of Pitot tube, on each hot water inlet piping header to measure the flow : Yes		
	• All necessary supports, hangers for piping in the Cooling Tower Area : Yes		
	• Baseplates, foundation plates, anchor bolts, sleeves, inserts, bolts, nuts for all equipment supplied : Yes		
	• Special Tools & Tackle : Yes		
	• Side Stream Filters & its auxiliaries : As per Job Spec.		
	• Start-up, Erection & commissioning spares : Yes		
	• Recommended Spare parts for 2 years of operation : Yes (Optional price is to be given)		
	• Final paint at site, supply & application : Yes		
	• Initial fill of lubricants & Consumables and that required upto the successful PG test of the total package : NA		
	• All instruments required for performance testing of the Cooling Tower : Yes		
	1.6.0 SCOPE OF SERVICES		
	1.6.1 Complete erection, testing and commissioning at site for the Mechanical, electrical, instrumentation equipment		
	1.6.2 Erection, testing and commissioning of all items covered under scope of supply.		
	1.6.3 Surface preparation (Mechanical items & Electrical devices) & their painting.		
	1.6.4 Training of Owner's personnel in operation and maintenance of the complete system.		
	1.6.5 Submission of all construction drawings for consultants review / approval.		
Ref. Doc	1.6.6 Submission all interface data required for design and engineering of systems which are included in the scope of supply defined above.		

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OPYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED . It must not be used directly or indirectly in any way detrimental to the interest of the company. 1.6.7 Preparation and submission of drawings / documents for approval / information to Purchaser / Consultant as per the drawings / documents submission schedule. 1.6.8 Quality plan, inspection and testing of equipment at works, submission of test certificates. 1.6.9 Submission of monthly progress report. 1.7.0 TERMINAL POINTS 1.7.1 Mechanical 1. Hot water - At ground level and at a distance of 1.0 m from the edge of tower. However the exact location shall be finalised during detailed engineering. 2. Cold water - As per the Job Specification 3. Over flow and drain - At a distance of 1.0 m from the edge of tower. 4. Instrument air/plant air at one point near cooling tower. However the exact location shall be finalised during detailed engineering. 1.7.2 Electrical 1. 415V, 3phase, 4 wired, 50 Hz incoming power supply at motor terminals (by BHEL) and control cabling from Local Push Button Station to the Junction box at ground level including the LPBS & JB are in bidder scope. 2. Lighting/illumination Power Supply at (lighting/illumination panel outdoor type with canopy) (panel by bidder including cabling and fixtures) at ground level near Cooling Tower 3. Earth riser at ground level. For all electrical equipment like motors, lighting panels, lighting fittings , LCS etc earthing shall be in bidder’s scope and bidder shall connect to the 2 nos. of earthing risers being provided at ground level by BHEL). 1.7.3 Instrumentation and Control 1. All signals shall be terminated at the local junction box (in bidder scope) located at the ground level near cooling tower 2. Non-UPS power supply at one point and further distribution shall be in Bidder’s scope. 3. Any requirement of UPS power supply shall be clearly indicated by the bidder in their offer. 1.8.0 EXCLUSIONS FROM BIDDER’S SCOPE OF WORK			
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OPYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED . It must not be used directly or indirectly in any way detrimental to the interest of the company. 1.8.1 Mechanical All piping beyond battery limit. 1.8.2 Electrical MCC and power cables. 1.8.3 Control & Instrumentation Supply and laying of interfacing cables between local junction box and DCS. 1.9.0 ERECTION, INSPECTION & COMMISSIONING Refer the Job Specification. 2.0.0 GENERAL CONDITIONS OF CONTRACT 2.1.0 LOCATION/POSITIONING OF WORKS The CONTRACTOR shall be responsible for the true and proper setting out of the WORKs in relation to points, levels of reference co-ordinates, orientation, alignment and marks given in the CONTRACT DOCUMENT in writing and for correctness of the positions, levels, dimensions, orientation and alignment of all parts of the WORKs, and for the provision of all necessary instruments, appliance and labour in connection therewith. If, at any time during the progress of WORKs, any error appears or arises in the position, orientation, alignment, levels or dimensions or dimensions or any part of the WORKs, the CONTRACTOR shall rectify the error at his own cost to the satisfaction of Purchaser/Customer. The checking of any setting out of any line, level, co-ordinate, depth, orientation or alignment or position of a marker by the Purchaser/Customer shall not in any way relieve the CONTRACTOR of his responsibility for the correctness thereof. CONTRACTOR shall carefully rotect and preserve all bench marks, sight rails, pegs and other things used in setting out the WORKs. 2.2.0 SAFETY PROCEDURES AND RESTRICTIONS The CONTRACTOR shall adhere to the following safety requirements at SITE during execution of WORKs: (i) SAFETY REGULATIONS a) In respect of all labour, directly, or indirectly employed in the WORKs for the performance of CONTRACTOR’s part of this agreement, the CONTRACTOR shall at his own expense arrange for all the safety provisions as per safety CODES of CPWD, Indian Standards Institute, The Electricity Act, The Mines Act and such other Acts as applicable.			
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b) The CONTRACTOR shall observe and abide by all fire and safety regulations of the COMPANY before starting construction WORK. CONTRACTOR shall consult with OWNER’s Safety ENGINEERs and must make good to the satisfaction of the OWNER

(ii) GENERAL

a) No labour below the age of eighteen years shall be employed on the WORK.

b) The CONTRACTOR shall not pay less than what is provided under laws to labourers engaged by him on the work.

c) The CONTRACTOR shall at his own expense comply with all labour laws and keep the OWNER indemnified in respect thereof.

(iii) WATCHING AND LIGHTING

The CONTRACTOR shall, in connection with the WORK, provide and maintain at his own cost all lights, guards, fencing, safety equipment, markers and watching when and where necessary or

required by the Purchaser/Customer or by any duly constituted authority for the protection of the WORKs or for the safety and convenience of the public or others.

(iv) TIME SPAN FOR RESPONSIBILITY OF WORKS

From the time of commencement of the WORKs till the issuance of a CERTIFICATE OF COMPLETION AND ACCEPTANCE of the WORKs , CONTRACTOR shall be fully responsible for the care of WORKs and of all Temporary WORKs, in case any damage or loss happens to the WORKs or to any part of them or to any Temporary WORKs from any cause whatsoever other than war risks in respect of which insurance cover is not available even with payment of additional premium including damage caused by the CONTRACTOR himself during the execution of the CONTRACT, the CONTRACTOR shall repair and make good the same as his own cost. The CERTIFICATE OF COMPLETION AND ACCEPTANCE will be issued by the Purchaser/Customer only if the WORKs are in good order and conditions and conform in every respect with the requirements of the CONTRACT and OWNER’s REPRESENTATIVE’s instructions in accordance with the CONTRACT .

(v) USE OF OWNER’s FACILITIES

Notwithstanding anything contained elsewhere in the CONTRACT, the CONTRACTOR shall make its own arrangements for all the facilities/resources required to carry out the WORK including but not limited to crane and Material Handling, living accommodation, etc. OWNER’s Crane and any other hoists, living accommodation etc. shall not be available for CONTRACTOR’s use.

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OPRYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED . It must not be used directly or indirectly in any way detrimental to the interest of the company. (vi) COMPLIANCE OF LOCAL LAWS & REGULATIONS The CONTRACTOR shall comply with all the laws, rules and regulations including but not limited to CONTRACT Labour (REA) Act, Minimum Wages Act etc. and shall keep the OWNER harmless and indemnified for any action brought against it for any violation non-compliance of any of the Acts etc. 2.3.0 POLLUTION RESPONSIBILITY In the performance of any and all services and the WORKs by the CONTRACTOR or his sub-contractors, the CONTRACTOR shall accept full responsibility for compliance with all applicable laws and governmental orders, rules and regulations as amended/in force from time to time relating to pollution. CONTRACTOR and his sub-contractors shall also comply additional provisions as may be notified to the CONTRACTOR by the OWNER. The CONTRACTOR agrees to inform himself and his supervisors of such Laws, Orders and Regulations and to make all his employees and the sub-contractors fully cognizant of their responsibilities thereunder. The CONTRACTOR shall i) Clean up and remove any pollution resulting from its non-compliance with the provisions of this section, at his cost and expense ii) If the CONTRACTOR fails to do so, the COMPANY may clean up and remove the pollution. In which case the CONTRACTOR shall reimburse the OWNER upon receipt of bill from the OWNER , the cost of such clean up and removal. 2.4.0 GUARANTEE AND WARRANTY/DEFECT LIABILITY PERIOD The CONTRACTOR agrees to ensure that all materials , equipment and components used in execution of the WORKs under this CONTRACT, shall be new and unused (not reconditioned) and of recent manufacture which shall in no case be of a date of manufacture older than one year from the date of shipment to SITE as the case may be. 3.0.0 SPECIAL CONDITIONS OF CONTRACT The bidder shall visit the plant site before submitting the offer and should acquaint himself with the existing rail/road linkage facilities, site conditions like approach, availability of material camping facilities for his labour force, statutory requirement, working condition at site. Bidder to provide by himself any crane, tools, tackles for his work at site. 1. All co-ordination for equipment and system to meet the performance requirement as found necessary should be taken care off by the bidder.			
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2. Bidder to consider back filling with soil obtained from borrow pits within 5km from cooling tower, in case excavated earth is not suitable for backfilling. However, the exact location shall be intimated during the contract execution stage.

3. Bidder to consider disposal of soil up to 5km from the point of excavation.

4. Bulk concreting like raft, basin walls, roof slabs etc to be done through batching plant/ready mix concrete either owned or loaned from elsewhere. However small volume concreting can be done using mixers.

5. For Construction Power and Construction Water refer Job Specification.

6. Bidder to consider rock excavation cutting of jungle (if any) and site grading and levelling limited to cooling tower area only(with prescribed setbacks on all sides of the area) in his scope.

4.0.0 PERFORMANCE, GUARANTEE AND TESTS

1. The complete cooling tower shall be guaranteed to meet the design performance conditions when tested in accordance with the cooling tower institute Acceptance Test Code ATC –105. If the performance test shows a deficiency, the contractor shall rectify the defects without any additional cost to the owner.

2. The contractor shall furnish performance curves based on constant L/G ratio under the following conditions.

a. For water rate at design condition and + 10% variation.

b. For cooling range at design condition + 20% variation.

c. For wet bulb temperature(+ 1.67°C) and (-3.9°C) of design wet bulb temperature.

d. For relative humidity at +20% and -20% of design condition.

3. The completed cooling tower in operation shall also be guaranteed to meet the following requirements.

a. Motor driving the fans shall be sized for total BHP required including gear losses. The power consumption for running the fan should not exceed the rated BHP.

b. There shall be no leakage of water through sides or ends of the tower.

c. Motors, speed reduction gears and fans shall be of adequate design and construction and properly protected for operation in all adverse climatic conditions. Water tightness of basin, piping, valves, sluice gates, etc.is to be ensured.

d. Test for cooling capacity to meet design parameters.

e. Test for tripping level of vibration switch.

f. Power consumption shall be within the guaranteed limit mentioned in bidder’s data sheets.

g. Motors and fans shall operate satisfactory in continuous operation with no injurious

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vibrations and the sound intensity shall not exceed 85 decibels above threshold level when measured at a horizontal distance of 1.5M from the nearest face of the tower and 1.5M above ground level.

4.2.0 PERFORMANCE GUARANTEE, TOLERANCE & PENALTIES

The performance test shall be carried out at site as specified and all defects shall be satisfactorily rectified within a time period decided by Purchaser. After rectification, Manufacturer will do retesting till satisfactory performance is achieved. In case the Cooling Tower fails to achieve the specified performance, the equipment will be rejected & the bidder shall replace the same.

5.0.0 PAINTING

Refer the Job Specification.

6.0.0 QUALITY ASSURANCE PROGRAMME

6.1.0 Quality Assurance Programme

To ensure that the equipment and services under the Scope of Contract whether manufactured or performed within the Bidder’s works or at his Sub-Vendor’s premises or at the Owner’s site or at any other place or work are in accordance with the specifications, the Bidder shall adopt suitable quality assurance programme to control such activities at all points, as necessary. Such programmes shall be outlined by the Bidder and shall be finally accepted by the Owner / Authorised representative after discussions before the award of Contract. The QA programme shall be generally in line with ISO-9002/IS-14001. A quality assurance programme of the Bidder shall generally cover the following :

1. System for shop manufacturing and site erection control including process controls and fabrication and assembly controls.
2. Inspection and test procedure both for manufacture and field activities.
3. Control of calibration and testing of measuring, testing equipment.
4. System for indication and appraisal of inspection status.
5. System for authorizing release of manufactured product to the Owner.
6. System for handling, storage and delivery.
7. Furnishing quality plans for manufacturing and field activities and detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of equipment / component.

6.2.0 Quality Assurance Documents

The Bidder shall be required to submit required no. of copies of the following Quality Assurance documents as required.

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OPyright AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED . It must not be used directly or indirectly in any way detrimental to the interest of the company. 1. Material mill test reports on components as specified by the specification and approved Quality Plans. 2. The inspection plan with verification, inspection plan check points, verification sketches, if used and method used to verify that the inspection and testing points in the inspection plan were performed satisfactorily. 3. Sketches and drawings used for indicating the method of traceability of the radiographs to the location on the equipment. 4. Non-destructive examination results, reports including radiography interpretation reports. 5. Factory tests results for testing required as per applicable codes and standard referred in the specification and approved Quality Plans. 6. Inspection reports duly signed by QA personnel of the Owner and Bidder for the agreed customer hold points. During the course of inspection, the following will also be recorded. a) When some important repair work is involved to make the job acceptable. b) The repair work for the remaining part of the accepted product quality. All the accepted deviations shall be included with complete technical details. The equipment shall be guaranteed to meet performance requirements required by this specification and rectification shall be carried out until satisfactory results are obtained. The Owner reserves the right to reject the equipment should the performance values fall short of those indicated in the schedule of Technical data sheets. In case of such option of rejection being exercised by the Owner the Bidder shall replace the faulty equipment with one which shall meet the guaranteed values. 6.3.0 Engineer's Supervision The work shall be performed under the supervision of the Owner. All matters and questions shall be referred to the Owner and the Bidder shall proceed to comply with the Bidder's/Owner's decision. The scope of the duties of the Owner pursuant to the Contract, will include but not be limited to the following 1. Interpretation of all the terms and conditions of these documents and specifications. 2. Review and interpretation of all the Bidder's drawings, engineering data etc: 3. Witness or his authorized representative to witness tests & trials either at the manufacturer's work or at site, or at any place where work is performed under the contract. 4. Inspect, accept or reject any equipment, material and work under the contract.			
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5. Issue certificate of acceptance and / or progressive payment and final payment certificates.
6. Review and suggest modifications and improvement in completion schedules from time to time
7. Supervise the quality assurance programme implementation at all stages of the works.

7.0.0 Taking Over

Upon successful completion of all the Owner Acceptance Tests, the Owner shall issue to the Bidder a Taking over Certificate as a proof of the final acceptance of the equipment. Such certificate shall not unreasonably be withheld nor will the Owner delay the issuance thereof, on account of minor omissions or defects which do not affect the commercial operation and/or cause any serious risk to the equipment. Such certificate shall not relieve the Bidder of any of his obligations which otherwise survive, by the terms and conditions of the Contract after issuance of such certificate.

8.0.0 Vendor Documentation

Vendor shall confirm in their bid for compliance in all respect for the submission of documents as follows-

Sl. No	Document Name / Type	To Contain	Required With Offer	Required After P.O	
			Compliances from Vendor & No. of Sets Req'd.	No. of Sets Required – Engg. & Approval/Review Activities.	No. of Sets Required- For Site & Customer Submission
1	(a) Drgs, , Data Sheets , Catalogues. BOM etc. (b) PIDs , SLDs, Block-Schematics etc. (wherever applicable)	Adequate Information & essential for proper Technical Evaluation of the Offers. Other Information to be furnished as defined in the applicable Tech Specs.	2 (Addl. Copies Required - wherever Offer Docs. are subject to Review by Customer . See	—	—

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										Compliances from Vendor & No. of Sets Reqd.	No. of Sets Required – Engg. & Approval/Review Activities.	No. of Sets Required- For Site & Customer Submission
										Spec. Requirement)		
							2	Terminal Point (s)	List of Scope Terminal Point (s) & Process Data etc. - wherever applicable.	2 (See also SI-1 above)	–	–
							3	Deviations if any	To be clearly listed, furnishing reasons for non-compliance	2 (See also SI-1 above)	–	–
							4	Master Document List (MDL)- (Blank format Attached with this specification)	a) List of all Documents & Drgs., Spares Items etc. which are applicable for the Project . They shall be group wise enlisted in MDL Doc. b) Submission of Up-dated MDL Doc.is required at the time of each submission of Drgs./Doc or group of Drgs. / Docs..	-	3	16
							5	Project completion activity “Bar-chart” matching with BHEL Project Schedule	Required for packages & for contracts and also for projects where Erection & Commissioning activities are in vendor scope.	Compliance required to meet BHEL Delivery Sch.	3	16
							6	(a) Drgs, , Data Sheets , Catalogues. BOM etc. (b) PIDs , SLDs, Block-Schematics etc. (wherever applicable)	While carrying out Detailed Engg. during Post-Ordering Stage.	-	10	16
							7	Information Reg. “INITIAL - FILL” Items & Consumable Items –	a) Confirmation from Vendor Required. The Items shall be	a) Supply Confirmation Required from	10	16
							Ref. Doc.					

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										Compliances from Vendor & No. of Sets Reqd.	No. of Sets Required – Engg. & Approval/Review Activities.	No. of Sets Required For Site & Customer Submission
								List - As Required (for each applicable systems) Various utilities required	considered as Part of main scope of supply. b) A Separate Doc. to be furnished with Detail List & Quantity. (Applicable Items & Qty subject to Review during detail Engg.)	Vendor b) Doc. to be Enlisted in MDL.		
							8	SPARES for Erection / Commissioning	a) Informative List required with Technical & Commercial bids. a.1) To consider as Part of main scope of Supply. b) Such Spares List is subject to Review during Detail Engg.	Vendor to Confirm Supply in their Offer.	6	16
							9	“Operation and Maintenance Spares” / “Mandatory Spares” List	a) Recommended List by Vendor b) List with Other Data – if Specified in Tech. Spec.	1) To Enclose with Offer. 2) To indicate price for the listed items in commercial offer & with extended validity	6	16
Ref. Doc.	10	Vendor’s “Bill of Material” Doc. (BOM) - This Doc. shall be Enlisted in MDL Doc.	1) The Engg. Part of Information in this Doc. shall be approved by BHEL 2) Submission of this Document is essential during	-	6	16						

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Ref. Doc.	Sl. No.	Document Name / Type	To Contain	Required With Offer	Required After P.O	
				Compliances from Vendor & No. of Sets Req'd.	No. of Sets Required – Engg. & Approvals/Review Activities.	No. of Sets Required- For Site & Customer Submission
			initial Submission stage of Engg. Docs. & the same be progressively Updated as the Detail Engg. progresses. 3) All Dispatchable Units shall be identified in this Doc with “Dispatch Tag-No.” (5 Chr. BHEL Des. No. <u>with</u> 3 Chr. Running Item SI No. - e.g. “Jxxxx / 001” , max. upto 999) . 4)The Despatch Tag no. shall be written on an ‘AI- Strip’ and tied to the dispatchable Unit or be prominently painted on each Item with washable paint. PL. NOTE – This Standard Unified System shall be followed being an essential part of Field Quality Assurance Practices & for proper Identification of Items at Site.			
	11	Quality Assurance Plan (QAP) & Factory Testing Procedure Documents	1) Approval from BHEL required. 2) Submission along with the Engg. Docs.	A) Submission - if already standardized with BHEL / Draft proposal & it may be finalized after Review.	6	4

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										Compliances from Vendor & No. of Sets Reqd.	No. of Sets Required – Engg. & Approval/Review Activities.	No. of Sets Required- For Site & Customer Submission
										B) Submission compliance from Vendor required		
							12	FQAP (Field Quality Assurance Plan) & Site Erection, Testing & Commissioning Procedure documents	1) Approval from BHELsite required 2) Submission along with the Engg. Docs.	same as for Sl-11 above	6	4
							13	<u>Erection Documents & Drawings:-</u>	1) To contain final MDL, BOM, Handling & Storage Instructions Doc., Initial-Fill & Consumables Items list, Erection & Commissioning Spares List , Operation & Maintenance spares list / Mandatory Spares List etc. 2) Submission minimum 6 – weeks before eqpt. schedule dispatch. 3) The drgs. shall be kept in plastic pouches and neatly arranged, submitted in an aesthetic, appropriate & durable folder(s). Documents filed appropriately in Folder in – seriatim of MDL.	-	-	16
Ref. Doc.												

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				Compliances from Vendor & No. of Sets Reqd.	No. of Sets Required – Engg. & Approval/Review Activities.	No. of Sets Required- For Site & Customer Submission
	14	O&M Manual Document Folder(s)	1) Submission 1-month before schedule eqpt. dispatch (Draft copy shall be submitted beforehand for review by BHEL) 2) The manual shall be submitted in an aesthetic, appropriate & durable folder(s). Each vol. shall be marked with its Vol. No. 3) <u>This Manual shall include primarily following information: -</u> i) Operational & safety instructions. ii) Environmental Safety instructions & indicating compliances of the Regulations in-force. iii) Guidelines incorporating requirements for Operation of the Equipment in Hazardous Environment- wherever applicable. iv) Master document List (MDL) doc. v) Bill of material (BOM) doc. vi) Erection Instructions. vii) Sub-vendor O&M Manuals	-	Adv. Copy (2 sets)- for review by BHEL	Final Copies – (16 sets)

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							Sl. No.	Document Name / Type	To Contain	Required With Offer	Required After P.O	
										Compliances from Vendor & No. of Sets Reqd.	No. of Sets Required – Engg. & Approval/Review Activities.	No. of Sets Required- For Site & Customer Submission
			vii) Operational & ns for all Systems / Items ions and sketches etc., ncluded- (and applicable ein), overhaul schedules etc. viii) Lubrication Schedule viii) Initial-Fill Items List ix) Approved QAP's Shop Tests & Calibration Reports. x) Approved FQAP - along with related docs. , with site testing & commissioning Protocols etc.									
15	"As –Built" Drawings & Documents	Submission within three weeks -after commissioning at site	-	-	16							
16	Compact Disc (CD)	1) MDL, All drawings, Documents, Data sheets – as Listed in Approved MDL Doc. , all applicable Catalogues (Scanned), BOM & all items covered in the O&M Manuals & the "As-built" Drgs. 2) To submit along with the submission of "As-built" drgs. & docs.	-	-	3							
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OPRYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED . It must not be used directly or indirectly in any way detrimental to the interest of the company. f. Thermal analysis of cooling tower, Power consumption calculations g. Tech. Details of the cooling tower offer and detailed specification, and drawings, calculations cross plots, brochures, catalogues, etc for all components of the system. Including mechanical and thermal capacity of reducing gear, its rating data and selection calculations. h. Fill characteristic curves and pressure drop curves duly certified by the manufacturer of the fill. i. The manufacturer's design performance curves as per ATC 105 of CTI. These curves shall be submitted along with the offer and should be in deg. F only. j. Detailed design calculations to be filled in data sheet enclosed elsewhere, tower sizing format and drawings etc. to explain all salient features of the offer shall be submitted along with the offer, failing which the offer shall be liable for rejection 2. Drawings & Documents to be furnished after placement of order not limited to the following: 1. For Approval a. Detailed design calculations for tower sizing, fan motor sizing calculations, etc b. QAP of various equipment c. GA and schematic view of cooling tower d. G.A of fan deck slab e. C.S and longitudinal section drawing of cooling tower f. G.A of fan cylinder g. Schedule of complete electrical equipment/ devices with specifications h. Fan motor data sheet and G.A of motor i. Layout drawing showing location of all electrical equipment t field devices. j. Illumination, cable and cable supporting structures layout plan and Sections drawing. k. Earthing layout drawing with bill of materials. l. Cable schedule indicating cable number, point of origin, point of termination, type, size and length of power and control cable. m. Terminal wiring and external cable connection diagrams. n. Detailed design calculations for civil works of cooling tower and civil construction drawings. o. PG test procedure with correction curves. p. Any other document as felt necessary during execution. 2. For Information (Mechanical) a. Distribution piping general arrangement b. Hot water distribution nozzle and details c. Lube oil equipment installation d. G.A and C.S drawing of sluice valve (with material of construction of Various components) e. G.A of drive shaft assembly (with material of construction of various Components) f. G.A of gear reducer (with material of construction of various components)			
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OPYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED . It must not be used directly or indirectly in any way detrimental to the interest of the company. 10.0.0 PROPOSAL EXHIBIT SHEETS Instructions To Bidder for submitting technical proposal: 1. The bidder may provide technical proposal as per his convenience. However, following things are to be ensured: a. A list of deviations or exceptions, if any, to technical specification GT57604, Job Specification and the enclosures including reference documents as attached shall be provided as per Annexure- V b. It is hereby informed that only those deviations which are listed by the bidder in Annexure-V and subsequently accepted by BHEL will be considered for evaluation of the bid and for finalisation of the order. No other deviations or exceptions even if mentioned elsewhere will be considered for any technical/ commercial evaluation or for ordering. c. Bidder will need to sign Annexure- V specifically endorsing the above understanding. 2. Guarantees Guarantees envisaged for the project are to be separately furnished as per Annexure- II. These guarantees shall form contract guarantees to be demonstrated through an Approved performance test after the completion of the Cooling Tower. The schedule shall be finalized during the contract execution stage. 3. Special Tools & Tackles Bidder to confirm the supply of Special Tools and Tackles as per Annexure- IV furnishing model nos./Types.			
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OPYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED . It must not be used directly or indirectly in any way detrimental to the interest of the company.	ANNEXURE –II <u>GUARANTEED DATA</u>	
	1.0.0 Water Flow rate per cell	M ³ /HR
	2.0.0 Cooling range	°C
	3.0.0 Approach to wet bulb temperature	°C
	4.0.0 Total Power consumption for fans at inlet of Motor terminal should not exceed	kW
	5.0.0 Head required at inlet header from Bidder terminal point including static and other losses, at normal water level in the basin	M
	The correction curves shall be submitted for the following conditions:	
	a) Cooling Range	±20% of design cooling range
	b) Wet bulb temperature	+ 1.7°C to – 3.9°C of design inlet wet bulb temp.
	c) Cooling water Flow rate	±10% of design Flow rate
Note: Guarantees for range, approach, fan power consumption & pump head required shall be at full load condition within the guaranteed zone of the performance curves.		
Signature of Bidder's Authorized representative .with date.....		
Date.....		

Ref.	Doc

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OPYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED . It must not be used directly or indirectly in any way detrimental to the interest of the company.		ANNEXURE – III						
		<u>LIST OF RECOMMENDED SPARE PARTS</u>						
		Bidder shall tabulate in the proforma below list of all spare parts as recommended by the respective manufacturer for regular, reliable operation. In case the Bidder has to add any other relevant information, the same shall be indicated herein. Continuation sheets of like size and format may be used as per Bidder’s requirements.						
		Sl. No	Description	Quantity	Unit	Total Price	Delivery Period	Remarks
Ref. Doc								

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ANNEXURE –IV <u>SPECIAL TOOLS AND TACKLE</u> Bidder shall supply the following tools and tackles for operation, maintenance and replacement of equipment and component, supplied under the specification. <table border="1"> <thead> <tr> <th>Sl.No.</th> <th>Description</th> <th>Quantity</th> <th>Model No./Type</th> <th>Confirm Supply</th> </tr> </thead> <tbody> <tr> <td>a</td> <td>Mechanical Hub puller for fan</td> <td>1</td> <td></td> <td>Yes/No</td> </tr> <tr> <td>b</td> <td>Bevel protractor with spirit level (For blade pitch angle adjustment)</td> <td>1</td> <td></td> <td>Yes/No</td> </tr> <tr> <td>c</td> <td>Drive shift alignment kit with dial indicator</td> <td>1</td> <td></td> <td>Yes/No</td> </tr> <tr> <td>d</td> <td>Torque wench</td> <td>1 set</td> <td></td> <td>Yes/No</td> </tr> </tbody> </table>					Sl.No.	Description	Quantity	Model No./Type	Confirm Supply	a	Mechanical Hub puller for fan	1		Yes/No	b	Bevel protractor with spirit level (For blade pitch angle adjustment)	1		Yes/No	c	Drive shift alignment kit with dial indicator	1		Yes/No	d	Torque wench	1 set		Yes/No
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ANNEXURE – V

DEVIATION FROM SPECIFICATION

If the proposal submitted has got any deviation from the technical stipulations in the bidding document, the Bidder shall tabulate below the full particulars of such deviations and shall sign below. Additional sheets may be enclosed, if necessary. Deviation is to be furnished with mention of specific clause numbers. Technical and commercial deviations to scope of supply and services, shall be indicated separately.

Sl.No	CLAUSE NO.	DESCRIPTION AS PER SPECIFICATION	DEVIATION BY BIDDER

We confirm that all the deviations/exceptions to the Technical Specification GT57604, Job Specification and enclosures including reference documents attached are listed in this Annexure only. No other deviations or exceptions even if mentioned elsewhere shall be considered for any technical/ commercial evaluation or for ordering.

Signature of Bidder's
Authorized representative .with date.....
Date

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<u>VARIANT TABLE - I</u> <table border="1"> <thead> <tr> <th>Var. No</th> <th>Item</th> <th>Type of Cooling Tower/ No. of Cells</th> <th>Cooling Tower cap. (m³/hr.</th> <th>Matl. Code</th> <th>Ref. docs /drgs</th> <th>Remarks</th> </tr> </thead> <tbody> <tr> <td>01</td> <td>RCC Cooling Tower</td> <td>Cross flow 4(3W+1S)</td> <td>7800</td> <td>PY9757604010</td> <td>PEMC-03922</td> <td>Approach = 4degC Range = 10degC</td> </tr> <tr> <td>02</td> <td>RCC Cooling Tower (Civil Work)</td> <td rowspan="3">Counter Flow 3(2W+1S)</td> <td rowspan="3">6600</td> <td>PY9751016029</td> <td rowspan="3">PEMC-05255</td> <td rowspan="3">Approach = 4 degC Range = 08 degC</td> </tr> <tr> <td>03</td> <td>RCC Cooling Tower (Supply)</td> <td>PY9751016037</td> </tr> <tr> <td>04</td> <td>RCC Cooling Tower (E & C)</td> <td>PY9751016045</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table>							Var. No	Item	Type of Cooling Tower/ No. of Cells	Cooling Tower cap. (m³/hr.	Matl. Code	Ref. docs /drgs	Remarks	01	RCC Cooling Tower	Cross flow 4(3W+1S)	7800	PY9757604010	PEMC-03922	Approach = 4degC Range = 10degC	02	RCC Cooling Tower (Civil Work)	Counter Flow 3(2W+1S)	6600	PY9751016029	PEMC-05255	Approach = 4 degC Range = 08 degC	03	RCC Cooling Tower (Supply)	PY9751016037	04	RCC Cooling Tower (E & C)	PY9751016045							
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	Rev. No.	Date	Revision Details	Revised By	Reviewed By
	00	26.06.13	First issue	R.Muralidhar	Radhika Sista
	01	03.03.15	Variant 02,03 & 04 added.	Amit Sinha	Radhika Sista
	Ref.	Doc.			



**BID PACKAGE
FOR
Combined Cycle Power Plant Project
At Hazira Plant**

Part-II
**GENERAL
CONDITIONS OF
CONTRACT**

Part-II

GENERAL CONDITIONS OF CONTRACT



**BID PACKAGE
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11.0 Planning Package and Progress Monitoring

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1.0 DEFINITIONS AND INTERPRETATION

1.1 Definitions

The following words and phrases shall have the meanings hereby assigned to them except where the context otherwise requires:

- 1.1.1 **"Bidding Documents"** means all documents mentioned under the Contract (refer para (b) of Appendix B.

Note: Annexure-B shall be prepared during finalization of Contract on the basis of Bidding Documents, Amendments/Addenda, other documents as issued by the Company at the time of inviting bids and subsequent addendum/ correspondence exchanged till the decision of Award of Work and shall be appended to the Contract.

- 1.1.2 **"Certificate of Completion and Acceptance"** means certificate issued by Company stating that Contractor has satisfactorily performed the entire Scope of Work under the Contract and the Scope of Work added subsequently in accordance with provisions of the contract.

- 1.1.3 **"Commissioning"** means completion of all activities as defined in Bidding Documents.

- 1.1.4 **"Company"/ "ONGC"** means Oil and Natural Gas Corporation Ltd. incorporated under Companies Act, 1956 having its registered office at Jeevan Bharati, Tower-II, 124 Indira Chowk, New Delhi - 110 001, India and one of its Mumbai Region Offices situated at 1st Floor, B-wing, NSE Plaza, Bandra Kurla Complex, Bandra (E), Mumbai-400 051 including its authorized legal representative, executors and administrators, legal successors and permitted assignees.

- 1.1.5 **"Company's Representative/ Project Coordinator"** means the person or persons appointed from time to time by the Company in the manner provided in Clause 5.1.2 for overall co-ordination and Project Management at the Site.

- 1.1.6 **"Constructional Plant and Equipment"** means all Plants, equipments, tools, appliances, things, facilities, machinery, apparatus of whatever nature needed, in or about the work or Temporary Works (as hereinafter defined) for execution of Works covered under the Contract but does not includes materials or other things intended to form or forming part of the Works.

- 1.1.7 **"Construction Schedule"** means that sequence and plan of Construction activity as affecting or being included in the Work which may be represented in drawings indicating the Construction activity and completion as planned and which will not be altered except with written consent of the Company which consent shall not be unreasonably withheld. The Project Key Dates as given in Appendix A-4 Volume I with all dates duly filled in by the Contractor and approved by Company shall be termed as the Construction Schedule.

- 1.1.8 Deleted

- 1.1.9 **"Construction Superintendent(s)"** means those person(s) designated in writing by the Contractor to the Company as being in full charge of each spread performing Works at the Site.



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- 1.1.10 "**Contract**" means the provisions contained in the documents listed in Para-b of the Agreement given in Appendix-B-4.
- 1.1.11 "**Contractor**" means M/s. _____, a Company established and registered under the laws of _____ (Name of the country) having the registered office at _____ the party to this Contract so defined in the agreement including its authorized legal representative, executors and administrators, **legal successors or permitted assignees**.
- 1.1.12. "**Contract Price**" means the total amount specified in the substantive article in the contract (i.e. Clause 3.1) subject to any additions thereto, or deductions there from which may be made through applications of the relevant provisions of the Contract.
- 1.1.13 "**Contractor's Representative**" means any personnel nominated by the Contractor and notified in writing to the Company to act on behalf of the Contractor and/or to perform the duties designated by the Contractor in the manner provided in Clause 5.1.4 hereunder.
- 1.1.14 "**Contract Specification/Specifications**" shall mean those Specifications of the Works included or referred to in the Bidding Documents as well as those specifications relating to Industry Standards and Codes, and applicable to the performance of Work, work performance quality and the Specifications affecting the Works and performance of Works as detailed in the specifications of this Contract and any modification thereof or addition/deletion thereto as may from time to time be furnished or approved in writing by the Company or any additional specifications required to be produced by the Contractor to meet the Design Criteria.
- 1.1.15 "**Day**" means a Calendar day of twenty four (24) consecutive hours beginning at 0000 hours (midnight) and ending at 2400 hours (midnight) as referred to local time at the Site.
- 1.1.16 "Day Rate" Deleted.
- 1.1.17 Deleted
- 1.1.18 "**Demobilisation of the Contractor**" means the removal of all things forming part of the Mobilisation of the Contractor including all temporary facilities, return of personnel and equipment and the clean up and restoration of the Site as required in this Contract.
- 1.1.19 "**Discharge Certificate**" means certificate issued by the Company to the Contractor after expiration of the guarantee period stating that the Works have been completed and made good to the satisfaction of Company's Representative, in accordance with the requirements of the Contract.
- 1.1.20 "**Drawings**" means drawings included or referred to in the Bidding Documents and any modification thereof approved in writing by the Company's Representative and any additional drawing which may from time to time be ordered, furnished or approved in writing by the Company's Representative or his authorised Representative or required to be produced by the Contractor as per the provisions of the Contract.



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- 1.1.21 "**Engineer**" means the person or agencies appointed from time to time by the Company to act on its behalf to the extent so authorized and notified in writing to the Contractor to perform the duties set out in Clause 5.1.3.
- 1.1.22 "**Engineer's Representatives**" means any resident engineer or assistant of the Engineer or any Representative appointed from time to time by the Company or the Engineer, to perform the duties as set out in Clause 5.1.3 hereof whose authority shall be notified in writing to the Contractor by the Company.
- 1.1.23 "**Guarantee**" means the period and other conditions governing the warranty/guarantee in respect of the Works as detailed in **Section 6.0** hereunder.
- 1.1.24 "**Inspector(s)**" means the person or persons of independent agency designated by the Company in writing to the Contractor to observe test, record and report to the Company quality surveillance of the Contractor's work.
- 1.1.25 "**Kick-off Meeting**" means a meeting convened by the Company to discuss and finalise the Work execution plan and procedures with the Contractor.
- 1.1.26 Deleted
- 1.1.27 "**Mobilisation of the Contractor**" means performance by the Contractor of all those thing necessary to be fully ready to execute Work at site satisfying all Work pre-requisites stipulated in the Contract. Mobilization of the Contractor shall include but shall not be limited to providing of all transport from points of origin to Site, all equipment and materials of construction, all personnel, satisfaction of government requirements, all logistical support to the construction operations and setting up at site in a condition of full readiness to execute Work.
- 1.1.28 Deleted.
- 1.1.29 "**Pre-Commissioning**" includes checking and testing of the equipment, machinery etc. as required by the Contract, and making them ready for use.
- 1.1.30 "**Punch list**" means those minor items/jobs relating to works outstanding at the time of issuance of "Certificate of Completion and Acceptance" which do not affect the normal operation of the Company and which have been mutually agreed by the Company and the Contractor, to be carried out / further completed (within a fix time period) by the Contractor to the satisfaction of the Company in accordance with the Contract.
- 1.1.31 "**Scheduled Completion Date**" means a date when the completion of entire Works is scheduled to be achieved in accordance with the construction schedule. The Scheduled Completion Date for entire Works of this project shall be as per Section 6.3.1 hereunder.
- 1.1.32 "**Site**" means the lands and waters and other places on, under, in or through which the Works are to be carried out and any other lands, waters or places approved by the Company for the purposes of the Contract together with any other places designated in the Contract as forming part of the Site.
- 1.1.33 Deleted.



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- 1.1.34 **"Temporary Works"** means all temporary Works of every kind needed in or about the Works.
- 1.1.35 **"Third Party"** means any group, agency, person or persons who may be engaged in activity associated with the Work specified but who shall remain at arms length from the Work and who shall not have a direct responsibility or authority under the terms of this Contract, or any contractual relationship to the Company, the Contractor or the Contractor's Sub-contractor for the Works.
- 1.1.36 **"Vendor"** when used in connection with materials/plants/equipments/spare parts procurement, means the equipment/ materials manufacturer, supplier (authorised and approved by the equipment(s) manufacturer) of materials/plants/equipments/spare parts to the Contractor.
- 1.1.37 **"Works"** means all things or tasks, which the Contractor is, or may be, required to do to comply with its Contract obligations. It includes everything required to provide and complete a full functioning Facilities. The Works is more fully described in the Bidding Documents including Part IV.
- 1.1.38 **"Startup and Commissioning"** includes introducing well fluids or gas or air or seawater or processed water for equipment testing and completion of running test as required by the contract.
- 1.1.39 Deleted.
- 1.1.40 Deleted.
- 1.1.41 **"Annualized Contract Price"** means Total Contract Price divided by Project Completion period in number of days and then multiplied by 365 days, in case completion period is more than 365 days and 'Annualized Contract price' shall mean Total Contract Price in case completion period is less than 365 days.
- 1.1.42 Deleted.

1.2 Interpretation

- 1.2.1 Words imparting the singular meaning only also include the plural and vice versa except where the context otherwise requires.

Save where the context otherwise requires, words imparting neutral gender shall include masculine or feminine gender and vice versa.

- 1.2.2 The headings and sub-titles in these Conditions of Contract are included solely for convenience and shall not be deemed to be part thereof and shall not affect the meaning or operation of the Contract.
- 1.2.3 Reference to "Section", "Clause" and "Article" and "Provision" shall have the same meaning.



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1.2.4 Governing Language

The governing language for the Contract shall be English. All Contract documents and all correspondence and Communication to be given and all other documentation to be prepared and supplied under the Contract shall be written in English and the Contract shall be Construed and interpreted in accordance with English Language.

1.2.5 Entire Agreement

The Contract constitutes the entire agreement between the Company and the Contractor with respect to the subject matter of the Contract and supersedes all communication, negotiations and agreement (whether written or oral) of the parties with respect thereto made prior to the date of this Agreement.

1.2.6 Amendments to the Contract

No amendment or other variation of the Contract shall be effective unless it is in writing, is dated, expressly refers to the Contract and is signed by a duly authorised representative of each party hereto.

1.2.7 Independent Contractor

The Contractor shall act as an independent Contractor performing the Contract. The Contract does not create any agency, partnership, joint ventures or joint relationship between the parties.

Subject to the compliance with the Contract, the Contractor shall be solely responsible for the manner in which works are performed. All employees, Representatives or sub-contractors engaged by the Contractor in performing the Contract shall be under the complete Control of the Contractor and shall not be deemed to be employees of the Company and nothing contained in the Contract or in any sub-contract awarded by the Contractor shall be construed to create any contractual relationship between any such employees or representative or Sub-contractor and the Company. Contractor shall be responsible for the acts, defaults or negligence of the Contractor, his agencies, servant or workmen.

1.2.8 Waiver of Recourse

Except for claims of breach of the Contract or for claims specifically assumed or authorized therein, the Contractor and the Company waive recourse each against the other for all other claims, which may arise with respect to the Works.

1.2.9 Waiver of Sovereign Immunity

The Company and the Contractor hereby represent and warrant that this Contract is a commercial act and that neither the Company nor the Contractor is entitled to claim immunity from any legal action or proceeding with respect to itself or any of its properties or assets in relation to the enforcement of this Contract on the ground of sovereignty or otherwise under any law. To the extent that the Company or the Contractor, or any of its properties or assets has or herein after may acquire any right to immunity from set-off, legal proceedings or action, attachment whether prior to judgment or otherwise, or



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execution of judgment on the ground of sovereignty or otherwise, the Contractor and the Company each for himself and his properties and other assets hereby irrevocably waives such right to immunity in respect of his obligations under this Contract.

1.2.10 Severability

If any provision or the condition of the Contract is prohibited or rendered invalid or unenforceable then such prohibition or invalidity or unenforceability shall not affect the other provisions or conditions of the Contract.

1.2.11 Unit of Measurement

All the Drawings and Specifications prepared by the Contractors shall be in Metric System.

1.3 Laws/Arbitration

1.3.1 Applicable Laws

All questions, disputes or differences arising under, out of or in connection with this Contract shall be settled in accordance with laws of India (both procedural and substantive) from time to time in force and to the exclusive jurisdiction of the Courts in India at Mumbai, subject to the provisions of clause 1.3.2.

1.3.2 Arbitration

(Applicable to other than Public Sector Enterprises)

Except as otherwise provided elsewhere in the contract, if any dispute, difference, question or disagreement arises between the parties hereto or their respective representatives or assignees, in connection with construction, meaning, operation, effect, interpretation of the contract or breach thereof which parties are unable to settle mutually, the same shall be referred to Arbitration as provided hereunder:

1.3.2.1. A party wishing to commence arbitration proceeding shall invoke Arbitration Clause by giving 60 days notice to the other party. The notice invoking arbitration shall specify all the points of disputes with details of the amount claimed to be referred to arbitration at the time of invocation of arbitration and not thereafter. If the claim is in foreign currency, the claimant shall indicate its value in Indian Rupee for the purpose of constitution of the arbitral tribunal.

1.3.2.2 The number of the arbitrators and the appointing authority will be as under:

Claim amount (excluding claim for interest and counter claim, if any)	Number of arbitrator	Appointing authority
Upto Rs. 50 lakhs	Sole Arbitrator to be appointed from a panel of retired officers from	ONGC [Note: ONGC will forward a list containing names of five retired officers from ONGC/other



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Claim amount (excluding claim for interest and counter claim, if any)	Number of arbitrator	Appointing authority
	ONGC/other PSU/Non-PSU organizations.	PSU/Non-PSU organizations for selecting one from the list who will be appointed as sole arbitrator by ONGC]
Above Rs. 50 lakhs to Rs.5 crores	Sole Arbitrator to be appointed from a panel of retired Jurists	ONGC [Note: ONGC will forward a list containing names of five jurists to the other party for selecting one from the list who will be appointed as sole arbitrator by ONGC]
Above Rs. 5 crores	3 Arbitrators	One arbitrator by each party and the 3rd arbitrator, who shall be the presiding arbitrator, by the two arbitrators. ONGC will appoint its arbitrator from the panel of jurists.

- 1.3.2.3 The parties agree that they shall appoint only those persons as arbitrators who accept the conditions of this arbitration clause, including the fees schedule provided herein. No person shall be appointed as arbitrator or presiding arbitrator who does not accept the conditions of this arbitration clause.
- 1.3.2.4 Parties agree that there will be no objection if the Arbitrator appointed holds equity shares of ONGC and/or is a retired officer of ONGC / any other PSU. However, neither party shall appoint its serving employee as arbitrator.
- 1.3.2.5 If any of the Arbitrators so appointed dies, resigns, becomes incapacitated or withdraws for any reason from the proceedings, it shall be lawful for the concerned party/arbitrators to appoint another person in his place in the same manner as aforesaid. Such person shall proceed with the reference from the stage where his predecessor had left if both parties consent for the same; otherwise, he shall proceed de novo.
- 1.3.2.6 Parties agree that neither party shall be entitled for any pre-reference or pendente-lite interest on its claims. Parties agree that any claim for such interest made by any party shall be void.
- 1.3.2.7 The arbitral tribunal shall make and publish the award within time stipulated as under:

Amount of Claims and Counter Claims (excluding interest)	Period for making and publishing of the award (counted from the date of first meeting of the arbitrators):
Upto Rs. 5 crores	Within 8 months
Above Rs. 5 crores	Within 12 months

The above time limit can be extended by the arbitrator(s), for reasons to be recorded in writing, with the consent of the parties.



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1.3.2.8 Arbitrators shall be paid fees at the following rates:

Amount of Claims and Counter Claims (excluding interest)	Lump sum fees (including fees for study of pleadings, case material, writing of the award, secretarial charges etc.) payable to each arbitrator (to be shared equally by the parties)
Upto Rs 50 lakhs	Rs. 10,000 per meeting subject to a ceiling of Rs. 1,00,000/-.
Above Rs 50 lakhs to Rs 1 crore	Rs. 1,35,000/- plus Rs. 1,800/- per lakh or a part there of subject to a ceiling of Rs. 2,25,000/-.
Above Rs. 1 crore and upto Rs. 5 Crores	Rs. 2,25,000/- plus Rs. 33,750 per crore or a part there of subject to a ceiling of Rs. 3,60,000/-.
Above Rs. 5 crores and upto Rs. 10 crores.	Rs. 3,60,000/- plus Rs. 22,500/- per crore or a part there of subject to a ceiling of Rs. 4,72,500/-.
Above Rs. 10 crores	Rs. 4,72,500 plus Rs. 18,000/- per crore or part thereof subject to a ceiling of Rs. 15,00,000/-.

1.3.2.9 If after commencement of the Arbitration proceedings, the parties agree to settle the dispute mutually or refer the dispute to conciliation, the arbitrators shall put the proceedings in abeyance until such period as requested by the parties. Where the proceedings are put in abeyance or terminated on account of mutual settlement of dispute by the parties, the fees payable to the arbitrators shall be determined as under:

- (i) 20% of the fees if the claimant has not submitted statement of claim.
- (ii) 40% of the fees if the pleadings are complete.
- (iii) 60% of the fees if the hearing has commenced.
- (iv) 80% of the fees if the hearing is concluded but the award is yet to be passed.

1.3.2.10 Each party shall pay its share of arbitrator's fees in stages as under:

- (i) 20% of the fees on filing of reply to the statement of claim.
- (ii) 40 % of the fees on completion of pleadings.
- (iii) 20% of the fees on conclusion of the final hearing.
- (iv) 20% at the time when award is given to the parties.

1.3.2.11 Each party shall be responsible to make arrangements for the travel and stay etc of the arbitrator appointed by it. Claimant shall also be responsible for making arrangements for travel / stay arrangements for the Presiding Arbitrator and the expenses incurred shall be shared equally by the parties.

In case of sole arbitrator, ONGC shall make all necessary arrangements for his travel/ stay and the expenses incurred shall be shared equally by the parties.

1.3.2.12 The Arbitration shall be held at the place from where the contract has been awarded. However, parties to the contract can agree for a different place for the convenience of all concerned.

1.3.2.13 The Arbitrator(s) shall give reasoned and speaking award and it shall be final and binding on the parties.



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1.3.2.14 Subject to the aforesaid conditions, provisions of the Arbitration and Conciliation Act, 1996 and any statutory modifications or re-enactment thereof shall apply to the arbitration proceedings under this clause.

1.3.3 Applicable to Indian PSU s

In the event of any dispute or difference relating to, arising from or connected with the Contract, such dispute or difference shall be referred by either party to the arbitration of one of the Arbitrators in the Department of Public Enterprises to be nominated by the Secretary to the Government of India, in charge of the Bureau of Public Enterprises. The Arbitration and Conciliation Act, 1996 shall not be applicable to the Arbitration under this clause. The award of the Arbitrator shall be binding upon the parties to the dispute, provided however; any party aggrieved by such award may make a further reference for setting aside or revision of the award to the Law Secretary, Deptt. of Legal Affairs, Ministry of Law & Justice, Government of India. Upon such reference the dispute shall be decided by the Law Secretary or the Special Secretary/ Additional Secretary, whose decision shall bind the parties finally and conclusively. The parties in dispute will share equally the cost of arbitration as intimated by the arbitrator.

1.3.4 Resolution of disputes through conciliation by OEC :

If any dispute, difference, question or disagreement arises between the parties hereto or their respective representatives or assignees, in connection with construction, meaning, operation, effect, interpretation of the contract or breach thereof which parties are unable to settle mutually, the same may first be referred to conciliation through Outside Expert Committee ("OEC") to be constituted by CMD, ONGC as provided hereunder:

1. The party desirous of resorting to conciliation shall send a notice of 30 (thirty) days to the other party of its intention of referring the dispute for resolution through OEC. The notice invoking conciliation shall specify all the points of disputes with details of the amount claimed to be referred to OEC and the party concerned shall not raise any new issue thereafter.
2. CMD, ONGC shall nominate three outside experts, one each from Financial/commercial, Technical and Legal fields from the Panel of Outside Experts maintained by ONGC who shall together be referred to as OEC (Outside Experts Committee).
3. Parties shall not claim any interest on claims/counterclaims from the date of notice invoking conciliation till execution of settlement agreement, if so arrived at. In case, parties are unable to reach a settlement, no interest shall be claimed by either party for the period from the date of notice invoking conciliation till the date of OEC recommendations in any further proceeding.
4. The Proceedings of the OEC shall be broadly governed by Part III of the Arbitration and Conciliation Act, 1996 including any modifications thereof.
5. OEC shall hear both the parties and recommend possible terms of settlement between the parties. The recommendations of OEC shall be non-binding and the parties may decide to accept or not to accept the same. Parties shall be at liberty to accept the OEC recommendation with any modification they may deem fit.



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6. Where recommendations are acceptable to both the parties, a settlement agreement will be drawn up in terms of the OEC recommendations or with such modifications as may be agreed upon by the parties. The settlement agreement shall be signed by both the parties and authenticated by all the OEC members either in person or through circulation. This settlement agreement shall have the same legal status and effect as that of an arbitration award on agreed terms on the substance of the dispute rendered by an arbitral tribunal under Section 30 of the Arbitration and Conciliation Act, 1996.
7. The parties shall keep confidential all matters relating to the conciliation proceedings. Confidentiality shall extend also to the settlement agreement, except where its disclosure is necessary for purposes of implementation and enforcement.
8. The parties shall not rely upon or introduce as evidence in any further arbitral or judicial proceedings, whether or not such proceedings relate to the dispute that is the subject of the conciliation proceedings,
 - (a) views expressed or suggestions made by the other party in respect of a possible settlement of the dispute;
 - (b) admissions made by the other party in the course of the OEC proceedings;
 - (c) proposals made by the OEC;
 - (d) the fact that the other party had indicated his willingness to accept a proposal for settlement made by the OEC.
9. The parties shall present their case before OEC only through their in-house executives. Neither party shall be represented by a lawyer unless OEC specifically desires that some issue of legal nature is in dispute that needs to be clarified / interpreted by a lawyer.
10. OEC members shall be entitled for the following fees and facilities:

Sl. No	Fees/ Facility	Entitlement	To be paid by
1.	Fees	Rs. 10,000 per meeting subject to maximum of Rs. 1,00, 000 for the whole case. In addition, one OEC member chosen by OEC shall be paid an additional amount of Rs. 10,000 towards secretarial expenses in writing minutes / OEC recommendations.	Claimant
2.	Additional Fee for attending meeting to authenticate the settlement agreement	Rs. 10,000/-.	Claimant



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3.	Transportation in the city of the meeting	Luxury car or Rs. 1,500 per day.	Claimant
4.	Venue for meeting	ONGC conference rooms/Hotels	ONGC
Facilities to be provided to the out -stationed member			
5.	Travel from the city of residence to the city of meeting	Business class air tickets/ first class train tickets/ Luxury car/ reimbursement of actual fare. However, entitlement of air travel by Business class shall be subject to austerity measures, if any, ordered by Govt of India.	Claimant
6.	Transport to and fro airport / railway station in the city of residence	Luxury car or Rs. 2,000/-.	Claimant
7.	Stay for out stationed members	5 Star Hotel.	ONGC
8.	Transport in the city of meeting	Luxury car or Rs. 1500 per day.	Claimant

11. All the expenditure incurred in the OEC proceedings shall be shared by the parties in equal proportion. The parties shall maintain account of expenditure and present to the other for the purpose of sharing on conclusion of the OEC proceedings.
12. If the parties are not able to resolve the dispute through OEC or do not opt for conciliation through OEC, the party may invoke arbitration clause as provided in the contract

1.4 Indian Agent/Consultant/Retainer/ Representative/ Associate

1.4.1 For those bidders who have indicated the involvement of an agent / consultant / representative/ retainer/associate, in their bid:

- (a) The Contractor confirms that M/s. is the agent / consultant / representative / retainer / associate against this contract. The agent's / consultant's / representative's / retainer's /associate's commission/fee is Rupees will become payable within 30 days of payment of first invoice made to the Contractor, provided installation/commissioning of equipment by such agent / consultant / representative / retainer / associate is not involved. In such case the amount of commission/ fee/remuneration will be deducted by Company from the payment of first invoice of the Contractor and paid to the Indian agent / consultant / representative / retainer / associate in non-convertible Indian Rupees at the closing market rate



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of exchange (BC selling rate) declared by State Bank of India (SBI) on the date prior to price bid / revised price bid (if any) opening.

Where, as a condition of contract, the equipment is to be installed / commissioned satisfactorily by Indian agent / consultant / associate / representative/ retainer, the payment of commission / fee / remuneration shall be made within 30 days of satisfactory installation / commissioning and issue of certificate to the effect by authorised officer of Company. The payment of Indian agent / consultant / associate / representative / retainer will be subject to the condition that he sends stamped pre-receipted bill for the commission / fee / remuneration.

- (b) The Contractor confirms that he has neither engaged nor shall engage the services of any other agent / consultant / representative / retainer / associate for the purpose of the Contract in India or abroad and no agent's/ consultant's / representative's / retainer's / associate's commission / fee other than as mentioned above shall be paid either in India or abroad against this Contract.
- (c) In the eventuality of any change in the status of above confirmation, the Contractor would intimate such a change to the Company and shall follow the commission / fee payment procedure as mentioned above. However, in case, it is established at any subsequent point of time that any other amount or remuneration either in India or abroad is being paid / has been paid without intimation to Company to any one (who is not an employee of the Contractor) against this Contract, the Contractor is likely to lose further business with the Company.

1.4.2 For those bidders who have not indicated the involvement of an agent / consultant / representative / retainer / associate in their bid:

- (a) The Contractor has not indicated in his bid either involvement of any agent / consultant / representative / retainer / associate or payment of any remuneration therefore in India or abroad. Therefore, no agent's / consultant's / representative's / retainer's / associate's commission / fee is payable either in India or abroad against this Contract.

In the eventuality of any change in the status of above confirmation, the Contractor would intimate such a change to the Company and would follow the following procedure for payment of agent's/consultant's/representative's/retainer's/associate's commission/fee.

- (b) The agent's / consultant's / representative's / retainer's / associate's commission / fee will become payable within 30 days of payment of first invoice made to the Contractor, provided installation / commissioning of equipment by such agent / consultant / representative / retainer / associate is not involved. In such case the amount of commission/ fee / remuneration will be deducted by Company from the payment of first invoice of the Contractor and paid to the Indian agent/consultant / representative / retainer / associate in non-convertible Indian Rupees at the closing market rate of exchange declared by State Bank of India (SBI) on the date prior to price bid/revised price bid (if any) opening.

Where, as a condition of contract, the equipment is to be installed / commissioned satisfactorily by Indian agent / consultant / associate / representative / retainer, the



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payment of commission / fee / remuneration shall be made within 30 days of satisfactory installation / commissioning and issue of certificate to the effect by authorised officer of Company. The payment of Indian agent / consultant / associate / representative / retainer will be subject to the condition that he sends stamped pre-receipted bill for the commission / fee / remuneration.

The closing market rate of exchange declared by SBI on the day prior to the price bid / revised price bid (if any) opening will be taken into consideration for working out the commission/fee/remuneration of Indian agent/consultant/representative/retainer/associate.

- (c) In case, it is established at any subsequent point of time that the Contractor's confirmation as mentioned above is not correct or that any amount of remuneration either in India or Abroad is being paid/has been paid to anyone (who is not an employee of the Contractor) against this contract without intimation to Company and/or without following aforesaid payment procedure, the Contractor is likely to lose further business with the Company.

- 1.4.3 Indian agent is not permitted to represent more than one foreign bidder (supplier / manufacturer / contractor) in a particular tender. In case an Indian agent represents more than one foreign bidder (supplier/manufacturer/contractor) in a particular tender, then offers of such foreign bidders (suppliers/manufacturers/contractors) shall be rejected in that tender.

1.5 Notices

Any notice to be given under the Contract shall be given by sending the same by personal delivery, post, telegram, telefax or e-mail to the address of the relevant party set forth below:-

To the Company

- 1) Attn: Head Engineering Services
Oil and Natural Gas Corporation Limited,
Magadalla, Hazira Plant, Hazira
Dist-Surat-394518, Gujarat, India

To the Contractor

Attn:

Any notice sent by, telefax or e-mail shall be confirmed after dispatch of notice sent by post.

Any notice delivered personally or sent by telefax or e-mail shall be deemed to have been delivered on the date of its dispatch.

Either party may, by notice to the other party in writing, change its postal, or telefax / e-mail address for receipt of such notice.



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In this connection, notices shall include any instructions, orders and certificates to be given under the Contract.

1.6 Liability of Government of India

It is expressly understood and agreed by and between the Contractor and Company that Company is entering into this Agreement solely on its own behalf and not on behalf of any other person or entity. In particular, it is expressly understood and agreed that the Government of India is not a party to this Agreement and has no liabilities, obligations or rights hereunder. It is expressly understood and agreed that Company is an independent legal entity with power and authority to enter into Contract solely in its own behalf under the applicable laws of India and general principles of Contract Law. The Contractor expressly agrees, acknowledges and understands that Company is not an agent, representative or delegate of Government of India. It is further understood and agreed that the Government of India is not and shall not be liable for any note, omissions, commissions, breaches or other wrongs arising out of the Contract. Accordingly, Contractor hereby expressly waives, releases and foregoes any and all action or claims, including cross claims, impleader claims or counterclaims against the Government of India arising out of this Contract and covenants not to sue the Government of India as to any manner, claims, cause of actions or things whatsoever arising of or under this agreement.

2.0 SUBJECT MATTER OF CONTRACT

2.1.1 Broad Scope of work and Specification

1.0 Plant Components and Major Equipment

Combined Cycle Captive power plant is to be designed to generate 51 MW (Minimum) Power. The CCCPP shall also be capable of generating minimum 55 TPH of steam as specified.

The EPC works for the proposed Combined Cycle Power Plant with support facilities shall include one (1) Gas Turbine generator, one (1) Waste Heat Recovery Steam Generator; one (1) Steam Turbine generator and all complete with required integral facilities, but are not limited to the following:

1.1 Mechanical

- **Gas Turbine Generator (GTG)**
 - a. Type - Industrial Heavy Duty Type
 - b. Quantity - 1 No.
 - c. Capacity – Suitable for minimum 51 MW gross unit Power output of the CCCPP
 - d. Medium for NOx control – DLN burners
 - e. Guarantee fuel - Natural Gas
- **Heat Recovery Steam Generators (HRSGs)**
 - a. Quantity - 1 No. (Associated with GTG) along with bypass stack and HRSG stack.



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- b. Type - Horizontal, Natural circulation
- c. Steam Parameters. – HP/ /LP (as required for the STG) and to suit Process steam parameter at tap-off point as specified.
- d. Capacity (Min.) / HRSG – Based on specified power and steam requirement. Design Code - Indian Boiler Regulation (IBR) latest Edition.

• **GAS CONDITIONING SKID:-**

Gas conditioning skid shall be suitable for CCCPP & existing i one Gas Turbine requirement.

Gas conditioning skid shall consists of:

- 1x100% Knock out drum (gas Scrubber) for GTG/HRSG stream,
- 1x100% steam gas heater,
- Pressure reduction valves, filter etc. shall be 2x100% for each services i.e. GTGs & HRSGs.
- Gas line from gas conditioning skid to Gas turbine inlet shall be properly insulated.
- Suitable Steam / Electric tracing system shall be provided.

• **Steam Turbine Generator and Auxiliaries**

- a. Quantity - 1 No. (Associated with GTG)
- b. Type -Straight condensing type with HP and LP steam injection preferably with axial exhaust

• **Condenser / Auxiliary / Closed Cooling Water System and Mechanical draft cooling tower**

- a. Three, 3 (2W+1S), 50% capacity CCW pumps
- b. Two, 2(1W+1S), 100 % capacity ACW pumps.
- c. Cooling tower (3 cells, 2W+1S).
- d. Cooling water treatment systems for biocide & anti scalant / anti-corrosion dosing, side stream filter and dosing for alkalinity control etc.

- **Fuel gas (Natural Gas) Handling system**
- **De-Mineralised, Filter, Potable & Service Water system.**
- **EOT cranes & hoists**
- **Instrument and Service Air system**
- **Heating, Ventilation and Air conditioning system**
- **Fire detection and Protection System**
- **Piping, Valves, specialties, fittings, supports for all in-plant and interconnection piping.**
- **Workshop equipments**



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1.2 Electrical:

- Generators f(GTG & STG)
- Generators Transformers, Station Transformers
- Segregated Phase HT & Non segregated phase LT Bus ducts
- Control and Relay panels
- 66 kV indoor type GIS
- Sub-station automation system (SAS)
- 66kV cables
- Replacement of existing 66kV transmission line conductor with special heat resistant aluminum alloy steel reinforced conductor
- HT and LT switchgear
- LT Transformers
- Batteries and battery chargers
- Electric motors and actuators
- Plant illumination system
- Earthing and lightning protection
- Plant Communication system
- CCTV
- 11kV connection shifting of existing GTG-3
- Uninterrupted Power Supply (UPS)
- Power and control cabling
- Cable trays and other miscellaneous electrical items
- Black start, emergency DG set as specified.

1.3 Control and Instrumentation System:

- Microprocessor based gas turbine generator control & protection system, vibration monitoring system, fire detection and protection system
- Microprocessor based steam turbine generator control system, protection system and turbo supervisory instrumentation
- Plant Distributed Control System (DCS)
- Vibration monitoring system for plant HT drives GPS-based Master and Slave clock system
- SWAS (Steam and Water Analysis System)
- SEMS (Stack Emission Monitoring System)
- HART Management System (HMS)
- PLC-based control systems and necessary local control panels for all BOP offsite facilities
- Instrumentation Lab
- Equipment:

1.4 Civil Structural and Architectural Works

- Earthwork and filling in proposed power plant area and its surrounding as per site grading requirements.
- Main power house Building for Gas Turbine and Steam Turbine Generator.
- Equipment foundation for GT, ST, Generator, HRSG, 66 kV GIS, Transformers and other Auxiliary equipment foundation.
- Plant roads and Storm Water Drainage System, Sewerage System with necessary Inter-connections to the existing plant system.



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- Pipe and Cable Trenches and Racks as required within and outside the plant area.
- BOP Buildings, Pump houses, Control and SWGR rooms.
- All other civil works required for the power plant and detailed elsewhere.
- Corrosion protection, Painting and Insulation.
- Conditions stipulated by AAI (Airport Authority of India – Chimney NOC) / SPCB, State Pollution Control Board) for construction of plant.
- Cutting of tree, shrubs and other matters in proposed CCCPP area and levelling.

2.0 GENERAL SCOPE OF SUPPLY AND SERVICES

The scope of supply and services covered shall be complete from site clearing to project takeover by Owner including all supplies and services. The Contractor's scope of supply and services listed in clause 1.0 above. Plant components and Major Equipment as well as listed below are to be included and shall not be limited to the following:

The scope of work for the Tender shall include in general but not limited to Project management, Residual Design / Engineering, Procurement, construction, installation, Testing at Manufacturer's Works and at site (Hazira Plant), painting, Packing, Forwarding and Supply of all equipment, plants and facilities and for connection at the boundary/defined limits and as specified in the relevant Detailed Technical Specification for the completion of the power plant on an EPC basis including pre-commissioning & commissioning, Special Tools and Tackles, pre-commissioning / commissioning spares and mandatory spares.

Any item or work that is not specifically indicated in the bid document but required for completeness of the project shall also be part of Contractor's scope.

The detailed Scope of Work of LSTK Contractor and Technical Specifications are indicated at respective Section of the technical Bid Document. The document contains 3 no. of Volumes including Technical addendum (if any).

2.1.2 Existing Facilities:

All the proposed facilities are located at Hazira Plant. Details of the existing facilities with reference to the scope of work for this tender are as provided at Part-IV of the tender document.

2.2 Commencement-Completion Dates

2.2.1 Date of Commencement

The effective date of this Contract coming into force and the commencement of Works shall be the date on which the Company issues the Notification of Award for the Works under this tender in acceptance of Contractor's final tender as mutually agreed prior to issuance of Notification of Award.



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2.2.2 Date of Completion

The completion date for works covered under the contract shall be as per clause 6.3.1.

2.2.2 Access to Installation Site

2.2.2.1 The Company's Representative upon receipt of request from the Contractor intimating commencement of installation/construction work at offshore site shall give to the Contractor access to as much of the Site as may be necessary to enable the Contractor to commence and proceed with the construction/installation of the Works in accordance with the program of Work in terms of Clause 2.3.4. Any reasonable proposal of the Contractor for access to Site to proceed with the construction/ installation of work in accordance with the program of work in terms of Clause 2.3.4 will be considered for approval and shall not be unreasonably withheld by the Company. Such requests must be made to the Company's Representative in writing at least 7 days prior to start of the Work.

2.2.2.2. Deleted

2.2.3 Start of Fabrication/Installation

Prior to taking up fabrication/installation of any major component of Work, the Contractor shall submit to Company his proposed construction sequence and procedures and obtain Company's approval in writing. If no response is provided by the Company to the Contractor within 10 working days [excluding intervening Saturday(s) & Sunday(s)] after receipt by the Company, then the proposed construction sequence and procedure shall be deemed to be approved by the Company.

2.3 General Obligations of Contractor

2.3.1 Knowledge of Site Conditions

2.3.1.1 The Contractor's undertaking of this Contract to carry out the Works shall be deemed to be based on and made in the light of (a) all data of hydrological, sub-surface (data contained in the Bidding Documents), climatic and physical conditions, and (b) all criteria of design contained in the Bidding Documents and conceptual design.

2.3.1.2 Subject to Clause 2.3.1.1 and 5.4, the Contractor shall, nevertheless, be deemed to have knowledge of the site and its surroundings and information available in connection therewith and to have satisfied himself the form and nature thereof including, the sub-surface (data contained in the Bidding Documents), the hydrological and climatic conditions, the quantities and nature of the Work and materials necessary for the completion of the Works, the means of access, and in general to have obtained himself all necessary information of all risks, contingencies and circumstances affecting his obligations and responsibilities therewith under the Contract and his ability to perform it. However, if during pre-engineering survey, Contractor detects physical conditions and/or obstructions affecting the Work, the Contractor shall take all measures to overcome above.

2.3.1.3 Contractor shall be deemed to have satisfied himself as to the correctness and sufficiency of the Contract Price for the Works. The consideration provided in the Contract for the Contractor undertaking the Works shall cover all the Contractor's obligations and all matters and things necessary for proper execution and maintenance of the Works in



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accordance with the Contract and for Complying with any instructions which the Company's Representative may issue in accordance with in connection therewith and of any proper and reasonable measures which the Contractor takes in the absence of specific instructions from the Company's Representative.

2.3.2. Weather Conditions

- a) The Contractor shall bear all cost and delays due to adverse weather conditions/ weather down time experienced during the execution period of the works.
- b) Deleted
- c) Deleted.
- d) Deleted.

2.3.3 Contract Administration

2.3.3.1 The Contractor is bound to carry out, complete and maintain the works only according to the Contract provisions & Specifications.

2.3.3.2 The Contractor shall accept instructions and directions only from the Company's Representative or the Engineer or from an Engineer's Representative.

2.3.3.3 The Company's Representative may give the Contractor directions and instructions about the execution of the Works and may take decisions and issue directions about the acceptability of materials and quality of workmanship to be used in the works and the Contractor shall adhere to and comply with those directions, instructions and decisions of the Company's Representative in accordance with the Contract.

Provided, however, such directions/instructions/decision of the Company's Representative shall not absolve the Contractor of his responsibility of execution of the Works in accordance with the Contract.

2.3.3.4 If the Contractor disputes any directions, Instructions or decisions of the Company's Representative that direction, instruction or decision shall (without prejudice to the Contractor's duty to adhere to and comply with it in carrying out the Works) have only provisional effect with regard to the final rights and duties of the parties and Contractor shall continue to carry out the Work, and shall have to represent against such directions, instructions or decisions of the Company's Representative to the Company with intimation to Company's Representative in writing. Any delay in implementing the said direction, instruction or decision shall be to Contractor's account. The Company and the Contractor shall meet as soon as practicable to reach an amicable settlement prior to invoking the provisions of settlement. If the said direction, instruction or decision is found to be not in accordance with the Contract, the time and cost effect shall be to Company's account. Only in the event of failure to reach an amicable settlement the Clause 1.3.2 shall apply to the said dispute.

2.3.4 Programme of Work

2.3.4.1 Within twenty one days after the award of the work under this Contract or prior to kick-off meeting whichever is earlier, the Contractor shall submit to the Company for its approval a detailed programme subject to Clause 2.3.4.2 showing the sequence, procedure and method in which he proposes to carry out the Works as stipulated in the



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Contract and shall, whenever reasonably required by the Company's Representative or the Engineer's Representative furnish in writing the arrangements and methods proposed to be made for carrying out the Works. The programme so submitted by the Contractor shall conform to the duties and periods specified in the Contract. The Company and the Contractor shall discuss and agree upon the Work procedures to be followed for effective execution of the Works. The Constructional Plant and Equipment and Temporary Works which the Contractor intends to deploy shall be clearly specified. Approval by the Company's Representative of a programme shall not relieve the Contractor of any of his duties or responsibilities under the Contract.

- 2.3.4.2. However if the Contractor's work plan necessitates a disruption/ shutdown in Company's operation, the plan shall be mutually discussed and developed so as to keep such disruption/ shutdown to the barest unavoidable minimum. Any time and cost arising due to failure of the bidder to develop/ adhere such a work plan shall be to his account.

2.3.5 Contractor's Organisation

- 2.3.5.1 The Contractor shall supply to the Company within 21 days of the effective date of commencement of works or prior to kick-off meeting whichever is earlier, an organisation chart showing the proposed organisation to be established by the Contractor for execution of the work including the identities and curriculum Vitae of the key personnel to be deployed. The Contractor shall promptly inform the Company in writing, of any revision or alteration of such organisation charts.

The Contractor shall provide necessary supervision during the execution of the Works and thereafter as the Company may consider necessary for the fulfillment of the Contractor's obligations under the Contract. The Contractor or his competent and authorised representative(s) shall be constantly present at the Work Site whole time for supervision. The Contractor shall authorise the Supervisor or his representative to receive directions and instructions from the Company's Representative or the Engineer's Representative.

The Contractor shall be responsible for the deployment, transportation, accommodation and catering of all labour local or expatriates required for the execution of the Works and for all costs/charges in connection thereof.

The Contractor shall be responsible for obtaining all necessary permits or visas from the concerned authorities for the entry of all labour and personnel to be deployed, into the country where the site is located.

The Contractor shall at his own expense be responsible for the repatriation to the country from which they were mobilised for all his and his sub-contractor's personnel deployed upon the Works at Site and shall be responsible for the suitable maintenance of all such personnel from the cessation of their deployment on the Works to their departure from the country where the Site is located.

- 2.3.5.2 The Contractor shall provide and deploy on the site for carrying out the Works only those technicians/assistants who are skilled and experienced in their respective trades and those foremen and leading respective trades and those foremen and leading hands who are competent to give proper supervision to the Work they are required to supervise.



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Further, only those skilled, semi-skilled and unskilled workmen who are necessary for the proper and timely execution of the Works shall be deployed at Site.

- 2.3.5.3 The Company's Representative may at any time object to and require the Contractor to remove forthwith from the Site a supervisor or any other authorised representative or employee of the Contractor's sub-contractor(s) or any person(s) deployed by Contractor or his Sub-contractor(s), if, in the opinion of the Company's Representative the person in question has mis-conducted himself or his deployment is otherwise considered undesirable by the Company's Representative, the Contractor shall forthwith remove and shall not again deploy the person in question of the Work Site without the written consent of the Company's Representative.
- 2.3.5.4 The Company's Representative may at any time request the Contractor to remove from the Work/Site Contractor's supervisor or any other authorised representative including any employee of the Contractor or his Sub-contractor(s) or any person(s) deployed by Contractor or his Sub-contractor(s) for professional incompetence or negligence or for being deployed for work for which he is not suited. The Contractor shall consider the Company's Representative's request and may accede to or dis-regard it. The Company's Representative, having made a request as aforesaid in the case of any person, which the Contractor has disregarded, may in the case of the same person at any time but on a different occasion, and for a different instance of one of the reasons referred to above in this Clause object to and require the Contractor to remove that person from deployment on the Works which the Contractor shall then forthwith do and shall not again deploy any person so objected to on the Works or on the sort of work in question (as the case may be) without the written consent of the Company's Representative.
- 2.3.5.5 The Company's Representative shall state to the Contractor in writing his reasons for any request or requirement pursuant to this clause.
- 2.3.5.6 The Contractor shall promptly replace every person removed, pursuant to this section, with a competent substitute.

2.3.6 Location/Positioning of Works

The Contractor shall be responsible for the true and proper setting out of the Works in relation to points, levels of reference coordinates, orientation, alignment, marks and water depths given in the Bidding Documents or given by the Company's Representative in writing and for correctness of the positions, levels, depths, dimensions, orientation and alignment of all parts of the works, and for the provision of all necessary instruments appliance and labour in connection therewith. If at any time during the progress of the Works, any error appears or arises in the position, orientation, alignment, levels, depths or dimensions of any part of the Works, the Contractor shall rectify the error at his own cost to the satisfaction of Company's Representative/ Engineer's Representative. The checking of any setting out of any line, level, depths, coordinate, orientation or alignment or position of a marker by the Company's Representative or the Engineer's Representative shall not in any way relieve the Contractor of his responsibility for the correctness thereof. Contractor shall carefully protect and preserve all bench marks, sight rails, pegs and other things used in setting out the Works. In case any data/instruction supplied by Company or its Representative after pre-engineering survey leads to changes/ additions in scope of work, the same shall be dealt with as per the provisions of Clause 8.0 hereof



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2.3.7 Time Span for Responsibility of Works

From the time of commencement of the Works to the issue of a Certificate of Completion and Acceptance of the Works pursuant to Clause 5.10 Contractor shall be fully responsible for the care of Works and of all Temporary Works. In case any damage or loss happens to the Works or to any part of them or to any Temporary Works from any cause whatsoever other than those war risks in respect of which insurance is not available even with the payment of additional premium including damage caused by the Contractor himself during the execution of the Contract, the Contractor shall repair and make good the same at his own cost. The certificate of Completion and Acceptance will be issued by the Company only if the Works are in good order and conditions and conform in every respect with the requirements of the Contract and the Company's Representative's instructions in accordance with the Contract. Notwithstanding the foregoing, in case the Company accepts any part of the Works by issuing a part Certificate of Completion and Acceptance in accordance with the provisions of Clause 5.10.3 the Company shall be responsible for the care of such part of the Works and for any damage and loss which may occur during the period such part of the Works are in the custody of the Company.

3.0 PAYMENT

3.1 Contract Price

The Company shall pay to the Contractor / Leader of Consortium or Joint Venture / Members of Consortium or Joint Venture (as per MOU between the parties) the in consideration of satisfactory completion of all the works covered by the Scope of Work under the Contract the Contract Price of _____ as per the details and break-up of prices given in schedule of prices. The Contract price is a firm price and the Contractor shall be bound to keep the same firm and without escalation on any ground whatsoever until completion of entire works against this Contract. Unless otherwise specified in the Contract, cost of execution of Works on turnkey basis and tests etc. as specified in Contract and all expenses, duties, taxes, fees charges in relation to or in connection therewith including insurance risk of weather, Constructional Plant and Equipment breakdown and Site conditions etc. as per provisions of the Contract, shall be deemed to be included in the Contract Price. Payment shall be made in the currency or currencies given in the schedule of prices for the work executed as per the procedure set forth in Clause 3.2. Adjustment to Contract Price, if any, shall be made in accordance with provisions of Contract.

3.2 Payment Procedure

- 3.2.1 Pending completion of the whole Works, provisional progressive payments for the part of the Works executed by the Contractor shall be made by Company on the basis of said work completed and certified by the Company's Representative as per the milestone payment formula provided in the bidding document at Appendix-A-10-MPF. Such certification of the Work completed shall be made by the Company's Representative within 15 days of receipt of Contractor's Application for Certification with all required supporting documents. No payments shall become due and payable to the Contractor until Contract is signed by the two parties and Contractor furnishes to the Company Performance Guarantee (as per Clause 3.3) and Certificate of insurance for Policy/Policies specific for the project and other policies (as per requirement of Cl.7.3).



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- 3.8.2** The other modalities to avail benefit under the EPCG scheme shall be mutually agreed and finalized by the Parties at a later date depending upon Customs requirement and such terms and conditions shall be deemed incorporated in the Contract.

4.0 INTELLECTUAL PROPERTY

4.1 Secrecy

Neither the Company nor the Contractor nor their personnel, agents nor any Sub-contractor shall divulge to any one (other than persons designated by the party disclosing the information) any information designated in writing as confidential and obtained from the disclosing party during the course of the execution of Works so long as and to the extent that the information has not become part of the public domain. This obligation does not apply to information furnished or made known to the recipient of the information without restriction as to its use by third parties or which was in recipients possession at the time of disclosure by the disclosing party. Upon completion of the Works or in the event of termination pursuant to the provisions of the Contract, Contractor shall immediately return to the Company all drawings, plans, specifications and other documents supplied to the Contractor by or on behalf of the Company or prepared by the Contractor solely for the purpose of the performance of the Works, including all copies made thereof by the Contractor.

4.2 Records of Contract Documents

- 4.2.1 The Contractor shall at all times make and keep sufficient copies of the Drawings, Specifications and Contract documents for him to fulfill his duties under the Contract.

- 4.2.2 The Contractor shall keep on each Site at least three copies of each and every Drawing, Specification and Contract Document in excess of his own requirement and those copies shall be available at all times for use by the Company's Representative and the Engineer/ Engineer's Representative and by any other person authorised by the Company's Representative , who shall be provided an adequately sized site office or offices, for the safe-keeping and use of such documents, by the Contractor throughout the duration of the Contract. Where one or more of Contractor's yards/offices/offshore spreads are deployed in the Works, all requirements of the Contract and Contractor's obligation under the Contract shall apply equally at each yard/office/ offshore spread so deployed.

5.0 WORK EXECUTION

5.1 Representatives

5.1.1 General

There may be more than one Company's Representative, Engineer, Engineer's Representative at the same time. The Company shall appoint and notify the Contractor in writing of the names(s) of the Company's Representative. The Company from time to time may appoint some other person(s) as Company's Representative in place of the person(s) previously appointed.



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5.1.2 Company's Representative

The duties of the Company's Representative are to act on behalf of the Company for overall coordination and Project Management at Site. The Company's Representative shall have the authority and powers to the extent so authorized and notified by the Company to the Contractor in writing from time to time. The Company's Representative shall liaise with the Contractor and monitor the progress for the timely completion of the Works. He will communicate Company's approval to the Contractor, issue drawings, specifications etc. and similar documents pertaining to the Works.

He shall also monitor that the Works are carried out in accordance with the specifications, drawings and other terms and conditions of the Contract as inspected by Engineer/Engineer's representative. The Company's Representative shall have the right to inspect any part of the Works at all reasonable time and order necessary tests to be carried out under supervision of Engineer / Engineer's Representative and reject such works which are not in accordance with the Contract.

He has the right to scrutinize the Contractor's records for the Work being done on Day to Day basis. In general, he shall have the authority to oversee the execution of the Works by the Contractor and to monitor compliance by the Contractor of provisions of the Contract.

Approval by the Company's Representative of any or all documents shall in no way relieve the Contractor of the responsibilities of execution of the Work in accordance with the terms and conditions of the Contract.

All notices, instructions, orders, certificates, approvals and all other communications shall be given by the Company's Representative, save as otherwise provided in the Contract. The Company's Representative shall carry out such duties in issuing decisions, certificates and orders as specified in the Contract. All notices, information and other communications to be given by the Contractor to the Company under this Contract shall be given to the Company's Representative except as otherwise provided.

5.1.3 Engineer/Engineer's Representative

The duties of the Engineer/Engineer's Representative are to supervise and monitor the Works and to test and examine any materials to be used or workmanship employed in connection with the Works. He shall have no authority to relieve the Contractor of any of his duties, obligations under the Contract, except as expressly provided in this Clause or elsewhere in the Contract. He shall not also have any authority to order any Work involving delay or any extra payment by the Company or to make any alteration of or in the Works.

The Company's Representative may from time to time in writing delegate to any or all of the Engineer/Engineer's Representative any or all of the powers and authority vested in the Company's Representative and shall notify the Contractor in writing of all said delegations of his powers and authorities.

Any instruction or approval given by an Engineer/Engineer's Representative to the Contractor within the terms of any delegation so notified (but not otherwise) shall bind the Contractor and the Company as though it had been given by the Company's Representative subject to the following provision:



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Failure of any Engineer/Engineer's Representative to disapprove any Work or materials shall not prejudice the power of the Company's Representative thereafter to reject that Work or materials and to order, subject to Clause 5.9.6, pulling down, removal or breaking up of them subsequently to ensure that whether or not such works or materials are in accordance with the requirement of the Contract.

5.1.4 Contractor's Representative

The Contractor's Representative shall have all the power requisite for the performance of Works. The Contractor's Representative shall liaise with the Company's Representative/Engineer, Engineer's Representative for the proper coordination and timely completion of the Works and on any other matters pertaining to the Works. Such Contractor's Representative shall be available to the Company's Representative in the vicinity of each site during the execution of Works.

5.1.5 Consultant

M/s Fichtner Consulting Engineers (India) Pvt. Ltd. Navi Mumbai shall be the Consultant for all technical matters under this work. This includes inter alia:

- a) Review of documents under Clause 5.1.7
- b) Review of following: Designs, Planning, Construction drawings and Specifications, Purchase requisition/specification, and engineering related to Fabrication, load out, installation, testing and hook-up, pre-commissioning and commissioning (wherever applicable as per bidding document) procedures, and Operating Manuals, etc. i.e. all issues related to the satisfactory completion of the Work as defined in the Bid package.
- c) Periodic reviews of Project Schedule established by the Contractor for the Company.
- d) Review of Change Orders prior to their approval by Company.

5.1.6 Third Party Inspection Agency

COMPANY shall engage a Third party inspection (TPI) agency for inspection etc. for Procurement, Fabrication at Vendor's Yard/ Premises during the execution of the project.

The Inspection reports of TPI are to be submitted by the Contractor along with the supply/dispatch documents wherever applicable or periodically as required by PMC/Company.

5.1.7 ENGINEERING

5.1.7.1 GENERAL

The design criteria, specifications and other engineering requirements and information supplied by Company are included in part IV, Description of Work, Spec. & Drgs. of the Bid package. The Contractor shall carry out complete engineering and detailing of these items. The Contractor will be responsible for developing such information as required to perform the survey, engineering, purchasing, fabrication, Inspection & Testing, transportation, installation, hooking up, testing, modifications, pre-commissioning, start up and commissioning of the facilities.



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It is the Company's intention to have the best equipment new and in first class condition, available for its facilities. The specifications contained within this bid package are to provide the Contractor with performance criteria for all major facility components and equipment. The Contractor may select unspecified equipment but will solicit Company approval in order to ensure compatibility with present equipment and trouble free operation.

5.1.7.2 REVIEW AND APPROVALS OF DESIGN AND ENGINEERING

Contractor shall submit to Company for review and approval of all layout drawings, detailed construction and approval drawings, design specifications, detailed calculations and purchase specifications etc. for the Work and other information required by Company prior to issuing for Construction.

All drawings shall be made to a reasonable scale and in detail. If it is found that Contractor has not complied with Company's drawings or specifications submitted, then the necessary changes required shall be made by Contractor at no additional cost and time to Company. In no way does this relieve the Contractor of his responsibility to comply with all Contract specifications for this project unless Contractor receives from Company on a written request for the specific deviation or written authority to deviate from the specifications pertaining to the item in question. Contractor shall maintain a design and drafting schedule that will allow sufficient time for Company to review all drawings and any necessary changes to be made. Preliminary drawings shall not be used for construction purpose.

Company or its representative will review all facets of Contractor's design including design calculations in order to ascertain compliance with design criteria, specifications and conceptual design.

The Company or its representative will review for approval including, but not limited to, the following items.

- i) Structural designs, plans, elevations, material selection etc.
- ii) Piping & Instrumentation flow diagrams including control, safety shutdown, alarms systems, and utility flow diagrams.
- iii) Piping GADs, Piping Isometrics, Equipment & piping support drawings, Instrument drawings and material take offs.
- iv) Protective systems including fire protection and cathodic protection.
- v) Terminal and Equipment layout drawings, piping layouts, plan and structural drawings.
- vi) Electrical wiring diagram, inter connection drawings, lighting cables and earthing layouts.
- vii) Fire and gas detection, alarm and protection system layouts.
- viii) Design data sheets and/or drawings for equipment.
- ix) Instrument interconnection drawings including tubing/cabling layouts.
- x) Installation procedures for all structures, etc. including all analysis, design and detailing connected with fabrication, transportation and installation.
- xi) All purchase specifications including engineering connected with vendor item.



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- xii) All modules of 3D intelligent modeling (online review) beginning with project setup to As-built.
- xiii) Deleted
- xiv) All engineering connected with Anti-corrosion

Company or its Representative's review for approval of Contractor's design in no way relieves the Contractor of the responsibility to satisfy the design criteria and specifications set out herein and install a safe and operable facility.

5.1.8 REVIEW PROCEDURE

The following procedures will be utilized in Company's review:

- a) Contractor will forward copies of all preliminary drawings and specifications in accordance with the correspondence schedule and procedure. Distribution of all documents etc. is the responsibility of the Contractor.
- b) In the event that Contractor does not receive Company's comments on items within 10 working days [(excluding intervening Saturday(s) and Sunday(s)] from the date of receipt by the Company / Company's Consultant then it may be assumed that there are no comments and the items may be issued for construction.
- c) Where marked-up drawings or comments on drawings and specifications are returned, Contractor shall make the corrections and obtain Company's approval before issuing the same for construction, transmitting copies in accordance with the correspondence procedure.
- d) Should any item shown on plans issued for construction be changed due to any reason whatsoever after the plans have been approved, new or corrected plans shall be made and new prints furnished for review and approval of Company. The above will also apply to site changes during fabrication and installation.

5.1.9 DRAWING AND SPECIFICATION RECORDS

5.1.9.1 Drawing Schedule

Contractor shall furnish to the Company as soon as possible (First issue not later than 30 days from Notification of award of Contract), a complete list of all drawings which will be used. This schedule of drawings shall show the drawing number, title, revision number, and issue number together with the date issued. A revised Catch-up plan shall be furnished periodically at least on a monthly basis, (in case of delays) until the work is completed. The Contractor shall supply reduced size prints of AFC drawings as and when required by the Company / Company's Representative at no extra cost to the Company.

5.1.9.2 Specification and Data Sheets

An up-to-date list of all specifications and data sheets shall be furnished by the Contractor as soon as practicable after the work is started. The sheets shall show number, title, revision number and date so that a current summary of latest specifications will be



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available for reference. This list shall be revised and new distribution made in the same manner as the drawing schedule.

5.1.9.3 As-Built Plans

Contractor shall design an intelligent 3D model of complete Terminal in Intergraph's PDS software 7.1 or upward revised version. The intent of generation of an intelligent 3D model in PDS is to consolidate complete project "As-built" documentation in the soft copy with single source of data repository. The model shall have instant access to all information (technical specification, data sheets, design write-ups, installation manuals, operation manuals, fabrication drawings, vendor details, maintenance history, safety instruments etc.) to all items of the model. This information shall be made available on the click of a button and by selecting in the 3D model. Updation and maintenance of the information stored in the 3D model shall be simple and automatic. Complete project data which includes reference data base, project directory, RIS dump files of project database, design data base and reference database, customization done for equipment, cranes etc., and extraction of reports, orthographic, isometric etc. shall be made available along with the project. The 3D model shall also serve as the source for interference checking, extracting isometric and orthographic drawings and generating bills of materials.

If at any stage, bidder wishes to submit 2D drawings, the same shall be submitted using latest version of micro-station format.

Upon completion of identifiable units or components of the construction and / or offshore installation phase of the project, the Contractor will complete all of the related plans to the "as-built" stage (including all Vendor drawings). Contractor shall provide Company the as built documents in hard & soft copies distribution shall be as per sec. 9.5 as detailed below:

- a) Full size of all drawings.
- b) Bound sets of approved specifications.
- c) Hard binders of the manufacturer's data book including certified prints and data for mechanical, electrical or any specialty equipment, which is part of the Contractor's Scope of Supply. Data Books shall be complete with index as to tag numbers associated with manufacture's data shown. Equipment data shall include as a minimum requirement the principle and description of operation, installation and maintenance instructions, drawings and dimensions, parts lists and unpriced purchase orders. Data Books shall be bound in volumes limited to a maximum of 3 inches in thickness.
- d) Bound copies each of the Spare Parts Data Books.
- e) Deleted.
- f) Deleted
- g) As built data filled in Computer Data entry forms.
- h) Certified full size as-built drawings of the Terminal
- i) Bound sets of certified as-built drawings in A3 size.
- j) Contractor shall develop data retrieval system for quick reference search and retrieval of the as-built information. This system shall be seamlessly integrated with the intelligent 3D model and other as built documentation of the project.

Distribution of the above items will be in accordance with instructions in the Correspondence procedure Section 9.0 herein.



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5.1.9.4 Data storage formats

Contractor shall furnish as-built record on hard copy and soft copy on CD-ROMs (in 'pdf' and native format) which shall contain explicit details on following points over & above to the bid package requirement.

- i) Certified 'As built' drawings
- ii) Name of the
 - Contractor (s)
 - Project Coordinator
 - Consultant
 - Certification Agency
- iii) Details such as
 - Location
 - Fabrication/Installation/Commissioning period
- iv) Deleted

Software for documentation

Contractor shall use latest version of MS Office for text documents and daily correspondences, reports etc.

5.1.9.5 Start-up and Operating Manuals

Contractor shall prepare start-up and operating manuals for the facilities including the items shown in the list below and as specified in Part-IV.

- a) Introduction
Described objective of facilities.
- b) Production Process and Auxiliary Systems including Fire Fighting
Describe the equipment and systems details, operating conditions and interrelation of the operating variable.
- c) Preparation for Start-up
Describe how equipment is initially prepared for operation.
- d) Start-up
Describe in detail how equipment and system are brought to proper operating conditions, commissioning and subsequent start-ups.
- e) Shutdown
Describe in detail how the equipment and system are shutdown and prepared for maintenance under normal and emergency conditions.
- f) Safety
Safe practices should be included in all procedures in each section of the manual. This Section itemizes and emphasizes these safe practices.



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- g) Appendix
Necessary drawings and equipment schedules. (This section to also include reduced copy of flow schemes and P&IDs).

The objective of the Manual is to assemble under one bound cover all of the instructions, data and drawings necessary for the operation personnel to start, operate, control and shut down the systems under normal and emergency conditions in a safe manner. It is desired that the instructions be written with clarity and simplicity.

Contractor will submit for Company's review and approval a draft of the Operating Manual at least 150 days prior to completion of facilities for Operation. Company shall return comments to Contractor within 60 days after receipt of draft. The final copies shall be furnished to the Company at least 30 days prior to pre-commissioning/ commissioning of the work. Distribution of copies of draft and final records shall be in accordance with instructions in Correspondence Procedure.

5.1.10 PURCHASING

5.1.10.1 GENERAL

Contractor is expected to co-operate with the Company in the purchase of material and equipment, subject to the provisions of clauses 5.2.2 and 5.2.3. Company reserves the right to review and evaluate contractor's selection. In case, contractor's selection is found not acceptable to the Company as per the provisions of the Contract, Company shall advise contractor to make a suitable substitution, which the contractor shall abide by.

5.1.10.2 PURCHASING PROCEDURE

Handling of requisitions and purchase orders shall be accomplished in the following manner.

- a) Contractor shall prepare material and equipment requisition lists indicating the names of all vendors (from suggested vendor list) proposed to be issued with an RFQ and showing the description, quantities or number required, designation of use, size, catalogue or identification number, mill report, etc. along with Vendor's published literature or any other information which will provide a clear and thorough understanding of the items to be purchased for the facilities, construction, installation and operation requirements as defined in this Bid package.. When purchase requisition refers to a specification for detail, Contractor shall make certain that this specification (purchase specification) has been approved by the Company. Company has an unconditional option/right to approve / reject individual vendors for equipments / items which are in the firm scope of bidder's Work. The Contractor shall call the preferred vendor and arrange discussions with the Company in a satisfactory manner to the Company's Representative before final approval.
- b) Contractor shall furnish copies of unpriced purchase orders for all material and equipment supplied including data on country of origin of the goods in accordance with the correspondence procedure. In addition, copies of unpriced purchase orders shall be included in the Manufacturer's data book for all items included in these data books.



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5.1.10.3 EXPEDITING, INSPECTION AND TESTING

Contractor shall be responsible for all expediting and inspection. Copies of Contractor's expediting and inspection reports shall be forwarded periodically to Company for information. Contractor shall ensure the Company's right of inspection in suppliers' shops or mills during the manufacturing or fabrication of the project components. Contractor shall inform Company promptly of any problems encountered in regard to quality or delivery, and of steps taken by Contractor to overcome such problems. Any air-freighting undertaken by the Contractor to meet the project completion date shall be to Contractor's account. Contractor shall furnish schedule of dates for factory tests of vessels, pumps, and other major equipment in accordance with instructions as per Part-IV of these specifications.

5.1.10.4 MATERIAL AND EQUIPMENT DELIVERY

Contractor shall be responsible for material and equipment delivery, receipt and handling as well as the necessary inspection as to its condition when received from suppliers. Damage claims and replacement or repairs shall also be handled by the Contractor.

5.1.10.5 PURCHASING STATUS REPORT

By the tenth of each month, Contractor shall furnish Company with a status of expediting report covering purchasing progress as of the last day of the preceding month. This report shall indicate purchase order numbers, description of item, supplier, date of order, original promised delivery date, latest revised delivery date, the name of the carrier or shipper, name of the vessel and any other information pertaining to the purchasing status.

5.2 Assignment/Sub-contracting and Procurement

5.2.1 Assignment

The Contractor shall not, except with the explicit prior approval in writing of the Company, transfer, sub-contract or assign his obligations or any benefit or interests in the Contract or any part thereof in any manner whatsoever. Any such assignment shall not absolve the Contractor from his obligations and responsibilities under this Contract.

5.2.2 Conditions of Sub-contracting

The following conditions shall apply as regards sub-contracting of any portion of the Work pertaining to design, engineering, procurement, fabrication, transportation, installation, pre-commissioning, start up and commissioning of Works entrusted to the Contractor:

- (i) The Contractor may sub-contract any portion of Work entrusted to him only with prior written consent of the Company, which shall not be unreasonably withheld. The extent to which the Contractor may sub-contract part of the Works shall be as stated in his bid and as accepted/approved by the Company prior to the opening of the price bid. All sub-contracting arrangements shall be finalised and sub-Contractors to be deployed shall be firmed up by the Contractor within three months from the date of placement of Notification of award by the Company. A signed copy of the detailed Agreement with prices blanked out or some similar



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document (indicating the scope of work of Sub-contractor) entered into between Contractor and Sub-contractor(s) to perform the work sub-contracted, shall be submitted to the Company within three months from the date of signing of the Contract between Company and Contractor

- (ii) Any change in the sub-contractor(s) after the arrangement is firmed up as mentioned in 5.2.2 (i) above, will be made by Contractor only with the prior written approval of the Company which approval shall not be unreasonably withheld and only from amongst those sub-contractor(s) as proposed by the Contractor in his tender and as are found technically acceptable. However, under unavoidable /exceptional circumstances the contractor may offer substitute subcontracting arrangement having requisite experience and capabilities to execute the work. The desired changes shall be put up by the contractor well in time.

Company's decision shall be notified to the Contractor within fourteen (14) working days of receipt of request for such change along with all necessary documents in support of the requested change provided, however, that request for change is received at least one (1) month prior to the schedule start of the relevant activity.

- (iii) Sub-contracting as mentioned herein shall not relieve the Contractor of his obligations and responsibilities under this Contract. Also in no case sub-contractors shall pass on any claim/ liability to Company.
- (iv) Provided however that the sub-contractors listed in Contractor's tender, unless rejected by Company prior to opening of price bids or revised / adjusted price bid, if any, shall for all purposes of the Contract be deemed approved by Company, Contractor shall then be free to sub-contract with any of the already approved sub-contractors subject to Para (ii).
- (v) Notwithstanding what has been stated in sub clause (i) to (iv) above, the contractor shall be required to perform by himself and not through subcontract (s) project management and at least one of the following main activities based on which its bid has been accepted by the Company as per technical BEC.
- a. Design and Engineering.
 - b. Procurement.
 - c. Construction, Installation and Commissioning
- (vi) Deleted.

5.2.3 Conditions for Procurement/Selection of Makes and Vendors

- a) Based on Company's previous experience of equipment installed and working on various installations of Company, a suggested vendor list for equipment & material is included in Part-IV or Appendix A-11 of bidding document. Contractor to select equipment / material from the vendors indicated in the list. In case of exceptional / unavoidable circumstances the contractor may offer other make of equipment / substituted material having specifications equivalent / superior to those specified in the contract through submission of pre-qualification document thereof. Vendors proposed by the contractor and not included in the suggested vendor list will be evaluated and approved by the Company according to their product specifications,



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length of experience in manufacturing a particular product, and availability of service organization along with operational performance experience gained by Company on the earlier procured equipments of the same vendor / manufacturer or other operator's experience.

- b) In respect of certain critical equipment like turbines, compressor, Generator & electric motors, etc., a recommended list of vendors for such equipment is included in Part-IV of bidding document. Contractor is required to select such critical equipment from the recommended list only.
- c) In case of plants/equipment/materials and other allied requirements to be procured for the Works covered under the Contract, the Contractor shall, subject to the limitation with regard to selection of Vendor(s), make(s) of plant/ equipment/ material as contained in a) & b) above, procure the required plant equipment/ material from amongst the make(s) and Vendor(s) of the respective plant/ equipment/ material which have been found to be acceptable and approved by the Company. The Contractor shall not procure plant / equipment / material of make(s) and from Vendor(s) other than those agreed and approved by the Company. Company's approval / comments for list of proposed vendors for critical equipment(s) will be given within 10 working days after submission of such list by Contractor during detailed engineering.
- d) For all plants/equipments/materials, for purpose of selection of the make(s) and vendor(s), the Contractor shall submit during detailed engineering the intended make(s) and vendor(s) from suggested vendor list provided in the document. Acceptance of Vendors or comments shall be issued by Company within 10 working days of receipt by Company of the documentation from the selected vendor. The Company shall have right to hold detailed technical discussion with the Vendor (s) and visit vendor's premises. The Company shall examine the details submitted by the Contractor and ascertain the suitability of the proposed make(s) and/or Vendor(s) capabilities to execute the Work. The Company shall have authority to disapprove or reject the proposed make(s) and/or Vendor(s), which do not meet the requirement of the Contract. The decision of the Company in this regard shall be final and binding on the Contractor. The Purchase Order will be issued by the Contractor only after written approval of the Company's Representative, from amongst make(s) and vendor(s), which have been approved by the Company which approval shall not be unreasonably withheld.
- e) Procurement of plants/equipment/materials from vendor(s) as approved by Company from the suggested vendor list shall not relieve the Contractor of his obligations and responsibilities under this Contract.
- f) Contractor shall source the fuels like petrol diesel etc., if required for carrying out the works / services covered under the contract, from M/s Mangalore Refinery & Petrochemicals Limited, Mangalore (a subsidiary of ONGC), wherever feasible.

5.2.4 Approval

- 5.2.4.1 The approval for finalising sub-contracting arrangement and procurement of plant/ equipment / materials shall be given by the Company only if the Contractor ensures the compliance to 5.2.2 & 5.2.3 above and following:



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- (i) The Contract Price as contained in the Contract shall remain firm and unchanged except as otherwise provided in the Contract.
- (ii) The Contractor shall not be entitled for any time and cost compensation on account of observance of requirements given in Sub-Clauses 5.2.1 through 5.2.3 above. Cost benefits however accruing to the Contractor shall be passed on to the Company

5.2.5 A firm which has been engaged by ONGC to provide goods or works for this project and any of its affiliates are disqualified from providing consulting service for the same project. **Conversely a firm hired to provide consulting services for the preparation or implementation of this project and any of its affiliates, are disqualified from subsequently providing goods or works or services related to the initial assignment for the same project.**

Consultants or any of their affiliates will not be hired for any assignment, which by its nature, may be in conflict with another assignment of the consultants.

5.3 Miscellaneous

- 5.3.1 The Company's Representative on behalf of the Company shall have full power and authority to supply to the Contractor or to instruct the Contractor to prepare further specifications, drawings or job instruction necessary for the proper and adequate execution of the Works in accordance with the Contract and the cost of such Work shall be deemed to be already included in the Contract Price. The Contractor shall carry out these instructions and be bound by them.
- 5.3.2 Unless otherwise specified, the Contractor shall pay all tonnage and other royalties, rent and other payments or compensation (if any) for getting stone, sand, gravel, clay or other materials required for the Works or Temporary Works.
- 5.3.3 All operation necessary for the execution of the Works and for the construction of any Temporary Works shall, so far as compliance with the requirements of the Contract permits, be carried out so as not to interfere unnecessarily or improperly with public convenience or the access to, use and occupation of navigable and other water, waterways, channels, roadsteads, harbors or harbor area, fisheries, natural harbors and anchorage and other places of shelter by sea or lands, public or private roads and footpaths or properties, whether in the possession of the Company or of any other person and the Contractor shall indemnify the Company against all claims, demands, proceedings, damages costs, charges and expenses whatever arising in relation to any said matters in so far as the Contractor is responsible therefore.
- 5.3.4 The Contractor shall use every reasonable means to prevent any of the highways, waterways or bridges, locks, docks, sea walls, harbor works or navigation marks, communicating with or on the routes to the Site from being damaged or obstructed by any traffic of the Contractor or any of its sub-contractors. The Contractor shall select routes, choose and use vehicles and vessels and restrict and distribute loads and cargo such that any extra ordinary traffic and material from and to the site will be limited as much as is reasonably possible and so that no unnecessary damage or injury may be occasioned to highways and the other facilities and areas aforesaid.



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- 5.3.5 The Contractor shall in accordance with the requirements of the Company's Representative, afford all reasonable opportunities and access to the Works/Site to the Company or to any other contractors employed by the Company and their workmen and to the workmen of the Company and of any other duly constituted authorities who may be employed in the execution on or near the Site of any work not included in the Contract or of any Contract which the Company may enter into in connection with or ancillary to the Works for carrying out their work. When instructed by the Company or its representative, the Contractor shall also liaise and coordinate with Company's other contractors for proper execution of the Works.
- 5.3.6 Unless otherwise specified, the Contractor shall at his own expense supply and provide all the Constructional Plant and Equipment, Temporary Works, materials, both for temporary and for permanent Works, labour (including the supervision of it) transport to and from the Site and in and about the Works, and other things of every kind required for design and engineering, procurement, fabrication, construction, load-out, tie-down, transportation, installation, testing, pre-commissioning, start up & commissioning and making good of the works, including during the period of Guarantee for Works required to be performed by Contractor at his own cost in accordance with the provisions of the Contract.
- 5.3.7 **Deployment of Additional Resources**
- If the resources proposed by the Contractor under this Contract are found to be inadequate to complete the Works including the optional items covered under this Contract, then the Contractor shall deploy additional resources as required to complete the Works under this Contract within the Contract Price and without any time effect to the Company.
- 5.3.8 Deleted.
- 5.3.9 On the Completion of the Works, the Contractor shall clear away and remove from the Site all Temporary Works, Construction Plant and Equipment, surplus materials, which he had provided, including any wreckage, debris and rubbish of every kind caused by Contractor or his Sub-contractor and leave the whole of the Site and Works clean and in a workman like and safe condition. If the Contractor fails to remove all such materials, debris and rubbish, the Company shall have the right to get them removed and any cost incurred by the Company in doing so shall be recovered from the Contractor.
- 5.3.10 The Contractor shall not dump any material in the vicinity of the existing facilities of the Company or the facilities which are being installed under the Contract. Contractor shall obtain requisite approval from concerned authority before dumping any material anywhere.
- 5.3.11 It shall be the responsibility of the Contractor to fully comply with the following Security Provisions:
- i. Entry/Access to any field / facility is governed by rules & regulations formulated from time to time by the Government of India and / or its concerned departments / agencies, which are binding on the Company and its contractors etc. All such rules and regulations (including amendments if any) are to be complied without any time and cost impact to the Company. The present requirements in this regard are as follows:



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For all the personnel (Indian/Foreigners) of contractor and/or their subcontractors, the Procedure for security clearance as listed below will have to be strictly followed/complied with before entering the Work Site. Any subsequent changes/modifications as may be issued from time to time in this regard shall also have to be duly complied without any time and cost impact to the Company.

Company's security section has right to deny permission to any person to go to the Site in case either the required procedures are not complied with or any person comes without stipulated advance notice, and in that case the Company will not be liable for any cost and time impact.

Duty Passes for all the personnel are to be obtained well in advance from the Security Section of the Company after providing the prescribed Declaration Forms along with 2 stamp size photographs in respect of each person.

- (a) Indian nationals: Before mobilising/deputing Contractor's persons (Indian nationals) at Site and/or its subcontractor/ vendor representative, etc. Contractor will submit minimum 2 weeks in advance a complete list of the persons along with necessary police verification to enable Company's security section to issue necessary non employee duty (NED) passes without which no person of Contractor/subcontractor or vendor is allowed to proceed to Site.
- (b) For Foreign nationals : At least 4 weeks in advance the Contractor will submit for obtaining necessary clearances from Ministry of Home Affairs (MHA) etc. a list of all foreign nationals required to be mobilised to site. Following information shall be provided :
- i. Full Name
 - ii. Passport No. date and place of issue
 - iii. Nationality
 - iv. Date of Birth
 - v. Parentage
 - vi. Present Address
 - vii. Permanent Address
 - viii. Validity of the passport
 - ix. Details of the visa
 - x. Date visited India last
 - xi. Purpose
 - xii. Duration of the last visit and
 - xiii. Occupation.

Contractor is to ensure that only such expatriates who are having valid passports and valid business visas are deployed for work under the Contract. Expatriates having Tourists visas are not permitted to work in any of Company's projects.

Contractor's personnel (crew/workers) proceeding to offshore should not be in possession of any personal camera/photography materials, Arms/ ammunition, liquor, prohibited drugs etc.



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Contractor is to ensure that all personnel display the Non-employee duty passes issued by the Security Section of the Company on work.

All non-employees duty passes issued for the Construction activities should be surrendered to security section of the Company promptly after construction activities are over in a particular working season.

Contractor is to ensure that all the personnel engaged by them abide by the Security & Discipline Rules prescribed from time to time by the Security Section of the Company.

Contractor and his sub-contractors/agents are to comply with any directive as may be prescribed/given by the Company from time to time in respect of Security matters.

- ii. Deleted
- iii. Deleted.
- iv. The schedule(s) prescribed in the foregoing paras for advance submission of details regarding personnel clearance is indicative only as the clearances are to be accorded by the concerned departments of the Govt. of India. Hence Company will not be liable for any time & cost impact due to any delays on this account or due to change of procedures etc. in this regard.

5.3.12 The Contractor shall ensure that none of his personnel / employees / representatives including personnel/employees/representatives of his sub-contractors / vendors carry out any type of cameras nor do any photography in or around any of Company's installations / facilities.

5.3.13 Deleted.

5.4 Surveys

5.4.1 Pre-Engineering Survey & Pre Construction/Pre Installation Surveys

i) Pre Engineering Survey

The Contractor shall at his own cost independently carry out pre-engineering topography survey & geo-technical investigations with his survey equipment like dumpy level, boring rig etc. to verify the data given in the Bid Document. Such verification shall include but not be limited to verification of site conditions i.e. ground levels, soil bearing capacity etc. Pre-Engineering survey shall be carried out well before design engineering. Details provided in the Bidding Documents are only indicative- Contractor shall be fully responsible to complete the Work as per actual parameters found during this survey without any time and cost effect to the Company.

ii) PRE-CONSTRUCTION / PRE-INSTALLATION SURVEY

iii) Deleted



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- iv) Failure to visit the Site, review the drawings and acquaint himself with all conditions will not relieve the Contractor, in any way, from furnishing any material or performing any work in accordance with the Contract.

5.4.2 While carrying out the Scope of Work under this Contract, Contractor may be required to open / dismantle / realign / modify any facilities or instrument or piping equipment of the existing facilities to carry out the Work. The same shall be carried out without any time and cost effect to the Company. It will be the total responsibility of the Contractor to, test and re-commission all such facilities during and after the completion of work in accordance with the Contract. The same shall be carried out without any time and cost effect to the Company.

5.4.3. Post Installation Survey

The Contractor shall carry out "as installed" / "as laid" surveys for preparation of As-Built Drawings of the Combined Cycle Power Plant Project.

If any debris or unwanted material is observed during post installation survey the same shall be removed by the Contractor without any time and cost effect to the Company.

5.5. Accommodation and Other Facilities for Company's Representative/ Engineers/ Engineer's Representative

The Company shall post Company's Representative(s) at each work site. Contractor is required to submit design documents/ drawings etc. at the Company's designated office at Mumbai for its review/approval, in case Company's Representatives are not posted at the work site. If required, contractor shall arrange for discussion between its engineers & Company's representative(s) / Engineers(s) for any clarification etc. either in person or through video conferencing / or at an extension of the design office in India. The Company may also depute its Engineers(s)/Representative(s) at Contractor's design center for review of critical documents. Contractor shall arrange to send the design documents/ drawings at the Company's designated office at Mumbai for its review. The documents drawings shall be reviewed by the Company at Mumbai. The cost incurred in dispatching the documents by fast courier service to and fro between Contractor's design centre(s) and Company's office(s) shall be borne by the Contractor and the time taken in transit shall also be to Contractor's account. The Contractor shall provide certain facilities for Company's Representative to perform whatever services are deemed necessary by the Company as given in Clauses 5.5.1, 5.5.2 & 5.5.3.

- 5.5.1 Throughout the execution of work at design centre, fabrication/ installation site, office space, stationery, secretarial services with, computers (3 nos. with internet facility), photocopying / reproduction facilities, communication facilities shall be provided for 10 persons (during design review) / 5 persons (at each site during fabrication /installation and equipment inspection) at no extra cost to Company. The communication facilities shall include, but not be limited to, Indian and overseas telefax, fast courier service for official mail/ documents and telephone facilities (i.e. minimum 1 direct telephones with overseas calling facilities, 1 fax machines, etc.). In case of more than one engineering/design office, the conditions mentioned above shall apply to each office. Bidder's lumpsum price shall be inclusive of all the above charges.



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5.5.2 Deleted

5.5.3 During the fabrication & assembly, reasonably accessible space will be made available at site if necessary, for testing or inspection of works.

5.6 Deleted

5.6.1 Deleted

5.7 Deleted

5.8 **Workmen**

5.8.1 **Facilities for Workmen**

5.8.1.1 The Contractor shall make his own arrangements for the engagement of all workmen, local or otherwise, and for their transport, housing, feeding and payment.

5.8.1.2 The Contractor shall provide at Site adequate supply of drinking water and other water for use at Site.

5.8.1.3 If any illness of an epidemic nature breaks out, the Contractor shall comply with and carry out whatever regulations, orders and requirements are imposed by the Government or the local medical or sanitary authorities for the purpose of promptly dealing with and overcoming it.

5.8.1.4 The Contractor shall at all times take all reasonable precautions to prevent any unlawful riotous or disorderly conduct by or amongst the persons deployed for the works at site and for the preservation of peace and the protection of persons and property in the neighborhood of the work.

5.8.1.5 The Contractor shall ensure that the provisions of this Clause 5.8 are complied with by his sub-contractors also.

5.9 **Materials and Workmanship**

5.9.1 **General**

All materials and workmanship shall be as specified in the Contract and in accordance with the requirements of the Contract.

In the event of any revision(s) in the Codes and Standards which become effective after the date of submission of techno contractual bid, the cost effect shall be borne by the Company subject to such change(s) being effected with prior approval of the Company.

All materials and workmanship shall be subjected from time to time to tests, inspections which the Company's representative may direct as per the Contract either at the place/ agency of manufacture or fabrication or at the site or at such other place(s) or agency (ies) as may be required for execution of the Works as per contract without any time and cost effect to Company.

The Contractor shall provide assistance, instruments machines, labour and materials which are normally required for examining, measuring and testing any work and the quality, weight or quantity of any material used and shall supply samples of materials before in Company in the Works for testing, as may be selected and required by the



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Company's/Engineer's Representative. The Company's/Engineer's Representative or duly authorised inspector shall be entitled to attend the said tests and/or inspection. Company shall bear all costs and expenses incurred in connection with traveling and boarding & lodging expenses except as otherwise provided in the Contract. In case the tests/inspections are not performed during the period or at the time mutually agreed for reasons other than those directly attributable to Company / its agents / its other Contractors then Company's Representative shall have the right to get the tests, inspections attended or performed through an independent agency (ies) or any other authorised inspector(s) and all costs incurred by the Company's Representative in doing so shall be recovered from the Contractor. Before any material is incorporated used in the Works Contractor must obtain necessary approval from the Company's Representative. If the Company's inspector fails to attend the test and or inspection at the time mutually agreed or if it is agreed between the parties that the Company's inspector shall not do so, then the Contractor may proceed with the test and/or inspection in the absence of the Company's inspector and provide the Company with a third party certified report of the results thereof.

Tests of materials, equipment, systems and workmanship shall include but are not limited to the tests referred to in and required by the Contract Specifications.

The testing of all welders/other workmen as required by the Contract Specifications shall be to the sole account of the Contractor, including but not limited to the time spent by workmen engaged upon such tests or re-tests and the provisions of all materials, equipment and supervision required for the performance of such tests or re-tests to the satisfaction of the Company's Representative in accordance with the Contract. The Contractor agrees that neither the execution of a test and/or inspection of Materials or any part of the works nor attendance by the Company's Representative/ authorised inspector nor the issue of any Test Certificate pursuant to Cl.5.9.6 hereof shall absolve the Contractor from his responsibility of execution of the Works in accordance with the Contract.

5.9.2 Samples

All samples shall be supplied by the Contractor at no extra cost to Company if their supply is provided for by the Contract specifications.

5.9.3 Cost of Tests

The cost of conducting any and all tests provided for in the Contract specifications and to meet the requirements of Contract shall be borne by the Contractor.

5.9.3.1 The Contractor will establish and maintain continuous radiography service facilities and personnel skilled in their use for the testing and inspection of welds or base metal in Contractor's and sub contractor's work sites and also ultrasonic, magnetic particle and Dye Penetrant tests/inspection services, as and when required by the Company's Representative in accordance with the Contract.

5.9.3.2 The Contractor will also make available, as and when required by the Company's Representative the necessary special equipment and skilled personnel for the operation of radiography. Service facilities for the testing and inspection of the Works as stated in the Contract Specifications.

5.9.3.3 The Costs of all Radiography, Ultrasonic, Magnetic particle or other inspection of weld or base metal, as provided for in sub-clause 5.9.3.1 and the costs of all other testing and



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inspection as provided for in the sub-clause 5.9.3.2 upto the limits prescribed in the Contract Specifications shall be to Contractor's Account.

- 5.9.3.4 Unless otherwise specified cost of all Works/tests etc. as specified in Contract are deemed to be included in the lumpsum Price of the Contract.

5.9.4 Additional Tests

If any additional test is ordered by the Company's Representative which either:

- a) is not provided for in Contract specifications
or
- b) though provided for in the Contract specifications, is ordered by the Company's Representative to be carried out by an independent person/agency at any place /agency other than the Site or at the place/agency of manufacture or fabrication of the materials; the costs and time effect of the test shall be borne by the Contractor if the test shows that workmanship or materials are not in accordance with the provisions of the Contract. If the tests show that workmanship or material are in accordance with the requirement of the Contract then actual cost related to tests shall be borne by the Company and appropriate time extension will be granted to the Contractor in the event that project critical path is affected. Should project critical path not be affected only cost impact will apply.

5.9.5 Access for Inspection/Tests

The Company's Representative/Engineer or any person authorised by him, shall at all times, have access to the Works and to the Site and to all workshops and places or where the Works are being executed or machinery are being obtained for the works to inspect the progress and the manner of manufacture or construction.

Whenever the Contractor is ready to carry out any such test or inspection, the Contractor shall give reasonable advance notice of such test and or inspection and of the place and time thereof. The Contractor shall obtain from any relevant third party or manufacturer necessary permission or consent to enable the Company's Representative/authorised inspector to attend the test and/or inspection. The Contractor shall provide every facility for and necessary assistance in obtaining the right of access for the Company's personnel including Company's Representative and Engineer/ Engineer's Representative. All accesses to works in at site provided by the Contractor shall in all respects be protected and safe.

The Contractor shall provide the Company's Representative with a certified report of the results of any such test and/or inspection.

5.9.6 Opportunity for Inspection of Works

- 5.9.6.1 Any part of the Works shall not be covered up or put out of view without the approval of the Company's Representative or the Engineer/Engineer's representative and the Contractor shall give reasonable notice and provide full opportunity to the Company's Representative or the Engineer/Engineer's Representative to examine and measure any work by providing the facilities for examinations and measurement including the equipment required for them, which is about to be covered up or put out of view or installed below the surface of the sea and to examine any part of the work before other part of the work is placed. The Contractor shall give reasonable notice to the Company's Representative or Engineer/Engineer's Representative whenever any work is ready or



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about to be ready for examination and the Company's Representative or Engineer/ Engineer's representative shall without unreasonable delay, unless he considers it unnecessary and advises the Contractor accordingly, examine/measure/inspect the works. Contractor shall mobilize vendor representative during pre-commissioning/commissioning as per bidding document requirements.

5.9.6.2 The Contractor shall uncover any part of the Works or make openings in or through it as the Company's Representative from time to time directs and shall reinstate and make good such part or parts to the satisfaction of the Company's Representative in accordance with Contract.

5.9.6.3 If any part uncovered or opened pursuant to Clause 5.9.6.2 has been covered up or put out of view after compliance with the requirements of Clause 5.9.6.1 and after inspection is found to be executed in accordance with the Contract the expenses for uncovering making openings in or through, reinstating and making the same good shall be borne by the Company and appropriate time extension shall be granted to the Contractor in the event that project critical path is affected. Should project critical path not be affected only cost impact will apply. But in any other case all the expenses shall be borne by the Contractor and time affect, if any, shall be to Contractor's account.

5.9.6.4 FIELD INSPECTION

Contractor shall have, at all times during the performance of the Work, a competent Superintendent or Foremen on the premises, and any instructions given to such Superintendent or Foremen shall be construed as having been given to Contractor.

5.9.6.5 Fabrication

Company reserves the right to inspect all phases of Contractor's operations including field and shop fabrication equipment assembly, testing, packing and load-out, operation etc. to ensure conformity to the specifications. Company will have an engineer, inspector (3rd party inspection Agency) or other duly authorized representatives, made known to the Contractor, present during progress of the Work and such Company's Representatives are to have free access to the Work at all times. The presence or absence of a Company's Representative does not relieve Contractor of the responsibility for quality control in all phases of the Work. In the event that any of the work being done by Contractor or any Sub-contractor is found by said Company's Representative to be unsatisfactory or not in accordance with the plans and specifications, the Contractor shall, upon verbal notice confirmed in writing immediately of such discrepancy or deficiency, take immediate steps to revise the Work in a manner to conform to said plans and specifications.

5.9.6.6 Erection and Installation

Company will have engineers, inspectors or other authorized representatives present who are to have free access to the work at all times. If a Company's Representative notifies the Contractor's Superintendent or foreman of any deficiency or recommends action regarding compliance with these specifications. Contractor shall make every effort to carry out such instructions in the fullest degree consistent with best industry practice and the prevailing conditions at the time.



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5.9.7 Removal/Replacement of Improper Work and Materials

5.9.7.1 During the progress of the Works the Company's Representative shall have the power to order:

- i) the removal from site of any materials which are not in accordance with the Contract and which are supplied by the Contractor. The material shall be removed by the Contractor at his own expense.
- ii) the substitution of proper and suitable materials according to Contract Specifications.
- iii) the removal and rectifications of any work (notwithstanding any previous test thereof or interim payment therefore) which in respect of material or workmanship is not in accordance with Contract.

Such orders shall be issued by the Company's Representative in writing.

5.9.7.2 In case of default on the part of the Contractor in carrying out an order pursuant to Cl. 5.9.7.1 the Company shall be entitled to deploy other person/agency to carry out such works and all expenses directly related thereto shall be recoverable from the Contractor by the Company. Company will notify the Contractor of the amount, with details, so incurred by it. If the Contractor fails to pay the amount to the Company within 30 days from the receipt of the invoice with the required back-up documents the amount may be deducted by the Company from any money which is due or which may become due to the Contractor.

5.9.7.3 In the event Contractor propose substitution of any materials/equipment, it shall be the Contractor's responsibility to prove to the Company's Representative that the materials/equipment offered by him are equivalent or better in specifications than those specified in the Contract.

Cost savings, if any, arising out of any substitution of materials/equipment shall be passed on to the Company. Cost increase if any, due to substitution shall be borne by the Contractor. No extension of time on this account shall be granted to the Contractor. The Contractor shall obtain prior written approval from the Company's Representative for resorting to substitutions of materials/equipment etc. It will be Contractor's responsibility to submit all relevant documents including Vendor quotation/ invoice to establish reasonability of cost savings with details proposed to be passed on to the Company.

5.10 Certificate of Completion and Acceptance of the Work

Certificate of Completion and Acceptance of the Works or part of the Works shall be issued by the Company subject to the provisions of following Clause 5.10.1, through 5.10.5.

5.10.1 When the whole of the Works have been completed in accordance with the Contract and have satisfactorily passed tests prescribed in the Contract and are ready for final inspection, the Contractor shall notify the Company in writing enclosing all the required documents and reports for review and acceptance by the Company's Representative. The Contractor will also notify the Company's Representative in writing within 7 days in advance regarding the likely completion date of the Works.



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As the work progresses, the Contractor shall continue to provide the required details and data for review by the Company's representative to assist in the expeditious inspection of the Works when completed. The Company's Representative shall review promptly and revert within 14 days after receipt of such notice. If the works are found to be complete in all respect and carried out in accordance with the Contract then the Company shall issue a Certificate of Completion and Acceptance as provided for in Clause 5.10.2. If some defects and/or deficiencies are noticed in the Works, the same shall be notified to the Contractor's in writing within 14 days after receipt of Contractor's notice. Such defects and/or deficiencies attributable to the Contractor's work and workmanship, shall be rectified promptly by the Contractor at his own expenses for which no extension shall be granted. The Contractor shall thereafter repeat the procedure for giving notice as stated above. Should the Company fail to notify such defects and deficiencies to the Contractor within the said period, the Works shall be deemed to have been completed and accepted by the Company without comments.

5.10.2 If the Company is satisfied that the entire Works have been completed as specified in the Contract and have successfully passed all tests provided in the Contract then the Company shall issue a Certificate of Completion and Acceptance which certificate shall be effective from the completion date which the Contractor had notified to the Company subject to the Company's Representative certifying that the entire Works were completed by the Contractor without any defect on the said notified completion date except for the Punch List items.

5.10.3 The Company may accept at its discretion either for flowing oil or gas or any other use any work which has been substantially completed to the satisfaction of the Company's Representative at site and shall issue a part Certificate of Completion and Acceptance before issuing a final Certificate of Completion and Acceptance referred to in 5.10.2 above.

Such part of the Works shall then be considered as completed by the Contractor except for any outstanding item for that part of the Work which the Contractor shall agree to complete before completion and acceptance of the entire Works. No extension of time or increase in cost will be acceptable to the Company on this ground.

5.10.4 The Contractor shall not use or occupy any part of the Works unless its use or occupation has been agreed to by the Company in writing.

5.10.5 Company's acceptance of the Works shall not operate as a waiver of the Company's rights under guarantees in the Contract herein contained as to any short supply specified in the Punch List and defects and deficiencies under Clause 6.1 of GCC.

5.10.6 Hydrocarbons (other than lubricating oils and the like) shall not be introduced to the Work until Contractor has received Company's approval in writing to do so.

5.11 Constructional Plant and Equipment, Temporary Works and Materials

5.11.1 Constructional Plant and Equipment brought to Site

All Constructional Plant and Equipment, Temporary Works and materials provided by the Contractor shall, when brought on the Site, be deemed to be exclusively intended for the Construction and completion of the Works and the Contractor shall not remove them or any



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part of them (save for the purpose of moving them from one part of the site to another) without the written consent of the Company's Representative, which will not be unreasonably withheld or delayed, subject, however, to the provisions contained in the Contract. Unless otherwise specified in the Contract, upon completion of the Work the Contractor shall remove from the Site all Constructional Plant and Equipment brought by the Contractor on to the Site and any surplus materials.

5.11.2 Constructional Plant and Equipment Breakdown

- a. It is expressly understood that breakdowns of Contractor's Constructional plant and Equipment on land or at offshore location during the execution of Works shall not be regarded as physical conditions which could not have reasonably been foreseen by Contractor and as such, the costs of such breakdowns and any resultant delays and costs thereof will be to Contractor's account, unless such breakdown are caused by an event of Force Majeure. In this case, the provision stated on Cl.7.5.2 of GCC shall be applied.
- b. The Contractor shall ensure that the Constructional Plant and Equipment brought by him to the Site are in good working condition. The Company would need a certificate from the Contractor that this Constructional Plant and Equipment before mobilisation at Site are adequate and in good working order to carry out the Works. The Company reserves the right to inspect such Constructional Plant and Equipment upon its mobilisation to the site and the Contractor shall intimate to Company well in advance of mobilisation of such Constructional Plant and Equipment to Site to enable Company to arrange inspection. However such an inspection by Company will not relieve the Contractor of his responsibilities about the adequacy and fitness of Constructional plant and equipment.
- c. The Contractor shall schedule repair and maintenance of his constructional plant and equipment in such a way that constructional plant and equipment breakdown will not delay completion of Works beyond the scheduled completion date. If the Contractor's constructional plant and equipment experience breakdown of such frequency and type that delay in completion of the Works beyond the scheduled completion date is probable, the Contractor shall take immediate action, and replace such constructional plant and equipment and/or mobilise suitable additional constructional plant and equipment in a timely manner at no additional cost to Company so as to prevent delay in completion beyond the scheduled completion date.
- d. If due to the occurrence of breakdown to Contractor's constructional plant and equipment, the execution of the Works is suspended or adversely affected for a period of 30 continuous days and Contractor has not taken an appropriate action to remedy the condition to the satisfaction of the Company, the Company shall enforce provisions of clause 6.3.2 of GCC.
- e. If during the course of execution of works, it is considered by Company's Representative that the constructional plant and equipment/marine spread etc. are found not adequate/sufficient, Contractor at his own cost shall mobilise additional constructional plant and Equipment/Marine spread etc. to complete the works in time.



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- f. The Contractor will not demobilise any equipment, marine spread etc. deployed for the Works without prior written approval of the Company which approval shall not be unreasonably delayed or withheld.

5.11.3 Customs/Excise Clearance Assistance

- 5.11.3.1 The Contractor shall acquaint himself with all the formalities and procedures of Indian Governmental agencies such as Customs, Excise, licensing authorities etc.

It shall be sole responsibility of the Contractor to get the materials, equipment, constructional plant and Equipment and other things required for the Works cleared from all Governmental Agencies including but not limited to, Customs/Excise and pay all duties/ taxes/charges/fees/expenses including fines/penalties imposed, if any, except where otherwise expressly provided in the Contract to be paid by the Company. The Contractor shall be responsible for import of said Constructional Plant and Equipment, material, equipment or other things etc. The Customs clearance will have to be obtained by the Contractor as per Customs Law irrespective of whether Customs Duty is applicable or not applicable. As regards examination of goods at site, the same shall be carried out by Customs Officer on receipt of information. However, IGM and Bill of Entry shall be filed by the Contractor with the Customs Authority well in advance of arrival of heavy equipment mentioned above at offshore site. The Contractor shall also be responsible for re-export of said Constructional Plant and Equipment and any unused materials within 15 days after completion of the Works.

The Contractor shall obtain any and all necessary Governmental Clearance required for such import/re-export, Company shall upon request from the Contractor along with necessary details, provide recommendatory letter(s) as per DGH's prescribed proforma for obtaining necessary Certificate from Directorate General of Hydrocarbons for availing the concessions/exemptions for import of materials, consumables and spares for the Works etc., if applicable. However, the responsibility of obtaining necessary Certificate will be that of the Contractor. Company shall also forward clarifications to DGH's queries, if any, with regard to issuance of Essentiality Certificate after receipt of the same from the Contractor. Rendering of such assistance will not make the Company liable for any time and cost effect.

- 5.11.3.2 The Contractor shall schedule all activities in advance, taking into account any possible delays in complying with the aforesaid requirements. No extension of time shall be granted to the Contractor on this account.
- 5.11.3.3 The Contractor shall defend and indemnify the Company against all claims, charges and expenses whatsoever which arises on account of not obtaining requisite import/re-export permit clearance and/or on account of not re-exporting his belongings including but not limited to Constructional Plant and Equipment, unused materials, consumables, components etc., expeditiously after completion of Works, in accordance with the Contract.
- 5.11.3.4 In the event of any part of the Works being damaged / lost subsequent to payment of customs duty due to reasons not attributable to the Company, it shall be the Contractors responsibility to make good the same through fresh import and to pay and bear the Customs Duty applicable. However, recommendatory letter to the DGH for obtaining fresh necessary certificate for replacement items will be furnished by Company, if so



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requested by the contractor along with proper justification for fresh import, without assuming any liability. In case the said part of the works is not imported afresh as a result of mutual agreement between the Contractor and the Company, the Company shall be entitled to recover the Customs Duty already paid/ reimbursed to the contractor for such parts of the works from any money due or which become due to the Contractor. In case the deficiency is restored satisfactorily by the Contractor without recourse to fresh import, then Company will not recover Customs Duty on such a loss or damage.

As regards import of items required for permanent incorporation in the works and consumable for repair/replacement during the warranty period. Company shall provide the Contractor without assuming any responsibility and liability with the recommendatory letter to DGH to enable Contractor to obtain Essentiality Certificate from DGH, if applicable.

- 5.11.4 The operation of Clause 5.11.3 shall not be deemed to imply any approval by the Company's Representative of the material or equipment or other matters referred to therein nor shall it prevent the rejection of any materials or equipment at any time by the Company's Representative.

5.11.5 Liability for Contractor's Constructional Plant and Equipment

The Company shall not at any time be liable for the loss of or injury to any of the Constructional Plant and Equipment, Temporary Works or materials, except as otherwise expressly provided for in the Contract.

5.12 Procedures for Measurement of Works

- 5.12.1 Payment of works or part thereof whose price is subject to adjustment shall be based on measurement of quantum of work executed and measured as stipulated herein. The measurement of works shall be based on the "as installed" drawings which shall be prepared based on latest revision of approved AFC and shop drawings and shall specifically, include all the changes incorporated during the execution of the entire works with their reasons for changes duly approved by Company. These drawings are required to be submitted along with weight calculation sheets within 90 days of completion of installation of respective items.

- 5.12.2 The Company's Representative shall ascertain and determine by a measurement the value in accordance with the Contract, of Work done pursuant to the Contract.

The Company's Representative shall give notice to the Contractors' authorised representative when he wants any parts of the Works to be measured. The Contractor shall forthwith attend or send a qualified person to assist the Company's Representative or the Engineer/ Engineer's Representative in that measurement and shall furnish all particulars of measurement by either of them. Should the Contractor not attend or neglect or omit to send representative then the measurement made by the Company's Representative or approved by him shall be taken to be correct.

- 5.12.3 Works shall be measured on "as installed" basis net of all loss and wastage of materials for the purpose of payments under the Contract notwithstanding any general or local custom, unless otherwise specifically prescribed in the Contract.



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- 5.12.4 The mode of measurement shall be in Metric System and the quantity shall be calculated in kilograms and rounded off to 2nd decimal place. All the drawings and Specifications prepared by the Contractors shall be in the Metric System.
- 5.12.5 Deleted.
- 5.12.6 The Contractor shall submit all Approved for Construction and Shop drawings and detailed structural Bill of Material for each structural drawing to the Company's Representative at the fabrication yard / site.
- 5.12.7 Payments to the Contractor shall be based on above measurements from the approved bill of materials, and in accordance with the agreed milestone payment formula and Appendix A-3 of the Contract.

5.13 & 5.14 Performance of Contract/Discharge Certificate

- 5.13 No certificate other than the Discharge Certificate referred to in Clause 5.14.1 shall be deemed to constitute approval of any Work or other matter in respect of which it is issued or shall be taken as an admission of the due performance of the Contract or any part of it or of the accuracy of any claim or demand made by the Contractor or of extra Work/Change Order having been ordered by the Company nor shall any other certificate conclude or prejudice any of the rights of the Company.
- 5.14.1 The Contract shall not be considered as completed until a discharge certificate has been signed by the Company's Representative on behalf of the Company and delivered to the Contractor stating that the Works have been completed and made good to the satisfaction of the Company's Representative in accordance with the Contract.
- 5.14.2 The Discharge Certificate shall be issued by the Company's Representative within (28) twenty eight days after the expiration of Guarantee period (or if different guarantee periods become applicable to different parts of the Works then, without prejudice to the Company's Representatives' rights upon the expiration of the latest of those periods) or as soon thereafter as any Works ordered during that period have been completed to the satisfaction of the Company's Representative in accordance with the Contract.
- In case Company fails to issue such Discharge certificate within the period prescribed herein above without any reason having been notified to the Contractor in writing, the Discharge Certificate shall be deemed to have been issued on the expiry of the above said period.
- 5.14.3 This clause (5.14) in its entirety shall have effect notwithstanding that the Company has entered on or taken possession of the Works after completion or any part of the Works by virtue of any agreement with the Contractor.
- 5.14.4 Neither the Company nor the Contractor shall be liable to the other for any matter or thing arising out of or in connection with the Contract or doing of the Works unless the party asserting the liability has given the other party written notice of its claim before the issuance of the last Discharge Certificate under this clause.
- 5.14.5 Notwithstanding the issue of the Discharge Certificate, the Contractor and the Company shall (subject to sub-Clause 5.14.4 of this clause) remain liable for the fulfillment of any obligation incurred under the provisions of the Contract before the issue of the Discharge Certificate which remains unperformed at the time the certificate in question



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is issued, and for the purposes of determining the nature and extent of any said obligation the Contract shall be deemed to remain in force between the parties.

5.15 Marking, Packing, Loading and Securing

5.15.1 General

The Contractor shall comply with the instructions for handling and storage, marking and loading, etc., as detailed in the Contract and any other instructions which may be issued by the Company in this behalf.

5.15.2 The Contractor shall load and stack the material in seaworthy condition conforming to the prescribed standards in force to withstand land / ocean journey and insuring the safety of cargo en-route and also arrival of material at ultimate destination in good condition. Each package shall have on its outer side the following marking in English in indelible paints.

- i) Port of loading
- ii) Name of Contractor
- iii) Port of destination
- iv) Consignee particulars in brief

5.15.3 In addition to the markings stated above, each package approved by the Company's Representative shall carry a serial number or other appropriate indelible marking/identification indicating the Company's Representative's certificate of quality and/or the Contractor's certificate of quality and/or the Contractor's certification of inspection and other documents as may be issued with reference thereto. The Company may also require that such marking / identification shall be applied or affixed by the Contractor in the presence of the Company's Representative. If the spare parts / additional items on arrival in India, are found not conforming (except transit damage) to prescribed specification or are deficient in quality or quantity, Contractor shall replace the same at his own cost.

5.15.4 The Contractor shall ensure that no packages are shipped unless marked to comply with all the instructions of the Company.

5.15.5 Markings shall be correlated in invoices, packing list and on bill of lading, express receipt of mailing certificates exactly as they appear on the equipment/ materials.

5.16 Supply of loose items, Spares and Consumables

5.16.1 Supply of one year's Spare Parts (not covered in Contract Price) **Deleted**

5.16.2 **Deleted**

5.16.3 **Deleted**

5.16.4 **Deleted**

5.16.5 LOOSE ITEMS, SPARES & CONSUMABLES **Deleted**



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5.16.5.1 **Deleted**

5.16.5.2 **Deleted**

5.16.5.3 **Deleted**

5.16.5.4 **Deleted**

5.16.6 Pre-Commissioning / Commissioning Spares

The Contractor shall provide a list of pre-Commissioning/ Commissioning spares item wise within a period of 6 - 9 weeks of placement of order for each equipment. Contractor shall ensure availability of all the spares at the offshore Site at respective platforms before commencement of pre-commissioning/ commissioning of all facilities. The Contractor shall supply the pre-Commissioning/ commissioning spares and maintenance tools at no extra cost to the Company. The Company shall provide the Contractor without assuming any responsibility and liability, with the recommendatory letter to Director General of Hydro-Carbons to enable Contractor to obtain necessary Certificates from Director General of Hydro-Carbons, if applicable.

5.16.7 Lubricants and Chemicals DELETED

5.17 Supply of loose items

The contractor shall ensure delivery of loose items at Hazira Plant, Surat district Gujarat at start of erection works at no extra cost to the Company.

5.18 Use of Company's Facilities

Notwithstanding anything contained elsewhere in the Contract, the Contractor shall make its own arrangements for all the facilities/resources required to carry out the work including but not limited to crane and material handling, living accommodation, power supply etc. However, if the same can be spared then the Company at its discretion may permit their use by Contractor on chargeable basis. The rates applicable shall be same as given in Contractor's rental rate schedule. In case rates are not available in Contractor's rental rate, charges shall be recovered as per the rates applicable from time to time or as decided by Company.

Company shall furnish to the Contractor the details of recoveries (for use of Company's facilities) made from the Contractor's Invoices upon receipt of such request from the Contractor.

Use of Utilities:

Water : Subject to availability , Company shall supply construction water at one point within a distance of 500 Metres of site from where the Contractor will make his own arrangements for temporary distribution through piping / fittings tested and certified meter on chargeable basis. The Charges of construction water will be Rs. 9.00 (Rupees Nine only) per Cubic Metre.

Land : Subject to availability , Company may provide land for Field Office, Stores (open or covered) required for execution of work during the contract period on chargeable basis. The Charges shall be Rs. 5.0 (Rupees Five only) per square Metre or part thereof



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per month. The Contractor has to construct the office duly fenced with required amenities at his own cost. After completion of the job, all these structures, temporary stores shall be dismantled, restored to the original conditions and hand over the land to the Company.

Electrical Power: Subject to availability, Company may supply power at one point at substation within a distance of 500 metres of site, from where the Contractor will make his own arrangement for temporary distribution. All the works will be done as per IEA regulation and passed by Engineer. The temporary line will be removed after the completion of work or if there is any hindrance caused to the other works due to alignment of these lines, the Contractor shall re-route or remove the temporary lines at his own cost. The Contractor at his own cost shall also provide suitable electric meters, fuses, switches etc. for payment to Company which should be in custody and control of Engineer. The cost of Power supply shall be payable to the Company every month at the rate of Rs. 5.00 (Rupees Five only) per KWH (three phase, 50 Hz, 415 volts) which would be deducted from the running account bills of the Contractor. The Company shall not however, guarantee the supply of electricity and no compensation for any failure or short supply of electricity will be entertained and this does not relieve the Contractor of his responsibility for timely completion of the work as stipulated in the Contract. However, Contractor shall use Welding equipment of having high power factor.

5.19 Diversion of Resources

Notwithstanding anything contained elsewhere in the Contract, the availability of the Work front shall be finalized by the Contractor in consultation with the Company. Planning of construction activities shall accordingly be made without affecting the overall schedule of completion. It is likely that the other contractors/ agencies may by carrying out their activities the same site. It is imperative that the contractor shall coordinate with other contractors/ agencies if required and necessary as and when instructed by the Company in writing.

Accordingly, if required by the Company, Contractor shall divert its resources and develop work schedules covering the entire scope entrusted to him. These schedules shall be discussed with other contractors/ agencies along with Company's representative and should it become necessary to further modify the schedules, to avoid/ minimise interference, needful shall be done without jeopardising the overall completion schedule.

5.20 Compliance with Local Laws & Regulations

- 5.20.1 The Contractor shall comply with all the laws, rules and regulations including but not limited to those related to security matters (Clause 5.3.11) Contract Labour (REA) Act, Minimum Wages Act etc. and shall keep the Company harmless and indemnified for any action brought against it for any violation/non-compliance of any of the acts etc.
- 5.20.2 The Contractor shall give all notices and pay/bear all duties, taxes, charges, fees and expenses except where otherwise expressly provided in the Contract required to be given or paid by any national or state statute, ordinance or other law or any regulation or by-law of any international, local or other duly constituted authority in relation to the performance of the works or of any temporary works and by the rules and regulations of all public bodies and companies whose property or rights are affected or may be affected in any way by the works or any temporary works. The Contractor shall acquire all permits, approvals and or licenses from all local, state or central government



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authorities or public sector undertakings in the country where the site is located, which such authorities require the Contractor to obtain in his name and which are necessary for the performance of the Contract including import licenses for materials and visas for the Contractor's and sub-contractors personnel and entry permits for all imported constructional plant and equipment and shall acquire all other permits, approvals and/or licenses which are not the responsibility of the Company and which are necessary for the performance of the Contract.

However, Company shall assist Contractor and/or sub-contractor upon receiving written request from Contractor to acquire the necessary permit, approvals and/or licenses including work permit, visas and import licenses from all local, state or central govt. authorities or public sectors to the extent of issuing recommendatory letters and documents mandatory required to be submitted by Company to the concerned authorities without assuming any liability whatsoever.

- 5.20.3 The Contractor shall comply with and conform in all respects, and shall ensure that all his sub-contractors also comply with and confirm in all respects with the provisions of any statute, ordinance or law as aforesaid and the regulations or by laws of any international, local or other duly constituted authority which may be applicable to the works or to any temporary works and with such rules and regulations of public bodies and companies as aforesaid and shall be responsible for all costs arising from compliance and/or violation of the same and shall keep the Company indemnified against all penalties and liabilities of every kind for breach of any statute, ordinance or law, regulations or bye-law.
- 5.20.4 Deleted
- 5.20.5 Deleted.
- 5.20.6 Subject to provisions of the Contract, the Contractor shall defend, indemnify and hold the Company harmless from and against all penalties, liabilities, damages, claims, fines and expenses of whatever nature arising out of or resulting from the violation of such laws or rules or regulation having the force of law within the scope of clause no. 5.20.3, 5.20.4 and 5.20.5 by the Contractor or his sub-contractors including their personnel.
- 5.20.7 All fossils, coins, articles of value of antiquity and structure and other remains or things of geological or archeological interest discovered at the site or during the works shall be the absolute property of the Company. the contractor shall take reasonable precautions to prevent its workmen or any other persons from removing or damaging any said article or thing and shall immediately on discovery thereof and before removal acquaint the Company's representative of the discovery and carry out at Company's cost the disposal of it at the Company's Representatives orders at rates to be mutually agreed where such rates are not available in the Contract.
- 5.20.8 Contractor shall take all necessary steps in order to equip themselves to avail of all concessions/ exemptions permissible under the statutes including the benefits under Central Sales Tax Act, 1956 failing which they will have to bear extra cost where Contractor does not avail concessional rates/ exemptions of levies like Customs duty, Sales tax / VAT etc. **and CENVAT on input service / capital goods.**



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5.20.9 LABOUR LAWS:

5.20.9.1 The Bidder shall furnish valid EPF code number together with supporting relevant document duly notarised by notary public to this effect along with his Bid.

5.20.9.2 The successful Bidder shall obtain license under Contract Labour (R&A) Act 1970 read with rules framed there under and furnish the same to ONGC within 15 days of the issue of letter for award of CONTRACT failing which the letter of award of Contract shall be cancelled / terminated without any further notice and his Bid bond (EMD) AND / OR performance guarantee (SD) shall be forfeited. The Bidder shall insure payment of minimum wages as per labour laws.

5.20.10 STATUTORY REQUIREMENT

5.20.10.1 CONTRACTOR shall be responsible for obtaining statutory approval from authorities like DGMS, IBR, CCE, Municipal Corporation, Development Authorities, Electricity Department., Electrical Inspector, Inspector of Factories and any other concerned authorities, wherever applicable and as required, for the execution / completion of the WORK before starting the work.

5.20.10.2 The application on behalf of the ONGC for submission for any statutory inspection along with copies of required certificates complete in all respect shall be done by CONTRACTOR and submitted to the Engineer-in- Charge for onward transmission well ahead of time so that the actual commissioning of equipment is not delayed for want of inspection by the Inspector. The actual completion of work of statutory inspection shall be arranged by the CONTRACTOR and necessary coordination and liaison work in this respect including charges and fees thereof shall be the responsibility of CONTRACTOR.

5.20.10.3 Inspection and acceptance of the work by ONGC/ statutory inspection authorities shall not relieve the CONTRACTOR from any of his responsibilities under the Contract.

5.21 Certification Agencies

The Contractor shall meet the requirements of the certification and TPI agencies and their back up consultants and shall also be responsible to co-ordinate with the certification and TPI agencies in supplying to them in a timely manner, specifications, drawings, plans, calculations and all such other information relating to the Work as may be required by the certification and TPI agencies from time to time including assistance at the appropriate Sites to carry out their Work.

The Contractor shall ensure at his own cost quick supply of required copies of documents / drawings to the certification and TPI agency as well as Company and consultants by fastest courier service available.

5.22 Shut down requirements

The works covered under this contract are to be hooked up with the existing facilities/ Terminal as detailed in bidding documents. Contractor shall examine the scheme of hook-up and submit to the Company a schedule of minimum essential shutdown required, if any at least four months in advance of the proposed shutdown for its approval. Company's approval for the final shutdown schedule shall be given not later than one months prior to



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the actual shutdown schedule. The shut down period shall exclude shut down time required for depressurization and restoring the platform. Contractor shall not propose any changes in the shutdown schedule once agreed by the Company. The exact period of the shutdown shall however, be dependent upon Company's operational exigencies subject to the overall project completion schedule not getting affected.

Notwithstanding, the stipulation contained above with regard to period of shutdown, it shall be Contractor's endeavor to avoid / minimize the period of shutdown at Terminal and carry out as much modification job as safely possible without taking shutdown.

Prior to finalising the shutdown period (if any) the contractor shall also obtain necessary inputs / confirmation from the concerned vendors/ and incorporate the same in the proposal for Company's review/approval.

5.23 INTERFACE WITH CONCURRENT OTHER JOBS AT SITE.

Deleted.

6.0 GUARANTEES AND LIABILITIES

6.1 Guarantee and Warranty Conditions

6.1.1 The Contractor agrees to ensure that all materials, equipment and components used in execution of the works under this Contract, shall be new and unused (not reconditioned) and of recent manufacture which shall in no case be of a date of manufacture older than one year from the date of delivery. (This delivery date shall be effected after Notification of Award) at the yard/site as the case may be and however, structural steel shall in no case be of a date of manufacture older than 2 years from the date of delivery at the yard/site as the case may be. The Contractor shall warrant that every Work executed under this Contract shall be free from all defects and faults in design and engineering, materials workmanship and handling etc., and shall be consistent with established and accepted standards for materials and workmanship of the type ordered and in full conformity with the design, drawings, specification, or sample, if any, and shall if operable, operate as per design, drawings, specifications and samples if any, and other stipulated conditions in accordance with the Contract. This warranty shall survive inspection of, payment for and acceptance of the plant, machinery and equipment and shall be valid for a period of 12 months from the date of issue of Certificate of Completion and Acceptance or 12 months from the date of issue of part Certificate of Completion and Acceptance of the respective part(s) of the works accepted and taken over by the Company as per provisions of Clause 5.10.3. The 12 months for the punch list items will start from the date of completion of Punch List.

6.1.2 If during the aforesaid period, the said plant, machinery and equipment be discovered not to conform to the description and quality aforesaid or have deteriorated otherwise than by fair wear and tear or than by Company's act or omission, the Contractor shall promptly and at its cost repair/replace or otherwise make good such defects as well as any damage to the works caused by such defect. If the Contractor fails to replace/repair such defective plants, machinery, equipment within a reasonable time depending upon exigency of the situation, then the Company will be entitled to deploy other agencies to carry out the same after advising Contractor of its intention and if such Work which was the liability of the Contractor to do at his own expense under the Contract, then all actual repairing/



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replacement cost and also physical damage sustained on account of such defective material by any other associated or allied plant, equipment and structures and other facilities forming part of the Works shall be recoverable from the Contractor.

The Contractor agrees to make payment against such claim within 30 days of receipt thereof. If the Contractor fails to pay the amount to the Company within 30 days from the receipt of the invoice then amount may be deducted by the Company from any money which is due or may become due to the Contractor including Company's right to encash the performance guarantee furnished by the Contractor in accordance with provision of Clause 3.3.

6.1.3 The period of guarantee for any part of the works shall be as specified in clause 6.1.1. If the works or any part thereof cannot be used by reason of such defect / damage and/or making good of such defect, and/or damage the warranty period of the works or such part thereof as the case may be shall be extended by a period equal to the period during which the works or such part thereof cannot be used by the Company due to any of the aforesaid reasons. The Contractor shall arrange for the performance guarantee to remain valid until the expiration of the extended warranty period with respect to such part of the works.

6.1.4 To the intent that during the period of guarantee the Works shall remain in as good condition (fair wear and tear excepted) as they were at the beginning of the period of guarantee and that all plant, machinery, equipment, thing or process shall continue to perform or operate (fair wear and tear excepted) during the period of guarantee in accordance with all relevant Contract specifications or Contract conditions. The Contractor shall do all repair, amendment, reconstruction, rectification and making good of defects, imperfections, shrinkages and settlements, including where necessary the repair or, if repair proves impossible, the replacement of any plant, machinery, equipment thing or process, which the Company requires of the contractor in writing during the guarantee period or within fourteen days after the expiration of the period of guarantee as a result of any inspection make during the period of the guarantee.

As regards import of required items for repair or replacement during warranty period, Company shall provide Contractor without assuming any responsibility and liability with the recommendatory letters to DGH on request by Contractor to enable Contractor to obtain necessary certificates from DGH.

6.1.5 The Contractor shall ensure that all guarantees or warranties issued by manufacturers of critical plant, machinery, equipment supplied by Contractor or by Contractor's sub-contractors and covering the performance of the said material and equipment supplied by them be issued in the joint name of the Contractor and the Company such that the Company enjoys the same benefits and protection provided by any such guarantees or warranties as does the Contractor. The issuance or existence of any such guarantees or warranties shall however in no way relieve the Contractor of his obligations under the Contract, in particular with reference to the provisions of this section.

6.1.6 The Contractor shall be and remain responsible during the period of guarantee for making good with all possible speed any defects arising from Contractor's defective design and engineering (other than a design made, furnished or specified by the Company and for which the Contractor has disclaimed responsibility in writing within 15 days time after receipt of the Company's instruction) of the aforesaid structure, pipeline plant,



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equipment or process which may develop under the conditions provided for in the Contract and under proper use in the works or any portion thereof.

- 6.1.7 The Contractor shall carry out all the works and supply and install all replacement materials and equipment pursuant to this section at no additional cost to the Company including the cost of timely transport of materials and equipments to site if the need for the work is due to poor workmanship or faulty materials, plant, equipment or process supplied by the Contractor or due to the use of materials or equipments not in accordance with the Contract or specifications or due to neglect or failure of the Contractor to comply with any obligations.
- 6.1.8 In case of spare part supplied under the Contract the Contractor shall be fully responsible during the warranty period for the correctness of the parts and their proper fitment to the machine for which the same are ordered. The Contractor shall replace such parts which may require replacement under the warranty clause free of the cost to the Company within the shortest possible time. In case of supply of plant, machinery and equipment, the Contractor shall use its best endeavors to ensure that vendor will supply spare parts as and when required for an agreed period. the agreed basis would be:
- a) agreed discount to be given on the published catalogue price.
 - b) before going out of production for spare parts vendor should give adequate advance notice to the Company so that the Company may decide on procurement of the balance of the life time requirement of spares.
- 6.1.9 During the guarantee period if the Contractor is requested by the Company to visit the Terminal for checking and carrying out remedial work of facilities and equipments, all expenses towards personnel, traveling to and from the site, living and accommodation etc. while in India for remedial works shall be borne by the Contractor unless such defects are caused by the Company or Company's agents/other contractors.
- 6.1.10 No warranty other than what is mentioned in 6.1.1 to 6.1.8 expressed or implied is made by Contractor and all such warranties are hereby specifically excluded. Company specifically waives any right to assert such claims for any other warranties not provided for in this "Section 6" irrespective of the basis for such claims.
- 6.1.11 The above warranty condition shall not apply for the part of the works in the event that the structures/ facilities have been modified without consent of the Contractor and/or equipment have been used/operated by the Company disregarding operating instructions provided by the Contractor and/or equipment manufacturer.

6.2 Consequential Damages

- 6.2.1 Subject to provisions of clause 6.3.2 neither the Contractor nor his sub-contractor shall be responsible for or liable to the Company or any of their affiliates for consequential damages which shall include but not be limited to loss of profits, loss of revenue, loss or escape of product (hydrocarbons) or facilities downtime, suffered by the Company or any of its affiliates, and the Company shall protect, defend, indemnify and hold harmless the Contractor and his sub-contractors from such claims even if such liability is based or claimed to be based upon:



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- i) Any breach by the Contractor or sub-contractor of his obligations under the Contract.

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- ii) Any negligent act or omission in whole or in part, of the Contractor or of any of his affiliates or Sub-contractor or their personnel or any of them in connection with the performance of the Works.

6.2.2 The Company or its other contractors or their personnel shall in no event be responsible for or liable to the Contractor or his Sub-contractor for consequential damages suffered by the contractor or his sub-contractor including without limitation to business interruption or loss of profits etc. The Contractor shall protect, defend, indemnify the Company, its employees, appointed representatives, agents and other Contractors, etc., from such claims even if such liability is based or claimed to be used upon:

- i) Any breach by the Company of its obligations under the Contract,

OR

- ii) Any negligent act or omission on the part of the Company or any of its employees, agents or other Contractors or appointed representatives in connection with the performance of the Works.

6.3 Completion, Failure and Termination

6.3.1 Completion

The scheduled Completion period for the project as described in the bidding documents shall be 24 months from the date of NOA.

6.3.1.1 Contractor agrees that time shall be the essence of the Contract and subject to any requirement(s) in the Contract Specifications as to the time of completion of any part(s)/ stages of activity (ies) of the Works before completion of the whole of the Works, the whole of the Works shall be completed within the Scheduled Completion date as mentioned above or the extended date (as may be extended as per provisions of the Contract) of completion of the Works.

Notwithstanding the above provisions, the Company reserves in itself the right, if the exigencies of the project under consideration so required, to phase out the completion of any part of the Works by mutual agreement.

6.3.2 Liquidated Damages:

Time is the essence of the contract. If the Contractor fails to complete the entire Work by the scheduled completion Date or the extended date or if Contractor repudiates the Contract before completion of the Works, the **ONGC** may without prejudice to any other right or remedy available to it as under the Contract/Law.

- i) Recover from the Contractor as ascertained and agreed liquidated damages and not by way of penalty, a sum equivalent to ½% (half percent) of the total contract price for each week of delay occurred or part thereof beyond the scheduled completion date subject to a maximum of 10% of the total Contract Price even though ONGC



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may accept delay in Completion of Work after the expiry of the Scheduled completion date. However, if contractor has completed certain part of the work within the scheduled completion date and the said part is ready for use and is accepted by ONGC pursuant to clause No. 5.10.3, then in that event, Liquidated Damages shall be leviable only on the Contract Price for the balance work remaining incomplete as on the scheduled date of completion.

AND/OR

- ii) Terminate the Contract or a portion or part of the Work thereof. ONGC shall give 14 days notice to the contractor of its intention to terminate the Contract and shall so terminate the contract unless during the 14 days notice period, the Contractor initiates remedial action acceptable to ONGC.

In case the Contractor is unable to complete the work by the schedule completion date, it may request ONGC before expiry of the scheduled completion date, to allow further time for performance of the contract indicating its willingness to pay the LD amount as agreed at (i) above. ONGC may at its discretion allow further time as requested by the Contractor with or without levy of LD.

The parties agree that the amount of LD provided herein is a genuine pre-estimate of the loss/damage which will be suffered on account of delay on the part of the Contractor and the said amount shall be payable on demand without there being any proof of the actual loss or damage caused by such delay / breach.

6.3.3 Calculation and mode of recovery of LD

LD will be calculated on the basis of contract price excluding duties and taxes, where such duties/taxes have been shown separately in the contract.

The amount towards Liquidated Damages shall become leviable from the original completion date as per contract or from the expiry of the extension, if any, given by ONGC without levy of LD. Applicable LD as on date shall be recovered progressively from balance due payment on pro-rata basis.

ONGC may without prejudice to its right to effect recovery by any other method, deduct the amount of Liquidated Damages from any money belonging to the Contractor in its hand (which includes ONGC's right to claim such amount against Contractor's Bank Guarantee) or which may become due to the Contractor. Any such recovery of Liquidated Damages shall not in any way relieve the Contractor from any of its obligations to complete the Works or from any other obligation and liabilities under the Contract.

6.3.4 Bank Guarantee towards Liquidated Damages

In case of delay in completion of the Project, if the Contractor so desires, then ONGC may accept a Bank Guarantee from the Contractor towards the maximum amount of LD applicable as per Clause No. 6.3. The unconditional and irrevocable Bank Guarantee shall be drawn in favour of the ONGC from a Scheduled Bank as per the Performa given at **Appendix-B-15**. The Bank Guarantee shall be initially valid from the date of submission upto a period of one year beyond the revised completion date and shall be kept valid till the final settlement is arrived either mutually or through Conciliation / Arbitration / Court.



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Upon submission of the Bank Guarantee and its acceptance by ONGC, the amount withheld on account of Liquidated Damages as per Clause No. 6.3, shall be released to the Contractor. In case such Bank Guarantee has been issued by a foreign bank (the same should be issued from any of the banks indicated at Appendix A-8 of this bid document) the same shall be accepted only with collateral security / guarantee / confirmation from any scheduled Indian Bank.

After final settlement of the issue regarding levy of LD as per the provisions of the contract, the applicable LD shall be remitted by the Contractor to ONGC, failing which the amount of LD shall be recovered by invoking the Bank Guarantee.

6.4 Indemnity

6.4.1 Indemnity by Contractor:

Contractor shall indemnify and keep indemnified Company, its other contractors and/ or sub-contractors and its/their employees from all actions, proceedings, suits, claims, demands, liabilities, damages, losses, costs, charges, expenses (including without limitation, wreck or debris, removal costs, where wreck or debris removal is ordered by a competent authority) judgments and fines arising out of or in the course of, or caused by the execution of work under the Contract or other obligations hereunder directly or indirectly associated herewith including but not limited to:

- a) personal injury, illness or death of:
 - i) any of Contractor's or subcontractor's personnel (even if caused by or contributed to by the negligence or fault of Company); and
 - ii) subject to clause 6.4.4 (a) (i) any other person to the extent the injury, illness or death is caused by the negligence or fault of the Contractor or Contractor's personnel or subcontractors or subcontractors' personnel and
- b) loss or damage to:
 - i) any property owned, hired or supplied by Contractor or Contractor's personnel or subcontractors or subcontractors' personnel including Constructional Plant (even if caused by, or contributed to by, the negligence or fault of Company); or
 - ii) subject to clause 6.4.4 (b) (i) any other property to the extent the loss or damage is caused by the negligence or fault of the Contractor or Contractor's personnel or subcontractors or subcontractors' personnel.

6.4.2 The Contractor shall defend and indemnify the Company against all claims and proceedings for or on account of infringement of any patent rights, design, trade mark, or name or other protected rights in respect of any plant equipment, construction plant and equipment, machinery, works, materials or process used for or in connection with the Works or Temporary Works or any of them and against all claims, proceedings, damages, costs, charges and expenses whatever in connection with works or temporary Works.



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6.4.3 The Contractor shall defend and indemnify the Company against any liability for damages on account of noise or the disturbance created during or in carrying out the works and against all claims, demands, proceedings, costs, charges and expenses whatsoever in that connection.

6.4.4 Indemnity by Company:

Company shall indemnify and keep indemnified Contractor (which expression in this clause includes, unless the context otherwise requires, Subcontractors of any tier and its and their employees) from all actions, proceedings, suits, claims, demands, liabilities, damages, losses, costs, charges, expenses and fines arising from :

- a) personal injury, illness or death of
 - i) any employee of the Company (even if caused by or contributed to by the negligence or fault of Contractor);
 - ii) subject to clause 6.4.1(a) (i) any other person to the extent that the injury, illness or death is caused by the negligence or fault of Company; and
- b) any loss or damage to:
 - i) any property owned, hired or supplied by Company (even if caused by or contributed to by the negligence or fault of Contractor); except to the extent that such property is in the care or custody of Contractor in connection with the work under the Contract.
 - ii) Subject to clause 6.4.1(b) (i) any loss or damage to any other property to the extent the loss or damage is caused by the negligence or fault of Company

6.4.5 Indemnification for existing properties of the Company

Notwithstanding anything contained in any provision of this Contract, Company shall defend, indemnify and hold Contractor harmless from and against any losses, damages, cost or claims relating to Company's existing property except in case of gross negligence or willful misconduct of the Contractor, its Sub-Contractor their agents or employees, in which case the Contractor shall be liable to bear any loss or damage occurring to the Property of the Company as a result of its gross negligence or willful misconduct , provided however, that such liability shall be limited to 100 % of the Contract Price.

"Gross Negligence" means: any act or failure to act (whether sole, joint or concurrent) by a person or entity which was intended to cause, or which was in reckless disregard of or wanton indifference to, avoidable and harmful consequences such person or entity knew, or should have known, would result from such act or failure to act. Notwithstanding the foregoing, Gross negligence shall not include any action taken in good faith for the safeguard of life or property,

"Willful misconduct" means: "Intentional disregard of good and prudent standards of performance or proper conduct under the Contract with knowledge that it is likely to result in any injury to any person or persons or loss or damage of property



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6.4.6 Notwithstanding any other provisions, except only in cases of willful misconduct and / or criminal acts,

- a) Neither the Contractor nor the Company (ONGC) shall be liable to the other, whether in Contract, tort, or otherwise, for any consequential loss or damage, loss of use, loss of production, or loss of profits or interest costs, provided however that this exclusion shall not apply to any obligation of the Contractor to pay Liquidated Damages to the Company and
- b) Notwithstanding any other provisions incorporated elsewhere in the contract, the aggregate liability of the Contractor in respect of this contract, whether under the Contract, in tort or otherwise, shall not exceed the 50% of the annualized Contract Price,, provided however that this limitation shall not apply to the cost of repairing or replacing defective equipment by the Contractor, or to any obligation of the Contractor to indemnify the Company with respect to Intellectual Property Rights.
- c) Company shall indemnify and keep indemnified Contractor harmless from and against any and all claims, costs, losses and liabilities in excess of the aggregate liability amount in terms of clause (b) above.

6.5 Design, Patents and Royalties

If any materials used or methods or processes practiced or employed in the course of execution of Work or otherwise for adopting the material to conform with the requirements of the Contract is/are covered by a patent in respect of which Contractor is not licensed, the Contractor shall, before using the material, method or process, as the case may be, obtain such license(s) and pay such royalty (ies) and license fee (s) as may be necessary. The Contractor shall keep the Company indemnified from / against any and all damages, demands, losses, costs and expenses that Company may suffer as a result of any infringement or alleged infringement of any patent, registered design, trademark, copy right or other intellectual property right registered or otherwise by reason of claims, actions, demands and proceedings whatsoever brought or made against the Company on the basis of any patent or infringement thereof claimed or otherwise relating to and arising from any method or process employed or matter or thing done to or in connection with any Work executed by the Contractor under the Contract and the Contractor shall, at his own risk and expenses, defend any suit for infringement of patent or like suit brought against the Company (whether with or without the Contractor being a party thereto) and shall pay any damages and costs awarded in such suit and keep the Company indemnified from and against all costs and other consequences thereof.

6.6 Limitation of Liability:

Notwithstanding any other provisions, except only in cases of willful misconduct and/or criminal acts,

- a) Neither the Contractor nor the Company (ONGC) shall be the liable to the other, whether in contract, tort, or otherwise, for any consequential loss or damage, loss of use, loss of production, or loss of profits or interest costs, provided however that this exclusion shall not apply to any obligation of the Contractor to pay Liquidated Damages to Company and



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- b) Notwithstanding any other provisions incorporated elsewhere in the contract, the aggregate liability of the Contractor in respect of this Contract, whether under the Contract, in tort or otherwise, shall not exceed the 50% of the annualized Contract Price,, provided however that this limitation shall not apply to the cost of repairing or replacing defective equipment by the Contractor, or to any obligation of the Contractor to indemnify the Company with respect to intellectual property rights.
- c) Company shall indemnify and keep indemnified Contractor harmless from and against any and all claims, costs, losses and liabilities in excess of the aggregate liability amount in terms of clause (b) above."

7.0 RISK DISTRIBUTION

7.1 Transfer of Ownership

- 7.1.1 Ownership of materials shall be transferred to the Company upon the date of issuance of certificate towards part completion or completion and acceptance of works.
- 7.1.2 Ownership of the construction Equipment used by the Contractor and its sub-contractors in connection with the Works shall remain with the Contractor and its sub-contractors.

7.2 Unforeseen Conditions

If, during pre-construction/pre-installation survey the Contractor observes that the Site conditions are at variance to what has been provided in the Contract, the time and cost effect shall thereupon be governed by clause 5.4

7.3 Insurance and Liability

- 7.3.1 Within 45 (30 days for submission of certificate of Insurance and 45 days for submission of policies) days of placement of NOA or before commencement of execution of Works, which ever is earlier, the Contractor without restricting in any manner any other provisions of the Contract, and in particular any such provision pertaining to his obligation, liability or responsibility shall take out and keep in force at his expenses the various insurance policies specified herein for the benefit of and in the joint names of the Company and the Contractor against all risks with the exception of those war risks(in respect of which insurance cover is not available even with payment of additional premium) for physical losses or damages suffered by Works and Temporary Works or part of the Works upto the contract value thereof or such additional sum as may be specified in the Contract in such a manner that the Company and the Contractor are covered,
- i) from the commencement of the Works until the date of issue of Certificate of Completion and Acceptance (excluding the value of the part of the Works which are taken over by the Company pursuant to clause 5.10.3 for the period when such part of the Works is in custody of the Company) for loss or damage arising from a cause, occurring prior to the date of issue of Certificate of Completion and Acceptance, and for any loss or damage occasioned by the Contractor in the course of any operations carried out by him.
- ii) during the guarantee period against any loss or damage arising from either the Contractor complying with his obligations under the Contract or for completing any outstanding work.

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for loss or damage in respect of the works completed by the Contractor prior to the commencement of the guarantee period.

- 7.3.2 The Contractor shall take out and keep in force adequate Insurance to cover all risks. (a) In respect of their personnel deputed to work under the Contract. (b) In respect of their own as well as hired equipment (to the extent of their insurance interest) tools, materials, marine spreads, vessels, barges, crafts, ships and operational facilities used during the entire period of their engagement in connection with the Contract to the insurable value of such constructional plant, equipment and other things. Company shall have no liability whatsoever in this regard. Such insurance policies of the Contractor shall embody the following clauses:

"The Insurers hereby waive their rights of subrogation against the OIL AND NATURAL GAS CORPORATION LIMITED, or any of their employees or their subsidiaries, affiliates or assigns."

- 7.3.3 Contractor shall suitably insure his constructional plant and equipment and other things brought to the Site including floating craft against the risk of removal of wreck under statute. Such policy/cover should be extended to include removal of wreck/debris in the event Company requires Contractor to do so. Any limit of liability specified by such policy shall not relieve the Contractor from any enhanced actual liability in carrying out his obligations.

- 7.3.4 Under the Company's package policy, privilege is granted to the Assured to release any individual, firm or Company for whom or with whom the assured is performing operation or who is performing operations for the Assured, under the Contract or otherwise, from liability for loss or damage (1) caused by an accident or occurrence taking place after the granting of said release and (2) arising out of or in connection with said operations.

When privilege above is exercised by the Assured Insurers hereunder hereby waive their rights of subrogation against such individual, firm or Company, their subsidiaries factors, or assigns, but only with respect to loss or damage to which the above release of liability applies

- 7.3.5 a) Contractor shall include in his respective contracts with their sub-contractors such clause(s) pertaining to insurance, indemnity and waiver of subrogation that appear in the Contract with the Company. This, however, shall not relieve Contractor from his responsibilities under this Contract.
- b) Without limitations of the Contractor's obligation and responsibilities, if the Contractor sub-contracts any part of the work, the responsibility and insurance provisions of each sub-contract shall be consistent with the Contract and the sub-contractors shall not carry any insurance which would duplicate any insurances provided by the Contractor or the Company. The Contractor shall be responsible for ensuring that sub-contractors maintain insurance as required in the sub-contracts during the course of Sub-contractor's operation.
- c) Deleted.



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7.3.6 Policies to be taken Out by Contractor

The Contractor and the Company shall be covered by insurances to be taken out and maintained by the Contractor as set forth below:

i) **Cargo Transit Insurance:**

Covering loss or damage of (a) materials & equipment etc. forming part of the works, occurring whilst in transit from the Contractor's, sub-contractor's, Vendor's/ Manufacturer's works and/or warehouse until arrival at the site and (b) constructional plant & equipment to be provided by the Contractor or its Sub-contractor(s). The Contractor shall comply with all warranties stipulated by his insurers in the marine transit policy including but not limited to the approval of packaging, marking, lifting, shifting/ transportation, loading, unloading, etc. at his own risk and cost.

ii) **Contractor's All Risk Insurance (including Onshore Terrorism Cover):**

Covering physical loss or damage to the Works at the site, occurring prior to Acceptance of the Works or part thereof with an extended maintenance coverage for the Contractor's liability in respect of any loss or damage occurring during the warranty period when the Contractor is on the site for the purpose of performing its obligations during the warranty period.

iii) **Third Party Liability Insurance**

Covering bodily injury or death suffered by third parties and loss or damage to third party property occurring in connection with execution of the Works. Before commencing the execution of the Works the Contractor, but without limiting his obligations, liabilities and responsibilities under the provisions of the Contract shall insure at his expense against his liability for any third party material or physical damage, loss or injury which may occur to any third party property or any person by or arising out of the execution of the Works or in the performance of the Contract. The insurance so provided shall specify as follows:

- a) Liability for property damage US\$ 50,000 (Fifty Thousand US dollars) per claim limited to US\$ 500,000 (Five Hundred Thousand US Dollars) in total for any one accident or occurrence.
- b) Liability for personal loss or injury US\$ 50,000 (Fifty Thousand US dollars) per person or US\$ 500,000 (Five Hundred Thousand US Dollars) in total for any one accident or occurrence.

iv) **Automobile and Transportation Liability Insurance**

Covering use of all automobiles and transport such as cars, trucks, aircraft, etc. used by the Contractor or its sub-contractors (Whether or not owned by them) in connection with the execution of the Works. Limits of liability specified in Clause 7.3.6 (iii) shall also be applicable to this clause.



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v) **Workman's Compensation**

In accordance with the statutory requirements applicable.

- vi) Such other insurances at actual cost to Company as may be specifically agreed upon by the parties to the extent Insurable risks not covered by the above policies (where the Company shall be the beneficiary) providing coverage for all direct loss caused by defective design, material or workmanship (including defective construction or erection) within the control of the Contractor or his subcontractor. Specific insurance for bodily injury and personal liability insurance (excluding that to third parties) and endorsements for such items as elevator and hoist liability etc. may also be included.

- 7.3.7 The Company and the Contractor's sub-contractors shall be named as additional insureds under all insurance policies taken out by the Contractor specifically for this Contract pursuant to the above sub-clauses except for the Workmen's Compensation and Employer's Liability Insurances, and all insurer's right of subrogation against such additional insureds for losses or claims arising out of the performance of the Contract shall be waived under such policies.

In the event there is any misrepresentation, non-disclosure, breach of express/implied warranties, unlawful activity, breach/non-fulfillment of any terms and conditions of the policy or any willful misconduct on the part of the Contractor which may result in automatic termination, expiry, or penalty under the policy, the Contractor shall be solely responsible for the same, and bear all such consequences. Further in the event of the Contractor has failed to insure (for whatever reason), or has inadequately insured, he alone shall bear the consequences of not being insured or protected fully by insurance. The Contractor shall also be responsible for the various deductible excess or fractions stated under his insurance policies.

The total amount of Deductibles shall not exceed 1.5% of the sum insured for any one accident or occurrence in the case of Contractors All Risk Insurance and Cargo Transit Insurance Policies.

- 7.3.8 The Contractor shall prior to commencing any relevant part of the Works deliver to the Company, copies of the Insurance Policies as evidence that the required policies are in full force and effect.

It shall be the responsibility of the Contractor to pay the premium in time and to keep the policies of insurance, as required by the Contract, valid throughout the period of execution of Works. The Contractor shall wherever required produce to the Company the policy(ies) of insurance. Provided always that in respect of any person employed by and Sub-contractor, the Contractor's obligation to insure as aforesaid under the sub-clauses shall be satisfied if the Sub-contractor shall have insured against the liability in respect of such persons in such manner that the Company is indemnified under the policy but the Contractor shall require such sub-contractor to produce to the Company or the Company's Representative when required such policy for insurance and the receipt for the payment of the current premium. The policy (ies) shall provide that not less than 21 days written notice shall be given to the Company by all insurers prior to any cancellation of material modification of the policy (ies).



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The Contractor shall produce a certificate from insurance Company to the effect that all premia under the policy have been paid and indicating validity of the policy.

All insurance policies of the Contractor shall embody the following clause:

"The Insurers hereby waive their right of subrogation against OIL AND NATURAL GAS CORPORATION LIMITED or any of their employees or their subsidiaries affiliates and assignees"

Such insurance shall be effected with an insurance Company incorporated and registered in India. The insurance cover shall apply even when the loss or damage might have occurred due to the negligence of the Company, its authorised representative or its workmen or any consultancy inspection or Certification agency working for the Company. The contractor shall, in all respects comply with any conditions stipulated in the Insurance policies which are required to take out under the Contract.

Note: Policies of insurance shall be provided in respect of those policies taken out specifically for this project. With regard to those other Corporate policies of Insurance in respect of bidder's worldwide cover, Certificates of Insurance from the Insurance Company shall be provided. Also bidder shall provide certified statements from the Insurance Company that premia have been paid and policies are in force.

7.3.9 Remedy on Contractor's Failure

Should the Contractor fail to take out and/or keep in force the insurance policies referred to above, or any other insurance which he may be required to effect under the terms of the Contract then the Company may at its option take out and keep in force insurance considered appropriate and necessary in the circumstances and pay such premium or premia as may be necessary for that purpose and from time to time deduct the amount so paid, by the Company as aforesaid with interest from any monies due or which may become due to the Contractor or recover the same as a debt due to the Contractor. However, if the policy lapses due to any reason, then the loss, damages and all liabilities on account of the policy having lapsed shall be to the account of the Contractor, nothing in this clause shall be construed by the Contractor as a waiver of his obligations to insure as required under the Contract. Further nothing in this clause shall impose upon the Company any obligation to insure on behalf of the Contractor. The Company may exercise its option to do so as stated herein but failure to exercise such option shall not entitle the Contractor to seek damages from the Company or eschew responsibilities under the Contract including his duties to insure and keep valid insurance policies.

7.3.10 Approval by the Company of any insurer or terms of insurance proposed by the Contractor shall not relieve the Contractor of any of its obligations or liability under or arising from this Contract or generally at law.

7.3.11 The terms of insurance shall include a provision whereby in the event of any claim being brought or made against the Company in respect of which the Contractor would be entitled to receive indemnity under the policy, the insurer will indemnify the Company against such claims and any costs charges and expenses in respect thereof.

7.3.12 The Contractor shall prepare and follow-up any claims made under the policies effected as required under the contract at the Contractor's risk and cost. The Contractor shall not give



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any release or make any compromise with the insurer without the prior written consent of the Company, in respect of the insurance claims in which Company's interest is involved, which consent shall not be unreasonably withheld.

7.3.13 Checklist for Insurance Policies.

(Caution: Checklist is not exhaustive one and hence contractors need to peruse the entire insurance clause for its compliance)

1. List of Policies to be taken:

- (a) Contractor's All Risk Insurance (including Onshore Terrorism cover).
- (b) Cargo Transit Insurance.
- (c) Third Party Liability Insurance.
- (d) Automobile and Transportation Liability Insurance.
- (e) Workmen's Compensation Insurance / Employer's Liability Insurance.
- (f) Insurance Policy for Contractor's Constructional Plant and Equipment and such policy to include removal of Wreck / debris.
- (g) Any other policy not mentioned above but required to be taken on the basis of specific nature of contract, as mentioned in the contract.

Note: In cases where Contractors content that their Corporate Policies with worldwide coverage meets the insurance requirements of the contract in respect of Policies from (b) to (g), Contractor needs to ensure that all the conditions mentioned in the contract in respect of insurance are complied with.

2. Principal Assured

The following are to be included as Principal Assureds in the Insurance Policies (except in case of Workmen's Compensation / Employer's Liability Insurance):

- (a) Oil & Natural Gas Corporation Limited, and Contractor's name (as appearing in the bid document / NOA)
- (b) Parent and/or Subsidiaries and/or Affiliated and/or Associated and/or inter-related Companies of the above as they are now or may hereafter be constituted and their Directors, Officers and Employees, while acting in their capacities as such.

3. Additional Insured

The following are to be included as Additional Insured in the Insurance Policies (except in case of Workmen's Compensation / Employer's Liability Insurance):

- (a) Any other Company, firm, person or party (including Contractors and/or Sub-contractors and/or manufacturers and/ or suppliers) with whom the below mentioned persons have entered into written contract(s) directly in connection with the Project:
 - (i) Oil & Natural Gas Corporation Limited,
 - (ii) Parent and/or Subsidiaries and/or Affiliated and/or Associated and/or inter-related Companies of the above as they are now or may



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hereafter be constituted and their Directors, Officers and Employees, while acting in their capacities as such.

- (iii) Project Managers
- (iv) Contractor

4. **Waiver or Subrogation**

Policy should have Waiver of Subrogation against Principal Assureds (as mentioned in point 2 above) and Additional Insured (as mentioned in point 3 above) and Contractor.

5. **Location of the Proposed Project** (in Contractors All Risk Policy).

6. **Project Description (Name)** (in Contractors All Risk Policy).

7. **Sum Insured** (Physical Damage portion of Contractors All Risk Policy). Not less than Estimated Final Contract Value as per NOA/Contract distributed in all currencies as mentioned in NOA/Contract.

8. **Period of Insurance** (Contractors All Risk Policy)

To be valid up to scheduled completion date of contract, with provision for an extended maintenance coverage for Contractor's liability in respect of any loss / damage occurring during the warranty period.

9. **Deductibles**

The aggregate amount of Deductibles shall not exceed 1.5% of the Sum Insured for any one accident or occurrence in case of Contractors All Risk Insurance and Cargo Transit Insurance Policies.

10. **Loss Payee Clause**

The Insurance Policies should mention the following in Loss Payee Clause:

"In respect of Insurance claims in which ONGC's interest is involved, written consent of OGNC will be required."

11. **Compliance with Sec 25(1) of 'The General Insurance Business (Nationalization) Act, 1972'**

Section 25(1) of 'The General Insurance Business (Nationalization) Act, 1972' is reproduced below:

"No person shall take out or renew any policy of insurance in respect of any property in India or any ship or other vessel or aircraft registered in India with an insurer whose principal place of business is outside India save with the prior permission of the Central Government"



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The above requirement of aforesaid Act needs to be complied with by the Contractor wherever the aforesaid provisions of Act apply, and compliance confirmation submitted.

12. Written Notice

All Insurance Policies should provide that not less than 21 days written notice shall be given to the ONGC by the Insurance Company prior to any cancellation or material modification of the Policy (ies)

13. All insurance policies should mention the following:

"Notwithstanding anything to the contrary elsewhere in the Policy, it is understood and agreed that Insurance cover shall apply even when the loss or damages might have occurred due to the negligence of the ONGC, its authorized representative or its employees or its workmen or any consultancy inspection or Certificate Agency working for the Company".

Taking out various insurance policies and payment of premium.

After the award of the contract, the contractor will be required to take insurance policy as per the provisions of the contract and the insurance should come in to force from the date of commencement of works

7.4 War Risks

7.4.1 In the event the Contractor is given written notice by the Insurance underwriters, that, because of impending hostilities or war like operations, piracy, civil war, revolution, rebellion, insurrection or civil strike in the Indian Territorial Waters, Indian Exclusive Economic Zone, the said Insurance underwriters intend to cancel the Contractor's war risk, confiscation insurance and detention cover in respect of the Contractor's offshore Constructional Plant & Equipment deployed at the Site, the Company agrees to indemnify (reimburse) and hold the Contractor harmless for any loss arising from the said risks beginning on the effective date as per the insurer's notice provided that the Contractor gives the Company immediate notice of such action proposed by the insurance underwriters (with photocopy of the insurer's notice) of the said cancellation. Alternatively, the Company shall have the option to suspend the Contract and direct the Contractor to demobilize his offshore Constructional Plant and Equipment, in which case the Contractor shall discontinue the work in accordance with Company's instructions and demobilize and the foregoing indemnity shall terminate upon Contractor's offshore Constructional Plant and Equipment leaving Indian Exclusive Economic Zone. Upon the Contractor's underwriters electing to increase the insurance premium for the said additional insurance risks, the Company, may instead of terminating the Contract, direct the Contractor to demobilize his Offshore Constructional Plant and Equipment to a safe location, or agree to compensate the Contractor for his additional insurance premium on production of proof of actual payment thereof.

7.4.2 Should the Contractor be prevented from performing the Work under the Contract on account of above said demobilisation, the Force Majeure Clause in the Contract shall come into force. The foregoing provisions of this Clause shall not be construed to prevent the Contractor / Company from invoking the provisions of Force Majeure clause when the



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conditions stated in Clause 7.4 occur. Any demobilization and remobilization ordered by the Company under the provisions of this Clause 7.4 shall be to Company's account, provided that the details of such demobilisation and remobilisation including the place, duration and cost of such demobilisation shall be mutually discussed and agreed between the parties.

Any additional cost incurred by the Contractor in protecting and preserving the Works prior to the Contractor leaving the Site under this Clause 7.4 and time lost as a result of any suspension under this Clause 7.4 shall be to the sole account of the Company.

7.5 Force Majeure

7.5.1 The term "Force Majeure" as employed herein shall mean act of God, revolt, riot, fire, flood, war, typhoon and Acts and Regulations of respective Governments of the two parties, namely the Company and the Contractor directly affecting the performance of contract.

7.5.2 In the event of either party being rendered unable by Force Majeure to perform any obligation required to be performed by them under the Contract, other than the obligation to make payments due and payable under this Contract except when the Company is physically prevented by a Force Majeure event from making payment, in which case the obligation shall be suspended the relative obligation of the party affected by such Force Majeure shall upon notification to the other party be suspended for the period of delay which is caused by such Force Majeure event.

7.5.3 Upon the occurrence of such cause and upon its termination, the party alleging that it has been rendered unable as aforesaid thereby, shall notify the other party in writing within (72) seventy-two hours of the alleged beginning and ending thereof giving full particulars and satisfactory evidence in support of its claim.

7.5.4 Time for performance of the relative obligation suspended by the Force Majeure shall then stand extended by the period of delay which is directly caused by Force Majeure event. The party who has given such notice shall be excused from the performance or timely performance of its obligations under the Contract, for so long as the relevant event of Force Majeure continues and to the extent that such party's performance is prevented, hindered or delayed, provided the party or parties affected by the event of Force Majeure shall use reasonable efforts to mitigate the effect thereof upon its performance of the Contract and to fulfill its obligation under the Contract.

7.5.5. If deliveries of bought out items and/or Works to be executed by the Contractor are suspended by Force Majeure conditions lasting for more than (2) two months, the Company and Contractor shall each have the option of terminating this Contract in whole or part thereof. Upon such termination provisions of Cl.8.3.1 and 8.3.2 shall apply.

7.5.6. Delay or non-performance by a party hereto caused by the occurrence of any event of Force Majeure shall not:

(a) Constitute a default or breach of the Contract,
OR

(b) Give rise to any claim for damages or additional cost or expense occasioned thereby, if such delay or non-performance is caused by the occurrence of an event



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of Force Majeure. Force Majeure conditions are not payable under any circumstances.

7.6 Subsequent Legislation- Change in Law and Regulations.

- 7.6.1 Notwithstanding the provisions of clause 3.4, in the event of introduction of any new legislation or any change or amendment or enforcement of any Act or Law, rules or regulations of Government of India or State Government(s) or Public Body which becomes effective after the date of submission of Price Bid or revised price bid, if any, for this CONTRACT and which results in increased cost of the works under the CONTRACT through increased liability of taxes, (other than personnel and Corporate taxes), duties, the CONTRACTOR shall be indemnified for any such increased cost by the COMPANY subject to the production of documentary proof to the satisfaction of the COMPANY to the extent which directly is attributable to such introduction of new legislation or change or amendment as mentioned above and adjudication by the competent authority & the courts wherever levy of such taxes / duties are disputed by COMPANY.
- 7.6.2 Notwithstanding the provisions of clause 3.4, similarly, in the event of introduction of new legislation or any change or amendment or enforcement of any Act or Law, rules or regulations of Government of India or State Government(s) or Public Body which becomes effective after the date of submission of Price Bid or revised price bid, if any, for this CONTRACT and which results in any decrease in the cost of the works through reduced liability of taxes, (other than personnel and Corporate taxes) duties, the CONTRACTOR shall pass on the benefits of such reduced cost, taxes or duties to the COMPANY, to the extent which is directly attributable to such introduction of new legislation or change or amendment as mentioned above.
- 7.6.3 All duties, taxes (except where otherwise expressly provided in the Contract) as may be levied / imposed in consequences of execution of the Works/Services or in relation thereto or in connection therewith as per the Acts, Laws, Rules, Regulations in force on the date of submission of Price Bid or revised price bid, if any, for the this CONTRACT shall be to CONTRACTOR's account. Any increase / decrease in the net amount of such duties, taxes (i.e. the amount of taxes/duties payable minus eligible credit of taxes / duties paid on input services / input) after the date of submission of price bid or revised price bid, if any, but within the contractual completion date as stipulated in the CONTRACT will be to the account of COMPANY.
- 7.6.4 Any increase in net amount of the duties and taxes (i.e. the amount of taxes/duties payable minus eligible credit of taxes / duties paid on input services / inputs) after the contractual completion / mobilization date during the extended period will be to the contractor's account, where delay in completion /mobilization period is attributable to the CONTRACTOR. However, any decrease in net amount of the duties and taxes (i.e. the amount of taxes/duties payable minus eligible credit of taxes / duties paid on input services / inputs) after the contractual completion date will be to COMPANY's account.
- 7.6.5 In case of introduction of new legislation or change or amendment in any act or law after the Scheduled/extended Completion Date (extended in accordance with the provisions of the Contract), but which comes into force or becomes effect retrospectively from a date on or before the Scheduled/extended Completion Date and which results in any increase / decrease in the duties, taxes and fees under the Contract, then such increase/decrease,



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subject to the conditions stipulated in clause 7.6.1, 7.6.2 and 7.6.3, shall be to the Company's account

- 7.6.6 The Contract Price and other prices given in the Schedule of Prices are based on the applicable tariff as indicated by the CONTRACTOR in the Schedule of Prices. In case this information subsequently proves to be wrong, incorrect or misleading, COMPANY will have no liability to reimburse/pay to the CONTRACTOR the excess duties, taxes, fees, if any finally levied / imposed by the concerned authorities. However, in such an event, COMPANY will have the right to recover the difference in case the rate of duty/tax finally assessed is on the lower side.
- 7.6.7 In order to ascertain the net impact of the revisions / enactment of various provisions of taxes / duties, the CONTRACTOR is liable to provide following disclosure to COMPANY:
- (i) Details of each of the input services used in relation to providing service to COMPANY including estimated monthly value of input service and service tax amount.
 - (ii) Details of Inputs (material/consumable) used/required for providing service to ONGC including estimated monthly value of input and excise duty/CVD paid/payable on purchase of inputs
- 7.6.8 Notwithstanding the provision contained in clause 7.6.1 to 7.6.7 above, the COMPANY shall not bear any liability in respect of:
- (i) Personal taxes on the personnel deployed by CONTRACTOR, his sub-contractor / sub-sub contractors and Agents etc.
 - (ii) Corporate taxes and Fringe benefit tax in respect of contractor and all of their sub-contractors, agents etc.
 - (iii) Other taxes & duties including Customs Duty, Excise Duty and Service Tax in addition to new taxes etc. in respect of sub-contractors, vendors, agents etc of the CONTRACTOR.
 - (iv) The deemed export benefits to domestic suppliers / sub-contractors shall be governed as per clause 3.6.

8.0 VARIATION IN CONTRACT ELEMENTS

8.1 Alteration/Variation

- 8.1.1 The Contractor agrees that the requirements given in drawings, specifications of the Bidding Documents are minimum requirements and are in no way exhaustive and guaranteed by the Company. It shall be the responsibility of the Contractor to meet all the requirements of Design criteria contained in the Bidding Documents and any upward revisions and/or additions of quantities, specifications sizes given in specifications and drawings etc. of the Bidding Documents required to be made during execution of the works shall not constitute a change order and shall be carried out without a change order and shall be carried out without any time and cost effect to Company. Further upward revisions and/or additions required make Contractors' selected equipment and installation procedures to meet Bidding Documents requirements expressed and to make entire



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facilities safe, operable and as per specified codes and standards shall not constitute a change order and shall be carried out without any time and cost effect to Company. Any upward revisions and/or additions consequent to errors, omissions, ambiguities, discrepancies in the specification and drawings etc. of the Bidding Documents which the Contractor had not brought out to the Company's notice in his tender shall not constitute a change order and such upwards revisions and/or addition shall be carried out by contractor without any time and cost effect to Company.

8.1.1.1 Change Order

Subject to provisions of Clause 5.3.1, a change order will be initiated only in case (i) the Company directs in writing the Contractor to include any addition to the scope of work covered under this Contract or delete any part of the scope of the Work under the Contract, (ii) Contractor requests to delete any part of the Work which will not adversely affect the operational capabilities of the facilities and if the deletions proposed are agreed to by the Company and for which cost and time benefits shall be passed on to the Company, (iii) the Company directs in writing the Contractor to incorporate changes or additions to the Design Criteria requirements already covered in the Contract.

8.1.1.2 Any changes required by the Company over and above the minimum requirements given in the specifications and drawings etc. included in the Bidding Documents before giving its approval to detailed design or engineering for complying with design criteria and changes required to ensure systems compatibility and reliability for safe (As per codes, standards and recommended practices referred in the Bidding Documents) and trouble free operation shall not be construed to be change in the Scope of the Work under the Contract.

8.1.1.3 i) Any change order as stated in 8.1.1.1 of GCC comprising an alteration which involves change in the cost of the Works (which sort of alteration is hereinafter called a "Variation") shall be the subject of an amendment to the Contract by way of an increase or decrease in the Contract price and adjustment of the schedule completion date if any.

ii) If the Contract provides applicable rates in accordance with Appendix A-3 of the Contractor for the valuation of the variation in question the Contract price shall subject to 8.1.1.3(iii) of GCC be increased or decreased in accordance with those rates.

iii) If parties agree that the Contract does not contain applicable rates or that the said rates are inappropriate or the said rates are not precisely applicable to the variation in question, then the parties shall negotiate a revision of the Contract Price which shall represent the change in cost of the Works caused by the Variations. Any change order must be duly approved by the Company in writing.

8.1.1.4 If there is a difference of opinion between the Contractor and Company's Representative whether a particular Work or part of the Work constitutes a change order or not, the matter shall be handled in accordance with the procedures set forth in Clause 8.1.1.6(h).

8.1.1.5 Within ten (10) working days of receiving the comments from the Company on the drawings, specification, purchase requisitions and other documents submitted by the Contractor for approval, the Contractor shall respond in writing which item(s) of the Comments is/are potential changes(s) in the Scope of Work covered in the Contract and



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shall advise a date by which change order (if applicable) will be submitted to the Company.

8.1.1.6 Procedure for Change Orders

- a) During detailed engineering and subsequently, if the Contractor observes that any new requirement which other than that required for meeting the design criteria is not specific or intended by the Contract has been stipulated by the Company, while approving the specifications, calculations, purchase requisitions, drawings, other drawings, other documents etc. he would discuss the matter with Company's Representative.
- b) In case such requirement arises from the side of the Contractor, he would also discuss the matter with Company's Representative giving reasons thereof.
- c) In either of the two cases as explained in (a) and (b) above, the representatives of both the parties will discuss on the new requirement for better understanding and to mutually decide whether such requirement constitutes a change order or not.
- d) If it is mutually agreed that such Requirement constitutes a "Change Order" then a joint memorandum will be prepared and signed by the Contractor and Company to confirm a "Change Order" and basic ideas of necessary agreed arrangement.
- e) Contractor will study the Work required in accordance with the joint memorandum under (d) and assess subsequent schedule and cost effect, if any.
- f) Upon completion of the study referred to above under (e), the results of this study along with all relevant details including the estimated time and cost effect thereof with supporting documents would be submitted to the Company to enable the Company to give a final decision whether Contractor should proceed with the change order or not in the best interest of the Works.

The estimated cost and time impact indicated by Contractor shall be considered as a ceiling limit and shall be provisionally considered for taking a decision to implement change order.

The time impact applicable to the Contract shall be mutually agreed subsequently on the basis of the detailed calculations supported with all relevant back up documents.

In case Contractor fails to submit all necessary substantiations/ calculations and back up documents, the decision of the Company regarding time & cost impact shall be final and binding on the Contractor.

- g) If Company accepts the implementation of the change order (f) above in writing, which would be considered as change order, then Contractor shall commence to proceed with the relevant work stipulated in the Change order pending final agreement between the parties with regard to adjustment of the Contract Price and the Schedule Completion Date.
- h) In case, mutual agreement under(d) above, i.e. whether new requirement constitutes the change order or not, is not reached, then Contractor in the interest



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of the Works, shall take up the implementation of the Work, if advised in writing to do so by Company's Representative pending settlement between the two parties to the effect whether such requirement constitutes a change order or not as per the terms and conditions of Contract documents. The time and cost effects in such a case shall be mutually verified and recorded. Should it established that the said work is constituting a change order, the same shall be compensated taking into account the records kept and in accordance with the Contract.

The Contractor shall submit necessary backup documents for the change order showing the break-up of the various elements (e.g. Engineering, Procurement, Fabrication, Installation, etc.) constituting the change order for the Company's review. If no agreement is reached between the Company and Contractor within 60 days after Company's instruction writing to carry out the change concerning the increase or decrease in the Contract Price and all other matters described above, either party may refer the dispute to arbitration pursuant to Clause 1.3.2 of GCC hereof.

8.1.2 Change order on Day Work Basis

- 8.1.2.1 The Company's Representative, if in his opinion it is necessary or desirable, may order in writing that any change order/extra work shall be done on a day work basis. The Contractor shall then be paid for that work as per the rates set out in the schedule of prices/rental rate schedule of the Contract.
- 8.1.2.2 For all work done on a Day Work basis, the Contractor shall furnish receipt of Vendor or other vouchers as may be necessary to the Company's Representative to prove the amounts paid and before ordering materials shall submit to the Company's Representative, quotations for his approval. Such approval shall not be unreasonably withheld.
- 8.1.2.3 In respect of all work done on a day work basis the Contractor shall, during the continuance of such work, submit each day to the Company's Representative an exact list, in duplicate, names, discipline and time of all workmen deployed on such work and a statement also in duplicate showing the description and quantity of all materials and plant utilised for extra work. The Company's Representative shall sign and return to the Contractor one copy of each list and the statement if correct or when agreed. At the end of each month the Contractor shall deliver to the Company's Representative a priced statement of the Labour, materials and plant (except as aforesaid) used. Whenever any dispute exists of any day work voucher, submitted for the Company's Representative's approval as to costs allocation between the Contractor and the Company, the voucher shall nevertheless be signed by the Company's Representative as a record of time worked and materials used. Lists and vouchers so signed will be the subject of negotiations between the Company and the Contractor regarding their costs allocation.
- 8.1.2.4 Should the quantum of extra work/change order if any, which the Contractor may be required to perform by the Company, fairly entitles the Contractor to extension of time beyond the scheduled completion date for completion of either the whole of the Works or for such Extra work only, the Company and the Contractor shall mutually discuss and decide the extension of time, if any, to be granted to the Contractor.



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8.1.3 Change of Quantities

Based on the Contractor's procurement and programme of the Works (as per PERT or equivalent programming system to be mutually discussed and agreed to between the Contractor and the Company) the Company will have the option to increase or decrease the quantities of the plant/equipment material to be supplied by the Contractor as mentioned in the Contract provided that such increase or decrease shall not, except with the written consent of the Contractor, exceed, ten percent (10%) of the total Contract Price. The written advice to this effect shall if so required be issued by the Company upto 8 (eight) weeks prior to the due date of supply of such plants equipments/material to the Contractor as may be specified in the PERT chart to be agreed. In case of increase in quantity, the Contractor agrees to carry out such additional quantity of work at the rate and terms and conditions as provided in the Contract except for the appropriate extension of time to be allowed for obtaining delivery of such extra equipment. In case of decrease in quantities the Contractor shall give a reduction in price at the rate given in the Contract corresponding to decrease of quantity. In case applicable rates for the increase/decrease in question are not available in the Contract then the rates as may be mutually agreed shall apply. Contractor shall not be entitled to any claim by way of change of price, damages, losses, etc. Contractor shall be compensated at actuals for any cancellation charges provided the claim is duly supported by documentary evidence of having incurred cancellation charges which results from Company's action in reducing/canceling Scope of Work.

8.1.4 Conditions for Extra Work/Change Order

The provisions of the Contract shall apply to extra work performed as if the Extra Work/Change Order has been included in the original Scope of Work. However the Contract price shall increase/decrease and the construction schedule shall be adjusted on account of the Extra Work/Change orders as may be mutually agreed in terms of provisions set forth in Clause 8.1.1 through 8.1.3 above. The Contractor's obligations with respect to such work remain in accordance with the Contract.

The extra work shall not be included in the Contract Price for the purpose of calculations of liquidated damages under Clause 6.3.2 of GCC. For Extra Works/ Change Order if implemented on day work basis, cost of testing shall also be payable by the Company.

8.2 Suspension of Work by Company

8.2.1 The Company may by notice in writing to the Contractor order the contractor to suspend performance of all Works or part of the Works under the Contract. Such notice shall specify all Works or part of the Works of which performance is to be suspended, its effective date and the reasons therefore. The Contractor shall thereupon suspend performance of such Works or part of the Works until ordered in writing to resume such performance by Company.

8.2.2 The Contractor shall during such suspension properly protect and secure the Work so far as is necessary in the opinion of the Company's Representative in accordance with the Contract. During the period of suspension the Contractor shall not remove from site any material, any part of the plant or any Constructional plant and Equipment without prior written consent of the Company. If the Contractor's performance on all Works or part of Work is suspended pursuant to this Clause, then the time for completion of the Works



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shall be extended and additional cost incurred by the Contractor in giving effect to the Company's Representative instructions under this Clause shall be borne and paid by the Company unless the suspension is:

- i) Otherwise provided for in the Contract.

OR

- ii) Necessary by reason of some default or breach of the contract on the Part of the Contractor.
- iii) Necessary for the proper performance of the Work in accordance with the Contract.
- iv) Necessary for the safety of the Works or any part thereof in so far as such necessity does not arise from any act of defaults by the Company or Company's Representative or any other property of the Company directly or indirectly relating to the Works for reasons not attributable to Company.

8.2.3 For the purpose of calculating costs incurred by the Contractor during the suspension of Work as mentioned above, day rate or rental rate schedules specified in the Contract shall be applied and details of the Contractor's spread affected by such suspension pursuant to this clause be recorded and submitted to the Company. If the progress of the Works or any part thereof is suspended at offshore site for a period(s) in excess of 90 days in aggregate on the written order of the Company's Representative otherwise than by reasons given in (i) through (iv) above and if permission to resume Work is not given by the Company's Representative, then at any time there after and provided that at that time such performance is still suspended, the Contractor may give a written notice to the Company's Representative requiring that the Company within 7 days of receipt of the notice either order the resumption of the Works or that part thereof in regard to which progress is suspended and if such order or resumption is not granted within that time, the Contractor by a further written notice so served may elect to treat the suspension where it affects a party only of the works as a deletion of such part in accordance with Clause 8.1 of GCC hereof or where it affects the whole of the Works as termination of the Contract by the Company. If the Contractor opts to terminate the Work or part of the Work upon such termination the provisions of Clause 8.3.1 and 8.3.2 shall apply.

8.2.4 In the event that Company suspends the progress of Work for any reason not attributable to Contractor for a period in excess of 30 days in aggregate, rendering Contractor to extend his performance guarantee then Company shall bear only the cost of extension of such bank guarantee for such extended period restricted to the normal bank rates as applicable in the international banking procedures subject to Contractor producing the requisite evidence from the bank concerned.

8.3 Termination

8.3.1 The Company may at any time terminate the Contract as per Clause 8.2, 7.5.5 and/or 7.4 by giving the Contractor a notice in writing to that effect. Upon termination under Clauses 7.4, 7.5.5 and/or 8.2 or upon receipt of the Termination Notice the Contractor shall either immediately or upon the date specified in the termination notice:



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- a) Cease all further Work, except for such Work as the Company may specify in the Termination Notice for the sole purpose of protecting that part of the Works already executed.
- b) Terminate all sub-contractors except those to be assigned to the Company pursuant to paragraph d) (ii) below.
- c) Remove all Constructional Plant and Equipment from the Site and repatriate the Contractor's and its Sub-contractor's personnel from the Site, remove from the Site any wreckage and debris of any kind and leave the whole of the Site in a clean and a safe condition.
- d) Subject to the payment specified in clause 8.3.2 below.
 - i) deliver to the Company the parts of the Works executed by the Contractor up to the date of Termination.
 - ii) Assign to the Company all right, title and benefit of the Contractor to the Works as at the date of Termination, and, as may be required by the Company in any sub- Contract(s) concluded between the Contractor and his sub-contractors and
 - iii) deliver to the Company all drawings, specifications, and other documents prepared by the Contractor or his sub-contractors as at the date of Termination in connection with the Works.

8.3.2 In the event of termination of the Contract under clause 8.3.1 the Company shall pay to the Contractor the following amount:

- (a) The Contract price properly attributable to the parts of the Works executed by the Contractor in accordance with the Contract as at the date of Termination.
- (b) The costs incurred by the Contractor in protecting the Works pursuant to paragraph (a) of clause 8.3.1 above as mutually agreed.
- (c) Reasonable demobilization charges as may be ascertained by the Company if Contractor has Constructional Plant and Equipment at offshore site at the time the termination becomes effective.
- (d) Cost of any materials or equipment already purchased and/or ordered by the Contractor, the delivery of which the Contractor must accept, such materials or equipment will become property of the Company upon payment by the Company of the actual Cost of the materials or equipment.
- e) All reasonable cost of canceling/terminating any subcontract(s)
- f) All reasonable cost on cancellation or orders for material, etc., which the Contractor may have committed for the project.

8.3.3. In case of termination of the Contract under the provisions other than Clause 7.4, 7.5 and Clause 8.2 of Contract, the recourse as mentioned in the relevant clause under which the termination has become effective shall be applicable.



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- 8.3.4 There shall be no liability for the Company to compensate the Contractor for loss of work or loss of profits or any other claim of similar nature on account of Termination.
- 8.3.5 In the event Company fails to pay invoiced amount due or communicate the reasons for its objection to any disputed amount in an invoice in accordance with Sub-clause 3.2.3 within a period of 90 days, the Contractor shall be entitled to terminate the Contract after giving fourteen (14) days prior written notice to the Company. Upon termination under this Clause Contractor shall be entitled for the compensation as per Clause 8.3.2.
- 8.3.6 In case of termination of Contract herein set forth, except under 8.3.3 and / or annulment of the contract due to non-submission of Performance Security, following actions shall be taken against the Contractor:
- i. ONGC shall conduct an inquiry against the Contractor and consequent to the conclusion of the inquiry, if it is found that the fault is on the part of the Contractor, then they shall be put on holiday [i.e neither any tender enquiry will be issued to such a Contractor by ONGC against any type of tender nor their offer will be considered by ONGC against any ongoing tender(s) where contract between ONGC and that particular Contractor (as a bidder) has not been concluded] for a period of two years from the date the order for putting the Contractor on holiday is issued. However, the action taken by ONGC for putting that Contractor on holiday shall not have any effect on other ongoing contract(s), if any with that Contractor which shall continue till expiry of their term(s).
 - ii. Pending completion of the enquiry process for putting the Contractor on holiday, ONGC shall neither issue any tender enquiry to the defaulting Contractor nor shall consider their offer in any ongoing tender

8.4 Remedies of Company

8.4.1 Remedies

8.4.1.1 If the Contractor:

- i) becomes bankrupt or has a receiving order made against him or presents his petition in Bankruptcy or makes an arrangement with or assignment in favour of his creditors or agrees to carry out the Contract under a committee of inspection of his creditors or (being a Company) goes into liquidation (other than a voluntary liquidation for the purposes of amalgamation or reconstruction)
OR
- ii) has an execution levied on his goods,
OR
- iii) assigns the Contract without the previous written consent of the Company,
OR
- iv) has to the detriment of good workmanship or in defiance of the Company's Representative's instruction to the contrary sub-contracted for any part of the Contract,
OR
- v) repudiates or abandons the Contract,
OR



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- vi) without reasonable excuse fails to commence the Works or suspends the progress of the Work for (30) thirty days after receiving from the Company's Representative, written notice to proceed,
OR
- vii) fails to remove materials from the Site (removal of material means removal from immediate vicinity of Work) or to pull down and replace Work or initiate remedial action acceptable to the Company for (30) thirty day after receiving from the Company's Representative, written notice that the said materials or Work have been condemned and rejected by the Company's Representative under these conditions of Contract.
OR
- viii) despite previous notice in writing by the Company's Representative is not executing the Works in accordance with the Contract to the satisfaction of the Company's representative or is persistently or flagrantly neglecting to carry out his obligations under the Contract;

then the Company may after giving notice of 10 days in writing, to the Contractor forthwith enter upon the Site and the Works and expel the Contractor from there without thereby making the Contract void or releasing the Contractor from any of his obligations or liabilities under the Contract or affecting the rights and powers conferred on the Company by the Contract and may at the risk and cost of Contractor complete the Works itself or deploy any other Contractor to complete the Works and the Company or that other Contractor may use for the completion of Works as much of the Constructional Plant and Equipment, Temporary Works and materials which have been deemed to be reserved exclusively for the construction and completion of the Works under the provisions of the Contract as it or they think proper.

Note: In case Company takes over Contractor's marine spread, it will continue to be operated by the same personnel manning the barge under directions from Company supervisor, will be used specially for the completion of this project and will return to the Contractor on completion of the Works.

- 8.4.1.2 If the Company enters and expels the Contractor under this clause it shall not be liable to pay the Contractor any money on account of the Contract until the costs of completion and making good damages for delay in completion (if any) and all other expenses incurred by the Company have been ascertained provided however that Contractor shall only be liable for the said costs and expenses that Company may sustain on this account upto a maximum amount of twenty percent (20%) of the Contract value. The Contractor shall then be entitled to receive only the sum or sums (if any) which would have been due to him on due completion by him after deducting the sum due to the Company as aforesaid, regard being had to the sums representing the value of the work actually done by the Contractor by the time of his expulsion and to represent the price of any said unused or partially used materials, any Constructional Plant and Equipment and any Temporary Works as well as for the use of marine spread by Company for completion of works as provided for in the note and Cl.8.4.1 above.
- 8.4.1.3 If the sum so due to the Company exceeds the sum which would have been payable to the Contractor on due completion by him then the Contractor shall on demand pay to the Company the excess amount and it shall be deemed a debt due by the Contractor to the Company and shall be recoverable accordingly.



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8.4.2. Remedies Under Emergencies

If by reason of any accident or failure or any other event occurring to, in or in connection with the Works or any part of them either during the construction of the Works or during the Guarantee period any remedial or other Work or repairs is, urgently necessary for security, safety and for the other purpose of performance of work, which justifies immediate remedial action and the Contractor is unable or unwilling at once to do that Work or repair, the Company may on its own or through other workmen do whatever Work or repair to the extent necessary for such purpose. If the work which was the Contractor's duty to do at his own expenses under the Contract, all costs and charges properly incurred by the Company in so doing shall on demand be paid by the Contractor to the Company or may be deducted by the Company from any money due or which may become due to the Contractor or recover by any other means at the Company's discretion. The Company's Representative or the Engineer's Representative (as the case may be) shall inform Contractor forth with of an emergency occurrence of and shall as soon as may be reasonably practicable after the occurrence of any emergency as aforesaid, notify the Contractor of it, in writing.

9.0 CORRESPONDENCE

9.1 GENERAL

The objective of this section is to establish a flow of correspondence on this project in order to direct the various forms of correspondence through desired channels thereby keeping all concerned informed as to detailed construction progress. Correspondence will normally be exchanged between Company's Eastern Offshore Asset, Company's Finance Department and Company's Material Management section, Company's Consultant, Certification Agency and the Contractor. The Contractor shall be responsible for quick dispatch / distribution of all documents to all the parties involved directly or indirectly.

Abbreviations for the above offices used throughout this procedure are as follows:

OP- ONGC, Office of OTP 1st floor, NSE Plaza, Bandra –Kurla Complex, Mumbai

CON - Company's Consultant, M/s. Fichtner Consulting Engineers (India) Pvt. Ltd

C - Contractor.

TPI- Third Party Inspection

OF - ONGC Finance & Accounts Department, Hazira Plant

OA - ONGC, Hazira Plant

9.2 ADDRESSES

The complete addresses are as follows:

OFFICE STREET ADDRESS MAILING ADDRESSES



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OP - ONGC, Office of OTP 1st floor, NSE Plaza, Bandra-Kurla Complex, Bandra(E) Mumbai-400051

CON- M/s. Fichtner Consulting Engineers (India) Pvt. Ltd., Navi Mumbai.

C - To be filled by Contractor

TPI- To be informed

OF - Magadalla, Hazira Plant, ONGC, Surat, District, Gujarat Pin Code: 394518, Atten: HES Hazira Plant

QA - Magadalla, Hazira Plant, ONGC, Surat, District, Gujarat Pin Code: 394518, Atten: HES Hazira Plant

9.3 **CODING**

The following chronological typical letter coding will also be required for ready reference, checking and filing of the correspondence as follows:

<u>From</u>	<u>To</u>	<u>Letter / Fax Code</u>
OA	C	OAC-1, 2 etc.
C	OA	COA-1,2 etc.

9.4 **HEADING**

A uniform system of correspondence heading is suggested as follows:

Date
Letter No.
Project Coordinator
Engineering Services,
Oil and Natural Gas Corporation Limited,
Magadalla, Hazira Plant, ONGC, Surat

9.5 **DISTRIBUTION**

Originals and copies of correspondence including attachments, tables, etc. will be distributed as shown on the following chart. Other copies may be furnished as required (To be confirmed by Company).

Sl. No.		OA	CON	TPI	OP
1.	General Correspondence				
	a) Commercial	1**	-	-	-
	b) Technical	1**	1**	1	-
2.	Detailed Calculation drawings.	1*	1**	-	-
3.	a) Construction specification & drawing including Vendor data/drawings.	1*	1**	1	



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Sl. No.		OA	CON	TPI	OP
	b) Shop drawings.	++	-	1	
4.	Material Requisition & Purchase Lists/Specifications & Others.	1*	1**	1	
5.	Progress Reports, Schedules etc.	1**	1	-	2
6.	Load out/transportation, hook-up, pre-commissioning procedures & installation manuals.	1	-	1*	-
7.	Change Orders	1	1	-	-
8.	Start-up and operating manual (draft)	1	1	-	-
9.	Start-up and operating manual (Final)	1*	1**	-	-
10.	Manufacturer's data books alongwith test reports.	1*	1*	-	-
11.	a) As-built drawings & purchase specifications.	1*	1**	-	-
	b) Certified full size as-built drawings of Skid/ Modules	-	-	1*	-
	d) Bound sets of certified as-built drawings in A3 size.	1	1	-	-
12.	Recommended Spare parts list and Catalogue.	1*	1*	-	-

- Notes:**
1. The above distribution does not include correspondence distribution at Design Centre(s), fabrication yard (s) and Onshore site
 - 2.* indicates distribution of soft copy.
 3. ** indicates distribution of hard copy and soft copy.
 - 4.*** indicates distribution of hard copy and two soft copy
 - 5.++ indicates intimation about issuance to ONGC.

10.0 Health, Safety and Environment

10.1 Health, Safety & Environment (HSE) Compliance

- a. The Contractor shall comply with the HSE requirements detailed in GCC and elsewhere in bidding documents. The Contractor shall also be responsible to comply with code requirements of International Standard Organization (ISO), Occupational Safety & Health Administration (OSHA), ISO-14000 series, American Petroleum Institute (API) RP and other relevant international practices. In case of conflict between the requirements of the various specifications and/or the requirements specified in the bid document, the more stringent requirement shall be followed.
- b. During installation, hook-up, pre-commissioning, start up and commissioning of new Terminal and modification works on existing terminals, Contractor shall ensure compliance of various activities related to Safety, Health & Environment as per applicable codes and submit the compliance report.



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- c. Contractor shall conduct a Safety Studies Methodology which shall be completed and submitted to Company within 30 days of Contract Award. Further, the Contractor shall implement the findings of the Safety Studies without impact on Schedule or Contract Price.

10.2 SAFETY/FIRE PROTECTION

Contractor shall take all necessary measures to protect the work and Workmen against accidents and occupational disease. They shall observe and comply with all Governmental safety regulations as well as Company's and accepted industry safety practices as required for this work.

10.2.1 The Contractor will be required to demonstrate that:

- i. the management systems and the installation are adequate to ensure that the design and the operation of the installation and the equipment are safe;
- ii. the potential hazards of the installation and the risks to personnel and environment have been identified and appropriate controls provided;
- iii. adequate provision is made for ensuring, in the event of a major emergency affecting the installation, the safe evacuation and rescue of personnel and
- iv. the statutory and Company requirements relating to safety and pollution control measures are complied with.

10.3 RULES AND REGULATIONS

Contractor shall observe national and local laws, ordinances, rules and regulations pertaining to the Works and shall be responsible for extra costs arising from violations of same.

The Contractor shall not do any exploratory excavations, including drilling/boreholes, without the previous written permission of the Company's Representative.

10.4 Watching and Lighting

The Contractor shall, in connection with the Works provide and maintain at his own cost all lights, guards, fencing and watching when and where necessary or required by the Company for the protection of the Works or for the safety and convenience of the Public or others.

10.5 Safety Audits:

10.5.1 Contractor shall within 30 days of commencement of Contract and also once every three months thereafter submit a safety report as per Appendix-C-1 attached, to the head of the Safety and Environment Management of the Company at Kakinada with a copy to the Project Coordinator

10.5.2 In the event of any accident or dangerous occurrence the Contractor shall forthwith send a notice of accident in the proforma at Appendix-C-2 to the head of the Safety and



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Environment Management of the Company at Kakinada with a copy to the Project Coordinator.

Contractor shall maintain a record of the relevant statutory and Company requirements relating to safety and pollution control measures and compliance.

The Contractor shall be responsible for following the proper procedures, as outlined below, in reporting accidents or incidence.

- 1) The Company's Safety Engineer located in Kakinada will be immediately notified by fastest means possible (Radio) of any accident which involves the following:
 - a) Death from any cause whatsoever.
 - b) A fractured skull, pelvis, arm, thigh or spine, forearm or leg.
 - c) A dislocated shoulder.
 - d) The amputation of an arm or hand, or of one or more fingers of the same hand, or of a leg or a foot.
 - e) The loss of sight of an eye.
 - f) Any other serious bodily injury, including internal bleeding or burns or asphyxia where such injury is likely to endanger life, cause permanent incapacity, or temporary incapacity of 5 days or more.
- 2) In case of death, the Contractor shall be responsible for immediately notifying the nearest Indian police so that they can make the proper investigation in accordance with the law.
- 3) Also in case of death, the Contractor shall immediately notify the Labor Officer of the Federal Ministry of the area in which the death occurred.

10.6 SAFETY PROCEDURE:

Contractor should submit a safety procedure prior to start of the construction activities for Company review. The procedure should include the safety measures to be taken during construction work, fire fighting / safety equipment available which will be provided to terminal in case of any emergency, number of safety / fire officers and their role, periodical exercise on awareness of workers towards safety. Familiarization of workers with safety equipment, teams for fire fighting etc. In case of any emergency, Contractor should immediately mobilize all resources to combat the emergency and co-ordinate with Company suitably.

Contractor should ensure that the contractor's supervisory personnel have undergone the approved basic training on fire fighting and Elementary First Aid before deployment and adequate number of trained personnel to be deployed at all times during execution at site.



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In case of any accident at site causing injury to personnel, Contractor shall inform Company's Representative immediately. Contractor shall also arrange for pickup and immediate medical attention for the injured personnel.

10.6.1. Deleted.

10.7 Hot Work Permits

Notwithstanding anything contained elsewhere in the Contract, to take up hot work for carrying out the required activities, the contractor shall be fully responsible to design, engineer, procure, supply fabricate, coat wrap (incase of rigid pipeline) transport, erect, install, pre-commission, test, commission (wherever applicable) making the related area of plants/ worksite gas free, clean and flushing with steam and/or chemicals of the complete system and whatever is necessary. The modification works shall be completed in shortest possible time and in a safe manner. The Company shall issue hot work permits only between dawn to dusk on Contractor's request keeping in view Company's production programmes safety requirements and the Contract with the provision that the Company reserves the right to divert the Contractor's activities involved in his work programme.

It is an essential requirement that there shall be no shutdown of the operating platforms unless the situation so demands subject to approval of Company and Clause 2.3.4.2 hereof.

The Contractor shall be responsible for devising methods and developing detailed procedure to realize this objective and carry out the modifications in orderly manner. The details and procedures shall be subject to Company's approval.

Contractor shall strictly comply with all safety requirements of Hot work permit during permit duration failing which Company's representative will have the right to stop Hot work and all Cost and time effect thereof shall be to Contractor's account.

Company shall not issue hot work permit at Site when critical activities or any other operation during which Contractor's working may be detrimental to the safety of the facilities are being carried out.

Any delay, rescheduling or interruption of already approved Work programme for modification works, attributable to Company on account of delay in issuing the Hot Work Permit, after the contractor having met the requirement of the hot work permit save for safety reasons of Company's facilities and personnel, shall be to Company's account in respect of cost and time effect (if it affects the critical path) as per the provision of the Contract. Company shall be responsible for the shutdown of operating terminals and depressurization of hydrocarbon systems related to the approved shutdown.

All hot works job shall be carried out in presence of the contractor's safety officer, who shall be directly responsible for carrying out the hot work job in a safe and orderly manner.

10.8 SAFETY AUDIT BY COMPANY:

Company may conduct safety Audits at any stage of project execution and before taking over the facilities. The audit shall be based on a protocol that covers elements which can affect the safety during execution or the safe operation of the facilities in the contractor's scope of work. The protocol shall cover documentation, process hazard analysis, fire



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detection and suppression system, life saving appliances and escape routes, operating procedures, pre-startup safety review, safe work practices, safety and shut down devices, management of change, assurances of quality and mechanical integrity, emergency response control investigation of accidents, personnel protective equipments, audit team which could be conducted by the Company's personnel or any agency appointed by the Company for the purpose, accord full access to site and provide all relevant information, comply with the observations and recommendations of the audit. An indicative description of the information which may be required to be submitted by the contractor for / during the safety audit is enclosed as per the Appendix C-3.

10.9 The Contractor (all the companies in a consortium or joint venture involved in construction activities) should be required to:

- Have in place a Safety Management System, approved by a recognized, approved authority.
- Prepare a project-specific Safety Plan for each Site
- Implement the Safety Plans.
- Ditto the above for Environmental Management

Contractor should submit the above for the approval of the Company considering the requirements for the Safety and Environmental plans for execution of the Work.

10.10 Quantitative Risk Analyses (QRA) Deleted

10.11 Deleted

10.11.1 Deleted

10.11.2 Deleted.

11.0 PLANNING PACKAGE and Progress monitoring

11.1 Planning package

The Contractor shall provide detailed Planning Package, live project data for continuous monitoring to the Company, which shall be developed by using Primavera Project Planner for the Enterprise Suite (P3e) ver 3.0. In case the contractor wishes to use the later upward version, the same shall be re-confirmed with the Company. The data shall be updated on daily basis and weekly reports (soft copy in XER format by e-mail & floppy and colour hard copy/printout) shall be submitted to the Company. Contractor to make provision for Company to be able to log on to contractor's server directly using Primavera Software (Read only access) for online status of project data, progress data & reports prepared by contractors. For any licensing issue for furnishing on line status, contractor to take care of the same.

This Planning Package shall cover the PERT-CPM and scheduled status of all functions of the project from Survey to Commissioning.



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Within twenty one (21) days of the Notification of award of Work or prior to the Kick-off meeting, whichever is earlier, the Contractor shall provide the Company with the detailed Planning Package diagram as mentioned under this Clause and, after work has started, issue updated statements on the progress and/or completion of the listed activities on a weekly basis. The Contractor shall also deliver on a monthly basis to the Company an updated PERT-CPM diagram showing changes in project status as of the end of the previous month. This diagram shall be delivered on or before the 5th of each month.

The Contractor shall provide additional effort whenever the scheduling shown on the Planning Package diagram indicates a possible delay in the completion date. Such additional effort may require an increased deployment of equipments and / or personnel. All extra costs incurred by the Contractor in order to prevent a possible delay in the completion date will be to the Contractor's account.

The Contractor shall notify the Company within twenty four (24) hours of any occurrence, which may adversely affect the completion date of the project. The Contractor shall also notify the Company, at least once in every week, the status of the critical items, which could affect the completion date of project. In addition, the Contractor shall include a statement of proposed remedial actions for expediting these items.

Contractor shall make every effort to keep Company adequately informed as to the progress of the Work throughout the entire project.

Contractor shall keep Company's Representatives informed as to the construction schedules so as to permit Company's inspection to be carried out in such a manner as to minimize interference with the job progress. It is imperative that close coordination be maintained with Company, particularly during fabrication phases. In order to minimize the burden of unnecessary work and extra cost, and to maintain the project schedule, it will be Contractor's responsibility to keep Company informed at all times of the fabrication progress, particularly as to the expected starting dates for a project or major component.

By the fifth of each month, Contractor shall furnish Company with a detailed report covering the progress as of the last day of the previous month. These reports will indicate actual and scheduled percentage of completion of engineering, purchasing and construction as well as general comments of interest on the progress of various phases of the Project. Critical path schedules shall be updated and included as part of this report. The progress reports shall also include Scheduled and actual progress.

The frequency of progress reporting by the Contractor shall be in general weekly for the period right from engineering to hook up and pre-commissioning checks. This can be increased if so required by the Company during installation, hook-up and commissioning. The Contractor may have to give daily progress report and the forecast of Work, deployment of manpower for the next twenty-four hours.

Once a week, Contractor shall furnish Company with a summary of the Work accomplished during the preceding week in the form of percentage completion of the various phases of the Works.

A meeting will be held thereafter which will be attended by a senior person in charge of the project from the Contractor's side to review the progress and also resolve the



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technical issues during hookup and commissioning. Daily meeting will be held at construction site to review the progress.

Distribution of the progress Reports is shown in the Correspondence Procedure, Section 9.0, herein.

11.2. Rate of Progress

Contractor shall monitor progress of all the activities specified in the programme of Works pursuant to Clause 2.3.4. and submit free of cost monthly progress report about various aspects of the Works to the Company as per proforma given in Appendix-C-7. The periodicity of such reports may be changed by the Company on mutual agreement between both parties.

- 11.2.2 The contractor shall create a separate Website for the Project for uploading of the reports and shall update the same on daily basis. The access to this website of the Project shall be given by the Contractor to designated Officers of the Company.

Extracts of the progress report to be termed as "Executive Summary" shall be submitted in 02 copies along with 02 copies of monthly progress report.

All the materials, plant and labour to be provided by the Contractor under Section 5 and the manner and speed of execution and maintenance of the Works are to be in accordance with the Contract. Should the rate of progress of the Works or any part of them at any time falls behind or is found to be too slow to ensure completion of the Works by the stipulated time or extended time for completion, the Company's Representative shall so notify the Contractor in writing. The Contractor shall reply to the written notice giving details of the measures he proposes to take to expedite the progress so as to complete the Works by the prescribed time. The Contractor shall not be entitled to any additional payment for taking such steps. If at any time it should appear to the Company or Company's rep. that the actual progress of Works does not conform to the approved programme the Contractor shall produce at the request of the Company's Representative a revised programme showing the modification to the approved programme necessary to ensure completion of the Works within the time for completion as defined in Clause 6.3 hereunder.

- 11.2.3 The submission to and approval by the Company or Company's Representative of such programme as the furnishing of such particulars shall not relieve the Contractor of any of his duties or responsibilities under the Contract.

In case during execution of Works the progress falls behind schedule, Contractor shall deploy extra manpower, Constructional Plant and Equipment, resources to make up the progress. Programme for deployment of extra man power/Constructional Plant and Equipment resources will be submitted to the Company for its review and approval which approval shall not be unreasonably withheld. All time and cost effect in this respect shall be borne, by the Contractor unless otherwise expressly provided in the contract.

11.3 CONSTRUCTION PHOTOGRAPHS/Documentary

- 11.3.1 Company desires to have two sets of monthly progress reports with construction photographs showing the progress of fabrication of all major works. Company also desires



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to have complete Video film of all major components during fabrication, transportation and installation/ erection.

Upon completion of the project, the contractor shall also provide a video film /documentary carrying highlights of Project execution from signing of contract to handing over.

11.3.2 Before utilizing any photographs for publicity, Contractor shall obtain prior approval of Company.

11.3.3 Company reserves its right to take photographs of the work related to the project any time during execution by contractor at any site/ yards.

12.0 CONTINUANCE OF THE CONTRACT

Notwithstanding the fact that settlement of dispute(s) (if any) under arbitration may be pending, the parties hereto shall continue to be governed by and perform the work in accordance with the provisions under this Contract.

13.0 SOURCING OF FUEL

Contractor shall source the fuel like petrol, diesel etc., if required for carrying out the works/services covered under this contract, from M/s. Mangalore Refinery & Petrochemicals Limited, Mangalore(a subsidiary of ONGC), wherever possible.

14.0 INTEGRITY PACT:

The Integrity pact, duly signed by the authorized official of ONGC and the Contractor, will form part of this contract / supply order.

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3.0.0 GENERAL SCOPE OF SUPPLY AND SERVICES

The scope of supply and services covered shall be complete from site clearing to project take over by Owner/Owner's representative including all supplies and services. The Contractor's scope of supply and services listed in clause 1.2.0, Plant components and Major Equipment as well as listed below are to be included and shall not be limited to the following:

1. Design, Engineering, Procurement, Testing at Manufacturer's Works, painting, sea worthy Packing, Forwarding and Supply of all equipment, plants and facilities within the limits of supply and for connection at the boundary/defined limits and as specified in the relevant Detailed Technical Specification for the completion of the power plant on an EPC basis including Special Tools and Tackles, pre-commissioning/commissioning spares, and mandatory spares.
2. Intermediate site / offsite storage, transport to erection area, Receipt of material at site including unloading from carriers at site, handling, storage and preservation at site and intra/off site transport to site or viceversa as may be required.
3. Inspection, testing, cleaning, painting, marking at the EPC contractors and/or subcontractors workshops, delivery and transportation to the site, including insurance, unloading.
4. Overall Project management, project control, quality assurance, site management and coordination for all technical matters, interconnections, connection to off-site facilities, scheduling, contractual matters and obligations, etc. with suppliers, sub-suppliers, subcontractors, vendors, the Owner/Owner's representative, as required on a EPC basis for the implementation, construction and putting into commercial operation of the whole project under the overall and sole responsibility of the EPC Contractor.
5. Complete civil engineering including, Soil and Geo-technical investigation and design and carrying out all necessary civil and construction works at site. To carry out soil resistivity test for designing of plant earthing system.
6. Supply of all information, documents, calculations, drawings, reports, etc. which are required for Owner/Owner's representative's approval and to obtain all necessary permits, clearances, from the Government authority, except those which are specifically stated to be obtained by Owner/Owner's representative.
7. All statutory clearances and approvals to be taken by the EPC contractor in relation to the performance of the works. However, the Owner/Owner's representative shall assist the contractor and /or sub-contractor upon receiving written request from the EPC contractor to acquire the necessary permit, approvals and /or licenses.
8. Supply of all consumable materials required for civil construction, erection, testing and commissioning, reliability run, performance guarantee test, taking over of the plant. However fuel (Natural gas) required for these trial/test of the plant will be provided by Owner/Owner's representative at specified terminal point.
9. Provision of all labour, necessary erection equipment, temporary site facilities, temporary connections to power supply, water supply etc. for erection and commissioning required for the fulfilment of the Contractor's duties in connection with the works and for completion of the entire project in time.
10. Provision of all accommodation, transport, canteen, social facilities, etc. for the Contractor's personnel employed at site.

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11. Co-ordination with other agencies including with the Owner/Owner's representative at the plant interconnections (interfaces), if any.
12. Cleaning and application of corrosion protection during erection as required by the Owner/Owner's representative and apply final painting in accordance with the specification.
13. Carry out erection test / test run, mechanical completion, electrical / instrumentation checks / tests, pre-commissioning tests, commissioning tests, trial operation, reliability run, performance guarantee test run, taking over, of the systems / equipments / plant including civil, structural and architectural works specified and handing over of the plant to the Owner/Owner's representative's requirements and approval and in compliance with the requirements of this specification.
14. Installation and removal of temporary piping and equipment for carrying out oil flushing, Acid / Alkali boil out , Steam blowing operation or such cleaning facilities as required.
15. Relocation & refurbishing of existing temporary shed existing now at the CCCPP plot area to a location as identified by Owner/Owner's representative within the Complex..
16. Removal of surplus materials, scraps out of fabrication yard, temporary infrastructures, subsequent cleaning up and handing over of plant to the Owner/Owner's representative.
17. Provision of supply of all documents required and specified including AS BUILT drawings.
18. Training services for the Owner/Owner's representative's operation and maintenance personnel.
19. Any other supplies and services in connection with or related to the works so far as the necessity for providing the same is specified in or reasonably to be inferred from the contract and/or required for the completion of the power plant.
20. The Contractor shall accept full responsibility for the completeness and for the satisfactory working of equipment and the plant as a whole. These shall be executed on the basis of proven design principles and in accordance with the state of-the-art in such a manner that the purpose to be served by the plant is fulfilled in every respect. Standardization of equipment, materials as well as of buildings shall be attempted and evidenced in the design. Care shall be taken to ensure simplicity of assembling and dismantling of all parts of the plant.
- 21. Construction power and water (ON CHARGEABLE BASIS) : Owner/Owner's representative will provide 415 V supply at one point within the plant boundary, further distribution shall be part of the Contractor's scope. Demand and consumption charges shall be borne by the Contractor. Contractor shall provide month-wise power requirement for the Project duration immediately after Contract signing. The temporary metering for power & water usage shall be put up by the contractor and informed to ONGC Engineer of Hazira plant.

Construction water shall be supplied by ONGC at one point and rest extension shall be part of EPC Contractor scope. No ground water tapping permitted.

22. Satisfactory conclusion of the contract

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By accepting the Contract, the Contractor shall be deemed to accept the obligation of supplying everything necessary as per the Contract for the purpose mentioned above, regardless of any omission in the specification or on the drawings.

More detailed scope of supply and service is described under this section and the relevant chapter of the detailed technical specification.

3.1.0 Scope of Engineering Services

The engineering services of the Contract refer to the complete basic and detail engineering of all equipment and equipment systems, Providing engineering drawings, data, instruction manuals, as built drawings and other information for Owner's/Owner's representative's review, approval and records. 3D walkthrough model of the plant shall be included in the scope of Contractor and the same shall be furnished before the final approval of the drawings. Full fledged 3D modelling shall be developed for power house. Also all piping for which isometric will be developed will be generated from 3D modelling.

The Contractor shall be responsible for the plant design & construction related licensing/permitting applications, However Owner/Owner's representative will extend necessary support as required to the Contractor.

3.2.0 Common Equipment and Services

The following supplies and services are to be included in the Contractor's scope and corresponding section.

3.2.1 General

- Material and personnel costs (e.g. for testing authority staff) for tests and inspections which are mandated by legislation and also cost involved in quality assurance requirements as specified.
- Material costs for site inspections.
- Declaration of conformity with Indian requirements and markings for all machines
- Engineering design of complete supplied equipment including interface coordination
- Preparation of General Arrangement and all layout drawings.
- Estimation of Bill of Materials
- All as-built documents (on data carriers; data formats as requested by the Owner/Owner's representative)
- Quality control plan and safety plan
- Complete documentation as set out in the technical specification.
- Operating and maintenance manual containing the summary. Detailed operating and maintenance instructions .
- Technical library shall contain O&M Manuals and As-built drawings of various systems / equipments in the plant. Further the plant hand book shall also cover system description, site conditions, technical parameters of all the items of the power plant indicating equipment features viz., configuration, design parameters, operating parameters, MoC, drawings.
- Conducting HAZOP Study for the entire proposed plant supplied by the EPC Contractor with the involvement of the "Owner/Owner's representative" and furnishing the report. For MPP supplied systems participation (for conducting HAZOP study by Contractor) in design review and implementation from MPP shall be ensured by EPC Contractor.
- All necessary co-ordination with other contractors on site for erection, testing and commissioning of equipment and accessories.
- Making available of all testing and commissioning equipment.

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3.2.2 Mechanical

- All necessary pipelines, warm up system, vents, drains, valves, actuators, required for commissioning, operation and preservation in standstill.
- All temporary installations required for tie-in measures including post weld heat treatment complete, inner cleaning.
- All temporary pipe work as required during connection measures.
- All support structures, hangers, supports.
- All base frames, mounting plates, grouted in parts, rag bolts, covers.
- All required steel parts embedded in concrete.
- All couplings and coupling guards for electric motors and other drives.
- All lifting equipment and hoists (for repair work where loads exceed 50 kg) (cranes, hoists, monorails installation arrangement.
- Required safety equipment, pressure relief valves.
- All thermal (Hot and Cold) and noise insulation including cladding as well as any other noise attenuation measures,
- Stairways, ladders, platforms, galleries and walkways to all plant components, including escape routes as necessary, pipe cross-overs in plant,
- All necessary steel structures, stairs, ladders and platforms including weather protection
- All required ventilation and / or air conditioning equipment as specified and as required for safe operation of mechanical and electrical equipment, to be supplied.
- All necessary corrosion protection measures for plant components and equipment stored or mounted on site up to the time of 'Handing Over'.
- Complete primer and top coatings conforming to colour code to be agreed with the Owner/Owner's representative
- Noise abatements measures to comply with noise pollution control requirement.
- All corrosion protection for outdoor installations.
- Complete labelling of all plant components according to the Owner/Owner's representative's system in English and also in local language for notices.
- All fire protection measures.
- All lubrication systems.
- Initial lubricant filling and sufficient lubricants for commissioning, minimization of lubricant types by screening and co-ordination with the Owner/Owner's representative.
- Provision of all connections and temporary pipe work for steam blowing of the steam pipelines to a safe height.
- Flushing of all other pipelines including disposal of the effluents; protection with wood and/or plastic at all instrumentation and appendages to be installed during construction
- Chemical cleaning and Steam blowing of piping. Chemical cleaning of the deaerator is not applicable if fully assembled deaerator is supplied to site.
- All standard accessories and auxiliary equipment which normally form part of the scope of supplies.
- All tests, inspections and works acceptances as well as all certificates and reports of these
- Cleaning of all GT Intake filter elements before 'Handing Over' of the relevant Unit.
- Valve trims for purging and subsequent exchange.
- Removal of any unused material from site.
- Scaffolding for all work above ground level.
- Proven and latest air quality monitoring system at the strategic locations in and around the plant/Property to monitor and to comply with norms of various statutory bodies.

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3.2.3 Electrical and Instrumentation

In general the power plant shall be started, stopped and operated through proprietary control systems of the GT, ST and also through plant DCS. The electrical control & monitoring of 66kV, 11kV & 415V system will be through a SAS system. The electrical, instrumentation and control for the plant shall mainly consist of, but not limited to the following:

- All controls, measuring and monitoring equipment for the complete power plant.
- All primary sensors, local and remote field instruments, valves and actuators (temperature gauges, pressure gauges, pressure / flow / level transmitters, local regulating devices) as well as all instruments for reliability and performance test and checks.
- All local instrumentation racks, enclosures and local gauge boards.
- All necessary electrical drives
- Complete installation material, that is wiring, cabling and impulse piping / tubing and fittings, valves, all needed fastenings, conduits, brackets and other supports, including the cable trays & its supports.
- All required junction boxes and cubicles
- All field control boxes
- Street and other outdoor lighting
- Lightning protection
- Electrical and electronic/signal earthing of equipment.
- Logic interconnections for sequencing, interlocking, protection, safeguarding for coordinated operation / start-up / shut down of various plant equipment and processes.
- Necessary interface with control systems of BOP offsite utilities for monitoring and supervisory controls.
- All the electrical equipment in the in the Hazardous area and battery rooms (shall be flame proof type. Refer Hazardous area classification plan (Overall) drawing no. 3114-00-16-50-0005,Rev-0) & Hazardous Area Classification Diagram (Drg. No.1-38101-00213, Rev.0).
- It shall be the endeavour of the EPC contractor to make maximum use of natural light while designing the buildings / sheds / enclosures.

3.2.4 Civil

- Soil investigations
- Any necessary surveying works
- Preparation of site, demolition works, removal of underground obstacles, cutting of trees-
- Preparation of site with barricading the proposed power plant area upto 10 Metre height with installation of sufficient number of gas detectors.
- FGL of proposed CCCPP shall be EL (+) 101.200 M Corresponding to NGL EL(+) 99.700 M.
- Earthworks, drainage, excavation and refilling works
- Roads and pavement
- Concrete and reinforced concrete works, masonry and earthing.
- Water proofing works.
- Fire protection during construction
- Roofing (non asbestos)
- Plumbing
- Facade works/glazing works(non asbestos)
- Non-load bearing walls/installation partitions/dry construction works
- Metalwork and blacksmith work/raised flooring/doors and gates/sheet metalwork
- Flooring work
- Fire protection with plumbing;

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- Corrosion protection for underground/ over ground RCC and steel structures
- Crane way works
- Service water and waste water, sewage water, storm water (permanent and during construction).
- Housekeeping during construction (at least once a week total)
- Staff facilities during construction
- Transport of all dumping material to dump locations (at least once a week).
- Proper drainage arrangement has to be ensured, so that adjacent plant area should not get affected.

4.0.0 PROVISIONS BY THE OWNER/OWNER'S REPRESENTATIVE

Refer Volume-I (Commercial Specification)

5.0.0 SITE CONDITION

5.1.0 Meteorological Conditions and other Project information

ONGC, Hazira Site conditions:

1.0	Location	ONGC Limited, Hazira
2.0	Elevation above mean sea level	RL 6.0 above, MSL
3.0	Nearest Railway Station	Surat, 20 KM
4.0	Nearest Airport	Surat, 10 KM
5.0	Nearest Harbour	Magdalla, 20 KM
6.0	Access Road	NH-8 (30 KM)
7.0	Atmospheric pressure at MSL	1.013 bar
8.0	Ambient Temperature	
a)	Max. average dry bulb temperature	45.6 °C
b)	Min. average dry bulb temperature	4.4 °C
c)	Design temperature for electrical equipment / device	50 °C
9.0	Relative Humidity	
a)	Max.	70%
b)	Min.	18%
c)	Average	64%
10.0	Seismic Zone	III (IS 1893)
11.0	Rainfall	
a)	Max. intensity of rainfall in 24 hrs.	459.2 mm
b)	Period – Monsoon showers	June to September
c)	Average rainfall per annum	1203.5 mm
12.0	Wind data	
	Max. wind speed (as per IS:875) 20-61 kmph for 20 days in a year < 20 kmph for remaining period	62 kmph
	Most predominant wind direction	South - West
13.0	Land	
14.0	Tropicalisation	
	All equipment supplied against specification shall be given tropical and fungicidal treatment in view of the climatic conditions prevailing at site.	
	Tropical protection shall conform to BS: CP-1014-1965 "Protection of Electrical Power Equipment" against climatic conditions.	

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ANNEXURE 2

VOLUME - III

SECTION - 5.0

DETAILED TECHNICAL SPECIFICATION

CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS

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SECTION - 5.0

CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS

5.1.0 GENERAL

This specification covers the design, detailing, supply, construction / erection, testing and commissioning of all Civil, Structural and Architectural Works for the Power Plant.

If any provision of this specification departs from the Bidder's standard design and construction practice sufficiently to materially increase the cost of construction without in his opinion providing corresponding increase in quality/reliability or if he considers that his usual design and construction would provide better quality/reliability, he shall offer the particular work/system based on his standard design and construction method. The proposed deviations from this tender shall be specifically highlighted in a standard format for technical deviations & only agreed deviations will be a part of the contract. Deviations mentioned elsewhere in the offer will not be accepted. In case such offer with deviations is made, the Bidder shall state very clearly the merit of his offer and the demerits (in his opinion) the specified design has. However, the Contractor shall stick to the same design and construction philosophy that he has offered, if accepted by the Owner/Owner's representative and shall not make any changes during execution.

The design and construction specifications included in this section are intended to cover the general design and construction quality requirements. It is not intended to cover the minute details. The Standard Technical Specifications for Construction included under Clause 5.5.0, cover the quality and workmanship requirements for the various materials and types of work. The specific material and type of work to be adopted for this project are specified in Clause 5.4.0 hereunder. In case the same is not specified, the Contractor shall indicate in his offer, the material and specification he proposes to adopt for such works and get the same approved. In case construction requirements for any item specified in Design Specifications are not covered in the Construction Specifications, the manufacturer's specification / recommendations, other International Standards or good Owner/Owner's representative's practice (but not contradictory or inferior to Indian Standards), as approved by Owner/Owner's representative, shall be followed. In case of any contradiction between the provisions of Clause 5.5.0 and Clause 5.4.0, the more stringent of the two shall govern. In all cases, the decision of the Owner/Owner's representative shall be final & binding.

Any reference to unit rates, Schedule of Item, Bill of Quantities, etc. if found, in the Standard Technical Specification under Clause 5.5.0 shall be considered as not applicable, as this is an EPC tender on lump sum basis. Units of linear dimensions, sizes etc. referred in this specification shall be in millimeters (mm) unless otherwise specified.

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5.2.0 SCOPE OF WORK

5.2.1 General

This section sets out the scope of necessary surveys and investigations, design, supply, construction, installation, testing and commissioning of Civil, Structural and Architectural works, without excluding necessary components and services not mentioned.

The scope shall include the demolition and removal of existing underground structures or any obstructions which are necessary for the execution of work.

The scope shall include other related works although they may not be specifically mentioned in the subsequent clauses and all such incidental items not mentioned, but are necessary for completion of the work as a whole. The Contractor shall supply all materials including cement, reinforcement steel and Structural steel. Each consignment of materials shall be tested at Government approved laboratory. All costs, royalties, taxes & duties, octroi, transportation etc. towards building materials shall be paid by the Contractor. Since this is an EPC contract, no work or supply shall be done by other agencies including the Owner/Owner's representative.

The scope also includes supply of all labour, technical personnel, materials and equipment for execution of work and getting all materials tested at site laboratory or approved laboratory outside, submitting test reports, arranging supervision of manufacturer for specialized items. After award of work the Contractor shall submit for Owner/Owner's representative's approval a detailed quality assurance programme for all the materials and types of works.

The intending Bidders are advised to visit the site to have a firsthand information about the site conditions such as access to site, access for construction and erection, clearance available, availability of material (e.g. aggregate, sand, bricks etc.) and all other relevant details before submission of tender. Non familiarity with the site conditions will not be considered a reason either for extra claims or for not carrying out work in strict conformity with time schedule, drawing and specifications.

5.2.2 Buildings, Structures and Facilities covered in the scope

- Chain link fencing around transformer yards including Gate
- Earthwork and filling in proposed power plant area as per grading drawing.
- Micro Site Grading and levelling
- BM main approach road from the existing road to the proposed plant area.
- Plant Internal BM roads and paved areas
- RCC Storm Water Drainage System on both sides of road along with pre- cast RCC covers and interconnection of drains to existing system wherever applicable.
- Gas Turbine and Generator / STG Building shed
- Gas Turbine Foundations
- Gas Turbine Area Equipment Foundations
- HRSG Foundations
- Steel Chimney and foundation.
- Steam Turbine Foundations
- Switchgear and Control Buildings
- Transformer Foundations
- Gas Insulated Switchyard Structure and Foundations, cable trenches, roads, gravel filling etc
- Fuel Gas Conditioning Station
- Blackstart cum Emergency DG Set Building
- CW Pump Shed and forebay

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- Mechanical Induced draft Cooling Towers
- Civil works related to Water Pipeline and Effluent disposal line
- Compressor house
- Service Water and Potable Water overhead tank
- Neutralization pit
- Chemical Laboratory
- Chemical House.
- HRSG Blowdown sump
- Pipe and Cable Racks
- Pipe and Cable Trenches
- Air washer room
- Sewage Disposal System
- Guard pond and with associated pumps and piping structures up to existing pit
- Lighting towers minimum 4 nos. of suitable height.
- Green belt area as per Statutory norms
- Any other buildings / structures required from system considerations.
- Watch towers with security lights
- Floor drains and sump with associated pumps.
- Temporary barricades/structures to protect the existing plant

Scope of work shall cover, but not limited to the following major items.

5.2.3 Survey and Investigation

Topographical survey & Geo-technical Report on the investigations carried out by Owner/Owner's representative shall be made available to intending Bidders for information with no liability on the accuracy of the information furnished in the reports. Additional investigation shall be carried out to substantiate the results of the investigation already carried out or to obtain specific soil properties not covered in the specification or soil report shall be carried out by Contractor during detailed engineering stage at no extra cost to Owner/Owner's representative. Contractor will be required to carry out investigation as per the decision of the Owner/Owner's representative, without any price implication. Such report/Investigation carried out by the Contractor shall be submitted to the Owner/Owner's representative for approval before proceeding with further engineering.

Plant grading, levelling, tree cutting, thorny jungle clearance as required. The grade level shall be maintained considering the elevation of the existing Plant level.

The surplus earth material after excavation shall be disposed in a lead of 5.00 KM radius without any extra cost.

- Fencing shall be provided to all areas where there is risk to human life or entry restriction is essential for safety purpose.

Chain link fencing at critical area as identified in the plot plan and as specified in specification.

5.2.4 Design and Engineering

- Preparation and submission of design calculations and construction drawings and getting the same approved by the Owner/Owner's representative.
 - a) Design criteria for Civil, Structural and Architectural works.
 - b) Design Calculations for road and drains

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- c) Structural calculations including analysis for structures and foundations.
- d) Hydraulic calculations for drains.
- e) Static and Dynamic analysis for machine foundations
- f) Calculations for piles
- g) General Arrangement and Reinforcement drawings for concrete works
- h) Architectural and joinery details for buildings
- i) Layout and details for outdoor facilities - Roads, Paving, drainage, sewerage, cable / pipe trenches, duct banks etc.
- j) General Arrangement and fabrication drawings for steel structures
- k) Architectural floor plans including conceptual interior/ equipment and furniture arrangement, elevations, cross sections and perspective view in colour of all buildings (i.e.) for GT/ST common control room etc., including provision of natural light for GT / ST buildings. Bidder shall submit two different schemes along with a report elaborating the underlying philosophy of the proposed architectural concepts.
- Preparation and submission of design and drawings for statutory approvals from local Municipal / Panchayat authorities, Factory Inspector, Civil Aviation Authorities and other authorities, as applicable.

Obtaining necessary details, permission and approvals from statutory authorities for carrying out the work. Owner/Owner's representative will issue necessary authorization letter and extend necessary help for the above to the extent possible.

5.2.5 Construction

- Construction of, Fences and Gates

The demolition and removal of existing (above ground / underground) structures or any obstructions which are necessary for the construction/execution of work.

- Tree cutting, thorny jungle clearance as required to the site, Earthwork in filling and site grading of the Power plant area to the finished ground level shall be as per drg no **10-5111168-C-002 (Rev B) – Site grading plan (Ref Volume IV & Section No. 06 of Technical specification)**.
- Construction of temporary buildings and structures for Contractor's use, such as Site Office, Cement Godowns, and Storage yards, Canteen, Construction Material Testing Laboratory and other facilities as required.
- Construction of roads, peripheral walkways, drainage, sewerage, culverts, duct banks etc. within the Power Plant. Interconnection of above systems to existing systems wherever applicable.
- Earthwork in excavation including rock quarrying/blasting if required, identifying borrow pits, transportation of soil from borrow pits, backfilling, disposal of excavated soil to designated areas within and outside the plant boundary etc. Archeological findings, if any, shall be reported to the Owner/Owner's representative.

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- Installation of trial piles, test piles and permanent working piles if required as per Geo-technical Report and its recommendations / interpretations.
- Pre-constructional Anti-termite treatment as specified.
- Civil, Structural and Architectural and finishing works for all buildings and structures.
- Sanitary and plumbing works for all buildings.
- Construction of all foundations and structures in RCC and steel work for all the buildings and facilities of the Power Plant.
- Construction of all equipment and machine foundations
- Construction of Steel chimney
- All other works required for completion of the project in all respects.

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5.3.0 Design Criteria for Civil, Structural and Architectural Works

This subsection covers the general design requirements related to Civil, Structural and Architectural works

5.3.1 Design Criteria - Codes and Standards

The following Indian Codes and Standards shall be generally used for design of civil and structural works. In all cases, the latest revisions with amendments, if any, shall be followed. For work not covered by Indian Standards, other International Standards, as applicable shall be followed. In case where either Indian or International standards, are not available, good engineering practice, as approved by the Owner/Owner's representative shall be followed.

Reference of only some of the codes in this document and various clauses of design criteria shall not limit or restrict the scope or applicability of other relevant codes. It shall be ensured that all other codes relevant to a specific job, in addition to those already mentioned, are followed wherever applicable.

In case of any deviation / conflict between provisions of IS codes and the design criteria, the provisions that are more stringent shall be followed unless specifically directed otherwise.

The Codes and Standards listed below are applicable for the design of structures and buildings in general. Codes and Standards applicable for specific design and construction are listed elsewhere in respective sections.

General

- IS: 875 Code of practice for design loads (other than earthquake) for buildings and structures.
- IS: 1893 Criteria for earthquake resistant design of structures.
- IS: 4326 Earthquake design and construction of buildings - Code of Practice.

Foundations

- IS: 1080 Code of practice for design and construction of shallow foundations in soils (other than raft, ring and shell).
- IS: 1904 Code of practice for structural safety of building foundations.
- IS: 2950 Code of practice for design and construction of raft foundations.
- IS: 2974 Code of practice for design and construction of machine foundations.
- IS: 6403 Code of Practice for determination of bearing capacity of shallow foundations.
- IS: 8009 Code of Practice for foundation settlement calculations.
- IS: 13301 Guidelines for vibration isolation for machine foundations

Concrete Structures

- IS: 456 Code of practice for plain and Reinforced concrete.
- IS: 3370 Code of practice for concrete structures for the storage of liquids.

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- IS: 3414 Code of Practice for design and installation of joints in buildings
- IS: 4326 Code of Practice for earthquake resistant design and construction of buildings
- IS: 5525 Recommendation for detailing of reinforced concrete works
- IS: 6313 Code of practice for anti-termite measures in buildings
- IS: 13920 Ductile detailing of Reinforced Concrete Structures subjected to Seismic forces.

Steel Structures

- IS: 800 Code of practice for use of structural steel in general building construction.
- IS: 802 Code of Practice for use of Structural Steel in over Head Transmission Line Towers.
- 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

Miscellaneous

- IS:1172 Code of basic requirements for water supply, drainage and sanitation
- IS:1742 Code of Practice for building drainage
- IS:1905 Code of Practice for structural use of un-reinforced masonry
- IS:2470 Code of Practice for installation of septic tanks
- IS:3067 Code of Practice for general design details and preparatory works for damp proofing and water proofing of buildings
- 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
- SP:20 Handbook on masonry design and construction
- SP:22 Explanatory handbook on codes for earthquake engineering
- SP:24 Explanatory handbook on Indian Standard Code of Practice for plain and reinforced concrete
- SP:25 Handbook on causes and prevention of cracks in buildings
- SP:32 Handbook on functional requirements of industrial buildings

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SP:34	Handbook of concrete reinforcement & detailing (SCIP)
IRC:37	Guidelines for design of flexible pavements
IRC:58	Guidelines for the design of rigid pavements for highways
IRC:73	Geometric design of roads

5.3.2 Design Criteria – Architectural and Finishing Works

Architectural Design

Architectural design of the buildings shall be in conformity with the following:

- Architectural design basis.
- National Building Code of India
- Local Municipal or other authority by-laws.
- Relevant state Government Factory Acts.
- Tariff Advisory Committee (TAC) recommendations
- Any other relevant information included elsewhere in this tender.

Space Requirement

Space requirement shall be based on one or combination of the following depending upon the specific situation.

- a. Occupancy
- b. Equipment layout
- c. Storage / operational requirement

Layout

Layout and detailing shall be developed in compliance with the relevant statutory regulations and good industry practices.

Design Consideration

Architectural design shall be developed within the frame work of space availability and layout taking into account of load conditions as well as local Architectural practices.

Architectural design of all buildings shall fully meet the functional requirement. Buildings shall be adequately sized and provided with sufficient passageways and access, ventilation and natural lighting for carrying out the desired activity and operations smoothly. An overall architectural control and harmony shall be maintained among all the buildings of the project. All plant and non-plant buildings shall have minimum two accesses.

Circulation

All buildings and open plant areas must be approachable by roads / paved pathways of required widths to suit the openings / approach to the buildings and shall lead up to entry points. Necessary car parking space shall be provided near the buildings. All internal corridors / passage inside the building shall have a clear width of minimum 1800 mm unless otherwise specified. All firefighting equipment etc. shall be provided in suitable niche as per requirements.

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Ventilation

Provision for natural ventilation and lighting as also for mechanical ventilation, pressurization, air conditioning shall be provided taking into consideration the local conditions, the activity and equipment in the building, statutory requirements and specific requirement, if any. Generally openable windows of area not less than 20% of the floor area shall be provided for natural ventilation. All outside doors, windows shall be adequately protected by sunshade (min.750 mm projection sunshades shall be provided with drip mould). The area of ventilation shall not be less than as specified / statutory requirement. Exhaust fan shall be provided in Toilet & battery room areas. 50 mm thick R.C.C. jali / ventilators / louvers shall be provided in cellar areas for ventilation.

Acoustic Treatment

Suitable acoustic treatment shall be incorporated in the architectural design to ensure that the noise generated shall satisfy the ambient noise level standard prescribed by the Pollution Control Board.

Architectural Requirements

Toilets

Toilets shall be provided near work areas, but isolated from main areas. Unless otherwise shown in drawings or specified, the dimension of the toilet blocks shall be decided by the number of sanitary fixtures, which shall be based on number of users in accordance with IS: 1172. Provisions of Factories Act / Local regulations with respect number of toilets and separate toilets for Ladies shall be complied with.

Toilets shall be provided with all necessary approved Indian Standard fittings. The floor of toilet shall have a drop of 15 mm from general floor level and shall have sufficient slope towards drain trap. Sufficient natural light and ventilation shall be provided as per requirement. Unless specified each toilet shall be provided with minimum one W.C. (water closet), one urinal, one washbasin, towel rail, mirror and liquid soap container, glass shelves etc. Western/Indian style water closets shall be provided as specified / directed by the Owner/Owner's representative. Urinals shall be without photovoltaic control flushing system.

Ramps

Ramps shall be provided for equipment entry. Slope shall not be steeper than 1:7, unless otherwise specified.

Stairways

All buildings must have access to roof by means of stairs / cage ladder. Access to roof shall be through stairways for multistoreyed buildings and for single storeyed buildings which require frequent access. All R.C.C. staircases shall have a minimum stair width of 1200 mm with hand railing on one or both sides as per requirements. Tread and riser shall be properly maintained to ensure comfortable climb. The nos. of stairs to be provided shall be as per statutory requirement / TAC recommendations. All approachable terraces shall be provided with 1000 high parapet wall. Non-approachable terraces or terraces where access is provided by ladders only, shall have min. 115 thick, 350 high parapet wall.

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Layouts of plant buildings

The layout of the buildings shall be developed considering the equipment layout, such as electrical panels, mechanical equipment etc. with due consideration for working space, maintenance space requirement, statutory clearances, etc. All buildings shall be protected with 1000 wide plinth protection all around the building.

The height of the buildings shall be provided as per the statutory requirements and equipment / crane / mono-rail requirement.

The location, numbers, dimensions and types of access doors, windows / rolling shutters shall be decided based on equipment layout, ventilation, operational and maintenance requirements. Fireproof doors shall be provided at fire exits with fire rating of 2 hours. Cable galleries shall be provided with fireproof wall rated for 2 hours.

Generally the building floors shall be 500 mm above the finished ground level of the respective areas.

Masonry walls

The external brick wall for the buildings shall be 230 mm thick and internal walls 230/115 mm thick as per requirement. The requirement of fire barrier wall between transformers shall be as per Electricity Rules and TAC recommendations but shall not be less than 350 mm thick. In case wall heights are more than 5 metres, RCC walls shall be provided and minimum thickness of the same shall be 230 mm. Internal plastering shall be 12 mm thick in mortar 1:3 and external plastering shall be 20 mm (in two layers) in cement mortar 1:3 for 230mm thick brick wall. 115mm thick brick wall will be plastered with 12mm thick cement mortar 1:3. Half brick internal walls shall be provided with 2 nos. of 6 mm dia steel bars reinforcement at every fourth layers. Damp proof coarse 40 mm thick in PCC 1:2:4 using 6 mm down stone shall be provided in the external brick walls at grade level. Ceiling plastering shall be 6mm thick with cement mortar 1:3.

Architectural and Finish Specification

The specification furnished below shall be applicable for architectural works as well as for finishes to concrete surfaces wherever specified.

Minimum size of single shutter door shall be 1200 mm x 2100 mm. For higher widths double shutters shall be provided. Maximum size of double shutter doors shall be restricted to 2000 mm x 2500 mm beyond which Rolling shutters shall be used.

a. Doors, Windows, Ventilators, Louvers and Rolling Shutters

Steel Door

- Double plated flush doors 45 mm thick with 18 gauge pressed steel frames conforming to IS: 4351 and 18 gauge plain steel sheets on both faces.
- Fixtures and other details as per specifications.

Timber Door

- Teakwood frames.
- 38 mm thick solid core teakwood flush shutters conforming to IS: 2191 with commercial quality teak ply and vision panel for flush doors.

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- 38 mm thick paneled shutters with 15 mm marine board panels (and plastic sheet on inside face for paneled doors for toilets. Minimum width of toilet doors can be 800 mm.
- Fixtures and other details as per specifications.

Aluminum doors, partitions & windows

- Extruded aluminum box section for frame and shutter with minimum thickness of 2.5 mm
- 4 mm thick plain glass for openable shutters
- 6 mm thick plain glass for fixed shutters.
- 6.3 mm thick laminated safety glass for fixed glazed partitions.
- Fixtures and other details as per specifications.

Steel Windows / Ventilators

- Steel windows of standard dimensions conforming to IS: 1361.
- 4 mm thick plain glass for openable shutters
- 6 mm thick wired glass for fixed shutters.
- 12 mm sq. MS safety bars @ 100 mm c/c.
- Fixtures and other details as per specifications.

Steel Louvers

- Pressed steel louvers from 18 gauge steel sheets and MS rolled channel frame.
- Fixtures and other details as per specifications.

Rolling shutter

- PVC Coated shutter made from 18 gauge steel sheets, suitable for saline weather conditions. Guides 75 mm x 25 mm steel channel.
- Details as per IS:6248,

b. Floor finishes

Indian Patent Stone (IPS) flooring

- 28 mm thick under bed in PCC 1:2:4 with 10 mm downgraded granite stone chips
- 12 mm thick topping. One (1) part of metallic hardener shall be mixed dry with 4 parts of cement by volume. To this mixture, 6 mm nominal size stone chips shall be added in portion of 1:3 (mixture of hardener & cement : stone chips) by volume.

Cast-in-situ terrazzo flooring

- 25 mm thick under bed in PCC 1:1.5:3 with 10 mm downgraded granite stone chips.

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- 15 mm thick terrazzo topping with 6 mm down marble chips of approved color.
- Panel size 1000 mm x 1000 mm with 40 mm x 3 mm thick glass dividing strip.

Precast Terrazzo tiles

- 20 mm thick underbed in PCC 1:1.5:3 with 10 mm down granite stone chips.
- 250 mm x 250 mm x 20 mm tiles.

Carborundum tiles

- 20 mm thick underbed in PCC 1:1.5:3 with 10 mm down granite stone chips.
- 250 mm x 250 mm x 20 mm tiles.

Acid Resistant Tiles

- 15 mm thick underbed in cement mortar 1:3.
- Intermediate layers of 3 mm thick bitumen and 6 mm thick acid proof mortar.
- 25 mm thick acid resistant tiles conforming to IS:4457.

Glazed Tiles

- 15 mm thick underbed in cement mortar 1:3
- Earthenware glazed tiles conforming to IS:777.

Heavy duty Ceramic Floor Tiles

- 15 mm underbed in cement mortar 1:3
- Ceramic floor tiles 600x600x10.

PVC Tiles

- 37 mm thick underbed in PCC 1:2:4 in areas without false flooring.
- To be directly installed over particle board tiles in false floor areas.
- 2 mm thick PVC tiles over false flooring and 3.02mm in other areas conforming to IS:3461/IS:3462.

Granite tiles

- 15 mm underbed in cement mortar 1:3
- 20 mm thick black color premium quality hard polished granite.

Vitrified Floor Tiles

- 12 mm underbed in cement mortar 1:3
- 300 mm x 300 mm x 6 mm or 300 mm x 200 mm x 6 mm Vitrified floor tiles (MARBONITE or approved equivalent).

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Epoxy coating

- Details as per detailed specification covered in Clause 5.5.0.

c. Roof finishes**Roof waterproofing with pressed flat tiles**

- 80 mm (min) thick layer of brick jelly lime concrete 1:2:4 using 20 mm downgraded brick bats.
- 20 mm thick underbed for tiles in cement mortar 1:3 with waterproofing admixture.
- 20 mm thick pressed flat tiles

Roof waterproofing with polymeric membrane

- 40 mm (min) thick screed layer in PCC 1:2:4 using 20 mm downgraded brick bats.
- Bituminous polymeric membrane as per specification or approved equivalent.
- 20 mm thick cement mortar 1:3 with chicken mesh over membrane.

Basement damp proofing with polymeric membrane

- Bituminous Polymeric membrane or approved equivalent as per specification.
- Vertical faces protected with 115 mm thick brick wall.

d. Painting**Oil bound distemper**

- One priming coat of cement primer or any other suitable primer as per manufacturer's recommendation.
- Two final coats of paint conforming to IS:428 to obtain even finish and uniform color.

Synthetic enamel

- One coat of Red oxide zinc chromate primer 25 microns thick.
- Two final coats of paint conforming IS:2932 each 25 microns thick.

Acrylic Plastic Emulsion

- One filler coat with plaster of Paris 3 mm thick.
- Two coats of suitable primer as per manufacturer's recommendation.
- Two final coats of paint to obtain even finish and uniform color.

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Waterproof Cement Paint

- One coat of paint as primer
- Two finish coats of paint to obtain even finish and uniform color.

Apex Ultima/Exterior weather shield

- One coat of paint as primer
- Two finish coats of paint to obtain even finish and uniform color.

White washing / color washing

- Three coats of white washing or color washing to obtain a uniform finish or shade.

Chlorinated Rubber Paint

- Two coats of high build chlorinated rubber zinc phosphate primer each 30 microns thick (for steel surface). One coat of chlorinated rubber paint (for concrete/masonry surfaces).
- Two final coats of chlorinated rubber paint each 40 microns thick.

High build Epoxy paint

- One coat of epoxy zinc phosphate primer 35 microns (for steel structure). Thin coat of epoxy high build paint (for concrete structure).
- Two finish coats of epoxy high build paint.

High build Coal Tar Epoxy Paint

- Two coats of epoxy red oxide zinc phosphate primer each 30 microns thick for (steel surface). One coat of epoxy sealer (for concrete surface).
- Two finish coats of high build coal tar epoxy paint.

Chemical Resistant Phenolic based enamel

- One coat of red oxide zinc chromate primer 25 microns (for steel surfaces).
- One thin coat of chemical resistant phenolic based enamel (for concrete surfaces).
- Two finish final coats of chemical resistant enamel each 25 microns.

Acrylic Polyurethane Paint

- Two coats of epoxy, zinc chromate primer each 35 microns thick (for steel surfaces)
- One coat of epoxy sealer (for concrete surfaces)
- Two finish coats of Acrylic Polyurethane paint each 30 microns thick.

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e. Underdeck Insulation

- 40 mm thick bonded mineral wool conforming to Group I of IS: 8183 with aluminium foil facing.

f. False Ceiling

LUXALON suspended by galvanised stud wire hangers.

g. False Flooring

600x600x32 mm cement fill metallic false flooring panel with 1.2 mm antistatic high pressure laminate tile on top.

Base Plate size	-	100x100x10 mm
Seamless pipe	-	25 mm OD
Support Stud size	-	M18x 100 mm

h. Sheeting

Permanent colour coated sandwiched insulated metal cladding and roofing system

Troughed zinc - aluminum alloy coated (both sides) MS sheet having 0.8 mm minimum thickness (or high tensile steel sheet of 0.5 mm 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) 40 microns (min) over primer. Inner side of external sheet shall be provided with suitable pre-coating of minimum 7 microns.

Double dip Galvanized (475 gsm) MS sheets of minimum 0.8 mm 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 40 microns (min) 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 150 gm /sq .m.

The permanent colour coated sheet shall meet the general requirements of IS: 14246 and shall conform to class 3 for the durability.

Inner sheet shall fixed directly to side runners and Z spacers made 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 1.50 m center to center to hold the insulation and external sheeting.

The insulation shall be of bonded mineral wool of minimum thickness 50 mm conforming to IS : 8183, having a density of 32 kg / cu.m for glass wool & 48 kg /cu.m for rock wool.

For roof sheeting the specification remains the same as that of side cladding except the thickness and galvanization. The minimum thickness of roof sheeting shall be 0.8mm with galvanized rate of 275 gm/sqm.

Prefabricated sandwiched polyurethane PUF panel system may also be used for side cladding and roof sheeting.

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Permanent colour coated (non-insulated) metal cladding system

Troughed zinc aluminum alloy coated not less than 150 gm/sq.m M.S sheets having 0.6 mm minimum thickness (or High tensile steel sheet of 0.5 mm 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. For roof sheeting the specification remains the same as that of side cladding except the thickness and galvanization. The minimum thickness of roof sheeting shall be 0.8mm with galvanized rate of 275 gm/sq.m.

Flashings, 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.

5.3.3 Design Criteria - Plumbing and Sanitary Works

a. Water Supply

Materials

- Water supply pipes shall be composite pipes of food grade quality
- Isolation valve (up to 50 mm) shall be of gun metal conforming to IS: 778 (Class II).

Valve pits for gunmetal valve shall be in brick construction.

System

- A water supply connection shall be made from nearby potable water main and the size of the same shall be decided based on fixture units.

Fixture unit value for peak discharge

Type of Fixture	Fixture Unit Value
1 Water closet	1
1 Bath	1/2
1 Wash Basin	1/2
1 Kitchen sink	1/2
1 Urinal	1/2

Fixture unit value = 9 liters/min.

Before entering the building, an isolation valve shall be provided on water supply line.

Flushing Tanks

- Provision of flushing tanks for each toilet shall be made having following storage capacities.

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Fixture	Storage Capacity (Litres)

Per WC	15

Per Urinal	5

b. Sanitary Fixtures

Each toilet block shall have the following minimum sanitary fittings/facilities shall be of approved brand of the following sizes and specification. All fittings shall be of chromium plated brass (fancy type) unless specified.

Indian Water Closet (IWC)	-	Orissa pan of size 580 mm conforming to IS: 2556.
European Water Closet (EWC)	-	Conforming to IS: 2556 with plastic seats and low level
PVC Cistern of 15 litres capacity.		
Urinals	-	Flat back half shell of size 610 mm x 410 mm x 380 mm including a pair of 250 mm x 125 mm white ceramic foot rest and shall be without photovoltaic control flushing system
Wash basin	-	550 mm x 400 mm conforming to IS: 2556 with chromium plated bottle trap.
Mirror	-	600 mm x 450 mm x 6 mm beveled edge mirror
Glass shelve	-	600 mm x 127 mm x 4 mm with chromium plated brackets.
Towel Rail	-	Stainless steel 600x20 mm.
Toilet paper holder shall be provided for each European closet		
Soap Holder	-	Stainless steel liquid soap holder cum dispenser

Janitor room

Provision of installation of water cooler outside the toilet

Provision of ventilation shaft.

c. Sewerage

Materials

- All horizontal buried soil and waste pipes shall be of stoneware or PVC, socket and spigot and shall conform to relevant IS.
- All vertical soil, waste and vent pipes shall be of PVC conforming to relevant IS.
- Manholes and gully trap chambers shall be in brick construction.

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System

- The system shall be designed on the principle of "TWO PIPE SYSTEM" having two separate vertical pipes namely Main Soil Pipe (MSP) and Main waste Pipe (MWP) receiving waste from number of Branch Soil Pipes (BSP) and Branch Waste Pipes (BWP)
- A BSP either shall have only one WC. to be connected to MSP or it shall receive discharge from number of urinals to be connected to MSP.
- A BWP shall receive waste from wash basins, baths, sinks, cooler areas, etc.
- Floor traps shall be provided to receive waste from waste pipes of various fixtures (except from WC. which shall be directly connected to MSP) and at locations where waste water is to be drained out.
- A MSP shall be directly connected to first manhole of an outside sewer.
- A MWP shall be discharged into first manhole through a gully trap.
- All vertical stacks and ventilating pipes shall be carried to a height of at least 1.5 meters above parapet and shall be provided with cowl on top.
- Gradient of the sewage piping shall be at least 1:200.

Sizing

The soil and waste pipe diameters shall be based on fixture units as given below:

Fixture Units for Different Sanitary Appliances

Type of Fixture	Fixture Unit Value as Load Factor
Water closet, tank-operated	4
Water closet, valve-operated	8
Urinal	4
Showers (group) per head	3
Wash basin ordinary	1
Kitchen sink, domestic	2
Floor trap	1
Drinking fountain	1/2

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Recommended Pipe Sizes for Branches and Main Vertical Pipes (STACKS)

Diameter of pipe (mm) Max. Number of Fixture Units that may be connected to

Any Horizontal fixture branch One stack of 3 stories in Height or 3 intervals

1	2	3
30	1	2
40	3	4
50	6	10
65	12	20
80	20	30
100	160	240
150	620	960

- Minimum size of BSP receiving discharge from WC. shall be 100 mm up to MSP/first manhole.
- Minimum size of BWP shall be 80 mm.
- Minimum size after gully trap up to first manhole shall be 100 mm.

Gradients

- The gradient of a horizontal branch shall be such that non-silting & non-scouring velocity is maintained.

Disposal

- Treated sewage can be used for horticulture. Treated solid wastes can be used as manure.

5.3.4 Design Criteria – Loads & Load Combinations

All structures shall be designed for the most critical combinations of dead loads, imposed loads, equipment loads, crane loads, steam piping (static & dynamic) and other piping loads, wind loads, seismic loads as per IS 1893 (**all parts**) and any other loading conditions which can occur during the design life of the facility.

Design loads shall comply with the requirements of IS: 875 & IS: 1893 as a minimum, unless more stringent requirements are specified herein. The following types of loads shall be considered in general for the analysis and design of structures and foundations.

Dead Loads (DL)

Dead loads consist of the weights of the structure complete with finishes, fixtures, partitions, wall panels and all equipment of semi-permanent nature including tanks, partitions, roofing, piping, cable trays, bus ducts etc.

Self-weight of materials may be calculated on the basis of unit weights given in IS: 875 (Part 1). The following unit weight of material shall be considered for computation of loads:

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MaterialsUnit Weight

Plain Cement Concrete	24 kN/m ³
Reinforced Cement Concrete	25 kN/m ³
Structural Steel	78.5 kN/m ³
Brick work	20 kN/m ³
Cement Plaster	21 kN/m ³
Floor finish	24 kN/m ³

Equipment loads (EQL)

Equipment causing heavy concentrated loads shall be considered separately. Loading data shall be initially estimated from suppliers' catalogues or from similar equipment supplied for other projects and the same shall be later verified based on certified manufacturer's drawing. Where both concentrated and uniform loads cannot act simultaneously, the structure shall be checked for each condition of loading separately and shall be designed for the more critical condition. The loading considered for tanks and piping shall include hydraulic test load. Crane girders and supporting columns shall be designed for vertical and lateral loads as furnished by the manufacturer. In the absence of data from manufacturer, wheel loads are estimated from crane weights and capacity of the crane and lateral loads and impact factors are arrived at based on the recommendations furnished in IS:875. Laydown areas in the turbine and generator halls shall be designed for concentrated loads resulting from storage of equipment components during erection and maintenance, and such areas shall be identified by permanent marking.

Static and dynamic loads of major equipments shall be based on the manufacturer's data of the specified equipments. However, where the uniform floor live load adequately accounts for the equipment moving weight, the weight of such equipment as a dead load shall not be considered e.g. switchgear and control room floors are usually designed for a live load that includes the equipment weight.

While arriving at seismic forces, the equipment loads should be accounted as dead loads.

All equipments, tank and piping design loading shall include hydraulic testing loads. 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 loading, anchorage and constraint effects.

Air duct loads shall include weight of insulation, duct attachments, dust accumulation loads, seismic or wind whichever is applicable and other loads as applicable.

Imposed Loads (IL)**General**

Imposed loads noted below are the general equivalent uniformly distributed loads to account for equipment/piping/cable tray/erection loads etc. and personnel movement. Where the actual loads of the equipment exceeds in specific areas due to concentration of facilities, the same shall be substituted in lieu of the above loads, in which case a nominal live load of 5 kN/m² shall be considered in the adjacent areas not covered by the equipment.

Imposed loads in different areas shall include live loads, minor equipment loads, cable trays, small pipe racks/ hangers, erection loads, operation / maintenance loads etc. The loads considered shall not be less than that specified in IS: 875 (Part II).

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The loads listed hereunder are minimum live loads for the areas involved. Special use areas shall be investigated and loads revised upward as necessary. Floors and supporting members which may be subjected to heavy equipment live loads shall be designed on the basis of the weight of equipment or specifically defined live loads, whichever is greater.

Roofs

a.	Flat Roof	:	1.5 kN/m ² for accessible roofs
		:	0.75 kN/m ² for non-accessible roofs
		:	5.0 kN/m ² for accessible roofs with HVAC equipment
b.	Sloped Roof	:	As per IS : 875

STG, GTG, Switchgear and Control Buildings

Ground floor		
- General	:	15 kN/m ²
- Unloading bay	:	Actual
- Heavy equipment storage area	:	50 kN/m ²
Cable spreader rooms	:	5 kN/m ²
Operating floor		
- General	:	15 kN/m ²
- Laydown area	:	30 kN/m ²
- Rotor removal area	:	30 kN/m ²
Switchgear floor	:	15 kN/m ²
Deaerator floor and platform around deaerator	:	10 kN/m ²
Control room	:	10 kN/m ²
Battery Rooms	:	20 kN/m ²
AHU, AC & Ventilation plant floors	:	10 kN/m ²
PLCC, relay room	:	15 kN/m ²
Platform & Stairs	:	5 kN/m ²
Other floors	:	10 kN/m ²
Chequered Plate & Grating floors (Including opening covers)	:	5 kN/ m ²
Precast concrete covers	:	12 kN/m ²

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Other Plant Buildings and Areas

Ground floor/Operating floor	:	15 kN/m ² or as required by the equipment supplier whichever is higher
Switchgear floor	:	15 kN/m ²
Stores	:	15 kN/m ²
Control Room	:	10 kN/m ²
Stairs and balconies	:	5 kN/sqm
RCC floors, laboratories. Conference rooms and other floors	:	5 kN/m ²

The above loads are applicable for slabs & secondary beams. 75% of the above load may be considered for design of columns & foundations as it is unlikely that the entire tributary area of the slab will be fully loaded at all levels at the same time.

However, for design of slabs and beams, in addition to the above loads, a live load of 2.5 kN/m² and concentrated load of 10 kN at the worst location shall be considered in Operating floor, Switchgear room & Control room to cater for hung loads due to piping and cable trays. Loads due to critical piping shall be taken at actual and checked for local effects.

A minimum UDL of 1.0 kN/sqm shall be considered as Hung loads for ventilation & air conditioning and miscellaneous piping in other floors as applicable.

For areas not covered above and for Non-plant buildings, the relevant loadings furnished in IS:875 (Part 2) shall govern.

Piping Anchor and Restraint Loads

Piping load shall be as per load plan drawings unless otherwise mentioned.

Piping anchor and restraint forces of major piping shall be obtained from piping analysis results, and be considered as live load in the structure design.

Miscellaneous

Culverts and allied structures including buried RCC Pipes shall be designed for IRC Class "AA" loading and checked for Class 'A' loading.

Covers for trenches & tunnels that are not exposed to vehicular traffic shall be designed for Live Load of adjoining areas or **10 kN/m²** whichever is higher. Where trenches / tunnels channels are likely to be exposed to vehicular traffic, the requirements of Code of Practice for Road Bridges shall be adhered to.

For design of walls of basement, trenches, channels etc. below ground, lateral pressure due to a vertical surcharge of 15 kN/m² shall be considered in addition to earth and ground water pressure etc. In case of heavy wheel loads, lateral surcharge due to actual wheel loads shall be substituted. When a portion or whole of the adjacent soil is below free water surface, computations shall be based on submerged weight of soil plus full hydrostatic pressure.

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Live Loads reduction shall be in accordance with the provisions of IS : 875 & IS : 1893.

Crane Loads (CRL)

Crane girders and supporting columns shall be designed for vertical and horizontal forces (including impact forces) as per crane vendor's data. All lifting beams and monorails shall have their design loads increased for impact factor as mentioned hereinafter.

Loads including impact factor for cranes, hoists and elevators shall be taken as per IS: 875 (Part 2).

Wind loads (WL)

Wind load shall be in accordance with IS: 875 (Part-3). The wind shall be assumed to blow in any direction and most unfavorable condition shall be considered.

The external / internal pressure co-efficient shall be as per respective clauses of IS 875 (Part-3)

In design of structures, wind force on equipments supported on frame including all fixtures, piping, staircases, ladders, handrails etc. shall also be considered.

Seismic load (SL)

Seismic loads shall be in accordance with IS1893 latest revision covering all parts, corresponding to Zone - III. The following factors as per the code shall be considered to arrive at the seismic loads.

Zone factor (Z)	-	0.16
Importance factor (I)	-	1.75 for power plant buildings
	-	(As per provisions of IS:1893, Part I & IV)
Response Reduction Factor (R)	-	As per the provisions of IS 1893.

Shear enhancement as per provisions of IS: 1893, Part IV. Seismic analysis shall be carried out by Response Spectrum method for critical structures like GTG/STG building and structures more than one storey high. Single storey buildings / structures may be analysed by equivalent static load method.

Seismic loads for structures not covered in IS: 1893-2002, shall be evaluated based on 1984 version of the code.

Dynamic increment of water pressure and earth pressure due to Seismic Loads shall be evaluated using IS: 1893: 1984 or other relevant Indian / International codes.

Temperature load

The structure will be designed to withstand stresses due to fifty percent of the total temperature variation. The total temperature variation for temperature loading should be taken as two thirds (2/3) of the average annual variation in the temperature. The average maximum annual variation for this purpose will be taken as the difference between the mean daily minimum temperature during the coldest month of the year and the mean daily maximum temperature during the hottest month of the year.

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Suitable expansion joints will be provided in the longitudinal direction wherever necessary with provision of twin columns. The maximum distance of the expansion joint will be as per provisions of IS: 800 and IS: 456 for steel and concrete structures respectively.

Earth Pressure

Earth pressure for design of underground structures shall be based on co-efficient of active earth pressure and earth pressure at rest for cantilever and propped cantilever / two way supported walls respectively.

In addition to earth pressure and ground water pressure etc a minimum surcharge load of 15kN/m² shall be considered for all underground structures including channels, sumps, cable trenches etc to take into the account the vehicular traffic in the vicinity of the structure.

Load Combinations

The individual members of the structures shall be designed for worst combination of forces such as bending moment, axial force, shear force and torsion.

Wind load and Earthquake load shall be assumed not to act simultaneously. The effect of both the forces shall be considered separately in each direction (along and across).

Some of the load combinations to be considered for the design of the main power house are given below.

1. DL + LL + EQUIP
2. DL + LL + EQUIP + Cb + CtLA + CS ± TL +CT
3. DL + LL + EQUIP + Cb +CtLB + CS ± TL+CT
4. DL + EL 1± TL +CT
5. DL + WL1± TL +CT
6. DL + WL2 ± TL +CT
7. 0.75 (DL+0.5 LL + EQUIP+Cb+Ct ±EL2) ± TL +CT
8. 0.75 (DL+ LL + EQUIP+Cb+Ct L1±(CS1 + WL1)) ± TL +CT
9. 0.75 (DL+ LL + EQUIP+Cb+Ct L1±(CS1 + WL2)) ± TL +CT

The following load combinations will be used for getting maximum tension of column base which will be used for the design of holding down bolts.

1. 0.9 DL + 0.9 EQUIP ± EL1
2. 0.9 DL + 0.9 EQUIP ± WL1
3. 0.9 DL + 0.9 EQUIP ± WL2

Notations for above loads are:

DL	-	Dead Load of structure, Floors, walls etc
LL	-	General Live Load on floors
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 with internal wind co-efficient negative
WL2	-	Wind load with internal wind co-efficient positive

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EL1	-	Earthquake load for DL only
EL2	-	Earthquake load for DL + 0.5 LL
TL	-	Temperature load
CT	-	Conductor tension load
SL1	-	Seismic Load from left to right
SL2	-	Seismic Load from right to left

Note

1. If equipment load is taken at actual, live load of 5 kN/m² only shall be considered.
2. Equipment loads shall not be considered as a part of DL for checking the stability of the structure.
3. 0.9 times DL shall be considered for checking stability.
4. Wind load and Seismic load shall be assumed not to act simultaneously. The effect of both the forces shall be considered separately in each direction (transverse and longitudinal).

For buildings with GI sheet roof on structural steel truss & open sides

DL + IL
DL + WL1
DL + WL2

Underground Structures

Following loading conditions shall be considered in addition to the loading from super structure for the design of substructure of pump house, channels, sumps, tanks, reservoirs, trenches and other underground structures.

Only liquid pressure from inside and no earth pressure & ground water pressure and surcharge pressure from outside (applicable only to structures which are liable to be filled up with water or any other liquid).

Earth pressure, surcharge pressure and ground water pressure from outside and no water or liquid pressure from inside.

Base slab of the sump shall be designed for the condition of different combinations of pump sumps being empty during maintenance stages with maximum ground water table. Intermediate dividing piers of pump sumps and partition walls in channel be designed considering water on one side only and the other side being empty for maintenance.

Note :

- a. Liquid pressure and surcharge load shall include Seismic effects also as applicable.
- b. The underground structures shall be checked for buoyancy due to ground water pressure during construction phase (without superstructure loads).

Loading Criteria for Pipe and Cable Rack Structures**a. Design Loads**

Loads due to self-weight of piping, insulation, valves etc. and the self-weight of structures constitute the Dead Loads. In the absence of exact loading, general uniformly distributed loading as indicated below shall be considered depending on the pipe size and spacing.

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Category	Udl	Equivalent Pipe Size
Light	1.5 kN/m ²	150 mm dia, schedule 40 @ 250 C/C
Medium	2.0 kN/m ²	200 mm dia, schedule 30 @ 300 C/C
Heavy	3.0 kN/m ²	250 mm dia, schedule 20 @ 300 C/C

Light	1.5 kN/m ²	150 mm dia, schedule 40 @ 250 C/C
Medium	2.0 kN/m ²	200 mm dia, schedule 30 @ 300 C/C
Heavy	3.0 kN/m ²	250 mm dia, schedule 20 @ 300 C/C

In case larger size pipes are supported, additional point loads shall be considered in addition to the above loads.

Cable tray loads shall be taken as 100 Kg/m per layer for 600 mm wide tray and proportionately for other sizes. Cable tray supports shall be generally provided at 1.5 m c/c.

The above loads shall be compared with actual piping and cable tray loads and highest loads shall be considered for final design.

The main beams shall be designed to cater for 100% of UDL indicated above, unless intermediate beams are provided, in which case, the load on the main beam can be reduced by 20%.

The intermediate beams and longitudinal beams shall be designed for 25% of UDL, provided pipes are supported only on main beams. In addition the longitudinal beam shall be designed for the reaction from the intermediate beam and concentrated load due to branch / loop pipe above 200 mm dia supported on them.

Unless otherwise specified, friction/temperature loads, shall be taken as 15% of the vertical load and assumed to act on the main beams as UDL, in a direction parallel to the pipes, and perpendicular to the pipes as concentrated load applied at the beam level. Both transverse and longitudinal friction shall be considered together.

Anchor forces shall be as per piping layout and pipe stress analysis. All anchors shall be located on the main transverse beams only.

Wind force acting on the rack frames shall be estimated based on the wind pressure arrived at from the design wind speed and force coefficients for windward frame and shielded frame respectively.

b. Load Combinations

The following load combinations shall be considered for Pipe Racks

DL ± FL ± AL
DL ± FL ± AL ± WL
DL ± WL

Where,

DL = Dead Load
FL = Friction Load
AL = Anchor Load

In case Seismic Load (SL) is governing, WL shall be substituted with SL in the above combinations.

Increase in Allowable Stresses

Appropriate increase in allowable stresses as per applicable IS Codes shall be considered under wind / seismic loading if design is carried out by Elastic/Working Stress method. If Limit State method of design is used, partial safety factors/load factors shall be applied to the loads as per relevant IS Codes.

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5.3.5 Design Criteria - Reinforced Concrete Structures and Foundations

General

All structures, building foundations, machines / equipment foundations, water retaining structures, trenches, pits etc. shall be designed as per relevant IS Codes in general.

All designs of RCC structures shall be carried out by limit state method as per IS: 456 unless use of working stress method is specifically mentioned. 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. For reinforcement detailing IS: 5525 and SP: 34 shall be followed.

Water Retaining structures shall be designed as uncracked sections by working stress method as per IS : 3370. The walls of liquid retaining structures shall be provided with reinforcement on both faces for sections 200 mm or more, even if not required from design consideration.

Increase in Stresses

Where stresses due to wind (or seismic) are combined with those due to other loads, the allowable stresses in concrete and reinforcement steel may be increased by 33.33% in case of working stress design.

Where the bearing pressure on soil due to wind load alone is less than 25% of that due to dead load and imposed load, it may be neglected in design. Where this exceeds 25%, foundation may be so proportioned that the pressure due to combine effect of dead load, imposed load and wind load does not exceed the allowable bearing pressure by more than 25%. When seismic loads are included, the permissible increase in allowable bearing pressure shall be as per IS: 1893. No increase in allowable stress is allowed when DL is alone is combined with wind/seismic load.

Appropriate increase in allowable stresses as per applicable IS Codes shall be considered under wind / seismic loading if design is carried out by Elastic/Working Stress method. If Limit State method of design is used, partial safety factors/load factors shall be applied to the loads as per relevant IS Codes. The above references are only guide lines and not limiting criteria.

Foundation

a. General

The foundation type and depth shall be decided based on the final soil investigation to be carried out by the EPC Contractor and recommendations based on the same. Minimum depth of foundation shall be 1500 mm below the natural ground level.

Settlement criteria for shallow foundations shall be generally as follows, or more stringent as per specific equipment requirement & differential settlement criteria.

- 25 mm for plant buildings and structures.
- 40 mm for non-plant buildings and structures.
- 150 mm for steel storage tank foundations (floating roof)
- 200 mm for steel storage tank foundations (fixed roof)

Settlement criteria for pile foundation shall be as per IS: 2911.

75 mm thick lean concrete 1:4:8 shall be provided below footings, base slab etc. as mud mat. For water retaining structures mud mat shall be of mix. 1:3:6 and minimum 100 mm in thickness.

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The Factors of safety for stability of foundation and underground structures shall be as per IS: 456 & IS: 3370.

Additional depth of excavation shall be filled up with PCC 1:5:10.

Piles shall be checked for vertical and lateral loads. Vertical load capacity shall be calculated based on soil bearing capacity (as per IS: 2911) and structural capacity. Lateral capacity shall be evaluated based on horizontal sub-grade reaction approach as per IS: 2911. Structural design of pile shall consider the worst loading (minimum vertical load and maximum moment due to design lateral loads or maximum vertical load capacity combined with maximum moment capacity). Structural load capacity of piles shall be evaluated based on limit state method. The structural capacity shall be calculated for working as well as test piles (load factor for test pile shall be equal to the ratio of test load to design load).

b. Foundations for Vibrating Machinery

Design of foundations for vibratory Equipment such as GTG, STG, Boiler feed pumps etc. shall be done in accordance with IS:2974 and they shall be isolated from other foundations for vibration control. To avoid resonance, natural frequencies of the foundations shall be kept at least 20% away from the operating frequency and amplitudes shall be kept within the allowable limits specified by the respective equipment manufacturer or in absence of manufacturer's specified value, as specified in the IS Codes/DIN Codes.

The design of machine / equipment foundation shall be as per IS: 456 and IS : 2974.

All block foundations resting on soil shall be analysed considering dynamic properties of soil. The mass of the RCC block shall not be less than the three times the mass of the machine. Dynamic analysis shall 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 by the relevant codes and / or machine manufacturers shall be satisfied. Minimum reinforcement shall be governed by IS: 2974 and IS : 456.

For the foundations supporting minor equipments 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. However, if such minor equipment is to be supported on building structures, floors etc. suitable vibration isolation shall be provided by means of springs, neoprene pads etc. and such vibration isolation system shall be designed suitably.

All such foundations shall be separated from adjoining part of building and other foundations. Joints at floor / slab shall be suitably sealed. All appendages to such foundations shall be reinforced suitably to ensure integral action.

c. Foundation for Chimney

The stability of the foundation as a whole shall be investigated and weight of foundation shall be so proportioned that the least resisting moment shall be not less than 1.5 times the maximum overturning moment due to dead load and wind load / seismic load in shell alone case and 2.0 for the completed chimney. Foundation shall be in the form of rigid mat.

No increase in bearing capacity or in stress shall be allowed for wind loads.

No Loss of contact shall be allowed for the foundation raft for any of the load combinations.

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Concrete

For structural concrete items, Cement to be used shall be either Portland slag cement with minimum 50 % slag or Portland pozzolana cement since the site is exposed to severe environmental condition due to marine environment,

Additionally if the detailed soil investigation calls for more severe protection, the same shall be considered for construction.

In case of any contradiction between the provisions of cement with any other clause, the requirement specified here in clause no 5.3.5 shall govern.

All structural concrete shall be made dense and nonporous with water cement ratio not exceeding 0.45. Plasticizers shall be used, if required, to maintain the required slump.

The following minimum grades of concrete as per IS: 456 shall be adopted for the type of structures noted against each.

- M20 - Base plate encasement, paving including plinth protection, encasement of structural steel etc.
- M20 - Grade slab, drain, pipe trenches, cable trenches, culverts, roads,
- M25 - All RCC members except where other grades are specified.
- M30 - For GTG, STG, Chimney foundations
- M30 - Piles
- M30 - Precast concrete
- 1:3:6 - Mud mat below tank foundations
- 1:4:8 - Plain Concrete Footing, base slab of drains.
- 1:5:10 - Fill concrete.

However requirement of table 4 & 5 of IS 456 shall be satisfied depending on the exposure condition. As per IS 456, the environmental exposure condition of "severe" shall be considered for design condition.

However requirements as per design mix shall be finally followed for the construction.

Intermixing of grades of concrete in the same structure shall not be allowed in a particular structural element.

All precast slabs for trenches shall be provided with MS edge protection angles on all sides with minimum size as 50x50x6 mm.

The RCC trench edge shall be provided with suitable MS angle for protection. All concrete edges shall be protected with MS angle of size 65x65x6 mm minimum with MS lugs of size 25x6 mm.

Underground structure painting: Irrespective of soil report recommendations, for concrete substructures two coats of ERPB (Epoxide resin based anticorrosive and chemical resistant paint) over a coat of CPCI (concrete penetrating bipolar corrosion inhibitor) shall be applied with 300 to

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325 micron DFT for protection of concrete against carbonation & chloride penetration in saline/marine environment.

IP Net coating system will be applied to the external surfaces of columns, beams, fan deck slabs and all other exposed concrete structure. The total DFT of 370 microns will be applied as per manufactures instructions

Reinforcements

TMT/High Yield Strength Deformed steel bars of grade Fe-500 bars conforming to IS-1786. painted with fusion bonded epoxy coating as per IS: 13620 shall be used for reinforcement. Binding wire shall be PVC coated binding wire.

Minimum Thickness of Structural Elements

The following minimum thickness shall be followed:

a.	Suspended floor slab / roof slab / walkways / Canopy slabs etc.	-	125 mm
b.	Ground floor slab (non - suspended)	-	150 mm
c.	Water Retaining Slab / Walls	-	200 mm
d.	Cable / Pipe Trenches / Underground pit / Launder walls and base slab	-	150 mm
e.	All footings (including raft foundations)	-	300 mm
f.	Tapered footings	-	150 mm (Min. at edges)
g.	Parapets / Chajjas	-	125 mm
h.	Precast louvers / fins	-	50 mm
i.	Precast trench cover slabs / floor slabs	-	75 mm
	Louvers		
j.	Precast beams	-	150 mm
k.	Paving	-	150 mm
l.	Basement walls and base slab	-	150 mm
m.	Pilecaps	-	300 mm

Minimum Cover to Reinforcement

Clear cover to reinforcement shall be as follows:

	Top (mm)	Bottom (mm)	Sides (mm)
Footings (Raft and Isolated)	50	75	50
Pile caps	50	100	50
Grade beam	40	40	40
Grade slab	25	25	25
Columns & Pedestals	50	-	50
Beams above ground level	35	35	35
Lintel beams (Size < 300 x 300)	25	25	25
Block foundation including			
GTG/STG foundation	50	100	50
Slabs & staircases	25	25	25
Cable trenches			
Base slab	20	35	35
Roof slab	15	35	35
Walls	20	35	35

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Liquid retaining Structures

Base raft	40	40	40
Side Walls (Water face)	30	-	30
Side Walls (Soil face)	50	-	50
Precast Units	15	25	20
Surface Drains (Base slab and walls)	25	25	25

Minimum Cover for Foundation Bolts, Base Plates and Pockets

- Clear distance from the edge of the base plate / base frame to the outer edge of the pedestal shall be minimum 50 mm.
- Clear distance from the face of pocket to the outer edge of the pedestal / foundation shall be 75 mm.
- Clear distance from the edge of the sleeve or anchor plate to the edge of pedestal shall be 75 mm.

Minimum Heights for Pedestals of Steel Columns**Pedestals to Steel columns for building structures**

Top of RCC foundations (pedestals) shall normally be kept at a height of 300 mm above the floor level.

Other Pedestals and Foundations

- Stair and ladder pedestal - 200 mm above the finished floor level
- Equipment in open area - as required (300 mm min.)
- Equipment in covered area - as required (150 mm min.)
- Structures / equipment supplied by vendors - as per vendor's data subject to minimum as specified above

In case the top of pedestal is kept at a lower level so that the column base plates together with gussets and stiffeners remain below finished floor level (FFL), the column bases as well as column sections shall be encased in concrete above FFL as per following:

- Open area - 300 mm above FPL/FGL, whichever is higher.
- Covered area - 150 mm above the finish floor level

FPL = Finished Paved Level

FGL = Finished Grade Level

Grouting

Cement mortar (1:1 or 1:2) grout with non-shrink additive shall be used for grouting below base plate of columns. For grouting of base of machine foundation, high strength ready mixed non shrink grout of approved brand (approved by OEM and Owner/Owner's representative) shall be used.

Crushing strength of the grout shall generally be one grade higher than the base concrete. Minimum grade of grout shall be M30.

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Nominal thickness of grouting shall be at least 50 mm for building columns and pedestals of major equipments. For secondary posts, stair and ladder base etc. grouting shall not be less than 25 mm thick.

Deflection Criteria

The following deflection criteria shall be considered in sizing of structures as per IS: 456.

- The final deflection due to all loads including effects of temperature, creep, and shrinkage, measured from as cast level of the supports of floors, roofs & all other horizontal members shall not exceed span/250.
- The deflection including effects of temperature, creep & shrinkage occurring after erection of partitions and the application of finishes shall not exceed span/350 or 20mm whichever is less.

Under transient wind load the lateral sway at the top should not exceed $H/500$, where H is the total height of the building.

The maximum horizontal relative displacement due to seismic forces between two successive floors shall not exceed 0.004 times the difference in level between these floors.

Water Retaining Structures / Basements

Water Retaining structures shall be designed as uncracked sections by working stress method as per IS: 3370.

Dry basements for which external water proofing is not provided and subjected to ground water pressure from outside may be designed in accordance with the recommendations of IS:456. Crack width shall be restricted to 0.1 mm.

Minimum thickness of structural elements for water retaining structure with two layers of reinforcement shall be 200 mm.

All construction joints in underground structures will be provided with 250 mm wide, 8 mm thick PVC water stop of approved make.

CW Pump House and Forebay

The dimensions of the Pump house shall be decided by the Bidder based on Equipment Layout considerations.

Forebay walls shall be designed as counterfort retaining walls. Forebay base shall be provided with pressure relief valves to prevent uplift due to buoyancy effects. The pump house and forebay have to be investigated for necessary factor of safety against uplift during various stages of construction.

5.3.6 Design Criteria - Steel Structures

Framing

All steel framed structures shall generally be of rigid frame in the generally transverse direction and braced frame in the longitudinal direction with bracing confined to selected bays.

Lateral forces shall be resisted by stiff jointed moment connections in rigid frame design. The column bases shall generally be fixed to concrete pedestal / column by providing moment resistant base detail.

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Design Methodology

The design of steel structures shall be done by working stress method in accordance with the provisions of IS : 800 and other relevant IS codes as applicable to specific structures.

Crane gantry girders shall be a rolled section with flange plate and or welded construction with bearing and intermediate stiffeners. Crane girder shall be designed as simply supported and of single span length.

Permissible stresses for different members shall be allowed to exceed by 33-1/3% under wind and seismic conditions. However, permissible stresses in bolts and welds shall be allowed to exceed up to 25% only.

For design which requires the use of the minimum column load (such as, uplift on anchor bolts, column axial tension etc.) 90% of Dead Load along with uplift forces if applicable shall be considered.

Base plates shall be placed on foundation pedestal with grouting. For large base plates necessary grout holes shall be provided. Generally anchor bolts for fastening steel columns on foundation shall be embedded in foundation during concreting itself using suitable templates for correct positioning. No anchor pockets in foundation shall be allowed for anchor bolts in tension. Design of base plates shall be based on design pressure on foundation, which shall not exceed the appropriate bearing values given in IS: 456.

The total horizontal shear force at the base of column is transferred to the column pedestals through friction between the base plate and the grout. A co-efficient of friction of 0.30 shall be used in conjunction with the minimum column load, as defined above. If the horizontal shear force exceeds the frictional resistance force shear may be transmitted through bolts or shear keys. If the column is subjected to a net uplift load, the total force shall then be transmitted through shear bars / shear keys welded to the base plate. Necessary recesses shall be kept in the foundation concrete for shear lugs.

Minimum height of the encasing of structural columns shall be 300 mm to 500 mm.

Angle sections shall not be used as flexural members except for roof trusses, purlins, side girts and walkway runners.

For axially loaded members in framework, minimum angle section to be used shall be ISA 50x 50 x 6.

End connections for rolled beams, built-up beams etc. shall be designed for a minimum of 75% of their shear capacity and 100% of moment capacity (for moment connection).

Moments shall be considered for design of columns arising due to eccentricity of floor beam connections with column. Minimum eccentricities on column shall be considered as per IS: 800.

For edge protection around cutouts / openings in floor slabs. Minimum angle section to be used shall be ISA 50 x 50 x 6 with suitable anchor lugs.

Toe guards shall have a minimum depth of 100 mm and a minimum thickness of 6 mm.

Hand railing shall be of hot dip galvanized construction out of 40 mm NB pipes of medium class conforming to IS: 1161 with threaded ends and necessary bends, tees, elbows, sockets etc. Hand railing shall be 1000 mm high with two horizontal rails one at 500 mm and another at 1000 mm above the base level along with vertical posts spaced at not more than 1500 mm centres.

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Where floor beams form part of the vertical bracing system, additional loads from floor beams transferred to bracing shall be taken into consideration in the design.

Minimum width of steel staircase shall be 1000 mm. Minimum width of treads without nosing shall be 250 mm. Maximum height of riser shall be 200 mm and they shall be limited to 16 per flight. Staircases shall be provided with hand railing. Staircase step shall be made out of chequered plate or gratings of presswelded construction designed for a live load of 500 Kg/Sqm.

For any structural steel member, a minimum of 2 nos. 16 mm dia black bolts shall be used for permanent bolted connection and 1 no. 16 mm dia erection bolt for site welded connections.

All foundations bolts shall be provided with one nut and one locknut.

Base plate arrangements of all structural steel columns in buildings shall be so provided that the entire base assembly is below finished floor level. The base plate assembly shall be suitably encased in RCC. For open structures, base plate shall be rest on RCC pedestals, which are 300 mm above finished ground level.

All grouting work below stanchions / bases of equipment shall be with, branded premixed non-shrink free flow grout of approved manufacture which shall have a minimum crushing strength of 450 Kg/cm.Sq. at 28 days.

Minimum thickness of color coated GI sheets to be provided as roofing and cladding shall be 0.5 mm Minimum slope of color coated GI sheet roofs shall be 10 degrees.

Materials

Structural steel shall conform to IS : 2062.

Chequered plates shall conform to IS : 3502. Pipes for handrail shall be as per medium grade of IS: 1161. Crane rails and transformer track rails shall conform to IS: 3443.

Connections

Generally all shop and field connections shall be welded except for field connections. All moment connections, if bolted shall be of High strength friction grip bolts. Shear and other minor connections, if bolted may be made with mild Steel / High strength bearing bolts.

IS: 816 and IS: 9595 shall be followed for welding of structures. Electrodes of approved makes shall be used.

For high strength friction grip (HSFG) bolt connections, IS: 4000 shall be followed. High strength friction grip bolts shall be of property class 8.8 and shall conform to IS: 3757 and shall not be less than 20 mm in diameter. High strength bolts shall be installed as bearing type joint except where loads are reversible.

All other (other than HSFG) bolted connections shall have bolts of minimum 16 mm dia. The connections of stairs and hand railing shall be made with 16 mm diameter threaded fasteners conforming to IS: 1363. Erection bolts shall be black bolts of minimum 16 mm dia.

All bolts and nuts have property class compatible to each other. Bolts carrying dynamic or fluctuating loads and those in direct tension shall be provided with an additional double coil helical spring washer conforming to IS: 6755.

Where a steel beam or member is to be connected on RCC structure, it shall be connected using an insert plate and preferably through shear connection.

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For crane girders, full penetration of weld between web plate and top flange shall be ensured.

The working point of the bracing connection shall be the centre of column and girder to which it connects, where practical. The connections of gusset plates to column and girders shall be made to include provisions for eccentricity in connection. The double angle back-to-back with gusset plates in between shall not be used in dust-laden areas. Where double angles are not adequate, beam sections with web in the plane of bracing are to be used.

Horizontal bracings shall be angle / tee section located at the bottom of framing beams. Field welding of bracing at the underside of beam as required to meet slenderness requirement of bracing member shall be indicated on the drawings. Horizontal bracing shall be arranged to avoid framing into the beams at columns locations.

Intermittent welding shall not be permitted.

Permissible Deflections

The permissible deflection 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 loads are acting concurrent with normal loading conditions.

Vertical Deflection

Beam and Girders : Span / 325 or 20 mm whichever is lesser.

For crane gantries or any member subjected to working 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 EOT Cranes < 50T : Span / 750

For EOT Cranes > 50T : Span / 1000

Horizontal deflections

Columns : 1/325 of height

Crane Supporting Columns : 1/1000 of height for horizontal surge load.

The maximum horizontal relative displacement due to seismic forces between two successive floors shall not exceed 0.004 times the difference in level between these floors.

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 marked corrosive environment shall be increased suitably in thickness or suitably protected otherwise as per good practice and sound engineering judgment in each instance.

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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	:	5 mm
h.	Minimum thickness of structural members, other than gratings and chequered plate, directly exposed to weather and inaccessible for painting and maintenance shall be	:	8 mm.

Minimum sizes

The flange width of purlins 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 50 mm.

Slenderness and Depth Ratio

The slenderness ratio of main members in tension, compression or bending shall be in accordance with IS : 800.

The following limiting ratios of depth to span shall be considered as general guide.

a.	Truss	1/10
b.	Rolled beams and girders for ordinary floors and rafters	1/24
c.	Supporting floor beams for vibrating machinery / equipments	1/15
d.	Roof purlins and girts	1/45
e.	Gable columns	1/30

Painting and Corrosion Protection Measures

Structural steel shall be painted after sand blasting as per specification.

For galvanised structures, rate of zinc coating shall be not less than 0.710 kg/m², unless mentioned otherwise.

5.3.7 Design Criteria for Chimney

General

The Steel Chimney shall be designed for all loads including the weight of chimney, accessories, temperature and wind or earthquake. Due consideration shall be given to loadings during the construction/erection phase and accounted for in the design.

Dead Load

All permanent loads due to the weight of chimney shell, platforms, ladders, flue ducts and other accessories.

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Imposed Load

Imposed load on service platforms around chimney shall be taken as 300 kg/m². Design live load during construction/erection shall be computed as per actual condition.

Imposed loads from the duct joining the chimney.

Wind Load

The wind loading shall conform to IS-875, Part III - 1987. Dynamic analysis shall be carried out as per relevant standards and stability ensured under such condition. If two or more chimneys are spaced at less than 20 times the diameter of bigger chimney at 2/3 of their height or when the chimney is located close to other structure of comparable height, special consideration shall be taken into account for carrying out wind loading analysis due to aerodynamic interference.

Earthquake Load

Earthquake forces acting on the chimney and analysis for the same shall be carried out as per IS-1893. The horizontal design seismic coefficient shall be worked out by response spectra method as per IS-1893 with an Importance Factor of 1.75.

Thermal Effect

Effect of temperature stresses due to flue gas temperature shall be considered.

Local Loads

The effect of following local loads shall also be considered.

- Local moment due to platform.
- Local buckling of shell (For steel chimney).

Load Combination

Chimney shall be designed for the most unfavorable load combination during construction, operation and shut down conditions. Various load combinations for calculation of stresses shall be as under.

- a) Dead load + Wind load.
- b) Dead load + Earthquake load.
- c) Dead load + Load due to lining + Imposed load on service platforms + Wind load.
- d) Dead load + Load due to lining + Imposed load on service platform + Earthquake load.

The thickness of lining shall not be assumed to increase the section modulus of the shell nor to resist overturning due to lateral bending action or strutting action from wind/seismic forces for stability checking.

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Design and Detailing Requirements

Design and construction of various components and systems of the chimney shall be in accordance with the relevant Indian Standards. For provisions not covered in the Indian Standards, reference shall be made to.

Latest editions (except as specified) of Indian and/or other international standards shall be followed for design. Some of the relevant available codes are listed hereunder.

IS: 6533	Code of Practice for Design and Construction of Steel Chimneys
IS: 800	Code of practice for use of structural steel in general building construction
ICAO	International Civil Aviation Organisation (ICAO).
DGCA	Instructions of Director General of Civil Aviation, India.
BS: 4076	Specifications for steel chimneys
CICIND	Model code for concrete chimneys
ASCE	Design and Construction of steel chimney liners prepared by Task Document committee on steel chimney liners. Fossil power committee (Power division published by ASCE-1975).

In case of any conflict between this document and the Indian and international standards, the stipulations of this document shall prevail.

Imposed loading for design of all chimney components shall not be less than 5 KN/Sq.m

The chimney and its components shall be designed to resist the most severe forces resulting from all the possible combinations of the various loadings.

All design calculations shall be submitted to the Owner/Owner's representative for approval, and construction work shall commence only after the design has been approved.

5.3.8 Design Criteria – Outdoor Facilities

Roads

All roads shall be well designed Bitumen Roads. Berms shall be minimum 1m wide and elevated 300 mm above grade level (FGL). Red murrum, minimum 150 mm thick shall be provided for berms. Approach roads to the plant site shall be provided to access from existing road network. Roads as required for plant operation & maintenance inside the proposed plant boundary shall be provided. The layout concept of roads is shown in plot plan. The peripheral roads along the Compound wall shall be of single lane.

The crown of the road shall be minimum 150 mm above FGL. The final finished roads shall have a camber of 1 in 60. Camber on top of compacted crushed stone soling surface shall be 1 in 40.

Wherever drains or other underground facilities cross the roads, concrete pipe culverts of class NP3 or RCC box culverts shall be provided. All culverts carrying storm water shall be cast-in –situ RCC box culverts.

Roads shall be provided with kerb stones and the same shall be painted as per specifications.

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The minimum recommended road section is as follows :

Sub-base : A layer 300 mm thick coarse sand liner sub-base. Sub base shall consist of stones of 150 mm maximum size in two layers compacted to a thickness of 230 mm.

Base : 2 layers of Water Bound Macadam (WBM) each 83 mm thick rolled to 150 mm depth.

Finish
Semi-grout : 75 mm thick
Premix carpet : 50 mm thick
Seal coat : 25 mm thick
(coarse sand and binder)

(All thickness are compacted thickness)

Initially only water bound macadam surface shall be constructed and after completion of the project but before COD, the damaged portions of the road shall be repaired and the bitumen topping shall be carried out.

The thickness given above is the minimum requirement and it shall be checked and confirmed by the Contractor as per design requirements based on CBR value of the subgrade. All roads should designed in accordance with IRC 37-2001 for a traffic intensity of 1500 vehicles per day.

Drainage

Surface drainage system shall be designed based on maximum rainfall intensity (meteorology report of proposed site area) or 100 mm/hr whichever is maximum. Run-off coefficients for paved areas and unpaved areas shall be assumed to be 0.9 and 0.6 respectively.

A network of open drains shall be provided to carry surface run off which would run along the sides of roads and lead to the nearest natural drain surrounding the plot.

Buildings shall be provided with plinth protection all around, sloped towards side drains. Garland drains shall be provided around all buildings to receive the drainage water from roof and floor connected to the main drains on either side of the roads. 160 mm down take pipes shall be provided for the buildings to carry rain water from roof.

For pipe drains, concrete pipe of class NP2 conforming to IS: 458 shall be used. However for road crossing, class NP3 pipe shall be used. If sufficient clearance cannot be provided between the top of pipe and road top, the pipes shall be encased in RCC.

The maximum velocity of drain shall be limited to 2.4m /sec and 1.8m /sec for pipe drains and open drains respectively. However a minimum self-cleansing velocity shall not be less than 0.6m/sec.

For process drains, catch pits shall be provided at the source locations and they shall be interconnected by buried RCC pipelines and connected to oily water system.

No bends and branches shall be allowed in underground pipes. Where change of direction and/or branches are required manholes shall be provided. Distance between Manholes shall not exceed 30m.

Acid cleaning water shall not be discharged into the storm water drains.

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Interconnection of the drains to the existing system shall be planned at applicable locations

Sewerage System

The sanitary sewage system shall be conveyed through underground pipelines by gravity and designed accordingly. Manholes shall be provided at all bends, intersection and in straight stretches more than 30 m long. Sanitary system within the buildings shall be provided as per standards and connected to sanitary disposal system specified elsewhere.

Sewers shall be designed for a minimum self-clearing velocity of 0.75 m / sec. Maximum velocity shall not exceed 2.4 m / sec.

Effluent treatment System

A Network of drains consisting of PVC pipes within the buildings and stoneware pipes outside (encased in concrete as required) shall be provided to convey oily water / waste water from the various buildings, transformer outlets, etc. The drains shall discharge into one or more oil water separators. The clear water from the oil water separator shall be let off into the Effluent treatment plant.

5.3.9 Design Calculations and Drawings

Detailed design calculations / design drawings shall be commenced by Contractor only after approval is obtained from the Owner/Owner's representative to the basic design criteria submitted by the Contractor. No deviation from the approved design criteria will be permitted unless specifically approved again by the Owner/Owner's representative in writing, prior to its adoption.

Civil scope drawings for structural system showing all equipment loads, cut-outs, embedment, etc. based on approved mechanical general arrangement (GA) drawings shall be submitted by the Contractor and these shall be accompanied by detailed design calculations. Drawings and design calculations submitted without prior approval of relevant mechanical GA drawings will not be considered for review.

After the approval of the Contractor's GA drawings, Owner/Owner's representative shall identify the structure for which detailed design calculations need to be submitted by the Contractor. Normally, Owner/Owner's representative shall review and approve design calculations for one typical structure / foundation of each type. However, Owner/Owner's representative reserves the right to call for design calculations for any additional structure and the Contractor shall have to submit these and obtain Owner/Owner's representative's approval. Contractor shall have to ensure that all the balance structures of the system are designed as per the approved designs of typical structures / foundation.

Designs and drawings shall be submitted sequentially in a phased manner and Contractor shall ensure that design calculations / drawings for several structures are not submitted at one time. For this purpose, design / drawing submission schedule shall be furnished by the Contractor for Owner/Owner's representative's review and approval. Owner/Owner's representative will review and furnish comments / approval to the designs and drawings, generally within a period of four weeks from the date of receipt of the same in the Owner/Owner's representative's office. Timely submission of designs / drawings to the Owner/Owner's representative for review / approval is the sole responsibility of the Contractor and postal or other delays as reasons for late / non-submission will not be entertained by the Owner/Owner's representative.

Designs and drawings submitted by the Contractor shall be thoroughly checked and approved by the Contractor's authorized engineers before submission for approval. Any unchecked / unsigned documents will not be reviewed by the Owner/Owner's representative. No claim from the Contractor

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for extension of time or extra cost on this account shall be entertained by the Owner/Owner's representative under any circumstances.

No check will be specifically carried out by the Owner/Owner's representative to verify arithmetical / numerical accuracy of the calculations, which shall remain entirely the Contractor's responsibility.

All design calculations and drawings shall be in English and shall be in SI units.

All modification suggested by the Owner/Owner's representative to meet specification requirements and sound engineering practice shall be incorporated by the Contractor at no extra cost to the Owner/Owner's representative. In this respect, the decision of the Owner/Owner's representative shall be binding on the Contractor.

Should there be a requirement for preparation of separate drawings to show enlarged details to facilitate construction / erection, then such drawings shall also be prepared by the Contractor at no extra cost.

Design drawings showing typical connections and details conforming to design assumptions shall be submitted for approval of the Owner/Owner's representative by the Contractor.

Design drawings for steel structures shall indicate structural arrangement, member size, member forces, splice location, details of base plate, anchor bolts, typical connection details, etc. so that the drawing indicates clearly all the necessary information brought out in relevant design calculations. Proposed bracing patterns shall be subject to approval by Owner/Owner's representative duly considering system requirement point of view. Changes in structural sections on approved drawings shall be got ratified with necessary supporting calculations and reason for the change.

Contractor shall note that all values / dimensions / elevations etc. without supporting break up of data adopted / assumed in his calculations / drawings shall be taken by Owner/Owner's representative to be correct unless these have been specifically indicated in the specification. Any problems later met in this regard shall be made good by the Contractor at his own cost and no extension of time on this ground shall be granted by the Owner/Owner's representative.

The designs shall clearly spell out the erection scheme for various structures envisaged by the Contractor and resulting additional loadings, if any, shall be duly accounted for. Before taking up actual erection work, detailed erection scheme proposed to be followed by the Contractor shall be submitted for Owner/Owner's representative's approval.

Approval / comments conveyed by the Owner/Owner's representative neither relieves the Contractor of his contractual obligations and his total responsibility for correctness of dimensions, materials of constructions, loadings, quantities, design details, assembly fits, performance particulars, safety and stability of the structures including foundations / appurtenances, and conformity of supplies with the statutory laws as may be applicable, nor does it limit the Owner/Owner's representative's right under this contract. No change in the approved designs / drawings shall be permitted without prior written approval of the Owner/Owner's representative.

Preparation of structural steel fabrication drawings is entirely the responsibility of the Contractor.

Detailed civil construction drawings including bar bending schedule for all concrete works shall be prepared by the Contractor and submitted to the Owner/Owner's representative for their review and approval. Construction work at site shall commence only after obtaining written approval to the drawings by the Owner/Owner's representative.

For framed structures, computer analysis shall be adopted and the computer output listing should include all input data covering the design loads and other particulars as specified. The calculations

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shall be supported by all back up documents and references including explanatory sketches and general arrangement drawings.

Computer analysis will be accepted only when the trust worthiness of the program used is established to the satisfaction of the Owner/Owner's representative.

Contractor shall submit typical hand calculations for a few important structural elements to be chosen by the Owner/Owner's representative to validate the computer programs used for the designs.

The Contractor shall submit 2 sets of final calculations/ computer output and 4 sets of drawings and soft copies of design and drawings also for Approval/Stamping by the Owner/Owner's representative and to be distributed after marking 'Approved for Construction' on each drawing. No construction shall proceed at site without 'Approved for Construction' drawings.

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5.4.0 SPECIFIC TECHNICAL REQUIREMENTS AND FUNCTIONAL REQUIREMENTS

5.4.1 Topographical / Contour Survey

Site is not graded but Earthwork in filling grading/levelling required for the construction shall be done by the Bidder. However Bidder shall carry out the same before carrying out engineering activities with no cost liability on the Owner/Owner's representative and the same shall be submitted for the approval of Owner/Owner's representative.

5.4.2 Geo-Technical Investigation

Preliminary Soil Investigation has been carried out near the Power Plant Area premises. Copy of the same is attached to the tender. This is intended to give an idea of the soil conditions prevailing at site. However, a detailed Soil Investigation shall be carried out by the Contractor to verify the data provided and to finalise the foundation concept and type of foundations for design work and the report shall be submitted to the Owner/Owner's representative for approval and the approval report shall become the basis for the design. Any variation in soil conditions and foundation parameters from those indicated in tender documents shall be incorporated in the final design without any cost or time implication. If the soil stratum requires pile foundation, the same shall be done by Bidder without any extra cost.

The investigation shall cover sufficient no. of bore holes in each area to get a longitudinal section of the soil profile, cone penetration tests and laboratory tests to obtain the engineering properties of soil including dynamic properties for areas where GTG, STG, Boiler Feed Pumps etc are to be located. Wherever the structures are to be supported on piles, the boreholes shall extend upto hard rock. The investigation and report shall be in line with the technical specification for soil investigation covered in Clause 5.5.0.

5.4.3 Fencing

The CI 6.1.3 of General Technical Specification shall be followed for the areas to be considered for fencing.

5.4.4 Site Grading

The area shall be suitably cut and filled to suit the layout requirement.

Fill if any shall normally be made up of Cohesive Non swelling material capable of being compacted upto 95% Modified Proctor density. Filling may also be made using dredged sand in which case a relative density of 85% shall be achieved. In case earth has to be borrowed from outside the plant boundary, the same shall be arranged by the Contractor himself. Earth from Swamps, marshy as well as logs, expansive type of clays, peats, organic material, material susceptible for combustion, material which will react with other material already used in work shall not be used as borrow material.

5.4.5 Roads & Paving

Roads

The details of the road network shall be in line with the plot plan with the suitable integration with the existing road layout of the Power plant. The arrangement shall be as specified in the CI 6.1.3 of General Technical Specification. For the details of the design and construction Design criteria of roads shall be considered.(refer CI 5.3.8).

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Paving

HRSG area shall be paved with RCC slab, 150 mm thick in grade M20. 230 mm thick rubble soling shall be provided below the paving. Higher thickness as per design shall be provided in areas of vehicular movement. Top of paving shall be kept 100 mm below FFL. All pavings shall be RCC, no PCC paving is allowed.

5.4.6 Pre constructional Anti termite treatment

Pre-constructional anti termite treatment shall be given to all vulnerable areas susceptible to termite attack and shall include column pits, wall trenches, foundations filling below the floors etc. as per IS : 6313 and other relevant Indian Standards.

5.4.7 Underground structures painting

Irrespective of soil report recommendations, For all concrete substructures two coats of ERPB (Epoxide resin based anticorrosive and chemical resistant paint) over a coat of CPCI (concrete penetrating bipolar corrosion inhibitor) shall be applied with 300 to 325 micron DFT for protection of concrete against carbonation & chloride penetration in saline/marine environment.

IP Net coating system will be applied to the external surfaces of columns, beams, fan deck slabs and all other exposed concrete structure. The total DFT of 370 microns will be applied as per manufactures instructions.

5.4.8 Construction Facilities

Construction Water & Power

For the provision of Construction water and Power **Clause 5.18** of “**General condition of contract**” shall be referred.

Site office and other facilities

Limited ware house and godown facility shall be given to the Contractor. However he has to make his own arrangement for additional requirements like site office, quality control laboratory, stores and other facilities in the available space. Contractor shall construct the above buildings and facilities at his own cost. Temporary construction shall be adopted so that these buildings can be demolished after commissioning of project.

Necessary temporary roads shall also be constructed by the Contractor. The quality control laboratory shall have facilities for testing all construction materials and other necessary tests to ensure field quality control.

All amenities to Contractor's workers, such as canteens, toilets, drinking water, rest places, creche shall be provided by the Contractor.

5.4.9 Architectural and Finishing Requirements

Reference shall be made to **Clause 5.3.2** for specification/thickness of the various Architectural finishes indicated below:

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Floor Finishes

Ground Floor (of all plant buildings) Switchgear rooms, Operating floors	-	Indian Patent Stone (IPS) with non-metallic hardener topping
Control room	-	Polished vitrified ceramic tiles- 600x600x10 thk
Battery room	-	Acid resistance tile flooring, dado and ceiling
Offices	-	Polished vitrified tiles of 600x600x10 thk
Toilet	-	Ceramic Tiles and skirting with 400x200x6 mm thk
Oil, Acid & Alkali- spillage areas	-	Acid / Alkali & Resistant tiles
General circulation areas like lift, Entrance area, office areas and	-	Heavy duty vitrified ceramic tiles- 600x600x10 thk
Laboratories		
RCC staircases	-	Granite-20 mm thick black colour premium quality
Non-Plant Buildings :		
Passages and lobby	-	Heavy duty vitrified ceramic tiles- 600x600x10 thk
Other Areas	-	Heavy duty vitrified ceramic tiles- 600x600x10 thk
All Pump houses, DG and compressor house	-	IPS with metallic floor hardener

False Ceiling

Control room and other office areas	-	LUXALON

Roof finishes

All Buildings	-	Polymeric membrane based waterproofing

Joinery**- Windows**

Turbine / Generator bay	-	Glazed, openable windows with aluminium frame
Control room	-	Glazed, fixed windows with aluminium frame with double glazing for outer windows and windows facing turbine bay and with single glazing for internal windows / partition
Switchgear room	-	Glazed, fixed windows with Aluminium frame
Offices	-	Glazed, openable windows with Aluminium frame

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Other buildings	-	Glazed openable / fixed windows with Aluminium frame
- Doors		
Control room	-	Fully glazed doors with aluminium frame
Offices	-	Fully glazed doors with aluminium frame
Toilets	-	Timber panelled doors with Teakwood frame and marine board panel with laminated plastic sheet on the inside face.
All other doors in Plant Buildings	-	Double plated steel doors
Fire barrier doors	-	Specially designed double plated steel doors with insulation having 2 hours fire rating.
Non plant buildings	-	Timber flush doors with teak wood frame or Fully glazed doors with Aluminium frame.
- Painting		
Structural steel	-	Primer coat- Epoxy resin based zinc phosphate of DFT 100 microns thickness
	-	Intermediate coat- Epoxy resin based paint pigmented with Titanium dioxide of DFT 100 microns thickness
	-	Top coat-epoxy paint suitably pigmented of approved color and shade with glossy finish of 75 microns thick with finishing coat of polyurethane of 25 microns thick
All steel doors/windows/ventilators	-	Epoxy based paint of 250 mm microns thickness
Timber Joinery	-	Synthetic enamel paint
All Ceiling	-	Oil bound distemper (office rooms without false ceiling)
		Acid resistant resin based Epoxy coating over two coats of DECKURDS-S manufactured by FOSROC or equivalent (Battery rooms)
		White washing (all other areas)
Internal wall surfaces :		
All areas (except following areas)	-	Epoxy based paint of 250 microns thickness
Control room/office/A/C areas	-	Acrylic Emulsion
External faces of walls equivalent	-	Apex Ultima/Exterior weather shield from ICI or equivalent

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Walls of battery room and
other acid/alkali spillage areas

- Chlorinated rubber paint
an exposed walls above Dado.
- 2100 mm high Dado of Acid / Alkali resistant tiling

Metal Cladding

STG & GTG Building
insulated metal cladding system

- Double skin permanent colour coated sandwiched

Other buildings
(Where metal claddings is Specified)

- Single skin permanent colour coated (non-
insulated) metal cladding system

A standard colour scheme for the different buildings/structures shall be prepared by the Contractor and the approval of the Owner/Owner's representative shall be obtained, before commencement of work.

5.4.10 Gas Turbine Generator (GTG) / Steam Turbine Generator (STG) Building

GTG / STG building shall be steel framed building with rigid jointed portal frames in the transverse direction and pin jointed braced frames in the longitudinal direction. TG bay shall have double skin colour coated sandwiched insulated cladding for roof and walls.

The building shall have double skin colour coated sandwiched insulated cladding for roof and walls. Walls have 230 thick brick cladding upto 1.0 metres from floor level and double skin insulated metal cladding above.

One row of continuous windows shall be provided at ground level and above crane girder. The ground floor slab shall be designed to withstand heavy vehicle movement. Suitable floor drainage arrangement with drain pits and buried pipes shall be provided and the same shall be connected to only water system.

5.4.11 Gas Turbine Foundation Steam Turbine Foundation and Other Equipment Foundations

STG Foundation

The Contractor shall choose between the following two types of foundation systems based on techno- economic considerations. The type of foundation offered shall be indicated in the bid document.

- a) Conventional framed foundation in RCC, isolated from other structures of Power House.
- b) Spring mounted foundation with inertia block supported on RCC structure isolated from the building frame.

Block type foundation may be adopted depending on the type of machine offered by the Contractor.

GTG Foundation

The Gas Turbine Generator foundation shall be a rigid mat foundation.

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The Contractor shall furnish detailed calculations containing loading data (static and dynamic), general arrangement drawings and detailed dynamic analysis (free and forced vibration analysis) for Owner/Owner's representative's approval. The model considered for analysis shall take into account pile/soil/structure interaction.

Other Equipment Foundations

Foundations for other major equipment such as HRSGs, Boiler feed pump etc. shall also be supported on piles to avoid differential settlement. Type of foundation for other equipment foundation shall be based on the recommendations of the final soil investigation report. Spring supported foundations shall be provided for low frequency machine foundations wherever the same are required from technical considerations. Dynamic analysis calculations shall be submitted for approval.

All the machine foundation structural components shall be tested for voids using Non destructive (NDT) methods as per the recommendations of IS: 13311/UPSV tests, as required by the Owner/Owner's representative.

5.4.12 Transformer Yard

Heavy Transformer foundations such as Generator Transformers, Unit auxiliary transformers / Station transformers / Inter Connecting Transformers shall be founded on piles/isolated spread footings depending on the final soil investigation report. Individual transformer foundations shall have its own pit which would cover the area of the transformer and cooler banks, so as to collect any spillage of oil or oil drainage in case of emergency. The oil pit shall be filled with granite stones of 40 mm size uniformly graded. The individual oil pits shall be connected to an oil collection pit which shall be sized to accommodate oil volume of the largest transformer connected to it, without backflow. The oil pit shall be connected to oily water drainage system. Dimensions of the discharge pipe shall consider rainfall intensity also. The water shall be discharged into the nearest drain by gravity flow or pumping.

Provision of fire protection walls shall be provided in between transformer unit for safety point of view.

Local rail track shall be provided from the nearest road for movement of the generator transformers to the foundation location. Rail track foundation shall incorporate jacking pad foundation at intersections of rail racks. Pulling hooks shall be provided at suitable locations for pulling the transformer over the rails.

The area around the transformer shall be provided with RCC grade slab with nominal reinforcement and galvanised chain link fence with fence posts and gates shall be provided. The portion of the fence covering the rail track shall be made of removable type for movement of transformer during erection /removal. Alternatively, gate with provision for locking shall be provided. For small transformers of width not exceeding 5 metres, a gate shall be provided for access of transformer. In addition a small gate, 1.2 m wide shall be provided for man entry. The gates shall have provision for locking.

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5.4.13 Local Electrical/Control Rooms

The dimensions of the buildings shall be decided by the Contractor from Equipment Layout considerations.

Local Electrical / Control rooms for DM Plant and CW pump etc. shall be of RCC construction with plastered brick cladding. Windows and doors shall be of fully glazed type with aluminium box frames. Control rooms will be air conditioned and shall have false floor (where no cable cellar is provided) and false ceiling. In electrical rooms, rolling shutters shall be provided for equipment entry. Electrical rooms and control rooms in upper floors shall have provision for lifting of panels and the equipment access door shall be suitably sized to accommodate the largest transportation module of panels. Cable trenches shall be of RCC construction and with pre-cast RCC covers, where no panels are located. Where panels are located, chequered plate cover shall be provided over the balance width not occupied by panels. Sufficient slope shall be provided in the base slab of cable trenches to drain out seepage water/floor wash water. A sump shall be provided in the deepest stretch of trench and the drains shall be sloped towards the sump. The sump shall be connected to the nearest drain by gravity flow (if possible) or by pumping. Wherever the cable trenches inside the building join with or are continuous with external yard trenches a barrier RCC wall shall be provided at the periphery of the building and pipe sleeves shall be provided in the wall for cable entry. The annular space between the pipe sleeve and the cables shall be sealed after erection of cables.

Sufficient office space and toilet facilities shall be provided for operating personnel.

5.4.14 Chimney

A single flue self supporting Steel chimney shall be provided for one HRSG. The details & heights given are tentative and contractor shall submit calculation to satisfy that provision of Pollution Control Board are met.

External ladders with safety cage for the entire height with landings at every 15m shall be provided. All exposed structural steel items shall be galvanised/painted.

The roofing panels of the platforms and risers of the staircase shall be of gratings construction 25TH. Handrails for platforms and staircase shall be of tubular construction with 40 NB medium tubes.

Painting of steel surfaces shall be carried out as per specification

Necessary aviation day warning shall be provided by way of orange & white bands as per requirement of aviation authorities.

Galvanised mild steel discrete strakes shall be provided at the top (usually 1/3rd height) if found necessary from design requirements.

The superstructure shall be supported on a foundation system with piles.

5.4.15 Water Treatment Plant

All the facilities required for the Water treatment plant like Filtration plant, DM plant shall be housed in a common facility with foundation arrangements for miscellaneous tanks, pumps etc. which are the part of the Water treatment plant. The entire area shall be suitably paved.

Acid/Alkali storage shall be separated with a kerb and the flooring shall be lined with acid / alkali resistant tiles. The drains from the exchangers and vessels discharging into the neutralisation pit

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shall be lined with acid/alkali resisting tiles. Neutralisation pit shall be designed as a water retaining structure with external polymeric membrane based water proofing and internal lining with acid / alkali resistant brick lining. The discharge from the neutralisation pit shall be pumped to Guard pond.

DM Water tanks located outside shall be supported on sand pads with ring wall. The foundation system chosen shall limit the differential settlements.

Suitable maintenance area shall be provided for the water treatment plant.

All the drains in the water treatment plant area shall be provided with FRP grating material.

5.4.16 GIS control Room

GIS Control room shall be of RCC construction with plastered brick cladding. Windows and doors shall be of fully glazed type with aluminium box frames. Control rooms will be air conditioned. In electrical rooms, rolling shutters shall be provided for equipment entry. Electrical rooms and control rooms in upper floors shall have provision for lifting of panels and the equipment access door shall be suitably sized to accommodate the largest transportation module of panels. Cable trenches shall be of RCC construction and with pre-cast RCC covers, where no panels are located. Where panels are located, chequered plate cover shall be provided over the balance width not occupied by panels. Sufficient slope shall be provided in the base slab of cable trenches to drain out seepage water/floor wash water. A sump shall be provided in the deepest stretch of trench and the drains shall be sloped towards the sump. The sump shall be connected to the nearest drain by gravity flow (if possible) or by pumping. Wherever the cable trenches inside the building join with or are continuous with external yard trenches a barrier RCC wall shall be provided at the periphery of the building and pipe sleeves shall be provided in the wall for cable entry. The annular space between the pipe sleeve and the cables shall be sealed after erection of cables.

Sufficient office space and toilet facilities shall be provided for operating personnel.

5.4.17 Pipe/Cable Racks & Trenches

Pipe / Cable Rack shall be of Steel Construction and shall be single / multi-tiered as required. The cable tray supports shall be provided above the topmost pipe tier. Minimum clearance to the lowest tier of pipe rack shall be 3.0 m in general and 9.0 m under road crossings. In between pipes below pipes shall be finished with concrete flooring.

Pipe / Cable trenches shall be of RCC Construction with precast RCC cover slabs. The trenches shall have cross slope and longitudinal slope and shall be connected to drain pits at maximum 100 metre intervals. The drain pits shall have provision for fixing mobile submersible pumps.

5.4.18 CW System

CW Pump houses shall house the cooling water pumps as well as ACW pump for GTG and STG auxiliaries. Necessary forebay and sump accommodating the coarse screen, stop-logs including the handling arrangements shall also be provided in the CW Pump house. Super structure of pump house shall be of Structural steel truss resting on RCC column. No side cladding for CW pump house.

The Mechanical Induced draft cooling tower shall be of RCC framed structure with outside protection of concrete shall be done by use of concrete penetrating silane/siloxane water repelling primer and compatible epoxy top coat with crack bridging ability. DFT of epoxy coating shall be 300 microns. Alternatively, polyurethane based paint system may be adopted with the approval of the Owner/Owner's representative.

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CW channel shall be covered with RC slabs. Precast slabs shall be given at regular intervals for purpose of inspection and maintenance.

Protection of concrete and reinforcement steel against corrosion shall be provided. This shall include use of dense and durable concrete with plasticizer cum water proofing agent, use of sulphate resistant cement, corrosion resistant steel reinforcement, etc.

5.4.19 Black start cum Emergency DG Shed

DG shed shall be of Structural steel shed supporting on RCC column with plastered brick cladding all round. Windows and doors shall be of fully glazed type with aluminium box frames. Rolling shutters shall be provided for equipment entry.

5.4.20 Compressor House cum workshop

The dimensions of the buildings shall be decided by the Contractor from Equipment Layout considerations.

Compressor house cum workshop shall be of Structural steel shed with side sheeting all round.

Rolling shutters shall be provided for equipment entry. Compressor house shall have provision for lifting of panels and the equipment access door shall be suitably sized to accommodate the largest transportation module. Cable trenches shall be of RCC construction and with pre-cast RCC covers, where no panels are located. Where panels are located, chequered plate cover shall be provided over the balance width not occupied by panels. Sufficient slope shall be provided in the base slab of cable trenches to drain out seepage water/floor wash water. A sump shall be provided in the deepest stretch of trench and the drains shall be sloped towards the sump. The sump shall be connected to the nearest drain by gravity flow (if possible) or by pumping. Wherever the cable trenches inside the building join with or are continuous with external trenches a barrier RCC wall shall be provided at the periphery of the building and pipe sleeves shall be provided in the wall for cable entry. The annular space between the pipe sleeve and the cables shall be sealed after erection of cables.

5.4.21 Misc. Plant Buildings

All miscellaneous plant buildings shall be of RCC construction with brick cladding. Glazed steel windows and steel plated doors shall be provided.

5.5.0 Standard Technical Specification for Construction

5.5.1 Soil Investigation

Scope

This specification describes the methods and procedures for soil boring, field and laboratory testing of soil samples. It also outlines the contents of the soil report.

Codes and Standards

Unless specifically mentioned otherwise, all applicable codes and standards in their latest editions as published by the Bureau of Indian Standards and all other such as may be published by them during the currency of the contract, shall govern in respect of design, workmanship and methods & procedures of testing. Some of the relevant available codes are listed here under.

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IS: 446	Presentation of drilling information and core description in foundation investigation.
IS:1498	Classification and identification of soils for general engineering purposes
IS: 1888	Method of load tests on soils
IS: 1892	Code of practice for sub-surface investigation for foundations
IS: 2131	Method of standard penetration test for soils
IS: 2132	Code of practice for thin-walled tube sampling of soils
IS: 2720	Methods of test for soils (ALL PARTS)
IS: 2809	Glossary of terms and symbols relating to soil engineering
IS: 2810	Glossary of terms and symbols relating to soil dynamics
IS: 4078	Indexing and storing of drill cores.
IS: 4968	Method of sub-surface sounding for (ALL PARTS) soils
IS: 5249	Method of test for determination of in-situ dynamic properties of soils
IS: 5529	Code of practice for in-situ permeability tests
IS: 9214	Method of determination of modules of subgrade reaction (k-value) of soils in field
IS: 10060	Code of practice for subsurface investigation for power house sites

In the event of any conflict between the requirements in the specification and the above referred codes, the former shall govern.

Equipment and Personnel

The Contractor shall ensure that all machinery, equipment, instruments, etc., mobilized by him at site are in proper working order and accurately calibrated. If necessary, the Contractor shall obtain from independent and approved testing laboratories such reports/ certification as the Owner/Owner's representative may require to satisfy himself about the reliability of the Contractor's machinery, equipment, instruments, etc. The Contractor shall ensure that the field investigation and laboratory work are performed by competent technical personnel and labour who are specifically qualified and experienced in soil investigation work.

Interpretation and recommendation shall be the direct responsibility of the experienced senior technical personnel in the Contractor's organisation.

Setting Out

The Contractor shall be responsible to perform the necessary survey work to locate the bore holes/test locations on ground and obtain the ground levels at these locations with respect to the grids and bench mark provided by the Owner/Owner's representative.

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Boring through Soil

The method and diameter of boring shall be approved by Owner/Owner's representative. Minimum diameter of bore hole shall be 150 mm. Uncased holes are permitted only up to a depth where the side can stand unsupported. In case of side fall is noticed, the holes shall be stabilized immediately by using bentonite slurry or providing casing pipes as directed by the Owner/Owner's representative.

Water shall not be added while boring above water table level. Mud circulation/bentonite slurry shall not be used in the bore holes from which water sample is to be collected for analysis.

Casing pipes, where used, shall be stopped 150 mm short of the bottom of the bore at any stage of boring, particularly before collection of undisturbed samples or before conducting Standard Penetration Tests.

Bore holes shall generally be sunk up to the hard stratum or to a depth of 25 m below the ground level whichever is earlier, unless otherwise instructed by the Owner/Owner's representative. Drilling must be continued into rock or hard stratum having SPT value more than 75 for at least two bore holes. If rock/hard stratum having SPT value more than 75 is met with at a shallower depth, it shall be ensured that it is really the rock/hard stratum by continuing the boring into the stratum by 3m. Drilling in rock shall be carried out by rotary core drilling described under Rock Drilling.

The Contractor shall send copies of daily boring records to Owner/Owner's representative at the end of each day. These records shall include the field observations with regard to visual description of soil strata, level of ground water table, drilling fluid consumption, presence of lime, mica, etc. Bore holes shall be backfilled with bentonite/mud cement grout after all samples and other information are obtained from the bore holes.

Rock Drilling

During boring operation, once the rock strata is encountered, the normal method of boring operation as described earlier shall have to be stopped and drilling operation shall be resorted to for determining depth and nature of rock strata, in a manner as described below.

Rotary core drilling technique with continuous core recovery should be adopted for drilling through rock. The behaviour of rock mass is governed more significantly by the nature of fractures in the rock than by the type and hardness of the material composing the rock itself. Hence, good drilling technique should be adopted to obtain an intact sample truly representative of the in-situ material and for achieving highest percentage of recovery possible.

Variations in the speed of rotation, the downward pressure on the core barrel, the pressure at which the drilling fluid is introduced into the hole and the length of hole drilled (run length) prior to removal of the core are major items which must be controlled by the driller. In general, coring should be initiated with short runs because the upper portions of rock masses are commonly highly fractured and also because the elevations of any core losses can be more accurately determined. If conditions indicate that it is possible, the length of the runs may be determined by the length of the core barrel.

In zones which are highly fractured or where the barrel continuously becomes blocked, it is essential that short runs be used even though this means removal of the entire string of drilling tools every 300 mm. or less. Reduced bit pressure should be resorted to when rod vibration or chatter occurs. The pressure under which the drilling fluid should be introduced into the hole shall be the minimum to be consistent with adequate removal of cuttings from the hole and proper cooling of the bit. To minimize the erosive action of the drilling fluid on the core and thereby to improve core recovery, double tube core barrels should be used. The casing and core barrel to be used shall be of designation BX or NX.

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During the drilling operation for each bore hole the Contractor shall record the rate of sinking of drill rods, ground water table elevations, if any, nature, type and sequence of rock drilled. From the recovered cores, the Contractor shall determine nature of fractures and degree of weathering of the rock for each bore hole. The Contractor shall also note and record any appreciable loss of drilling fluid throughout the entire drilling operations for each bore hole. The Contractor shall also determine the percentage recovery ratio and rock quality designation from the recovered cores for each stage of core advance and for all the bore holes.

The Contractor shall furnish all the information mentioned above fully verified and signed by the Owner/Owner's representative at site and submit them in triplicate to the Owner/Owner's representative.

The drilling operation shall be terminated either 3 metres in hard rock or 95% of core recovery whichever is later.

In addition to the above mentioned points, the Contractor shall also take into consideration the provisions of the latest revisions of the relevant BIS Codes of Practice along with Amendments, if any.

Collection of Samples

Sampling Depths

Soil samples shall be taken generally at intervals of 1.5m and each change of strata in bore holes. Disturbed and undisturbed samples, wherever possible shall be collected. All samples collected shall be suitably and uniquely labelled.

Undisturbed Soil Samples

Soil samplers shall conform to relevant Indian standards. Undisturbed samples shall be 90 mm in diameter and 450 mm long. The type of sampler shall be appropriate for the soil to be collected. The undisturbed samples need not be collected when the SPT value is greater than 50.

All care shall be exercised by the Contractor not to disturb the soil during sampling operation. The sampler shall be forced in one continuous motion, not driven, into the ground below the casing. The sample shall be shipped to the laboratory in such a manner as not to cause any disturbances to or loss of moisture from the sample. The soil sample shall not be removed from the sampler tube and the ends shall be filled with paraffin and sealed with metal/ plastic caps. The Contractor shall have, at site, adequate number of samplers at all times.

Disturbed Soil Samples

Disturbed soil samples shall be collected from thin walled samplers or split spoon samplers of SPT. The samples shall be collected in air tight jars.

Ground Water Sample

Ground water sample shall be collected from any three of the bore holes. Care shall be taken to ensure that no other extraneous water, slurry or storm water, etc., gets mixed with natural ground water in the bore hole before collection. One litre of ground water shall be collected in clean and air tight container to be sent to the laboratory for immediate testing.

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Trial Pits

Trial pits shall be of minimum 3 m. x 3 m. size at base so as to permit easy access for a visual examination of the walls of the pit and to facilitate sampling and in-situ testing operating. Precautions shall be taken to ensure the stability of pit wall, if necessary even by the provision of shoring. Arrangements shall be made for dewatering if the pit is extended below water table. In-situ tests shall be conducted and undisturbed samples obtained immediately on reaching the specified depths, so as to avoid substantial moisture changes in the subsoil.

After completion of tests and examination, the pits shall be suitably backfilled as directed by the Owner/Owner's representative. Unless specified otherwise, the excavated soil shall be used for this purpose.

Standard Penetration Test (SPT)

The equipment and procedure for Standard Penetration Test shall conform to IS: 2131. The bottom of bore hole shall be cleaned of mud slurry before conducting the Standard Penetration Test (SPT). The SPT shall be conducted generally at 1.5 m intervals and at changes of soil strata, as per IS: 2131. The blow count shall be recorded. If the blow count exceeds 75 or if the penetration is less than 25 mm per 50 blows, the test shall be stopped.

Static Cone Penetration Test

The test equipment and procedure shall meet the requirements of IS: 4968 (Part III). This test shall not be carried out on gravelly soils and for soils having SPT value greater than 50. The capacity of the equipment to be used for test shall not be less than 3.0 tonnes but preferably 10.0 tonnes. The cone resistance and cone & friction resistance shall be measured at pre-determined intervals. The rate of pushing shall be 1 cm per second. Unless otherwise specified it shall be conducted up to a depth of 25 m. If the penetration is found to be difficult at a shallower depth due to occurrence of fragment of rock or boulder the test shall be terminated and be executed at adjacent location as directed by the Owner/Owner's representative.

The results shall be prescribed in graphical form as well as in tabular form as given in Appendix-A of IS: 4968 (Part III).

The Contractor shall carefully interpret the results of boring and sounding.

Dynamic Cone Penetration Test

The test equipment and procedure shall meet the requirement of IS: 4968 (Part II). The driving shall not be done for more than 30 cm at a time after which it shall be stopped for a minute or two. Pumping shall, however, be continued. The tests shall be terminated when the blow counts exceed 35 for 100 mm. penetration when the cone is dry and 20 for 100 mm. penetration when the cone is penetrated by circulating slurry.

The results shall be reported in a suitable tabular form giving blow counts for every 30 cm. penetration supplemented by a graphical plot of blow count versus depth.

Plate Load Test

Plate load tests shall be conducted at the specified founding depth by making test pit of sufficient size as per IS: 1888. Side protection, if required, shall also be provided by the Contractor at no extra cost. The Contractor shall provide suitable access to the bottom of the pit. The load shall be applied to the plate by hydraulic jack of suitable capacity jacking against a fixed platform loaded with sand bags or heavy truss anchored in the ground. The increment of each loading shall be such that the

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ultimate load is reached in not less than ten increments. The water table level shall be noted in the nearest bore hole at the time of testing. If water table is within test zone to a depth of 3 times the width of plate, it is advisable to conduct the test at higher level.

The pit shall be backfilled with excavated earth in layers not exceeding 300 mm and well compacted.

Cyclic Plate Load Tests

The equipment and set up for cyclic plate test shall be similar to plate load test described above. The testing procedure shall be as per IS: 5249. The duration of each loading and unloading cycle shall be decided based on the type of soil under investigation. The initial loading and unloading cycles up to the safe bearing capacity of soil should be with smaller increments in load. The magnitude of load increment should be such that the ultimate load is reached in five to six increments. Based on the above test, the Contractor shall recommend the coefficient of sub- grade reaction, coefficient of elastic uniform compression.

Vane Shear Test

The test shall be conducted in soft to firm clays and sensitive clays. The test shall also be conducted in case of stiff fissured clays where samples cannot be taken. Tests may also be conducted by direct penetration from ground surface. The equipment used for vane shear tests shall be as per IS: 4434.

Straightness of vane shall be checked while the entire assembly of vane connected with the rod is being lowered to the bottom of bore holes. Samples shall be collected from the levels at which the tests have been conducted.

The results shall be reported in a suitable tabular form.

In-Situ Permeability

In-situ permeability test shall be performed in the bore holes specified or as directed by the Owner/Owner's representative for the determination of the permeability coefficient of the soil. The tests shall be conducted as per IS : 5529 (Part I) using pumping out method with piezometer installations.

Menard Pressure Meter Test

This test shall be carried out as per IS : 1892 to the full depth of bore holes, to assess the coefficient of earth pressure at rest and the stress-strain modules of soil. The tests shall be carried out at every 3.0 m. intervals.

The Contractor shall submit, for approval of the Owner/Owner's representative, detailed arrangement drawings for the tests including the detail of the equipment proposed.

Block Vibration Test

In-situ dynamic properties of the soil shall be determined by performing Block vibration tests in accordance with IS: 5249 at the location and depth indicated. A plain concrete block in concrete grade M 15 and of size 1500 x 750 x 700 mm shall be cast, at the specified founding depth for machine foundations. The test pit should be of suitable size having sufficient clearance for conducting the test. Forced vibration and free vibration tests shall be conducted. The wave propagation test for determination of shear modules shall also be conducted by exciting the block to the steady state vibrations in the vertical direction. The block shall have suitable provisions to fix the oscillator in different modes and at different frequencies. By suitable and adequate instrumentation,

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the soil responses to the excitation are measured and various dynamic properties are computed. Based on these tests, the Contractor shall recommend design values to be adopted in design. Before backfilling the pit, the concrete block shall be dismantled and disintegrated and all rubbish shall be disposed off as directed by the Owner/Owner's representative.

Electrical Resistivity

Electrical Resistivity of subsurface layers shall be determined by vertical electrical soundings by Wenner's method as indicated in IS: 1892. The spacing between the electrodes is initially kept as 0.5 metres and then gradually increased in steps of 0.5 metres up to 5.0 metres depth. Graphical representation of resistivity versus depth shall be plotted.

Laboratory Tests

All laboratory tests to assess the engineering properties of soil/rock shall be conducted by the Contractor in an approved laboratory. It is not the intent nor is it practical to specify all technical details and requirements of soil testing in the laboratory that would enable the proper evaluation of the soil parameters used in the detailed engineering stage. The Owner/Owner's representative reserves the right to direct the Contractor to perform any particular test during the course of the investigation. The Contractor shall keep furnishing preliminary copies of all test results to the Owner/Owner's representative for their review.

Soil Report

The soil report shall include but not limited to the following.

- A detailed write up on the procedures adopted in all phases of the soil investigation.
- A plan of bore hole and field test locations.
- Individual bore logs indicating various soil strata encountered their thicknesses and classifications, sampling locations, ground level, laboratory test results, SPT blow counts, ground water level and pertinent data.
- Cross section of soil profile in two perpendicular and diagonal directions and all load test curves & consolidation test curves.
- Detailed test results, laboratory observations both in tabular and graphical form and necessary extracts from technical literature used in calculation, evaluation & recommendations.
- Recommendation for type, depth, ultimate and safe bearing pressure and settlement of foundations for various structures.
- A summary of all design parameters.

The Contractor's recommendations shall include specific and definitive information on the following, supported by detailed calculations.

- a. Founding depths for various foundations as given below and corresponding safe soil bearing capacities evaluated from both strength and settlement considerations. Values obtained from field tests and laboratory tests shall be compared and suitable interpretation shall be furnished.
 - i) Heavy foundations for powerhouse building columns, boilers.
 - ii) Heavy machine foundations such Turbo generator foundation, FD fans etc.
 - iii) Foundations for smaller and larger circular storage tanks.

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- iv) Light foundations for non-plant buildings, sheds, compound wall, small pumps etc.
- b. Consolidation and settlement characteristics.
- c. Coefficient of sub grade reaction.
- d. Dynamic properties of soil.
- e. Type and capacity (vertical and lateral) of piles, if necessary, and data/ information on related aspects.
- f. Anticipated problems during foundation construction and recommended solutions.
- g. Roads, paving and grade slabs.
- h. Harmful chemical contents in soil and ground water, if any, and recommendations to protect underground structures from their harmful effects.
- i. Coefficient of earth pressure to be adopted for design of retaining structure.
- j. Specification for soil to be used for backfilling.
- k. Swelling characteristic of soil clearly indicating all swelling pressure etc.

5.5.2 Earthwork in Site Grading & Embankment

Scope

This specification covers the requirement in respect of materials, workmanship and quality for clearing, grubbing, grading, forming embankments and compacting of the areas in all kinds of soil.

Codes and Standards

Unless specifically mentioned otherwise, all applicable codes and standards in their latest editions as published by the Bureau of Indian Standards shall govern in respect of design, workmanship, quality and properties of materials and method of testing. Some of the relevant available codes are listed hereunder:

IS:2720	Method of test for soils - grain size (Part 4) analysis
IS:2720	Method of test for soils - Determination (Part 5) of limit & plastic limit
IS:2720	Method of test for soils - Determination (Part VII) of water content - dry density relation using light compaction.
IS:10379	Code of practice for field control of moisture and compaction of soils for embankment and sub grade.

Materials

Earth used for filling shall be selected earth as approved by the Owner/Owner's representative and free from organic and other objectionable matter. As far as possible excavated earth from excavation for foundations within the project area shall be used for filling. All clods of earth shall be broken or removed. Expansive soil shall not be used. The Contractor shall indicate in his offer the location of borrow areas and type of soil that he proposes to use.

Soil having plasticity index less than 20 and maximum proctor laboratory dry density more than 1.5 gm/cc shall only be used.

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Adequate dewatering facilities like dewatering pumps, pipes etc. shall also be provided by the Contractor for this work including for excavation in borrow areas at his own cost.

Initial Levels

The Contractor shall carry out the survey of the site before starting any work by taking accurate cross-section of the areas perpendicular to established grid / reference lines at 10 m interval or other intervals chosen by the Owner/Owner's representative based on the ground profile. For embankments initial levels shall be taken along the line of embankment and at right angles to the proposed alignment. These shall be checked by the Owner/Owner's representative and thereafter properly recorded.

Clearing

The area to be graded shall be cleared of plants, logs, stumps, bush vegetation, rubbish slush etc. If any roots of stumps of trees are met they shall also be removed. The material so removed shall be disposed of as directed by the Owner/Owner's representative, including burning if necessary. Trees to be cut shall be marked and the Owner/Owner's representative's approval taken before felling them. After the tree is cut and roots taken out the pot holes formed shall be filled with good earth in 250 mm layers and compacted. The tree shall be cut in suitable pieces as instructed by the Owner/Owner's representative, stacked and delivered to the Owner/Owner's representative. After the area is cleared of plants, logs, vegetation etc., the filling area shall be compacted with power roller of 8 - 10 tonne capacity to obtain 90% of maximum proctor laboratory dry density of top soil as per IS:2720 part VII, Initial level shall be taken again as described in the above clause. These initial levels shall be considered for calculation of compacted volume of fill subsequently.

Grading

The grading shall be carried out so as to obtain the levels indicated in the drawing after compaction. Generally such grading includes cutting and filling. The Contractor may employ any suitable means, mechanical, manual or a combination of both. The filled up area shall normally be filled with selected earth in layers of 250 mm (in loose condition uncompacted thickness) and compacted using rollers so as to obtain a density desired by the Owner/Owner's representative, normally minimum of 95 % of Proctor dry density for cohesive soils and 85% of Relative Density for non-cohesive soils.

When a layer of loose earth over an area has been removed during grading, the area shall be prepared by ploughing to loosen the earth before addition of soil to make up the lost earth. After the addition of soil over the ploughed area, it shall be compacted to the desired density.

Embankments

The finished formation width, side slopes and grade of the embankment shall be true to the line and level as shown on the drawings.

The embankment shall be made up in layers not exceeding 250 mm thickness (uncompacted thickness), over the whole width between the surface of the side slopes and shall be slightly concave in section so as to retain the water for water subsidence. All large clods shall be broken up.

When the embankments are on side-long ground the whole area of the embankment on slope shall be benched out or stepped so as to prevent the material from slipping.

In construction of embankment over the culverts or pipe drains care shall be taken to bring the embankment up, equally on both sides and over the top of the structure. Earth embankment shall be compacted as specified under Grading. In rock embankments, the rock filling shall be carefully packed to the depths as shown on the drawing.

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If embankments are made from borrow pits, the Contractor shall excavate the earth from borrow pits at the locations indicated on the drawings. They shall be regular in width and shape and shall be properly graded, drained and finished with neatly trimmed slopes.

Testing and Acceptance Criteria

The degree of compaction shall be as specified above or as decided by the Owner/Owner's representative as per site conditions. The actual method for measuring the compaction will be decided by the Owner/Owner's representative. The Contractor shall carry out at his own cost the required tests to prove that the soil has been compacted to the desired dry density. These tests shall be carried out at different stages of filling and also after entire fill height has been completed. Since the degree of compaction largely depends on moisture content of soil, a close watch shall be kept on it and corrections done to optimise the moisture content. Generally the moisture content shall be brought to within plus or minus 2% of optimum moisture content prior to rolling. The quality control operations shall include but not limited to the following items of work.

- i) Lines, levels and grades
 - a) Periodic surveys
 - b) Establishment of markers, boards etc.
- ii) Grading
 - a) Checking the quality of fill material
 - b) Checking moisture content of fill material
 - c) Checking degree of compaction

The Contractor has to offer inspection request on each layer and Owner/Owner's representative may take the inspection on degree of compaction if desires. If a layer fails to meet the required density, it shall be reworked or the material shall be replaced and method of compaction/equipment altered as directed by the Owner/Owner's representative to obtain the desired density.

5.5.3 Concrete Piling

Scope

This specification covers the requirement in respect of materials, installation and testing of driven cast-in-situ, bored cast-in-situ, driven precast and bored precast concrete piles.

Codes and Standards

Unless specifically mentioned otherwise, all applicable codes and standards in their latest editions (with all official amendments) as published by the Bureau of Indian Standards and all other such as may be published by them during the currency of the Contract, shall govern in respect of workmanship, quality and properties of materials and methods of testing. Some of the relevant available codes are listed hereunder:

- IS:2131 Method of standard penetration for soils
- IS:2911 Code of practice for design and construction of pile foundation.

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Materials

The materials, cement, aggregates, steel used in the work shall be as specified hereunder:

Cement Portland slag cement conforming to IS-455 with minimum 50% slag or Portland pozzolana cement conforming to IS:1489 shall be used for construction, however if detailed final Soil Investigation Report recommends for more severe cement, the same shall be used without any extra cost to Owner/Owner's representative.

Aggregate Machine crushed blue granite conforming to IS:383.

Steel TMT/High Yield Strength Deformed steel bars of grade Fe-500 bars conforming to IS-1786. painted with fusion bonded epoxy coating as per IS:13620 shall be used for reinforcement.

Water used for mixing shall be potable water conforming to IS:456.

Requirements for Precast Piles

Precast piles shall be of octagonal shape, unless otherwise specified or approved by the Owner/Owner's representative.

The casting yard shall be so arranged that piles can be lifted directly from their beds and transported to the installation point with a minimum of handling.

Piles shall be cast in one operation. The form boxes shall be robust and clean using horizontal steel shutters of suitable length. The concrete shall be vibrated with the aid of shutter/immersion vibrators. Care shall be exercised that no cement slurry is lost. All faces of the piles shall be worked to be as smooth and dense as possible, including the exposed face at the top.

The cross-sectional dimensions of the pile as cast shall not be less than the specified dimensions and shall not exceed them by more than 6 mm. Further, any face of the pile shall not deviate by more than 6 mm from a straight edge 3 m long, laid on the face. The centroid of any cross-section of the pile shall not deviate by more than 12 mm from the straight line connecting the centroids of the end faces (head and tip) of the pile, or 1/500 of pile length, whichever is the least.

Side shutters shall not be struck till after 24 hours from the time of casting or later if so instructed by the Owner/Owner's representative.

Piles shall not be moved from the beds on which they were cast until the concrete has sufficiently hardened. This period shall be a minimum of 10 days for ordinary Portland cement/Sulphate resistant Cement concrete and 7 days for rapid hardening Portland cement concrete from the time of casting. Care shall be exercised by the Contractor during such movement that the pile does not crack or chip.

Piles shall be kept continuously wet for ten days from the time of casting, but longer curing shall be done, as directed by Owner/Owner's representative, when hard driving is expected.

When piles are stacked between the period of wet curing and driving/installing, they shall be protected from rapid drying by sheltering them from the wind and direct sunlight by covering the stacks.

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All care shall be taken at all stages of transporting, lifting and handling of the piles to ensure that they are not damaged or cracked. During transport, the piles shall be supported at the appropriate lifting hooks provided for the purpose. If the piles are put down temporarily after being lifted, they shall be placed on trestles or blocks located at the lifting points.

Piles shall be provided with a coaxial cast iron or steel shoe for protecting the tip of the pile during driving, as indicated on drawing. The area of the tip of the shoe shall be such that the stress in the concrete in this part of the pile is within the safe limits.

For precast piles to be installed in pre-bored holes, a grouting pipe of appropriate diameter shall be embedded along the centre line of the pile for the entire length.

Requirements for Driven Piles

Standard helmet of cast-steel or structural steel shall be fitted on the pile head, unless a follower is required, to ensure axial alignment of the hammer and pile at instant of impact. Short hardwood dolly in one piece not thicker than the width of the pile with grains parallel to the pile axis shall be used with the helmet and shall be closely fitted inside the recess on top of the helmet. A steel band is to be pressed over the top of the dolly to prevent it from splitting. A steel plate of 25 mm minimum thickness shall be used on top of the dolly to distribute the hammer blows. The use of wood chips, small wood blocks or such other materials is prohibited. The Contractor shall note on the driving log when fresh cap block material is placed under the hammer and shall discount the measured resistance to driving immediately thereafter.

It is desirable that double acting diesel/ compressed air/steam operated hammers are used for driving the pile. Single acting hammers may be used only if permitted by the Owner/Owner's representative. The Bidder shall submit with his Bid, the details of driving equipment to be specifically deployed on this job. It shall be the responsibility of the Contractor to use the right equipment for driving. The Contractor shall satisfy the Owner/Owner's representative regarding suitability, efficiency and energy of driving equipment. The hammer blows shall always be in line with the pile axis. Drop of each and every blow shall be controlled and monitored.

The heaviest practical hammer with drop or stroke limited to the minimum shall be employed so as not to damage the pile. In any case, the weight of the hammer shall exceed 10 times the weight of 1.0 M length of the pile. Long continued driving after the pile has almost ceased to penetrate, shall be avoided. Care shall be taken not to damage the piles by overdriving. Any sudden change in the rate of penetration, which cannot be ascribed to the nature of the ground, shall be noted and its cause ascertained, if possible, before driving is continued/pile is accepted.

The Contractor under the supervision of the Owner/Owner's representative shall take temporary compression or rebound set curves on the piles during driving, as described in IS-2911. These shall be taken at a few pile penetration depths and at the final set, on the first few piles of each size and/or length. The values of (C1 + C2 + C3) thus obtained shall be used to recheck and modify if necessary the required "Set" for the safe load bearing capacity specified for the pile.

The final set of each pile shall be recorded as the penetration in millimetres per 10 blows.

Set criterion shall be mutually agreed upon on the basis of set recorded for piles for initial pile load tests, the Contractor's pile driving equipment, etc. In case of any conflict or disagreement, decision of the Owner/Owner's representative shall be binding.

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Installation of Piles

General

- Location of Piles

A plan in triplicate showing clearly the designation of piles to be installed by an identifying system shall be submitted to the Owner/Owner's representative before the installation of piling is started.

- Trial bore holes

To ascertain the founding strata, especially for precast driven piles, trial bore holes shall be carried out.

- Record of Piles

The record shall be kept by the Contractor in an approved form of the total penetration of every pile and the behaviour of each pile during driving / boring. Type of soil encountered, depth of boring/driving, depth of water table, cut-off level working level, time taken for concreting, consumption of cement, density of bentonite slurry and all other important observation shall be indicated in the standard record format. Any deviation from the designated location, alignment or load carrying capacity or any upheaval noticed only any pile during installation shall be immediately reported to the Owner/Owner's representative and adequate corrective measures taken as decided by the Owner/Owner's representative. On the completion of pile installation, pile driving / boring records together with the records of such changes or other sub-surface information that were obtained during the installation of piles shall also be submitted by the Contractor with the Owner/Owner's representative in triplicate.

Sequence of Installation

The Owner/Owner's representative shall decide the sequence of the group of piles that the Contractor should undertake for installation and Contractor shall proceed from those in the centre of the group towards those on the periphery or from one side to other.

Installation

- General

Piles shall be installed with due consideration for safety of adjacent structures, working equipment etc by a method which leaves their strength unimpaired & which develops and retains the required load bearing capacity.

- Driven cast-in-situ piles

Steel casings, shall be straight and shall have sufficient wall thickness and strength to withstand without damage, distortion etc., the handling stresses and driving stresses set up in obtaining the specified depth and set and to resist harmful distortion or buckling due to soil pressures developed during installation of pile or adjacent piles. Joints shall be welded or lock seamed. Casings and their joints shall be sufficiently tight to exclude water.

Casings shall be of such diameter as to give the specified nominal diameter of the pile. Casing lengths shall be the maximum consistent with standard practice, transport, handling and driving facilities.

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Detachable shoes shall be of cast iron or mild steel and of requisite strength of the standard sizes used with the respective steel casings and the shoe shall be coaxial with the steel casing.

In case of piles close to the existing plant & structures, the Owner/Owner's representative if necessary, may specify the fall of smaller than the standard and working hours for the rig & no extra claim shall be entertained due to these restrictions. The equipment and methods for installing piles shall be such that the loss of energy is limited to a suitable minimum.

Casings distorted from true and uniform shape, whether caused by driving or earth and water pressure, resulting in a reduction of the cross-sectional area of the pile in excess of 10% shall not be used on the work.

If there is a major variation between the depths at which adjacent foundation piles in a group meet refusal, a boring shall be made nearby to ascertain the cause of this difference. If the boring shows that the soil contains pockets of highly compressible material below the level of shorter pile, the pile shall be taken below the bottom of such layer.

Provisions of IS: 2911 (Part 1/Sec.1) shall be adopted for requirements not covered above.

- **Bored cast-in-situ piles**

Bored cast-in-situ piles shall be installed by suitable choice of techniques covering the manner of soil-stabilisation i.e. the use of casing and / or use of drilling mud, manner of concreting i.e. direct pouring and placing or by use of tremie and choice of boring tools in order to permit a satisfactory installation of pile. Preferably Direct Mud Circulation method shall be adopted for installation. The bentonite and bentonite slurry shall meet the requirement specified in IS. A minimum length of 1 meter of temporary casing shall be inserted in each bored pile. In case of collapsible soil strata, the full depth of boring shall be provided with temporary casing. If piles are founded on rocky strata, the casing shall be keyed for a minimum depth of 150 mm. After the borehole has been drilled to its final depth, fresh bentonite slurry shall be pumped through the chisel resting at the base of hole, to remove completely all cuttings and other loose materials from the base of pile. During this flushing the speed of pump shall be increased to maintain additional high pressure for 10 - 15 minutes. After the hole has been thoroughly flushed, the chisel and API rods shall be removed for the concrete. When installing piles in a group, sufficient time shall be allowed for freshly poured concrete in the adjacent pile to set.

Provisions of IS: 2911 (Part 1/Sec.2) shall be adopted for requirements not covered above.

- **Driven Precast Piles**

A minimum period of 28 days shall be allowed for curing from the time of casting the pile, before selecting the pile for driving. This period may be relaxed by the Owner/Owner's representative if he is satisfied that the pile has achieved adequate strength to take up driving stresses without suffering distress. In such case the Contractor shall obtain expressed permission of the Owner/Owner's representative in writing.

Driving shall be performed with fixed leads or leaders capable of holding the pile firmly in position, with the hammer and the pile in axial alignment. Care shall be taken during driving to prevent and correct any tendency of the pile to twist or rotate. Pile drivers shall have firmly supported leads extending down to the lowest point the hammer must reach.

Where cut off levels are below grade level, the Contractor shall be required to use followers to drive the pile further below ground level when the head of the pile is near ground level.

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In general, driving sequence of piles and clusters of piles shall, unless otherwise specified by the Owner/Owner's representative, proceed from the centre of the pile groups and progress outward from the centre, towards any two opposing sides of the perimeter.

Piles shall be driven in a continuous manner, without interruption, until the pile has been driven to final elevation of specified resistance, or a combination of both as shown on the drawings or as directed by the Owner/Owner's representative. Where, in exceptional cases driving is interrupted before final penetration is reached, the set per blow immediately upon retrieving shall be disregarded and such pile shall be driven to the final elevation to which the adjacent piles, which were not interrupted, have been driven.

Piles shall be driven in such manner that previously driven piles are not damaged/affected including partly set concrete of lengthened piles.

Piles shall not be abandoned partially driven at the end of the shift.

When a pile head is damaged during driving, the head shall be cut-off square at sound-concrete level, and all loose particles shall be removed by wire brushing, followed by washing with water. If pile is subjected to further driving, the head shall be replaced by concrete of an approved grade. Such piles shall not be driven until appended concrete has reached the specified strength.

If the driving of the pile has been accepted but sound concrete of the pile is below the cut off level, the pile shall be made good to the cut-off level with concrete of a grade not inferior to that of the concrete of the pile. While lengthening the pile, joints in the reinforcement shall be such that the full strength of the bar is effective across the joint. Welded joints shall be made in accordance with IS: 816 and/or IS: 1323 and the main longitudinal reinforcing bars in the head of the pile shall be exposed for at least 300 mm below the weld. For lap or splice joints sufficient link bars shall be provided to resist eccentric forces.

Provisions of IS:2911 (Part 1/Sec.3) shall be adopted for requirements not covered above.

- **Bored Precast Piles (Precast Pile Installed in Prebored Hole)**

Boring shall be similar to that for bored cast-in-situ piles.

Where indicated by site conditions, precast piles in prebored holes shall be socketed into competent stratum as indicated on the drawing or as directed by the Owner/Owner's representative.

In order to determine the competency of the stratum including rock for socketing as well as supporting the pile, standard penetration tests (SPT) shall be conducted during the progress of boring/chiselling into the stratum including rock.

The precast pile shall be brought near the borehole and lifted in vertical position. The pile shall be suspended over the borehole. The flush water shall be switched on through the central grout passage in the pile as the pile tip approaches the founding strata. On reaching the founding strata, water flush shall be continued for 10-15 minutes. Flushing shall be done under adequate pressure in order to ensure the cleaning of borehole bottom of any soft/cohesive material.

After cleaning the bottom of borehole, cement/sand grout (1 cement: 2 sand) with W/C ratio of 0.55 shall be pumped through the grouting pipe in the pile so as to grout the base and fill up the annular space around the pile. The grouting pressure shall be adequate to grout the full length of the pile. The minimum thickness of the grout mantle shall be 40 mm.

Temporary liners/casings if provided shall be extracted progressively as the grout level inside the borehole rises.

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Provisions of IS: 2911 (Part 1/Sec.4) shall be adopted for requirements not covered above.

Jetting of Piles

Jetting of piles by means of water shall not be permitted.

Reinforcement

All reinforcement for use in pile shaft shall be assembled and joints in longitudinal bars, if unavoidable, shall be made by lapping and the lap shall be tack-welded to prevent distortion of the reinforcing cage. The projecting length of the longitudinal bars beyond the pile cut-off level shall be equal to 50 times bar diameter. Minimum cover shall be 50 mm; however in aggressive soil cover shall be increased to 60 mm.

The helical reinforcement shall fit tight against the longitudinal bars and be fixed to them by soft annealed 16 gauge black iron wire, the free ends of which shall be turned into the interior of the pile.

In addition, lateral circular templates with 8 mm dia bar shall be provided at spacing specified by the Owner/Owner's representative and longitudinal bars shall be welded to templates. Care shall be taken to preserve the correct cover and alignment of reinforcement free from any twist, throughout the operation of placing the reinforcing cage into the borehole and concreting of pile.

Concreting work in cast-in-situ piles

The specifications laid down for concrete work shall also apply to the concrete work for piles, except as modified in this specification. The Contractor shall submit mix design as per IS method or ACI Code 211.1 and carry out adequate number of tests to ensure the minimum strength. The minimum cement content and the maximum water cement ratio considered in mix design shall be 400 kg/m³ and 0.45 respectively unless otherwise specified. The slump (130 - 180 mm flowing consistency for bored piles, 80-100 mm flowing consistency for driven piles) shall be selected by the Contractor based on the suitability of the chosen method of concreting for pile installation. If, during execution, workability is to be increased, higher cement content or admixtures shall be used with Owner/Owner's representative's approval.

The concrete shall be freshly mixed and of sufficient quantity in the casing (where used) to ensure that during the withdrawal of the casing, a sufficient head of concrete is maintained to prevent inflow of subsoil and ground water and to prevent formation of necking or wasting.

Exposed portions of piles be cured for ten (10) days.

When installing piles in a group, sufficient time shall be allowed for the freshly poured concrete in a pile to set before installing adjacent piles.

All care shall be taken to prevent formation of voids in the pile by pockets of air trapped within. Particular attention shall be paid to this during withdrawal of casing. The volume of concrete placed shall be checked against calculated volume of pile at the time of withdrawal of casing.

Minimum Casting Levels

Piles shall be cast at least 500 mm above the finished cut-off level so as to permit the removal of all laitance and weak concrete.

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Testing of Piles

General

The Contractor shall cast/drive test piles for each kind of loading and carry out the load bearing tests before actually commencing the work unless otherwise specified, the number of test piles shall be based on the criteria specified in IS:2911(Part 4). The Contractor may be allowed to use quick setting cement or add the necessary admixtures to enable him to conduct the test within seven (7) days after installation for cast-in-situ piles or within 7 days of casting for precast piles.

The load tests shall be carried out by the Contractor as described herein. the load test on working pile however shall not normally be undertaken by the Contractor within 28 days after the installation of the pile in position for cast-in-situ piles or 28 days after casting precast piles. The vertical load test shall be carried out on single pile. The lateral load test shall be carried out between two piles. Before any load test is made the proposed arrangement for carrying out the load test including the preparation of the structure to receive the loads and the type of loading to be adopted shall be furnished by the Contractor and approved by the Owner/Owner's representative. The load tests shall be made under the supervision of the Owner/Owner's representative. The complete record of such loads shall be filed with the Owner/Owner's representative in triplicate. The responsibility for carrying out such load tests satisfactorily and safely and on proper lines rests with the Contractor.

The test shall be carried out at cut-off level wherever practicable, otherwise suitable allowance shall be made in the interpretation of the test results.

Method of Testing

The testing shall be conducted according to IS:2911, Part IV as described herein. If there is any discrepancy observed between the IS guidelines and the specification given here, the following guidelines shall be governing.

- Vertical load test (compression)

The test load to be applied on the loading platform supported on pile shall be

- a) 2.5 times the proposed safe designed load in case of test pile.
- b) 1.5 times the proposed safe designed load or upto a maximum settlement of 25 mm whichever occurs earlier in case of working pile.

The load increments shall be

- a) 1/5, 2/5, 3/5, 4/5, 1, 1.25, 1.5, 1.75, 2, 2.25 and 2.5 times the safe designed load in case of test pile and
- b) 1/5, 2/5, 3/5, 4/5, 1, 1.25 & 1.5 times the safe designed load in case of working pile.

Readings of settlements shall be recorded with minimum 2 dial gauges of 0.01 mm sensitivity each positioned at equal distance around the pile and normally held by datum bars resting on immovable supports at a distance of 3D (subject to minimum of 1.5 m) from the edge of the pile where 'D' is the stem diameter of circular piles or diameter of circumscribing circle in the case of square or non-circular piles.

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Taking of measurement or displacement of the pile top for each load increment is continued until the settlement is either 0.1 mm in first 30 minutes or 0.2 mm in first one hour or till 2 hours whichever occurs first.

The final test load shall be maintained for 48 hours. The safe load on single pile for the test pile shall be at least of the following:

Two thirds of the final load at which the total displacement attains a value of 12 mm.

50 percent of the final load at which the total displacement equal 10 % of the pile diameter in case of uniform diameter piles and 7.5 % of bulb diameter in case of under-reamed piles.

- **Lateral Load Test on Pile**

The safe lateral design load shall be the least of the following:

- 5% of the safe axial load.
- Load corresponding to a maximum calculated deflection of 5 mm.

The test load shall be

- 2.5 times the proposed safe lateral design load or 12 mm whichever occurs later in case of test piles.
- 1.5 times the proposed safe lateral design load or 7.5 mm whichever occurs earlier in case of working pile.

The load increments shall be similar to the one given for the vertical load. The safe lateral load on a single pile shall be taken as the least of the following :

- Fifty percent of the final load at which the total displacement increases to 12 mm.
- Final load at which the total displacement corresponds to 5 mm.

- **Cyclic Load Test on Pile**

Alternate loading and unloading shall be carried out at each stage as given in relevant clause and each loading shall be maintained as given in relevant clause and each unloading stage shall be maintained for atleast 15 minutes and subsequent elastic rebound in the pile shall be measured accurately as specified in relevant clause. This test shall be continued upto 1.5 times the proposed safe design load. The skin friction and end bearing load of the pile shall be separated out either by graphical method or analytical method as described in IS.

- **Pull out Test**

Pullout test requirements shall be as per IS:2911 (Part 4).

Acceptance Criteria

The following are the general acceptance criteria.

The clauses pertaining to acceptance of concrete work as described for Plain and Reinforced Concrete work shall also be applicable to the work of piles.

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Positional Tolerance

The permissible positional deviation of pile should not be more than 75 mm or D/4 whichever is less where 'D' is the diameter of pile (75 mm or D/10 whichever is more in case of piles having diameter more than 600 mm) at the working level. In the case of single pile under a column the positional deviation should not be more than 50 mm or D/4 whichever is less (100 mm in case of piles having diameter more than 600 mm). This will be measured after the driving of the pile and during the inspection of the tube prior to placing of reinforcement and concrete. Should the deviation be greater than that specified above, the Contractor shall remove the casing at his own cost & redrive the pile, if ordered so by the Owner/Owner's representative.

In the alternative, the Owner/Owner's representative may at his discretion order the driving of additional piles at the Contractor's cost which he considers necessary after checking up the design load on the pile group.

Pile size & capacity

The Contractor shall guarantee 90% of full cross sectional area of the pile and also guarantee against occurrence of necking of wasting, bulging, spalling of shaft concrete, exposure of reinforcement, porous concrete and similar defects which will impair the strength and durability of pile. The Owner/Owner's representative may direct the Contractor to completely exhume some or all test piles before or after load testing to examine the quality of the pile shaft. This shall be done either by excavating around the pile or by pulling out or by a combination of both methods. If the quality of the pile shaft does not satisfy the requirements of this specification and/or if the pile fails to attain workmanship or negligence on the part of the Contractor, all costs of mobilisation, installation and testing of test piles exhuming of test piles and any other work in connection with the test piles shall be to the cost of Contractor.

Structural Soundness

The concrete should have the minimum strength specified based on the cube test. The acceptance criteria mentioned in the specification for concrete works under Clause 4.5.0 shall be referred in this aspect. However the Owner/Owner's representative reserves the right of rejecting any pile which in his opinion is not structurally sound or is not in proper position and alignment. The Contractor shall be bound to pull the same out and re-install a new pile in its place or leave the defective pile and install at the Contractor's cost one or more additional piles to substitute the defective pile, as per directions of the Owner/Owner's representative.

5.5.4 Earthwork in Excavation & Backfilling

Scope

This specification covers the requirement of site clearing, excavation & backfilling in all types of soil for foundations, basements, trenches, drains, culverts etc.

Codes and Standards

Unless specifically mentioned otherwise, all applicable codes and standards in their latest editions as published by the Bureau of Indian Standards shall govern in respect of design, workmanship, quality and properties of materials and method of testing. Some of the relevant available codes are listed hereunder:

IS:1498 Classification and identification of soils for general engineering purposes.

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IS:3764 Safety code for excavation works

IS:4081 Safety code for blasting and related drilling operations

IS:9759 Guidelines for dewatering during construction

Setting Out

The work shall be set out to exact dimensions as shown on the drawings and shall be checked and approved by the Owner/Owner's representative before commencement of excavation.

In firm soil, the sides of excavation in foundations shall be kept vertical up to a depth of 1.5 m from the bottom and for greater depths the sides shall be widened by forming steps of 300 mm on either sides after every 1.5m from the bottom. Where soil is soft, loose or slushy, the width of steps shall be suitably increased or the side sloped or shored up, as directed by the Owner/Owner's representative. Working space shall be approved by the Owner/Owner's representative.

In case of excavation for pipes, the authorized width of excavation shall be 600 mm plus outer diameter of pipe or the width of bedding as shown in the drawing whichever is higher, upto a depth of 1.5 m. For higher depths, the width shall be widened by forming steps of 300 mm on either side after every 1.5 m from the bottom.

Initial Levels

Initial levels either in a definite grid pattern or as directed by the Owner/Owner's representative shall be taken by the Contractor jointly with the Owner/Owner's representative over the original ground prior to starting actual excavation work and after setting out.

Clearing and Grubbing Etc.

The area to be excavated shall be cleared out of trees, logs, stumps, bush, vegetation, rubbish, slush etc. and leveled up. Trees up to 300 mm girth shall be uprooted. Trees above 300 mm girth shall be cut up to 600 mm below ground level. Useful materials, saleable timber shall be the property of the Owner/Owner's representative and hence shall be handed over. All the spoils and unserviceable materials and rubbish shall be burnt or removed from site to approved disposal areas as may be specified.

Excavation and Cutting

The Contractor shall excavate to remove materials of any nature or description which may be encountered and excavate to depths, widths and inclinations as shown on the drawings and/ or as directed. The bed of the excavation shall be made level and firm by watering and ramming. The Contractor shall not remove any tree without permission.

While carrying out excavation for drain work, the sides and bottom shall be cut to the exact shape, slope and gradient as shown on the drawings. The surface shall be properly dressed. Excavated material shall not be placed within 1.5 m from the edge of any excavation or half of trench depth whichever is more.

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Excavation in Rock

Blasting where permitted shall be carried out as specified in IS:4081. Where blasting is prohibited, rock excavation shall be by chiseling, wedging or any other approved method. Depending on the exact location of rock excavation, decision to excavate by blasting or not will be taken by the Owner/Owner's representative.

Variation in Excavation

Bad Soil

Should the bottom of any excavation at design depth appear to be soft, unsound or unstable, the Contractor shall report the matter to the Owner/Owner's representative and if the Owner/Owner's representative so directs, shall excavate the same to indicated depths. The extra depth shall be filled up with concrete or such other materials as the Owner/Owner's representative shall direct. No extra compensation will be entertained in this account.

Excavation Too Deep

If the Contractor excavates to levels deeper than those shown on drawings for any reason other than those stated above, he shall fill it up at his own expense to the proper level with lean concrete 1:5:10 or sand filling as directed. No payment will be made for excavation taken down to depths more than those shown on the drawings or for the filling carried out as directed.

Slips and Falls

Every precaution shall be taken against slips and falls of earth, clay, sand or other materials in the excavations, but in the event of any such occurring; the Contractor shall at his own expense make good the space affected by slips or falls even if the affected area is outside the dimension of the work ordered.

The Owner/Owner's representative will determine in each case whether such affected area is to be filled up in whole or in part with concrete, brickwork or masonry of the quality used in the adjoining work or where only a part is to be so filled, the materials to be used for this remaining part.

If in the opinion of the Owner/Owner's representative there is a possibility of the newly constructed work having been damaged or disturbed by such collapse, the work shall be laid bare at the expense of the Contractor for inspection. Any damage caused shall be made good by the Contractor, at his own expense.

Soil/Sub-soil Water Condition

Boring and sub-surface data regarding the nature of soil, sub-soil water furnished to the Contractor shall be taken as guidance only and variation there from shall not affect the terms of Contract. The Contractor must satisfy himself regarding the character and volume of all work under this item and expected surface, and/or sub-soil water to be encountered.

Keeping Works Site Free From Water

The Contractor shall provide and operate pumps and all other equipment necessary to drain the sub-soil water, rain water etc. to the nearest sewer or drain through properly laid pipes or channels and keep excavation pits, trenches etc free from water at all times during excavation, backfilling and the continuance of the contract. Adequate care shall be taken to prevent movement of water through freshly laid concrete or masonry work. Sumps made for dewatering shall be kept clear of

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the foundation. Method of dewatering shall be approved by the Owner/Owner's representative but in no case the pumping arrangement shall be such that there is any movement of sub-soil or blowing-in due to differential head of water during pumping. If water table is high, well point dewatering has to be adopted for excavation beyond 1 metre below the water table. The dewatering shall be continued for a sufficient period so as not to affect the strength and other properties of the concrete. Guideline given in IS: 9759 shall also be followed.

Protection of Work

The Contractor shall support and maintain adjoining and abutting property and structures to render work safe to persons and property.

The Contractor shall provide necessary decking, guard, fencing, planking with red flags and red lights at night to maintain safe pedestrian and vehicular traffic near all open excavations.

Shoring and Strutting

Shoring and strutting shall be used as directed when excavation is to be carried out in soft or slushy soil which is likely to collapse during the excavation of the work. The shoring shall be either open or close boarded type depending on the nature of the soil and depth of excavation and the type adopted shall be as directed by the Owner/Owner's representative. While excavating in very unstable ground requiring support throughout the period of excavation, runners shall be used and shall be driven always in advance of the excavation. The size and spacing of different members to be used in shoring shall be as directed by the Owner/Owner's representative, depending on the site conditions. If however slips do occur, the same shall be removed by him and backfilled later by him at his own expense. The withdrawal of shoring & shoring material shall be done very carefully to prevent the collapse of pit or trench. No claim shall be entertained for any material which cannot be removed and is lost or buried.

Disposal

The excavated earth shall be disposed off in the following manner or as directed by the Owner/Owner's representative

- By keeping separately the materials suitable for backfilling/area filling and material not suitable at areas to be designated by the Owner/Owner's representative.
- The excess material remaining after back-filling/area filling shall be spread evenly so as to allow natural flow of water in the area.

Backfilling and Filling in Plinth

Earth used for filling shall be free from organic and other objectionable matter. As far as possible, materials obtained from excavation in foundation shall be used. The earth shall be basically CNS soil (Cohesive Non-Swelling Soil). All clods of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not bigger than 150 mm in size and mixed with fine materials consisting of decomposed rock, moorum or earth and the mixture shall be used for filling. Expansive soils shall not be used for filling. Maximum thickness of filling (uncompacted) shall be 200mm and compacted to 95% of proctor density.

Filling Around Foundation with Earth

Filling shall be carried out in layers not exceeding 200 mm (un compacted thickness) in depth. Each layer shall be watered, rammed and properly compacted to 95% of proctor density or 85% of relative density depending on the soil type. For Turbine Foundation it shall not be less than 98%.

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Sand filling in plinth

Sand used for filling shall be free from dust, organic and other objectionable matter and shall not contain more than 10 percent of clay.

When filling has reached the appropriate level, the area shall be flooded with water for a minimum period of 24 hours to allow the fill to settle. The filling shall be allowed to dry and then compacted and dressed to the required level.

Filling in trenches for pipes

Filling in trenches for pipes shall be commenced as soon as the joints of pipes have been tested and passed. Filling of trenches shall be carried out simultaneously on both sides of pipes to avoid unequal pressure on the pipe. The earth shall be spread on the sides and top of the pipes in layers not exceeding 200 mm (un compacted thickness), watered, rammed and consolidated, taking care that no damage is caused to the pipe below. Maximum particle size for fill material around pipes shall be less than 20 mm.

Testing and Acceptance Criteria

Excavation

On completion of excavation, the dimensions of the pits will be checked as per drawings after the pits are completely dewatered, the work will be accepted after all under-cuts are set right, all over excavations are filled with lean concrete or compacted earth as directed and all necessary shoring & strutting done, all temporary approaches to the bottom of trenches provided, all to the satisfaction of the Owner/Owner's representative.

Backfilling / Plinth Filling

All filling shall be done to the compaction specified. The backfilling work will be accepted only after the Owner/Owner's representative is satisfied with the degree of compaction.

Level of each layer of backfilling shall be marked on the sides in order to exercise the control on the thickness of layer being laid.

5.5.5 Plain and Reinforced Concrete Work

Scope

This specification covers the requirement in respect of materials, workmanship and quality for Plain Cement Concrete (PCC) and Reinforced Cement Concrete (RCC) for all types of structures in foundation and superstructure.

Codes and Standards

Unless specifically mentioned otherwise, all applicable codes and standards in their latest editions as published by the Bureau of Indian Standards and all other such as may be published by them during the currency of the Contract, shall govern in respect of design, workmanship, quality and properties of materials and methods of testing. Some of the relevant available codes are listed hereunder:

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Cement

IS:269	Ordinary and low heat Portland cement
IS:455	Specification for Portland slag cement
IS:1489	Specification for Portland pozzolana cement
IS:4032	Method of chemical analysis of hydraulic cement
IS:6452	High alumina cement for structural use
IS:8041	Rapid hardening portland cement
IS:8112	Specification for 43 grade ordinary Portland cement
IS:12330	Sulphate resisting portland cement

Aggregate

IS:383	Coarse and fine aggregates from natural sources for concrete
IS:2386	Methods of test for aggregates for concrete
IS:2430	Methods of sampling of aggregates for concrete

Concrete Plain and Reinforced

IS:456	Code of practice for plain and reinforced concrete
IS:460	Test sieves
IS:516	Methods of test for strength of concrete
IS:1199	Methods of sampling and analysis of concrete
IS:1607	Methods for test sieving
IS:1834	Hot applied sealing compounds for joints in concrete
IS:2645	Integral cement water proofing compounds
IS:2750	Steel scaffolding
IS:2974	Code of practice for design and construction of machine foundations
IS:3370	Code of practice for concrete structures for the storage of liquids
IS:9013	Method of making, curing and determining compressive strength of accelerated-cured concrete test specimens
IS:9103	Admixtures for concrete
IS:9893	Precast concrete lintels and sills

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- IS:10262 Recommended guidelines for concrete mix design
- IS:10297 Code of practice for design and construction of floors/roofs using pre-cast reinforced/pre-stressed concrete ribbed or cored slab units
- IS:10566 Methods of tests for preformed fillers for expansion joints in concrete paving and structural construction
- IS:10790 Methods of sampling of steel for prestressed and reinforced concrete

Steel

- IS:432 Mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement
- IS:1566 Hard-drawn steel wire fabric for concrete reinforcement
- IS:1568 Wire cloth for general purposes
- IS:1786 High strength deformed steel bars and wires for concrete reinforcement
- IS:2502 Code of practice for bending and fixing of bars for concrete reinforcement
- IS:2751 Code of practice for welding of mild steel plain and deformed bars used for reinforced concrete construction

Materials

All materials that shall be used for works covered under this specification shall conform to following standards / specification.

- Aggregate Machine crushed blue granite conforming to IS:383
- Cement
 - IS:269 - Ordinary Portland Cement
 - IS:455 - Specification for Portland slag cement
 - IS:8041 - Rapid Hardening Portland Cement
 - IS:8112 - High strength Ordinary Portland Cement
 - IS:12330- Sulphate Resisting Portland Cement
- Reinforcement IS:432/IS:1786/IS:1566
- Embedded plates IS:2062
- Binding wire PVC binding wires
- Joint filler Approved non extruding, resilient fillers
- Sand River or pit sand conforming to IS:2116
- Water stops PVC/Rubber/Metallic - GI, Aluminium, copper

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- Admixtures IS:9103

- Water Clean, potable as specified in IS:456.

Source of coarse & fine aggregate shall be approved by the Owner/Owner's representative.

Test certificates for each consignment of cement procured have to be submitted by the Contractor to ensure conformity with relevant standards. The Owner/Owner's representative may reject such cements supplied in the event of unsatisfactory tests or in the event of deterioration due to age or bad storage etc. Decision of the Owner/Owner's representative shall be final in this regard.

Admixtures shall be used only after getting permission from the Owner/Owner's representative and as per the instruction of the manufacturer.

Grades and Proportioning

Any grades of concrete designated in latest revision of IS: 456 as shown on the drawings or as specified shall be used. Design mix concrete shall be adopted for all RCC works. Contractor, at his own cost shall get this Design Mix done by any premiere institute like approved by the Owner/Owner's representative. If the submitted results are not satisfactory to the Owner/Owner's representative, the Owner/Owner's representative has every right to reject the design mix. In case the Contractor fails to submit or comply with the design mix, he requires to follow Nominal Mix as per IS: 456 after obtaining the permission from Owner/Owner's representative. The mix shall be designed as per "Handbook on concrete mixes", SP:23. While designing the mix, the strength, durability, minimum cement content, maximum water cement ratio allowed and workability necessary for the job by most economical use of the various ingredients shall be considered by the Contractor. Contractor must use the same ingredients in the Design Mix which he uses in the works. The mix design shall be verified by carrying out preliminary test.

The water cement ratio, coarse aggregates and grading for each mix shall be predetermined from the results of cube tests of trial mixes. The mix proportions determined thus shall be followed at site and shall in no way relieve the Contractor of his responsibility as regards the prescribed strength mix. The mix proportions, however, shall be revised if the results of the cube tests during the construction show consistently lower than the prescribed one. No extra claim will be entertained due to such changes in mix designs, as the Contractor will be responsible to produce the concrete of required grade. The maximum size of aggregates used shall be as indicated in IS: 456 or specified elsewhere.

Nominal mix concrete in accordance with IS: 456 for grade M20 or lower may be used if shown on drawings or approved by the Owner/Owner's representative. 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 Owner/Owner's representative is satisfied regarding its adequacy and after obtaining his approval in writing.

Mixing

Mixing should be carried out in mechanical mixers. No hand mixed concrete is permitted for RCC works. Hand mixing if permitted for PCC works shall be carried out on a clean, hard and water tight platform. Water cement ratio shall be rigidly controlled during mixing. Mixers shall be fitted with automatic devices to discharge measured quantity of water to the mixing pan. The water shall not be admitted to the drum until the cement and aggregate constituting the batch are thoroughly mixed. Mixing shall continue until the concrete is uniform in colour and not less than 2 minutes and forty (40) revolutions after all the material and water are in the drum. Regular checks on mixer efficiency shall be carried out as directed by the Owner/Owner's representative. Only those mixers whose efficiencies are within the tolerances specified in IS: 1791 will be allowed to be employed. Batching

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plant where used shall conform to IS: 4925. Concrete shall be prepared only by weigh batching the ingredients. Volume batching will not be permitted.

The entire content of the drum shall be discharged before the ingredients for 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 and when the next mixing commences, the first batch shall have 10% additional cement at no extra cost to the Owner/Owner's representative to allow for loss in the drum.

Placing

Concrete shall be transported from the mixing plant to the forms, as rapidly as possible, by means which will prevent segregation, consolidation or drying out in hot weather. Concrete shall be placed within thirty (30) minutes after commencement of mixing. At the time of placing concrete in very hot weather, care shall be taken to see that the temperature of wet concrete does not exceed 38°C.

Before placing concrete, formwork, embedment's and reinforcement shall be checked for completeness, location and dimension. It should also be square and plumb. All chips and saw dust or other foul matter shall be removed from within the forms with the help of an air compressor. The base surface shall be well moistened and puddles wiped up. Earth foundation on which direct placement of concrete is allowed will be rammed and consolidated as directed by the Owner/Owner's representative such that it does not crumble and get mixed up with the water during or after placement, before it has sufficiently set and hardened. Concrete may be placed against moist surface but never on pools of water. In case the foundation cannot be dewatered completely, special procedure and pre-caution, as directed by the Owner/Owner's representative will have to be adopted. A layer of mortar of thickness between 12 mm to 25 mm as directed, of the same or less W/C ratio and the same proportion as that of concrete being placed and /or cement slurry will be spread thoroughly on the foundation or construction joint just prior to placement of concrete. Placing equipment and accessories shall be kept clean and free of partially set grout and concrete, and maintained in proper working order. Walking on reinforcement layers is not permissible. Walkways of wooden planks or similar can be placed with removable supports and should be independent of reinforcement.

In general, placing shall be direct, by transporting buckets. Where it is necessary to deposit the concrete at level differences of more than 1.5 m, short chutes shall be used. Short chutes and hoppers shall be so designed and installed that segregation will not take place. In cases where chutes are impracticable due to excessive drop to placing level, hoppers and sectional tubes (elephant trunks) shall be used.

After the concrete has been placed, it shall be spread, if necessary and thoroughly worked around reinforcement or other embedded fixtures into concrete form and shape. Vibrators shall not be used for pushing the concrete into the adjoining areas. Care must be taken to ensure that the inserts, fixtures, reinforcement and formwork are not displaced during or immediately after the placement and bring the concrete surface out of the alignment beyond tolerance limits, the Owner/Owner's representative may direct to remove the portion and reconstruct or repair the same at the Contractor's expense.

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, while it rains. During rainy season, no placement in open is to be attempted unless sufficient tarpaulins or other similar protective arrangement for complete 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.

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Compaction

Concrete in general shall be consolidated by vibration using high frequency mechanically driven vibrators. Concrete shall be placed in layers at least 300 mm deep in walls and approximately 450 mm in mass pouring. Vibrators shall not penetrate more than 50 mm into the surface of previously placed layers but shall completely vibrate the working layer. Care shall be taken not to over-vibrate any concrete and especially those with higher slumps. Under no circumstances vibrators shall be attached to or allowed to touch reinforcement. Spare vibrators in good operating condition shall be on hand during placing operations.

Construction Joints

In general, construction joints shall be limited to those indicated on the drawings. In mass concrete, construction joints may not be indicated in the drawings but shall be made at breaks, offsets or other convenient levels as controlled by volume, plant capacity and time factors. Such construction joints shall be so located that they do not impair the strength of the structure. In walls and columns, height of each lift shall not generally exceed 1.5 m unless otherwise specified in the drawings or directed by the Owner/Owner's representative. Method of forming all construction joints shall conform to the provisions of IS:456.

All construction joints shall be cleaned with wire brush and water to remove all laitance and loose material to expose the aggregates. Immediately before placing fresh concrete, the surface of previously placed concrete shall be coated with a thin coat of cement mortar slurry of the same proportion as that of concrete.

Where locations of the joints are not specified, it will be in accordance with the following:

- In a column, the joint shall be formed 75 mm below the soffit of the beam or the edge of the anchored bar of the beam framing into it whichever is lower. The Contractor shall refer to the beam reinforcement drawing before deciding on the location of the joint at column-beam junction.
- 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 one third of the span, clearing the cross beam location, if any.
- A joint in a suspended floor slabs shall be vertical and at the middle one third of the span and at right angles to the principal reinforcement.
- In general, construction joints shall be located preferably in a low shear stress zone and at right angles to the direction of the principal stress

Any deviation from the above shall be approved by the Owner/Owner's representative.

Curing and Protecting

As soon as the concrete has hardened sufficiently, it shall be covered either with Hessian, canvas or similar materials and kept continuously wet for at least seven (7) days after final setting. Curing by continuous sprinkling of water will be allowed if the Owner/Owner's representative is satisfied with the adequacy of arrangements made by the Contractor.

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Curing of concrete with water shall comply with IS:456. Curing compound shall be used subject to approval by the Owner/Owner's representative. Finished floors shall be protected carefully until completely set. Protection of concrete against extreme weather conditions shall comply with the code.

Finishing

No touching-up will be permitted to the concrete after removal of formwork. Where damages, honey-combing or other unsatisfactory finishes have occurred to the concrete surfaces, they shall be rectified in a manner as directed by the Owner/Owner's representative, at no extra cost. If in the opinion of the Owner/Owner's representative the concreting is unsatisfactory, demolition of the entire concrete work and reconstruction of the same shall be carried out by the Contractor, as directed by the Owner/Owner's representative at his own cost.

Formwork & Centering

Form work in general shall conform to IS: 456.

For complicated work, the Contractor shall submit his proposal of formwork before starting the work for approval of the Owner/Owner's representative. The number of props, their sizes and dispositions shall be such as to be able to safely carry the full dead load and constructional loads. However, approval of the Owner/Owner's representative to this effect shall not relieve the Contractor of his responsibility for proper work and safety.

All forms of beams, slabs and members shall be so designed and erected that the sides can be removed without disturbing the soffit shutter and supports there to.

Beam soffit shall be provided with an upward, camber of 6mm for each 3 m of horizontal span or as directed by the Owner/Owner's representative. Vertical props shall be supported on wedges or sole plates or other measures where by the props can be gently lowered while commencing to remove the shuttering. Columns shuttering shall not be over 1.5 m in height a piece.

Before removal of the shuttering the concrete shall be examined and its removal order taken from the Owner/Owner's representative. In no circumstance shall forms be struck until the concrete reaches strength of at least twice the stress to which the concrete may be subjected at the time of striking.

Shuttering shall not be removed until the number of clear days specified in IS: 456 have elapsed since the last day of placing concrete in the member concerned. All formwork shall be removed without such shock or vibration as would damage the reinforced concrete. Before the soffits and struts are removed, the concrete surface shall be exposed, where necessary, in order to ascertain that the concrete has sufficiently hardened. The specified period may be extended if desired by the Owner/Owner's representative on account of delayed hardening caused by low atmospheric temperature.

Reinforcement

The reinforcement bending shall be carried out as per the approved bar bending schedule prepared based on design drawing.

Workmanship shall conform to IS: 2502. All reinforcement shall be free from loose mill scale, rust, oil, grease and paint. Reinforcement shall not be bent or straightened in a manner that will injure the materials and all bars shall preferably be bent cold. Hot bending shall not be permitted for bars whose strength have been increased by cold working.

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Reinforcement bars shall be placed and maintained accurately in positions as shown in the drawings. The correct cover to the reinforcement shall be maintained by use of precast concrete blocks.

All intersections of longitudinal and transverse bars or stirrups and all laps shall be securely tied together with approved binding wire. The binding wire shall be so placed that it touches all the four corners of the intersection and the two ends shall be looped with pliers and the ends shall be turned into the body of the concrete.

Welded joints may be used but in all cases of important connections, tests shall be made to prove that the joints are of the full strength of bars connected. Welding shall be done in accordance with IS:2751 and IS:9417. Butt welding between the ends of a rod in line, whereby stress is transferred across the section may be adopted only for mild steel bars. In case of tack welding for fixing reinforcements in their position, no special precaution need be taken.

Steel Embedment

All embedment shall be accurately set, rigidly fastened and suitably anchored by welding lugs. Anchor bolts shall be set to template and firmly secured in vertical and horizontal line and required positions. The guidelines furnished by equipment supplier / vendor shall be taken in to account

Exposed surfaces of embedded materials are to be painted with one coat of red oxide zinc chrome and/ or bituminous paint. Correct location and alignment of all anchor bolts, anchor sleeves, inserts, hangers, conduit pipes and other embedded fixtures as per drawings/instruction shall be entirely the responsibility of the Contractor.

Expansion & Isolation Joints

General

Expansion and isolation joints in concrete structures shall be provided at specified 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 Owner/Owner's representative. All materials are to be procured from reliable manufacturers and must have the approval of the Owner/Owner's representative. Where it is the responsibility of the Contractor to supply the material, the Owner/Owner's representative 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/Owner's representative. Approved samples of the material to be incorporated in the works shall be with the Owner/Owner's representative. 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 Owner/Owner's representative before starting the work.

Bitumen Board

Bitumen impregnated fiber board of approved manufacturer as per IS: 1838 may be used as fillers for expansion joints. It must be durable and water proof. 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.

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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 Owner/Owner's representative. 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.

Joint Filler

The concrete surface shall be made clean, smooth and free from dirt or loose particles. When the surface is completely dry, a coat of hot blow bitumen conforming to IS: 702 of grade 85/25 shall be given with brush or spray. When the bitumen is still hot, the premoulded joint filler fibre board shall be pressed against the surface and held in position till the time it takes to adhere. When more than one layer of filler are specified each layer shall be made to adhere to the preceding layer with a few patches of bitumen between the two layers. After placing the filler in position, the surface of the filler against which further concreting is to be done is given a coat of bitumen.

Joint sealing compound

Sealing compound shall be of Grade A conforming to IS: 1834. Bitumen shall conform to IS: 3384.

Before application of the sealing compound the sides of the joint are sprayed or brushed with bitumen primer. The primer is then allowed to dry out thoroughly for at least 24 hours and then filled with a mix of 30 % fine sand and 70 % sealing compound by weight.

Joint Sealing Strips/Water Stops

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 GI, Aluminium or non-metallic like PVC.

Sealing strips shall not have any longitudinal joint and shall be procured and installed in largest practicable lengths having a minimum number of transverse joints. The jointing procedure shall be as per the manufacturer's recommendations, revised if necessary, by the Owner/Owner's representative.

- Metal Sealing Strips

Metal sealing strips shall be either GI or Aluminium and formed straight, U shaped, Z shaped or any other shape and of thickness as indicated in the drawing and/ or as instructed by the Owner/Owner's representative.

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. In case it is found that the joints cannot be made leak proof, longer lap length 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.

GI Strips : GI Strips shall be minimum 1.5 mm thick and 150 mm in width unless specified otherwise. The standard of Galvanising shall be as per relevant Indian Standards for heavy duty work. The strips shall be strong, durable, without any rust or crease. At the joints, the over-lapping should be for a minimum length of 50 mm.

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Aluminium Strips : Aluminium strips shall be minimum 18 swg. thick and 300 mm wide unless specified other wise and shall conform to IS:737 of 19000 grade or 31000 grade (Designation as per IS:6051). A minimum lap of 50 mm length is required at the joints.

It should be cleaned thoroughly before use to expose fresh surface, without any reduction in gauge. A minimum lap of 50 mm is length is required at the joints.

- **Water stops**

This shall be of P.V.C. having any combination of the following features :

- Plain
- Central bulb
- Dumb-bell or flattened ends
- Ribbed and Corrugated Wings
- V-shaped

Transverse joints will be allowed only under unavoidable circumstances and with the specific approval of the Owner/Owner's representative. The method of forming these joints, laps etc. shall be specified by the Manufacturer and/or as approved by the Owner/Owner's representative, taking particular care to match the central bulbs and the edges accurately.

The minimum thickness of P.V.C water stops shall be 8 mm and the minimum width 150 mm. The actual size and shape will be as shown in drawings and/or as directed by the Owner/Owner's representative. 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 Owner/Owner's representative, may vary slightly. PVC water stops used in water retaining structures shall be able to withstand the water pressure to which it will be subjected to.

Bitumen Compound

When 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 manufacturer and shall conform to the requirements of IS: 1834.

Isolation Joints

Strong and tough alkathene sheet or equivalent, about 1 mm in thickness and as approved by the Owner/Owner's representative shall be used in Isolation Joints. It shall be fixed by an approved adhesive compound on the cleaned surface on 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.

Rubber Pad

Hard foundation quality rubber pads of required thickness and shapes shall be used below machine or other foundation for vibration isolation. The rubber shall have a unit weight of 930 Kg/m³, shore hardness - 65 A to 70 A and be of best quality of approved manufacturer, 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.

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Precast Concrete

All precast work shall be carried out in a yard 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 form for the units, it shall be paved with concrete or masonry and provided with a layer of cement plaster with smooth neat cement finish or a layer of M.S. sheeting. Where directed by the Owner/Owner's representative, 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 seven (7) days of curing and can be removed for erection after twenty eight (28) 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 Owner/Owner's representative, 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 removed and the hooks finished after erection if directed by the Owner/Owner's representative.

Precast concrete units, when ready, shall be transported to site by suitable means approved by the Owner/Owner's representative. Care shall be taken to ensure that no damage occurs during transportation. All adjustments, levelling and plumbing shall be done as per instructions of the Owner/Owner's representative. The Contractor shall render all help with instruments, materials and men to the Owner/Owner's representative for checking the proper erection of the precast units. Chipped or cracked or otherwise damaged pre-cast elements will be rejected.

After erection and alignment, the joints shall be filled with grout or concrete as directed by the Owner/Owner's representative. If centerings 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 fourteen (14) days. The joint between precast roof planks shall be pointed with 1:2 cement : sand mortar unless otherwise shown in the drawings.

Waterproofing of Concrete to Structures

General

Waterproofing of concrete structures shall be done by suitable extraneous treatments like applying paints, fixing bitumen felts polymeric membrane, installing water bars at construction joints etc.

The design, material and workmanship shall conform to the relevant I.S. codes where applicable. The Owner/Owner's representative's approval of the materials shall be obtained by the Contractor before procurement. If desired by the Owner/Owner's representative, test certificates for the materials and samples shall be submitted by the Contractor. The materials shall be best quality available indigenously, and suitable for the duties called upon.

Water Stop

Water bearing structures and underground structures shall have PVC water stops installed at the joints. Installation will be as described under "Expansion & Isolation Joints".

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Waterproofing Admixtures

- In Concrete

The admixture shall be procured from reliable and reputed manufacturers and approved by the Owner/Owner's representative. The method of application and other details shall conform to the manufacturer's specification and/or as instructed by the Owner/Owner's representative.

- In Plaster

The concrete surface, to be plastered, shall be hacked to Owner/Owner's representative'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 layer not exceeding 15 mm or as per manufacturer's specification. The additive shall be of quality and type approved by the Owner/Owner's representative. On completion, the plastered surface shall be cured continuously for a minimum period of fourteen (14) days like concrete.

Bituminous or Tar Coating

The surface to be waterproofed shall be rendered absolutely dry, clean and dust free. The surface shall be sand papered, cleaned and completely coated with hot coal tar pitch of approved manufacture and quality as per IS:216 (not heated above 375°F) using not less than 2 kg./ Sq.m. or with hot asphalt i.e. bitumen according to IS:73 (not heated above 400°F) using not less than 1.5 kg per Sq.m. When the first coat has completely dried up and approved by the Owner/Owner's representative, the second coat shall be applied in the same manner using not less than 1.25 Kg. per Sq.m. in case of coal tar and 1 kg per sq m in case of asphalt. Immediately after application of the second coat and before it is dried up, sand shall be spread on the surface to cover it completely. Sufficient time shall be allowed after spreading of sand before backfilling is done in order to allow the final coat to dry up completely.

Testing Concrete Structures for Leakage

Hydro-static test for water tightness shall be done at full storage level or soffit of cover slab, as may be directed by Owner/Owner's representative, as described below (In compliance with IS: 3370):

- In case of structures whose external faces are exposed, such as elevated tanks, the requirements of the test shall be deemed to be satisfied if the external faces show no sign of leakage or sweating and remain completely dry during the period of observation of seven days after allowing a seven day period for absorption after filling with water.
- In the case of structures whose external faces are submerged and are not accessible for inspection, such as underground tanks, the structures shall be filled with water and after the expiry of seven days after the filling, the level of the surface of the water shall be recorded. The level of water shall be recorded again at subsequent intervals of 24 hrs. over a period of seven days. Backfilling shall be withheld till the tanks are tested. The total drop in surface level over a period for seven days shall be taken as an indication of the water tightness of the structure. The Owner/Owner's representative shall decide on the actual permissible nature of this drop in the surface level, taking into account whether the structures are open or closed and the corresponding effect it has on evaporation losses. Unless specified otherwise, a structure whose top is covered shall be deemed to be water tight if the total drop in the surface level over a period of seven days does not exceed 40 mm. For open type, it shall be 60mm.
- Each compartment/segment of the structure shall be tested individually and then all together.

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For structures such as pipes, tunnels etc. the hydrostatic test shall be carried out by filling with water, after curing as specified, and subjecting to the specified test pressure for specified period. If during this period the loss of water does not exceed the equivalent of the specified rate, the structure shall be considered to have successfully passed the test.

Any leakage that may occur during the hydro-test or subsequently during the defects liability period or the period for which the structure is guaranteed shall be effectively stopped either by cement/epoxy pressure grouting, guniting or such other methods as may be approved by the Owner/Owner's representative. All such rectification shall be done by the Contractor at his own cost to the entire satisfaction of the Owner/Owner's representative.

Testing of Materials

Cement

The Contractor shall submit to the Owner/Owner's representative the manufacturer's certificate for each consignment of cement procured by him. If required by the Owner/Owner's representative's, representative samples shall taken from each consignment and tests for fineness (by hand sieving), setting time and compressive strengths as per IS:269 shall be carried out, free of charge by the Contractor.

Aggregates

Coarse and fine aggregate and the grading shall be as per IS:383. It shall be free from organic or clay coatings and other impurities, flaky particles, and any other material liable to affect the strength, durability or appearance of concrete. Washing of aggregates by approved means shall be carried out, if desired by the Owner/Owner's representative.

The Contractor shall carry out all the tests on aggregates as may be required by the Owner/Owner's representative in accordance with IS: 2386. The records of these shall be maintained and made available by the Contractor for the checking of Owner/Owner's representative. The acceptance criteria of samples tested shall be in accordance with the requirements of relevant Indian Standards.

Admixture

- Air Entraining Agents

Initially, before starting to use Air Entraining Agents, relationship between percentage of air entrained and the cylinder cube crushing strength vis-à-vis quantity of Air Entraining Agents used for all types of concrete will be established by the Contractor free of charge by carrying out sufficiently large number of tests. After that, at regular intervals and whenever directed by the Owner/Owner's representative, the Contractor will check up free of charge, the actual percentage of air entrained and corresponding curing strengths to correlate with the earlier test results.

- Other Admixture

Tests for establishing the various properties of any other admixtures which may be required to be added shall be carried out by the Contractor free of charge to the Owner/Owner's representative.

Usage of admixtures shall be purely subjected to the approval of Owner/Owner's representative.

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Concrete

Sampling, curing and testing of specimen will comply with IS: 1199 and IS: 516. Sampling procedure shall generally conform to IS: 456. Sampling frequency for each grade of concrete M20 and above shall be as per relevant IS codes.

In case, the stripping time for shuttering needs to be reduced or early age strength is required to be known in specific cases, the Contractor shall carry out at short notice testing of cubes at one (1) day and three (3) days after accelerated curing as per IS:9013. The required number of additional samples for the same shall also be taken.

To control the consistency of concrete from every mixing plant/machine, slump tests and/or compacting factor tests as per IS:1199 shall be carried out by the Contractor every two hours or as directed by the Owner/Owner's representative in addition to the slump measured when making test cubes.

Acceptance Criteria

Structural Criteria

Acceptance criteria of concrete shall be generally in accordance with IS: 456. Immediately after stripping the formwork, all concrete shall be carefully inspected and any defective work or small defects either removed or made good before the concrete has thoroughly hardened.

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. 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 Owner/Owner's representative.

Dimensional Criteria

The permissible variation from dimension, lines given in the drawing shall be within tolerances specified below. Wherever tolerances are not specified below the same shall be in accordance with the relevant IS codes/other applicable national/international standards or as indicated by the Owner/Owner's representative.

- Tolerances for R.C. Buildings :

i) Variation from the plumb

- In the lines and surfaces of columns, piers, walls and in arises. : 5 mm per 2.5 m or 25 mm, whichever is less

- For exposed corner columns and other conspicuous lines

In any bay or 5 m max. : 5 mm
In 10 m or more : 10 mm

ii) Variation from the level or from the grades indicated on the drawings

- In slab soffits, ceilings, beam soffit, and in arises

In 2.5 m : 5 mm
In any bay or 5 m max. : 8 mm
In 10 m or more : 15 mm

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- For exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines
 - In any bay or 5 m max. : 5 mm
 - In 10 m or more : 10 mm
- iii) Variation of the linear building lines from established position in plan and related position of columns, walls and partitions.
 - In any bay or 5 m max. : 10 mm
 - In 10 m or more : 20 mm
- iv) Variation in the size and locations of sleeves, - 5 mm except openings in walls and floors in the case of and for anchor bolts
- v) Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls
 - Minus (-) : 5 mm
 - Plus (+) : 10 mm
- vi) Footings
 - Variation in dimension in plan
 - Minus (-) : 5 mm
 - Plus (+) : 50 mm
 - Misplacement or eccentricity : 2% of footing width not more than 50 mm of misplacement but in the direction
 - Variation in thickness
 - Minus (-) : 5% of specified thickness subject to a max. of 50mm
 - Plus (+) : 100 mm
- vii) Variation in steps
 - In a flight of stairs
 - Riser : 3 mm
 - Tread : 5 mm
 - Inconsecutive steps
 - Riser : 1.5 mm
 - Tread : 3.5 mm
 - Tolerances in other Concrete Structures
- i) All structures other than those covered in ii) below.
 - Variation of the constructed linear outline from established position in plan
 - In 5 m : 10 mm
 - In 10 m or more : 15 mm

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- Variations of dimensions to individual structure features from established positions
 - In 20 m or more : 25 mm
 - In buried construction : 50 mm
- Variation from plumb, from specified batter or from curved surfaces of all structures
 - In 2.5 m : 10 mm
 - In 5 m : 15 mm
 - In 10 m or more : 25 mm
 - In buried-construction : Twice the above amounts
- Variation from level or grade indicated on drawings in slab, beams, soffits, horizontal grooves and visible arises
 - In 2.5 m : 5 mm
 - In 7.5 m or more : 10 mm
 - In buried construction : Twice the above amounts
- Variation in cross-sectional dimensions of columns beams, buttresses, piers and similar members
 - Minus (-) : 5 mm
 - Plus (+) : 10 mm
- Variation in thickness of slabs, walls, arch sections and similar members
 - Minus (-) : 5 mm
 - Plus (+) : 10 mm
- ii) Footing for columns, piers, walls, buttresses and similar members
 - Variation of dimension in plan
 - Minus (-) : 5 mm
 - Plus (+) : 10 mm
 - Misplacement or eccentricity
 - 2% of footing width in the direction of misplacement but not more than 50 mm
 - Reduction in thickness
 - 5% of specified thickness subject to a max. of 50 mm

Tolerances in other types of structures not covered above shall generally conform to those given in Recommended Practice for Concrete Formwork (ACI 347)

Tolerances in fixing anchor bolts and embedded parts shall be as follows :

- Anchor bolts without sleeves : (±) 1.5 mm in plan
- Anchor bolts with sleeves : (±) 5.0 mm in elevation
- For bolts upto and including 28 mm dia : (±) 5 mm in all directions
- For bolts 32 mm dia and above : (±) 3 mm in all directions
- Embedded parts : (±) 5 mm in all directions

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- Tolerances in precast members

i) Length

Upto 3 m	:	(±) 6 mm
3 m to 4.5 m	:	(±) 9 mm
4.5 m to 6 m	:	(±) 12 mm
Additional for every subsequent 6 m	:	(±) 6 mm

ii) Cross Section (Each direction)

Upto 50 cm	:	(±) 6 mm
50 cm to 75 cm	:	(±) 9 mm
Additional for every subsequent 25 cm	:	(±) 3 mm

iii) Straightness or bow (Deviation from intended line)

Upto 3 m	:	6 mm
3 m to 6 m	:	9 mm
6 m to 12 m	:	12 mm
Additional for every subsequent 6 m	:	6 mm

iv) Squareness

When considering the squareness of a corner, the longer of the two adjacent sides being checked should be taken as the base line. The shorter side should not vary in its distance from a perpendicular so that the difference between the greatest and shortest dimensions does not exceed the following limits.

Length of shorter sides up to and including 1.2 m	:	6 mm
Over 1.2 m but less than 2 m	:	9 mm
2 m and over	:	12 mm

For the purpose of this requirement, any error due to lack of straightness should be ignored; squareness should be measured with respect to the straight lines which are most nearly parallel with the features being checked.

v) Flatness

The maximum deviations from a 1.5 m straight edge placed in any position on nominally plane surface should not exceed 6 mm.

STORAGE AND HANDLING OF MATERIALS

Cement

Cement shall be stored in easily countable stacks with consignment identification mark above ground level in perfectly dry and watertight sheds. Bulk cement shall be stored in air tight containers. Cement shall be stored in a manner so as to facilitate removal of first-in first-out basis. Any cement considered defective by the shall not be used by the Contractor and shall be removed from the site immediately. Cement that has been in store for three months or more shall be tested for quality. Should at any time the Owner/Owner's representative has reasons to consider that any cement is defective, then irrespective of its origin, date of manufacture and manufacturer's test certificate,

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such cement shall be tested immediately at the Contractor's cost at an approved laboratory and until the test results are found satisfactory, the cement shall not be used on any work. The Contractor is not entitled to any claim of any nature on this account.

Coarse and fine aggregate

Aggregates shall be stored in easily measurable stacks 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 different stacks. If so desired by the Owner/Owner's representative, aggregate from different sources shall be stacked separately with proper care to prevent intermixing.

Any aggregate delivered at site in a wet condition or becoming wet at site due to rain or any other means shall be kept in storage for at least twenty four (24) hours to obtain adequate drainage before it is used for concreting or the water content of the mix must be suitably adjusted as directed by the Owner/Owner's representative.

Reinforcement

Reinforcement bars shall be stored off the ground under all circumstances and under cover, if so desired by the Owner/Owner's representative. If necessary, a coat of cement wash shall be given to bars to guard against rusting. Reinforcing steel shall be stored consignment wise and diameter wise.

5.5.6 Turbo Generator Foundations

Scope

This specification covers specific requirements in regard to formwork, staging and placing of concrete for the construction of turbo-generator foundation and pedestal. The requirements specified below shall be in addition to the general requirements as specified in Clause 5.5.5 for Plain & Reinforced Concrete Works". Although the specification covers the requirements for STG foundation, the same is applicable for GTG foundation also.

Codes and Standards

Unless specifically mentioned otherwise, all applicable codes and standards in their latest editions as published by the Bureau of Indian Standards and all other such as may be published by them during the currency of the Contract, shall govern in respect of design, workmanship, quality and properties of materials and methods of testing. Some of the relevant available codes are listed hereunder:

IS: 456	Code of practice for plain and reinforced concrete
IS: 2974(Part 3)	Code of practice for design and construction of machine foundation - Foundation for rotary type machines (Medium and high frequency).

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Formwork

Design of Formwork

The design of Form work shall take into account all vertical and lateral loads that the forms will carry or be subjected to, during the construction process. Besides weight and pressure of reinforced concrete and weight of the forms themselves, the design shall consider loadings due to unsymmetrical placement of concrete; impact from dumping of concrete; concentrated loads produced by storing materials on the freshly placed concrete; movement of men and construction equipment; wind action and any other imposed load during construction. Contractor shall assess the magnitude of vertical live load to be taken for design of formwork duly considering his method, sequence and rate of pour of concrete. However, minimum design vertical live load to be considered shall be 750 Kg/m² excluding weight of concrete.

Staging for the deck slab shall be supported directly from the TG raft independent of the TG pedestal columns already cast.

Side shuttering shall be designed to cater for concrete pressures, duly considering rate of pour, temperature of concrete, slump and rate of vibration. The column shuttering shall be designed for a rate of vertical pour not less than 4 metres per hour. For shuttering of deck slab of pedestal, the design rate shall not be less than 1.5 metres per hour. Concrete temperature for design purpose shall be taken to be 21°C (or 70°F) or less. Lateral pressures for design of forms shall be based on ACI Committee 622 Pressure Formula or CERA Research Report No.1 Pressure Design Chart. Following Table, based on ACI Committee 622 Pressure Formula, is given as guidance for assessing maximum lateral pressure for design of forms. Pressure in excess of 2400 Kg/m³ x height of fresh concrete in metres shall not be considered.

Rate of Concrete placement in metre per hour	Maximum lateral pressure in Kg/cm ² for temperature indicated		
	21° C (70°F)	15° C (60°F)	10° C (50°F)
1.5	3870	4395	5125
1.8	4500	5125	6005
2.1	5130	5860	6885
2.4	5750	6590	7765
3.0	7010	8055	9520
3.6	8265	9520	11280
4.2	9520	10985	13035

Materials for Formwork

Scaffolding, props, struts and bracings for the shuttering of TG pedestal shall be of structural steel. Plywood faced shuttering shall be used for achieving smooth exposed concrete finish.

Wall ties/through bolts

Through bolts, when used as wall ties, shall be in one single piece for the full length.

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Through bolt diameter and spacing should be designed to cater for entire lateral concrete pressure on the shuttering. In addition, side stays shall be provided to take atleast 50% of the specified design pressure.

Where use of through bolts is not feasible, the entire pressure shall be taken by side stays/props.

Welding of through bolts to reinforcement shall not be permitted.

Platforms/Windows

Suitable and adequate working platforms shall be provided at TG deck slab level, all round the TG pedestal for easy access for construction and inspection.

Adequate windows at maximum 2 m vertical spacings shall be provided in column shuttering for concreting, inspection and introducing vibrators. Arrangements should be made for closing tightly the windows to prevent loss of water and fine material from concrete, as the pour level overtakes the window level.

Inserts/Embedment

Inserts/embedment shall not be supported on or tied to reinforcement, but independently on shuttering. If the embedments are to be welded, separate rebars have to be provided for the purpose. Suitable arrangements shall be made to locate and fix them to shuttering. Stools shall be provided where required.

Main equipment foundation bolts, pipe sleeves and block-outs for pockets shall be placed and maintained in position at the top by means of an adequately braced steel template. While planning the template, care should be taken to ensure that it does not block the top of beam and that adequate free space is left to pour concrete from the top.

Placing of Concrete

Contractor shall furnish to Owner/Owner's representative together with formwork design, his proposed scheme for concreting the TG base raft and pedestal. The scheme shall indicate types of equipment, mobilisation of men and materials, standby arrangements and method, sequence and rate of pouring concrete. Work shall proceed only after Owner/Owner's representative's approval.

Concrete for TG raft and TG deck slab be cooled to a temperature of 23°C and adequate arrangements shall be made to ensure this. Concrete for columns shall be cooled if the least dimensions of column is more than 1.4m.

The base raft shall be cast in not more than two pours or as shown on the drawing. Full raft thickness shall be achieved in each continuous pour. Extent of each pour and sequence of pours shall be as directed by Owner/Owner's representative or as shown in drawing released for construction.

TG pedestal columns from top of base raft to bottom of TG deck etc., shall be cast in one single continuous pour, unless otherwise directed by Owner/Owner's representative or as shown in drawings released for construction.

TG deck slab shall be cast in a single pour without construction joints/cold joints. Successive layers shall be placed before initial set of previous layer or within one hour, whichever is earlier. For proper placement and vibration, the layers shall not be less than 500 mm thick.

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Chutes/tremie pipes of adequate dia (225 mm) shall be used to place concrete if the beams are more than 2 m deep and for this purpose, some top bars will have to be displaced temporarily to allow inserting of the same.

In areas where second stage grouting is to be done after the TG set is erected and aligned, the concrete shall be laid 50 mm higher than the actual level required and chipped back to exact required level. The concrete surface under equipment sole plates shall be ground to ensure a minimum contact area of 85%.

Tolerances in TG Foundation

Concreting of TG foundation (raft & pedestal) shall be to following tolerances in horizontal and vertical directions:

- Foundation dimensions : ± 10 mm
- Location of embedded anchor bolts : ± 5 mm
- Location of sleeves for piping and through holes for anchor bolt : ± 10 mm
- Others : As specified in Clause 4.5.0

Technical Specifications for
"Plain & Reinforced Concrete Work"

5.5.7 Prestressed Concrete

Scope

This specification covers the requirements in respect design, workmanship and quality of prestressed concrete structures. It is supplementary to and has to be read in conjunction with the specification of plain and reinforced concrete work in Clause 5.5.0.

Codes and Standards

Unless specifically mentioned otherwise, all applicable codes and standards in their latest editions as published by the Bureau of Indian Standards and all other such as may be published by them during the currency of the contract, shall govern in respect of design, workmanship and methods & procedures of testing. Some of the relevant available codes are listed hereunder.

- IS : 1343 Code of practice for the prestressed concrete.
- IS : 1785 Specification for plain hard drawn steel wire for prestressed concrete.
- IS : 6003 Specification for intended wire for prestressed concrete
- IS : 2090 Specification for high tensile bars for prestressed concrete.
- IS : 6006 Specification for uncoated stress relieved strand for prestressed concrete.

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Prestressing Steel

Prestressing steel shall conform to IS: 1785, IS: 2090, IS: 6003 and IS: 6006.

Non-tensioned Reinforcement

Non-tensioned reinforcement may be mild steel bars conforming to IS: 432 or high yield strength deformed bars conforming to IS: 1786.

For other materials refer specification for plain and reinforced concrete work.

Grades and Proportioning

For prestressed concrete construction, only controlled concrete shall be used. The design of the concrete mix shall conform to the requirements laid down for controlled concrete under relevant clauses of IS: 456, and the workmanship shall conform to specification for cement concrete subject to the following further conditions :

- The minimum cube strength of concrete at 28 days where ordinary portland cement is used, and at 7 days where rapid hardening portland cement is used on 15 cm cubes, shall not be less than 45 N/mm² for pre-tensioned system and 35 N/mm² for post-tensioned systems.
- The mix shall contain not less than 380 kg of cement per m³ of concrete for pre-tensioned work. The corresponding value of the post-tensioned work shall be 360 kg/m³ of concrete. The cement in the mix shall not normally exceed 530 kg/m³ of concrete.
- The mix shall contain as low a water content as consistent with adequate workability.
- The concrete shall be compacted thoroughly by vibration, pressure, shock, spinning or other means and shall have a density of not less than 24 KN/m³.

Workmanship

Workmanship and method of execution shall conform to the requirements of IS: 1343.

The type of jack, like hydraulic jack, etc. used for prestressing shall be standard type and of approved manufacture. The method of anchorage shall be also of approved type so as not to allow more than nominal slip in the wires. The anchorage shall be safe and secure against both dynamic and static loads as well as against impact.

Testing and Acceptance Criteria

Sampling, strength test and acceptance of precast prestressed members shall be in accordance with the provisions of IS:456 & IS:1343. The Contractor shall conduct load test on one random piece per batch or 1000 units precast. Load test on more than one piece per batch may have to be done if required by the Owner/Owner's representative. The Contractor shall inform the Owner/Owner's representative the number of units that would be cast in a single operation based on which the number of units to be tested will be decided. If a piece/unit fails in a load test the entire batch will be rejected.

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5.5.8 Structural Steelwork

Scope

This specification covers the requirements in respect of materials, workmanship and quality for preparation of fabrication drawings, supply, fabrication, inspection, testing, painting and erection of structural steelwork including tubular steel work for buildings and structures.

Codes and Standards

Unless specifically mentioned otherwise, all applicable codes and standards in their latest editions as published by the Bureau of Indian Standards and all other such as may be published by them during the currency of the contract, shall govern in respect of design, workmanship, quality and properties of materials and methods of testing. Some of the relevant available codes are listed here under:

IS:800	Code of Practice for use of structural steel in general building construction.
IS:801	Code of Practice for use of cold formed light gauge steel structural members in general building construction.
IS:806	Code of Practice for use of steel tubes in general building construction.
IS:808	Dimensions of hot rolled steel 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 mild steel.
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	Hot-rolled 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 steel work and Part VIII iron work.
IS:1239	Mild steel tubes, tubular and other wrought steel fittings.
IS:1363	Hexagon head bolts, screws and nuts of product grade C.

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IS:1364	Hexagon head bolts, screws and nuts of product grade A and B.
IS:1367	Technical supply conditions for threaded steel fasteners.
IS:1442	Covered electrodes for metal arc welding of high tensile structural steel.
IS:1608	Method for tensile testing of steel products.
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	Weldable structural steel.
IS:2074	Ready mixed paint, air drying, red oxide zinc-chrome, priming.
IS:2633	Methods of testing uniformity of coating on zinc coated articles.
IS:3757	High strength structural bolts.
IS:4000	High strength bolts in steel structures - Code of Practice.
IS:5369	General Requirements for Plain Washers and Lock Washers
IS:5372	Taper washers for channels (ISMC)
IS:5374	Taper washers for I-beams (ISMB)
IS:6610	Specification for Heavy Washers for Steel Structures
IS:6649	Specification for Hardened and Tempered Washers for High Strength Structural Bolts and Nuts
IS:6623	Specification for High Strength Structural Nuts
IS:7205	Safety code for erection of structural steelwork.
IS:7215	Tolerances for fabrication of steel structures.
IS:9595	Recommendations of metal arc welding of carbon and carbon manganese steels.
AISC	American Institute of Steel Construction Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.
SP6(4)	Hand book for use of high strength friction grip bolts.

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Structural steel

All structural steel shall be of tested quality and shall conform to IS:2062. High tensile steel, when supplied, shall conform to IS:961.

Bolts and nuts

Bearing bolts and nuts shall conform to IS:1363 and IS:1364 and unless shown or specified otherwise shall be hexagonal. All nuts shall fit tight. Mechanical properties shall conform to IS:1367. High strength friction bolts shall conform to IS:3757 and nuts to IS:6623.

Washers

Washers shall conform to IS:5369, IS:5372, IS:5374, IS:6610 and IS:6649 as applicable.

Plain washers shall be made of mild steel, unless otherwise specified. Spring washers shall be provided for those parts which carry dynamic loads and where black bolts for connection are permitted.

Electrodes

Mild steel electrodes shall conform to IS:814 and high tensile steel electrodes to IS:1442. The manufactures shall have ISO certification. The Contractor shall furnish to the Owner/Owner's representative a certificate issued by the manufacturer to the effect that the electrodes supplied are in accordance with the above specifications. For welding in any particular position, the electrodes used shall be those recommended by the manufacturer for use in that position.

Paints

Paints to be used for shop coat of fabricated steel shall be compatible with the finish coat specified.

Other Materials

Other materials used in association with steel work shall comply with the appropriate Indian Standard specifications.

General requirements regarding supply of materials by Contractor

Before ordering bought out items, special accessories, equipment etc. and materials of any description, the Contractor shall submit, for the approval of the Owner/Owner's representative, the names of the proposed manufacturers or suppliers together with the specification of the materials and shall, thereafter, send to the Owner/Owner's representative copies of the orders.

When a supplier or sub-Contractor orders materials for the execution of his sub-contract, he shall also comply with the aforesaid requirements, by the submission through the Contractor, for the approval of the Owner/Owner's representative, of the names of the manufacturers proposed and by sending to the Owner/Owner's representative of copies of the orders.

The Contractor shall furnish to the Owner/Owner's representative the following certificates, if required, before commencement of fabrication:

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- i) A certificate stating the process of manufacture and chemical composition of the steel supplied.
- ii) Test certificates by the manufacturer giving the results of each of the specified mechanical tests applied to the structural steel, bolts, nuts and washers and the chemical composition of the same.

Drawings and Lists

Unless otherwise stated, the Contractor shall be responsible for the preparation of the detailed fabrication/working drawings, erection and marking plans and all necessary lists such as indents, rivet and bolt lists, material lists, Despatch lists and lists for all bought out items. The fabrication drawings shall indicate the size of each component and length and sequence of all welds & bolted connections.

Fabrication work shall not be taken in hand until the relevant shop drawings have been approved by the Owner/Owner's representative. Although these drawings receive the approval of the Owner/Owner's representative, the Contractor shall be wholly responsible for their being correct and complete. The drawings shall be supplied at least two weeks in advance to enable the Owner/Owner's representative to study the drawings. One copy of the approved drawings will be returned to the Contractor and the work shall be carried out according to the approved drawings.

Fabrication

General

- Workmanship

All workmanship shall be equal to the best practice in modern structural shops. Greatest accuracy shall be observed in the manufacture of every part of the work and all similar parts shall be strictly interchangeable.

- Templates

Templates used throughout the work shall be all steel, steel bushed in such cases as the Owner/Owner's representative may consider necessary. In cases where actual materials have been used as templates for drilling similar pieces, the Owner/Owner's representative shall decide whether they are fit to be used as parts of the finished structure.

- Straightening

All materials shall be straight and if necessary before being worked shall be straightened and/or flattened by pressure unless required to be of curvilinear form and shall be free from twists.

- Clearance

The erection clearances for cleated ends of members connecting steel to steel should preferably be not greater than 2.0 mm at each end. The erection clearance at ends of beams without web cleats should be not more than 3 mm at each end, but where for practical reasons greater clearance is necessary suitably designed seatings should be provided.

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- **Shearing, flame cutting and planning**

Shearing or flame cutting may be used at the Contractor's option provided that a mechanically controlled cutting torch shall be used for the flame cutting and that the resulting edge shall be reasonably clean and straight. Sheared members shall be free from distortion at sheared edges.

The edges and ends of all flange plates and web plates of plate girders and built-up columns of plates, forming chords or web members of lattice girders and all cover plates, the ends of all angles, tees, channels and other sections forming the flanges of plate girders and columns and chords and web members of lattice girders shall be planed.

The ends of all stiffeners shall be planed or ground to fit tightly between the main angles or flanges. Care shall be taken to ensure a full bearing of the stiffeners at the supports and at other points where concentrated load is applied. The ends shall not be drawn or caulked.

The butting surfaces at all joints of girders or columns shall be planed so as to butt in close contact throughout the finished joint.

The ends of all built-up girders and of all columns shall be faced in a machine. The bearing surfaces of all slabs and plates for caps and bases of columns and for seatings for heavy girders shall be machined.

Unless clean, square and true to shape, all flame-cut edges shall be planed.

Cold sawn ends if reasonably clean and flame cut ends of sections not inferior to sawn ends in appearance need not be planed except for butting ends.

- **Holing**

Holes for black bolts shall be not more than 1.5 mm larger than the nominal diameter of the bolt, unless specified otherwise. All holes, except as stated here under shall be drilled to the required size or sub-punched 3 mm less in diameter and reamed thereafter to the required size. All matching holes for black bolts shall register so that a gauge 1.5 mm less diameter than the hole can pass freely through the members assembled for bolting. All holes for turned and fitted bolts shall be drilled and reamed, if necessary, to a tolerance of only plus 0.13 mm unless specified otherwise. When the number of thicknesses to be riveted exceeds three or the total thickness is 90 mm or more, the holes shall be drilled or reamed in position after assembly, except when steel-bushed jigs are used. The parts shall be firmly bolted together during such block drilling and taken apart for removal of burrs after drilling.

Holes in purlins, side sheeting, runners, packing plates and lacing bars may be punched full size.

All punching and sub-punching shall be clean and accurate and all drilling free from burrs.

No holes shall be made by gas cutting process.

- **Assembly**

All parts assembled for bolting shall be in close contact over the whole surface and all bearing stiffeners shall bear tightly at both top and bottom without being drawn or caulked.

The component parts shall be so assembled that they are neither twisted nor otherwise damaged and specified cambers, if any, shall be provided.

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- Bolting

Bolted construction shall be permitted only in the case of field connections, if called for on the drawings and is subject to the limitation of particular connections as may be specified. In special cases, however shop bolt connections may be allowed if directed by the Owner/Owner's representative. Unless otherwise specified, faces of heads and nuts bearing on steel work shall be machined. All such bolts shall be provided with washers having a hole of 1.6 mm larger in diameter than the barrel of bolt and thickness not less than 6.5 mm so that the nut, when tightened, shall not bear on the unthreaded body of the bolt. In all cases, where the full bearing area of the bolt is to be developed, the threaded portion of the bolt should not be within the thickness of the parts bolted together. The threaded portion of each bolt shall project through the nut by at least one thread. Tapered washers shall be provided for all heads and nuts bearing on beveled surface.

- High Strength Friction Grip Bolting

Installation of high strength friction grip bolts in joints shall comply with IS:4000 and/or BS:3294. The diameter of the bolt holes must not be more than 2.0 mm larger than the nominal diameter of the bolt. All contact surfaces in a connection including those associated with the bolt heads, nuts and washers, shall be free of scale, burrs, dirt and other foreign matter tending to inhibit uniform sealing of the joint components. However, tight mill scale and the light residual oil coating on bolts, nuts and washers need not be removed.

All fasteners in a joint shall be tightened to a tension equal to or greater than the tension specified in Table 3 of IS: 4000.

Tightening may be achieved by use of Direct tension Indication or part twin method. A hardened washer shall be placed under the element being turned. Bolts shall be tightened at the most rigid portion of the joint, proceeding towards the free edges. Procedure given in IS:4000 shall be followed.

Inspection of friction grip bolting shall ensure that the selected tensioning procedure has been correctly applied and all bolts are fully tensioned. The methods suggested in IS:4000 shall be used to check that all bolts are fully tensioned.

Welding

- General

The welding and the welded work shall conform to IS: 816 unless otherwise specified. The permissible stresses for welding shall be taken as 75 per cent of those specified in IS:816, where welds are not tested by either radiographic or ultrasonic methods. All butt welds in critical structures such as crane girders, heavy columns, bunkers, etc. shall be tested by either radiographic or ultrasonic methods. As much work as possible shall be welded in shops and the layout and sequence of the operations shall be so arranged as to eliminate distortion and shrinkage stresses to the satisfaction of the Owner/Owner's representative.

- Plant and equipment

The plant used shall be of sufficient capacity to suit the welding procedure laid down and be capable of depositing the particular type or types of electrodes to be used under the conditions of current and voltage specified by the electrode manufacturer. The number of welding sets, both automatic and hand operated proposed to be used in the work shop for fabrication of the structural steel work for the contract shall be given by the Bidder along with his tender. Efficient means shall be provided for the accurate indication of the current and in addition, a pair of tong testers shall be supplied by the Contractor and be available to the Owner/Owner's representative.

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All equipment, accessories and connections shall be maintained in proper working order.

- **Electrodes**

All electrodes shall be kept under dry conditions. Any electrode damaged by moisture shall not be used unless it is stated by the manufacturer that when it is properly dried, there will be no detrimental effect. Any electrode which has part of its flux coating broken away or is otherwise damaged, shall be discarded. Any electrode older than 6 months from the date of manufacture shall not be used. Low hydrogen electrodes shall be used for joints in material above 20 mm thick and all important connections.

- **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.

- **Welding procedure**

Before commencement of work the Contractor shall submit to the Owner/Owner's representative for his approval, the procedure proposed to be adopted. The welding procedure shall be arranged to suit the details of the joints as indicated on the drawings and the position at which welding has to be carried out. Welding procedure shall cover the following:

- i) Type and size of electrodes
- ii) Current and (for automatic welding) arc voltage
- iii) Length of run per electrodes, or (for automatic welding) speed of travel
- iv) Number and arrangement of runs in multi-run welds

When necessary the procedure shall also cover the following:

- v) Position of welding
- vi) Preparation and set up of parts
- vii) Welding sequence
- viii) Pre or post heating
- ix) Any other relevant information

- The welding procedure shall be so arranged that the distortion and shrinkage stresses are reduced to a minimum and that the welds meet the requirement of quality specified here under.

- The Contractor shall record the approved welding procedure and shall provide each operator with all relevant details. Alternative approved procedure may be furnished in such cases when it is desirable to make the fullest use of available plant. The welding procedure then laid down shall be strictly followed and no variation shall be permitted without the approval of the Owner/Owner's representative.

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- Preening of the welds involving deformation of the weld surface either during deslagging operation or thereafter, shall not be allowed.

Fusion faces and surrounding surfaces:

- Fusion faces and the surrounding surfaces within 50 mm of welds shall be free from all mill scale and free from oil, paint, or any substance which might affect the quality of the weld or impede the progress of welding. They shall be free from irregularities such as would interfere with the deposition of the specified size of weld or be the cause of defects.
- All mill scale within 50 mm of welds shall be removed prior to welding either by pickling at works followed by thorough power wire brushing or by other approved methods.
- If preparation or cutting of the fusion faces is necessary the same shall be carried out by shearing, chipping, gas-cutting or flame-gouging.
- Where hand gas cutting or hand-gouging is employed, the blow pipe or gouging blow pipe shall be properly guided.

Assembly for welding:

Parts to be welded shall be properly assembled and held firmly in position by means of jigs and clamps prior to and during welding.

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 or 25% of the thickness of thinner plate whichever is smaller shall be corrected and in making the correction the parts shall not be drawn into a sharper slope than two degrees (2 deg).

The work shall be positioned for flat welding whenever practicable.

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 minimise shrinkage stresses. Where it is impossible to avoid high residual 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 Owner/Owner's representative, 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 Owner/Owner's representative.

Welding technique

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 compact fusion throughout the entire cross-section. Groove welds made with the use of a backing of the same material as the base metal shall have the weld metal thoroughly fused with the backing

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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 specifications.

The effective area of fillet welds shall be considered as the effective length times the effective throat thickness. The effective length of fillet welds except fillet welds in holes and slots shall be the overall length of full size fillet, including returns.

The effective throat thickness of a fillet weld shall be the shortest distance from the root to the face of the diagrammatic weld.

The minimum size of weld is determined by the thicker of the two parts joined except that the weld size need not exceed the thickness of the thinner part joined unless a larger size is required by calculated stress. For this exception, particular care shall be taken to provide sufficient preheat for soundness of the weld. The minimum size of fillet welds are as follows.

Material thickness of thicker part joined	Minimum size of fillet weld	Minimum effective throat thickness of partial penetration groove welds
Upto 6 mm	3 mm	3 mm
6mm to 12 mm	5 mm	5 mm
12 mm to 19 mm	6 mm	6 mm
19 mm to 38 mm	8 mm	8 mm
38 mm to 57 mm	8 mm	10 mm
57 mm to 152 mm	8 mm	13 mm
Over 152 mm	8 mm	16 mm

The minimum effective length of a fillet weld designed on the basis of strength shall not be less than 4 times the nominal size (of weld) or else the size of the weld shall be considered not to exceed 1/4 of the effective length.

In intermittent welds the effective length of any segment of intermittent fillet welding shall be not less than 4 times the weld size with a minimum of 40 mm.

The minimum amount of lap on lap joints shall be 5 times the thickness of the thinner part joined but not less than 25 mm.

Side or end fillet welds terminating at ends or sides respectively of parts or members shall wherever practicable, be returned continuously around the corner for a distance not less than 2 times the nominal size of weld.

To get the best and consistent quality of welding, automatic submerged arc process shall be preferred. The technique of welding employed, the appearance and quality of welds made, and the methods of correcting defective work shall all conform to the relevant Indian Standards.

Preheating techniques combined with the use of low hydrogen electrodes shall be used for

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- i. Certain joint configurations as specified in the drawings and as directed by the Owner/Owner's representative.
 - ii. Welding involving plates over 20 mm thickness conforming to IS:2062.
- Temperature

No welding shall normally be done on parent material at a temperature below (-) 5 deg C. However, if welding is to be undertaken at low temperatures, 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 deg C and 0 deg 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 pre-heated till it is handwarm. When the parent material is more than 40 mm thick, the temperature of the area mentioned above shall in no case be less than 20 deg C. All requirements regarding preheating of the parent material shall be in accordance with the relevant Indian Standard.

The table below may be used as a guideline for preheat and interpass temperature to be maintained within 75 mm on either side of the point of welding.

Thickness of the thickest part at the point of welding other than low hydrogen welding electrodes	Minimum preheat & Interpass temperature	
	Low hydrogen welding electrodes	
Upto 20 mm	None	None
20 mm to 40 mm	65°C	20°C
40 mm to 63 mm	110°C	65°C
Over 63 mm	150°C	110°C

- **Accuracy of fit up:**

Parts to be fillet welded shall be brought into as close contact as practicable and the gap due to faulty workmanship or incorrect fit up shall not exceed 1.5 mm. If greater separation occurs at any position, the size of fillet weld shall be increased at such positions by the amount of the gap.

- **Jigs and manipulators:**

Jigs and manipulators shall be used where practicable and shall be designed to facilitate welding and to ensure that all welds are easily accessible to the operators.

- **End of butt welded joints:**

The ends of butt joints shall be welded so as to provide the full throat thickness. This may be done by the use of extension pieces, cross-runs or other means approved by the Owner/Owner's representative.

- **Weld face and reinforcement of butt welds:**

The weld face shall at all places be deposited proud of the surface of the parent metal. Where a flush surface is required the surplus metal shall be dressed off.

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- **Minimum leg length and throat thickness in fillet welds:**

The minimum leg length of a fillet weld as deposited shall be not less than specified size. In no cases shall a concave weld be deposited without specific permission of the Owner/Owner's representative. Where permitted, the leg length shall be increased above that specified, so that the resultant throat thickness is as great as would have been obtained by the deposition of a flat-faced weld of the specified leg length.

- **Deslagging:**

After making each run of welding all slag shall be thoroughly removed.

- **Quality of welds:**

The weld metal, as deposited (including tack welds if to be incorporated) shall be free from cracks, slag inclusions, gross porosity, cavities and other deposition faults. The weld metal shall be properly fused with the parent metal without serious undercutting or overlapping at the toes of the weld. The surface of the weld shall have a uniform consistent contour and regular appearance.

- **Working conditions:**

Welding shall not be done under weather or other conditions which might adversely affect the efficiency of the welding and where necessary effective protection or other safeguard shall be provided.

- **Qualification and testing of welders:**

The Contractor shall satisfy the Owner/Owner's representative that the welding operators are suitable for the work upon which they will be employed and shall produce evidence to the effect that welders have satisfactorily completed appropriate tests as described in IS:817. The Owner/Owner's representative may at his discretion order periodic tests of the welders and/ or of the welds produced by them. Such tests shall be at the expense of the Contractor.

- **Supervision:**

The Contractor shall employ a competent welding supervisor or charge-hand to ensure that the standard of workmanship and the quality of the materials comply with the requirements laid down in this specification.

Machining of butts, caps and bases

Column splices and butt joints of struts and compression members depending on contact for stress transmission shall be accurately machined and close butted over the whole section with a clearance not exceeding 0.2 mm locally. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc. after rivetting, bolting and/ or welding together as the case may be, should be accurately machined so that the parts connected butt over the entire surfaces of contact. Care should be taken that those connecting angles or channels are fixed with such accuracy that they are not reduced in thickness by machining by more than 2.0 mm.

Where sufficient gussets and bolts or welds are provided to transmit the entire loading or where connection is by full penetration butt welds, the column ends need not be machined.

Slab bases and caps, if applicable, shall be in one solid piece, and except when cut from material with surfaces, and shall be accurately machined over the bearing surfaces and shall be in effective contact over the whole area of the machined end of the stanchion. A bearing face need not be

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machined if it is to be grouted directly to a foundation provided it is true and parallel to the machined face. To facilitate grouting, holes shall be provided where necessary in stanchion bases for escape of air.

Shop painting

The whole of steel work with the exception of bolts and nuts and machined surfaces after being thoroughly cleaned to remove rust, loose scale, grease, dust etc. shall be given one shop coat of primer compatible with the finish paint. For epoxy based paints, surface preparation shall be by sand blasting. All rivets, bolts, nuts and washers etc. shall be thoroughly cleaned and dipped in boiled linseed oil. All machined surfaces shall be well coated with a mixture of white lead and tallow. Surfaces which are to be held in contact by bolting shall be painted before assembly, and the parts brought together while still wet. Unless specified otherwise, all surfaces inaccessible after bolting or intermittent welding shall be given two coats of approved paint before assembly. In the case of surfaces to be welded, the steel shall not be painted or metal coated within a suitable distance of any edges to be welded if the paint specified or the metal coating would be harmful to welders or impair the quality of the welds. Welds and adjacent parent metal shall not be painted prior to deslagging, inspection and approval. Parts which are to be encased in concrete shall not be painted or oiled.

Marking, packing and despatching

Each piece shall be distinctly marked before delivery, in accordance with an approved marking diagram and shall bear such other marks as will facilitate erection. For easy identification at site, a small distinguishing mark for each building shall be painted on each end of every member before despatch from fabrication shop. The fabricated steel work shall be despatched in such portions as may be found convenient for erection or as ordered by the Owner/Owner's representative.

All projecting plates or bars and all ends of members at joints shall be stiffened, all straight bars and plates shall be bundled, all screwed ends and machined surfaces shall be suitably packed and all rivets, bolts, nuts, washers and small loose parts shall be packed separately in cases so as to prevent damage or distortion during transit.

Erection

General

The material shall be verified with marking on the marking plan or shipping lists which shall be supplied by the Contractor.

Any material found damaged or defective shall be stacked separately and the damaged or defective portions be painted in distinct colour. Such material is to be dealt with under the orders of the Owner/Owner's representative without delay.

The field assembling of the component parts of a structure shall involve the use of method and appliances not likely to produce injury by twisting, bending or otherwise deforming the metal. No member slightly bent or twisted shall be put in place until the defects are corrected and members seriously damaged in handling shall be rejected.

All small bends or twists received by members shall be rectified before such members are put in place; any serious bends or damage shall be reported at once to the Owner/Owner's representative by the Contractor for instructions. The straightening of bent edges of plates, angles and other shapes shall be done by methods not likely to produce fracture or other injury.

Following the completion of the straightening of a bend or buckle, the surface of the metal shall be carefully inspected for evidence of incipient or other fractures.

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Setting Out

The Contractor shall assume full responsibility for the correct setting out of all steel work and erecting it correctly as per alignment and levels shown on the drawings and plumbing of vertical members. Datum points will be fixed by the Owner/Owner's representative near the work site. Notwithstanding any assistance rendered to the Contractor by the Owner/Owner's representative, if at any time during the progress of the work any error should appear to arise therein, on being required to do so, the Contractor at his own cost shall remove and amend the work to the satisfaction of the Owner/Owner's representative.

Field connections

All field connections in the trusses, columns, girders, framework etc. shall be welded, unless otherwise specified. Connection of purlins, girts and other unimportant members only may be bolted with black bolts, except where welded connections are required.

Use of "high strength friction grip" bolts in place of welding may be permitted for field connections at the discretion of the Owner/Owner's representative.

Field bolting

All relevant portions in respect of bolted construction of the Specification for Fabrication of Structural Steel work 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 galvanising.

All high tensile bolts shall be tightened to provide, when all fasteners in the joint are tight, the required minimum tension by any of the following methods.

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 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

Bolt length exceeding	Remark
8 times diameter or 200 mm	
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

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Bolts may be installed without hardened washers when tightening is done by the turn-of-nut method.

Bolts-tightened by the turn-of-nut method may have the outer face of the nut 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.

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. 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)	Torque to be applied (Kg.M) for Bolt class 8.8 of IS:1367
20	56.93
22	81.63
24	103.73

In either case of the above two methods if required, because of 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.

Field welding

All field assembly and welding shall be executed in accordance with the requirements for shop fabrication, excepting such as manifestly apply to shop conditions only. Where the steel has 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.

Bedding and grouting

Bedding shall be carried out with cement grout or mortar having a compressive strength of 250 kg per sq. cm at 28 days for main column bases and 200 kg per sq. cm at 28 days for secondary column bases. For the main column the Contractor shall provide screed bars of mild steel flats and fix them in mortar. The Owner/Owner's representative will be the sole authority in deciding "main"

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and "secondary" columns and his decision in this matter will be binding on the Contractor within the terms of this contract.

The bedding shall not be carried out until a sufficient number of columns has been properly aligned, levelled and plumbed and sufficient girders, beams, trusses and bracings are in position to the satisfaction of the Owner/Owner's representative.

Immediately before grouting, the space under the base plate and around bolts shall be thoroughly cleaned and made free from excessive moisture.

The grout or mortar shall be mixed as thick as possible consistent with fluidity and shall be poured under pressure with pressure grouting machine, until the space has been filled with mortar. Admixtures, if directed to be added will be measured and paid separately. If desired, ready mix high strength non-shrink grout of specified strength shall be used.

Painting after erection

Before painting of steel which is delivered unpainted is commenced, all surfaces to be painted shall be dry and thoroughly cleaned of all loose scale, rust, dust, grease, etc.

The specified protective treatment shall be completed after erection. All rivet and bolt heads and the site welds after deslagging shall be cleaned. Damaged or deteriorated paint surfaces shall be made good first with the same type of paint as the shop coat. Where specified, surfaces which will be in contact after site assembly shall receive a coat of paint (in addition to any shop priming) and shall be brought together while the paint is still wet.

Surface which will be inaccessible after site assembly shall receive the full specified protective treatment before assembly.

Site painting should not be done in frosty or foggy weather or when humidity is such as to cause condensation on the surface to be painted.

Two or more final coats of approved paint as specified shall be applied to the steel work after erection.

Correction of misfits

Correction of minor misfits, a reasonable amount of reaming and cutting of excess-stock from rivets will be considered a legitimate part of the erection.

Any error in shop work which prevents the proper assembling and fitting up of parts by the moderate use of drift pins or a moderate use of reaming and slight chipping or cutting shall immediately be reported to the Owner/Owner's representative and his approval of the method of correction obtained.

Testing and Acceptance Criteria

General

The Owner/Owner's representative shall have free access at all reasonable times to those parts of the manufacturer's works which are concerned with fabrication of the steel work and shall be afforded all reasonable facilities for satisfying himself that the fabrication is being undertaken in accordance with the provisions of this specification.

Unless specified otherwise, inspection shall be made at the place of manufacture prior to despatch and shall be conducted so as not to interfere unnecessarily with the operation of the work.

Tolerance for fabricated structures shall be as per IS:7215.

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Should any structure or part of a structure be found not to comply with any of the provisions of this specification, it shall be liable to rejection. No structure or part of the structure, once rejected shall be resubmitted for test, except in cases where the Owner/Owner's representative considers the defect as rectifiable.

Defects which may appear during fabrication shall be made good with the consent of and according to the procedure laid down by the Owner/Owner's representative.

All gauges and templates necessary to satisfy the Owner/Owner's representative shall be supplied by the manufacturer.

The Owner/Owner's representative may, at his discretion, check the test results obtained at the manufacturer's works by independent tests at the Government Test House or elsewhere.

When all tests to be performed in the Contractor's shop under the terms of this Contract have been successfully carried out, the steel work will be accepted forthwith and the Owner/Owner's representative will issue an acceptance certificate, upon receipt of which, the items will be shop painted, packed and despatched. No item is 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/Owner's representative to accept the work, should it, on further tests before or after erection, be found not in compliance with the Contract.

Tolerances

- Fabrication

Tolerances for fabrication of structures shall be generally as per IS:7215.

In particular the acceptable fabrication tolerances for various parameters are given below:

- Length

- Length of strut finished for tight bearing contact : (±) 1 mm
- Length of any other member upto and including 12 m : (+) 0, (-)3.0 mm
- Length of any other member over 12 m : (+) 0, (-)0.00025 L subject to a max. of (-)5.0 mm

- Width

- Width of built-up girders (plate girders) : (±) 3 mm
- Deviation in the width of members required to be inserted in other member : (+) 0, (-)2 mm

- Depth

- Depth of girders (measured at centreline of web) for depths upto 4 m : (+) 3, (-)2 mm
- -do- for depths over 4 m : (+) 4, (-)3 mm

- Sweep, Camber

- Deviation from straightness in plan (Sweep) : 0.001 L subject to max. of 10 mm

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- Deviation in elevation convexity (Camber) : (+)5 mm, (-)0
- Deviation of centreline of web from centreline of flanges in built-up members at contact surfaces : 3 mm
- Deviation from flatness of plate webs of built-up members in a length equal to the depth of the member : 0.005 d subject to max. of 10 mm

Tilt of flange of plate girders

- at splices & stiffeners, at supports, at the top flanges of crane girders, at bearings : 0.005 b subject to max. of 2 m
- at other places : 0.015 b subject to max. of 4 mm
- Deviation from squareness of flange to web of box columns and box girders : ($\pm$) 3 mm
- Deviation from squareness of fixed base plates to axis of column. This dimension shall be measured parallel to the longitudinal axis of the column at points where the outer surfaces of the column sections make contact with the base plate
- Deviation from squareness of machined ends to axes of columns : 0.5 mm
- Deviation from squareness of machined ends to axes of beam or girder : 0.6 mm

In addition to the above tolerances, the fabrication of crane girders shall comply with the following:

- Top flanges shall be as flat as possible and the cross camber over the central width of 150 mm shall not exceed 0.6 mm with the convex surface upwards. Crane girder with a concave surface over the central width of 150 mm will not be accepted.
- Webs will be flat and straight and shall not vary from the intended line by more than 2 mm measured at the top flange.
- Gantry girders shall be straight with SWEEP not exceeding 3 mm in 12 m length of the girder. CAMBER shall not exceed 3 mm in 12 m length.
- The tolerance on the overall depth of crane girders without their bearings shall be ($\pm$) 2 mm.

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 Owner/Owner's representative considers the defects rectifiable. The Owner/Owner's representative may, at his discretion, check the test results obtained at the Contractor's works by independent tests at an approved laboratory.

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Erection

- Columns
- Shifting of column axis at foundation with respect to building both in longitudinal & lateral direction : (±) 3 mm
- Out of plumbness (verticality) of column axis from true vertical axis as measured at column top
- For column upto 10 m height : (±) 5 mm
- For column exceeding 10 m 10 m height : (±) 1/2000 of column height but not more than 15 mm
- Deviation in the level of bearing surface of columns at foundation top with respect to true level : (±) 3 mm
- Deviation in bearing levels for beams, trusses . etc. with respect to true level : (±) 3 mm
- Difference in bearing level between adjacent column both across and along the building : (±) 6 mm
- Difference in erected position at adjacent pairs of columns along the length or across the width of building prior to connecting trusses/beams with respect to true distance : (±) 10 mm
- Trusses/Beams
- Deviation at Centre of span of upper chord from vertical plane running through of truss or of chord and perpendicular to plane at truss/beams : 1/250 of depth member 20 mm whichever is less
- Lateral displacement of top chord at centre of span from vertical plane running through centre of supports : 1/1500 of the span or 10 mm whichever is less
- Lateral shift in location from it true line of purlin/beam : (±) 5 mm
- Crane Girders & Rails
- Difference in levels of crane girder/crane rails measured between adjacent columns : 5 mm
- Difference in levels of crane rails (across the building)
- Over the supports : 10 mm
- At the mid span of girders : 15 mm

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- Difference in level of flange of successive girders at connection : 1 mm
- Deviation in the crane rail level at any point from true level : (±) 5 mm
- Difference in crane rail actual levels between any two points 2 m apart along the rail length : 2 mm
- Relative shift of crane rail surfaces at a joint in plan and elevation : 2 mm subject to grinding of Surfaces for Smooth transition
- Relative shift in the location of crane stops (end buffers) along the crane tracks : 1/1000 of track gauge to a max. of 20 mm
- Deviations of crane rail axis from centerline of web : (±) 3.5 mm
- Deviations in alignment of crane rail in plan measured between any two points 2 m apart : 1 mm
- Deviation in crane rail gauge : 5 mm

5.5.9 Brickwork & Plastering

Scope

This specification covers the requirements in respect of materials, workmanship and quality for brickwork and plastering.

Codes and Standards

Unless specifically mentioned otherwise, all applicable codes and standards in their latest editions as published by the Indian Standards Institution and all other such as may be published by them during the currency of the Contract, shall govern in respect of design, workmanship, quality and properties of materials and method of testing. Some of the relevant available codes are listed hereunder:

Brick work

- IS:1077 Common burnt clay building bricks
- IS:1542 Sand for plaster
- IS:1661 Code of practice for application of cement and cement-lime plaster finishes
- IS:2166 Sand for masonry mortars
- IS:2212 Code of practice for brickwork
- IS:2250 Code of practice for preparation and use of masonry mortars
- IS:2691 Burnt clay facing bricks

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IS:3495 Methods of tests of burnt clay building bricks

IS:3696 Safety code for scaffolds and ladders

IS:5454 Methods of sampling of clay building bricks

Materials

Cement

Cement used shall conform to IS:269, IS:455 or IS:1489

Sand

The sand shall be approved river or pit sand and it shall conform to IS:2116 for masonry mortar and to IS:1542 for plaster mortar.

Bricks

The bricks used shall be at least chamber burnt second class (class B) bricks conforming to IS:1077 having a minimum compressive strength of 35 kg/cm². Bricks are to be whole, uniform texture, sound, well burnt, free from cracks, square and well shaped, uniform in size, uniform red cherry or copper colour and shall emit a clear ringing sound when struck. Slight distortion or rounded edges are permitted provided no difficulty arises during laying of uniform course.

Water absorption after 24 hours immersion shall not exceed 20% by weight. Dimensional tolerance shall not exceed 8%. Laboratory test has to be conducted to ascertain the same. Representative samples shall be submitted and approved samples shall be retained by the Owner/Owner's representative for future comparison.

Storage and Handling

Bricks shall not be dumped at site. These shall be stacked in regular tiers on firm ground, even as these are unloaded, to minimize breakage and defacement of bricks. Bricks selected from different situation of use in the work shall be stacked separately. The broken bricks shall not be used in the masonry and shall be separated from the lot being used for masonry works.

Workmanship

Brick work

The whole of the brickwork shall be carried out by the Contractor in a uniform manner.

All the bricks shall be kept under water till they are completely soaked and used on the works on their becoming skin dry.

The Contractor shall set out and build all brickwork to the dimension, thickness and heights shown on the drawings. The Contractor shall build all brickwork in English bond and half brick walls and casing to pipe, chases etc in stretcher bond. Brickbats shall not be used except where required for bond.

The Contractor shall lay bricks in full mortar beds with shoved joints. The joints are not to exceed 10 mm in thickness and are to be full of mortar, close, well finished and neatly struck. The vertical joints in any course shall not be nearer than quarter of a brick length from those in the course below. All joints shall be of same width except for small variations to maintain bond. The brickwork

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shall be laid plumb and trim to line and level. No portion of brickwork shall be raised more than 1 metre above another at one time. If the mortar in any course has begun to set, the joints shall be raked out before another course is laid. The top course of brickwork in reinforced concrete framed structure shall be wedged against reinforced concrete surface and joint well filled with mortar.

The Contractor shall flush up thoroughly with mortar all joints as the work proceeds. Where brickwork is to receive plaster, the joints shall be raked to a depth of 12 mm to provide proper bond.

The brickwork as it progresses shall be thoroughly watered on its faces and top. New work shall be properly bonded with the old work. The surface of unfinished work shall be cleaned and thoroughly wetted before joining new work to it.

Any work in which the mortar perishes shall be dismantled and rebuilt by the Contractor at his own expense.

The Contractor shall carry out work in as clean a manner as possible and shall remove excess material and mortar droppings daily.

Where brick walls, are to receive plaster, excess materials and mortar droppings shall be removed and the surface shall be brushed clean.

During cleaning operations, adjacent work shall be protected and any damage resulting from improper protection shall be made good by the Contractor at his own cost.

Reinforcement if shown in the drawing shall be provided fully embedding in mortar after thoroughly cleaned. These shall be lapped with dowels if left in RC columns or welded to steel columns.

Encasing of structural steel 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 Owner/Owner's representative. The minimum lap in chicken wire mesh shall be 50 mm. Other steel embedment shall be generally embedded in mortar and masonry unit shall be cut as required.

Plastering

Unless otherwise specified, all plaster work shall be carried out according to IS:1661. The thickness and proportion of cement plaster shall be as specified in the drawing.

The surface to be plastered shall be cleaned of all extraneous matter and rubbish. In brickwork the joints shall be raked and concrete surface roughened by chipping or hacking. Any shuttering material adhering to the concrete shall be removed. The Contractor shall make plaster pads of the required thickness of plaster for correctness of plumb, line and level. The surface shall be thoroughly watered and soaked and aerated and all holes shall be closed before starting plastering operation.

Plaster, when more than 15 mm thick shall be applied in two coats - a base coat followed by the finishing coat. Thickness of under coat shall be of sufficient to fill up all unevenness in the surface, no single coat, however, shall exceed 15 mm in thickness.

For one coat plaster work, the plaster shall be laid slightly thicker than the specified thickness and the surface then levelled with flat wooden rule to the required thickness. The plaster shall be well pressed into the joints and the surface finished as specified.

For two coats of plaster work, the first coat shall be applied as described above except that the surface shall be left rough and keys formed for the application of second coat. The second coat shall be applied a day or two after the first coat has set, but the first coat shall not be allowed to dry.

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The second coat shall consist of mortar ground very fine and shall be laid on with a wooden rule to a specified thickness, rubbed smooth and levelled and the surface plastered completely the same day. The levelling shall be continued till the plaster is quite dry and all moisture which exudes from the plaster shall be wiped off with a fine cloth. The surface shall be kept dry until exudation of moisture ceases, during the process of rubbing.

Finish

- Sand faced plaster

The plaster shall be applied in two coats. The first coat or the scratch coat should be approximately 14 mm and shall be continuously carried out without breaks to the full length of wall or up to 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 finish coat. The scratch coat shall be cured for at least 7 days and then allowed to dry.

The second coat shall be 6 mm thick and it shall not be applied until at least 10 days have elapsed after the application at second 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 and without joints, finish shall be straight, true and even. Only approved river sand shall be used for the second coat and for finishing work. Sand for finish shall be of even coarse size and shall be dashed on the surface and sponged.

- Plaster-of-Paris Punning

Plastered surfaces, where specified, shall be finished with plaster-of-paris punning. The thickness of punning shall be 2 mm and shall be applied by skilled workman. The finish shall be smooth, even and free from undulation. Before bulk work is taken in hand, a sample of punning shall be done on roughly 1 sq.m area and approval of the Owner/Owner's representative taken. The work shall be taken then in hand as per approved sample.

Curing

The brick shall be cured for a period of fourteen (14) days after laying and the plaster shall be cured for a period of seven (7) days.

Expansion & Separation Joints

Location and details of expansion joints shall be strictly as shown in the drawings. Expansion joint filler boards and sealing strips shall have minimum transverse joints. Transverse joints shall be approved by the Owner/Owner's representative.

Separation joints shall be with standard water proof paper or with alkathene sheets about 1 mm in thickness. Length and sealing of laps shall be to the satisfaction of the Owner/Owner's representative.

Damp Proof Course

The proportion of cement to aggregates shall be 1:2:4 using 6 mm down stone chips with a water proofing admixture. The percentage of waterproof admixture shall be as per manufacturer's specification but not less than 1% by weight of cement. The brick masonry surface shall be levelled, flushed up and prepared as directed to receive the damp-proof course. The thickness of damp proof course shall be 40 mm. In masonry walls of buildings it shall normally be placed above the external ground level. It shall be laid for the full width of the wall. The top surface shall be kept rough or ribbed for mortar for brickwork coming over it, for proper adhesion. All exposed surfaces of the damp-proof course shall be finished fair and smooth. It shall be cured for at least 7 days. After the

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surface has partially set, hot bitumen shall be applied in two coats at the rate of 1.7 kg / sq.m per coat and dry sand spread over it.

5.5.10 Sheeting Work in Roof and Siding

Scope

This specification covers the requirements in respect of materials, workmanship and quality for sheeting work in Roof and Siding of Buildings.

Codes and Standards

Unless specifically mentioned otherwise, all applicable codes and standards in their latest editions as published by the Bureau of Indian Standards and all other such as may be published by them during the currency of the Contract, shall govern in respect of design, workmanship, quality and properties of materials and methods of testing. Some of the relevant available codes are listed hereunder:

IS : 277	Galvanised steel sheets.
IS : 730	Hook bolts for corrugated sheet roofing.
IS : 2096	Asbestos cement flat sheets.
IS : 5119	Laying and finishing sloped roof coverings.
IS:1726	Sheet metal rain water pipes.
IS : 8869	Washers for corrugated sheet roofing.
IS :12866	Fibre glass reinforced plastic sheets.

Materials

Roof and Side sheeting shall generally be of the following types of materials.

- Aluminium Sheet (AL)
- Galvanised Iron (GI)/Galvanised Steel (GS)
- Fibre Glass Reinforced Plastic (FRP)
- Colour Coated steel sheets

Aluminium Sheet (AL)

Aluminium sheets and accessories shall be of INDAL (Indian Aluminium Company) brand or approved equivalent.

Aluminium roofing and siding shall be of the following types as indicated in the drawings.

- Corrugated
- Troughed

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Aluminium sheets shall be 0.71 mm and 0.56 mm thick for roof and side sheeting respectively unless otherwise specified.

Flashing ridge etc. shall be of plain aluminium sheets.

Galvanized Iron/Steel Sheet (GI/GS)

Galvanised sheets shall be zinc coated cold rolled sheets, confirming to class 3 of IS 277 and of the following types.

- a) Corrugated
- b) Plain

Galvanised sheets shall be of 1 mm (20G) corrugated sheets for roofing, 0.8 mm (22G) corrugated sheets for side sheeting, flashing etc and 1 mm(20G) plain sheets for ridges, flashing gutters etc unless otherwise specified.

Fibre-glass reinforced plastic sheets (FRP)

Fibre glass reinforced plastic sheets shall conform to IS: 12866 and shall be translucent or opaque as shown in drawing. These sheets shall be shatterproof and should not crack, chip or rot.

The sheets shall have uniform thickness, translucency (if specified) and strength. The sheets shall be of approved manufacture and shall match the roofing profiles.

Wherever necessary and as shown in the drawing, caulking shall be of non-hardening and non-staining type.

Colour Coated Sheets

- Permanent colour coated sandwiched insulated metal cladding system

Troughed zinc - aluminium alloy coated (both sides) MS sheet having 0.6 mm minimum thickness (or high tensile steel sheet of 0.5 mm 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 (min) over primer. Inner side of external sheet shall be provided with suitable pre-coating of minimum 7 microns.

Galvanized MS sheets of minimum 0.6 mm 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 (min) 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 150 gm /sq .m.

The permanent colour coated sheet shall meet the general requirements of IS : 14246 and shall conform to class 3 for the durability.

Inner sheet shall fixed directly to side runners and Z spacers made 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 1.50 m center to center to hold the insulation and external sheeting.

The insulation shall be of bonded mineral wool of minimum thickness 50 mm conforming to IS : 8183, having a density of 32 kg / cu.m for glass wool & 48 kg /cu.m for rock wool.

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- **Permanent colour coated (non-insulated) metal cladding system**

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 of 0.5 mm 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.

General

The Contractor shall also supply all necessary, special fittings, fasteners, flashings, caulking etc. required for installation of the sheets in strict accordance with manufacturer's instructions.

Roof & siding sheets shall be capable of withstanding 200 kg/sq.m wind loads. Wind tie of 40 mm x 6 mm GI flat shall be fixed at the two eaves end of the roof slopes. Fixing shall be done with the same bolts which secure sheets to the purlins. Slot holes shall be cut in the wind ties to allow for temperature variations.

Installation

Aluminium Sheets

Aluminium sheets shall be fixed with aluminium fasteners along with aluminium curved/flat washers with bituminous felt, neoprene or rubber washers. Generally manufacturer recommendations shall be followed.

Galvanised Sheets

Galvanised sheets shall be fixed with minimum 150 mm and 100 mm end laps for roof and side sheets respectively, unless higher laps are specified by the manufacturer or in the drawings. Side laps shall be as per manufacturer's recommendations. Unless otherwise specified, 10 mm and 8 mm dia GI Hook/J Bolts shall be used for roof and side sheets respectively. 6 mm dia GI seam bolt and nut with GI round washer/limpet washer shall be used for stitching of roof sheets/fixtures and GI round washer/diamond washer for side sheets. There shall be at least three hook bolts at the ridges of corrugations in each sheet in every purlin and their spacing shall not exceed 300 mm. Seam bolts shall be placed zigzag on overlapping corrugations, with spacing not exceeding 600 mm in each staggered row. Ridge pieces shall be fabricated from 600 wide (girth) sheets with a radius of curvature of 50 mm unless specified. For fixing requirements not specified here, manufacturer's recommendations shall be adopted.

Colour Coated Sheets

Installation procedure and fixing details shall be generally in line with that for GI sheets. The sheets shall be fixed with J or L polymer coated bolts, polymer caps, seal washer and thrust washer. Spacing of bolts etc. shall be identical to GI sheets.

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Acceptance Criteria

The installation shall present a neat appearance and shall be checked for water-tightness. The following shall be checked.

- Side and end laps.
- Absence of holes or damages in sheet.
- Spacing of bolts.
- Provision of double washers.
- Proper installation of flashings, wind ties etc.

5.5.11 Floor and Floor Finishes

Scope

This specification covers requirements in respect of material, workmanship and quality for soling, concrete floor and floor finishes work.

Codes and Standards

Unless specifically mentioned otherwise, all applicable codes and standards in their latest additions as published by Bureau of Indian Standards and all other such as may be directed published by them during currency of the contract, shall govern in respect of design, workmanship, quality and properties of materials and method of testing. Some of the relevant available codes are listed here under:

IS:777	Specification for glazed earthenware wall tiles.
IS:2114	Code of practice for laying in situ terrazo floor finish
IS:2571	Codes of Practice for laying in-situ concrete flooring
IS:3461	Specification for PVC Asbestos floor tiles.
IS:3462	Specification for unbacked flexible PVC flooring.
IS:4457	Ceramic unglazed vitreous acid-resistant tiles
IS:5318	Code of practice for laying PVC flooring.
IS:5491	Code of practice for laying in-situ granolithic concrete floor topping

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Boulder Soling

The boulders for soling shall be granite, basalt or similar hard stone approved by the Owner/Owner's representative and generally shall be 230 mm thick. The sub grade shall be dressed to correct level and shall be rammed or rolled to proper consolidation before laying the soling. Stones shall be placed close to each other. The specified thickness shall be made up in one or more layers depending on thickness. The voids between the stones shall be hard packed first with smaller pieces and hammered into place so as to completely fill up the void along with murum as binding material and the layer is watered and is compacted by roller/mechanical compactor. In case of building enclosing heavy machinery like Gas turbine/Steam turbine, the compaction shall be by roller of 8/10 MT capacity.

Cement Concrete Flooring

Materials

Requirements given in Section 5.5.5 shall be applicable.

Workmanship

The workmanship shall generally conform to the specification for Plain & Reinforced concrete (Section 5.5.5) and also to IS:2571. For ground floor slab or paving in open area, where the slab has to be laid over a consolidated ground, soling, a kraft paper shall be spread over the area and kept moist before concreting.

The floor shall be laid in alternate panels, of size not exceeding 4 m to reduce risk of cracking, intermediate panels being filled in after two or three days. For paving in open area, contraction joint and expansion joints shall be provided as per IS specification. The expansion joints shall be filled with bitumen impregnated boards 25 mm thick of approved manufacturer and top 25 mm shall be covered with approved mastic sealing compound.

Floor Finishes

Indian Patent Stone (IPS) with ironite topping

It shall consist of a under bed and a topping laid on an already laid and matured concrete base.

- Thickness

The total thickness of finish shall be 40 mm of which the topping shall be 12 mm. While the topping shall be uniform thickness the under bed may vary in thickness to provide necessary slopes.

- Mix

For underbed, it shall be 1:2:4 mix using 10 mm down graded stone chips.

For toppings of heavy duty, the proportion of metallic hardener shall be strictly as specified by the manufacturer. In absence of such direction, one (1) part of metallic hardener shall be mixed dry with 4 parts of cement by volume. To this mixture, 6 mm nominal size stone chips shall be added in portion of 1:3 (mixture of hardener & cement : stone chips) by volume. Minimum quantity of water to be added to make it workable.

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- **Laying**

The topping 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 latter has already been 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 under bed then laid, compacted and levelled 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 troweled to a dense finish to the satisfaction of the Owner/Owner's representative. All trowel marks shall be mopped out with a cloth to give a clean smooth surface.

- **Curing**

After the surface is sufficiently set, the finished floor shall be kept moist for 7 days for curing.

Indian Patent Stone (IPS) with non-metallic surface hardener finish

It shall consist of an underbed and a topping on which the hardener shall be laid.

- **Thickness**

The total thickness of finish shall be 40 mm of which the topping shall be 12 mm including the hardener finish.

- **Mix**

Mix for underbed and topping shall be same as for IPS flooring.

- **Hardener**

Hardener shall be non-metallic abrasion resistant surface hardener NITOFLOHARDTOP or equivalent.

- **Laying**

The topping and underbed shall be laid as for IPS flooring. While the topping is still green, the hardener shall be applied by dry shake-on system. Cleaning of surface, surface preparation, curing and trowel finish shall be as per manufacturer's specifications and recommendation. The surface hardener application rate shall be as follows:

Heavy duty	:	7 kg/m ²
Medium duty	:	5 kg/m ²
Light duty	:	3 kg/m ²

Precast Terrazo Tile Finish

It shall consist of manufactured terrazo tiles and an underbed.

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- **Thickness**

The total thickness of finish including underbed shall be minimum 40 mm for floors and 30 mm for skirting. The skirting shall project 6 mm out from the adjacent wall finish. The necessary cutting into the surface receiving tile finish shall also be done.

- **Tiles**

The tiles shall be hydraulically pressed under strict quality control in a shop. The size of tiles shall be 250 x 250 x 20 mm unless otherwise specified. The topping of tiles shall not be less than 10 mm. Maximum tolerance allowance in length & breadth shall be ± 1 mm and the thickness ± 3 mm. All angles of tiles shall be right angles, all arises sharp and true, colour and texture of wearing face uniform throughout, and face shall be plane, free from pin holes and other blemishes.

The topping of tiles shall be composed of cement, (grey or white or mixture of two) colour pigment, marble dust and marble chips (chips size 3 to 20 mm) in such a proportion so as to produce the desired colour, texture & pattern approved by the Owner/Owner's representative.

The backings shall be composed of 1 part of ordinary grey cement, 1 1/2 part of sand and 3 parts of 6 mm down graded stone chips mixed with water. 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 stored carefully to prevent staining of damp, rust, oil and grease or other chemicals.

- **Underbed**

The underbed for floor shall consist of a mix of 1 part cement, 1 1/2 parts coarse sand and 3 parts machine crushed 10 mm down stone chips by volume. For skirting, the mix shall consist of 1 part cement and 3 parts coarse sand. Only sufficient water to be added to give workable consistency.

- **Laying**

The underbed mortar shall be evenly spread and brought to proper grade and consolidated. The surface shall be roughened for better bond. Before the underbed has 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 tiles shall immediately be placed upon and firmly pressed by wooden mallet onto 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 also as possible and not more than 1.5 mm wide.

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 Owner/Owner's representative taken.

The floor tiles shall atleast enter 12 mm under the skirting tiles.

After fixing, the floor shall be kept moist and allowed to mature undisturbed for 14 days.

Aluminium or glass dividing strips shall be used for forming the panels.

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- **Grinding and Polishing**

After sufficient curing, the surface shall be ground with fine grit blocks. It shall again be cleared with water, the slurry (mixture of cement & pigment) applied again to fill up any pinholes might have appeared and allowed to be cured again for five days. The surface is ground again with very fine grit blocks to get smooth surface without any pinhole. The grinding shall be done by a suitable machine. Where grinding machine cannot be used, hand grinding may be allowed. The choice of grit blocks at different stages of polishing shall be as per manufacturer's recommendations.

The surface shall be cleaned with water, dried and covered with oil free clean saw dust if directed by the Owner/Owner's representative. The final polishing shall be postponed till before handing over if so desired by the Owner/Owner's representative.

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. If desired by the Owner/Owner's representative, wax polish shall be applied. However, all excess wax polish to be wiped off and surface to be left glossy but not slippery.

Acid Resistant Tile Finish

This shall include all varieties of special tiles used for specific chemical/acid resistance function and an underbed over already laid concrete or masonry.

- **Thickness**

The total thickness of finish shall be 50 mm of which the tile shall be 25 mm, acid proof mortar 6 mm, bitumen 3 mm and cement mortar underbed 15 mm.

- **Tiles**

The tiles shall be of best approved manufacture, conforming to IS:4457 and resistant to the chemical likely to come in contact. The tiles shall have straight edges, uniform thickness, plain surface, uniform non-fading colour and textures. The water absorption after 24 hours of soaking shall not be more than 2% by weight. The compressive strength of tiles shall not be less than 700 kg/cm². The surface shall be abrasion resistant and durable.

- **Under bed**

The underbed shall be laid in three layers. The first layer shall be composed for 1 part cement and 3 parts river sand with just enough water to make the mix workable. This layer shall be trovelled level and curved with water for atleast 3 days prior to application of the second layer. The second layer consist of 3 mm thick hot blown bitumen conforming to IS:702 of grade 85/25 and shall be applied in three coats with brush or spray. The third layer of acid proof mortar as specified by manufacturer shall be applied. The acid proof mortar shall have chemical resistant properties equal to that of the floor tiles.

- **Laying**

The tiles shall be embedded in the acid proof mortar and the gap between the tiles shall be grouted to the full depth of tile. The setting and fixing shall be strictly as per the manufacturer's specification and shall be approved by the Owner/Owner's representative.

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- **Curing**

The joints in the floor shall be cured with the solution of 25% proof hydrochloric acid or as specified by the manufacturer.

In-Situ Terrazzo Finish

It shall consist of an underbed and a topping laid over an already laid and matured concrete base.

- **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 15 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 accommodate the specified thickness. All junctions of vertical with horizontal shall be rounded neatly to uniform radius of 25 mm.

- **Underbed**

The underbed for floors and similar horizontal surfaces shall consist of a mix of 1 part cement, 1-1/2 parts sand and 3 parts stone chips by volume or cement sand mixture 1:3. 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. Stone chips are machine crushed blue granite metal.

- **Topping**

The mix of 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 Owner/Owner's representative. The cement shall be white or grey 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 1-1/2 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 I.S. Sieve No. 30. The size of marble chips may be between 3 mm to 10 mm.

Sufficient quantity to cover all 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.

- **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 underbed plus topping. These strips shall be left in place.

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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. 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 troweled over, pressed and brought to a smooth dense surface showing a minimum 75% area covered by marble chips in an even pattern of distribution.

- **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.

- **Grinding and Polishing**

When the surface has sufficiently hardened it shall be watered and ground evenly with rapid cutting coarse grade (no.60) 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. This surface shall be cured for seven (7) days by keeping it moist and then ground with the fine grit blocks (no. 120). It shall again be cleared with water, the slurry applied again to fill up any pinholes that might have appeared and allowed to be cured again for five (5) days. Finally the surface is ground again third time with very fine grit blocks (no. 320) to get smooth surface without any pin hole. The grinding shall be done by a suitable machine. Where grinding machine cannot 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.120).

The surface shall be cleaned with water, dried and covered with oil free clean sawdust if directed by the Owner/Owner's representative. The final polishing shall be postponed till before handing over if desired by the Owner/Owner's representative.

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. If desired by the Owner/Owner's representative, wax polish shall be applied. However, all excess wax polish to be wiped off and the surface to be left glossy but not slippery. The choice of grit blocks at different stages of polishing shall be as per manufacturer's recommendations.

Carborandum Tile Finish

It shall consist of manufactured carborandum tile and an underbed.

- **Thickness**

The total average thickness including underbed shall be minimum 40 mm for floors, and 30 mm for skirting unless otherwise specified.

- **Tiles**

The tiles shall be heavy duty carborandum tile 'STILAN or equivalent', machine made under quality control in a shop. The tiles shall be pressed hydraulically to a minimum of 140 kg/cm².

Each tile shall bear on its back, permanent and legible trade mark of the manufacturer. All angles of the tiles shall be right angles, all edges sharp and true, colour and texture of the wearing face uniform throughout. Maximum tolerance/allowance for length and breadth shall be ± 1 mm and the

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thickness + 3 mm along the wearing surface of the tile and the wearing surface shall be plane and free from pin-holes and other blemishes.

The tiles shall be composed of a backing and topping. The topping shall be of uniform thickness not less than 6 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 grey cement, 2 parts and sand 4 parts of stone chips by volume and mixed with water.

The topping shall be carborandum grit (passing 1.18 mm mesh but retained on 0.6 mm mesh) and shall be sprinkled on the surface at the rate of 1.35 kg/m² and worked into the surface, to achieve a smooth and uniform surface.

The tile shall be cured at the shop for at least 14 days before delivery to the site. Tiles shall be packed properly to prevent damage during transit and storage. The tiles must be stored carefully 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 the 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 of the grout mix shall be suitably marked to relate it to the particular type and batch of tiles.

- **Underbed**

The underbed for floors and similar horizontal surfaces shall be 1 part cement, 1.5 parts coarse sand and 3 parts stone aggregate by volume mixed with sufficient water to form a stiff workable mass. For skirting and dado and all vertical surfaces it shall be about 10 mm thick and composed of 1 part cement and 3 parts coarse sand by volume.

- **Laying**

The underbed mortar shall be evenly spread and brought to proper grade and consolidated to a smooth surface. The face shall be roughened for better bond. Before the underbed has 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 be immediately placed upon and firmly pressed by wooden mallet onto 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 dimension. These shall be sawn and the edges rubbed smooth. The location of cut tiles shall be planned in advance and approval of the Owner/Owner's representative taken.

At the junction of horizontal surface with vertical surface, the tiles on the former shall enter at least 12 mm under the latter.

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PVC or Vinyl Asbestos Tile/Sheet Finish

This shall include various types of tiles or sheets manufactured from PVC, set with a sticker on concrete or masonry or particle base. An underbed may be required to secure desirable surface and grade.

- Thickness

The thickness of the tiles/sheets shall be 2 mm for light duty and 3.02 mm for heavy-duty applications. The total average thickness including the underbed shall be 40 mm.

- Tiles

Unless otherwise specified, the tiles/sheets shall conform to the requirements of IS:3461 & IS:3462 and shall be 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 other physical defects which affect appearance or serviceability. All edges shall be cut true and square.

The colour shall be non-fading 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 trade mark, the thickness, sizes, batch number and date of manufacture.

Tiles/sheets shall be delivered securely packed and stored in a clean, dry, well ventilated place at a temperature near about to that the tiles/sheets shall be called upon to stand ultimately.

Adhesive to be used for sticking the tiles or sheets shall be neoprene based rubber adhesive of approved make and approved by the manufacturer of the tile. The adhesive shall have a short drying time and long life in addition to toughness.

- 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 cement : 2 parts of coarse sand : 4 parts stone aggregate 10 mm down size, mixed with just sufficient water to make it workable.

- Laying

The tiles or sheets 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 or sheets and allowed to surface dry. The tiles and sheets shall be placed neatly on the surface exactly to the approved pattern and set with a suitable tool. If the edges tend to curl up, weights shall be used to keep the edges down. Special

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care shall be taken to avoid formation of air pockets under the tiles or sheets. The joints shall be very fine. Any adhesive squeezed out through the joints shall be removed immediately.

- **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 water and soap, dried and polished with an approved type of polish just before handing over.

- **Epoxy Floor Coating**

Epoxy floor coating shall consist of a solvent based, two pack system with epoxy resins and amine curing agents, chosen to withstand high degrees of chemical and abrasive action.

- **Thickness**

Thickness of the epoxy coating including screeding shall be minimum 3 mm. Total thickness of finish including underbed shall be 40 mm when applied on floors of buildings. In pits and dyke areas, no underbed is required to be provided.

- **Materials**

The screed shall be solvent free combination of epoxy resin, modified amine hardeners filled with specially graded and selected chemically inert aggregates of high strength. The system shall include an epoxy resin primer and screed which are both supplied in pre-weighed units ready for on-site mixing and application.

An epoxy resin sealing coat of specified thickness shall form the topping coat.

- **Underbed**

Underbed shall be similar to that PVC floor finish.

- **Laying**

The surface shall be sound, clean and dry in order to achieve maximum adhesion with the primer coating.

The primer shall be applied by brush and shall be allowed to become tacky. The screed shall be prepared as per manufacturers specification and laid in specified thickness evenly over the base floor by trowel. The finished, cured screed shall have a slightly granular texture of uniform brown.

The epoxy resin topping shall be applied at least 24 hours after the laying of the screed. This topping shall be applied by brush or sprayed to a specified thickness in two coats with 3-5 hours interval between them. Care shall be taken to finish the topping perfectly smooth and devoid of any bubbles and unevenness. The newly laid floor shall be protected from dust or moisture and allowed to be used only after a minimum lapse of 48 hours.

Ceramic Floor Tile/Glazed Wall Tile Finish

This finish shall be composed of glazed earthen ware tiles with an underbed laid over a concrete or masonry base.

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- **Thickness**

The total thickness shall be between 20 mm and 25 mm 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.

- **Tiles**

The glazed tiles shall be of earthenware, covered with glaze, white or coloured, plain or with designs, of 100 mm x 100 mm nominal sizes and 5 mm thick, unless otherwise specified. Ceramic floor tiles shall be of matt finish, white or coloured, plain or with designs of 150 mm x 150 mm nominal size and 6 mm 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, coves, 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 Owner/Owner's representative. The tiles shall be flat and true to shape. The colour shall be uniform and fractured section shall be fine grained in textures, dense homogenous. The tiles shall be strong and free from flaws like cracks, chips, craze, specks, crawlings etc. and other imperfections. The edges 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.

- **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.

- **Laying**

Procedure for laying shall be same as that for precast terrazzo tiles.

- **Finishing**

The joints shall be cleaned and flush pointed with white cement and cured for seven (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.

5.5.12 Doors, Windows, Louvres, Rolling Shutters & Glazing

Scope

This specification covers the requirements in respect of materials, workmanship and quality for doors, windows louvres, Rolling Shutters and glazing work.

Codes and Standards

Unless specifically mentioned otherwise, all applicable codes and standards in their latest editions as published by the Bureau of Indian Standards and all other such as may be published by them during the currency of the Contract, shall govern in respect of design, workmanship, quality and properties of materials and method of testing. Some of the relevant available codes are listed hereunder:

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Metal Doors & Windows

IS:733	Wrought aluminium and aluminium alloy bars, rods and sections (for general engineering purposes)
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 buildings.
IS:4351	Steel door frames

Timber Doors

IS:4021	Timber door, window and ventilator frames
IS:1003	Timber paneled and glazed shutters.
IS:2191	Wooden flush door shutter (cellular and hollow core type)
IS:2202	Wooden flush door shutters (solid core type)

Rolling Shutters

IS:6248	Metal rolling shutters and rolling grills
Glazing	
IS:1081	Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators
IS:2553	Safety Glass - Specifications
IS:2835	Flat transparent sheet glass
IS:3548	Code of practice for glazing in buildings
IS:5437	Figured rolled and wired glass Builder's Hardware
IS:204	Tower bolts
IS:205	Non-ferrous metal butt hinges
IS:208	Door handles
IS:281	Mild steel sliding door bolts for use with padlocks
IS:363	Hasps and staples
IS:723	Steel counter sunk head wire nails
IS:1823	Floor door stoppers

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IS:2209	Mortice locks (vertical type)
IS:2681	Non-ferrous metal sliding door bolts for use with padlocks
IS:3564	Door closers (hydraulically regulated)
IS:3847	Mortice night latches
IS:4992	Door handles for mortice locks (vertical types)
IS:6607	Rebated mortice locks (vertical type)

Materials & Workmanship

Steel doors, Windows, Ventilators Etc.

- Door Frames

Frames shall be rolled or pressed sections from 18 g sheet conforming to IS: 4351. They shall be mortised, reinforced, drilled and tapped for hinges and lock and bolt strikes where necessary, frames shall be reinforced for door closures. Welded construction with mitred 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 supplied. Frames shall be brought to site with floor ties/ weather bars installed in place.

- Double Plate Flush Door Shutters

Door shutters shall be 45 mm thick, completely flush design and shall comprise of two outer sheets of 18 g steel sheets, rigidly connected and reinforced inside with continuous vertical 20 g stiffeners, spot welded in position at no 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 by steel channels running full width of door. Doors shall not have more than 2.5 mm clearance at jambs and head, shall have proper bevel 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.

Doors shall be mortised, reinforced, drilled and tapped in shop for hinges, locks and bolts. They shall also be reinforced for closures, push-plates and other surface hardware where necessary. Any drilling and tapping required for surface hardware shall be done at site. Where necessary, provision shall be made for fixing glazing, vision panels, louvres etc. glazing mouldings shall be of 18 g steel and suitable for fixing 6 mm glass. Louvre blades shall be V or Z shaped and made out of 16 g sheets.

- Sliding Doors

Sliding doors shall be double plate construction made out of 18 g steel sheets with adequate stiffness. The Contractor shall specify the weight of the door in his shop drawing and submit the manufacturer's catalogue of the sliding gear he proposes to use. Where shown on drawings, the Contractor shall make provisions for openings in the door for mono-rail beams. Doors shall close positively to exclude rain water from seeping in. Sliding doors shall withstand specified wind loads without buckling or jamming. The door shall slide freely under all ambient conditions.

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- **Steel Windows, Sashes, Ventilators, etc.**

These shall conform in all respects to IS: 1038 and IS:1361. The details as called for in the above codes shall be applicable for coupling mullions, transoms, weather bars, pivot arrangements for ventilators, etc.

All welds shall be dressed flush on all exposed and contact surfaces.

Where composite unit openings are provided 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.

All welds at the corner of casement shall be done by flash butt welding process and dressed flush on all exposed and contact surfaces.

Aluminium Doors, Windows and Frames

Aluminium sections for fabricating doors, windows, partitions etc., shall be extruded sections conforming to IS:1948 & IS:1949 or as manufactured by Indian Aluminium Company Ltd or approved equivalent. The alloy used shall conform to IS designation HE 9-WP of IS:733.

Extruded sections shall have a minimum 2.5 mm wall thickness. All sections shall be approved by the Owner/Owner's representative before fabrication is taken up. Doors, frames, mullions, transoms etc. shall be anodized in a bath of sulphuric acid to provide a clear coating of minimum

0.06 mm thickness. The anodised 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 a uniform colour throughout the work. Work on the above, other than described, shall be neatly finished with concealed fasteners. Glazing beads shall be snap fit type, without visible screws and shall be of sizes to accommodate 6 mm thick glazing.

Timber Doors

All timber shall be best quality well seasoned specified species free from large or loose knots cracks or other defects. Where specified, timber shall be treated with approved wood preservative before starting the joinery work, the Contractor shall have the rough timber approved by the Owner/Owner's representative.

Plywood shall be of commercial quality teak veneer or with decorative surface veneer as specified.

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 Owner/Owner's representative. The Contractor shall give a guarantee that the adhesive used is phenol-formaldehyde confirming to IS:848.

Fixtures for doors, windows, furniture etc. shall be as shown on drawing. These shall be of heavy type, best quality and from approved manufacturer. The Contractor shall have to mention the name of the manufacturer for different types of joinery hardware, fittings and fixtures. Samples of each type of fittings shall have to be submitted to the Owner/Owner's representative for obtaining approval before bulk supply.

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The work shall be done by skilled carpenters as per details shown on drawing or instructed by the Owner/Owner's representative.

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 or chip-board sheets. All exposed plywood edges shall be finished with teakwood timber lipping unless otherwise shown on drawings.

All carpentry work after finishing shall be sand papered smooth. Prime coat paint shall be given after inspection of the Owner/Owner's representative to all surfaces other than those which shall be subsequently polished or covered with laminated plastic sheet.

When shown on drawings decorative ply or laminated plastic sheets shall be bonded under pressure to the surface to be finished. The adhesive used shall be of approved brand and bought 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 instruction. The edge of sheets shall be protected by teakwood timber lipping. However, where available factory made ready for use material of reputed manufacturer shall be used.

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.

PVC Doors & Windows

PVC doors and windows shall be obtained from reputed manufacturers and shall be SINTEX or approved equivalent quality. The material used shall be unplasticised PVC having superior impact resistance. Density of the material shall be 1.4 grams/cm³ and tensile stress and bending stress of 480 and 770 kilopascal/cm². The outer section wall thickness shall be min. 1.7 mm.

The section shall be reinforced with steel sections concealed inside a cavity of PVC sections. Corners shall be welded, transom/mullions welded or mechanically joined. Weather sealing shall be by double sealing with elastomeric weather strip, the corners being glued.

Opening for PVC doors/windows shall be 10 mm more than the window/door size.

The doors shall be fixed to the wall by expandable fasteners or by brackets. Manufacturer's recommendation shall be followed for installation.

Rolling shutter (Hand operated, Mechanical gear operated and Electrically operated).

Rolling shutters shall be fabricated from 18 gauge steel and machine rolled with 75 mm rolling centres with effective bridge depth of 12 mm lath sections, interlocked with each other and ends locked with malleable cast iron clips to IS:2108 and shall be designed to withstand a wind load of 200 Kg/m² without excessive deflection.

The guides shall be either rolled or pressed deep channel sections 75 mm and 25 mm wide fitted with necessary fitting and fixtures.

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The suspension shaft shall be formed from heavy duty tubes conforming to IS:1161 and of sufficient diameter so as to resist deflection due to weight of the rolling shutter. The deflection shall not exceed 5 mm/ metre width. The shaft shall be provided with CI pulleys and helical springs for counter balancing the weight of the shutter adequately.

The springs shall be approved high tensile flat springs conforming to Grade 2 of IS:4454. These shall be fitted inside the fabricated housing of either ends which counter-balance the shutter curtain.

The ball bearings shall be double row self-aligning ball bearings fitted inside C.I. housing fixed on side brackets holding the suspension shaft at either end. The roller assembly shall be designed so as to be capable of producing sufficient torque to ensure easy operation of the rolling shutter in any position. The spring tension shall be adjustable by means of suitable adjustments holes drilled on the rims of the pulley.

The hood cover shall be made of 20 gauge galvanized sheets with necessary stiffeners and framework to prevent sag. The bottom lock plate shall be made of 5 mm thick M.S. plate and 95 mm wide reinforced with angle/T iron of suitable section with 6 mm dia M.S. rivets interlocked with last stride of curtain.

The locking arrangement shall consist of sliding bolts at both ends of the bottom plate fitted to engage with suitable receiving pockets at the bottom of guide channels.

Unless otherwise specified, for overall area of rolling, shutters up to 9 sq.m pull and push type hand-operated shutters shall be used; for area between 9 and 12 sq.m pull and push type shutters shall be provided with ball bearings; for area larger than 12 sq.m mechanical gear type or electrically operated shutters shall be supplied.

Glazing

Glass for glazing shall be of the following types:

- 4 mm thick transparent sheet glass conforming to IS:2835 generally used for openable shutters of windows.
- 6 mm thick wired glass conforming to IS:5437 generally used for fixed shutters of windows.
- 6.3 mm thick laminated safety glass conforming to IS:2553 generally used for fixed glazed partitions.
- 6 mm thick transparent sheet glass used for aluminium glazed doors.

All glass shall be cut according to the sizes required as per drawings. Glazing of metal doors, windows and ventilations shall conform to IS:1081 either with putty or metal clips. The Contractor shall thoroughly clean all glass and replace all putty or glass damaged during the work.

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Double Glazing

Shall be as per approved manufacturer's specifications and relevant IS codes.

Storage and Handling

All metal doors, windows etc. shall be packed and crated properly before despatch and 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 or mortar etc. Glass shall be brought to site in manufacturer's original packing.

Assembly and Erection

The Contractor shall assemble and install all doors, windows, louvers, etc. including transoms mullions for composite units in respective places keeping proper lines and levels, and in approved workman like manner, to give trouble free and leak proof installations. The installations shall be done according to the instructions of the manufacturer and/or as approved by the Owner/Owner's representative. If required by the Owner/Owner's representative, the installation shall have to be carried out under the supervision of the manufacturer's staff.

After installation of steel doors, windows etc. all abrasions to shop-coat of paint shall be retouched and made good with the same quality of paint in shop coat. All coupling mullions, transoms, frames etc. in contact with adjacent steel and other members shall be well bedded in mastic. Door shutters, partitions, hardware fixtures shall be fixed only after major equipments have been installed in rooms.

Hardware and Fixtures

Hardware and fixtures shall be best quality from the approved manufacturers and shall conform to the relevant IS specification and able to withstand repeated use. The Contractor has to provide the required number / size of fixtures for trouble free operation and adequate strength. Door closers shall be suitable for shutter weight and shall be guaranteed against manufacturing defect for one year and any defect found within this period shall be rectified or the door closer replaced without extra cost to the Owner/Owner's representative.

The Contractor shall submit samples of each type of hardware to the Owner/Owner's representative and the approved samples shall be retained by the Owner/Owner's representative for comparison with bulk supply.

5.5.13 Painting, Colour Washing Etc.

Scope

This specification covers the requirements in respect of materials, workmanship and quality for finishing works, such as white washing, colour washing, distemping and painting to masonry, concrete, timber and metal surfaces of doors, windows, rolling shutters etc. Separate specification shall be referred for painting of structural steel work.

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Codes and Standards

Unless specifically mentioned otherwise, all applicable codes and standards in their latest editions as published by the Indian Standards Institution and all other such as may be published by them during the currency of the Contract, shall govern in respect of design, workmanship, quality and properties of materials and method of testing. Some of the relevant available codes are listed hereunder:

White washing, colour washing and distempering

IS:427	Distemper, dry colour as required
IS:428	Distemper, oil emulsion, colour as required
IS:6278	Code of practice for white washing and colour washing

Painting

IS:5	Colours for ready mixed paints and enamels
IS:102	Ready mixed paint, brushing, red lead, non-setting, priming
IS:123	Ready mixed paint, brushing, finishing, semigloss, for general purposes
IS:1477	Code of practice for painting of ferrous metals in buildings
IS:2074	Ready mixed paint, air drying, red oxide-zinc chrome, priming
IS:2338	Code of practice for finishing of wood and wood based materials.
IS:2339	Aluminium paint for general purposes in dual container
IS:2395	Code of practice for painting concrete, masonry and plaster surface
IS:2932	Enamel, synthetic, exterior, a) undercoating, b) finishing.
IS:2933	Enamel, exterior, a) under coating, b) finishing.
IS:5410	Specification for cement paint, colour as required
IS:5411	Specification for plastic emulsion paint

Materials

Distemper

Dry Distemper shall be made from suitable pigments, extenders lime proof tinters, water soluble binders confirming to IS:427. Oil bound washable distemper shall be of oil emulsion type containing suitable preservatives confirming to IS:428.

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Gum and blue pigment

Gum and blue pigment for white wash shall be of best quality and of approved make.

Water Proof Cement Paint

Water proof cement paint shall be made from best quality white cement and lime resistant colours with accelerators, water proofing agents and fungicides. The paint shall confirm to IS: 5410.

Paint

The painting and finishing materials for use in the work shall conform to relevant Indian Standards specifications and shall be best brands of approved make produced for each kind of work. Aluminium paint shall be in two back containers and shall resist weathering.

The acrylic emulsion 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.

Primer coat

Unless otherwise specified, the primer coat for concrete, steel and iron work shall be as specified by the manufacturer.

Weather Shield coating

Shall be as per approved manufacturer's specifications and relevant IS codes.

Acrylic Emulsion Paint

Shall be as per approved manufacturer's specifications and relevant IS codes.

Textured Paint

Shall be as per approved manufacturer's specifications and relevant IS codes.

Acid Resistant Paint

Shall be as per approved manufacturer's specifications and relevant IS codes.

Enamel

Shall be as per approved manufacturer's specifications and relevant IS codes.

White Washing, Colour Washing and Distempering

Mixing

The slaked lime shall be screened to pass through a sieve of 49 meshes per sq.cm. and dissolved in a tub with sufficient quantity of water and shall be well mixed to give a thin creamy consistency. It shall then be strained through a clean coarse cloth and clean gum dissolved in hot water added to it at the rate of 2 kg for each cubic meter of lime and ultramarine blue added to the mixture in small proportion just sufficient to give a very light bluish tint.

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Colour wash shall be prepared in the same way as for white washing except that necessary amount of colouring matter shall be added to lime wash to obtain the colour specified. No blue shall be added in this case. The entire quantity shall be mixed strictly in accordance with the manufacturer's instructions unless these are varied by the Owner/Owner's representative.

Distemper shall not be mixed in a larger quantity than is actually required for a day's work and hot water shall be used in preparing the mixture.

Preparation of Surface

Before white wash is laid on new wall, the surface of wall shall be well cleaned and brushed and all patching must be scraped properly. After cleaning the surface, all holes, cracks and patches shall be made good with approved materials.

Masonry cracks shall be cleaned out and patch filled with mortar similar to the original surface and finished with cement wash. For all internal painting the surface shall be made smooth by application of approved paste fillers before applying primer.

The distemper shall not be applied on damp walls and shall be applied in dry weather. The surface to be distempered shall be thoroughly cleaned of dust, dirt, grease, oil marks, cement marks, loose scales etc. and rubbed with sand paper to give a uniform smooth surface.

Workmanship

White wash shall be applied with brush, each coat consisting of vertical stroke from top downwards followed by opposite stroke upwards over the first stroke and horizontal stroke from left to right followed by stroke right to left. Each coat must be allowed to dry before the next coat is applied. On completion, the surface when it becomes dry, shall present a uniform white appearance. When dry, no coat of white wash shall show any patches, haircracks or streaks nor shall it come off when rubbed with hands. White washing shall be done in 3 coats unless otherwise specified. Doors, windows, floors etc. must be protected from white wash splashes. Any splashes and droppings shall be removed and cleaned.

Colour wash shall be applied in the same manner as specified for white wash. During application, the solution shall be stirred continuously and wash shall be applied with care to avoid any cut shade or brush marks on the walls when the work is complete. For all new work, the surface to be colour washed shall first be treated with a priming coat of lime wash. Unless otherwise specified, two coats of white wash shall first be applied before colour wash is applied. The colour wash, whether applied inside or outside of a building shall be of uniform tint and shade.

The workmanship for distempering shall conform to IS:427 and IS:428 unless specified otherwise. Distempering shall be done with proper distemper brushes of approved quality. The finished surface shall be of absolutely uniform shade throughout and free from brush marks. On drying, the distemper shall not come off on touch and shall not crack. Distemper shall be applied in two coats over one coat of priming. The priming coat shall be as specified and the primer shall be in accordance with the recommendation of the manufacturer. Before applying the primer, the plastered surface shall be washed with a solution of 100 gm of zinc sulphate to one litre of water and then allowed to dry. Succeeding coats shall not be applied until the previous coat has been approved by the Owner/Owner's representative. The first coat shall always be of a lighter tint and shall be applied with care. In case the finish is not up to the standards, the entire surface shall be sand-papered and a fresh coat or coats of distemper shall be supplied without any extra cost.

All decorative mouldings, cornices, bands etc. shall be finished according to detailed drawings. All splashes of distemper shall be removed by the Contractor at his own cost.

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The surface to be coated with water proof 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 four to six hours, 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.

Painting

Preparation of surface

The surfaces of iron and steel work to be painted shall be cleaned free of dirt, oil, rust, millscale and be thoroughly dry before painting. Cleaning, degreasing, derusting and descaling wherever necessary shall be carried out as specified in IS:1477 (Part I). All galvanised iron surfaces shall be pre-treated with a compatible primer according to the manufacturer's direction.

The surfaces of wood shall be rubbed down smooth. All nails and screws shall be sunk below the surface and filled with mastic after applying an under coat. Small knots that do not justify cutting and sap streaks shall be covered with minimum two coats of pure shellac coating applied thinly and 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.

Application

Painting of iron and steel work shall generally be carried out as per IS:1477.

The paint manufacturer's specification/instructions shall be followed as far as possible at all times. Particular attention shall be paid to the following:

- Proper storage to avoid exposure, as well as extremes of temperature.
- Surface preparation prior to painting
- Mixing and thinning
- Application of paints and the recommended time limit on time intervals between coats.

Painting operations shall not proceed until the Owner/Owner's representative has the opportunity to inspect the condition of prepared surface to be painted. Paint shall be thoroughly mixed and not more than 1/2 kg of recommended thinner per 4.5 kg litres of paint shall be added if thinning is necessary. Exterior paint shall not be performed during the period of inclement weather. Interior painting may proceed during such periods only with the approval of the Owner/Owner's representative. Prior to application of subsequent coat, the Owner/Owner's representative shall be given the opportunity to inspect the prior coat. Should the work be judged by the Owner/Owner's representative be inferior, a supplementary coat shall be applied at no additional cost.

The number of coats including the primer coat shall be applied as specified. Each coat shall be allowed to dry sufficiently before the succeeding coat is applied.

The type of intermediate and finish coat and the number of coats to be applied shall be as specified. Intermediate and finish coats may be oil bound, bituminous, aluminium or other types of paints. The intermediate and finish coats for structural steel work, sheet metal work and cast iron work shall be applied as specified in IS:1477 (Part II).

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Acceptance Criteria

- All the painted surface shall be uniform and pleasing in appearance.
- The colour, texture etc. shall match exactly with those of approved samples.
- All stains, splashes and splatters of paints shall be removed from surrounding surface.

5.5.14 Water Proofing

Scope

This specification covers the requirements in respect of materials, workmanship and quality for water proofing of roofs and underground structures.

Codes and Standards

Unless specifically mentioned otherwise, all applicable codes and standards in their latest editions as published by the Bureau of Indian Standards and all other such as may be published by them during the currency of the contract, shall govern in respect of design, workmanship, quality and properties of materials and method of testing. Some of the relevant available codes are listed hereunder:

IS:1322	Bitumen felts for water proofing and damp proofing
IS:1346	Code of practice for waterproofing of roofs with bitumen felts
IS:1580	Bituminous compound for water proofing and caulking purposes.
IS:1609	Code of practice for laying damp-proof course using bitumen felts
IS:2645	Integrated cement water proofing compounds (1987)
IS:3067	Code of practice for general design details and preparatory work for damp-proofing and water-proofing of building.
IS:7193	Specification for glass fibre base coal tar pitch and bitumen felts.

Materials

Bituminous Polymeric membrane for roof water proofing.

Bituminous Polymeric membrane used for waterproofing of roofs shall be 5 layered membrane consisting of a central core of 90 microns thick High Molecular High Density Polyethelene (HMHDPE) film protected on both sides with polymeric asphaltic mix and further covered on both sides with protective thermofusible HMHDPE film. For precast roofs, the top HMHDPE layer shall be substituted with embossed aluminium foil 75 microns thick. Product to be used for cast-in-situ roof slab shall be MULTIPLAS STANDARD and that for roof with precast slab panels shall be MULTIPLAS ALUMINIUM or approved equivalent.

Bituminous polymeric membrane for underground damp proofing.

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The membrane used for waterproofing underground structures shall be 7 layered membrane similar to 5 layered roofing membrane, but reinforced with a non woven polyester mat of minimum 140 g/m² for additional mechanical strength and covered with additional layer of polymeric asphalt. Product to be used shall be MULTIPLAS HYPER or approved equivalent.

Bitumen Felt

It shall conform to IS:1322.

Fibre Glass Tissue Reinforced Bitumen Felt

It shall conform to IS: 7193, consisting of reinforced glass fibre base coated on both sides with bitumen modified with thermo plastic polymers.

Bonding Materials

Bonding materials used for applying the polymeric bituminous membrane on surfaces shall be fibre and solvent based, rubber modified bituminous primer of density 0.92 g/cm³ with viscosity 500 to 10,000 cps. Ordinary bitumen wherever used shall be of blown type conforming to IS:702 or residual bitumen conforming to IS:73 or a mixture thereof.

Water proofing admixture

The water proofing admixture shall conform to IS: 2645 and shall be approved by the Owner/Owner's representative.

Cement

Cement shall conform to IS 455 or IS:1489.

Aggregates

The aggregates shall conform to IS:383. Fine aggregate shall be river sand or pit sand from approved pits. Coarse aggregate shall be stone chips of size not exceeding 6 mm.

Metal Flashings

Metal flashings shall be of 18 g or 20 G galvanised iron.

Workmanship

Waterproofing of roof

- With polymeric bituminous membrane

The roof slabs shall be cleaned of all dust, dirt, grit etc. and if rough it shall be made reasonably smooth either by clipping of projections or by applying a thin coat of cement slurry of cement sand and water. The roof surface shall be regraded prior to waterproofing with cement mortar or concrete screed to provide a minimum slope of 1:75 for cast-in-situ roofs and 1:50 for precast roofs. At the places of drain outlets, projecting pipes, parapet walls and expansion joints etc. the surface shall be prepared in indicated in IS : 1346.

Over the hardened and finished surface of roof slab, suitable approved primer such as MULTIPLAS PRIMER or approved equivalent is coated at the rate of 250 g/cm². The waterproofing membrane is unrolled over the coated surface with overlaps of 100 mm and bonded completely to the substrate.

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The overlaps are then sealed by flame. Installation of the waterproofing membrane shall be strictly as per the manufacturer's instructions and supervision.

In case of roofs with parapets, a chase 75 mm deep shall be cut in the parapet masonry at about 150 mm above the roof level and the membrane shall be laid as flashings in widths with a minimum overlap of 100 mm. The lower edge of the flashing shall overlap the membrane laid on the flat portion, and the upper edge of the flashing shall be tucked into the groove made in the parapet. After the flashing has been properly bonded, the chase shall be cleaned and shall be filled up with cement mortar 1 : 4 flush with the face of the wall, and allowed to set by adequate curing.

For gutters, the membrane shall be laid over a primer coat, and finally painted with a coat of hot bitumen at not less than 1.5 Kg/sg.m. The membrane treatment shall be carried down into the outlet pipes to a minimum depth of 100 mm.

After the treatment is over, the surface shall be covered with 20 mm plaster of cement mortar 1:4 reinforced with chicken wire mesh marked off into squares 600 mm wide with expansion joints provided at a distance of 3 metres for cast-in-situ accessible roofs.

- **With hessian based bitumen felts**

The roof slab shall be cleaned of all dust, dirt, grit etc. and if rough it shall be made reasonably smooth either by chipping of projections or by applying a thin coat of cement slurry of cement, sand and water.

The roof surface shall be regraded prior to waterproofing either with cement mortar or lime-surkhi mortar. At the places of drain outlets, projecting pipes, parapet walls and expansion joints etc. the surface shall be prepared as indicated in IS:1346.

The workmanship in general shall conform to IS:1346 unless otherwise specified. Over the hardened and finished surface of the roof slab, a thin layer of approved bitumen primer shall be first brushed over the roof surface and allowed to dry.

The felt shall be first cut to the required lengths and laid out flat on the roof in position at right angles to the direction of run-off gradient and shall be brushed clean of dusting materials. Each length of felt thus laid in position shall be rolled up for a distance of half of its length. Then the bonding material heated to correct temperature shall be poured on to the roof across the full width of the rolled felt as the latter is steadily rolled out and pressed down. Excess bonding material shall be squeezed out at the ends and removed as the laying proceeds. When the first half of the strip of felt has been bonded to the roof, the other half shall be rolled up and then unrolled on to the hot bonding material in the same way.

Minimum overlaps of 100 mm shall be allowed at the end and the sides of strips of felt. All overlaps shall be firmly bonded with hot bitumen. The laying of the second layer of felt shall be so arranged that the joints are staggered with those of the layer beneath it.

In case of roofs with parapets, a chase 75 mm deep shall be cut in the parapet masonry at about 150 mm above the roof level and the felt shall be laid as flashings in widths with a minimum overlap of 100 mm. The lower edge of flashing shall overlap the felt laid on flat portion of the roof and the upper edge of the flashing shall be tucked into the groove made in the parapet. After the flashings have been properly bonded, the chase shall be cleaned and shall be filled up with cement mortar (1:4) flush with the face of the wall and allowed to set by adequate curing.

In case of drain mouths, waterproofing shall be done as specified for the roof excepting that the treatment shall be carried inside the drain pipes overlapping at least 100 mm.

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For gutters, a priming coat shall first be applied. Over this, a specified number of layers of felt shall be laid and bonded together with hot bitumen and finally painted with a coat of hot bitumen at not less than 1.5 kg per sq. metre. The felt layers laid separately in the gutters shall be overlapped with the corresponding layers on the roof proper. The felt treatment shall be carried down into the outlet pipes to a minimum depth of 100 mm.

After the treatment is over, the surface shall be covered by pea-sized gravel or grit at the rate of 0.6 cu.m per 100 sq.m. On flashings and at drain mouths a finish of two coats of approved bituminous primer shall be provided.

- **With fibre glass tissue reinforced bitumen felt**

Water proofing for roofs shall be according to the guide lines in IS:1346. Other requirements shall be the same as those for hessian based bitumen felt.

- **With brick lime concrete and pressed flat tiles**

The exposed surfaces of the roof slab shall be thoroughly cleaned. A layer of brick lime concrete shall be laid over the cleaned surface. Brick lime concrete shall be 1:2:4 by volume using 20 mm down graded brick bats. The slope of the lime concrete layer shall be 1:100 and the minimum thickness shall be 80 mm. The slope of the draining surfaces shall be formed on all the sides as necessary.

Care shall be taken to check the quantity of water. The quantity of water shall be so as to make the concrete just workable. Cement sand mortar 1:3 with 2% mixture of "Accoproof"(or approved equivalent water proofing agent) shall be laid over the underbed to a thickness of 20 mm. Pressed flat tiles are set over the mortar and pointed with cement mortar 1:3 with 2% "Accoproof" (or approved equivalent water proofing agent).

Damp proofing of underground structures

- **With polymeric bituminous membrane**

Prior to application of the membrane, the surface shall be coated with MULTIPLAS PRIMER or equivalent applied at the rate of 250 g/m². Application procedure will be similar to roof water proofing, strictly as per manufacturer's instructions and supervision. Membranes shall be fastened with the vertical surfaces for height exceeding 4.5 mtrs. Half brick thick brick work in cm 1 : 4 shall be provided as protection to waterproofing on external side faces.

- **With hessian based bitumen felts**

Damp proofing for underground structures wherever indicated shall be done as per recommendations of IS:1609, for heavy treatment with three layers of felt. The method of laying damp proofing treatment shall be as per IS:1609.

- **With fibre glass tissue reinforced bitumen felt**

It shall be done as per guidelines laid in IS:1609 and those specified for hessian felts. The felt layers shall be fastened to the wall surface wherever the height exceeds 4.5 metres. Half brick wall in CM 1.4 shall be erected as protection to the external face of the water proofing.

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The slopes and surface level shall be such as to allow quick draining of water 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 specialised agency for the waterproofing treatment work. The guarantee shall be for materials and workmanship for five (5) years.

5.5.15 False Ceiling and False Flooring

Scope

This specification covers the requirements in respect of materials, workmanship and quality for suspension system and ceiling panels required for false ceiling work and false flooring work.

Codes and Standards

Unless specifically mentioned otherwise, all applicable codes and standards in their latest editions as published by the Bureau of Indian Standards and all other such as may be published by them during the currency of the contract, shall govern in respect of design, workmanship, quality and properties of materials and methods of testing. Some of the relevant available codes are listed here under :

IS:848	Synthetic resin adhesives for plywood
IS:1642	Code of practice for fire safety of buildings.
IS:2095	Gypsum plaster boards
IS:2441	Code of practice for fixing ceiling coverings.
IS:3087	Wood particle boards for general purposes.
IS:3129	Low density particle board.
IS:4671	Expanded polystyrene for thermal insulation purposes

Materials

Ceiling Panels for False Ceiling

Ceiling panels shall be of best quality material in thickness and properties specified. The Contractor shall submit test certificate to the Owner/Owner's representative for approval before bulk supply.

The ceiling panels may be of the following types manufactured by reputed manufacturers

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- **Teakwood particle board**

Teakwood particle board shall conform to IS:3087 (3 layer flat pressed particle board bonded with BWP type phenol Formaldehyde Synthetic resin conforming to IS:848), satisfying the requirements of Class I of IS:1642 and treated with antifungus Chemicals. The bottom (facing the floor) of tiles shall be painted with two coats of acrylic emulsion paint over a coat of primer.

- **Gypsum board**

Gypsum board shall conform to IS:2095 and shall have the following properties

Thermal conductivity	:	0.16 W/mK
Thermal resistant	:	0.06 to 0.09 m ² K/W
Fire propagation	:	Class-1

- **Aluminium panels**

Aluminium panels shall be square edged plain panels, 84 mm wide x 15 mm deep with 25 mm recessed flanges, formed out of 0.5 mm thick aluminium alloy electrically powder coated in standard colours. LUXALON 84C or approved equivalent shall be used.

Floor Panels for False Flooring

- Particle board with PVC tiles
- Cement fill metallic panels with antistatic HPL tiles

Floor panels for false flooring shall be of 600x600x32 mm cement fill metallic false flooring panels with 1.2 mm thick antistatic, high abrasion resistance, high pressure laminate tiles on faced on top (Lloyd insulations or approved equivalent) unless otherwise specified. All steel works and stools shall be provided with two coats of polyurethane paint over a coat of approved primer. Each panel shall have PVC beading on all edges. The floor panels shall be of completely removable type. The clearance under the floor shall be as per drawing, The floor panels shall be cut wherever required for providing suitable outlets for cables etc.

The false flooring Panel shall be provided for the area of cable route as per requirement and the other areas shall be covered with PVC antiskid flooring.

Installation

The Contractor shall prepare a layout for false ceiling showing the framing and the cut outs for AC/Electrical fixtures and other services and get the same approved before commencement of work.

Suspension system for false ceiling boards

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 walls, slabs and beams or trusses. Anodized aluminium grid ceiling system from the approved supplier shall be used. 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

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a deflection of 1/360th of their span. Samples of suspension system shall be submitted to the Owner/Owner's representative and approval obtained.

Main runners shall be extruded anodized (25 microns) aluminium Tee section of minimum 25 mm x 35 mm size. Secondary runners shall be aluminium Tee section of minimum size 25 mm x 25 mm. Wall angles shall be of minimum size 38 mm x 38 mm. Generally the grid dimensions of 610 mm x 610 mm shall be adopted.

Angle cleats or other suitable fixing device shall be fixed to the structural beam or slab above for fixing of hangers. Main runners shall be hung by M.S. flats or galvanised tie rod at maximum 1.2 m 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 to suit the ceiling panel size and as recommended by the supplier. The cross runners shall intersect the main runners at perfect right angles and positively locked together with intersection clips. Cutouts for light fixtures, diffusers etc. shall be the exact dimensions and in exact locations.

Suspension system for aluminium panels

The panels shall be supported on formed carriers, 15 mm wide at top and 43 mm deep, made out of 0.91 min. thick aluminium alloy electrically powder coated in stain black with protruding cars to hold panels in a module of 100 mm (16 mm gap between the panels) at a maximum spacing of 1.3 metres. Carriers shall be suspended from the slab/roof by 4 mm dia galvanised steelwire/rod hangers with height adjustment suspension springs made out of galvanised spring steel hangers, fixed to slab by J hooks and nylon inserts. Edges of the ceiling shall be trimmed with suitable matching edge profiles to cover the gap between the false ceiling and the walls.

Supporting arrangement for false flooring

The supporting arrangement for particle board false flooring shall consist of pedestal made out of aluminium zinc, alloy rod with check nut into 20 mm. dia and 10 mm thick base plates. The pedestal shall be fixed on the floor @ 600 mm c/c with araldite (or other approved method) including surface preparation. The pedestal heads will receive main end cross M.S. cold roll formed 40 mm x 40 mm x 2.5 mm thick channels including provision of additional angles 50 x 50 x 6 mm and ISMC 100 at cable entries and sides of well as required. The pedestals will have level adjustments to ± 25 mm for levelling. Each pedestal shall be able to support a load of 2500 kg without deformation. All steel framework shall be hot dip galvanised.

The supporting arrangement for cement fill metallic panels false flooring shall consist of seamless pipe 25 mm. outer dia and 12 mm thick base plates. The pipes shall be fixed on the floor @ 600 mm c/c with 50x6 mm metal screw with nylon rowal plug. The pipe heads will have MS check nut and M18x 100 long studs with jackhead zinc plated of size 90x90x4 mm thick over which GI stringer 30x20x1.5 thk having pre punched holes 6 mm dia for the fixing of panels.

Fixing of Ceiling and Floor Panels

The Contractor shall submit sample panels and get the approval of the Owner/Owner's representative. Installation of ceiling and floor panels shall be strictly as per manufacturer's instruction. The hold down clips for ceiling panels shall be used at the rate of minimum one per 1.2 metre length of perimeter or as per manufacturer's specification. These shall however be omitted in access panels which shall be located as per the instruction of the Owner/Owner's representative.

Finished ceiling and floor shall be at the correct plane and present a pleasing and uniform appearance, free from sags, wraps, disfigured or damaged boards. Joints, exposed grids etc. shall be in true lines and symmetrically placed.

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Finished ceiling and floor shall be at the correct plane and present a pleasing and uniform appearance, free from sags, warps, disfigured or damaged boards. Joints, exposed grids etc. shall be in true lines and symmetrically placed in manner shown on drawings. Cutouts for light fixtures, diffusers, cable ducts etc. shall be to the exact dimensions and in exact locations.

5.5.16 Roof Insulation

Scope

This specification covers the requirements in respect of materials and workmanship for under deck roof insulation.

Codes and Standards

Unless specifically mentioned otherwise, all applicable codes and standards in their latest editions as published by the Indian Standards Institution and all other such as may be published by them during the currency of the contract shall govern in respect of design, workmanship, quality and properties of materials and method of testing.

The relevant available code is listed hereunder:

IS: 8183 Bonded mineral wool.

Materials

The materials for insulation shall be resin bonded mineral wool insulation of Group I as per IS: 8183 with aluminium facing.

Workmanship

Slotted angle 50 x 50 x 6, 50 mm long shall be fixed to the underside of the slab at 600 mm centres in both direction. The insulation board or rolls shall be fixed to the underside of the slabs at 600 mm centres in both directions with the aluminium foil face at the bottom with a suitable adhesive. The insulation material shall be held in position by means of the 25 mm x 24 SWG net tied to the slotted angles. The joints if any of the wire netting shall be butted and lightly laid down with GI wire.

5.5.17 Water Supply, Drainage and Sanitary Works

Scope

This specification covers the requirements in respect of materials, installation and quality for water supply, drainage and sanitary works.

Codes and Standards

Unless specifically mentioned otherwise, all applicable codes and standards in their latest editions as published by the Bureau of Indian Standards and all other such as may be published by them during the currency of the Contract, shall govern in respect of design, workmanship, quality and properties of materials and methods of testing. Some of the relevant available codes are listed hereunder:

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Roof Drainage System

IS:1230	Cast iron rain water pipes and fittings
IS:1626	Asbestos cement building pipes, gutters and fittings (spigot and socket type)
IS:1729	Specification for sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
IS:1742	Code of practice for building drainage.
IS:2527	Code of practice for fixing rainwater gutters and down pipes for roof drainage
	Pipes and fittings for sanitary plumbing and drainage
IS:404	Lead pipes
IS:405	Lead sheet and strip
IS:458	Concrete pipes (with and without reinforcements)
IS:651	Salt glazed stoneware pipes and fittings
IS:77	Glazed fire clay sanitary appliances
IS:774	Flushing cistern for water-closets and urinals (other than plastic cisterns)
IS:775	Cast iron brackets and supports for wash basins and sinks
IS:778	Copper alloy gate, globe and check valves for water works purposes.
IS:781	Cast copper alloy screw down bib taps and stop valves for water services
IS:782	Caulking lead
IS:783	Code of practice for laying of concrete pipes
IS:804	Rectangular pressed steel tanks
IS:1172	Code of basic requirement for water supply drainage and sanitation
IS:1239	Mild steel tubes and tubulars and other wrought steel fittings
IS:1536	Centrifugally cast(spun) iron pressure pipes for water, gas and sewage
IS:1537	Vertically cast iron pressure pipes for water, gas and sewage.
IS:1703	Ball valves (horizontal plunger type) including floats for water supply purposes
IS:1711	Self closing taps for water supply purposes
IS:1726	Cast iron manhole covers and frames
IS:1742	Code of practice for building drainage

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IS:1795	Pillar taps for water supply purposes
IS:2065	Code of practice for water supply in buildings
IS:2104	Water meter boxes (domestic type)
IS:2326	Automatic flushing cisterns for urinals (other than plastic cisterns)
IS:2470	Code of practice for installation of septic tanks
IS:2548	Plastic seats and covers for water-closet
IS:2556	Vitreous sanitary appliance (vitreous china)
IS:2963	Copper alloy waste-fittings for wash basins and sinks
IS:3004	Plug cocks for water supply purposes
IS:3006	Chemically resistant glazed stoneware pipes and fittings
IS:3076	Low density polyethylene pipes for potable water supplies
IS:3114	Codes and practice for laying of cast iron pipes
IS:3311	Waste plug and its accessories for sinks and wash basins
IS:3486	Cast iron spigot and socket drain pipes
IS:3597	Methods of test for concrete pipes
IS:4127	Code of practice for laying of glazed stoneware pipes
IS:4346	Washers for use with fittings for water services
IS:4984	Specification for high density polyethylene (HDPE) pipes for potable water supplies, sewage and industrial effluents
IS:4985	Unplasticized PVC pipes for potable water supplies
IS:5219	Cast copper alloy traps ('P' & 'S' (Part-I) traps)
IS:5329	Code of practice for sanitary pipe work above ground for buildings
IS:5961	Cast iron gratings for drainage purposes
IS:7634	Code of practice for plastic pipe work for potable water supplies
IS:8008	Injection moulded high density polyethylene (HDPE) fittings for potable water supplies
IS:10124	Fabricated PVC fittings for potable water supplies

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Materials

Sanitary Fittings

All sanitary fittings shall be procured from approved vendors and shall conform to the requirements of the relevant IS Codes listed above. The sizes shall be as specified in the General Technical Specification, where not specified, the same shall be as per Owner/Owner's representative's approval.

Glazed earthenware fittings shall be of Hindustan Sanitaryware, Parryware or approved equivalent make, white colour and one piece construction. All metallic fixtures like taps, stop cocks, soap holders etc. shall be of Chromium Plated (CP) brass, Jaguar, GEM or approved equivalent make. PVC fixtures shall be of CALIPLAST or approved equivalent make. All wall fittings shall be fixed with wooden cleats and CP brass screws and washers.

Pipes and Fittings

Pipes and specials shall be of standard quality conforming to IS:3486.

Stoneware pipes shall conform to IS:651.

RCC pipes for underground sewer shall be P1 class conforming to IS:450.

Cast Iron rain water pipes shall conform to IS:1230.

Water supply lines of GI, PVC, HDPE shall conform to IS:239, IS:4985 and IS:4984 respectively. PVC fittings for water supply lines shall conform to IS:10124.

The Contractor shall submit to the Owner/Owner's representatives samples of all materials, fittings and appliances for approval well in advance of starting the work. All materials, fittings and appliances used in the work shall conform to the approved samples.

General

All water supply, drainage and sanitary works shall be executed by a licensed or authorised plumbing supervisor or a license or authorised plumber and shall be in accordance with the requirements of IS:1742 and other relevant codes.

For items such as earthworks, excavation, concrete, brick work, stonework, painting etc. relevant specifications for these shall apply, unless otherwise specified.

Unless otherwise specified, all exposed work such as cisterns, brackets etc. shall be painted with one coat of red oxide paint and two coats of oil paint of approved colour.

The diameter of pipes and fittings wherever mentioned shall mean the internal diameter or nominal bore, unless otherwise specified.

The job shall include the cost of making necessary chases, holes etc. in walls, floors and in other places and also making good on completion of the works. Any damage caused to floors, walls etc. during execution of the sanitary and plumbing works shall be made good by the Contractor at his own cost to the satisfaction of the Owner/Owner's representative.

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Installation

All execution will be done on the basis of drawings /instruction given by the Owner/Owner's representative. 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.

Cast iron soil and waste pipe line

- Laying

The laying of cast iron pipelines shall commence only after the bottom of the trench at various points have been levelled and aligned in accordance with the drawings. The sides of the trenches shall be as vertical as possible, and the width at the bottom shall be 400 mm wider than the diameter of the pipe. Where joints are made, the trench shall be widened suitably to provide room for caulking joints. Shoring and timbering shall be used where required. For pipes buried in the ground, the Contractor shall take care to maintain always a minimum cushion of earth over the pipes as indicated in the drawings. All pipes, water mains, cables etc. met within the course of excavation shall be carefully protected and supported. All pipes and fittings shall be sounded with a light hammer and check properly to detect any crack or blow holes before laying. The excavated material shall be thrown on one side of trench and the pipes stacked on the other side. The inside of socket and the outside of spigot shall be thoroughly cleaned of all foreign matter before laying. The pipes shall be laid with their socket ends facing the direction of the flow. The pipes shall be lowered in the trenches by a method as approved by the Owner/Owner's representative. The pipes shall then be jointed by caulking as specified under jointing. After each section of the pipeline has been laid it shall be tested for water tightness before backfilling the trench. On successful completion of testing, the trench shall be backfilled with the excavated earth in layers of 200 mm and shall be watered and rammed. Any subsidence occurring in the line of trenches after backfilling shall be repaired by the Contractor at his own cost. Where the pipelines cross roads, the sides of the trenches shall be suitably shored.

When the pipe line has to be laid above ground vertically by the side of wall, it shall be securely fixed to the wall with wooden plugs and nails.

- Jointing

The type of jointing for C.I. pipes conforming to IS: 3486 shall be socket and spigot either with molten lead or lead wool and gasket conforming to IS:782.

If the joints used are spigot and socket type, the spigot shall be carefully centred in the socket by one or more laps of clean white hemp spun yarn with about 25 mm overlap. Sufficient yarn only shall be forced into the socket to leave a correct depth of lead for caulking. The pipe shall then be examined again for line and level and the proper depth of each joint shall be tested before running the molten lead. For pouring of molten lead a ring of hemp rope shall be wrapped round the pipe at the end of the socket and the joint shall be covered with stiff damp clay. The rope shall then be removed carefully leaving a V-shaped large hole at the top of the joint to pour the molten lead. Lead shall be poured in one operation only. After a section of convenient length of pipe has been laid, lead shall be caulked sufficiently with caulking tools and hand hammered till the excess lead removed and the joint shall be made neat and clean. Depth of lead in joints from the top of socket shall be 37 mm for 150 mm dia pipes and 25 mm for 100 mm dia pipes.

The type of joint CI pipes conforming to IS:1729 shall be socket and spigot with cement and sand mortar (1:1) and gasket yarn.

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The spigot shall be carefully inserted and centered in the socket by one or more laps of thin clean hemp spun yarn and shall be forced into the socket to leave a correct depth of 30 mm all-round and level and the proper depth of each joint shall be tested before inserting the cement mortar. The joints shall then be carefully be levelled to the edge of the socket. Each joint shall be adequately cured by covering with wet clothes and pouring water at frequent intervals.

The packing ring or washer for the flanged joints shall be rubber for the full diameter of the flange with proper pipe hole and bolt holes cut out suitably. The packing shall be smeared with graphite paste or a mixture of red lead and white lead and shall be introduced between the flanges of both the pipes and nuts tightened in opposite pairs keeping the longitudinal axes of adjoining pipe lines in exactly the same straight line. Lead washers shall be provided along with bolts to prevent any leakage through bolt holes.

Stoneware pipes

- Laying

The laying of stoneware pipelines shall commence only after the bottom of the trench at various points have been levelled as shown in the drawings. The centre line excavated to correct depth, slope and width at all points. The pipes shall be carefully laid to the alignment, levels and gradients as shown on the drawings. The trench shall be excavated wide enough under the sockets to allow hands to pass for making joints. The pipes between manholes shall be laid truly in straight lines and without any vertical or horizontal deviations on a bed of concrete as shown on the drawings. While laying pipes, portion of concrete under each socket shall be dug and taken off so that the barrel of the pipe gets full support on the concrete bed. Pipes shall be haunched with concrete tangentially upto the crown of the diameter of the pipe as shown on the drawings. When it crosses under a road, the pipe shall be fully encased in concrete as shown on drawings. The Contractor shall take precautions to maintain always a minimum cushion of earth over the pipes as indicated in the drawings. All pipes shall be carefully examined with a light hammer of soundness before laying. After each section of the pipelines has been laid, the joints shall be allowed to set properly and shall be inspected and tested as directed by the Owner/Owner's representative. Backfilling of the trench shall be carried out only after the approval. After testing, the trench shall be backfilled with selected earth in layers of 200 mm and shall be watered and thoroughly rammed. All pipes, water mains, cables etc. met within the course of excavation shall be carefully protected and supported.

When the pipelines cross roads, the trenches shall have vertical sides with suitable shoring. Any subsidence in the line of trench after backfilling shall be repaired by the Contractor at his own cost.

- Jointing

The type of jointing for stoneware pipes shall be socket and spigot type. The inside of the socket shall be first painted with a thin layer of cement mortar (1:2) and a gasket of yarn dipped in cement slurry shall be inserted in the socket of the pipe with the wooden caulking tool and wooden mallet in such a way that the gasket shall fully encircle the spigot with a slight overlap. When the spigot end received the gasket, it shall be wrapped round with two or three turns of treated spun yarn at its ends before being inserted into the socket. The rest of the joint shall then be completely filled with cement sand mortar (1:1) having very little water and the joint shall be levelled to form a smooth splayed fillet at an angle of 45°. All excess of cement mortar left inside the pipe joint shall be neatly cleaned off and the joint shall be adequately cured by covering with wet gunny bags and pouring water at frequent intervals. In jointing stoneware pipes, care shall be taken that the pipes are kept concentric and the socket, specially on the underside shall be completely filled with cement mortar. Where settlement of earth is envisaged, the joint shall be made with bitumastic filler or any other materials as approved by the Owner/Owner's representative.

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Concrete pipes

- Laying

The laying and jointing of pipes shall conform to IS:783. The trench shall be checked for proper level, gradient and alignment before lowering the pipes.

The pipes shall be lowered cautiously to prevent disturbance of the bed and sides of the trench. The heavy pipes shall be lowered by means of proper shear legs, chain pulley blocks or as directed by Owner/Owner's representative. Great care should be taken to prevent sand etc. from entering the pipes.

Laying of pipes shall proceed up grade of slopes. The error of grade shall not be rectified by packing up earth underneath the pipes. If required, concrete shall be used for packing. The ends of the pipes shall be kept closed to keep dirt, mud and foreign materials, out. Adequate provision shall be made to prevent floating of pipe in the event of flooding of trenches. The body of the pipe for its entire length shall rest on an even bed in the trench and places shall be excavated to receive the collar for the purpose of jointing.

- Jointing

The type of jointing for concrete pipes shall be with loose concrete collars and the joints shall be packed from either side with spun yarn dipped in cement slurry as specified for jointing stoneware pipes. Stiff cement mortar (1:1) shall be filled from both sides and splayed at an angle of 45° on both sides. The joint shall be adequately cured as specified for joints in stoneware pipes.

Cast iron rainwater pipes

Cast iron rainwater pipes fixed to the external walls shall be blocked out atleast 20 mm from the plastered surfaces by means of cast iron bobbins. The rainwater pipes at the roof level shall be fitted with a cast iron bend with a masonry bell mouth of suitable size fitted with a cast iron grating. The bottom of the down pipe shall be fitted with a shoe fixed 150 mm above ground/apron level of the building. The socket and spigots of pipes and fittings shall be jointed as specified for cast iron soil and waste pipe line.

Galvanised steel water supply pipes

Screwed galvanised steel pipes shall be jointed with screwed joints and screwed fittings of the same materials as that of the pipes. Any burrs remaining on the pipe ends after the treads are out shall be removed. An approved jointing compound together with a grummet of a few strands of fine yarn shall be used for jointing pipes and fittings. Any pipe threads exposed after jointing shall be painted or in the case of underground piping thickly coated with approved bituminous compound to prevent corrosion.

The depth at which the underground water supply pipe is to be laid be as shown on the drawings. The service pipe passing into or beneath the building shall be laid at least 200 mm below the ground floor level and accommodate in a previously laid sleeve in the structure where it enters the building. The space between the sleeve and the pipe at its entry into and exit from the building shall be filled with a bituminous material for a minimum of 150 mm at both ends.

Piping shall not be buried in walls or floors as far as possible. However, when unavoidable, piping shall be buried for the shortest distance necessary and adequate protection shall be provided against damage.

Galvanised steel piping shall be secured by iron or steel clamps and hooks when fixed on walls.

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All pipe work shall be completely watertight and the joints shall be such that there are no projections of jointing materials or the like in the interior of pipes. Before the pipe line is commissioned, all piping and fittings shall be flushed clean.

High Density Polyethylene water supply pipes

All high density polyethylene pipes shall have screwed ends and shall be jointed with screwed fittings of the same materials of that of the pipes. Any burrs remaining on the pipe ends after cutting threads shall be removed. If necessary, an approved jointing compound with a few strands of fine yarn may be used for jointing pipes and fittings. All exposed high density polyethylene pipes shall be installed with PVC saddles screwed on 25 mm thick wooden blocks securely fixed on walls at suitable intervals, not exceeding 1 m. Pipe wherever installed in wall chasing shall be fixed as in the case of galvanised steel pipes.

PVC water supply pipes

All exposed pipes shall be installed with PVC saddles screwed on 25 mm thick wooden blocks securely fixed on walls at suitable intervals, not exceeding 1 m. Pipe wherever installed in wall chasing shall be fixed as in the case of galvanised steel pipes.

Inspection pits and trap pits

Construction of pits shall commence only after the pipes have been laid in position to true line and levels as shown on the drawings and to the satisfaction of the Owner/Owner's representative.

- Inspection pits

Unless otherwise specified, all inspection pits shall be constructed with rubble masonry in cement mortar (1:4). Half round channels of size suitable for the inlet and outlet pipe diameters shall be formed on the floor of the pit with PCC 1:3:6. The floor of the pit shall be haunched towards the channel as shown on the drawings. Inside of pits shall be finished with cement-sand plaster (1:4) and finished smooth with cement punning. Care shall be taken to avoid unevenness on the surface and sharp bends in the channel. The invert level after finishing shall be as shown in the drawings or as indicated by the Owner/Owner's representative.

- Intercepting/master trap pits

The pits for the glazed stoneware master trap shall be constructed as indicated in the drawings. The construction and finishing of the pit shall be haunched towards the intercepting/master trap.

- Gully trap pits

Gully trap pits shall be constructed as indicated in the drawings. The construction and finishing of the pit shall be as described above for inspection pits. The cast iron grating shall be set flush with the finished ground/floor level.

Sanitary appliances

All sanitary appliances shall be fixed in position rigidly on floor and walls as indicated in the drawings or as directed by the Owner/Owner's representative. All appliances shall be from the approved manufacturer and of approved colour.

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- **Indian Water Closet - Squatting type (IWC)**

Squatting type water closet shall be fitted on trap and shall be jointed with gasket yarn and cement mortar. Rim of the pan shall be levelled properly and set flush with the finished floor. The pan shall be connected to PVC low level push button/lever type cistern of 10 litre capacity. The flushing cistern shall be supported on a pair of CI cantilever brackets firmly embedded in the wall in cement mortar (1:4) or screwed to wall with suitable plugs. The flush pipe from the cistern shall be 32 mm dia tested quality Chromium Plated (CP) pipe and connected to the pan inlet by means of hemp and putty joint.

- **European Water Closet (EWC)- pedestal type**

Pedestal type water closet shall be rigidly fixed on the finished floor by means of 75 mm long brass screws with suitable plugs. The flushing cistern shall be PVC low level push button/lever type cistern of 10 litres capacity. The cistern shall be supported on a pair of cast iron or rolled steel cantilever brackets firmly fixed on wall with brass screws and suitable plugs. The flush pipe from the cistern shall be 40 mm dia chromium plated brass end and fitted to the closet by means of rubber adopter. The closet shall be provided with double plastic seat cover conforming to IS: 2548 and chromium plated hinges.

- **Urinals**

Standing type urinals shall be firmly fitted on finished wall by means of 50 mm long brass screws and suitable plugs. Height of the lip from the standing point shall be as shown in the drawings. Urinals shall be fitted with automatic flushing cistern of 10/15 litres (2/3 urinals) capacity. Flushing pipes shall be of CP pipes of 25 mm dia and connected to the urinal with 15 mm dia PVC connector fitted with brass cap and lining at one end. The joint to the inlet of urinal shall be neatly finished with putty joints.

The arrangement of waste pipes and discharge to the floor trap shall be as shown on the drawings or as directed by Owner/Owner's representative. For single urinal the discharge may be direct to the floor trap through a 40 mm dia waste pipe. For a range of urinals, the discharge may be collected in a common waste pipe of 50 mm dia leading to the floor trap. Each urinal shall be connected to the common discharge pipe by 40 mm dia waste pipes. Alternatively, the discharge from each urinal through 40 mm dia pipe shall be lead to the 100 mm W.G half round channel laid on the floor leading to the floor trap.

- **Wash hand basin**

Wash hand basin shall be fitted in position to true level on a pair of cast iron brackets plugs. The basin shall be fitted with 15 mm dia approved quality CP pillar tap and 32 mm dia waste fittings. The type of waste pipe and their connections shall be as shown in the drawings or as directed by the Owner/Owner's representative.

- **Sink**

Stainless steel sink of shall be levelled properly and fitted in position on a pair of cast iron cantilever brackets firmly embedded in the wall in cement mortar (1:4). The sink shall be fitted with chromium plated brass waste fittings of standard size. The type of waste pipes and their connections shall be as shown on the drawings or as directed by the Owner/Owner's representative.

- **Other miscellaneous fittings (e.g. mirror, towel rails, soap cases etc.)**

All such fittings shall be of type and sizes specified in General Technical Specification and shall be fitted in position true to line, level and plane as shown on the drawings or as directed by the Owner/Owner's representative.

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Water tanks

Water storage tanks shall be of SINTEX brand or approved equivalent make, unless otherwise specified.

In case large volume tank is to be constructed, the same shall be of GI, Masonry or RCC. They shall be fitted with a ball valve of the inlet pipe. A mosquito proof overflow pipe shall be fixed to the tank with the pipe invert about 25 mm above the top of water line. Approved type of stop valve shall be provided for every outlet pipe. All outlet and inlet pipes shall be fixed as shown in the drawings. Inside surface of galvanised steel tanks shall be painted with anti-corrosive drinking water paints.

All storage tanks, water supply fittings and pipes before being put into commission shall be disinfected with liquid chlorine by the Contractor at his own cost.

Testing and Acceptance Criteria

All sanitary appliances and fittings shall be inspected and tested as per the requirements of IS:1742. All defects and deficiencies detected shall be promptly rectified by the Contractor to the satisfaction of Owner/Owner's representative.

Soil and waste pipe line

On completion of laying, the cast iron, soil, waste and ventilation pipelines shall be tested by the Contractor at his own cost to detect leakages and any other defects in the pipelines.

Test shall be conducted using proper apparatus with attachment for smoke making machine for applying smoke to the pipelines under pressure. Only cotton waste of brown paper soaked in cresote oil shall be used and fired to obtain dense and pungent smoke. While conducting smoke test, top of soil, waste and ventilation pipes shall be kept open till smoke starts coming out of the openings. The openings shall then be securely plugged with expanding rubber or any other approved plug. The floor traps and other openings for connecting sanitary fixtures shall be sealed with water or other approved plug. The floor traps and other openings for connecting sanitary fixtures shall be sealed with water or other approved plug. The entire pipeline shall be tested in suitable sections as directed by the Owner/Owner's representative. The entire length of the pipelines including all joints under tests shall be closely observed for any sign of smoke leakage.

Galvanised steel water supply pipes

After the laying and fixing of all galvanised steel water supply pipes and fittings are completed, the line shall be slowly and carefully charged with water to a test pressure of 5 kg per sq cm or the specified working pressure plus 50% as may be prescribed by the Owner/Owner's representative. Care shall be taken that air in pipelines is completely exhausted while filling the pipelines with water. This pressure shall be maintained for at least one hour, unless otherwise specified.

5.5.18 Tank Pads

Scope

This specification covers the requirements in respect of materials, workmanship and quality for bituminous works, crushed rock ring and ring walls for tank pads.

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Codes and Standards

Unless specifically mentioned otherwise, all applicable codes and standards in their later editions published by the Bureau of Indian Standards and all other such as may be published by them during the currency of the contract, shall govern in respect of design, workmanship, quality and properties of materials and methods of testing. Some of the relevant available codes are listed hereunder:

IS:383	Coarse and fine aggregating from natural sources for concrete.
IS:2720 Part VII -	determination of water content-dry density relation using light compaction.
IS:2720 Part VIII -	determination of water content - dry density relation using heavy compaction.
IS:2720 Part IV -	grain size analysis
IS:1478	Classification and identification of soils for general engineering purposes.
IS:803	Code of practice for design, fabrication and erection of vertical mild steel cylindrical welded oil storage tanks.
IS:73	Paving Bitumen

Materials

Bitumen

Bitumen used for anti-corrosive layer shall be of grade 80/100 or equivalent.

Sand

Sand shall be clean, dry, coarse, hard, angular free from coatings of clay, dust and mix of vegetable and organic materials and shall conform to IS:383 grading Zone II or III. Silt content shall not be more than 5%.

Moorum

Moorum for filling shall consist of coarse and granular moorum containing not more than 20% cohesive fines such as clay (grain size less than 0.074 mm). The moorum shall be 20 mm and down size grading and shall be taken from approved quarries.

Stone Aggregates for crushed Rock Ring

Stone aggregates for the crushed rock ring shall be 50 mm and down grade size and shall be of granite or such other approved materials.

Stone chippings for premix carpet

Stone chippings for premix carpet shall be hard blue granite or approved locally available stone. The grading shall be normally 12 mm down size and 6 mm down size in the ratio 3:2 respectively.

Cement, steel and aggregates for R.C.C. works in dyke wells

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The material specifications for the above shall be the same as in Clause 5.4.5

Workmanship

Sub Grade Preparation

The surface of the natural soil exposed at the bottom of excavated pit shall be thoroughly compacted by rolling arising 8 - 10 ton road roller or other means as directed by Owner/Owner's representative to obtain 95% of maximum laboratory/ standard proctor dry density for the soil as per IS:2720 part VII. The minimum number of passes shall be five. The rolling shall also be done outside the tank pad area for atleast 1.5 m beyond the edge of tank pad. Relevant clauses in Section for Earthwork shall also apply.

Sand/Moorum Filling

The sand/moorum shall be spread in layers not exceeding 15 cm in loose thickness over the areas. Each layer shall be uniform in density, quality of materials and moisture content before compaction. The moisture content shall be within two percent (2%) of optimum moisture content (OMC) on the dry side of OMC as per IS:2720. Compaction of each layer shall be done by mechanical means as per directions of Owner/Owner's representative. Only inaccessible reaches shall be worked manually.

Each layer shall be uniformly compacted to obtain 95% standard proctor density or 85% relative density. If the material fails to achieve the required density, the layer should be reworked with necessary alteration in the composition, so that the required compaction is obtained.

Further layer shall be placed only after the layer has been compacted to the required density. The finished surfaces must be dressed to required grade and slope. Excess material must be removed from compaction site.

Crushed Rock Ring

The stone aggregates for the above shall be laid in layers of 150 mm thickness (compacted thickness) and each layer shall be compacted to obtain a hard core ring wall to the satisfaction of Owner/Owner's representative. The surface shall be checked from time to time during spreading and compaction to ensure a finished surface true to levels and grade as per drawings. Use of fine aggregates such as sand or finer stone aggregates may be required to fill voids and pockets to obtain a uniform compacted hard core. Over the final compacted layer of stone aggregate, sand shall be evenly spread and compacted by tamping/ rolling.

Anti Corrosive Layer

Anti corrosive layer shall consist of screened coarse sand mixed with 80/100 bitumen or equivalent, 8 to 10% by volume. The bitumen shall be treated to a temperature of 75oC to 190oC with 3% kerosene if required and sand shall be thoroughly mixed with it in mixing drum to give uniform mixture and shall be laid over the compacted surface of the pad in line, grade and levels as shown in the drawings or as directed by the Owner/Owner's representative. Bitumen shall not be treated beyond the temperatures limits given above. The layer shall be tamped to form hard mass of uniform compacted thickness specified. The anticorrosive layer shall be made in one layer for a 50 mm thickness. For higher thickness it should be laid in two layers after application of a tack coat of bitumen. These layers shall be finished to grade as specified.

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Premix carpet

The crushed rock ring where provided and the areas on which the premix is to be laid (generally the areas exposed to sun & rain) shall be thoroughly cleaned of all dust and loose materials. On the cleaned surface a tack coat at the rate of 1.0 Kg/m² of hot bitumen shall be uniformly applied by sprayers. The applied binder shall be evenly brushed. The binder bitumen 80/100 shall be heated to the temperature of about 190°C with 3% kerosene, if required and mixed with stone chippings at the rate of 6.1 m³ for 400 Kg of bitumen for 100 sq. m of surface of 50 mm thick carpet. Mixing shall continue until the aggregate is well coated.

The premix carpet shall be laid in two layers of 30 mm and 20 mm. After compacting and laying the first layer of 30 mm, a tack coat of hot bitumen at the rate of 1 Kg/m² shall be uniformly applied to the surface by means of sprayer and second layer of 20 mm thick shall be laid, tamped and compacted to the satisfaction of the Owner/Owner's representative. Sand shall be spread on the final surface at the rate of 0.5 m³/100 m².

Reinforced Concrete Works for Ring Wall

Reinforced concrete works shall be done as per specifications laid down in Clause 4.5.0.

The ring wall shall be cast in quick succession and completed within a period of maximum 7 days. It is desirable that it is cast in alternate lengths along the perimeter at first keeping the horizontal reinforcements independent on the next cast panels. Intermediate panel lengths shall be cast after 3 days to provide some relief from shrinkage strain.

Tolerances

The top surface of tank pad shall be to true level & line within the tolerance limit specified below.

- Where concrete ring wall is provided, the differential level shall be within plus or minus 3 mm in any 10 metres of circumference and within plus or minus 6 mm in total circumference.
- Where concrete ring walls are not provided, the differential level shall be within plus or minus 3 mm in any 3 metres of circumstance and within plus or minus 12 mm in the total circumference.

5.5.19 Water Bound Macadam (WBM), Roads

Scope

This specification covers the requirement in respect of materials, workmanship and quality for road works like sub-grade preparation, sub-base layer, water bound macadam, drains, pipe culverts etc.

Codes and Standards

Unless specifically mentioned otherwise, all applicable codes and standards in their latest editions as published by the Bureau of Indian Standards shall govern in respect of design, workmanship, quality and properties of materials and method of testing. Some of the relevant available codes are listed hereunder:

Specification for road and bridge works of Ministry of shipping & Transport (Roads wing) Published by IRC.

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IRC -19	Standard specification and code of practice for Water Bound Macadam
IRC SP 11	Hand Book of quality control for construction of roads and runways
IS: 458	Specification for concrete pipes
IS: 783	Code of practice for laying of concrete pipes
IS: 2720	Methods of test of soil (All parts)

Sub Grade

Excavation

After the earthwork in cutting and the earthwork in embankments have been done properly up to the final road level with gradients and camber as per drawings and proper consolidation of the filling is completed, earthwork in box cutting shall be taken in hand. Before starting of Box cutting, the Contractor shall obtain Owner/Owner's representative's approval of cutting and embankment work.

The surface of the formation for a width equal to that of the sub-base course shall be properly prepared before any further courses are laid. Surface shall be cut to a depth below the ground level equal to depth of sub-base course due allowance being made for compaction. Preparation of sub-grade also includes removal of any and all foreign substance accumulation and removing undulations up to 150 mm by filling and cutting as required. The sub-grade shall be dressed parallel to the finished profile.

The excavated spoils shall be transported and utilized in filling of low areas or as directed by the Owner/Owner's representative. The filling shall be done in layers or as directed by the Owner/Owner's representative. The filling shall be done in layers of 150 mm and clods and lumps shall be broken and consolidation done to the satisfaction of the Owner/Owner's representative.

In case of presence of weak soil-pockets below the formation, the Contractor shall excavate and remove such soil to an extent as instructed by the Owner/Owner's representative. Extra depth shall then be filled up with 38 mm down stone-metal and voids in metal shall be filled up with moorum. Then, the filling shall be rammed and rolled uniformly with a road-roller of 8 tonnes minimum weight. These operations of removing weak soil pockets and filling with stone-metal shall be done by the Contractor.

If, by mistake the depth of box cutting is made more than required, the Contractor shall make up the extra depth by metal consolidation, as specified above, at his own cost.

After the top layer/WBM course is laid and compacted, the existing surface at the shoulders of the road must be scarified. Fresh quantity of approved earth must be extracted from the surplus earth obtained by box cutting spreading in layers for building up the berms. The layer of earth must be compacted by at least three passes of 8 - 10 tonne rollers. The edges must be well compacted by suitable means to prevent edge slips and the work properly trimmed and dressed.

Rolling

After the box cutting is completed, the sub-grade shall be compacted with powered road roller 8-12 tonnes. The roller shall run over the sub-grade till the soil is evenly and densely compacted, to achieve a dry density of not less than 95% of maximum density as obtained from standard proctor compaction test. There shall be a minimum of five (5) roller passes. All the undulations on the surface which develop due to rolling shall be made good with earth and quarry spills as approved by

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Owner/Owner's representative and the sub-grade re-rolled. The top of the sub grade shall be dressed evenly to the required camber and necessary drainage arrangement at the time of rolling shall be provided. Care shall be taken to avoid excessive rolling of the formation. If, after rolling the formation is higher than required, the excess earth shall be removed by carefully cutting and dressing and the formation shall be rolled as specified above. In case after rolling the formation is depressed below the required level, the Contractor shall continue the process of filling and rolling as above till the correct level is attained up to a limit as decided by the Owner/Owner's representative at Contractor's cost.

Soling (Sub-Base)

This work shall consist of laying and compacting rubbles or boulders on prepared sub-grade in accordance with the requirements of this specification. The material shall be laid in one or more layers as shown on the drawings and according to lines, grades and cross sections shown on the drawings or as directed by the Owner/Owner's representative.

Materials

The materials to be used for the work shall be rubbles or boulders and gravel from approved quarries. The maximum size of stone shall be 150 mm. The length and breadth of stone shall not be more than twice of its depth. The stones shall be hard, tough and durable and free of earth, loam or vegetable matter. The flaky material shall not be used.

Construction

The soling shall be laid as per the cross section as shown on the drawing and the finished thickness after consolidation shall be as directed by the Owner/Owner's representative. The boulders shall be laid flat with their broad faces resting over the sub-grade to have good seating. The stones shall be hand packed as close as possible and bedded firmly. The voids in the soling shall be filled with stone chips and small stones and hammered and wedged into position. Gauge pegs shall be driven into indicate the thickness of the stones to be laid. Any hollows formed during rolling shall be filled in with spills during the process of consolidation so as to conform to the gradient, camber and cross section of the road and leave an even finished solid surface.

The soling shall be rolled by a 8 to 12 tons power roller after blinding with approved quality moorum. The shoulder shall be rolled first to wedge the stones firmly at the edges and then rolling shall proceed towards the centre. The rolling shall be done longitudinally at the shoulder and worked towards the centre of the pavement overlapping on each successive trip by at least one-half of the width of the roller while starting and 300 mm width while finishing. In case of super elevated strips, the rolling shall commence from the inner edge and proceed towards the outer edge.

The roller shall be operated at the lowest speed possible. The speed in any case shall not be greater than 3 km per hour. Rolling shall be continued till a satisfactory surface is obtained. Wherever use of power roller is not feasible, suitable hand roller may be used as per instructions of the Owner/Owner's representative.

The soling if not done as per the specification, if instructed by the Owner/Owner's representative the whole soling over the defective portion shall be taken out, re-laid and compacted with a road roller as specified earlier, by the Contractor at his own cost.

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Sand-Gravel Sub-Base

The work shall consist of laying and compacting of a mix of sand and gravel in specified proportion over a prepared sub-grade to the required lines, grades and cross-section in layers as per requirement of this specification.

Materials

Sand shall be medium hard, strong, free from organic and deleterious matter and shall be from a source approved by the Owner/Owner's representative. Sea sand shall not be approved.

Gravel shall be clean, well graded and free from any vegetation organic clay or other materials and shall be from a source approved by the Owner/Owner's representative.

Construction

The sand and gravel shall be mixed thoroughly in specified proportions by approved means. The moisture content shall be brought to within two (2) percent of the optimum moisture content for the mixed materials as per IS:2720 (Part viii).

The sand gravel mix shall be spread over the prepared sub-grade in layer not exceeding 200 mm thick (uncompacted thickness) and compacted by power rollers (8-10 tonnes) to achieve 85% relative density. The layer shall be compacted to the required camber, slope and line.

Further layer shall be placed only after the layer already laid has been compacted to the required density and approved by the Owner/Owner's representative based on the test results. The finished surface shall be dressed to required camber and level and excess material removed and disposed off by the Contractor at his own cost as instructed by the Owner/Owner's representative.

Water Bound Macadam (Sub-Base/Base Coarse)

Water bound macadam shall consist of clean, crushed aggregates mechanically interlocked by rolling and bonded together with screenings, binding material, where necessary and water, laid on a prepared surged or sub-base, as the case may be, and finished in accordance with the requirements of these specifications and in conformity with the lines, grades and cross-sections shown on the drawings or otherwise directed by the Owner/Owner's representative.

Materials

- Coarse Aggregate

Coarse aggregate shall be of crushed blue granite. Aggregate shall be hard and durable and shall be free from excess of flat, elongated, soft and disintegrated particles, dirt and other objectionable matter and shall be from a source approved by the Owner/Owner's representative.

Crushed aggregate shall meet the following requirements:-

- Flat or elongated pieces shall not be more than 15%.
- Los Angeles Abrasion value shall not be more than 40% or Aggregate Index value shall not be more than 30%. Coarse aggregate shall be graded as follows :

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Size Range	IS Sieve designation	Percentage passing by weight
63 - 40 mm	80 mm	100
	63 mm	90 - 100
	50 mm	35 - 70
	40 mm	0 - 15
	20 mm	0 - 5

Following test shall be conducted on samples of aggregate :

- i) Sieve analysis
- ii) Impact tests
- iii) Water absorption test - Maximum water absorption shall be 1%
- iv) Wetting and drying - The samples shall be subjected to alternate wetting and drying for 3 days and shall not show signs of disintegration.

- **Screenings**

Screenings shall generally be of same material as the coarse aggregate and meet the following gradings :

Size of screening	IS Sieve designation	Percentage passing by weight
10 mm	10 mm	100
	4.75 mm	85 - 100
	150 microns	10 - 30

Where non-plastic material like moorum is specified, the liquid limit and plastic limit of such material shall be below 20 and 6 respectively and the fraction passing 75 microns sieve shall not exceed 10%.

- **Binding Materials**

Gravel of suitable plasticity available from local quarries may be used as binding materials and the same shall be approved by the Owner/Owner's representative.

When sample of the binding material is wetted and squeezed in hand the following characteristics shall be noted:

- i) The material shall be extremely gritty.
- ii) It can be formed into definite shapes that retain their form even when dried.

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- iii) When the wetted sample is patted in the palm of the hand it will compact into a dense cake that cannot be penetrated easily with a blunt stick.

Construction

- Preparation of Base

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.

- Inverted Choke

If the water bound macadam is to be laid directly over the sub-grade, without any other intervening pavement course, a 25 mm course of screenings shall be spread on the prepared sub-grade before application of the coarse aggregate is taken up.

- Spreading Coarse Aggregate

The coarse aggregates shall be spread uniformly upon the prepared surface. The spreading shall be done from stockpiles along the side of the roadway or directly from vehicles. In no case shall the aggregate be dumped in heaps directly on the surface prepared to receive the aggregate nor shall hauling over the uncompacted or partially compacted base be permitted.

The surface of the aggregates spread shall be carefully checked with template 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 the pockets of fine material.

The coarse aggregate shall not normally be spread more than three (3) days in advance of the subsequent construction operations.

- Rolling

Immediately following the spreading of the coarse aggregate, rolling shall be started with three wheeled power rollers of 8 to 10 tonne capacity or tandem roller or vibratory rollers of approved type. The weight of the roller shall depend upon the type of the aggregate and be indicated by the Owner/Owner's representative.

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, in successive passes uniformly lapping preceding tracks by at least one half width.

Rolling shall continue until the aggregates are thoroughly keyed and the creepage 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 wave-like motion in the sub-grade or sub-base course. Wherever use of power roller is not feasible, suitable hand roller may be used as per the instructions of the Owner/Owner's representative.

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The rolled surface shall be checked transversely and longitudinally with templates. If irregularities noticed, which exceed 12.5mm when tested with a 3m straight edge, the surface shall be loosened and aggregates added or removed as required and re-rolled until the entire surface conforms to desired camber and grade. In no case shall use of screenings be permitted to make up depressions.

- **Applications 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 aggregate. 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 spreaders, or directly from trucks. Trucks operating for spreading the screenings shall be so driven as not to disturb the coarse aggregate.

The screenings shall be applied at a slow and uniform rate (in three or more application) so as to ensure filling of all voids. This shall be accompanied by dry rolling and brooming with mechanical brooms, hand brooms or 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 of the coarse aggregate.

The spreading, rolling and brooming of screenings shall be carried out in only such lengths of the road which would be completed within one day's operation.

- **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 sweep the wet screenings into voids and to distribute them evenly. The sprinkling, sweeping and rolling operations shall be continued, with additional screening as necessary, until the coarse aggregate has been thoroughly keyed, well-bonded and firmly set in its full depth and a grout has been formed of screening. Care shall be taken to see that the base or sub-grade does not get damaged due to the addition of excessive quantities of water during construction.

- **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, the resulting slurry 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 of voids, forms a wave ahead of the wheels of the moving roller.

- **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 materials as directed, lightly sprinkled with water if necessary and rolled. No traffic shall be allowed on the road until the macadam has set. The Owner/Owner's representative shall have the discretion to stop hauling traffic from using the completed water bound macadam course if in his opinion it would cause excessive damage to the surface.

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- **Second Layer of WBM (where specified)**

Before laying the second layer of WBM, the surface shall be scarified and reshaped to the required camber and profiles and all ruts, depressions, pot holes etc. made good. The second layer shall be laid after the surface preparation is approved by the Owner/Owner's representative.

The specification for second layer of WBM shall be similar to the first.

Pipe Culverts

Materials

The drainage pipes unless otherwise shown on drawings or instructed by the Owner/Owner's representative, shall be made of RCC (Hume pipe) and shall be either Class NP2 or NP3.

Pipe culverts shall be made of reinforced concrete pipe (Hume Pipe) and shall be of class NP2 or NP3 as decided by the Owner/Owner's representative or shown in the drawing. All pipes shall meet the requirements of IS:458 and shall be procured from approved manufacturers with collars as per manufacturers standard specifications. The Bidder shall specifically mention the particular manufacturer's product he proposes to use.

Cement to be used shall be either Portland slag cement with minimum 50 % slag or Portland pozzolana cement.

Aggregate shall be as per IS: 383 - Maximum size shall not exceed one third the thickness of the pipe or 20 mm whichever is smaller. For bedding concrete for laying the pipes, the maximum size of aggregate shall be 38 mm.

Fine aggregate for concrete shall be as per IS: 383.

Laying of Pipes

Laying of Hume pipes and collars shall be done as per IS:783. Pipes shall be laid either in trenches or on supports as per drawing and/or Owner/Owner's representative's instructions. All pipe sections and collars shall be inspected carefully for defects before laying in the trenches. Broken or defective pipe shall not be used and shall be properly marked and removed from site as soon as the defects are detected. Pipes shall be laid true to line and grade as specified in the drawings and/or Owner/Owner's representative's instruction. The bedding of the pipes shall be 'First class bedding' or ordinary bedding as per IS:783. The profile of cutting of trenches, free working space provided on each side of the pipe, etc. shall be decided at site by the Owner/Owner's representative as per site condition. 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 in layers of 150 mm, clods and lumps broken, watered and compacted with iron rammers to the satisfaction of the Owner/Owner's representative. The surplus spoils shall be transported and filled in low areas within the plant area, as instructed by the Owner/Owner's representative. The filling shall be done as per specification.

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 a height. The joints of pipes shall be grouted with 1:2 cement - sand mortar and the procedure of jointing shall be as per IS:783.

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Pipes laid in trenches in earth shall be bedded evenly and firmly and as far up the haunches of the pipes as consistent with the load expected to be transmitted from the backfill through the pipe to the bed. This shall be done either by excavating the bottom of the trench to fit the curve of the pipe or by compacting the earth under and around the curve of the pipe to form an even bed.

Where the pipe is laid in trench in rock, hard clay, shale or other hard materials, the space below the pipe shall be excavated and replaced with an equalising bed of concrete (1:4:8 mix), sand or compacted earth as approved by the Owner/Owner's representative. In no place shall the pipe be laid directly on such hard material.

If end protection wall is shown in drawing, the wall shall be constructed with first class quality locally available bricks from approved source. All civil works connected with the protection work, like concrete, brick masonry, plastering etc. shall be done as per relevant Indian Standards and in accordance with approved construction drawings. All materials used shall also conform to Indian Standards.

5.5.20 Bitumen Roads

Scope

This specification covers the requirement in respect of materials, workmanship and quality for bitumen roads like bitumen macadam, premix carpet etc. Moreover, for specification for base course, sub-base course of roads, the technical specification 5.5.19 (Technical Specification for road works construction roads) shall be referred.

Codes and Standards

Unless specifically mentioned otherwise, all applicable codes and standards in their latest editions as published by Indian Road Congress and Bureau of Indian Standards shall govern in respect of design, workmanship, quality and properties of materials and methods of testing.

Some of relevant available codes are listed here under.

IRC - 47	Standard specification and code of practice for bitumen road.
IRC - 48	Standard specification for bitumen roads surface dressing using pre coated aggregates.
IRC - SP - 11	Hand book of quality control for construction for roads and runaways.
IS:73	Specification for paving bitumen.
IS:217	Specification for cut back bitumen.
IS:454	Specification for digboi type cut back bitumen.
IS:1200	Method of measurement for road work (Part-17) including air field pavements.

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Execution

Tack Coat

- Description

The work shall consists of application of a single coat of low viscosity liquid bituminous material to an existing road surface preparatory to another bituminous construction.

- Materials

Binder: The binder used for tack coat shall be bitumen of a suitable grade as directed by the Owner/Owner's representative and conforming to IS:73, 217 or 454, as applicable, or any other approved cutback.

Construction Operations

- 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 material before the application of the binder.

- Application of Binder

Binder shall be heated to the temperature appropriate to the grade of bitumen used and approved by the Owner/Owner's representative 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 existing bitumen treated surface and 10 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.

Semigrout (Bituminous Macadam Binder Course)

This work shall consist of construction, in a single course, 115 mm thickness of compacted crushed aggregates premixed with a bituminous binder, laid immediately after mixing, on a base prepared previously in accordance with the requirements of these specifications and in conformity with the lines, grades and cross sections shown on the drawings or directed by the Owner/Owner's representative.

Materials

- Binder

The binder shall be straight run bitumen of a suitable grade as directed by the Owner/Owner's representative complying with IS:73.

The aggregates shall satisfy the physical requirements set forth in Table-I.

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Table I
Physical Requirements of Aggregates for
Bituminous Macadam

Los Angeles Abrasion *	IS:2386	35% Maximum (Part IV)
Aggregate Impact Value *	IS:2386	30% Maximum (Part IV)
Flakiness Index	IS:2386	35% Maximum
Stripping Value	IS:6241	25% Maximum
Water Absorption	IS:2386	2% Maximum value

* 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 Tables II & III.

Table II
Aggregates Grading for 115 Mm Compacted Thickness
of Bituminous Macadam

Sieve	Percent by weight passing the sieve	
Designation	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 III
Aggregates Grading for 50 Mm Compacted Thickness
of Bituminous Macadam

Sieve	Percent by weight passing the sieve	
Designation	Grading A	Grading B
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	-	0-20
75 micron	0-5	0-4

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- **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, except when otherwise directed by the Owner/Owner's representative.

The quantities of aggregates to be used shall be sufficient to yield the specified thickness after compaction.

- **Variation in Proportioning of Materials**

The Contractor shall have the responsibility for ensuring proper proportioning of materials and producing a uniform mix. A variation in binder content of ± 0.3 percent by weight of total mix shall, however, be permitted for individual specimens taken for quality control tests.

Construction of Operation

- **Weather and Seasonal Limitations**

Bituminous macadam shall not be laid during rainy weather or when the base course is damp or wet.

- **Preparation of Base**

The base on which bituminous macadam is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross sections as directed by the Owner/Owner's representative. The surface shall be thoroughly swept and scraped clean and free from dust and foreign matter.

- **Tack Coat**

A tack coat shall be applied over the base.

- **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°C - 165°C and that of aggregates in the range 125°C - 150°C provided that the difference in temperature between the binder and aggregate at no time exceed 25°C.

Mixing shall be thorough to ensure that the 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 suitable vehicles. The vehicles employed for transport shall be clean and be covered over in transit if so directed by the Owner/Owner's representative.

- **Spreading**

The mix shall be spread immediately after mixing by means of a self propelled mechanical paver with suitable screeds capable of spreading, tampling 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 Owner/Owner's representative, he may permit manual laying of the mix.

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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 in the layer below by about 150 mm. 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 centreline 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.

- Rolling

After the spreading of mix, rolling shall be done by 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 keep from unduly roughening the pavement surface.

Rolling of the longitudinal joint shall be done immediately behind the paving operations. After this, the rolling shall commence at 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.

The initial or breakdown rolling shall be done as soon as it is possible to roll the mixture without cracking the surface or having the mix pick up on the roller wheels. The second or intermediate rolling shall follow the breakdown 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 material. The rolling shall then be continued till the entire surface has been rolled to compaction, there is no crushing of aggregate and all roller marks have been 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 operations shall be completed in every respect before the temperature of the mix falls below 80 deg C.

Rollers shall not stand on newly laid material while there is a risk that it will be deformed thereby. 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. Wherever use of power roller is not feasible, suitable hand roller may be used as per the instructions of the Owner/Owner's representative.

The bituminous macadam shall be provided with final surfacing without any delay. If there is to be any delay, the course shall be covered by a seal coat before allowing any traffic over it.

Open Graded Premix Carpet

- Description

This work shall consist of laying and compacting an open-graded carpet of 5 cm thickness in a single course composed of suitable small sized aggregates premixed with a bituminous binder on a previously prepared base, to form a wearing course, in accordance with the requirements of these specifications.

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- **Materials**

- **Binder**

The binder shall be bitumen of a suitable grade, as directed by the Owner/Owner's representative and satisfying the requirements of IS: 73, 217, 454 or other approved cutback as applicable.

- **Aggregate**

The aggregate shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be obtained by crushing rock and be free of elongated and flaky pieces, soft and disintegrated materials and vegetable or other deleterious matter. They shall preferably be hydrophobic type.

The aggregates shall satisfy the quality requirements set forth in Table I except that the Flakiness Index shall be limited to a maximum of 30%.

- **Proportioning of Materials**

The materials shall be proportioned as per quantities given in Table IV.

Table IV

Quantities of Materials Required for 10 sq.m.
of Road Surface for 5 cm Thick open-graded

Premix Carpet

Aggregates of carpet

a)	Stone chippings - 12 mm size; passing 20 cm sieve and retained on 10 mm sieve	0.18 cu.m
b)	Stone chippings - 10 mm size; passing 12.5 mm sieve and retained on 6.3 mm sieve	0.09 cu.m

Binder for premixing (quantities in terms of straight run bitumen)

a)	For 0.18 cu.m of 12 mm size stone chippings at 52 kg per cu.m	9.5 kg
b)	For 0.09 cu.m of 10 mm size stone chippings at 56 kg per cu.m	5.1 kg
	Total	14.6 kg

Construction Operation

- **Weather and Seasonal Limitations**

Open graded premix carpet shall not be laid during rainy weather or when the base course is damp wet or when the atmospheric temperature in shade is 16 deg C or below.

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- **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 Table V as directed by the Owner/Owner's representative. The surface shall be well cleaned by removing caked earth and other foreign matter with wire brushes, sweeping with brooms and finally dusting with sacks as necessary.

- **Tack Coat**

A tack coat complying with relevant clause above shall be applied over the base preparatory to laying of the carpet. Application of tack coat shall, however, not be necessary when the laying of carpet follows soon after the provision of the bituminous course.

- **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 Owner/Owner's representative, 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 Owner/Owner's representative 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 mixture 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.

- **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 commence with 8 to 10 tonne power rollers, preferably of smooth wheel tandem type, or other approved plant. Rolling shall begin at the edges and progress toward the centre longitudinally, except that on the super elevated portions 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 roll remarks 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. Wherever use of power roller is not feasible, suitable hand roller may be used as per the instructions of the Owner/Owner's representative.

Rollers shall not stand on newly laid material while there is a risk that it will be deformed thereby.

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The edges along and transverse of the carpet laid and compacted earlier shall be cut to their full length 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.

- Seal Coat

A seal coat conforming to relevant clause 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.

Seal Coat

- Description

This work shall consist of application of a seal coat (Type-B) for sealing the voids in a bituminous surface laid to the specified levels, grade and camber.

Seal coat shall are of two types as given below:

Type A Liquid seal coat comprising of an application of the bituminous binder followed by a cover of stone chippings.

Type B Premixed seal cost comprising of a thin application of fine aggregate premixed with bituminous binder.

Materials

- Binder

The binder shall be bitumen of a suitable grade as directed by the Owner/Owner's representative and conforming to the requirements of IS: 73, 217, and 454 as applicable or any other approved cutback.

The quality of binder to be utilized, 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.

- 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 matter. Stone chippings shall be of 6 mm size defined as 100 percent passing through 10 mm sieve and retained on 2.36 mm sieve. The quantity used for spreading shall be of 0.09 cu.m. per 10 sq.m. area. The chippings shall satisfy the quality requirements spelled out in Table I except that the upper limit for flakiness Index shall be 30%.

- 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 cu.m. per 10 sq.m. area.

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Construction Operations

- Preparation of Base

The seal coat shall be applied immediately after the laying of bituminous course which is required to be sealed. Before application of seal coat materials the surface shall be cleaned free of any dust or other extraneous matter.

- 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 Owner/Owner's representative 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 of 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 gritter, 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 super elevated portions where it shall proceed from the inner edges 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 irregularities. Rolling shall continue until all aggregate particles are firmly bedded in the binder and present a uniform closed surface.

- 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 Owner/Owner's representative. Also the aggregates shall be dry and suitably heated to a temperature directed by the Owner/Owner's representative before the same are placed in the mixer. Mixing of binder with aggregates to the specified proportions shall be continued till the later are 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 8 - 10 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. Wherever use of power roller is not feasible suitable hand roller may be used as per the instructions of the Owner/Owner's representative.

Opening to Traffic

In the case of Type B seal coat, traffic may be allowed soon after final rolling when the premixed material has cooled down to the surrounding temperature. However, as regards Type A seal coat traffic shall not be permitted until the following day.

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Repair of Existing Roads

Pot holes or patches and ruts in existing bitumen road, concrete road and WBM road shall be repaired by removal of all loose material 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 out 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

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 Owner/Owner's representative.

Payment for (i) shall be done as per items for water bound macadam and for (ii) as per item for open graded premix carpet. Cutting removal of materials shall be paid under dismantling items.

In case, however it is found that there has been damage to the granular sub-base as well, the area of the damaged surface shall be repaired by removal of all loose materials, out to regular shape with vertical sides and relaid with graded material as per specification of granular sub-base and then surfaced with water bound macadam as per specification for the same.

Further any making up the level of existing soling shall also be done as per procedure given above for repair of granular sub-base and as directed by the Owner/Owner's representative. Measurements and payment will be based on the compacted volume only. The rate will be worked out based on quoted rates for soling of specified thickness.

Quality Control & Tolerance

The Contractor shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used.

All works performed shall conform to the lines, grades, cross sections and dimensions shown on the drawings or as directed by the Owner/Owner's representative. Permitted tolerances for roadwork's are described hereinafter.

- i) **Horizontal Alignment :**

Horizontal alignments 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 pavement shall be $\pm 40\text{mm}$.

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ii) **Longitudinal Profile :**

The 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 Owner/Owner's representative beyond tolerances mentioned below :

Sub-grade	± 25mm
Sub-base	± 20mm
Base course	± 15mm
Wearing course	± 10mm

Tolerance in wearing course shall not be permitted in conjunction with the positive tolerance for base course if the thickness of the former is thereby reduced by more than 6mm.

iii) **Surface Regularity of Sub grade and Pavement courses :**

The surface regularity of completed sub-bases, base courses and wearing surfaces in the longitudinal and transverse directions shall be within the tolerances indicated in Table V.

The longitudinal profile shall be checked with a 3 metre 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 chamber boards at intervals of 10 metres.

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Table - V
Permitted Tolerances of Surface Regularity for Pavement Courses

Sl	Type of construction	Longitudinal Profile with 3 metre straight edge Cross Profile					
		Maximum Permissible undulation mm	Maximum number of undulations permitted in any 300 metres length exceeding (mm)				Maximum permissible variation from specified profile under camber template (mm)
			18	12	10	6	
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 (20-50mm 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 or built-up spray grout	12	-	-	30	-	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
10	Concrete pavements	8	-	-	-	10***	4

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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% above these values in this column may be permitted at the discretion of the Owner/Owner's representative. 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 profile should be simultaneously satisfied.

5.5.21 Steel Chimney**SCOPE**

This specification covers the specific requirements for construction of Steel Chimney. General construction requirements shall be as per other standard specification included in section 5.3.7. In case of conflict between this specification and other specification, the requests given in this specification shall provide.

CODES AND STANDARDS

Unless specifically mentioned otherwise, all applicable codes and standards in their latest additions as published by Bureau of Indian Standards and all other such as may be directed published by them during currency of the contract, shall govern in respect of design, workmanship, quality and properties of materials and method of testing. Some of the relevant available codes are listed here under :

IS: 6533	Code of Practice for Design and Construction of Steel Chimneys
IS: 800	Code of practice for use of structural steel in general building construction
ICAO	International Civil Aviation Organisation (ICAO).
DGCA	Instructions of Director General of Civil Aviation, India.
BS: 4076	Specifications for steel chimneys
CICIND	Model code for concrete chimneys
ASCE	Design and Construction of steel chimney liners prepared by Task Document committee on steel chimney liners. Fossil power committee (Power division published by ASCE-1975).

GENERAL

Contractor shall provide and maintain at the site necessary number and type of machinery and equipment including survey instruments in good working condition for proper setting out and timely completion of the works covered under this specification. All arrangements for transporting the equipment to and from the site shall be done by the Contractor at his own expense.

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It shall be ensured by the Contractor that work shall proceed uninterrupted even in the event of power failures. As such, adequate number of diesel operated equipment (such as concrete mixers, vibrators, etc.) shall be provided by the Contractor, as an alternative arrangement, in case, electrically operated equipment are proposed to be brought to site.

All materials supplied by the Contractor shall be of the best quality and shall conform to this specification. Approval in writing shall be obtained from Owner/Owner's representative, before any alternative or equivalent material is proposed to be used by the Contractor.

Contractor shall furnish Manufacturer's test certificate for the materials supplied by him. Where such certificates are not available, and where the Owner/Owner's representative so desires the specimen from the materials supplied to site shall be got tested at a recognized and approved testing laboratory at Contractor's cost.

MATERIAL, CONSTRUCTION REQUIREMENTS & SPECIFICATIONS

Material

Structural Steel

The structural steel to be used for steel chimney shall be as per IS-2062 Grade-A unless specified otherwise in tender drawings.

Welding electrodes shall be of a make approved by Owner/Owner's representative. All electrodes shall conform to IS-814 unless specified otherwise to suit the requirement of shell plate and welding procedure. Contractor shall conduct all tests at site, as directed by Owner/Owner's representative to get his approval for use on Job. Manufacturer's batch certificates shall be submitted at least 2 weeks prior to commencement of welding.

Base Plate and Holding Down Bolts

The material shall conform to the requirement of IS-2062 Grade-A and IS-432 Grade-I unless specified otherwise in tender drawings.

Concrete work in Foundation

This shall conform to provisions of clause No. 5.3.5

Receipt and Storing of Material

All steel parts furnished by supplier shall be checked, sorted out, straightened, and arranged by grades and qualities in stores.

All sections shall be free from surface defects such as pitting, cracks, laminations, twists etc. Use of defective materials shall not be permitted and all such defective material shall be removed from the site immediately.

Welding electrodes shall be stored separately by qualities and lots inside a dry and enclosed room, in compliance with IS-9595 and as per instructions given by the Owner/Owner's representative. Electrodes shall be kept perfectly dry to ensure satisfactory operation and weld metal soundness.

Fabrication and Erection

All fabrication and erection shall be done in accordance with IS-800, IS-9595 and based on the fabrication drawings adhering strictly to work points and work lines on the same.

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All connections shall be welded connections except for ladders and platforms unless specified otherwise. Welding shall be done as per IS-9595. Welding procedures shall be conducted and approved as per IS-7307. Approval of welders shall be as per IS-7310.

The vertical butt weld seam shall be staggered at about 120° between adjacent sections of chimney shell.

Any defective material used shall be replaced by the contractor at his own expense.

Any faulty fabrication pointed out at any stage of work shall be made good by the contractor at his own cost.

Radiography examination shall be carried out to a minimum aggregate weld length of 3 meters in a chimney. However, the weld length radiographed shall not be lower than 5% of total weld length of the chimney.

Atleast one spot of 300mm length shall be radiographed for each thickness produced.

If the random radiography of a weld in any joint reveals unacceptable defects, two further welds in the group represented by the weld shall be radiographed to the same extent. If these further welds show no unacceptable defects, the group of welds represented by the weld shall be accepted. However, the first defective weld shall be repaired. If one of the two further welds show unacceptable defects, each weld in the group shall be radiographed. Unacceptable welds shall be repaired and then radiographed.

Radiography shall be carried out using x-ray or Gama ray as decided by the Owner/Owner's representative.

PAINTING

All painting work shall be carried out with the best quality of materials and workmanship and in accordance with the best engineering practice and instructions of the Owner/Owner's representative. The compatibility of the paint system shall suit the environment envisaged in and around the plant and confirmed by the paint manufacturer.

Surface preparation

The surface to be painted shall be cleaned by chipping, scraping hammering and wire brushing. On completion of cleaning the detached rust, mill scale and other deleterious material shall be removed by clean rag and/or washed by water or steam and thoroughly dried with compressed air jet if required before application of paint.

Internal surface painting

Unlined Chimney Shell

One coat of suitable priming paint to the interior surface shall be provided.

If required suitable protective treatment shall be used to withstand the corrosive, abrasive and thermal effects of the flue gases.

Lined Chimney Shell

If required one coat of a suitable priming paint shall be used followed by two coats of a finish paint or paints applied in accordance with the instructions of the manufacturer.

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External surface painting

The outer surface shall be given two coats of epoxy zinc chromate primer followed by two coats of epoxy high build finish coating of approved quality and shade. Where aviation warning signals are required, top 20m of the outer face of the chimney shell shall be painted with two coats of above finish coat of more than one colour in horizontal alternate bands of minimum 5m width to give a perfect contrast. The bands at extremities shall be of darker colour.

Structural Steel Members

All structural steel works such as walkways, platforms, handrails, ladders etc. shall be given two coats of high build chlorinated rubber zinc phosphate primer followed by two coats of chlorinated rubber paint of approved quality.

CHIMNEY FOUNDATION

Concreting of the foundation (pile cap) shall be carried out in segments only after the steel reinforcement for the entire foundation has been placed and tied in position. Only vertical construction joints with joggles shall be permitted between any two segments. Horizontal construction joints shall not be permitted.

5.5.22 Fencing & Gate

Scope

This specification covers the requirements in respect of materials, workmanship and quality for chainlink/barbed wire fencing fixed on M.S. angle posts or RCC precast posts.

Codes and Standards

Unless specifically mentioned otherwise, all applicable codes and standards in their latest editions as published by the Bureau of Indian Standards and all other such as may be published by them during the currency of the Contract, shall govern in respect of design, workmanship, quality and properties of materials and methods of testing. Some of the relevant available codes are listed hereunder:

IS:278	Galvanised steel barbed wire for fencing
IS:1161	Steel tubes for structural purposes
IS:2062	Steel for general structural steel purposes
IS:2721	Galvanised steel chainlink fencing

Materials & Installation

Angle Iron Post

Angle Iron Post shall be rolled angle section conforming to IS:2062 and shall be double dip galvanised.

Precast Concrete Posts

Concrete mix shall be M20 as per IS:456. Reinforcement shall be M.S. and/or torsteel bars.

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Posts shall be cast in smooth steel forms made to correct dimensions as per drawing and concrete shall be compacted by table vibrators or needle vibrator to give smooth finish. Curing of concrete shall be done by submerging the posts in water tank for minimum 15 days.

Precast posts shall be installed in PCC 1:3:6 foundation, with a minimum embedment depth of at least 600 mm. Damage to the post shall be avoided during installation of the posts in position, aligning and levelling.

Diagonal post bolted to the vertical posts shall be provided at every eighth bay and on either side of the corner posts. Spacing of the posts shall be not greater than 3 m or as per drawing whichever is less.

All hardware used shall be of hot-dip galvanised steel.

Chain link fence

Chainlink shall conform to IS:2761. It shall be procured in rolls of appropriate length and width and shall consist of 10 G hot dip galvanised steel wires woven in the form of zigzag mesh giving an opening size of 50 mm square.

Chainlink shall be secured to the posts with 6 mm dia GI hooks/rings.

Tension wire shall be provided passing through the mesh at top, centre and bottom of the erected chainlink mesh and shall be of 3 mm dia hot dip galvanised wire and shall be stretched to keep the chainlink in taut position. 25 mm x 6 mm GI flat stretcher bar shall be provided at the end posts to tie the tension wires.

Barbed wire fence

Barbed wire shall conform to IS:278

Barbed wire shall be made from hot dipped galvanised wire of 12 G, 2 ply with barbs of 16G spaced at 100 mm.

Barbed wire shall be procured in bundles of standard weights and shall be fully stretched across the posts and secured with G.I. hook bolts and washers.

Spacing of horizontal wires shall not be greater than 225 mm or as specified in the drawing. Diagonal wires shall be provided in each bay between two adjacent posts. No wire shall be left loose or sagging.

Gate

Gate shall be fabricated out of tubular sections conforming to IS:1161 and shall be hot dipped galvanised. Outer frame shall be 65 NB (medium) tube and diagonal 50 NB (medium) tube. 50 mm sq. welded mesh with 4 mm dia GI wire fabric shall be welded to 25 mm x 6 mm thick GI flat which in turn shall be welded to the outer tubular frame. The gate shall be provided with 20 mm wide x 80 mm dia flat M.S. roller at the bottom. The gate frame shall be fixed to GI tubular post or RCC post.

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5.5.23 Concrete Roads and Pavements

Scope

This specification covers the requirement in respect of materials, workmanship and quality for concrete roads and pavements. However, for general requirements, testing etc. the technical specification for plain & reinforced concrete work shall be referred.

Codes and Standards

Unless specifically mentioned otherwise, all applicable codes and standards in their latest edition as published by Indian Road Congress and Bureau of Indian Standards shall govern in respect of design, workmanship, quality and properties of materials and method of testing.

Some of the relevant available codes are listed here under :

IS:269	Ordinary and low heat Portland cement
IS:455	Specification for Portland slag cement
IS:456	Code of practice for plain & reinforced concrete
IS:1200	Method of measurement for road work including air field (Part-17) pavements
IS:1489	Specification for Portland pozzolana cement
IS:1838	Specification for performed fillers for expansion joints in concrete pavement and structures.
IS:1834	Specification for hot applied sealing compounds for joints in concrete
IS:6509	Code of practice for installation of joints in concrete pavements
IS:8112	Specification for 43 grade ordinary Portland cement
IRC:15	Standard specification and code of practice for construction of concrete roads
IRC:58	Guidelines for the design of rigid pavements for highways

Materials

Cement to be used shall be either Portland slag cement with minimum 50 % slag or Portland pozzolana cement.

This should comply with the requirements of IS:269, IS:455, IS:1489 or IS:8112

Aggregates (General)

Aggregates should comply with the requirements of IS:389 - Specification for coarse and fine aggregates from natural sources for the concrete work. In order to make good the concrete for roadwork it is important to avoid crushed aggregates of poor particle shape. Weather rock, and very angular, flaky or splintery aggregates should not be used.

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Coarse aggregates

This should be furnished in at least two separate sizes with separation at 20 mm when combined material graded from 5 to 38 mm is specified and at 25 mm when combined material graded from 20 to 50 mm is specified. Gap graded single sized coarse aggregate as alternate to the continuously graded may be used particularly where grading of fine aggregate is fine to very fine.

Fine aggregate

Fine aggregate shall be natural sand and should comply with IS:383. Bulking due to presence of moisture in the fine aggregate should be accounted for when the volumetric batching is employed.

Water

Water is used in mixing or curing of concrete shall be clean and potable quality.

Reinforcement

Bar mats

This shall conform to the requirements of IS:432/IS:1786/IS:1139. The bars shall be of the size and spacing shown on the plans. All junctions of longitudinal and transverse bars shall be securely tied or welded together.

Load transfer devices

Dowel and tie bars shall be of plain round steel bars conforming to the requirements of IS:432.

Expansion joint filler

The material for filling the expansion joints shall be of premoulded, non-extruding and resilient type of approved quality. The premoulded joint filler shall be of thickness shown on the drawings or as stated in the bill of quantities. It shall be 25 mm less in depth than the thickness of the slab and of the full width between road forms. Holes to accommodate dowel bars shall be bored or punched out accurately. The joint filler shall comply with the requirements of IS:1838 - Specification for Preformed Fillers for Expansion Joints in concrete, non-extruding and resilient type (bitumen impregnated fibre).

Joint sealing compound

The sealing compound shall comply with the requirements of IS:1834 - Specification for Hot Applied Sealing Compound for joints in concrete.

Waterproofing under layer

Waterproofing paper used as under layer be of a brand of approved quality. The paper shall be unrolled with an overlap of not less than 10 cm.

Forms

All side forms shall be of mild steel unless use of wooden sections are specifically permitted. The steel forms shall be of M.S. channel sections and their depth equal to the thickness of the pavements.

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The sections shall have a length of at least 3 m except on curves where shorter sections may be used. Side shuttering shall be provided at curves as per the drawings or as directed. When set to grade and staked in place, the maximum deviation of the top surface of any section from a straight line shall not exceed 3 mm in vertical plane and 5 mm in horizontal plane. The method of connection between sections shall be such that the joint formed shall be free from movement in any direction. the use of bent, twisted or worn out forms will not be permitted. At least 3 stake pockets for bracing pins or stakes shall be provided for each 3m of form and the bracing and support must be ample to prevent the springing of the forms under pressure of the concrete, or the weight of machinery operating on the forms, Contractor shall arrange for sufficient number of forms so that the forms in position are not disturbed within 12 hours of concreting or longer if in the opinion of the Owner/Owner's representative it would be necessary.

Workmanship

Form setting

Forms shall be jointed neatly and shall be set with exactness to the required grade and alignment. After the forms are placed and aligned, the earth under the base of the form shall be thoroughly damped in an approved manner. Sufficient rigidity shall be obtained to support the forms in such a position during the entire operation of compaction and finishing. All forms shall be cleaned and oiled each time before they are used.

Placing of reinforcements

The overall dimensions of the bar mats shall be such that when properly placed into the work, the extreme longitudinal wires of the mat will be located not less than 50 mm nor more than 100 mm from the edges of the slab. Except for dummy joints, the length of the bar mat shall be such that when properly placed into the work, the reinforcement will be clear of transverse joints by not less than 50 mm and not more than 100 mm when measured from the centre of the joint to the ends of the longitudinal wire of the fabric.

While overlapping the bar mats in either direction, the overlap shall be at least equal to the spacing between the bars in the respective direction.

The bar mats shall be placed in position as shown on the drawings. For placing the top layer of the reinforcement, the first stage of concreting shall be brought up to the level of the reinforcement and lightly compacted by a screed vibrator to obtain uniform level. The reinforcement bar mats shall then be placed on the compacted layer of the concrete and then the remaining depth shall be filled in with concrete. The time lag between laying of the two courses shall not exceed the initial setting time of the cement used. Displacement of the reinforcement during concreting operation shall be prevented.

Fixing dowel bars

The dowel bars in expansion joints and transverse construction joints shall be placed and supported in such a manner that they will be truly parallel with the gradient and the centreline to the pavement, and they shall remain in position during the placement and compaction of the concrete. They shall be placed at the mid depth of the slab and the drawings. Half length of the dowel bars shall be painted with one coat of hot bitumen of approved make or equivalent as shown on the drawings or as directed by the Owner/Owner's representative.

Fixing tie bars

Tie bars in longitudinal joints shall be placed approximately the mid depth of the slab and shall be securely held in the slabs on both sides of the joints.

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Transporting and placing of concrete

The concrete shall be mixed in quantities required for immediate use and shall be deposited in position to the required depth and width of the pavement, sections, in successive batches and in continuous operation without the use of intermediate forms or bulk continuous between joints. The spreading shall be as uniform as possible to avoid re-handling of concrete.

Compaction and finishing

The surface of the pavement shall be compacted either by means of power driven finishing or by a vibration screed. For areas where the width of the slab is very small, hand compaction and finishing may be adopted. Immediately after the tamping or screeding has been completed and before the concrete has hardened the surface shall be inspected for irregularities with a profile checking template and any needed corrections made by adding or removing of concrete followed by further compaction and finishing.

Floating

As soon as practicable after the concrete has been struck off and a compacted it shall be further smoothed and compacted by means of longitudinal float operation from a foot bridge.

Straight edging

After the longitudinal float has been completed and excess water has been disappeared but while the concrete is still plastic, the slab surface shall be tested for trueness with a 3 metre straight edge swung from handles 1 metre longer than one half width of the slab. Any depressions found shall be filled immediately with freshly mixed concrete, struck, compacted and refinished. High areas shall be cut down and refinished. No extra payment shall be made for the removal of the rejected concrete and for laying of the fresh concrete. Unless otherwise specified, and for laying of the pavement surface shall be obtained by belting or brooming or by a combination of both as directed by the Owner/Owner's representative.

Edging

After belting and / or brooming has been completed, but before the concrete has taken its initial set, the edges of the slab shall be carefully finished with a edger of 6 mm radius and the pavement edge shall be left smooth and true to line.

Joints

Expansion Joints

Expansion joints shall be formed at the intervals shown on the drawing at right angles of the longitudinal axis of the pavement. The width of the joint shall be as shown on the drawing and shall be straight, truly vertical and shall extend from the bottom of the slab. The expansion joint shall be filled with an approved pre-moulded joint filler, which shall extend from the bottom of the slab to 25 mm below the finished surface of the concrete. A timber or metal cap shall be fitted temporarily on the top of the joint filler and the top of this cap shall be flush with the finished surface. Care shall be taken that filler and the cap are set accurately in position and are maintained in position during placing and compaction of concrete. After the pavement has been struck off and finished the metal cap shall be removed. Under no circumstances shall any concrete be left above the expansion joint material or across the joint at any point. After about 15 days of concreting the cavity on the top of the joint filler shall be carefully cleaned of all loose materials and sealed with an approved joint sealing compound. the sealing shall not be done until the concrete is quite dry. The sealer and any

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primer required shall be applied strictly in accordance with manufacturer's instructions. The joints shall be sealed flush with the surface of the concrete. The end of the sliding half of the dowel bar shall be provided with a PVC or G.I. sheets cap at least 75 mm long and minimum 25 mm length of this cap shall be filled with cotton waste dipped in hot bitumen as shown on the drawings.

Longitudinal and transverse construction joints

These shall be of top chamfered and sealed type and shall be formed by placing the concrete against the face of the slabs concrete earlier. The face of the old concrete slabs shall be painted with bitumen before placing of fresh concrete.

Tie bars shall be used at construction joints and shall be of the dimensions and at spacings as shown on the drawings.

Curing

Immediately after finishing operations have been completed the entire surface of the newly laid concrete shall be covered against rapid drying and cured in accordance with the following methods.

Failure to provide sufficient cover material of whatever kind required or inadequate supplies of water to take care of both curing as well as other requirements shall be adequate cause for immediate suspension of concreting.

Initial curing

Immediately after completion of finishing operations, the surface of the pavement shall be entirely covered with wetting burlap, cotton or jute mats. The mats used shall be of such length (or width) that as laid they will extend at least 450 mm beyond the edges of the slab. the mats shall be placed so that the entire surface and both the edges of the slab are completely covered. The covering shall be placed as soon as the concrete has set sufficiently to prevent marring of the surface. Prior to being placed, the mats shall be thoroughly saturated with water and shall be placed with the wettest side down. The mats shall be so placed and weighed down as to cause them to remain in intimate contact with the surface covered, and the covering shall be maintained fully wetted and in position for 24 hours after the concrete has been placed or until the concrete is sufficiently hard to be walked on without suffering damage. Water shall be gently sprayed so as to avoid damage to the fresh concrete. If it becomes necessary to remove a mat for any reason, the concrete slab shall not be exposed for a period of more than half an hour.

Worn burlap or burlap with holes will not be permitted. Burlap reclaimed from previous use other than curing concrete shall be thoroughly washed prior to use for curing purposes. If burlap is furnished in strips, the strip shall be laid overlap at least 150 mm. Burlap shall be placed from suitable bridges. Walking on freshly laid concrete to facilitate placing burlap is not permitted.

Final curing

Upon removal of the burlap the slab shall be thoroughly wetted and then finally cured as under :

"Exposed edges of the slab shall be banked with a substantial berm of earth. Upon the slab shall then be laid a system of transverse and longitudinal dykes of clay about 50 mm high immediately covered with a blanket or sandy soil free from stones to prevent the drying up and cracking of clay. The rest of the slab shall then be covered with sufficient sandy soil so as to produce a blanket of earth not less than 37 mm depth after wetting. The earth covered shall be thoroughly wetted while it is being placed on the surface and against the sides of the slab and kept thoroughly saturated with water for 14 days and thoroughly wetted down during the morning of the 15th day and shall thereafter remain in place until the concrete has attained the required strength and permission is given, the covering shall be removed and the pavement cleaned and swept. If the earth covering

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becomes displaced during the curing period, it shall be replaced to the original depth and shall be re-saturated”.

Removing of Forms

Forms shall not be removed from freshly placed concrete until it has set at least 12 hours. They shall be carefully removed and in such a manner that no damage will be done to the edges of the pavement. After the forms have been removed, the ends of all joints shall be cleaned and any honeycombed areas painted up with 1:2 mortar, after which the sides of the slabs shall be covered with earth to the level of the top of the slab. All ditches and drains shall be so placed as to provide effective drainage.

Opening to Traffic

Traffic shall be excluded from the newly constructed pavement for a period of 28 days. Before the pavement is opened to traffic it shall be cleaned and the joints shall be filled and trimmed or topped out as required. The joint or line of separation between adjacent strips or slabs of concrete, when the pavement is constructed in lanes or strips, shall be cleaned and filled with bituminous material as directed.

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ANNEXURE 3

VOLUME – III SECTION - 2 DETAILED TECHNICAL SPECIFICATION – MECHANICAL

SUB - SECTION - 2.6 CRANES AND HOISTS

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VOLUME - III**SUB-SECTION - 2.6****CRANES AND HOISTS****1.0.0 GENERAL**

This section is intended to provide the scope, design, manufacture, erection, testing & commissioning of EOT crane and hoist requirement.

2.0.0 SCOPE OF SUPPLY

Electric Overhead Travelling (EOT) cranes shall be provided for ease of dismantling and maintenance of major plant equipments. The crane shall comprise a main hoist & auxiliary hoist each to be capable of lifting and accurately positioning all heavy loads within their specified rating.

Each cranes or hoists shall be complete with its accessories, supporting structure, power supply, safety devices and controls and shall conform to local statutory rules and regulation and an internationally recognised standard suitable for their intended application.

2.1.1 EOT cranes

The EOT crane shall be provided for the following areas,

- EOT crane in GTG and STG common hall.

2.1.2 Hoists**Electrical Operated Hoists**

The hoists shall be of the motor operated type with motor trolley on monorail and shall be provided with pedant control unit.

Manual Operated Hoists

The manual operated hoist shall be provided with manual chain drive for hoist and trolley on monorail.

The scope of supply shall include at least:

- Under slug crane with electric hoist, motor operated CT & LT for Air compressor / Workshop building.
- Monorail with hoist for Cooling water pump area (for both pump & motor)
- Monorail with hoist for Boiler feed pumps, BFP area.
- Monorail with Hoist for A/C and Ventilation System.
- Monorail with hoist for cooling tower (for fan gear box & motor)
- Monorail with hoist on top of the HRSG area.
- Any other hoists / chain pulley blocks as required for normal lifting operation of the system above 50 kg in weight as specified in the design requirement.

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3.0.0 DESIGN REQUIREMENT

- Electric Overhead Travelling (EOT) Crane shall be provided in the areas where the weight of the heaviest component exceeds 5 MT and movement of the components will be required in both cross wise and longitudinal direction.
- Manual Hoist with geared trolley will be provided for areas with equipment / component to be lifted for erection and maintenance weighing up to 1 MT and below and lift is less than 10 m. Electrically operated Hoist with trolley will be provided for handling equipment / component weighing 1 MT or above and / or lift more than 10 m.
- Cranes with carrying capacity of more than 10 MT shall be in the form of double-girder cranes with the crab running on top.
- Smaller cranes i.e. 10 MT and below shall be in the form of single-girder cranes with the crab running on the lower flange or in the form of suspension cranes.
- For guidance purposes the following crane speeds, for the turbine hall crane, should be considered as maximums:-

Sl. No.	Lifting Arrangement	GTG / STG hall area	
A	EOT	Main	Auxiliary
1	Hoisting	2.0	5.0 m/min
2	Trolley Travel	15.0 m/min	15.0 m/min
3	Bridge Travel	10.0 m/min	10.0m/min
4	Creep speeds	10% of operating speeds	10% of operating speeds

- Speeds for the hoists shall be

Hoisting speed 3 m/min.

Travel speed 4 m/min.

- The workshop and stores buildings shall be provided with a suitably sized pendant operated overhead travelling cranes.

4.0.0 CONSTRUCTION REQUIREMENTS

4.1.0 EOT Crane

The span of EOT cranes shall be derived based on the GTG & STG hall layout with considerations to clearances and hook approach. The lift for the EOT crane shall be based on lifting the tallest piece from the operating floor to grade, with consideration of sufficient clearances for lifting over other equipment on operating equipment. Capacity shall be fixed by considering the heaviest equipment during maintenance with 10% margin. EOT capacity shall be as per heaviest equipment to be lifted and used only during maintenance but not used for erection of GTG / STG. EPC contractor shall arrange separate crane for erection of GTG / STG assembly on respective foundation during installation and alignment.

All other components of EOT crane shall be designed and provided as per IS: 3177.

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Auxiliary hoist shall be rated for a minimum capacity 20% of main hoist capacity. Both the hooks will be of swivelling type.

The EOT cranes are designed to operate at 100% load and over load test at 125% of rated load as per codes. The EOT cranes shall be designed with maximum deflection of 1 / 900 of the crane span at rated load.

The crane bridges of the double-girder cranes shall be of box-girder construction.

EOT Crane in STG / GTG Hall shall be as under:

- Indoor.
- Double girder box type, class M5 for mechanical M5 for electrical.
- Pendent push button operated

Pendent push button station shall be used for the operation of the crane and push buttons shall be present for the following motions / operations.

- i. To and from motion of the bridge (long travel).
- ii. Right and left motion of the trolley (cross travel).
- iii. Hoisting (lifting) of hooks.
- iv. Lowering of hooks.
- v. Creep motion.
- vi. Power ON - OFF push buttons.
- vii. Emergency off push button.

Indication lamp for power on-off shall be provided in the pendent push button station. pendent push button shall be provided with a lockable (with key) ON-OFF provision. The push button stations shall have an independent motion on a separate track with respect to the cross travel motion.

Load hooks for up to 30 T nominal carrying capacity shall be designed as plain shank hooks. For nominal carrying capacities above 30 T, rams horn type hooks shall be used. It is essential for all load hooks to be equipped with ball - thrust bearings & safety latch.

The turbine building EOT Cranes shall be able to be operated both from cabin located on the crane and also by radio remote operation.

Spring / rubber buffer shall be provided on the trolley and bridge structural frame at suitable places to absorb the shock of impact without transferring to the structure frame.

The cranes shall be provided with walkways (minimum 500 mm wide for turbine building EOT crane) with hand railing along the full span length on either side of crane bridge girders. Walkway shall to be provided at rail level on both sides.

The complete electrical equipment shall include:

- The lockable multi-pole mains isolator switch (main crane switch) operating on all poles, for the main power supply.
- The rising cable from the multi-pole mains isolator switch up to the feed point of the ON/OFF main power supply.
- The main contactor (crane switch) with short circuit protection and thermal protection by means of bimetallic tripping device.

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- The necessary equipment to provide precision speeds (creep speed motor, and planetary gear arrangement).
- The motor protection and all the equipment necessary for the crane
- The limit switches for the travel gears, including all the necessary strikers.
- All the necessary contactors and relays as well as the necessary contactor cabinets for these.
- All cable including festooned type cables with caviel clips and miscellaneous material for the complete installation of the crane.
- The control and lighting transformer.
- Resistor panel.
- The work-area light fittings of HPSV / MV with the crane.
- The control panel pendant control with operation switches and other controls.
- Alternating current slip-ring motors, which can be started practically without jolting by means of switched series resistors, (minimum 4 steps) shall be used for the travel and lifting gear drives.

4.2.0 Hoists

The final number of hoists, to be supplied, shall be decided later according to the requirements of the equipment. Electrical or manual hoists are selected based on the design criteria given above.

Each hoist installation shall include but not be restricted to the following:

a) Manually operated hoists.

The load chain shall be electrically welded, accurately calibrated, and pitched and polished conforming to IS: 6216 grade T (8).

The forged hook shall be properly heat treated and so designed that in loaded condition, it is free to swivel without twisting load chain. The hook shall conform to IS: 8610 Min. C-20 acceptable.

The hand chain shall also be electrically welded, calibrated, pitched and polished and shall conform to IS: 3832. All other components of chain pulley block such as anchorage, guide, pawl, stripper etc. shall be designed and provided as per IS: 3832.

Manual hoists shall take the form of chain pulley blocks with load and hand chains. The crabs shall be fitted with a drive also operated by a chain. The runways shall be designed according to approved standard.

b) Electrically operated hoists.

The hoists used shall be standard production hoists. The hoists shall be designed and calculated in accordance with the principles of IS: 3938 Class II, or according to accepted and equivalent standards.

The control panels shall also be equipped with a key-operated switch and a mushroom-shaped emergency "off". Limit switches shall be fitted to all lifting and travel gear.

The technical requirements of the ropes and shackles to be provided with each hoist installation, shall be similar to the requirements as given for EOT cranes.

Electrically driven hoists and crabs (trolley) shall be equipped with squirrel cage/ slip ring motors. The crab power supplies shall be in the form of trailing cables with cable carriers running in tubular track.

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Electrical switchgear and control gear shall be mounted directly on the hoists in cabinets.

The electrical hoists shall be operated by pendant control units fitted with push-button and shall be fixed to the hoist in such a way that safe operation is guaranteed.

Where hoists are not easily accessible by simple means such as ladders or mobile scaffolds, maintenance platforms with means of access shall be provided.

The complete electrical equipment, basically including:

- The lockable mains isolator switch (main hoist switch) operating on all poles, for the main power supply.
- The rising cable from the mains connection switch up to the feed point of the main power supply.
- The main power supply arrangement vide trailing cable (feestoned cables).

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5.0.0 SPECIFIED DESIGN DATA SHEET**5.1.0 EOT Crane**

Sl. No.	Description	Unit	Data
1.0.0	Standards		IS 807 & IS 3177
2.0.0	Duty Class		M5 Mechanical, Structural M7 Electrical
3.0.0	Capacity		To lift heaviest equipment during maintenance with 10% margin for main hook
4.0.0	Wire rope		IS 2266 6 x 36 or 6 x 37 multi strand construction.
5.0.0	Factor of Safety		Min. 5.25
6.0.0	Lifting hooks		
	i. Main hoist		Ramshorn type swivelling hook with locking device as per IS 5749
	ii. Auxiliary hook		Shank Swivelling hook with locking device as per IS 3815 / IS 8610
	Brakes		150% rated torque
	- Type		
	- Main Hoist		1 no. Electro hydraulic thruster 1 no. DC Electromagnetic brake
	-Auxiliary Hoist		1 no. Electro hydraulic thruster 1 no. DC Electromagnetic brake
	- CT		1 no. Electro hydraulic thruster
7.0.0	Emergency brake for long travel		Electro hydraulic thruster type emergency parking brake.
8.0.0	Down shop lead (DSL):		
	Long travel		Shrouded conductor
	Cross transverse		Festoon cable arrangement
9.0.0	Limit switches		Two way type
	Cross		Lever type (2 nos.)
	Long travel		Lever type (2 nos.)
	Hoisting -Main -Auxiliary		Rotary gear & gravity (1+1)

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5.2.0 Electric Hoist

Sl. No.	Description	Unit	Data
1.0.0	Standards		IS 3938
2.0.0	Capacity		To lift heaviest equipment during maintenance with 25% margin.
3.0.0	Trolley type		Electrically operated
4.0.0	Operation		By pendant push button
5.0.0	Factor of safety		As per IS / Not less than 5
6.0.0	Wire Rope		Flexible plough steel with lubricated fibre core as per IS:2266
7.0.0	Pendant push button		Hoisting, lowering, power ON/OFF, emergency ON/OFF with key.
8.0.0	Motor CDF		40%
9.0.0	Brakes		150% rated torque
	- Type		AC thruster brake
	- Hoisting	No.	1 no.
10.0.0	Limit switch		DC / ACEM
	- Hoisting	No.	1 No.

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General

The manual operated chain hoist and trolley assembly shall be complete with following components with respective constructional features. Hoist & trolley capacity shall be based on maximum weight of the part to be lifted / handled after dismantling during maintenance. This maintenance hoist & trolley arrangement shall not be used for installation or erection of complete Equipment assembly. EPC contractor shall arrange separate crane for Equipment Assembly erection on respective foundation during installation and alignment.

The following maintenance hoist and trolley shall be supplied:

Sr. No.	Description	Locations									
		Boiler / HRSG area	Boiler feed pump, BFP area.		Emergency DG area	Utility Compressor area		Cooling Tower Fans area	Main & Auxiliary Cooling water system.		
1.0	Hoist Capacity (SWL), T	Suitable capacity (min 5T)	Suitable capacity (min 5T)		Suitable capacity (min 2T)	Suitable capacity (min 2T)		Suitable capacity (min 2T)	Suitable capacity (min 2T)		
2.0	Quantity (No.)	One	1		1	1		1	1		
3.0	Minimum Height of Lift (Mtrs.)	Contractor to specify	Contractor to specify		Contractor to specify	Contractor to specify		Contractor to specify	Contractor to specify		

NOTE:

EPC Contractor shall submit EOT / Cranes & hoist (lifting arrangement) description, data sheet, list of drawings, testing procedure, performance guarantee, power consumption, special tools & tackles, mandatory spares, Inspection & test procedures, Quality Assurance requirement, Operation & Maintenance (O&M) manual, etc.

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ANNEXURE 4

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SECTION - 2

DETAILED TECHNICAL SPECIFICATION – MECHANICAL

SUB-SECTION - 2.13

INSPECTION AND TESTING AT MANUFACTURER'S WORKS

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VOLUME - III**SUB-SECTION - 2.13****INSPECTION AND TESTING AT MANUFACTURER'S WORKS****1.0.0 GENERAL**

This section is intended to provide the scope, design, constructional and functional requirements for Inspection and Testing of various mechanical equipment, material, parts, and workmanship of the Plant during manufacture, to demonstrate compliance with specification, codes and standards and to ensure overall reliability of plant operation and performance.

2.0.0 INSPECTION AND TESTING REQUIREMENTS

The equipment to be supplied under this Contract shall be subject to works' inspections and workshop tests.

Bidder shall issue a quality assurance programme, indicating the kind and extent of inspections and tests to be carried out on plant components. These inspections and tests shall prove whether the equipment fulfils the requirements of the Contract in view of:

- safety conditions
- consideration of the applied standards and regulations
- execution of workmanship
- Conformity with the present state of modern technology.

2.1.0 Material tests

Test specimens shall be taken from all important forgings, castings, tubing, etc., in accordance with the relevant standards and codes. Dimensions shall be adequate for the purpose intended and the test specimen shall accompany the component through all phases of the heat treatment. Before cutting or otherwise removing the test specimens, these shall be permanently banded together with the forgings, castings or components which they represent and, if requested, in the presence of the Owner/Owner's representative. Except where expressly otherwise approved, all test specimens shall be machined to the dimensions specified in the relevant standards and codes. Steel castings and forgings, in all cases; be annealed before the test specimens are withdrawn.

Chemical analysis and mechanical properties of the material concerned shall also be submitted.

All casting components shall be tested for compliance with the relevant standards and codes and shall be suitable for the purpose for which the castings are to be used. The chemical analysis and mechanical properties of the material tested shall be provided by the Bidder. The results obtained from these material tests shall be in compliance with the values contained in the relevant standards and codes and with the figures quoted in the relevant sections of the Contract, if any X-ray examination and ultrasonic examination of circumferential, longitudinal, nozzle welded joints, stiffening rings, etc., shall be carried out by the Bidder in compliance with the standards under which the relevant equipment will be designed.

All castings and forgings shall be subjected to X-ray and / or ultrasonic tests before the start of machining procedures, in order to detect defects as early as possible and to replace in time defective parts, thus avoiding undue delay in the manufacture and delivery of plant components. After partial machining in the Bidder's workshop, further tests may be performed. No repair welding machining of castings and forgings of major components shall be carried out without prior

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inspection and confirmation by the Owner/Owner's representative. In case of a rejection, written and certified notice must be given to the Owner/Owner's representative, indicating also measures undertaken by the Bidder in order to cope with the requirements of the Contract.

Major steel forgings

Purchase specifications shall clearly state the quality and inspection requirements and should include, but not be limited to:

- a) chemical composition range
- b) heat treatment
- c) mechanical test specimen locations
- d) mechanical properties
- e) magnetic properties (when applicable)
- f) non-destructive testing
 - methods and procedures
 - stage and extent of application
 - recordable indication size
 - allowable indication size
- g) thermal stability test (HP and reheat turbine shafts only)

Each forging shall be suitably marked with an identification number which shall be transferred throughout all machining stages. The identification number shall be indicated on all documents relating to the forging.

Repair welding will not be permitted on rotating parts and on other components the proposal will be subject to approval by the Owner/Owner's representative.

Rotor forgings

The profile of forgings at the stage of final ultrasonic inspection should be such as to minimize the regions where complete coverage is not possible.

Ultrasonic indications should be measured by the equivalent flat bottomed hole or AVG (DGS) method.

The toughness of rim and core (where applicable) material shall be evaluated by testing charpy V- impact specimens over a range of temperatures and thus determining the 50% fibrosity fracture appearance temperature.

Allowable indication size and material toughness are interdependent design related criteria and the Bidder must be prepared, if requested by the Owner/Owner's representative, to justify his proposals by reference to fracture mechanics calculations.

Bores, when provided, shall be magnetic particle inspected and a suitable intrascope used for examination.

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Major steel castings

Purchase specifications shall clearly state the quality and inspection requirements and should include:

- chemical composition range
- heat treatment
- mechanical test specimen locations
- mechanical properties
- non-destructive testing
 - methods and procedures
 - stage and extent of application
 - recordable indication size
 - allowable indication size
- other tests
- standard weld repair procedure

Each casting shall be identified by hand stamped or cast-on reference numbers which shall be Indicated on all documents relating to the casting.

Non-destructive testing

Minimum requirements are as follows:

- Crack detection of critical areas of castings which in the case of castings to operate at high temperature or high pressure shall consist of 100% of all accessible areas. Magnetic particle inspection shall be used for ferritic steel castings.
- Ultrasonic inspection of all surfaces of castings to operate at high temperature or high pressure.
- Ultrasonic thickness check of critical areas.
- Radiographic examination adjacent to future butt weld regions (Acceptance Standard Level 1 of ASTM E446 or E186 as appropriate).
- Radiographic examination shall also be used to assist in defining defects indicated by ultrasonic inspection.

In addition to being applied as necessary quality control on as cast items, inspections outlined in a) and b) above shall be applied to the finally heat treated casting.

Prior to non-destructive testing all surfaces shall be satisfactorily prepared and visually examined.

Repair welding

Unacceptable defects observed by visual examination or indicated by non-destructive testing shall be excavated by chipping or thermal gauging and grinding and their complete removal proved by crack detection.

In the case of excavations which penetrate more than 25 mm or 50% of the wall thickness or cover more than 10,000 mm² area the Owner/Owner's representative's written approval of the proposed repair must be obtained.

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Only welders qualified by performance tests on similar cast materials shall be used.

On completion of repair welded areas shall be ground smooth and carefully blended into the surrounding material. The repaired areas shall be surface crack detected, magnetic particle inspection being used for ferritic steel castings and in addition ultrasonic inspection shall be used on castings to operate at high temperature or high pressure.

Steel plates and sections

The following requirements, which may be supplementary to the applicable material standards, shall be considered when selecting material grades:

- impact testing of plate or sections over 50 mm thick (impact requirements to be dependent on application)
- ultrasonic testing of plate where the presence of non-metallics may interfere with the interpretation of ultrasonic testing of future welds
- ultrasonic testing and through thickness ductility measurement, where the application involves the risk of lamellar tearing in the material at regions of high restraint (e. g. at set-on nozzle locations or cruciform joints)
- ultrasonic testing clad materials to detect lack of bonding (proposed rectification procedures shall be submitted for the approval of the Owner/Owner's representative.

Reinforced thermosetting resin pipes

Checks shall be made on all raw materials to ensure that they comply with the relevant ASTM Standard.

All deliveries of resin shall be checked for consistency by viscosity and reactivity. Any resins deviating from the manufacturer's published figures shall not be used.

Testing of reinforced thermosetting resin pipes:

- Long term hoop strength (type test for pressure pipes only)

In accordance with ASTM D2992 Procedure B with the exception that the test results shall be extrapolated to determine the stress which the pipe can withstand for a period of 60 years without failure. The lower 95% confidence limit at 60 years shall also be calculated.

- Hydraulic test

100% of the pipes shall be subjected to an internal hydraulic pressure test at the manufacturer's works prior to delivery. The test shall be applied to a pressure equal to 1.5 times the maximum working pressure stated for each classification of pipe. The test pressure shall be applied for a minimum period of 5 minutes without signs of leakage.

- In addition to the above the first pipe and every thirtieth thereafter of each class and diameter shall be maintained at test pressure for a minimum of 4 hours without signs of leakage.

Each pipe and fitting shall be subjected to an internal low pressure air test at the manufacturer's works prior to delivery. The test pressure shall be an overpressure of 0.1 bar and this shall be applied for a minimum period of 5 minutes without signs of leakage or distress. Fittings which are of mitred construction shall be manufactured from pipes which have successfully passed the tests defined above.

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- Dimensions

The dimensions and tolerances of all pipes shall be determined in accordance with ASTM-D 2122 Stiffness.

A minimum of one pipe for every 30 pipes manufactured shall be tested for stiffness in accordance with ASTM-D 2412 "Method of Test for External Loading Properties of Plastic Pipe by Parallel Plate Loading". A minimum of one pipe of each class and diameter of pipe shall be tested.

Longitudinal and hoop tensile strength. The tensile strength properties of a minimum of one pipe for every 100 pipes manufactured shall be measured in accordance with ASTM-D 638. A minimum of one pipe of each class and diameter of pipe shall be tested.

- Cure

Curing, to be tested by the Barcol Hardness test determined in accordance with ASTM-D 2583 standard: 100 % of the produced pieces. Minimum acceptable hardness is 90% of the value recommended by the resin manufacturer of the particular resin used, when non-reinforced. The sample pipe shall also withstand a commercial acetone test on the internal portion of the laminate.

- Loss on ignition

A minimum of one pipe for every 30 pipes manufactured shall be tested in accordance with ASTM-D 2584 "Standard Method of Test for Ignition Loss of Cured Reinforced Resins".

- Joint tests

A minimum of two pipes in every 100 pipes manufactured shall be jointed and tested in accordance with the requirements of section 7.2 of ASTM-D 3262.

- Visual inspection

Each pipe and fitting shall be subjected to a complete visual inspection before shipment in accordance with ASTM-D 2563.

- Vacuum test

Vacuum test of pipe shall be carried out for each diameter once at beginning of production. The vacuum to be applied shall be equivalent to the condition which occurs during full vacuum. The corresponding derated vacuum for this test shall be proved by the pipe manufacturer.

- Failure of tests on completed pipes.

In the event of a specimen not fulfilling the minimum requirements for strain corrosion resistance, all pipes of that class and diameter which have been manufactured shall be rejected and shall be replaced entirely.

Any pipe or fitting which fails any of the quality control tests which are to be carried out on each and every pipe or fitting shall be rejected. In the event of any pipe failing any of the remaining tests outlined above that pipe shall be rejected and the relevant test shall be carried out on a further ten pipes of that class and diameter. If any one of these ten pipes fails then the manufacture of pipes of that class and diameter shall cease and the Owner/Owner's representative reserves the right to reject all the pipes of that class and diameter.

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- Thermal insulating materials

Materials shall be tested for bulk density, specific heat, compressive strength, fire resistance under pressure, service temperature limit in accordance with VDI 2055 or equivalent standards.

- Workshop manufacturing and pre-assembly

All workshop fabricated components and parts of the plant shall, to the fullest practical extent, be formed, machined, fitted, welded, stress-relieved. X-rayed, adjusted, tested, cleaned and painted. The equipment shall be pre-assembled in the workshop of the Bidder or his sub-supplier to the maximum possible extent, then dismantled only as far as required for safe and proper shipment, in order to keep erection work on site to a minimum. Equipment and parts shall be marked, labelled or otherwise identified to facilitate assembly and erection on site. Marks and labels shall be fixed in such a manner so that deformation or obliteration shall not occur during shipment, storage and erection on site.

2.2.0 Manufacturing tests

2.2.1 Welding

Welding procedures shall be qualified in accordance with the requirements of the construction code/specification for the item of plant concerned and in the case of critical plant items the tests shall be witnessed by an internationally recognised inspection authority.

Welders shall be qualified in accordance with the requirements of the construction code/specification for the item of plant concerned for all types/positions of welding he may perform.

A system of positively identifying the work of each welder shall be maintained and any welder whose work is the subject of multiple rejections shall be required to undergo a requalification test. Any welder failing the retest may, at the discretion of the Owner/Owner's representative be disqualified from further welding on items under this contract.

Welded fabrications shall be stress relieved when specified by the applicable standard or for dimensional stabilisation prior to machining.

Copies of temperature charts referenced with load items shall be included in the test certification supplied for the relevant items.

All welds shall be visually examined and shall be of smooth contour, free from cracks, undercut and other significant defects. Wherever possible the interior of tubes etc. shall be examined using a suitable optical device where necessary.

Fillet welds shall be checked for size using suitable gauges which shall be available for use on request by the Owner/Owner's representative during an inspection visit.

Non-destructive examination of pressure and vacuum containment welds

Welds shall be non-destructively tested in accordance with the construction standard applicable to the item of plant. In addition the requirements of the **following Table 2.15.1** shall be observed. This table shall also apply in cases where the standards used for design and construction of an item of plant does not specify the quality requirements for welds. Fault limitations to be subject of agreement with the Owner/Owner's representative prior to fabrication.

Table 2.15.1 : Non-Destructive Testing

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Type of Steel	Design Factor (shell)	Wall thickness (mm)	Inside diam. (mm)	Type and Extent of Non-Destructive Testing			Remarks
				Butt	Nozzle	Fillet	
C and C-Mn steels with C content not exceeding 0.25%	≤ 0.85	≤ 10	all	-	-	-	Only applicable to: Atmospheric systems (excluded systems, which handle chemicals, toxics or flammable media).
		≤	all	10% R	-	-	
		> 40	all	100% R	10% M	10% M	
	> 0.85	≤ 40	≤ 100	10% R	-	-	
			> 100	100% R	10% M	10% M	
		> 40	all	100% R	100% M	100% M	Test after stress relief
C-Mn steels with C content 0.25 to 0.35% and C 1/2 Mo steels		≤ 30	all	10% R	10% M	10% M	Applicable below 50 bar
	all	> 30	all	100% R	100% M	100% M	Test after stress relief
Low alloy steels except CrMoV and 2 CrMo	all	all	all	100% R	100% U	100% M	Test after stress relief
CrMoV and 2CrMo steels and 12% Cr ferritic/martensitic steels	all	all	≤ 100 > 100	100% R 100% R* 100% U	100% M 100% M 100% U	100% M 100% M 100% M	Test after stress relief Test after stress relief
* Radiographic examination may be omitted if done on as-welded joint							

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Type of Steel	Design Factor (shell)	Wall thickness (mm)	Inside diam. (mm)	Type and Extent of Non-Destructive Testing			Remarks
				Butt	Nozzle	Fillet	
Austenitic Stainless Steels	≤ 0.85	≤ 15	all	-	-	-	Not applicable to: Butt welds made from one side only Operating temperatures exceeding 200 °C
		≤ 30	all	10% R	-	-	
		> 30	all	10% R	10% D	10% D	
			≤ 100	10% R	-	-	
	> 0.85	≤ 30					
			> 100	100% R	10% D	10% D	
		> 30	all	100% R	100% D	100% D	

Legend: R = Radiographic examination
U = Ultrasonic examination
M = Magnetic particle examination
D = Dye penetrant examination

Note:

- Where 10% examinations are shown for pipe work under 100 mm diameter bore this shall be the circumference of 10% of the welds by each welder selected at random with a minimum of one per welder.
- Where 10% examinations are shown for vessels or large diameter pipework this shall be 10% of each weld length and must include all intersections of longitudinal and circumferential welds.
- Where partial examinations reveal rejectable defects, adjacent welds or areas of weld shall be examined. In the event of rejectable defects being found welds shall be subject to 100% examination.
- Welds in clad materials shall be tested in accordance with the requirements of the base material and the surface of the overlaid welds shall be dye penetrant tested throughout their length.

Non-destructive examination of structural welds

Welds shall be non-destructively tested in accordance with the construction standard applicable to the item of plant. Where appropriate, the following requirements shall also be observed:

Magnetic particle testing of the tension side welds In major fabricated girders and sections.

Ultrasonic examination of heavily restrained welds (e. g. cruciform joints) where there is a risk of lamellar tearing in the parent material.

Weld repairs

Unacceptable defects observed by visual examination or indicated by non-destructive testing shall be completely removed by chipping or thermal gouging and grinding. The resulting excavation shall be crack detected prior to re-welding.

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Details of the original defects and repair shall be recorded.

Repaired welds shall be subjected as a minimum requirement to the same inspection requirements as the original welds and test records should indicate that a repaired weld is referred to.

2.2.2 Pressure testing

All items subjected in service to internal pressure or vacuum shall, unless otherwise agreed, be pressure tested in the manufacturer's works and prior to any internal or external coating.

Hydrostatic testing

All pressure vessels, inserts or other parts of such vessels, which are subject to an internal pressure or vacuum during operation shall undergo a hydraulic or other approved test. Unless otherwise stated in the specification, the test pressure shall be maintained for a sufficient period to permit complete examination by the inspector.

Should it be necessary to carry out repair welding on stress-relieved equipment, it must undergo a stress-relieving process again. In all such cases, the hydraulic test must be repeated.

Particular attention must be paid to the temperature of water used for hydraulic testing which shall not be less than 20°C. Prior to testing, metal temperatures shall also not be less than 20°C. Where pressure parts 600 mm in diameter and above are being tested, the hydraulic pressure shall be raised to the test pressure in stages, during which the item shall be examined and all defects rectified before the full test pressure is reached.

Suitable water shall be used as the test media unless otherwise agreed and test pressures shall be in accordance with the applicable construction standard but if none is specified then the test pressure shall be 1.5 times the design pressure but not less than an overpressure of 3.5 bar. Test pressure of vacuum containment items shall be agreed with the Owner/Owner's representative.

The test pressure shall be maintained for sufficient time to permit complete visual examination of all surfaces and joints and in no cases less than specified in the applicable construction standard.

The chloride content of water used for testing austenitic stainless steel items shall not exceed 30 ppm unless immediate flushing with water of this quality is done after the test.

Pneumatic testing

The Bidder shall apply pneumatic testing in cases where hydrostatic testing is impractical or undesirable. Safety precautions, test pressures/ duration and degree of prior non-destructive examination of the subject items shall be agreed with the Owner/Owner's representative.

Pneumatic or gas leak testing supplementary to hydraulic testing shall be applied in appropriate cases where specified by the applicable construction standard.

2.2.3 Testing of corrosion protection

Surface coatings

Following tests have to be performed before, during and after coating:

- visual inspection of blasted surfaces according to DIN 55928 part 4, annex 1
- checking of coating material

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- measurement of air humidity, air temperature and coating area temperature (determination of dew point)
- visual inspection of coating
- checking of dry film thickness (DFT)
- checking of adhesion.

Galvanised zinc coatings

Surfaces shall be visually inspected. Bare patches, lumps blisters or inclusions of foreign matter shall be cause for rejection.

Zinc coating thickness shall be determined non-destructively in accordance with DIN 50981 or coulometrically in accordance with DIN 50932. For coatings with a weight exceeding 900 g/m² the coulometric test method specified in DIN 50932 shall be used.

Hard rubber linings

Surfaces shall be visually inspected. Uneven surfaces, splits, blisters or inclusion of foreign matter shall be cause for rejection.

The thickness of linings shall be measured in accordance with VDI Standard 2539 or equivalent. A tolerance of + 10% is permitted for rubber coatings of 3 mm nominal thickness.

Hardness tests shall prove compliance with the rubber manufacturers standards.

The absence of pores shall be proved by the induction sparking test method. The potential used shall be 5,000 Volts for each mm of thickness plus an additional 5,000 Volts (i.e. potential of 20,000 Volts for 3 mm thick lining).

2.3.0 Mechanical equipment

2.3.1 Rotating units

Balance testing of rotating units

Each rotating unit shall be first statically balanced and then dynamically balanced (in the case of impellers this shall be done before and after mounting of the service rotor shaft). A check balance of items that have undergone overspeed test shall also be made.

Vibration testing of rotating units

The vibration characteristics of rotating units shall be measured during performance tests. Locations of measurement and standards to be achieved shall, on request, be subject to agreement by the Owner/Owner's representative.

2.3.2 Gas turbine

All equipment and components of gas turbine generator shall be works tested in accordance with the manufacturer's standard methods and procedures as necessary to ensure high quality materials and equipment, reliable and safe operation, and long life. Copies of the manufacturer's quality assurance programme, manufacturing test description and pre-shipment operating test descriptions shall be submitted in advance of the start of fabrication, along with a listing of the test reports to be provided to the Owner/Owner's representative and a schedule of each test. Example copies of representative key test reports shall also be provided.

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All major components namely the gas turbine, auxiliary components, generator and other major and critical systems included in the gas turbine package shall be required to undergo acceptance test-run at the manufacturers works prior to delivery at site. The Owner/Owner's representative will witness the acceptance test for all major components.

A no-load operational test shall be made for the turbine, using Natural Gas fuel. All control and safety devices shall be checked for proper operation during this test.

The GT compressor rotor is to be statically and dynamically balanced and over speed tested at the factory.

The following items shall be checked during no-load operation of the turbine :

- Bearing oil temperature rise.
- Vibration levels over the operating speed range.
- Exhaust temperature.
- Wheel space temperatures.
- Fuel system operating characteristics.
- Overspeed trip.
- Coolant system.
- Air flow & pressure ratio.
- AOP cut-in and cut-out pressures.
- Individual accessories, including heat exchangers for lube oil and water, solenoid valves, stop valves, control valves, pumps, motors, ignition system, gauges, thermocouples, heaters and electric switches.
- Check for assembly clearance after the test.

Prior to the no-load test, all pressure containing parts shall be hydrostatically tested at 1.5 times the design pressure. The turbine and compressor rotors shall be precision balanced before being fitted into the turbine stator and the turbine and generator rotor shall also be tested for a minimum of 120% rated speed for about five (5) minutes.

2.3.3 Steam turbine

The turbines shall be completely assembled with their control, stop and governing valves on a suitable erection rig at the manufacturer's works and shall be carefully inspected and measured for manufacture and assembly tolerances. Functional tests shall be performed on the safety equipment (running with steam is not requested).

Important items of turbine control equipment which cannot be adequately tested during the main tests shall be separately bench tested.

Furthermore testing shall comprise:

- Balancing and overspeed test of the assembled rotor.
- Measurement of radial clearances.
- Assembling inspection.
- Bearing oil temperature rise.
- Vibration levels over the operating speed range.
- AOP cut-in and cut-out pressures.
- Check for assembly clearance after the test.

2.3.4 HRSG

As per the requirement of IBR / ASME.

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2.3.5 Pumps

Running tests and performance tests shall be conducted on all pumps:

Performance tests shall be conducted through the full operation range of the pump to closed valve conditions. Graphs indicating flow/head, flow/power absorbed, flow/efficiency, flow/NPSH and speed shall be produced.

The lubricating oil used in the test shall be of the same brand and grade as that recommended by the manufacturer for service use.

Bearing oil temperature rise and Vibration levels over the operating speed range shall be measured and shall be as per the standard.

Dismantling of the pump for visual examination of parts for damage following test shall be done when required by the inspection standard, when considered necessary by the manufacturer, or when requested by the Owner/Owner's representative's witnessing the running or performance tests. Replacement of parts following test shall necessitate repeat testing.

Job motor shall be used for testing the BFP, CEP CW, ACW and CCW pumps.

NPSH test shall be performed for BFP and CEP pumps. For vertical pumps minimum submergence test shall be conducted.

For all the pumps in the plant, the Testing and acceptance std. shall be IS 5120 / HIS / PTC code. However no negative tolerance is allowed for Flow, Head, Shut off head & Efficiency at Guarantee point. However positive tolerance of 3% on Head at Guarantee point and 5% on shut off head is permitted.

2.3.6 Fan

All fans shall be tested in accordance with the BS 848 part 1 and other applicable standards.

The particular test procedure to be applied to each type of fan shall be agreed with the Owner/Owner's representative. The tests shall be conducted strictly to the requirements of the agreed test procedure so that all points on the performance curves are within agreed tolerances.

2.3.7 Fuel Gas compressor and conditioning System

- Running tests and performance tests as per API and ASME
- balancing test of the assembled rotor
- measurement of radial clearances
- assembling inspection.
- Bearing oil temperature rise
- Vibration levels over the operating speed range

2.3.8 Deaerator, Condenser and Plate Heat Exchanger

- Hydro Test as per IBR/ASME sec VIII , Div 1
- Air test of tube to tube sheet joints for condenser

2.3.9 Gate, Globe, Regulating and Check valves

- As per IBR / ASME
- Shell Hydro test
- Seat leakage test as per BS 6755 part 1 Rate A with Air test & Hydro test.

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2.3.10 Control Valve, Pneumatic block valve and PRDS

- As per IBR / ASME.
- Shell hydro test as per ASME 16.34.
- Seat leakage test , Actuator chamber leakage test, as per ASME 16.104.
- Operation test (calibration , Hysteresis).
- Flow characteristics test.

2.3.11 Butterfly valves

- Shell hydro test & Disc strength test as per BS 5155.
- Seat leakage test BS 5155.
- Open & close operation check for more than 14" valve.
- Flow characteristics test.

2.3.12 Air compressors

Air compressors shall be tested in accordance with the requirements of BS 1571, class C.1 part 1, ISO 1217, ASME PTC-9 or similar standards. Any request for deviation from the test conditions shall be accompanied by the manufacturers' proposals for the adjustment of the correction factors contained in the standard.

No Tolerance on guaranteed values of energy consumption, volumetric efficiency, air drier capacity, dew point of air, is allowed.

2.3.13 Air Drying Plant

Leakage test, Auto sequential test, operating time for regeneration cycle, Dew point test

Performance test for the air dryer shall be conducted at site to prove the following parameters:

- Rated dew point temperature.
- No spikes in the dew point temperature during changeover from one tower to the other in the dryer.

2.3.14 Cranes and hoists

Where size permits cranes and hoists shall be completely assembled at the manufacturers works and functional tests without load conducted.

2.3.15 Fire fighting system

All testing requirement as per TAC / NFPA.

Hydrant Valves and stand post assembly

The stand post assembly along with the hydrant valve (valve being open and outlet closed) shall be pressure tested at a hydrostatic pressure of 21 Kg/cm² to detect any leakage through defects of casting.

Flow test shall be conducted on the hydrant valves. The flow through valves shall not be less than 900 Litres/min.

Leak tightness test of the valve seat shall be conducted at hydrostatic test pressure of 14 kg/cm²(g).

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2.3.16 HVAC

a) All Building area of the power plant shall be ventilated.

b) Air Handling Unit

Visual and dimensional check shall be done for quality workmanship and completeness of each section and component and their assembly. The cooling coils shall be pressure tested (hydraulic for chilled water, pneumatic for direct expansion type) for minimum 1.5 times the design pressure.

Performance Tests

All Air handling units shall be performance tested at the manufacturer's work. During the test reading shall be taken for various parameters like:

- Air flow rate and static pressure developed by the air handling fan.
- Cooling capacity of the cooling coil.
- Noise level at specified distance from the unit and Vibration.
- Power consumption.
- Leak tightness for the assembled unit.
- Smooth operation and responsiveness of the face and bypass damper.

c) Cooling Tower

Following test shall be carried out as shop test

- Visual check on hub for fan, FRP components, FRP casing, drift eliminators, nozzles and fills.
- Visual dimensional and leakage test of the basin, visual dimensional and profile test on the fan blade.
- Static balancing of the fan assembly.
- Thickness of zinc coating for GI components.
- Vibration.

Performance Tests

Cooling towers shall be performance tested at the manufacturer's work. During the test reading shall be taken for various parameters like;

- Noise and vibration level of the equipment shall be measured.
- Power consumption.
- Leak tightness for the assembled unit.

2.3.17 Water system

Functional tests on completed individual equipment shall include:

- Pumps.
- Interlock and protection panels.

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7.0.0 GENERAL PLANT DESIGN REQUIREMENTS

7.1.0 General

The design of the combined cycle power plant consisting of GT, ST & Generator, HRSGs and associated auxiliaries shall generally conform to the following requirements and shall be new and unused.

The plant shall be constructed considering prudent engineering practices and optimal utilization of resources. These shall be complete and include all the equipment and systems necessary to ensure required level of reliability, availability, efficiency, and high level of safety and maintainability over their lifetime. It is also necessary to consider various precautions to safeguard the operating and maintenance personnel.

The Plant shall be suitable for full range of ambient and other environmental conditions as per specified site conditions in this contract. The design of the power plant shall ensure that the plant can, in the state of normal operation, adapt itself to load, frequency, power factor, ambient variations within the allowable range of design and the Grid Code requirements.

The auxiliary systems and plant facilities shall be designed for serving the whole power plant with adequate redundancy. The redundancies shall be provided as specified in this Contract. Secondary system component shall be designed with suitable redundancy (redundancies are as specified in this Contract) in order to achieve the required reliability and availability of the power plant.

The life span to be considered for the design of equipment and component selection shall be at least 25 years and components which are not meeting this requirement shall be identified and its life shall be guaranteed, specifically in the Contract. Due to operation requirement, the plant components or parts will have definite material life span requiring replacement on more frequent basis, which needs to be recognized. Certain components like electronic parts, DCS, bearings, components subjected to wear and tear etc. will have a definite life span which will be less than 25 years. These components have lower shelf life and the life of the equipment needs to be prolonged by replacement of these components.

The various parts and systems of the power plant shall be designed to achieve the object of providing integrated and coordinated power plant operations. For the design of the power plant, it is necessary not only to consider the requirements of operation, but also, by suitably planning the layout, the convenience for inspection, cleaning, maintenance and repair are ensured.

The various parts or components or assemblies of equipment and systems shall be of proven materials with well established physical and chemical properties appropriate to the service as intended.

All materials, components and equipment shall be tested at all stages of procurement, manufacturing, erection, commissioning as per comprehensive Quality Assurance Programme to be agreed mutually between the Owner/Owner's representative and the equipment supplier.

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In the design of the power plant and selection of equipment, the specific requirements of this project and likely occurrences of abnormal operating conditions (The abnormal conditions are, 1. During fluctuations in grid frequency and voltage (within the specified limits as specified in the specifications) 2. During load swings (from minimum stable operating load to base load) without any restrictions in operation). have to be taken into consideration to ensure that the power plant can, under these circumstances, operate continuously, safely and without undue loss of efficiency. The selection of materials shall be suited to local operating and ambient conditions.

Equipment installed outdoors shall be capable to operate in all-weather conditions and withstand the work site environment.

The equipment must operate without undue vibrations that may affect its operation/life and that of other machinery or of civil works under every condition.

Corresponding parts throughout the plant shall be made to gauge and be interchangeable for all models of same duty. The supplier shall provide the necessary original part references for all kinds of parts of equipment.

All equipment performing similar duties shall be of the same type and manufacture in order to limit the stock of spare parts required and maintain uniformity of plant and equipment to be installed to the extent feasible. Exact requirement, if feasible, will be ascertained during detail engineering.

The design & construction of plant shall be such that it is suitable to comply with all applicable environmental stipulations of the Central Pollution Control Board (CPCB) and State Pollution Control Board (SPCB) including in regards to flue gas emissions, liquid effluent discharges, solid waste disposal, noise levels.

The plant site is in the coastal area, hence the environment is likely to be corrosive and the materials of construction for all exposed metal/ concrete surfaces shall be so chosen as to withstand the corrosive environment. Also suitable weather protection shall be provided to all exposed surfaces. Underground piping shall be provided with suitable anti-corrosive measures.

All stand-by auxiliaries shall be designed for auto start up, on failure of running auxiliaries with minimum time delay and without runback on unit load.

All heavy parts of the plant must be provided with some convenient arrangement for aligning and for handling during erection and overhaul. Any item of plant required to be stripped or lifted during period of maintenance and weighing one tonne or more shall be marked with its approximate weight.

7.2.0 Standards and Codes of Practice

All equipment, systems and works covered under these specifications shall be in accordance with all the applicable statutes, regulations, codes and standard specified as well as all such standards, statutes, regulations and safety codes applicable in the locality where the equipment will be installed. Contractor may familiarize themselves with all such requirements. Complete design including pressure parts, piping, valves and fittings shall meet or exceed all the latest requirements of the Indian Boiler Regulations (IBR), latest Indian Standards /ASME codes, latest codes and standards as applicable. Any Indian/International standards shall be followed for any imported equipment. For plant layout aspects and area classification requirements OISD standards shall be followed.

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The design, construction and testing of all equipment, facilities, components and systems shall be in accordance with relevant standards and codes issued by Bureau of Indian Standards (BIS) and/or reputed international standards and codes as on the date of Award of Contract. A non-exhaustive list of reputed international standards is given below:

- a) American National Standards Institute (ANSI)
- b) American Petroleum Institute (API)
- c) American Society of Mechanical Engineers (ASME)
- d) American Society of Testing and Materials (ASTM)
- e) American Water Works Association (AWWA)
- f) American Welding Society (AWS)
- g) British Standards (BS)
- h) Cooling Technology Institute (CTI)
- i) Deutsches Institut fur Normung (DIN), Germany
- j) Gosstandart of Russia (GOST) standards
- k) Heat Exchange Institute (HEI), USA
- l) Hydraulic Institute Standards (HIS), USA
- m) International Electro-technical Commission (IEC)
- n) Institute of Electrical and Electronics Engineers (IEEE)
- o) International Organisation for Standardisation (ISO)
- p) Japanese Industrial Standards (JIS)
- q) National Electric Code (NEC), USA
- r) National Electrical Manufacturers Association (NEMA), USA
- s) Central Electricity Authority (Construction of Electrical Plants and Electric Lines) Regulations, Notification, 20th August 2010 and to those referred therein
- t) National Fire Protection Association (NFPA), USA
- u) Occupational Safety and Health Administration (OSHA)
- v) Tubular Exchanger Manufacturers Association (TEMA), USA
- w) VDE association for Electrical, Electronic and Information Technologies (VDE), Germany
- x) OISD

Other international Standards, equivalent or superior to the above Standards can also be adopted. However, In the event of any conflict between the requirements of the international

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standards or codes and the requirements of the BIS standards or codes, the latter shall govern unless specified elsewhere in the specifications. Any Indian/International standards shall be followed for imported equipments.

The Plants and Electric Lines (within the plant) shall also be designed to comply with the requirements stipulated in.

- Central Electricity Authority (Installation and Operation of Meters) Regulations, 2006.
- Central Electricity Authority (Technical Standards for Connectivity to the Grid) Regulations, 2007.
- Central Electricity Authority (Measures relating to Safety and Electricity Supply), Regulations as and when these are notified by the Authority.
- Central Electricity Authority (Safety Requirements for Construction, Operation and Maintenance of Electrical Plants and Electric Lines) Regulations as and when these are notified by the Authority.
- Central Electricity Authority (Grid Standards) Regulations as and when these are notified by the Authority.
- Central Electricity Authority (Construction of Electrical Plants and Electric Lines) Regulations, Notification, 20th August 2010 and to those referred therein
- Indian Electricity Grid Code issued by Central Electricity Regulatory Commission (CERC) and
- Applicable State Grid Code issued by appropriate Regulatory Commission.

All material and equipment supplied and all work carried out as well as calculation sheets, drawings, quality and class of equipment, methods of inspection, constructional peculiarities of equipment and parts and acceptances of partial plants, as far as these are beyond the special requirements of the specifications, shall comply in every respect with the technical codes of the above listed codes and Standards.

It shall be the responsibility of the Contractor to take all approvals required and get the HRSG registered under the IBR. In all other cases where IBR does not govern, IS/ASME, Japanese, American, British, German or other international standards established to be equivalent or superior to IS/ASME shall be acceptable with the approval of the Owner/Owner's representative at the time of detailed engineering.

Where there are no standards or regulations, or the standard is not sufficient to meet the need of design and supply, for such items relating to the power plant, the Contractor shall carry out the design, manufacture, supply and installation on the basis of good engineering practice.

During the period of Contract execution, if any standards change, the Contractor shall be responsible to notify the Owner/Owner's representative and provide the basis for the prospect that it would not cause the lowering of quality, performance and service life of the power plant due to alteration of the standard and the latest standards shall be followed by the Contractor.

Further requirements about applicable standards and codes are specified in the detailed technical specifications.

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7.3.0 Operating Capabilities

The power plant will be operated in parallel with the grid normally at base loads as required and as permissible by the Original Equipment designs, but meeting the requirement of the Grid Code in all cases considering the fuel specified.

Combined cycle module, comprising of Gas Turbine, Steam Turbine, Generator and HRSG, shall deliver its Guaranteed Gross Power Output of 51 MW (Minimum) at the specified Site Reference Conditions and with the specified fuels & utilities at the guaranteed Gross Heat Rate at the time it is tested as per the Contract and thereafter with normal and reasonable degradations (as provided by MPP), performance will be subject to degradation as per MPP supplied curves.) where applicable considering the planned inspection and maintenance as proposed by the Contractor in the Contract without any undeclared expiry of life expectancy.

All combined cycle plant equipment sizing shall be carried out considering the maximum unrestricted gross power output.

In all cases it is understood that the plant will be operated & maintained by qualified professionals utilizing the Operation instruction and the Routine & Preventive Maintenance instructions as specified by the MPP and Planned Maintenance will be conducted under the supervision of MPP utilizing the parts acceptable by the MPP. It is also understood that Operator actions in case of emergency situations will be as per prudent industrial practices in India.

The unit shall be designed for constant pressure and sliding pressure operation.

The gas turbine, steam turbine and all rotating auxiliaries shall be suitable (That is offered equipment and its arrangement in relation with other connected equipment should have been already validated) for continuous operation within the frequency range of 47.5 Hz to 51.5 Hz.

All the auxiliary equipment and the drive motors shall be capable of delivering satisfactorily their actual output continuously for voltage variation, frequency variation and combined voltage and frequency variation as indicated elsewhere in the specification.

The design of the equipment and control system shall be suitable for operation of the CCGT module in automatic load frequency control.

The design shall cover adequate provision for quick start up and loading of the unit to full load at a fast rate. The ST loading or unloading shall be in line with the recommendations of MPP.

The unit shall be capable of automatically coming down to house load and operation at this load in the event of sudden external load throw off.

There shall be a HP and LP bypass system to facilitate quick starting and loading under hot restart conditions and to facilitate conserving condensate where too many start ups occur. Owing to certain conditions in the system, part load operation of the machine could occur for prolonged durations. Under such conditions there shall not be any undue deterioration in the parts and the elements. The turbine unit shall be capable of deriving economic benefits due to lower temperature of inlet air to GT as per ISO conditions, circulating water and environment in winter.

7.4.0 Vibration

Vibration shall be reduced to the minimum as far as possible where it cannot be completely eliminated. Amplitude and frequency limitation in the design and supporting structure shall be considered for vibration, The variation in grid frequency to be considered for vibration design

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shall be 47.5 Hz to 51.5 Hz. Also verification of structures for their natural frequencies shall be carried out by Contractor.

Special care shall be taken to avoid operating equipment making resonance with foundations, packing, duct, platform, piping or other components.

Unless otherwise stated or agreed by the Owner/Owner's representative, each rotating machine has to comply with the requirements for designation as 'good' stipulated by ISO standard for the respective group of machinery. If the vibration is higher than stipulated as 'satisfactory' the Owner/Owner's representative has the right to reject the corresponding equipment, subject to the conditions specified elsewhere.

7.5.0 Noise levels

The plant shall be designed and constructed to reduce the operating noise level as much as possible and when the plant is operating at all loads, the noise pressure levels specified in Section 17-Environmental Requirements shall not be exceeded. Any noise emanating from any protective systems such as ST bypass, and safety valve is excluded. For background noise from the existing plant, noise levels will be measured before commencing the test for proposed plant,

- Noise level at the Property boundary shall not exceed the Ambient Air Quality Standard in respect of noise as stipulated by CPCB and SPCB in this regard.
- Noise level for the continuously operating equipment including GT, ST & Generator, BFP, and CWP shall not be more than 85 dB(A) at a distance of 1 metre and at a height of 1.5 metre from any equipment. For short term exposure, noise levels shall not exceed the limits as stipulated in the Occupational Safety and Health Administration (OSHA) Standard.
- For control room and offices, noise level shall not exceed 60 dB (A) near to the duct and at other places in the control room/offices noise levels shall not exceed 50 dB (A).
- Equipment/ machines shall be provided with acoustic enclosures, wherever required so as not to exceed the permissible noise limits.

7.6.0 Units of Measurement

For all the technical tables and diagrams, calculation results, drawings, test data and scales adopted in the design and provided for the power plant, the standard international unit system (SI) as per International Standardization Organization (ISO) shall be uniformly employed.

SI system shall be employed for all the plant layout and arrangement drawings of equipment made especially for the project.

7.7.0 Safety

For this Project, Contractor shall have a dedicated Safety and Health Section, within the Project Team. The dedicated Safety and Health Section shall monitor all safety and health related activities at the site.

The construction site shall have one qualified officer responsible for health and safety co-ordination. He will be assisted by requisite numbers of safety supervisors and firemen to ensure smooth progress of work at site. This person shall ensure that safe and healthy working practices are implemented and maintained. A pro-active health and safety programme shall be implemented that provides the following for all Contractors' workers:

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- Policy statement, philosophy, objectives and targets, procedures and training that are compiled to produce a Health and Safety Plan;
- A minimum of one (1) health and safety awareness meeting per month for all personnel; and a minimum of two (2) health and safety preview meeting per month for construction supervisors and designated health and safety personnel to assess the programme's effectiveness and implement improvements as necessary;
- Continuous health and safety performances monitoring and audits;
- Weekly health and safety statistics reporting;
- First aid facilities and personnel; and
- Procedures for responding to emergency situations.

The Contractor shall furnish and issue approved safety helmets, safety boots, safety belts, protective goggles, protective clothing, breathing equipment, as applicable, to all workmen and authorised personnel during the course of hazardous construction of all types.

The Contractor shall provide and properly maintain warning signs and lights, barricades, railings, and other safeguards for the protection of personnel as required by the conditions and progress of the work.

Special importance shall be assigned to all aspects related with the safety of personnel operating, assembling and maintaining the equipment, including other persons who are likely to come in contact with same.

The possibilities of human failure must be foreseen. Provisions shall be taken to avoid damage caused by human error or to ensure that such damage both to persons as well as to the equipment is the least possible.

Rotating or any other moving part of the machinery, hot parts or any part that may cause accident to the staff must be adequately protected, in accordance with the safest method known.

All components with surface temperatures exceeding 60°C shall be fitted with insulation to protect personnel. The surface temperature shall not exceed 60°C if the condition of the ambient temperature is 40°C and wind velocity is 1 m/s.

However if there are any hot spots such as connection of expansion joint to duct, where the surface temperature may exceed 60 deg. [C], suitable personal protection for the hot spot on exhaust duct shall be provided.

Bright paints used will be agreed upon with the Owner/Owner's representative to protect personnel, so that anything representing a potential danger will stand out: such as elements in movement, suspended hot, with electric tension.

It should be possible to carry out routine maintenance operations required by the equipment without interrupting its operation and without danger to the personnel.

Access stairs to the equipment must be safe, with anti-skid rungs and handrail. Normal circulation areas of the equipment shall be protected to keep personnel from falling or shall be surrounded by strong guardrails, platforms should have kicking plates to keep loose objects placed on the floor from dropping off, entrances and large openings in the equipment

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shall be provided with lids or doors affixed in such a way as to open them also from the inside.

Every equipment or parts of equipment that must operate under certain conditions of maximum pressure, temperature, speed, position, should have devices to keep such limits from being exceeded and, if necessary, to stop the operation of the machine (Safety valves, limit switches, thermal switches).

For protection against the possible failure of the above devices, additional safety elements shall be provided such as stroke limiting stops, diaphragms, bolts and/or links or other dimensioned rupture elements so that in case of failure, when exceeding extreme operating conditions, additional safety is provided to the equipment.

Inside air and gas ducts, ladders have to be installed for inspection of dampers, venturies.

In designing an area where combustible gases are likely to accumulate, due consideration shall be given to provide safety measures to allow the gas to continuously diffuse or leak off to prevent explosion. The electric equipment in those areas shall be of the fireproof and explosion proof type. Suitable grounding shall be provided on the casing of electrical apparatus which might be energized.

Draining of water and venting of gas shall be performed with respect to the safe mode of discharge, and is not allowed to be carried out at or near the places where people exit and at the exit of the plant.

7.8.0 Fire Protection and precautions

The Contractor shall adopt necessary methods to minimize fire hazards.

The fire protection system shall in general follow the recommendation of TAC / NFPA / OISD standards. However, GT CO₂ Fire detection and protection system will be designed and supplied based on NFPA 12, IS – 2189/ NFPA-72.

The design of power plant shall include a complete set of composite fire monitoring, protection, and fighting system to identify, isolate, and distinguish fires as well as minimizing potential fire hazards.

A warning alarm for the power plant and alarm for evacuation shall be provided. The alarm is to be audible in the normal working areas of personnel. The selection of the alarming device shall be such that it is audible about the normal background noise of the plant. Visual alarm shall be provided in addition to audio alarms in high noise areas.

During the construction phase of power plant, the Contractor adopts advanced and safe working practices and a set of guidelines to keep the site in a clean condition to reduce the possibility of fire. The basic guiding ideology is to adopt two methods: fire prevention and fire control shall adopt to improve conditions in designing the layout, to reduce potential fire danger, ensure the safety of personnel, ensure the safety of the important and main equipment of the power plant.

Use fire proof or fire resistant materials ensuring that isolating combustible material is not used or stored in possible fire source area of the power plant.

The end connection type of hydrant shall fit in with local fire brigade requirements to ensure the manual device in power plant to be compatible with the fire control device of local fire brigade.

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7.9.0 Signs

Safety colours, safety symbols and safety signs must comply in construction, geometrical form, colour and meaning with the ISO Recommendation 507 of the ISO committee TC 80 'Safety Colours'. All signs should give the identification number. All signs shall be in the English language.

The signs should be of a material which is weather-resistant and of sufficient durability for the conditions prevailing on site. Indian regulations and codes are to be considered.

The positions for the signs must be chosen so that they are within the field of vision of the persons to whom they apply. The signs should be permanently attached. Temporarily dangerous areas (e.g. construction sites, assembly areas) may also be marked by movable signs. The safety signs must be mounted or installed in such a manner that there is no possibility of misunderstanding.

All Necessary Traffic signs, Information sign, Emergency sign, Mandatory signs, Warning sign, Prohibition sign viz., No Smoking, No Entry, Do Not Start, shall be provided at appropriate area in the entire power plant area.

7.10.0 Package, Storage and Store House

The Contractor should provide all the specifications and instructions for the self purchased and fabricated equipment during the planning period of the Contract. These specifications should include the cleanliness and maintenance requirements of materials during fabrication and the protection measures for the equipment from damage during transportation. Loss of materials during storage should be avoided before installation. The instruction should be worked out especially to suit the particular work site program.

All materials and equipment should be packaged according to the typical environmental conditions during storage. In case of severe conditions, these materials and equipment should be packaged carefully by taking a full and appropriate preventive measure to protect from any damage or wear.

The Contractor and his appointed Subcontractor for installation should guarantee jointly that a good supplementary storage will be carried out within the equipment site controlled by them.

Three classes for storehouse are described as follows:

Storehouse class A items: Special measures are taken to protect the stored goods and the temperature, humidity are controlled within a specified range.

Storehouse class B items: Goods are stored with temperature uncontrolled.

Storehouse class C items: It is an outdoor storage with a drainage system on the ground.

For storehouses of class A and B they should be fireproof, heat resisting, waterproof and well ventilated. They should not be wet and should be provided with good drainage system and preferably with a brick laying or concrete ground. For storehouses of class C, they should not be wet and should be well drained, preferably with a brick laying or crushed stone ground, should be protected from rainfall, salt corrosion, ash and other adverse conditions with a temporary cover or tent if possible.

Component surfaces should not be contacted directly with the ground or ground laying material. There should be a layer of oilcloth or wax or other similar materials between the machine surface and ground surface.

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All components shall be inspected for their painting, storing, sealing and any damage or wear should be repaired during acceptance and storage periodically. The inspection interval is determined by the component function, applied protection measure and storehouse class.

Many components are provided with a drying agent or sealed in a coverage (polyethylene or insulating cover) containing drying agent. The drying condition shall be inspected during storage in an interval of every 4 weeks.

7.11.0 Painting, Insulation, Anti-dewling

Anti corrosive coatings and painting shall be carried out as a pre-treatment to all equipment and parts. The paint system used should coordinate with the painted objects and surrounding conditions of project.

In multi-layer painting system, different painting layers should be selected to make the painting coordinate. If multi-layer painting system is used, various painting layers should have distinct colours so that the later layer can be distinguished from the former one.

After the equipment or apparatus finished preliminary or full painting, it can be supplied to field. After the installation is finished, ground coat must be painted.

Entire painting procedure should be supplied in order to repair the injures of painting coat after the equipment is delivered to field.

Colour strip indication system should be used for pipes. These strips should be painted on the joint of pipes, entrance, valves of pipe. This pipe without outside protection layer should be marked by some colour in whole length. **Refer Annexure-3 (Vol-IV,Sec-8) for the color coding of piping and fire equipments.**

The principal colour of field equipment should be determined by Owner/Owner's representative and Contractor during execution stage. For Electrical equipment, paint shade shall be as mentioned in the equipment Specification.

Further requirements with regard to painting, insulation, and anti-dewling are specified in the relevant sections in the detailed technical specifications. The specified requirements shall be applied to the whole equipment and facilities of the Contract.

Insulation specification for MPP supplied equipment shall be as mentioned in detailed technical specification.

7.12.0 Language to be used

English shall be used as the general Contract language English translations shall be provided for any code and standards not in English language.

Name plates of equipment and instrument scale shall be marked in English.

Documents for training shall be provided in English.

Danger signs / Exit signs shall be in English, Hindi and Gujarati.

7.13.0 General Mechanical Requirements

This section covers the general mechanical requirements of all other sections of this specification and shall be complied with in every respect unless otherwise stated or agreed by

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the Owner/Owner's representative. Further requirements to be applied are specified in the detailed technical specifications.

7.13.1 Castings and Forgings

The quality requirements of approved international other national standards shall be taken as the minimum requirements.

Cast iron is not to be used for any part of equipment which is in tension or which is subjected to impact, or to a working temperature exceeding 100°C unless specifically approved by the Owner/Owner's representative. Materials for iron castings shall comply with approved international or national standards.

All forgings are to be manufactured from basic electric steel or fully killed acid open-hearth steel. Consideration shall be given to the use of vacuum-degassed steels in appropriate cases.

Forgings shall be free of cracks externally or internally, extensive non-metallic inclusions and surface defects which cannot be removed by subsequent machining.

Each forging shall be suitably branded with an identification number which shall be transferred throughout all final machining stages. The identification number shall be marked on all documents and test certificates relative to the forging.

7.13.2 Pumps

The following represents general requirements for pumps Intended for various services and the same shall be read in conjunction with the requirement specified elsewhere in the detailed specifications.

General

All pumps shall be so designed that they are suitable for continuous operation unless otherwise specified.

Pumps installed for parallel operation or as standby sets are to be of the same design, i.e. interchangeable (Subject to application, fluid handled and identical model).

Standard-type pumps with suitable characteristics shall be used wherever practical. Only proven makes and models are to be supplied to the extent feasible. All accessories and the overall design of pump sets are to be such that they are suitable for automatic operation as specified for the relevant systems.

All pumps shall comply with the applicable recommendations of Hydraulic Institute Standards (U.S.A) or approved equivalents (Latest codes and latest standards as applicable). Special pumps which are designed only as per manufacturer standard shall be identified and stated in the bid. Deviations to the specified Standard if any shall be subjected to approval by the Owner/Owner's representative prior to ordering the same. Owner/Owner's representative understands that deviations to the standard are to be recognized, but the reputation of the OEM, past performance at similar application and fit for the purpose consideration are the only considerations in accepting the deviations.

Pump types

Centrifugal pumps shall be used wherever possible.

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Rotary-type positive displacement pumps will be accepted for handling viscous liquids, and reciprocating/plunger pumps will be accepted for chemical dosing and metering purposes

All pumps shall have a continuously rising head (up to shut-off) characteristics with the minimum shut-off head of 115% but not exceeding 125% of the head at best efficiency point for the rated impeller.

The pump shall be designed to have best efficiency between the rated and normal point. However in no case the rated point should be beyond 115 % of the best efficiency point.

Contractor shall note that the pump characteristics as obtained during the performance testing of pump shall not deviate from the characteristic furnished during earlier stages of approval particularly with regard to the operating point and shut off head and steepness of the curve beyond the duty point. Pump characteristic curve can be furnished during detailed engineering stage after finalization of specific vendor.

All large capacity and continuously operating pumps shall have 5% flow and head margin each, and all other pumps shall have flow and head margins of 10% and 15% respectively unless specifically stated otherwise in the detailed specification

The pump shall be capable of meeting the actual requirement for continuous operation at 47.5 Hz.

The equipment shall be made suitable for outdoor installation (this shall be applicable for pumps intended to be located outdoors). Weather/environmental conditions under which the equipment must operate are specified in the 'Project Data'. However, for the Owner/Owner's representative's guidance, the contractor shall any special protection that the Owner/Owner's representative is required to arrange.

Pump shall be capable of automatic start up from stand still condition with discharge valve fully open in general. Motor shall be selected according to the above requirement.

Difference in flows handled by the two pumps when operating in parallel shall not be more than 5% of the flow through any one pump.

The impeller shall be of non-overloading type, Overloading type of impellers are acceptable for BFPs and CEPs, however the motor shall be designed taking this into consideration and shall be suitable for run out flow.

A hardness difference of 50 BHN minimum shall be maintained between the impeller ring and wearing ring, inter-stage bushing and spacer sleeve and balancing and spacer sleeve and Balancing disc/piston and counter balancing disc.

Mechanical seal of shall be provided at both ends of the shaft of pump for DM water/ Feedwater/ Condensate.

The maximum temperature rise of bearings shall not exceed as per standard over ambient temperature.

All major rotating components shall be dynamically balanced. The assembled rotors shall be dynamically balanced.

The Contractor shall also demonstrate that the pump can operate at the quoted minimum continuous stable flow without exceeding the vibration limits as stipulated in HIS.

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Pump-motor set shall run smooth without undue noise and vibration .The limits of vibrations shall be applicable with maximum wearing clearances.

Acceptance of the forced lubrication system shall be subjected to the approval by the Owner/Owner's representative. Forced oil lubrication system provided for HP/LP BFPs shall be supplied with separate AC driven lube oil pumps, lube oil plant with interconnecting piping and controls. Acceptable peak to peak vibration limits shall generally be guided by HIS.

The drive motor rating shall be selected such that a minimum margin of 25% up to 18.5KW, 15% for 22-55KW, 10% for above 75 KW is available over the pump input power required at the rated duty point. However, motor rating shall not be less than the maximum power required by the pump at any point on the curve including the run-off condition.

7.13.3 Piping and Appurtenances

All the skid mounted equipment piping wherever specified shall be in fully assembled condition. Piping shall be duly supported on the base plate and terminated with ANSI flange at the edge of the base plate towards suction. Piping shall be properly tagged with metallic strips.

In mechanical seal cooler, cooling water shall be used on shell side. Tube shall be made of SS304.Shell shall be of carbon steel. Tubes used for cooling bearing housing shall be of SS 304.

Forced oil lubrication when used shall have all supply lines in stainless steel (from downstream of strainers) and return lines in carbon steel.

MPP supplied piping and Appurtenances shall be as per MPP standards.

The technical and design features of each is elaborated in a separate section.

7.13.4 Suction Strainer

Strainer shall be provided on suction line of each pump except for DM water application. Generally Basket type strainer is preferred .The clear area of strainer shall be five times the inlet cross sectional area of the connecting piping. Strainers shall be constructed of 16 gauge perforated stainless steel plates (304grade) and shall be lined with stainless steel (316 grade) screen.

The design pressure for strainers shall corresponding to maximum system pressure envisaged during the worst operating condition

The pressure drop across the strainers at rated flow under 100% cleaned condition and 50% clogged condition shall not exceed 0.1 kg/cm² (max.) and 0.15 kg/cm² (max.) respectively.

The strainer shall be so designed that they all capable of sustaining the differential pressure at rated design flow and 50% clogged condition.

Suction Strainers supplied by MPP shall be as per MPP Standard.

7.13.5 Welding

All welding / cutting / rework on IBR piping shall be strictly done as per IBR code.

All welding process shall be of standard and internationally agreed type and designation free from all unproven innovative or development features

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All costs for inspection and testing including any additional tests required by the Owner/Owner's representative shall be deemed to be included in the Contract Price. Any additional inspection and testing required by the Owner/Owner's representative shall be performed promptly and no claims for consequent delay or disruption of the work will be considered. All tests shall be conducted as per finally approved QAP. There is no additional test required other than mentioned in the QAP.

The procedure to be followed in production welding of all parts of the vessel including main seam, circumferential seams, and branches shall be provided in detail by the Contractor for the Owner's /Owner's representative's approval.

Welding, post weld heat treatment and other non-destructive testing shall be conducted by Contractor as required by the ASME and as instructed by the Owner/Owner's representative. Procedures of all welding, welder qualification and treatment of welding defects, pre/post welding heat treatment, NDT shall be performed after welding as per ASME and Testing requirement shall be approved by Owner/Owner's representative. Contractor shall arrange suitable stress relieving equipment with automatic recording device.

All necessary radiography as per applicable code shall be included in the scope of work of the Contractor.

Approval of the welding procedure shall not relieve the Contractor of his responsibility for correct welding, electrodes and for minimising distortion in the finished structure.

All welders and welding operators shall be qualified for the work and shall hold current welder's qualification certificates in accordance with the ASME Sec. IX and IBR.

For welding on site, the Contractor shall provide drying ovens in sufficient number to permit the correct storage of electrodes for 48 hours before use. Drying ovens shall preferably be heated by electric means and shall have automatic heat controls and visual temperature indication. The storage temperature for electrodes shall be as stated by the manufacturer but in the case of low hydrogen electrodes shall not be less than 100 °C. The re-baking of low hydrogen electrodes shall be strictly in accordance with the manufacturer's recommendations.

Welds of stainless or special steel with steel which is not stainless must be made in a manner which ensures that the stainless steel or special steels do not lose their corrosion-resistant or other special properties.

Welded seams shall not be painted before inspection; in case of necessity, only colourless coating may be used.

All controls, examinations and tests corresponding to these specifications, shall be performed by the supplier, without detriment to the Owner's/ Owner's representative's inspection right to verify and control them on their part or to repeat them if they deem it is necessary.

The supplier shall keep 'welding records' for all pressure pipes with a qualified welding method, as well as for condensers, deaerators, water pipes, pressure vessels and other important weldings. He shall record on them, after every working day, the number of weldings executed during the day, their location, identification of welders, measured preheating temperature (if any) and other information of interest.

The Inspector shall be notified at regular site meetings at least 2 days prior to the commencement of any assembly or fabrication work.

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All control protocols, such as of the qualifications of welders and methods, of evaluation of x-rays, of magnaflux examinations, as well as the x-ray films, shall be submitted to the Owner / Owner's representative's inspection for their approval at appropriate time.

Qualification of welders

The standard to be applied for the qualification of welders shall be approved by the Owner/Owner's representative. Welders shall be qualified according to the section IX of the before mentioned ASME standard. The inspector of the Owner's / Owner's representative's has the right to attend during the qualification tests. Tests with unsatisfactory results made by a welder under qualification may be repeated by him doubling the number of tests (This will be reviewed case by case during detailed engineering). For the welders acceptance each of the repetition tests has to be satisfactory. The supplier shall keep a 'registry of welders' on which he shall record systematically: qualifications, part of the supply on which they intervene, major faults and comments.

Qualification of methods

The variables to be considered in defining the weldings subjected to special qualification of method shall be agreed upon with the Owner/Owner's representative. Stipulations in Q-11, section IX, of the mentioned ASME standard, shall govern for this purposes.

Control of executed weldings

Unless otherwise agreed or unless other contractual stipulations exist, the section VIII, point UW 51 of the ASME standards, shall apply for 100 % x-ray controls, and the point UW 52 for x-ray sampling examinations, excepting from the last the indications about porosity which shall be agreed upon separately.

The Contractor shall have at the works site all necessary equipments and facilities to perform control, like portable x-ray equipments, radioactive isotope equipments, x-ray laboratory, magnaflux equipment, dye check penetrants and developers, fluorescent power and ultraviolet lamp to verify the watertightness of expanded tubes. The Contractor's personnel shall include a specialist and the auxiliary workers necessary to execute the controls.

7.13.6 Lubrication

Lubricated elements shall have a safety reserve against occasional lubricating deficiencies or their retaining capacity should be such as to operate without damage even if delays occur during maintenance periods. As far as possible, lubrication of the given element in the machine should be done with the same lubricant under all climatic conditions (winter and summer) and furthermore, a limited number of different types of lubricants should be required for the different parts of the equipment. Lubrication oil and grease of any brand shall be easily obtained on the local market in India. This requirement will be ascertained during detailed engineering and outcome of this will be informed to Owner/Owner's representative.

Where centralised lubrication system is provided then it shall include purification of the main lubricant by centrifugal or static filter.

Lubricant deposits such as those on bearings, accumulation tanks, should be easily accessible, simple to clean and to control their level and it should be possible to empty their contents.

The required lubricant characteristics shall be stated, also indicating the trade name for the products.

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7.13.7 Vessels, Tanks and heat exchanger

All pressure vessels shall be designed in accordance with ASME Boiler and Pressure Vessel, Section VIII Unfired Pressure Vessels. All butt welds shall be subject to radiography test as per ASME relevant code and all other welds shall be subject to 100% non destructive testing. Other standards the Contractor intends to use are to prior approval of the Owner/ Owner's representative. All flanged connections to pressure vessels shall conform to at least pressure class 150. Threaded connections shall conform to pressure class 300. MPP supplied vessels, tank and heat exchangers shall be as per MPP standards.

All connections shall match for pipe instrumentation, drains and relief valves. All bolt holes must straddle the centre line of nozzles. Access stairways and handrails necessary for safe operation and easy maintenance shall be provided. Corrosion allowance shall be considered for carbon steel material. However, in case of coating or rubber lining or SS material, corrosion allowance will not be applicable.

If any degree of vacuum may occur the pressure vessel or tank shall be designed for full vacuum even if vacuum breakers are installed.

The items listed below shall be provided as a minimum.

- One(1) manhole (minimum nominal bore 600 mm) for vessels of 1.0 meter diameter and above
- Two(2) handholes (minimum size 200 mm) for vessels below 1.0 meter diameter.
- Two(2) spare nozzles
- One(1) drain nozzle

Manhole covers shall be provided with davit arrangement.

The saddle and reinforcing plates welded to the vessel shall be of the same material as the vessel shell or head. Insulated vertical vessels and tanks shall be furnished with insulation supports or clips.

Tanks

Unless otherwise specified, tanks used for the storage, lubricating oil, make-up water, condensate, chemicals. and tanks used for mixing and agitation shall be of welded construction, manufactured from mild steel plates of accepted quality and thickness in accordance with the approved relevant standards.

All welds shall be continuous, including welds around internal stays, stiffeners and supports.

All large tanks shall have at least two manholes each of 600 mm inner diameter complete with covers of the bolted type, fitted with a davit for easy handling.

All tank nozzles shall be provided with flanges, if not otherwise specified.

Nozzles shall be provided where necessary for the fitting of instruments, and piping.

Internal and external protection coating/painting of the tanks shall be performed according to the requirements of this Contract.

Arrangements shall be made for the blanking-off or removal of all valves or pipe connections during shot-blasting and painting to prevent the ingress of blasting material or other matter.

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The protective process shall be applied also to any ferrous or non-ferrous parts mounted inside the tanks.

Heat exchanger

Heat exchangers are to be designed, manufactured and erected in accordance with the applicable standards.

Only proven products shall be delivered. No cast iron components are permitted.

It must be possible to install and remove the heat exchangers without undue difficulty. Lifting lugs and eyes and other special tackle shall be provided to permit easy handling.

Only Tubular heat exchangers are acceptable. Where necessary the tubes are to be protected by impact shields. An adequate number of visual inspection ports is to be provided in critical areas to facilitate condition monitoring.

Unless otherwise specified, all heat exchanger tubes and casings must be designed to withstand 1.2 times the zero flow pressure of the relevant pump at cold conditions, or 1.2 times of the maximum positive operating pressure, as applicable. The minimum design pressure is 6 bar, and the design shall be proof against full vacuum. The test pressure must be 1.5 times the design pressure.

The heat exchangers shall be designed for the maximum temperature incurred plus 20 K except for MPP Supplied Heat exchangers. For MPP supplied heat exchangers the design temperature shall be as per MPP standard design philosophy.

Heat exchangers must be capable of continuous unrestricted operation with up to 10% of plugged tubes, and a corresponding factor of conservatism of at least this amount must be used in the design of the heat transfer areas. However, plug margin for Condenser shall be as per Detailed Technical Specification (DTS).

Considerable importance will be attached to the ease of cleaning the heat exchangers.

Where any heat exchanger part in contact with liquid can be isolated, and there is a possibility of being heated from the other side, safety valves are to be provided for pressure relief.

Pipes from drains, vents and safety valves are to be grouped together, and routed to easily observable points equipped with covered funnels or to the flash tanks.

The overall design and conception of the heat exchangers and accessories is to be such that they are suitable for the degree of automation envisaged for the individual system.

7.13.8 Cranes and Hoists

Cranes and hoists are to be designed in accordance with the applicable Indian and International Standards.

The crane installations must be supplied with all the ropes, chains, shackles. needed for operation.

The minimum scope of supply per hoist for each lifting tackle includes the following items:

- four (4) single ropes each with 2 eyes at the ends, each rope 1 m long
- four (4) single ropes each with 2 eyes at the ends, each rope 2 m long

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- two (2) single ropes each with 2 eyes at the ends, each rope 4 m long
- two (2) endless ropes, extended length 4 m each
- eight (8) shackles.
- 2 Sets of soft/synthetic slings of suitable capacity for handling generator rotor of GTG and STG.

The load-bearing capacity of the ropes and shackles must be suitable for the relevant hoist.

The maximum tension in the rope must not exceed 1/8 of the calculated breaking capacity of the rope. The ropes must be of the stranded type, and galvanized wires must be used.

The eyes of the single ropes must be secured with compression fittings. The length of the eyes must be at least 15 times the nominal diameter of the rope.

In special cases, where safe lifting of the relevant component is not certain, specially-made devices must be provided. At least two (2) of these must be provided in each individual case.

For each installation a list must be submitted, showing the number, type, nominal load-carrying capacity and strength characteristics of the materials used. In addition, factory and acceptance certificates must be submitted for all ropes and materials.

The safe lifting capacity of lifts is to be clearly marked stating both the maximum load in kg and the number of persons the lift was designed for. For this purpose the weight of a standard person shall be taken to be 75 kg.

For Design data for lifting devices for MPP supplied equipment shall be as per MPP standard, refer the detailed technical specification.

7.13.9 Elevator

One (1) no. elevator with a carrying capacity of ten (10) passengers shall be provided for the Switchgear / control building.

7.14.0 General Electrical Requirements

All equipment supplied and all work done including system design and detailed engineering shall also comply with the statutory requirements of the State/Central government and with the Indian Electricity Rules.

Unless otherwise specified, at least 10 % margin shall be considered in equipment sizing over and above the calculated load current/fault current/power requirements.

If not specified otherwise the electrical operational equipment must be designed to meet protection classes stated below.

• HT Switchgear (Indoor)	-	IP 4X
• LT Switchgear (Indoor)	-	IP 52
• Control panels (Indoor)	-	IP 42
• Relay panel	-	IP 42
• Motors (indoor)	-	IP 54
• Motors and other equipment located outdoor	-	IP 55
• Emergency DG (Indoor)	-	IP 23

Each individual enclosure accommodating electrical equipment which is liable to suffer from internal condensation due to atmospheric or load variations shall be fitted with heating

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devices suitable for electrical operation at AC single phase. Heaters in switchgear / control cubicles, panels, desks shall be controlled automatically by thermostats.

Motors rated 0.2 kW and below, except otherwise required for reversible service, shall be rated for use on a 240 V, single phase, 50 Hz, solidly grounded system. Motors rated above 0.2 kW and up to 160 kW shall be rated for use on 415V, 3 phase, 50 Hz, solidly grounded system. Motors above 160 kW shall be rated for use on a 11 kV, 3 phase, 50 Hz resistance grounded system. All Motors shall be designed for direct on line starting at full voltage.

Electrical motor operated actuators shall have non- integral starters.

Guards shall be provided for protection of personnel from all exposed moving and/or rotating machine elements. Necessary supports and accessories shall be furnished with each guard to prevent vibration. Guards for outdoor installation shall be galvanized steel. Grease fittings shall be extended through the safety guards.

For all other requirements of electrical system, the respective electrical sectionals shall be referred.

7.15.0 General Control and Instrumentation (C&I) Requirements

The Instrumentation and control systems shall be provided for safe, reliable and efficient operation of the combined cycle power plant. In general a consistent control and instrumentation philosophy is to be applied throughout the power plant. Standardization concepts shall be applied wherever possible to rationalize operation, maintenance and reduce spare parts. Adequate redundancy are to be ensured, so that no single point failure of the I&C systems/ equipments in the power plant results in the overall reduction of the plant output.

For the turbine control package standard control/protection system shall provide no single failure of field sensor cause Unit to trip. Redundant sensors shall be provided for control / protection functions with the exception of functions used only during start-up and where redundancy cannot be provided due to limitation in installation space. Also final control elements (trip solenoids and fuel valves) themselves and related accessories shall not meet this requirement.

In general all I&C systems/ equipments should be of modern and compact design, incorporating proven technology and modern industrial practice.

7.16.0 General Civil Requirements

The design specification covered in Section 5 of Vol-III establish the minimum basic requirements for all Civil structural and Architectural works. However all structures shall be designed for the satisfactory performance of the function for which the same are to be constructed.

With regard to soil and other hydrographic data furnished, it shall be clearly understood that the same are given to the Contractor in good faith and as such no claim for extra payment shall be entertained by the Owner/Owner's representative, if the actual condition met with during execution are at variance with the data given in Contract. The Contractor shall fully satisfy himself about the site conditions, nature of soil, ground water, contour levels etc, prior to the submission of the bid. The contractor shall conduct his own investigations to ascertain the correctness of the data furnished and based on the actual data the Contractor shall finalise the most suitable civil and structural design basis, which will be submitted to Owner/Owner's representative for review & approval.

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8.0.0 QUALITY ASSURANCE, SHOP INSPECTION AND TESTING

8.1.0 General

This section contains general requirements for inspection of material, parts, equipment and workmanship of the plant during manufacture, assembling to demonstrate compliance with specification, codes and standards to ensure overall reliability of plant operation and performance.

The Owner/Owner's representative and/or authorised Representatives shall, at any time, be allowed free and ready access to the Contractor's premises and those of his suppliers as well as to the site installation and the Contractor has to make the plant items available for the purpose of inspecting the specified equipment components and obtaining information as to the progress of the work. Failure on the part of the Owner/Owner's representative, at this or any other time, to discover or reject materials or work which do not meet specified requirements shall not be deemed an acceptance thereof nor a waiver of defects therein.

The approval of the Owner/Owner's representative shall not prejudice the right to reject equipment if it does not give complete satisfaction in service.

8.2.0 Scope

All materials, components and equipments covered under this specification shall be tested at all stages of procurement, manufacturing, erection, commissioning as per a comprehensive quality assurance programme. The requirements of minimum quality plans to be followed by the Bidder in respect of various equipment are specified in detailed technical specification. The Bidder shall draw his own quality plans in line with these requirements and his standard practices and implement such programme after approval by the Owner/Owner's representative. The Owner/Owner's representative shall appoint a Third party inspection (TPI) agency for bought out items/outside inspection. The Owner/Owner's representative will carry out on-site supervision and inspection.

Manufacturing quality plan shall detail out, for all the components and equipments, various tests/inspection 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 document and standards, acceptance norms and inspection documents raised. during all stages of material procurement, manufacture, assembly and final testing/performance testing.

The Contractor has primary responsibility for ensuring the quality of items of equipment supplied under the contract and remains accountable when manufacture or erection is subcontracted. It is therefore a requirement of the specification that work is only subcontracted to companies with effective quality control organization and that the Contractor monitors the performance of these by the attendance at tests of experienced inspectors employed by the Contractor. The Contractor shall, at the appropriate time, prove that his

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material and / or equipment comply with all the requirements of this Section, such proof being the successful completion of tests and inspections. Routine test and type test certificates shall be submitted for each item of equipment, wherever applicable.

All materials, components and equipment supplied under the contract shall be subject to inspection by the Owner/Owner's representative, his representative, Inspectors of Boilers (India) or his authorized Agency or any other Inspector of the Government, should they so require during manufacture, erection and after completion. The necessary inspection charges of the authorized agency of Inspection of Boilers (India) shall be borne by the contractor. The inspection and tests shall include but shall not be limited to the requirements of this section of the specification. Further requirements to be applied are specified in the detailed specification.

The Bidder along with quality plan, shall also furnish copies of the reference documents/plant standards/acceptance norms/test and inspection procedure referred by him in quality plans. These quality plans and reference documents/standards will be subject to Owner/ Owner's representative's approval and will form a part of the contract. In these approved quality plans, Owner/Owner's representative shall identify customer hold points (CHP), indicating tests/checks which shall be carried out in presence of the Owner/Owner's representative's or authorized representative and beyond which work will not proceed without consent of Owner/Owner's representative's in writing.

No materials/equipment shall be dispatched from the manufacturer's works before the same is either accepted subsequent to pre-dispatch final inspection including verification of records of all previous tests/inspections by Owner/Owner's representative or such pre-dispatch final inspection is waived by the Owner/Owner's representative and dispatch is authorized after review of test reports.

All materials used or supplied shall be accompanied by valid and approved material certificates and test and inspection reports duly approved by the Owner/Owner's representative. These certificates and reports shall indicate the acceptable identification number of the material they proposed to certify. The material certified shall also have the identification details stamped on it.

All material used for equipment construction including castings and forgings shall be of tested quality as per relevant codes/standards. Details of results of the test conducted to determine the mechanical properties, chemical analysis and details of heat treatment procedures recommended and actually followed shall be recorded on certificates and time temperature chart. Tests shall be carried out as per applicable material standards and/or as specified in detailed specification.

All welding shall be carried out as per welding procedure drawn and qualified in accordance with requirements of ASME Section IX. Welding procedures shall be submitted to the Owner/Owner's representative for approval prior to carrying out qualification test in the presence of I/Owner/Owner's representative

All welders/welding operators employed on any part of the contract either in the Supplier's works or at site or elsewhere shall be qualified as per ASME Section-IX.

Test results of qualification tests and specimen testing shall be furnished to the Owner /Owner's representative for approval. However, wherever required by the Owner/ Owner's representative, tests shall be conducted in presence of Owner/Owner's representative

All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.

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All the sub-vendors proposed by the Bidder for procurement of major bought out items including castings, forgings, pumps, heat exchangers, semi finished and finished components/equipment-(list of which shall be drawn up by the Bidder along with his offer and finalized with the Owner/Owner's representative) shall be subject to Owner/ Owner's representative's approval.

The type and extent of inspection of items shall be in accordance with the relevant International/Indian Standards/Indian Boiler Regulations and other standards approved by the Owner/Owner's representative, supplemented or amended by the requirements of this section of the specification or as specified elsewhere in the Specification.

8.3.0 Inspection Program and Test Notifications

Before manufacturing commences and not later than 45 days after award of contract, the Contractor shall submit an outline of his proposed inspection program, which shall include all major stages during manufacturing. The inspection and test program shall include for the various items the designation No., name of equipment, part of equipment, the kind of test, test standard, company which carries out the test, place, date and witnesses by the Contractor, third party or Owner/Owner's representative's .

The Owner/Owner's representative will return a copy of the Contractor's proposed inspection program indicating those inspection stages for which notification is required. Notification shall be by Fax or email in a format to be agreed and shall be sent at least 20 days prior to the intended test in accordance with 'Conditions of Contract'. If the Owner/Owner's representative intends to be represented at the test he will provide at least 24 hours' notice and if his representative does not attend on the notified date, the test may proceed unless an alternative date has been requested by the Owner/Owner's representative.

8.4.0 Test Certificate Documentation

The results of all tests shall be certified by the manufacturer, Contractor or independent agency as appropriate.

Document files containing material certificates, welding procedures, test report shall be compiled for each item of plant and shall be suitably identified (including equipment classification reference) and bound.

Three copies of each document file containing inspection reports and certificates of site erection testing activities of a particular item of plant or system shall be supplied to the Owner/Owner's representative prior to commissioning.

Copies of the performance and acceptance test reports shall be prepared and distributed as specified in Clause 'Performance and acceptance test data and reports' of this Section. All documentation as required by IBR shall also be prepared and submitted.

8.5.0 Certification of Equipment by Owner/Owner's representative's

The Personal and travelling costs in connection with the Owner/Owner's representative's inspection and witnessing of tests of equipment, components and material manufactured in India and abroad will be borne by the Owner/Owner's representative.

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8.6.0 Codes and Standards

8.6.1 General

The type and extent of inspection shall generally be in accordance with that specified in the standard used for design and construction of the item of equipment supplemented or amended by the requirements of this section of the specification. The Contractor should provide the relevant codes and standard to the Owner/Owner's representative.

8.6.2 Reference to Codes and Standards

Reference to special codes and standards, where designated either directly or as "relevant", is intended to provide a measure of performance, safety, in-shop and on-site testing, and methods of construction and/or installation which must be equalled or exceeded in order to be considered acceptable for use under this specification. If more than a single degree of quality or accuracy is permitted within the scope of particular code or standard, the highest quality shall be applicable and the degree of accuracy commensurate with the intended function shall be selected, but with the understanding that the final decision will be made by the Owner/Owner's representative.

In all instances, the finally accepted applicable code or standard shall be the version last published.

8.6.3 Alternative Standards

Where no appropriate standard is available, tests shall be conducted in accordance with the manufacturer's standard practice, subject to the approval of the Owner/Owner's representative.

In such cases the Contractor shall submit to the Owner/Owner's representative, complete data and a suggested procedure for the testing to be performed. Commencement of manufacture before receipt of the Owner/Owner's representative's approval shall be at the Contractor's risk.

If the proposed procedures are accepted, the Contractor shall provide the Owner/Owner's representative with four additional copies in English before any test is performed.

8.6.4 Derating Standards

The Contractor's attention is drawn to the climatic conditions in the site area. Derating factors shall apply in accordance with the relevant and approved standards if not specified in the contract documents.

8.7.0 Services prior to and During Inspection and Testing

In accordance with and in addition to specified standards the Contractor shall submit procedures for material testing, manufacture, quality control and performance testing as they apply from the procurement phase of raw materials to the finished product. Manufacture commenced before receipt of the Owner/Owner's representative's approval of material specifications and testing procedures shall be at the Contractor's risk.

No inspection shall be valid unless the Contractor and manufacturer are in possession of relevant approved drawings and procedures for the item to be tested. The Contractor on

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request shall supply the Owner/Owner's representative's with a copy of drawings and procedures at the time of the test.

All instruments and apparatus required for the inspection or used for the performance of tests shall be subject to the approval of the Owner/Owner's representative at his discretion and shall be calibrated to an agreed standard in approved laboratories. The cost of making such calibrations shall be borne by the Contractor in all cases.

If the Contractor wishes to apply for a concession in respect of a departure from an approved procedure or standard, this shall be made in writing with full information substantiating the technical acceptability of the proposed change. The Owner/Owner's representative's decision shall be final. Concessions granted shall not absolve the Contractor from any of his responsibilities under the Contract.

8.8.0 Testing During Manufacturing

The minimum testing requirements for mechanical, electrical and C&I equipment testing to be conducted at manufacturer's works are specified in the detailed specifications.

9.0.0 EQUIPMENT ERECTION, SITE TESTING, COMMISSIONING AND PERFORMANCE TEST

This Specification generally covers the standards, scope of works, documentation, scope of installation, testing and commissioning of various mechanical, electrical, control and instrumentation equipment & system and various requirements to be adhered to during the execution of the works.

Works shall be performed in accordance with this technical specification and various other drawings and schedules submitted and approved by the Owner/Owner's representative during the execution and the instructions from Engineer-in-charge or his authorized representatives during the progress of the work. Consumables required for the job shall be ensured by the Contractor. All necessary equipments and instruments required to carry out the works, recalibration of the instruments required during loop checking and commissioning shall be done by the contractor.

Field quality plans shall be submitted and shall detail out for all the equipments, the quality practices and procedure to be followed by the Contractor's site quality control organization during various stages of site activities including receipt of materials/equipments at site, preservation and storage, pre-assembly, erection, pre-commissioning and commissioning. The Contractor shall provide all necessary means for execution of inspection and testing, according to the requirements.

9.1.0 Erection

9.1.1 General

Erection work shall be carried out in the manner and sequence as may be directed by Contractors supervisory Engineers and the Owner/Owner's representative.

All existing structures, piping, conduits, equipment and facilities shall be protected by the Contractor against damage/degrade during erection. Any damage/degradation caused by Contractor shall be rectified at his cost to the satisfaction of the Owner/Owner's representative within short timelines.

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As erection proceeds each assembled part before being boxed up with a view to erecting it finally, shall be inspected and approved by the concerned supervisor. Should any defect be found out during such inspection, the Contractor shall make it good as per directives from Owner/Owner's representative.

All materials such as electrodes, gaskets, bolts, nuts shall be of reputed make and conforming to relevant Indian Standards. Prior approval of Owner/Owner's representative will have to be obtained before commencement of work. Manufacturer's test certificate shall have to be provided when called for.

Contractor shall furnish all instruments, isotopes, films for conducting radiography and equip himself fully. Necessary operators of all testing equipment shall be provided by the Contractor. Dark room facilities with air conditioners for storing and processing radiography films and equipment, as necessary, shall have to be arranged by the Contractor. The radiography shall be done on any weld (including welds for repair) only after final heat treatment.

The equipment shall be placed on respective support, levelled and aligned with precision measuring instruments, checked for proper clearance between moving and stationary parts wherever applicable.

The installation of motors shall be carried out along with driven equipment in accordance with manufacturer's instructions and/or as directed by the Owner/Owner's representative.

Wherever the scope includes control panels, all connections in control panels shall be completed, checked and adjusted to ensure safety and satisfactory operation of the equipment.

Particular attention shall be given towards removal of buckles and other forms of distortion.

Holes in plate work to assist in erection should be avoided.

Misalignment in vertical joints shall not exceed 10% of plate thickness or 1.0 mm, whichever is larger.

Misalignment in horizontal joints shall not exceed 15% of upper plate thickness with a maximum of 2 mm for plate thickness above 8 mm and a maximum of 1.0 mm for plate thickness less than 8 mm.

Welding sequence shall be adopted in such a way so as to minimise distortion due to weld shrinkage and shall be got approved from the Owner/Owner's representative prior to commencement of work.

Welding shall not be carried out on wet surfaces and shall be protected from high winds.

9.1.2 Erection Program and notification

The Contractor shall furnish a detailed erection programme taking into consideration the constraints likely to be encountered during various phases of work including interfacing with the existing plant. This erection programme shall be strictly adhered. The Contractor shall take appropriate steps as directed by the Owner/Owner's representative to make up for any slippage from this erection programme and no additional compensation shall be allowed on this account.

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Before erection commences and not later than three months before start of erection, the Contractor shall submit the proposed erection test program and the commissioning test program with all proposed erection and commissioning tests and checks. Together with the test programs the proposed test procedures have to be submitted.

The test programs should consider:

- that the sequence and duration of the proposed activities are logical, realistic and in accordance with safety and permit regulations in force
- that the commissioning of any item of plant would not interrupt the normal operation of the existing plant.
- that allowance for training the Owner/Owner's representative's operation personnel during this period has been made.

The Contractor has to take care that the test programs are maintained by the erection organization during erection and commissioning.

The Contractor has to mark all stages, which are subject to the Owner/Owner's representative's acceptance and has to notify at least two week's in advance when such inspection for acceptance becomes due.

9.1.3 Supervision during Erection

The Contractor shall provide at proper time the necessary supervisory Engineers, Supervisors and other supervisory personnel duly qualified and in sufficient number for transportation, handling, unloading, storage, erection, pre-commissioning and post commissioning, startup, testing and test operation of plants and equipment.

The Contractor shall keep a competent representative who will be resident Engineer-in-charge and shall remain as In-charge of Contractor's work site and also remain answerable to the Owner/Owner's representative for all activities of the Contractor at site. Before his placement at site, the Contractor shall submit his bio-data to the Owner/Owner's representative for his approval.

The Resident Engineer-in-charge shall supervise the work of all men of the Contractor working at site. He shall work in complete harmony and co-operation with Owner/Owner's representative. All statutory rules and labour laws prevailing in the area must be observed by the Contractor. All safety measures against occurrence of accidents must be taken effectively. Resident Engineer-in-charge shall not be withdrawn without written permission of the Owner/Owner's representative. If any of the Contractor's personnel was found unsuitable for the job, the Contractor shall remove him forthwith and a suitable replacement shall be posted to site within a reasonable time. No compensation for withdrawing of unsuitable or unqualified person(s) from site or for posting suitable person(s) to site at any stage of the project shall be allowed by the Owner/Owner's representative.

9.1.4 Sequence of Erection Work

All packing cases and packages shall be opened in presence of the Owner/Owner's representative or his authorised representative.

Nails and packing strips should be pulled out with suitable appliances and kept separately in container and not thrown away at random. All timber of packing cases shall have to be sorted out and stored properly at a suitable place as directed by the Owner/Owner's representative.

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From time to time packing materials, timber, nails and strips shall be delivered back to the Owner/Owner's representative or otherwise disposed of as directed by the Owner/Owner's representative. All timber and packing materials shall remain the property of the Owner/Owner's representative.

Each material after stripping from boxes or received loose, shall be carefully inspected, checked with shipping list and identified with erection drawing if necessary. Any short supply and/or damaged part shall be reported forthwith to the Owner/Owner's representative in writing. The Contractor shall be completely responsible to make all necessary arrangements, application and follow procedure to process claim on underwriters, obtain replacement repair/rectify and modify as required on all such damaged/defective/lost equipment and material at no extra cost to the Owner/Owner's representative in order to execute the work to satisfaction of the Owner/Owner's representative within the stipulated contract time. Once the materials are inspected, the same shall be preserved properly and adequately protected from theft and deterioration or damage by rain, storm, dust, water, tampering by casual visitors or workers. The Contractor shall prepare and maintain stores, ledgers and bin cards for all materials in his custody.

Carrying out all repairs to damages/degradation that might have occurred during transit and in subsequent storage. Also modifications and rectification work as necessary and replacement of all lost parts, are under the Contractor's scope.

9.1.5 Safety Regulations

Contractor should follow all the safety regulations / norms as imposed by the Law/Authority/factory inspectorate /Owner/Owner's representative. When going to or from place of work in the plant only the prescribed walkways, paths or cross-overs shall be used and required protections, barricades shall be established for the plant area.

Crawling on, over or under movable equipment shall generally be prohibited.

For overhead work, proper signs shall be placed below and, when conditions justify, a watchman shall be stationed to warn employees in the vicinity.

Work on or about crane runways shall not be undertaken without the Owner/Owner's representative's permission. Whenever it is necessary to do any work on or above the crane runways, the Contractor shall furnish a flag man stationed on the floor.

Only scaffolds which meet the requirements of governing laws shall be used in the project.

Work in area of electric wires and cables shall generally be avoided.

All burning and welding equipment shall conform to, and be used in accordance with, regulations governing such equipment. No burning or welding shall be done at any place on the site until location where such work is to be done is approved.

Adequate fire protection shall be available before work preceding the work.

All warning signs shall be observed.

Contractor shall require his employees to wear hard hats at all times when they are inside the plant area.

Goggles shall be worn whenever there is a possibility of flying particles or splashing of corrosive fluid.

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While working at site all workmen shall wear necessary safety protective equipment.

When ladders are the means of access to a platform, they shall be firmly secured top and bottom and the ladder rails shall extend at least one meter above the top landing. When a ladder cannot be secured, a man shall be stationed at the base.

Safety belts shall be used by men working in high places when no hand rails or other guards are in place.

All accidents resulting in injury shall be reported to the Owner/Owner's representative promptly. Owner/Owner's representative's safety rules, regulations and directives shall be followed and reports thereon shall be submitted as and when required.

9.1.6 Proper Treatment of Injured

Contractor shall ensure that proper treatment of injuries is immediately available either as such or in the form of constantly available transportation to a source of such treatment.

Contractor shall ensure that stretchers are available near all areas in which their men are working and that the location of stretchers are well marked.

Contractor shall be solely responsible for the dissemination of all safety regulations including those written here, those promulgated by Owner/Owner's representative and those dictated by good practice, and shall ensure that all his employees and those of his Sub-Contractors are conversant with same

9.2.0 Inspection

After completion of erection and/or installations and before start-up the equipment and all its appurtenances shall be thoroughly cleaned and then, inspected in the presence of the Owner/Owner's representative for correctness, soundness and completeness of installation and acceptability for start-up.

All works to be carried out by the Contractor shall be subject to inspection by the / Owner/Owner's representative as applicable. The work shall be carried out as per applicable specifications, codes of practice, drawings and instructions of Owner/Owner's representative . The Contractor shall provide necessary facilities, instruments and personnel for carrying out the inspection as above and shall comply with the instructions given.

A check list in triplicate will be furnished for the approval of Owner/Owner's representative wherein all items to be checked and necessary instructions will be listed. Inspection and checking shall strictly follow this check list. On completion of the joint inspection and checking two (2) copies of the check list will have to be handed over to the Owner/Owner's representative. The check lists after checking will have to be jointly signed by the Contractor's supervisor and the Owner/Owner's representative to ensure that all inspection and checking have been properly carried out. However, such endorsement shall not relieve the Contractor from the responsibility in ensuring proper erection and cleaning.

During inspection all clearance, alignment and important measurements and adjustments as may be directed shall be noted by the Contractor for future reference and guidance. Two (2) copies of such notes shall be delivered to the Owner/Owner's representative.

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All reports of radiographic examination in a format approved by the Owner/Owner's representative shall be submitted to the Owner/Owner's representative for his approval and records.

9.2.1 Cleaning

The Contractor shall observe strict cleanliness during execution of the work and shall be in possession of vacuum cleaner for cleaning the internals of machinery under installation. They shall check that all the finished surfaces are greased and covered.

Before boxing up, the Contractor shall examine carefully to ensure that no foreign material, such as welding rod ends, welding beads, metal chips, rope, working tools has been left inside any equipment.

In the case of motors, the following procedure shall be observed

- Checking and cleaning of bearings and charging / filling of lubricants, wherever necessary.
- Cleaning of core and winding, drying out and cornicing the winding and measurement of air gap for motor assembled at site.

Wherever the scope includes control panels, all withdrawable components shall be taken out and internals shall be cleaned with vacuum cleaner, if required.

9.3.0 Testing and Commissioning

9.3.1 Erection Test

Following the satisfactory completion of inspection, checking and cleaning of a unit, the plant will be placed in test run. During this period, all adjustments and repairs as required shall be made by the Contractor. Protocol shall be made and signature has to be obtained from Owner/Owner's representative. On completion of satisfactory test run, the plant will be placed under trial operation.

Prior to trial operation of any equipment the following shall be checked:

During erection all required erection tests as well as final erection checks of the mechanical completion of the systems and part thereof have to be performed.

After successful mechanical completion Mechanical Completion Certificates will be issued.

The activities necessary for mechanical completion shall include but not be limited to following testing:

- Visual inspection after unloading at site
- Checking of completion of relevant systems
- Proper installation of the drive and equipment on the foundation
- Proper alignment of drive and the driven equipment
- Proper connection of supports, hangers, piping, valves, instruments and other fittings.
- Freeness of the rotors of drive and equipment
- Healthiness of lube oil system, changing and filling as necessary.
- Safety audit
- Testing of site welds (non-destructive examinations)

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- Pressure/leak/tightness test
- Pipe line and equipment flushing and cleaning
- Chemical protection of piping systems
- Checking of coating
- Testing of cranes and hoists
- Safety signs and warning signs
- Completion of buildings and civil works
- Test of ventilating and air-conditioning units

Electrical/instrumentation equipment tests

The following checks and tests measurements shall be made:

- Screwed connections for correct assembly
- Terminals and terminal connections for correct assembly
- Checking of earthing connections and testing of earthing resistances
- Measurement of insulation values
- Verification of neutralization conditions
- Fire-proof partitioning
- Marking, inscription, provision of designation plates
- Voltage checks
- Polarity checks in the case of DC voltages
- Fuses, over current trips, short-circuit trips, time settings, relay settings
- Transformer oil levels
- Setting indicators, revertive (check-back) signals to the central control room.
- Checks on wiring and cabling for conformity with the constructional circuit-drawings and plans
- checking and functionality testing of electrical systems according to IEC standards
- checking and testing of instruments

9.3.2 Pre-Commissioning Testing

After alignment of all equipment, alignment tests shall be carried out by the Contractor to check levelling, clearance, eccentricity. Measurements will be witnessed and acceptance will be certified by the Owner/Owner's representative.

Hydro-test / eddy current test, as applicable will be carried out on equipment as identified in the QAP to be finalized during detailed engineering. . All necessary blanking arrangements for hydro testing shall be furnished by the Contractor. All necessary test pump/temporary piping shall be supplied by the Contractor.

Preconditions for the commissioning are the issue of the Mechanical Completion Certificate and the availability of the accepted commissioning program and the Contractor's commissioning procedures. The Pre-commissioning Checks cover the functional tests of the individual items and their alarm and tripping systems. Following tests shall be included:

Mechanical equipment

- Individual pre-commissioning runs of all rotating equipment such as pumps, compressors, dosing equipment.
- functional tests of the mechanical equipment
- Testing and adjustment of safety devices.

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Chemical Cleaning of Piping Systems and Equipment

Necessary procedure for chemical cleaning of piping and equipment shall be submitted to Owner/Owner's representative for their approval along with pre-commissioning document during detail engineering stage.

Before introducing chemicals, all the piping systems and equipment shall be water flushed. Water flushing will be followed by alkaline cleaning, acid cleaning and passivation or by EDTA (Ethylene Diamene Tetra Acid) and passivation.

However, the Contractor shall submit along with the offer his usual procedures and practices for chemical cleaning of the piping and equipment specified. The Contractor shall submit all schematics, write up, details of chemicals to be used. and detailed procedures he intends to follow. These schematics and procedures shall be subject to the approval of the Owner/Owner's representative.

Pre- cleaning procedure:

Prior to starting any phase of cleaning operation the following procedures shall be ensured:

Installation of all temporary piping, valves, pumps and equipments as required for the flushing and chemical cleaning operations. Temporary piping shall be routed at floor level as far as possible and secured in place to prevent movement/ vibration beyond acceptable limits.

Installation of the instruments as required to ensure satisfactory monitoring and control of the cleaning process. The Contractor shall also determine and arrange locations for sampling of the cleaning solution during cleaning.

By passing all regulation/control valves coming in the cleaning circuit or installation of temporary spool pieces.

Installation of special end covers and temporary suction strainers, for boiler feed pumps and condensate pumps. Pump internals shall not be installed.

Installation of plastic seal in the condenser neck to protect the turbine from alkaline fumes.

Blocking and securing of all spring hangers in the steam lines which may be flooded during the cleaning operation.

Hand cleaning of the interiors of all vessels which are included in the cleaning operation.

General cleaning procedures:

- Seal water lines to pump shall be flushed by the permanent arrangement provided for the same.
- Where pipeline terminate in spray headers, these headers shall be inspected after each phase of the cleaning operation and cleaned if necessary.
- All strainers shall be observed closely during the cleaning operation by reading differential pressure gauges, and shall be cleaned when the differential pressure exceeds a predetermined value.
- All high points, vents shall be opened periodically to ensure full system flow.

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- e) Upon completion of each stage of cleaning, the waste products shall be drained and transferred to the waste treatment basins. The Contractor shall then supply and add the necessary chemicals to the basin to neutralise all waste solutions and rinses generated by the cleaning process, and arrange for its disposal to an area to be indicated by the Owner/Owner's representative.
- f) Strict safety precautions shall be exercised at all times during the chemical cleaning and during storage and handling of the chemicals. The Contractor shall ensure provision of all protective clothing, apparatus and equipment along with necessary first aid kits as required for handling the chemical and for carrying out the cleaning operation.
- g) All Hazardous waste material generated during construction, erection and commissioning shall be disposed by Contractor using authorised waste disposal agency.

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Electrical equipment

As far as not already covered by the erection tests the pre-commissioning tests shall cover:

- High voltage tests
- trip tests
- Equipment Functional Test

Tests on Motors as per IS

- Insulation test of winding by megger, drying out and, if necessary, high potential test.
- Winding resistance measurement on all 3 phases for motors of bigger size.
- Testing the motor for proper direction of rotation and reconnection, if necessary.
- No load test run of the motor for a minimum of eight (8) hours to check out bearing or other associated parts.
- During test run, hourly record of currents on all the three phases shall be maintained and careful watch shall be maintained on the equipment for any abnormal sound, temperature of bearing, vibrations.
- After no load test run of the motor each rotary equipment shall be coupled and shall be subjected to a test run. The duration of this test run shall be mutually agreed.
- The objective of the test run shall be to ascertain that the following are within the permissible limits and the operation is satisfactory.
 - Vibration and noise level
 - Bearing vibration and temperature
 - Performance of the lube oil systems

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- Motor winding temperature
- Performance of various control, interlocks and protective elements, wherever applicable.
- Performance of annunciation system and indication, wherever applicable.

Tests on earthing and lightning protection system

Acceptance tests and measurements of the earthing installations in accordance with IEC or IS standards.

Tests on lighting system

Proof of the minimum new value of lighting densities, checking of correct operation both electrically and mechanically.

Contractor shall provide the list of site tests to be performed on electrical equipment as part of pre-commissioning activities for Owner/Owner's representative's review.

Control Equipment

- Calibration tests of all analog measuring loops including all remote indications and recorders and the input signals used for closed loop control.
- Testing of all plant mounted transmitters.
- Wiring test of all control cabling in the field, control rooms combined with the function tests.
- Testing of all control modules in the control room

Functional testing of remote control of drives, circuit breakers, solenoid valves, actuators etc.

- Testing of open loop devices especially all sequence logic equipment using simulated inputs.

Testing of all interlocks to ensure safe operation.

- Testing of the alarm annunciation and event recorder system in connection with all field and control room devices using simulated inputs.
- Testing of all closed loop controls.
- Testing of insulation between cable screen and ground.

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9.3.3 Commissioning

Preconditions of the commissioning are the successful completion of the pre-commissioning checks of all items of the whole system.

Commissioning tests shall be performed in accordance with the procedure contained in the commissioning program approved by the Owner/Owner's representative for individual equipment/system and as a plant. Commissioning test shall also include Redundancy and automatic fall back by simulation of fault conditions

On completion of each commissioning activity to the satisfaction of the Owner/Owner's representative, the commissioning schedule shall be signed and dated by the Contractor and countersigned by the Owner/Owner's representative.

Commissioning test shall prove that the plant is prepared and adjusted to ensure the correct functioning of the individual components and of the complete plant.

After successful completion of the commissioning tests "Authorization to Performance Test " shall be signed.

The Commissioning test shall cover at least following tests:

- Protection tests
- operation of protection devices including the following as a minimum
 - fire protection
 - HRSG protection
 - Gas turbine protection
 - steam turbine protection
 - generator protection
 - transformer protection
 - 66kV GIS protection
 - Balance of plant protection
- Method of alarm/trip condition reset for subsequent starting Isolation procedures method of isolation of plant equipment for safe shut-down and maintenance procedures including as a minimum
 - HV station and unit supplies
 - LV supplies
- Protection systems/settings, in accordance with agreed design and the requirements of the transmission system
- Start-up tests
 - Normal automatic start to preset load
 - Staged automatic including start to synchronous speed, manual synchronizing (including synchro-check), automatic synchronizing, manual and automatic loading
 - Starting with stand-by auxiliaries
 - Operation of all auxiliaries
 - Verification of start-up times and loading rates of power units and steam generators at various conditions
 - Power unit(s), test partial and full load rejection to demonstrate.

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- Full load rejection tests to measure transient maximum speed and steady state speed at normal governor droop setting
- Method of resynchronism to be demonstrated.
- Turbine bypass operation capability
- Demonstration of start up of the plant utilising start up power only from black start DG and demonstration of safe shut down utilising DG for emergency purposes.
- Operating stability when operated in the full range of load conditions with load variations by increasing or decreasing the electric load/steam delivery.
- Demonstration of the capabilities of the Power Units to operate at rated voltage and frequency, at power factors and reactive conditions between 0.85 (lag) and 0.95 (lead)
- Start-up tests of the Plant equipment, facilities and
- Verification of vibration and noise emission
- Environmental monitoring equipment, water quality monitoring equipment, functioning tests and verification of guarantees
- Verification of active power response and voltage control response according to the requirements specified in the network connection conditions
- Demonstration of proper controlling, monitoring and recording according to the requirements of the grid code shall be as per MPP recommendations.
- Verification of completeness of scope of supply. This shall be carried out along with the punch list.
- Verification of 24 hours uninterrupted MCR operation
- Establish the capability to deliver the specified process steam even at minimum Gas turbine load, without any fresh air for atleast 8 hours on a continuous basis.

9.4.0 Trial Operations

After successful completion of commissioning test and after relevant test protocols have been accepted by the Owner /Owner's representative, the Contractor shall be allowed to prepare the Plant Units for trial operation. The plant will be started up and loaded. During this loading operation all the controls and protections shall be finally set.

After the plant is loaded to the maximum capability rating and the contractor is fully satisfied with its performance he shall offer the unit for Trial Operation by communicating the same to the Owner/Owner's representative in writing. After receipt of such communication the plant will be on trial operation. The trial operation will be for a minimum period of fifteen (15) days continuously at rated full load/part load as made available by the Owner/Owner's representative or as mutually agreed between the contractor & / Owner/Owner's representative to demonstrate the following :-

- Sustained capability of the plant
- Reliability of the equipment and auxiliaries
- Adequacy of the various auxiliaries, ancillaries & systems and controls.
- Capability of each equipment of the plant to correctly perform the functions for which it is specified.
- Safety requirements

This trial operation shall be undertaken jointly with the Owner/Owner's representative. As a part of the trial operation reliability run and guarantee tests of the plant shall be conducted.

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9.5.0 Reliability Run

Reliability run shall be undertaken jointly with the Owner/Owner's representative as a part of the trial operation and within the trial operation period. Reliability run shall be conducted for seven (7) days uninterrupted at a load as available at prevailing ambient conditions.

In the event of interruptions to the reliability test run, for which the Contractor is responsible, the length of the reliability test run can be extended by a period equal to the total duration of the interruptions. If such an interruption lasts more than 24 hours, the reliability test run shall be restarted, after repairing the defect. The reliability test run may be interrupted on a maximum of three occasions, provided that no interruption exceeds 8 hours and that the Owner/Owner's representative is notified of the interruption in good time.

After the successful completion of reliability run test the Contractor shall offer the Owner/Owner's representative to conduct the guarantee test on prior intimation to the Owner/Owner's representative. The Contractor shall conduct guarantee test as per approved procedures for such test to the satisfaction of the Owner/Owner's representative. Performace and gurante tests shall be a part of the trial operation and shall be conducted to the requirements of testing stated under the clause Guarantee test.

Essentially the performace tests shall consist of a simultaneous test to establish the capability of the plant when delivering the base load. The gross heat rate of the unit shall be also tested while demonstrating to the Owner/Owner's representative the Gross Power Output and Auxilliary Power Consumption.in order to demonstrate that the plant is able to perform within the parameter limits specified in clause 20 below.

A joint log would be maintained to note various performance data, the malfunctions, output deficiency and short comings and would be compiled and furnished at the end of the trail operation along with the performace test results.

9.6.0 Guarantee Test

This consists of performance and guarantee tests as a part of the trial operation and within the trial operation period.

9.6.1 Objective of the test

The parameters which have an impact on commercial viability of the station are Gross Power Output &Gross Heat rate of the plant and the Auxiliary Power Consumption for the entire plant.

Performance Guarantee shall be provided for operation at contract specific site reference conditions as specified and the guaranteed performance parameters of the plant shall be proved by the Contractor during the test. Should the results of these tests show any deficiency from the guaranteed value, the Contractor shall modify the equipment as required at no extra cost to enable it to meet the guaranteed parameters.

All heat rates shall be based on Lower Heating value for the fuel.

9.6.2 Test Documents

The procedure for carrying out the above tests shall be submitted to the Owner/Owner's representative for approval six (6) months in advance. The procedure shall highlight the anticipated date for the test, arrangement and form of the tests.

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The procedure shall include the following for each test or group of tests:

1. The sequence of the tests to be conducted.
2. The time duration of each test
3. The number of test runs
4. A list of instruments that will be used for each test. The list shall define which instruments are (a) special test instruments, (b) certified, (c) to be calibrated before and after each test, (d) check instruments, (e) station supply instruments (f) Schematic diagram showing all test points and cross referenced to the instrument list and (g) method of data logging. Data logging thro' satellite communication is not permitted.
5. All formulae, calculations, conversion factors, curves, correction curves etc., to be used in the conducting of the tests and the calculations of the test results. All such items shall be to a accuracy level of four decimals.
6. Sample test reports to data sheets and all specific result sheet forms that will be used for the test.
7. Written procedure and description of conducting the test.

9.6.3 Testing Method

The testing shall be carried out as per PTC – 46. The test boundary shall include the entire unit with heat sink.

9.6.3.1 Measurements

The following measurement has to be taken during performance and guarantee test

Output

- Gross power out put of the GTG and STG
 - Auxiliary Power Consumption
- Noise level

All the plant, equipment and systems covered under this specification shall perform continuously without exceeding the noise level over the entire range of output and operating frequency.

Noise level measurement shall be carried out using applicable and internationally acceptable standards. The measurement shall be carried out with a calibrated integrated sound level meter meeting the requirement of IEC 651 or BS 5969 or IS 9779.

Sound pressure shall be measured all around the equipment at a distance of 1.0 m horizontally from the nearest surface of any equipment/machine and at a height of 1.5 m above the floor level in elevation.

A minimum of 6 points around each equipment shall be covered for measurement. Additional measurement points shall be considered based on the applicable standards and the size of the equipment. The measurement shall be done with slow response on

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the A-weighting scale. The average of A-weighted sound pressure level measurements expressed in decibels to a reference of 0.0002 micro bar shall not exceed 85 dBA.

Corrections for background noise shall be considered in line with the applicable standards. All the necessary data for determining these corrections in line with the applicable standards shall be collected during the tests.

- Emission level

Input

- Natural Gas consumption

Specific Site Conditions

- Ambient pressure
- Ambient temperature
- Relative humidity
- Grid frequency
- Power factor
- Fuel analysis (Natural Gas)
- Cycle blow down

Correction curves shall be applied only on the above measured specific site conditions to arrive at the Plant Performance Parameters at the contract specified specific site reference conditions.

9.6.3.2 Contract Specific Site Reference Conditions

- Ambient pressure - 1013 mbar
- Ambient temperature- 35°C
- Relative humidity - 70 %
- Grid frequency - 50 Hz
- Power factor – 0.80
- Design NOX – As per GPCB norms
- Design fuel analysis - LHV of the Natural gas fuel as per contract
- Cycle blow down equal to 0 %
- Deterioration due to aging - factors that are to be applied for Gross power output as agreed and stated in the contract.
- Tolerances that are to be applied on corrected Gross Heat Rate and Gross power output parameters as specifically stated in the contract.

9.6.3.3 Specific Conditions of Testing Method

The correction method stated under cl.5.5.2 in PTC 46 shall be applied to correct the performance parameters measured and corrected as per the above stated method. Tolerances are applied over these corrected performance parameters in such case.

9.6.3.4 Test Uncertainties

The test uncertainty (not tolerance) shall be calculated based on the accuracy and number of test instruments utilized. The same shall be done as per PTC 46 and the maximum expected uncertainty shall not exceed 3 % for corrected gross heat rate and 1.2% for corrected Gross

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power output to validate the test. Accordingly the Tenderer shall state in the proposal the permitted deviations/fluctuations of design parameters that are permitted during the test for each operating mode testing.

9.6.3.5 Correction Curves & Tolerance

The correction curves shall be provided as mathematical equations in addition to the curves to an accuracy of four decimals. The equations supplied shall be utilized to perform the test result calculations.

9.6.4 Measuring Equipment

All test instrumentation and test equipment shall be provided by the Contractor. All the instruments shall be calibrated by a certified body before and after the tests. The calibration certificates shall be submitted to the Owner/Owner's representative prior to the tests. The calibration certificates shall be considered valid for a period of not more than six (6) months from the date of its calibration.

The anticipated points of measurement together with necessary isolation during the tests shall be indicated by the Contractor.

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ANNEXURE 1

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SURFACE PREPARATION AND PAINTING

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SUB-SECTION – 2.15

SURFACE PREPARATION AND PAINTING

1.0.0 SURFACE PREPARATION

1.1.0 General

This specification covers the general requirements related to the cleaning protective coating and painting of equipment, component and system. The components and/or equipment shall be mechanically and / or chemically cleaned during the following stages of the Contract.

- Cleaning in workshop.
- Cleaning before painting and / or corrosion protection (application of prime coat).
- Cleaning before erection and during installation.

Cleaning of fabricated component items shall be carried out after fabrication and final heat treatment of welding at manufacturer's work or at site, as appropriate.

For cleaning in workshop and before painting mechanical cleaning as opposed to alternative chemical cleaning is the preferred method of for works cleaning except where this is precluded by design or access considerations.

Mechanical surfaces shall be protected during the cleaning operations.

In the event of the surfaces not being cleaned to the purchaser's satisfaction, such parts of the cleaning procedures or agreed alternatives as are deemed necessary to overcome the deficiencies shall be carried out at the supplier's sole expense.

For reclining small areas, hand cleaning by wire brushing may be permitted wire brushless used on austenitic steel bristles.

Austenitic stainless steels, copper and aluminium alloys, cast iron, bimetallic and metallic / plastic items, and components fabricated by spot welding or riveting shall not be chemically cleaned. All weld areas shall be suitably stress relieved before chemical cleaning.

various international standards equivalent to Swedish standard for surface preparation are given in Table-1.

The contractor shall arrange at his own cost, to keep a set of latest edition of the above standards and codes at site.

The paint manufacturer's instruction shall be followed as far as practicable at all times. Particular attention shall be paid to the following.

- Proper storage to avoid exposure as well as extremes of temperature.
- Surface preparation prior to painting.
- Mixing and thinning.
- Application of paints and the recommended limit on the intervals between coats.
- Shelf life for storage.

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Any painting work (including surface preparation) on piping or equipment shall be commenced only after the system tests have been completed and clearance for taking up painting work is given by the Engineer, who may, however, at his discretion authorise in writing, the taking up of surface preparation of painting work in any specific location, even prior to completion of system test.

1.2.0 **Tools & Tackles**

All tools, brushes, rollers, spray guns, blast material, hand power tools for cleaning and all equipment, scaffolding materials, shot/sand blasting equipment and air compressor etc. shall be arranged by the contractor at the site in sufficient quantity at his own cost. He shall arrange to his own cost, for suitable paint thickness measuring instrument like Elkometers acceptable to the Engineer (with calibration facilities).

Mechanical mixing shall be used for paint mixing operation in case of two pack systems except that the Engineer may allow the hand mixing of small quantities at his discretion.

1.3.0 **Mechanical Cleaning at Manufacturer's Works**

Mechanical cleaning shall preferably be carried out by abrasive blasting. The Purchaser is prepared to consider alternative methods provided they achieve the necessary surface condition.

1.3.1 **Surface condition**

The Metal surfaces shall be clean and free of mill scale, rust dirt, grease and any other deleterious matter.

Where metal surfaces are to be painted the surface profiles shall conform with the painting specification requirements.

Where this does not apply surfaces shall have a surface texture not coarser than Grade 80 abrasive paper.

1.3.2 **Abrasives**

Abrasives containing silica, silicates of slag, residues shall not be used for water/steam side surfaces of plant except for cleaning sand castings, where hydro blasting with sand may be used.

For austenitic materials only abrasives containing 98% or more of alumina, Al_2O_3 , shall be used.

1.3.3 **Removal of abrasive and debris:**

After cleaning abrasive and debris shall be thoroughly removed from components.

1.3.4 **Alternative Chemical Cleaning at Manufacturer's Works**

The procedure shall comprise of Pre-treatment and Acid treatment.

To achieve cleanliness equivalent to that specified for mechanical cleaning. The procedure to be adopted must meet with the purchaser's approval.

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1.3.5 Protection at Manufacturer's Works

As soon as all items have been cleaned and within four hours of the subsequent drying, they shall be given suitable anti-corrosion protection.

All water, air and steam side surfaces shall be protected by the application of approved water soluble corrosion inhibitors, or vapour phase inhibitors that can be subsequently removed by site water washing or steam blowing.

The rate of application of volatile corrosion inhibitors shall be at least 10 grams per square metre or 35 grams per cubic metre, whichever is the greater, except for pipes up to 300 mm diameter for which the minimum application rates shall be 5 grams per square metre.

Immediately after the protective treatment has been applied all vessels and pipes shall be suitably sealed off by discs or caps or approved alternatives to prevent ingress from the surrounds. Cylindrical plugs shall not be driven into the ends of pipes. These protective covers shall not be removed until immediately before final connection is made to the associated equipment.

1.4.0 Weather Conditions

Painting shall be done only when the surface temperature is above 5°C surface temperature must be at least 3°C above dewpoint to ensure that condensation does not occur on the surface.

Reasonable protection against precipitation, corrosive fumes and vapours shall be exercised for the painting of outdoor parts.

Precautions shall also be taken against solar radiation to ensure that the specified dry film thickness of priming or finish coats is obtained.

Any prime coat exposed to excess humidity, rain, dust etc. before drying, shall be permitted to dry & the damaged area of primer shall be removed and the surface prepared & primed again.

Sheltered or unventilated horizontal surfaces on which dew may collect require more protection, and to achieve this an additional top coat of paint shall be applied.

1.5.0 Surface Preparation

In preparing any surface to be coated, all loose paint, dirt, grease, rust, scale, weld slag or spatter or any other extraneous material shall be removed and defects repaired so as to obtain a clean, dry, even surface to receive the priming or finishing coat(s) as called for in the painting schedules. Sharp edges should be rounded especially when tank linings have to be applied.

All machined surfaces, including flange faces, shall be suitably covered to prevent damage during surface preparation.

All surface should be blast cleaned whenever possible.

1.5.1 Surface preparation methods.

Bare steel surfaces should be prepared by one of the methods described below in order of preference and in accordance with Swedish Standard SIS 05 5900 or Steel Structures Painting Council, SSPC, Vis1, or DIN 55928, section 4.

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1.5.1.1 White metal blast cleaning: Sa 3 or SSPC - SP 5

Sa 3 Blast cleaning to bare metal, Mill scale, rust and foreign matter must be removed completely. Subsequently, the surface is cleaned with vacuum cleaner, clean dry compressed air or a clean brush. It must then have a uniform metallic colour & correspond in appearance to the prints designated Sa 3.

1.5.1.2 Near white metal blast cleaning Sa 2 1/2 or SSPC - SP 10

Sa 2 1/2. Very thorough blast cleaning. Mill scale, rust and foreign matter shall be removed to the extent that the only traces remaining are slight imperfections in the form of spots or stripes. Subsequently, the surface is cleaned with a vacuum cleaner, clean dry compressed air or a clean brush. It must then correspond in appearance to the prints designated Sa 2 1/2.

Mechanical cleaning should only be used when procedures (a) and (b) are not practicable.

1.5.1.3 Commercial Blast Cleaning Sa 2

Sa 2 Blast cleaning until atleast two-thirds of each element of surface area is free of all visible residues. This method of Blasting is suitable for steel required to be painted with conventional paints for exposure to mildly corrosive atmosphere for longer life of the paint system.

1.5.1.4 Near white metal blast cleaning P Sa 2 1/2 DIN 55928

Very thorough blast cleaning. Very adhesive coatings remain. From all other surface mill scale and rust are to be removed to such an extent that the only traces remaining are slight imperfections in the form of spots or stripes. Further treatment see Sub b).

1.5.1.5 Very thorough mechanical scraping and wire brushing St 3

St 3 very thorough scraping and wire-brushing - machine brushing - grinding - etc. are to be preferred. Surface preparation as for St 2. But much more thoroughly. After the removal of dust, the surface must have a pronounced metallic sheen and correspond to the prints designated St. 3.

1.5.1.6 Thorough scraping and wire brushing: St 2

St 2 Thorough scraping and wire-brushing - machine brushing - grinding - etc. The treatment shall remove loose mill scale, rust and foreign matter. Subsequently, the surface is cleaned with a vacuum cleaner, clean dry compressed air or a clean brush. It should then have a faint metallic sheen. The appearance must correspond to the prints designated St 2.

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Table -1 (Surface Preparation Standards)

Surface preparation methods	SIS 055900	DIN 55928, Part-4	BS 4232 only for blasting	SSPC-Vis
Blasting ACC to item (a)	Sa 3		First quality	White metal SP 5
Blasting ACC to item (b)	Sa 2 1/2		Second near quality	White SP 10
Blasting ACC to item (c)	Sa 2		Third quality	Commercial blast SP 6
Hand / or power tool derusting ACC to item (f)	St 2		--	Hand tool cleaning SP 2
ACC to items (e)	St 3		--	Power tool cleaning SP 3
Flame jet cleaning		F1	--	Flame cleaning SP 4
Pickling		Be	--	Pickling

Steel structures to be blast cleaned have to be free of pitting and other severely corroded places in accordance with B.S. 4232 and SIS 055900.

The abrasives used for blast-cleaning shall be graded flint, grit, shot or silica sand and shall be such that they will produce an average keying profile on the blast-cleaned surface of not more than 40 microns.

An air pressure of 7 bar (g) at the nozzle shall be used.

After blast-cleaning all accumulated grit, sand, dust etc. must be removed leaving the surface clean, dry and free of mill scale, rust grease and other foreign matter.

In the event of rusting after completion of the surface preparation, the surface must be cleaned again in the manner specified.

Oil, grease, soil, cement, salts, acids or other corrosive chemicals shall be cleaned from steel surfaces, by the use of solvents, emulsions or cleaning compounds. The final wiping shall be with clean solvent and clean rags or brushes. There shall be no detrimental residue left on the surface.

Primed areas which suffer damage must be spot blasted on site to a degree of cleanliness P Sa 2 1/2 before touching up.

Protective coating must be applied as quickly as possible after the completion of surface preparation no matter what cleaning method has been used.

No blast-cleaned surface shall be allowed to remain uncoated overnight.

Steel work protected by shop primer after arrival on site must be cleaned of salt, sand, oil etc. before the coat of paint is applied on site. Shop primer damaged during transport must be rectified by blast-cleaning and coating before application of the site coats.

Wood surfaces shall be sanded clean. All nail holes shall be puttied and sanded before priming.

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Concrete: If a protective coating is required, concrete shall be allowed to cure before painting.

1.5.2 **Rub Down and Touch up of Primer**

The shop coated surfaces shall be rubbed down thoroughly with emery paper to remove all dust, rust and other foreign matters, washed, degreased, then cleaned with warm fresh water and air dried. The portions, from where the shop coat has peeled off, shall be touched up and allowed to dry before applying a coat of primer. The compatibility between shop coat and field primer should be ascertained from the paint manufacturer. In case degreasing with white spirits is not effective, the surface should be finally wiped clean with aromatic solvent like xylol or light naphtha.

1.5.3 **Non Compatible Shop Primer**

The compatibility of finishing coat should be confirmed from the paint manufacturer. In the event of use of primer such as zinc rich epoxy, inorganic zinc silicate etc., the paint system shall depend on condition of shop coat. If the shop coat is in satisfactory condition showing no major defect, the shop coat shall not be removed. The touch up primer and finishing coat(s) shall be identified for application by Engineer.

Shop coated (coated with primer & finishing coat) equipment shall not be repainted unless paint is damaged.

Shop primed equipment and surfaces shall only be spot cleaned in damaged areas by means of power tool brush cleaning or hand tool cleaning and then spot primed before applying one coat of field primer unless otherwise specified. If shop primer is not compatible with field primer then shop coated primer shall be completely removed before application of selected paint system for particular environment.

For package units / equipment, shop primer shall be as per the paint system given for particular environment.

In case of existing paint, compatibility between finishing coat and new selected finish coat shall be ascertained before application of finish coat. In case the coat is selected for upgrading existing alkyd coating to high performance coating, then surface preparation can be by manual / mechanical means to remove loose rust, peeled off/damaged paint, but sound old coating need not be removed. It should be touched with red oxide zinc chromate primer wherever it has peeled off before application of the coat. The tie coat shall be applied after 7 days of curing of red oxide zinc chromate primer. If new paint system is not suitable to upgrade existing coating then complete paint shall be removed by mechanical or blast cleaning before application of new coating system.

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2.0.0 SCHEDULE OF PRIMER & FINISH COATS

2.1.0 PRIMERS

- P-1 Red Oxide zinc chromate primer
- P-2 High build chlorinated rubber zinc phosphate primer
- P-3 High build zinc phosphate primer
- P-4 Etch primer/wash primer
- P-5 Epoxy zinc chromate primer
- P-6 Epoxy zinc phosphate primer
- P-7 Epoxy high build mio paint
- P-8 Epoxy red oxide zinc phosphate primer
- P-9 Epoxy based tie coat finish coats
- P-10 Inorganic zinc silicate coating.

2.2.0 FINISH COATS

- F-1 Synthetic enamel
- F-2 Acrylic polyurethane paint
- F-3 Chlorinated rubber paint
- F-4 High build chlorinated rubber mio paint
- F-5 Chemical resistant phenolic based enamel
- F-6 Epoxy high build coating
- F-7 High build coal tar epoxy
- F-8 Self priming epoxy high build coating
- F-9 High build black
- F-10 Heat resistant aluminium paint suitable upto 250°C
- F-11 Heat resistant silicone paint suitable upto 400°C
- F-12 Synthetic rubber based aluminium paint suitable upto 150°C
- F-13 Heat resistant silicone paint suitable upto 600°C

2.3.0 PRIMER

a) Primer (P-1) Red oxide zinc chromate primer

- Type and composition : Single pack modified phenolic alkyd medium pigmented with red oxide and zinc chromate
- Volume solids : 30 - 35%
- DFT : 20 ~ 40 microns/coat (min)
- Covering capacity : 11-13 sq. m/Lit/coat

b) Primer (P-2) High build chlorinated rubber zinc phosphate primer

- Type and composition : Single pack Chlorinated rubber medium plasticised with unsaponifiable plasticiser pigmented with zinc phosphate
- Volume solids : 35-40%

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DFT : 50 microns/coat (min).
Covering capacity : 7-8 sq. m/lit/coat

c) Primer (P-3) High build zinc phosphate primer

Type and composition : Single pack Synthetic medium, pigmented with zinc phosphate
Volume solids : 40 - 45%
DFT : 35 - 50 microns/coat
Covering capacity : 10 - 12 sq. m/lit/coat
Heat resistant : Upto 100 °C (dry)

d) Primer (P-4) Etch primer / Wash primer

Type and composition : Two pack of Polyvinyl butyl resin medium cured with phosphoric acid solution pigmented with zinc tetroxy chromate
Volume solids : 7 - 8%
DFT : 8 - 10 microns/coat
Covering capacity : 7 - 8 sq. m/lit/coat

e) Primer (P-5) Epoxy zinc chromate primer

Type and composition : Two pack of Polyamide cured epoxy resin medium pigmented with zinc chromate
Volume solids : 40% (min.)
DFT : 35 microns/coat
Covering capacity : 11 - 12 sq. m/lit/coat

f) Primer (P-6) Epoxy zinc phosphate primer

Type and composition : Two pack of Polyamide cured epoxy resin medium pigmented with zinc phosphate
Volume solids : 40% (min)
DFT : 35 microns/coat (min)
Covering capacity : 11 - 12 sq. m/lit/coat

g) Primer (P-7) Epoxy high build MIO paint (Intermediate coat)

Type and composition : Two pack of Polyamide cured epoxy resin medium pigmented with micaceous iron oxide
Volume solids : 50% (min)
DFT : 100 microns/coat (min)
Covering capacity : 5.0 sq. m/lit/coat

h) Primer (P-8) Epoxy red oxide zinc phosphate primer

Type and composition : Two pack of Polyamide cured epoxy resin medium pigmented with red oxide and zinc phosphate
Volume solids : 42% (min)
DFT : 30 microns/coat (min)
Covering capacity : 13 - 14 sq. m/lit/coat

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i) Primer (P-9) Epoxy based tie coat

(Suitable for conventional alkyd based coating prior to application of acrylic polyurethane / epoxy finishing coat).

Type and composition : Two pack of Polyamide cured epoxy resin medium suitably pigmented
 Volume solids : 45-60%
 DFT : 40 microns/coat (min)
 Covering capacity : 10 - 12 sq. m/lit/coat

j) Primer (P-10) Inorganic Zinc silicate coating

Type and composition : Two pack of Self cured Ethyl - silicate solvent based Inorganic Zinc coating.
 Volume solids : 60% (min)
 DFT : 65-75 microns/coat
 Covering capacity : 8-9 sq.m./lit/coat

2.4.0

FINISH COATS

a) Finish coat (F-1) Synthetic Enamel

Type and composition : Single pack
 Alkyl medium pigmented with superior quality water & weather resistant pigments
 Volume solids : 30 - 40%
 DFT : 20 - 25 microns/coat (min)
 Covering capacity : 16 - 18 sq. m/lit/coat

b) Finish coat (F-2) Acrylic Polyurethane paint

Type and composition : Two pack
 Acrylic resin and isocyanate hardener suitably pigmented.
 Volume solids : 40 % (min)
 DFT : 30-40 microns/coat
 Covering capacity : 10-12 sq.m./lit/coat

c) Finish Coat (F-3) Chlorinated Rubber paint

Type and composition : Single pack
 Plasticised chlorinated rubber medium with chemical & weather resistant pigments.
 Volume solids : 30 % (min)
 DFT : 30 microns/coat (min)
 Covering capacity : 10 sq.m./lit/coat

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d) Finish Coat (F-4) High build chlorinated rubber MIO paint.

Type and composition	:	Single pack Chlorinated rubber based high build pigmented with micaceous iron oxide.
Volume solids	:	40-50 %
DFT	:	65-75 microns/coat
Covering capacity	:	6-7 sq.m./lit/coat

e) Finish Coat (F-5) Chemical Resistant Phenolic based Enamel

Type and composition	:	Single pack Phenolic medium suitably pigmented.
Volume solids	:	30-40%
DFT	:	25 microns/coat (min)
Covering capacity	:	15 sq.m./lit/coat

f) Finish Coat (F-6) Epoxy High Building Coating

Type and composition	:	Two pack Polyamide cured epoxy resin medium suitably pigmented.
Volume solids	:	55-65%
DFT	:	100 microns/coat (min)
Covering capacity	:	6.0-6.5 sq.m./lit/coat

g) Finish Coat (F-7) High build coal tar Epoxy.

Type and composition	:	Two pack Polyamine cured epoxy resin blended with coal tar.
Volume solids	:	65 % (min)
DFT	:	80-125 microns/coat
Covering capacity	:	6.0-6.5 sq.m./lit/coat

h) Finish Coat (F-8) Self priming epoxy high build coating (complete rust control coating)

Type and composition	:	Two pack Polyamido-amine cured epoxy resin suitably pigmented. Capable of adhering to manual prepared surface and old coatings.
Volume solids	:	65-85%
DFT	:	100-125 microns/coat
Covering capacity	:	4-5 sq.m./lit/coat

i) Finish Coat (F-9) High build black.

Type and composition	:	Single pack Reinforced Bituminous composition phenolic based resin.
Volume solids	:	55 - 66 % (min)
DFT	:	100 microns/coat (min)
Covering capacity	:	5.5 – 6.0 sq.m./lit/coat

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j) Finish Coat (F-10) Heat Resistant Aluminium Paint Suitable upto 250°C

Type and composition	:	Dual container (paste & medium) Heat resistant special Ole Ore resinous medium with leafing aluminium.
Volume solids	:	20 - 25 %
DFT	:	20 microns/coat (min)
Covering capacity	:	10 - 12 sq.m./lit/coat

k) Finish Coat (F-11) Heat Resistant Silicon paint suitable 250 - 400°C.

Type and composition	:	Single pack of Silicon resin based with aluminium flakes
Volume solids	:	15-25 %
DFT	:	20 microns/coat (min)
Covering capacity	:	7-12 sq.m./lit/coat

l) Finish Coat (F-12) Synthetic Rubber Based Aluminium Paint suitable upto 150°C.

Type and composition	:	Single pack of Synthetic rubber medium combined with leafing Aluminium.
DFT	:	20-25 microns/coat (min)
Covering capacity	:	9.5 sq.m./lit/coat

m) Finish Coat (F-13) Heat Resistant Silicon paint suitable 500 - 600°C

Type and composition	:	Single pack of Silicon resin based with aluminium flakes.
Volume solids	:	25-35%
DFT	:	20 - 25 microns/coat (min)
Covering capacity	:	12 - 14 sq.m./lit/coat

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3.0.0 PAINT SYSTEM

SL. NO.	SURFACE/LOCATION	TEMP. °C	SURFACE PREPARATION	PAINT SYSTEM			PER COAT MICRONS Dft	APPLICATION	
				COAT	NO. OF COATS	GENERIC TYPE		IN SHOP	ON SITE
✓ 1	Structural steel work, piping (oil + water) tanks outside surface, transmission towers, cranes, steel floors, galleries, stairways, outdoor.	upto 130°C	Sa 2½	Prime	2	P6	35	x	
							35	x	
				Intermediate	1	P7	100		x
				Finish	1	F2	50		x
						Total DFT	220		

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SL. NO.	SURFACE/LOCATION	TEMP. °C	SURFACE PREPARATION	PAINT SYSTEM			PER COAT MICRONS Dft	APPLICATION	
				COAT	NO. OF COATS	GENERIC TYPE		IN SHOP	ON SITE
8	Cast iron water pipe lines-outside surface, buried in the soil	upto 60°C	Sa 3	Prime	2	P8	30	x	
				Finish	3	F7	30	x	
							125		x
							125		x
						Total DFT	435		

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SL. NO.	SURFACE/LOCATION	TEMP. °C	SURFACE PREPARATION	PAINT SYSTEM			PER COAT MICRONS Dft	APPLICATION	
				COAT	NO. OF COATS	GENERIC TYPE		IN SHOP	ON SITE
9	Steel pipes inside surface such as cooling water lines	upto 60°C	Sa 2½	Finish	4	F7	125		x
							125		x
							125		x
							125		x
						Total DFT	500		
10	Water pipelines - outside surface, indoor	upto 60°C	Sa 3	Prime	2	P2	50	x	
				Finish	3	F3	50	x	
							30		X
							30		X
						Total DFT	190		
11	Oil pipelines - outside surface, above ground	upto 90°C	Sa 3	Prime	2	P3	50	x	
				Finish	2	F6	50	x	
							100		x
							100		x
						Total DFT	300		

3.1.0 Colour Code for Piping

The colour code scheme is intended for identification of the individual group of the pipeline. The system of colour coding consists of a ground colour and colour bands superimposed on it. The colour coding for the identification of pipelines should comply with the standard and shall submit for Owner/Owner's representative's approval. (For colour code for piping and fire equipment refer Annexure- A.

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Notes :

1. Covering capacity and DFT depends on method of application. Covering capacity specified above are theoretical. Allowing the losses during application, min specified DFT should be maintained.
2. All primers and finish coats should be cold cured and air dried unless otherwise specified.
3. Selected chlorinated rubber paint should have resistance to corrosive atmosphere and suitable for marine/saline environment.
4. All paints shall conform to relevant Indian Standard and shall be applied in accordance with manufacturer's instructions for surface preparation, intervals, curing and application. The surface preparation, quality and workmanship should be ensured.
5. Technical data sheets for all paints shall be supplied at the time of submission of quotations.
6. In case of use of epoxy tie coat, manufacturer should demonstrate satisfactory test for inter coat adhesion. In case of limited availability of epoxy tie coat (P-9) alternate system may be used taking into consideration the service requirement of the system.
7. All primers should be top coated immediately as per manufacturer's recommendations.
8. In ONGC Hazira complex no sand blasting or shot blasting shall be done. All equipment shall be protected with anti-corrosive coat and after final painting only shifted to project site for further erection. Touch – up painting for the damage area during transportation can be done at project site.

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3.2.0 Specific Requirement

3.2.1 Following paint schedules shall be followed :

- Acid resistant paint for DM plant building / structure, neutralisation pit, battery room, other corrosive area.
- Synthetic enamel paint for Structural steel, structural sheds, window grills, hand railings, etc.
- Epoxy high build paint for DM plant equipment with piping valves.

3.2.2 All steel work not embedded in concrete to be given one coat of commercial grade zinc chromate primer before painting.

3.2.3 Synthetic enamel paint :

a) General building / structure :

- Surface preparation : ST – 2 according to Swedish standard SIS 055900
- Primer paint : Two coats of Zinc phosphate in phenolic alkyd medium (DFT = 35 microns / coat)
- Finish paint : Two coats of Synthetic enamel (DFT = 25 microns / coat) confirming IS 2932, 1974.

b) Part of steel structure embedded in concrete :

- Surface preparation : ST – 2 according to Swedish standard SIS 055900
One coat of port land cement slurry.

c) Epoxy high building coating:

- Epoxy zinc phosphate primer : two coats of 35 DFT per coat.
- Epoxy high build coating : one coat of 100 DFT.

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ANNEXURE – A
**COLOUR CODE FOR PIPING AND
FIRE EQUIPMENT**

SYSTEM OF IDENTIFICATION/COLOUR CODING OF PIPINGS AND FIRE EQUIPMENT

The colour coding system for pipings has been formulated basically on Indian standard; that in itself includes the British & the American standard and follow the system of colour coding as well as positive identification.

However, in some cases of our products (not included in the Indian standard), colour bands have been specified as per EIL specifications or proposed, either based on the present system at Ankleshwar Asset or Uran/Hazira plant. It has been ensured that the colour bands do not clash with other products/utilities and the base colour is maintained as per the Indian standard.

The system of colour code consists of a base/ground colour and colour bands/strips superimposed on it. Lettered labels/legends, direction of arrows and danger sign shall also be used as superimposed on colour coding system for positive identification of the contents of a piping system.

The colouring scheme of the valves and hazard indication too are prescribed.

1.0 Colour Code System

The system of colour coding consists of a base/ground colour and colour Bands / strips superimposed on it. For identification of piping, the colour code as per Table 1 & 2 (placed at the end)shall be used which is for products being processed and utility items being used in ONGC (Based on Indian standard, British standard and the EIL standard).

1.1 Base / Ground Colours

The base/ground colour identifies the basic nature of the fluid carried and distinguishes one fluid from another and has been based on IS 2379:1990 reaffirmed 1996.

1.1.1. How much and where to paint

- a) Base/ ground colour shall be applied throughout the entire length on un-insulated pipelines
- b) Ground colour coating shall be applied at places requiring colour bands ,with minimum 2 meters length or adequate length so that it will not be mistaken as colour band for the following kinds of piping. (As per IS 2379:1990 reaffirmed – 1996 para 6.1.1).
 - i) Insulated pipes at the position of metal cladding.
 - ii) Un-insulated austenitic stainless steel.
 - iii) Plastic and/or plastic coated materials.
 - iv) Pipes of non-ferrous metals like Alluminium, galvanized "piping", etc.

1.1.2. Application

Ground colours as given in Table 1 & 2 shall be applied in one of the following ways : (As per IS 2379:1990 reaffirmed – 1996 para 7.1)

- a) Through out the entire length of the pipings.

- b) As a colour coating of adequate length, (but in no case less than 300 mm) so that it is not mistaken for a colour band.
- c) As a colour panel for pipes which are not accessible on all the sides.
- d) As label attached to pipes which are very small in diameter.
- e) By the use of colour adhesive tapes for pipes with small diameter or which are difficult to access.
- f) Where ever the ground colour are not applied throughout the entire length, it shall be applied at all the places in conjunction with other bands and markings as mentioned in applications- (1.1.1.b).

1.2 Colour bands/strips

Colour bands/strips (as given in Table 1 & 2)are superimposed on the base/ground colour to distinguish one kind or condition of a fluid from another kind or condition of the same fluid, or one fluid from another but belonging to the same group, for example diesel fuel from the furnace fuel.

1.2.1. Identification & Size

- a) The width of colour band shall confirm to the following table shown below : (As per IS 2379:1990 reaffirmed.- 1996 PARA 7.3.3).

NOMINAL PIPE SIZE (mm)	WIDTH: L (mm)
80 NB and below	25 MM
Over 100 NB up to 150 NB	50 MM
Over 200 NB up to 300 NB	75 MM
Over 350 NB	100 MM

NB- Nominal Bore

- b) The relative proportional width of first colour band to the subsequent bands shall be 4:1.

1.2.2. Application

- a) Colour bands shall be applied at the following location (IS 2379:1990 – reaffirmed 1996 para 7.3)
 - i) Battery limit points.
 - ii) Intersection point and change of direction points in piping ways.
 - iii) Other points such as midway of each piping way, near valves, junction joints of service appliances, walls, on either side of pipe culverts:
 - iv) For long stretch yard piping at 50m interval; and
 - v) At start and terminating points.
- b) Colour bands shall be arranged in the sequence shown in Table 1 & 2 and the sequence follows the direction of flow.
- c) All uninsulated pipes having temperatures above 100° C (Heat resistance aluminium painted) need be identified as special case by using Teflon tape.
- d) For insulated pipes, nominal pipe size means the outside diameter of insulation.

TABLE FOR DIMENSIONS OF ARROW

SN	Outside diameter of pipe (mm)	Size of dimension A,B,C & D (mm)
1.	Upto 200	A=65, B=30, C=95 & D=20
2.	Above 200	A=90, B=30, C=95 & D=30

4. For pipes with small diameter, if the label with a code indication is attached to the pipe, the direction of flow shall be shown by the pointed end of this label.

2.3 Hazardous warning

To indicate that a pipeline carries a hazardous material, a band of diagonal strips of black and golden yellow as (per IS 2379:1990 reaffirmed 1996 para 8 (c)) shall be painted on the ground colour at location stated at 1.2.2 – Application (a) and next to the colour coding identification and lettered label. Further if material is flammable or explosive material, chemically active or toxic materials, etc. may be indicated by lettering.

2.4 Visibility of Marking

Attention shall be given to visibility with reference to pipe markings. Where lines are located above or below the normal line of vision, the lettering shall be placed below or above the horizontal centerline of the pipe. (As per IS 2379:1990 reaffirmed – 1996 para 10).

2.5 Colour of Valves

The valves shall be painted as per the IS 2379:1990 reaffirmed – 1996 para 7.4 as per the following table.

Condition	Colour of valve
Valves on Fire fighting piping	Red
Valves on piping carrying hazardous material	Golden yellow with black strips
Valves on water carrying piping (potable or non potable)	French blue
All other piping	Same colour as the main piping

Example below shows the colour code for a pipe carrying sour gas where light grey and dark violet colour bands have sequence numbers C and D.

2.0 Positive identification system

Positive identification system includes lettered label/legend, direction of arrows and danger sign and shall be used as superimposed on colour coding system for positive identification of the contents of a piping system (Based on British standard, Indian standard and ANSI standard).

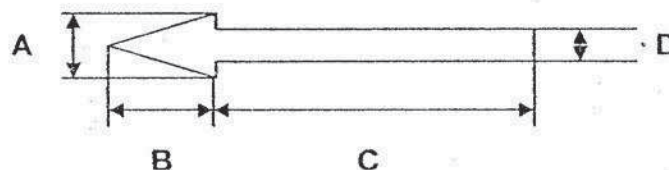
2.1 Lettering Label

Positive identification of the contents of piping shall be by lettered label giving the name of the contents in full or the abbreviated form at the locations stated at 1.2.2 Application (a) and next to the colour coding indication.

The lettering shall be as per IS 2379-1990 reaffirmed 1996 para 9.1. The recommended size of letters for pipes of different diameters are given as under :

Outside diameter of pipe or Covering (mm)	Size of legend (mm)
20 to 30	10
Above 30 to 50	20
Above 50 to 80	30
Above 80 to 150	40
Above 150 to 250	63
Over 250	90

2.2 Direction of flow : Flow Direction



1. Flow direction shall be indicated by arrow in the location stated at 1.2.2 application (a) and next to the colour code indication and lettered label.
2. The colour of arrow shall be black or white and in contrast to the colour on which they are superimposed.
3. The size of arrows shall be as per IS 2379 para 9.2 which is :

TABLE -1 COLOUR SCHEME FOR PRODUCTS BEING PROCESSED IN ONGC

A. GASES

Sl. No.	Description of Products	Colour Code Identification		Sl. No.	Description of Products	Colour Code Identification	
		Base/ Ground Colour	Colour Bands i)First band ii)Second band			Base/Ground Colour	Colour Bands i)First band ii)Second
1.	Sour gas	Canary Yellow	i) Grey ii)Dark violet	6.	Rich gas	Canary yellow	i)Signal red ii)Smoke grey
2.	Sweet gas	Canary yellow	Grey	7.	Flare gas	Canary yellow	Aluminium
3.	Fuel gas	Canary yellow	i)Light brown ii) White	8.	Regenerated gas	Canary yellow	i) White ii)Dark violet
4.	Residue	Canary yellow	i)Oxide red ii) White	9.	C2-C3	Canary yellow	i)Brilliant green ii)Signal red
5.	Lean gas	Canary yellow	i) White ii) French blue	10.	Propane gas	Canary yellow	i) Signal red ii) Black

B. LIQUIDS

Sl. No.	Description of Products	Colour Code Identification		Sl. No.	Description of Products	Colour Code Identification	
		Base/ Ground Colour	Colour Bands i)First band ii)Second band			Base/Ground Colour	Colour Bands i)First ii)Second
1.	Crude oil	Light brown	No band	12.	Surphuric acid	Dark violet	i)Brilliant green ii)Light orange
2.	LPG (Refrigerated)	Dark admiralty grey	i)Brilliant green ii)Dark violet	13.	Hydrochloric acid	Dark violet	i)Signal red ii)Light orange
3.	Kerosene	Light brown	Brilliant green	14.	Sodium Hydroxide	Smoky grey	Light orange
4.	Neptha	Dark admiralty grey	i)Light brown ii) Black	15.	Triethylene glycol (TEG)	Dark Admiralty grey	i)Sea green ii) Yellow
5.	Light diesel oil/heavy cut	Light brown	i) Brilliant green ii) Black	16.	DIPA	Dark Admiralty grey	i) White ii) Black
6.	High speed diesel	Light brown	i) Brilliant green ii) White	17.	MDEA	Dark Admiralty grey	i) Brilliant green ii) Red
7.	Slope oil	Light brown	Black	18.	Oily water	Black	No band
8.	Hydrocarbon condensate	Dark Admiralty grey	i)Signal red ii) Black	19.	Dozing chemical	Dark Admiralty grey	No band *
9.	Methanol	Dark Admiralty grey	i) White ii) Gulf red	20.	NGL	Dark Admiralty grey	i)Brilliant green ii) Black
10.	Mercaptane	Dark Admiralty grey	Signal red	21.	ATF	Dark Admiralty grey	i) Black
11.	Chlorine	Dark violet	Signal red				

TABLE-2 COLOUR SCHEME FOR UTILITY ITEMS USED IN PROCESS IN ONGC

A. Water

Sl. No.	Description of Products	Colour Code Identification		Sl. No.	Description of Products	Colour Code Identification	
		Base/ Ground Colour	Colour Bands i)First band ii)Second band			Base/Ground Colour	Colour Bands i)First band ii)Second
1.	Drinking water	Sea green	i)French blue ii) Signal red	8.	Wash water	Sea green	Canary yellow
2.	Domestic Hot Water	Sea green	Light grey	9.	Fire water	Fire red	Crimson red
3.	Cold water service from storage tank	Sea green	i)French blue ii) Canary yellow	10.	Sea/river untreated water	Sea green	White
4.	De mineralized water	Sea green	Gulf red	11.	Waste water	Sea green	i) Canary yellow ii) Signal red
5.	Cooling water	Sea green	French blue	12.	Treated water	Sea green	Light orange
6.	Boiler feed water	Sea green	Gulf blue	13.	Chilled water	Sea green	i) Black ii) Canary yellow
7.	Condensate water	Sea green	i)Light brown ii) Signal red				

B. STEAM

Sl. No.	Description of Products	Colour Code Identification		Sl. No.	Description of Products	Colour Code Identification	
		Base/ Ground Colour	Colour Bands i)First ii)Second			Base/Ground Colour	Colour Bands i)First ii)Second
1.	Very high pressure (VHP) steam (above 40 Kg/cm ²)	Aluminium	Signal red	4.	Low pressure steam (SL) (1 kg/cm ² to 15 kg/cm ²)	Aluminium	Canary yellow
2.	High pressure steam (SH) (25 kg/cm ² to 40 kg/cm ²)	Aluminium	French blue	5.	Purge steam	Aluminium	Grey
3.	Medium pressure steam (SM) (15 kg/cm ² to 25 kg/cm ²)	Aluminium	Gulf red	6.	Steam condensate	Aluminium	i) Sea green ii) Canary yellow

C. COMPRESSED AIR

Sl. No.	Description of Products	Colour Code Identification		Sl. No.	Description of Products	Colour Code Identification	
		Base/ Ground Colour	Colour Bands i)First band ii)Second			Base/ Ground Colour	Colour Bands i)First ii)Second
1.	Compressed air up to 15 kg/cm.sq	Sky blue	---	4.	Instrument air	Sky blue	French blue
2.	Compressed air above 15 kg/cm.sq	Sky blue.	Signal red	5.	Drainage	Black	--
3.	Plant air	Sky blue	Silver grey				

D. OILS

Sl. No.	Description of Products	Colour Code Identification		Sl. No.	Description of Products	Colour Code Identification	
		Base/ Ground Colour	Colour Bands i)First ii)Second			Base/Groun d Colour	Colour Bands i)First ii)Second
1.	High speed diesel fuel	Light brown	---	3.	Lubricating oil	Light brown	Light grey
2.	Hydraulic power	Light brown	Dark violet				

E. GASES

Sl. No.	Description of Products	Colour Code Identification		Sl. No.	Description of Products	Colour Code Identification	
		Base/ Ground Colour	Colour Bands i)First ii)Second			Base/Groun d Colour	Colour Bands i)First ii)Second
1.	Acetelene	Canary yellow	Service brown	4.	Carbon dioxide	Canary yellow	Light grey
2.	Nitrogen	Canary yellow	Black	5.	Acid gas	Violate	No band
3.	Oxygen	Canary yellow	White				

NOTE : 1. Any product which is not covered will be governed as per colour code standard IS :2379-1990 / (re affirmed in 1996)/other standard under reference.

* Name of the dozing chemicals should be written with flow of direction on pipe lines.

TABLE- 3 FIRE EQUIPMENT, FIRE TENDERS, etc.

S. N	Item/Application	Standard painting colour	S. N	Item/ Application	Standard painting colour
1	A.Extinguishers : Water based, Foam,DCP, CO ₂	Fire red paint (shade No. 536 of IS-5-AS AMENDED)	2	Foam tank & foam piping/ Nitrogen cylinder	Dark Admiralty grey
	B.All fire tenders/ Jeep, Fire engines (except Foam tank, foam piping & Nitrogen cylinder)		3	Driver compartment & inside of the lockers	Pale cream
	C. Fire tender water piping/ Wet risers/ Fire hose reel box		4	Chassis & wheel arches	Black
	D. Fire tender water pump & engine/ Water pipeline in engine & pump.		5	Fire service insignia & identity nomenclatures	Canary yellow with black border on both sides of the vehicle/equipment
	E. DCP tank & DCP piping				

[Please click here for colour coding illustration](#)

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12.0.0 SPECIAL TOOLS, TACKLES AND EQUIPMENT

One set of special tools and tackles required unit for the operation, maintenance, inspection and repair of the individual main equipment and auxiliary equipment shall be supplied by the Contractors in sufficient quantity to equip the shift personnel, maintenance personnel and workshop craftsman for commissioning, testing, calibration, modification and maintenance of the unit, List of such special tools, tackles and equipment shall be submitted in the EPC bid. Special tools and tackles excludes conventional ones and those locally available normally (not those requiring a drawing and considered as those made to order).

The special tools and equipment for maintenance and repair shall be delivered by the Contractor in lockable steel boxes and they shall be marked in an approved manner for identification purposes and a corresponding tool chart shall be supplied with the steel boxes.

The following tools and appliances shall be supplied under this Contract for use by the Owner/Owner's representative:

- two sets of special tools and gauges required for the maintenance of the Plant
- one set of special lifting and handling tackles / appliances required for the maintenance of the Plant.

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The tools, tackles and appliances supplied in general, shall not be used for erection purposes by the Contractor and shall be handed over in brand new condition. Damaged tools, tackles, and appliances shall be replaced before handing over.

The exception to this is the special lifting gear which may be used provided that when it is handed over to the Owner/Owner's representative it has not been subjected to more than normal wear and is still fully suitable for its intended use.

Each set of tools, gauges and appliances under category (a) above shall be suitably arranged in fitted boxes of mild steel construction, the number of boxes being determined in relation to the layout of the plant and equipment in question.

If the weight of any box and its contents should be such that it cannot conveniently be carried, it shall be supported on steerable rubber-tyred wheels.

Each cabinet and box shall be painted, fitted with a lock and clearly marked in white letters with the name of the item of equipment for which the tools and appliances contained are intended.

Suitable storage racks shall be provided for all portable lifting tackle supplied under this contract.

Suitable lifting lugs, ears or ring bolts, or tapped holes for lifting rings shall be provided on all equipment items where the weight exceeds 15 kg.

All lifting tackle shall be stamped with a unique identification number and safe working load. A test certificate from an approved Authority shall be supplied for each item of lifting tackle.

The Contractor shall provide a schedule of all lifting tackle and tools and appliances being supplied, for the approval of the Owner/Owner's representative.

The Contractor shall provide all runway beams, trolleys, lifting blocks, special slings necessary for the safe and efficient handling and maintenance of the works. Particular attention shall be paid to handling of equipment located at higher elevations safety valves

The tools and appliances with the appropriate storage racks, cabinets and boxes shall be handed over to the Owner/Owner's representative at the time of Taking Over of the complete Plant.

Since the Contract includes site erection, any special tools or appliances required solely for erection shall be provided by the Contractor for his own use and shall remain the property of the Contractor.

Control and Instrumentation: Software with associated hardware required to access instruments or control systems to be provided.

13.0.0 CONSUMABLES

13.1.0 Lubricants and greases

All lubricants proposed for the Plant operation shall be suitable for all operating and environmental conditions that will be met on site.

All oils and greases shall where possible be readily available in India.

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The number of oils and greases shall be kept to a minimum to the extent feasible. For each type and grade of lubricant recommended the contractor shall list at least three equivalent lubricants manufactured by alternative companies. This will be in line with that suggested by OEM and outcome will be informed to the Owner/Owner's representative.

In case of imported oils, lubricants and other consumables, the contractor shall indicate the indigenous equivalents to enable the Owner/Owner's representative to arrange subsequent fills. Preference should be given to indigenous oils and lubricants during first filling itself. Short shelf life items if any may be supplied in a phased manner keeping in view of their actual use.

The Contractor shall supply the first fill lubricants and greases, and also shall provide at the Completion Certificate sufficient lubricants and greases necessary for the efficient operation and maintenance of the Plant at full load 24 hours per day for a period as mentioned in the relevant portion of Commercial Specification.

13.2.0 Chemicals and other consumables

Contract includes the supply (by the Contractor) of all chemicals, reagents, resins, and other consumables required for testing, commissioning and setting to work of each section of the Works.

The Contractor shall provide all chemicals and other consumables required for the efficient operation and maintenance of the plant at full load 24 hours per day for a period as mentioned in the relevant portion of Commercial Specification.

The Contractor shall prepare a list of these consumables giving quantities necessary for each section of the works and the recommended suppliers.

The Contractor shall deliver to site sufficient quantities of consumables in his supply to allow for 6 months running of the Works prior to the issue of the Completion Certificate. The delivery of the remainder of the consumables shall be programmed to suit the operational requirements and space availability within the various stores.

14.0.0 DOCUMENTATION

14.1.0 Format of Documentation

All engineering documents and drawings shall be of international "A" series sizes, that is, A0, A1, A2, A3 and A4.

One set of CD containing all the drawings in Auto CAD (for final as built drawings) shall also be supplied in addition to hard copies.

Soft copy of all other documents shall be supplied in a CD in PDF or editable format. For review purpose pdf or editable version shall be considered.

Grouped documents shall be provided by size A4, with the inclusion of bigger size drawings which, however, have to be folded as Size A4.

For MPP package documentation shall be as per MPP standard.

14.2.0 Numbering and Identification of Documents

All the drawings shall be identified through a common way of numbering in accordance with the requirement of contracting. The numbering system of drawings and documents proposed by the Contractor shall be in compliance with the plant identification system and to be agreed

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with the Owner/Owner's representative. Apart from this, some drawings may also be numbered in the way which the contractor or subcontractors are used to do. But, there shall be a common title Block on all published drawings which include the following contents:

- Owner
- Owner's Engineer
- Project
- Contractor
- System
- Drawing No.
- Sheet No
- Revision No.

The measuring units and dimensions marked on the project engineering drawings shall be of SI system conforming to ISO 1000.

English words shall be used as descriptions on drawings.

In case dimensions are not marked in conformity with the scale of drawings and any dimension on the drawing does not conform to those dimensions and sizes measured through certain scale, the actual marked dimensions shall be applicable.

For revision of drawings, the revised part shall be clearly and definitely shown on the drawing. For revision of documents which have been grouped together, a brief description shall be a perpendicular line with the margin of the revised copy closely following it.

14.3.0 Provision for Documents

Generally, copies of drawings or documents containing trade secret and drawings with patented nature need not be provided.

However, to know whether the Contractor has performed its obligations, the Owner/Owner's representative has the right to examine those drawings within the Contractor's working scope.

The Contractor shall meet the Owner/Owner's representative's reasonable demands to files and do the following to satisfy the Owner/Owner's representative:

- Contractor will work according to the requirements specified in the contract.
- Contractor's working has been arranged properly and developed according to the plan.
- The quality control system is reliable.
- After receiving all documents necessary for power plant operation and maintenance, Contractor shall supply equipment and systems.
- Having received all necessary documents for Contractor to perform its legal obligations or other relevant responsibilities.

14.4.0 Owner/Owner's representative's Responsibilities

The Owner/Owner's representative agrees that the Contract will be concluded in accordance with the EPC method of building the power plant. It is the Contractor's duty to ensure that design standards and conditions meet the requirements and that the power plant shall operate safely and reliably and with high efficiency, having the same performance as

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stipulated and guaranteed. This is applicable until the plant performance is established in the last PG test. The plant performance beyond such last PG test will not be the same because of degradation as per equipment characteristics.

The Owner/Owner's representative will examine and check the drawings and documents with the aim of ensuring all these drawings and documents meet the demands and duties written in the documents. The Contractor shall have an active and cooperation working relationship with the Owner/Owner's representative.

If drawings and documents have been supplied to the Owner/Owner's representative, Contractor will await clearance / approval from Owner/Owner's representative at a pre-agreed time frame, before proceeding on design. In case, Owner/Owner's representative has comments / opinion, the same can be informed to the Contractor on priority basis so that corrections, if feasible could be incorporated in the drawings.

15.0.0 PLANT AND EQUIPMENT IDENTIFICATION, LABELLING

15.1.0 Plant and Equipment Identification

The contractor shall follow identification system for the whole plant equipment, instruments, facilities and systems as per the Annexure-4 Guide for Coding Equipment, Documents & Drawings

MPP generated drawings, identification system shall be based on MPP standard.

15.2.0 Labelling

Name plates which are to be firmly fixed on all the equipment, instruments, buildings and structures shall be provided. For equipment of small size, these are to be fixed on the piping or structure adjacent to the equipment. The contents of nameplate are to include the designation and principal parameters of the equipment.

The nameplate within the field shall be made of a high temperature - resistant metallic sheets, with designation permanently engraved on them. Indoor installed equipments (e.g., panels, cabinets, switchgear) shall also be labelled by appropriate name plate.

The form, size, base colour and colour of contents of the name plates and prompting plates will be agreed between the Contractor and the Owner/Owner's representative. It shall be possible for these to be readily seen by the operator. The designation of warning tags shall be different from that of other tags. All buried pipes and cables routes shall be identified with permanent marker.

16.0.0 CONTRACT DRAWINGS, DOCUMENTS FOR APPROVAL, LIAISON MEETINGS

16.1.0 General

The Owner/Owner's representative reserves the right to ask the Contractor to submit copies of drawings and other documents for approval to his Head Office or to the Office of his Representatives. If the Owner/Owner's representative or his Representatives are satisfied with the drawing, one copy will be returned to the Contractor marked with an 'Approved' stamp. Within a pre-agreed time frame, If the Owner/Owner's representative or his Representatives are not satisfied with the drawing, one copy stamped 'Examined and Returned with Comments' will be returned to the Contractor with comments marked thereon and the drawing shall be revised and re-submitted for approval.

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The purpose of having drawings checked and approved by the Owner/Owner's representative is to assist the Contractor in interpreting the Technical Specification so as to eliminate mistakes in the equipment or material actually shipped to the site of the work. The formal approval given to the Contractor is to be considered as in conformity with this purpose and in no manner shall be construed so as to release the Contractor from any liability or responsibility for proper design, fabrication or compliance with the Contract Documents.

Equipment drawings shall clearly indicate the general arrangement of the equipment to be furnished, give principal dimensions, and show sufficient details required for a complete power station.

While submitting drawings for approval, including any prepared by a Sub-Contractor, the Contractor shall certify that he has fully examined such drawings and that they comply with the requirements of the Contract.

If any item, equipment or work shown in the drawings does not completely comply with the requirements of the Specification or any other requirement of the Contract Document, the Contractor is obliged to clearly inform the Owner/Owner's representative and his Representatives of the differences giving full explanations and reasons for such changes.

For the purpose of this Clause, the term "drawing" shall include design calculations, equipment specifications, diagrams, schedules, performance curves.

Approval of a drawing by the Owner/Owner's representative will imply that:

- Arrangement and layout drawings and key diagrams have been examined and appear to be in accordance with the basic design concept of the project and meet the requirements of the Specification.
- Other drawings of components and equipment have only been examined in relation to compatibility of the items and equipment with the Specification and in respect of interconnection with other items and equipment.
- Any approval given by the Owner/Owner's representative shall in no way relieve the Contractor of his responsibility under the Contract.

The Owner/Owner's representative will not normally require to receive copies of detailed manufacturing drawings but the Contractor shall make these available if requested to do so.

The Contractor shall ensure that drawings are submitted in due time to permit amendments to be made and the drawings re-submitted for approval without delaying the scheduled deliveries or the guaranteed completion dates according to the Contract. Execution of work shall be taken up after the drawings are cleared by the Owner/Owner's representative.

If, during the Contract period, the Contractor is required to modify the size of any buildings, foundation from that shown in Technical Specification drawings to accommodate the finally approved arrangement of the Work (with due allowance for access, laydown, maintenance), then such modification shall be deemed to be included in the scope of the EPC Contract.

Requirements about the format of drawings and documents, the provision for documents and the Owner/Owner's representative's responsibilities with regard to documentation are specified in relevant section of this volume.

The Contractor shall be responsible for any discrepancies, errors or omissions in the drawings and other particulars supplied by him, whether such drawings and particulars have been approved by the Owner/Owner's representative or not.

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16.4.1 Document Distribution Schedule - After Placement of Order

Sl. No.	Document	Total Copies	Distribution		
			Owner		Owner's representative
			HQ	SITE	
1.	PERT Network, work schedules, Bar charts, Layout drawings	10	-	5	5
2.	Data, drawings, documents, write-ups, calculation				
	- Preliminary	10	-	5	5
	- Revised	10	-	5	5
3.	Approved drawings and documents.	10	-	5	5
4.	Instruction manuals for erection and O&M	10	-	8	2
5.	As built drawings including O &M manual				
	- Hard Copy	10	-	8	2
	- Soft Copy	-	-	-	-

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16.5.0 Manuals

General

The Contractor shall provide the manuals in a timely manner to enable the Owner/Owner's representative to review and comments and request changes as necessary.

Payments will be withheld for non-compliance or for late delivery of the drawings, procedures and manuals. In particular the Contractor shall be held responsible for consequential damage to the plant where such damage is due to late delivery of the O&M manual resulting in non-familiarity of the operating technique.

The Contractor shall also note that while all documents, procedures and manuals shall be in the English language including that of the Subcontractor of the Contractor, it is particularly important that the O&M manuals be in clear concise English.

All manuals shall be divided by systems or sections and cross-indexed as necessary.

Construction Manual

This shall include a comprehensive record of as built site construction tests and records. Again the manual(s) shall be compiled in separate parts to reflect the plant and services supplied.

Commissioning Manual

This manual shall include all the records, certificates and test results arising from the agreed pre-commissioning and commissioning procedures carried out on site. The performance tests and guarantee test results shall also be included. There is a particular requirement that all commissioned plant/equipment values be recorded in this manual and subsequently incorporated into the O&M manuals.

Operating and Maintenance (O&M) Manuals

The Contractor shall provide the O&M Manual properly bound, within the time specified, to enable the Owner/Owner's representative's staff to become fully acquainted with the operation, adjustment and maintenance of the entire plant. The manuals shall contain full and explicit instructions in respect of the operation of the plant under all operating conditions and the maintenance routines and requirements to be established to maintain the plant in optimum performance. These instructions shall be in the English language and be as comprehensive as possible and the form in which they are to be set out shall be agreed with the Owner/Owner's representative. The instructions may be divided as appropriate into individual sections and sub-sections as necessary. All section and sub-sections shall be clearly indexed and cross-referenced as required for clarity.

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The instructions shall be tailored to suit the specific requirements of the Operations and Maintenance functions and personnel, taking into account the staffing philosophy for the combined cycle power plants.

The instructions for the related parts shall be accurate and easy to understand and shall contain the necessary sequence of individual activities. The diagram and drawings associated with the instruction shall be clear and unambiguous.

It is an essential requirement that all information and plant data contained in the manual must be project specific and derived from the design, manufacturers / suppliers and commissioning data of the as-built plant. Where the Contractor includes standard brochures the installed item of plant or equipment shall be clearly identified. All sections shall contain an introductory description of the particular item/system including its function and operating criteria and any special features. On the basis of the commissioning and running experience of the Plant, the instructions shall be amended to a final form within three months of the end of commissioning and, for this purpose; the Contractor shall supply the required number of printed copies of all approved amendments for insertion in the bound set of instructions.

The entire O&M manuals including that of the Subcontractor shall all adopt the same format paper size. The Contractor shall prepare manuals integrating all equipments supplied by the Subcontractors.

Operating Instructions:

The instructions shall include at least the following specific procedures/practices /items:

- starting-up
- shutting down
- operation / procedures during fault conditions
- surveillance and monitoring of plant .check lists
- standard readings
- operational parameters (especially limiting values in critical areas)
- isolating procedures
- Earthing /switching
- trouble-shooting
- fault reporting
- normal operational reporting
- compliance with requirements for interfacing with grid.
- safety/security/fire fighting/ first aid
- general plant standards and guidelines .
- test procedures
- maintenance and operating management systems
- drawings, schematics, logics and wiring diagrams, function diagram, P&IDs.
- protection

Maintenance Instructions:

The instructions should provide for the three maintenance functional groups – 1) Mechanical, 2) Electrical, and 3) Control and Instrumentation - and shall include at least the following:

Maintenance Management System

- a complete and accurate description of the main plant items and systems of the Power Station specific to each function
- detailed maintenance procedures and intervals for all plant items.

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- assembly and disassembly procedures.
- spare parts
- use of special tools and equipment
- lifting procedures
- drawings, detailing tolerances
- schematics, logics and wiring diagrams, function diagrams P&ID's.
- isolating procedures,
- Safety and Codes of Safe Practice.
- Fire fighting/first aid
- set-up and calibrating procedures .
- optimisation of Control Loops
- diagnostics and trouble shooting
- specialist maintenance/repair procedures including welding procedures.
- materials test procedures

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17.0.0 ENVIRONMENTAL PROTECTION

17.1.0 Applicable Standards

The project must conform to the national standards of the Republic of India. The following standards and /or regulations are to be applied:

17.1.1 Environmental Quality Standards

The discharge of pollution in water and air as well as noise levels shall meet with the stipulations of State Pollution Control Board as well as other Acts of the Government under the Ministry of Environment and Forestry. It is a pre-condition that irrespective of what is stated in statutory regulations or any other act or norms, the Specification stipulated environmental qualities standards are the minimum requirements and shall be fulfilled in all aspects.

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17.2.4 Noise Pollution Prevention and Control

The Contractor shall take all necessary measures for noise attenuation in order to meet the specified noise levels.

General requirements of noise control :

- The minimum requirement shall be met as whatever has been specified in each of the Detailed Technical Specifications. However the station shall be acoustically designed so that an admissible noise level of 70 dB (A) during night time and 75 dB(A) during day time shall not exceed at nearest Property boundary during normal operating mode.

For Central Control room, near to the duct noise level shall not exceed 60 dB(A) and at other places noise levels shall not exceed 50 dB(A)

The noise level in the offices and the control room shall be not more than 50 dB (A)

The Contractor shall take measures for noise attenuation, if the above mentioned noise levels are not met.

	Subject	Doc. No.	Rev.	Vol. / Sec.
	BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT	5111168-ME-SPC-100-001	R1	IV / 8
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VOLUME – IV

SECTION – 8

**GEOTECHNICAL INVESTIGATION
REPORT - INSIDE AREA**

 LARSEN & TOUBRO LIMITED E&C DIVISION		GEOTECHNICAL INVESTIGATION REPORT-INSIDE AREA - RESOLUTION OF EIL COMMENTS ON REV00	DOCUMENT NO. A067-LT-00-CV-04-RP-0004
PROJECT : Additional Gas Processing Facilities (Phase-IV)			REVISION : 01
CUSTOMER : ONGC,HAZIRA			
Resolution of EIL Comments dtd. 26.08.2010			
Sr. No.	COMMENT / OBSERVATION	L&T RESOLUTION	
1	Refer Cl. 7.0 Option 1: Adapted pile capacity in Compression, uplift and lateral mode is on the higher side. Provide Backup calculation as per IS 2911 relevant parts.	Pile capacities revised as follows: Axial compression: 65T Lateral: 4.5T (fixed head) 2.0T (free head) Backup calculations provided in Appendix-I	
2	Refer Appendix-I: For pile bearing capacity calculation, Use Nq value given in Fig.1-Ammendment No-1 of IS: 2911 (Part-1/Sec-2)-1979 instead of the Fig. 1 given in page-24 of the same code. And, earth pressure coefficient (k) taken for pile capacity sample calculation of layer-4 is 2.5. But according to IS: 2911 (Part-1/Sec-2)-1979 this value for bored cast in-situ pile ranges between 1 and 2. Revise pile capacity as per codal provision.	Calculation has been corrected (ref Appendix I)	
3	Evaluating of pile lateral capacity shall be as per IS Code of relevant parts.	Complied (ref Appendix I)	
4	Refer Cl. 7.0 Option 2: The points to be addressed along with the recommendation of lightly loaded structures and equipments. i) For lightly loaded structures and equipments, open foundation with a depth of 2m below FGL is recommended. Ground treatment shall be provided below foundation considering swelling nature of soil. ii) Recommended bearing capacity at 2m depth of footing in both shear and settlement is on the higher side considering poor consistency of soil bearing layer.	i) As per good engineering practice, 300mm granular cushion shall be provided below foundations (section 7, note 1, 5) ii) Bearing capacity has been revised to values provided in Section 7, note 1	
5	As the soil is of swelling nature, Geotechnical recommendation is required for road & pavement sub grade, culverts, building floors, underground piping etc. with backup calculation and standard practice.	Mitigation measures will be submitted separately. Design ground water table shall be at EL 99.500 (section 7, note 2)	
6	Precaution to counteract the harmful effect of high chloride and sulphate content in soil and ground water is to be recommended.	Clear cover increased to 65mm from 50mm. Requirements governing type of cement and cement content included in Section 7, note 3	
7	Refer Cl. 2.2.4 and BVT Test Results: There is a discrepancy in the block size mentioned at the above mentioned clauses. Clarify the discrepancy. Moreover, Why the block size taken is not according to IS: 5249, 1992. Explain.	Typographical error in Cl. 2.2.4 has been corrected	
8	Refer Results of Block Vibration Test: There is some error in calculation of modulus of rigidity and modulus of elasticity value. Verify and correct the same.	Corrected	

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9.	Concentration of sulphates, expressed as SO ₃ shall be performed for the chemical analysis of water and suitable precaution shall be adopted to counteract the harmful effect of sulphates.	Typographical error in Table 3 has been corrected. SO ₃ is within limits specified for Class 2 as per IS 456 Table-4