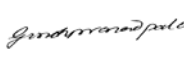
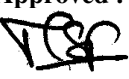


TD-106-1 Rev No. 5	Form No.	 HYDERABAD	PRODUCT STANDARD BHEL, HYDERABAD –32. PROJECT ENGINEERING & SYSTEMS DIVISION		PY51150 Rev No. 02 Page 1 of 3	
COPYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED, It must not be used directly or indirectly in any way detrimental to the interest of the company.		PURCHASE SPEC FOR PUMPS & MOTOR				
Ref. Doc		Revisions : Refer to record of revisions :	Prepared : -sd- OM	Approved : -sd- SIVA PRASAD	Date : 13.05.15	

TD-106-2 Rev No. 5	Form No.	 HYDERABAD	PRODUCT STANDARD BHEL, HYDERABAD –32. PROJECT ENGINEERING – MECHANICAL	PY51150	
				Rev No. 02	
				PAGE 2 of 3	
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	<u>VARIANT TABLE</u>				
	Variant No.	Item	Material code	Job Specification	Project
	01	Motor for OILY & WASTE water pumps	PY9751150019	PEMC-05522	OIL-Duliajan
	02	Motors for OILY & WASTE water pumps	PY9751150027	PEMC-05797	OIL-Duliajan
	03	HRSG Boiler Feed pump with drive	PY9751150035	PEMC 05923	CPCL-GT/HRSG, Manali
Ref. Doc					

TD-106-3 Rev No. 5 Form No.	 HYDERABAD	PRODUCT STANDARD BHEL, HYDERABAD –32. PROJECT ENGINEERING – MECHANICAL		PY 51150			
				Rev No. 02			
				PAGE 3 of 3			
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		Rev. No.	Date	Revision Details	Revised By	Approved By	
		00	03.02.15	FRESH ISSUE	-sd-	-sd-	
		01	28.03.15	Variant 02 added	<i>Gundurramanadpala</i>	<i>RCR</i>	
		02	13.05.15	Variant 03 added	<i>Shankar</i>	<i>TSR</i>	
		Ref. Doc.					

TD-201 Rev No. 00	Form No.		PRODUCT STANDARD PROJECT ENGINEERING HYDERABAD		PEMC-05923 Rev No. 00 Page 1 of 20	
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 SPECIFICATION FOR BOILER FEED PUMPS FOR HRSG - MOTOR DRIVEN (INCLUDING DRIVE MOTOR)				
		<u>PROJECT</u> : RESID UPGRADATION PROJECT/GTG & HRSG PCKG <u>OWNER</u> : CHENNAI PETROLEUM CORPORATION LIMITED (CPCL) <u>LOCATION</u> : CPCL REFINERY MANALI, CHENNAI, INDIA. <u>CONSULTANT</u> : M/S JACOBS ENGG INDIA PVT LTD, MUMBAI.				
Ref. Doc		Revision :00 Refer to record of revisions :	Prepared :  OM	Checked:  GIRISH	Approved :  SIVA PRASAD	Date : 06.05.15

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		DOCUMENTS TO BE SUBMITTED WITH THE BID: The bidder must submit the following documents along with their bid so as to enable BHEL to evaluate their offer. a) Duly filled in HRSG BFP Pump datasheet b) Duly filled in HRSG BFP Drive motor datasheet c) Tentative GA / P&ID for BHEL' reference only. d) Performance curves for Pump and drive motor for various conditions as per clause no 7.0.1. e) Un-priced copy of price in attached BHEL price bid format indicating quoted/ not quoted against each row & column. f) Equipment qualification criteria / PTR / Reference Lists g) Checklist (Annexure-23)		
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Form No.	बी एच ई एल BHEL HYDERABAD	PRODUCT STANDARD PROJECT ENGINEERING HYDERABAD	PEMC-05923
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TECHNICAL SPECIFICATION FOR BOILER FEED PUMPS FOR HRSG - MOTOR DRIVEN			
1.0.0. INTENT OF SPECIFICATION: This specification specifies the requirement of Design, Engineering, Manufacturing, Assembling, Inspection, Testing at manufacturer's works and Delivery properly packed and painted for transport of BFP including drives with all accessories as specified in the scope of work and as required for the safe and trouble-free operation of equipment to be installed at site.			
2.0.0 SPECIAL NOTES TO BIDDERS: 2.0.1 This specification shall be read in conjunction with its enclosures. In case of any discrepancy arising between this specification & its enclosures, the most stringent of all shall be followed and shall over-ride others. 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 distinctively in 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. 2.0.2 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. 2.0.3 The Bidder shall accept full responsibility for the completeness and for the faultless working of all the equipments. These shall be executed on the basis of proven design principle and in accordance with the latest state of the art in such a manner that the purpose to be served by the Pump unit is fulfilled in every respect and a maximum of operational dependability and efficiency are assured. Standardization of equipment, materials etc. shall be employed in the design. Care shall be taken to ensure safe operation as well as simplicity of assembling and dismantling of all parts of the plant. 2.0.4 Bidder shall quote strictly as per the scope of supply and requirements of this specification. 2.0.5 Bidder offer shall be strictly as per these specification requirements. Unsolicited or Alternate offers from the bidders will not be entertained. 2.0.6 In case bidder feels that it is necessary to exclude some components of scope of supply or some of the features of specification requirements due to any technical constraints, bidder shall bring the same to the notice of purchaser during pre-bid stage and take their prior approval before submission of their bid. 2.0.7 Incase Bidder is unable to offer due to any specific requirement of specification, Bidder shall bring out the same in their regret letter. Otherwise it will be considered that non participation by the bidder is attributable to reasons other than any specification requirements.			
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3.0.0 APPLICATION OF SYSTEM: The BFP's are envisaged to transfer feed water from De-aerator to HRSG's. Total Two numbers (1 Working + 1 Stand-by) of HRSG BFP's are envisaged. Location of pump & Motor shall be: Outdoor 4.0.0 SCOPE OF SUPPLY: The scope of supply for this enquiry is as given below. Please refer to the enclosed P&I D for BFP's (Anexure-1) for general clarity on scope of supply. The system shall be provided as per P&I D for BFP's (Anexure-1) taking into all requirements including for testing, painting documentation, sub vendor list, equipment specifications etc., specified in this specification and enclosures. - No. of Pump & Drive Assembly: 2 Nos. [All Motor Driven] – For HRSG's A) The scope of supply for each Pump & Motor Drive assembly is as given below. 1) Pump : Horizontal, centrifugal, multi stage, Barrel casing design pump complete with all accessories as per specification. (Refer Annexure-1, clause no. 3.6 of Annexure-5, Annexure-6 & 7) 2) Motor : Suitable drive motor complete with terminal box, canopy, space heater, cable glands, earthing lugs and all other accessories required as per specification. (Refer Annexure-8, Annexure 9 and Annexure 10) Rating of Motor: 6.6 KV, 3 phase, 50 Hz 3) Current Transformers for Motor (If Applicable): Unless otherwise specified, motors rated 1500KW and above shall have differential protection and shall be equipped with current transformers suitably designed for installation in the neutral terminal box. Unless otherwise specified, the CTs shall be supplied along with the motor and mounted in the terminal box, which shall be suitable for housing the CTs and providing the necessary connections. CT terminals shall be brought out to a separate auxiliary terminal box. These transformers shall have a secondary current of 1A, and the characteristics of the CTs (V_k, R_{CT} and I_m) shall be finalized at detailed engineering stage in consultation with the purchaser. CT ratio shall be as indicated in the motor datasheet. 3no CTs for each Motor Driven BFP's shall be provided at motor neutral end with following parameters for achieving motor differential protection as per contract. 300/1A, CL PS, $V_k \geq 500V$, $I_m \leq 30mA$ at $V_k/2$, $R_{CT} \leq 5\Omega$ at $75^\circ C$ 4) Coupling between pump and motor : Coupling between pump and motor shall comply with the following. - Coupling shall be as per API 671 - Metallic, Non-lubricated, flexible element type [diaphragm or disc type], - With Non sparking type coupling guard - With spacer - With a minimum service factor of 1.5 5) Gear Box (If Applicable):			
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Gear Box shall be as per:

(a) API 677 for motor rating less than 750 KW
(b) API 613 for motor rating greater than 750 KW.

6) ARC Valve:

a) Modulating type Automatic Recirculation Control valve with flanged ends for minimum flow control.
b) The ARC valve size shall be as per Bidder's recommendation, however not less than Pump discharge nozzle size.
c) ARC valve shall be selected based on required minimum re-circulation flow of the pump
(Higher of thermal/stable minimum flow).
d) ARC Valves to be selected in such a way that the increase in pressure drop through the ARC Valve from rated flow of the pump to approx. 130% of the rated flow shall be limited to 1.0 kg/cm² only. This is to ensure flexibility of operating system at marginally higher flows as per site conditions if any.
e) Material of construction: Body: CS, Internals: SS

7) Conical Type Suction Strainer :

Conical type suction strainer with flanged ends, with

a) Strainer size & rating shall be same as **BHEL suction pipe size (Refer Annexure-1).**
b) MOC of the strainer:
Body: CS
Internals: SS 316/SS 304
c) Suction strainer Mesh size : 40 mesh **
d) With Free flow Area: Minimum 6 [six] times that of BHEL inlet pipe size.

*** Bidder to note that Mesh size of 40 mesh of screen mentioned in the specification is for indicative purpose only. Bidder is requested to select the suitable mesh size of the screen for strainer based on the actual pump clearances & also considering quality of water during commissioning at site.*

8) Forced Lubrication System(If Applicable):

(a) Forced oil lubrication system shall be as per API-614 (4th edition).
(b) The interconnection piping between the equipment & Lube oil system.

9) Local gauge board (As required)

10) Common base frame with fixing bolts for pump, motor, Gear Box (if applicable) etc.

11) Inter connecting Piping & Instrumentation :

Interconnecting piping and instrumentation as per P&I D [Annxure-1]
Consisting of following as minimum as indicated in P&I D:

a) Suitable reducers/expanders at all terminal points matching with BHEL pipe sizes as indicated in the P&I D [Annxure-1]
b) Counter flanges with necessary gaskets & bolts at all terminal points. (Please refer P&I D [Annxure-1])

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c) Minimum instrumentation as shown in P & ID i) Pressure Gauges at: - pump suction - pump discharge - Re-circulation line - Balance leak off line - Cooling water inlet ii) Temperature Gauges at: - pump suction - pump discharge - Cooling water inlet - Cooling water outlet - seal coolers <i>Note: All temperature instruments shall be provided with thermo -well.</i> iii) Differential Pressure Gauge across Suction strainer: iv) Differential Pressure Transmitter across Suction strainer: v) Pressure Transmitter [Smart type with HART protocol] at: - pump suction - pump discharge - Balance leak off v) RTD with Temperature Transmitter [Smart type with HART protocol] at: - pump suction - pump discharge <i>Note: All temperature instruments shall be provided with thermo -well.</i> vi) Pressure Safety relief valve at: Balance leak off line vii) Temperature relief valve to be provided on each individual cooling water Outlet line. viii) Sight flow indicators shall be provided on each individual cooling water return line. 12) Necessary foundation bolts, nuts, shims/grouting pads etc. 13) MONITORING SYSTEM For motor driven centrifugal pumps machine monitoring will be provided for all pumps above 160 kW. Machine monitoring system will include following probes along with racks, modules, display unit. For instruments and JB details, refer Annexure 15, 15(a), 12 & 13. 1) VIBRATION MONITORING PROBES : Vibration measurement shall be provided in both X & Y directions for Pumps, Gear Box [if applicable], Motors for both Driven end and Non-Driven end Bearings. The required probes/proxy meter, Key Phasor and other auxiliary measurements shall also be envisaged, as required for VMS. The specification for the same shall be as detailed in enclosures. Vibration monitoring system for each pump: - Provision & supply of non contact type/contact type probe-Horizontal-Drive End-1 No. - Provision & supply of non contact type/contact type probe-Vertical-Drive End-1 No. - Provision & supply of non contact type/contact type probe-Horizontal-Non Drive End-1 No. - Provision & supply of non contact type/contact type probe-Vertical-Non Drive End-1 No. - Provision & Supply of non Contact Type/contact type Axial Probe for Pump-2 Nos.			
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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.	Ref. Doc	Provision & Supply of non contact type/contact type Key Phasor-1 No. *Vendor to select suitable contact / non-contact type probes based on type of pump bearing. Vibration monitoring system for each motor. Supply of Contact/non contact type probe-Horizontal-Coupling End-1 No. Supply of Contact/non contact type probe-Vertical-Coupling End-1 No. Supply of Contact/non contact type probe-Horizontal-Non Coupling End-1 No. Supply of Contact/non contact type probe-Vertical-Non Coupling End-1 No. *Non contact type casing velocity probes shall be provided for motors above 750 kW & contact type casing velocity probes shall be provided for motors below 750 kW. For Gear Box (If Applicable): Provision & Supply of Non-Contact/Contact type Probes for shaft vibration at each bearing location-8 Nos. (2 Nos. at each bearing location, 1 for horizontal & 1 for vertical) Provision & Supply of Non Contact/Contact Type Axial Probe-2 Nos. Provision & Supply of Key Phasor-1 No. *Vendor to select suitable contact / non-contact type probes based on type of bearing. Supply of cables, probes/proxy meters & field junction boxes with accessories for the above probes. VMS shall be as Bentley Nevada 3500 series and shall confirm to API 670 (4th edition). VMS beyond junction box is excluded from bidder scope.[Bidder to note that Vibration monitoring system is in BHEL scope. Only probes, Supply of cables, proxy meters & field junction boxes to be provided] 2) BEARING & Winding RTD'S & Temperature Gauges: Pump: 1) Duplex type RTD with TT for radial bearing of pump DE 2) Duplex type RTD with TT for radial bearing of pump NDE 3) Duplex type RTD with TT for thrust bearing of pump 4) TG for radial bearing of pump DE 5) TG for radial bearing of pump NDE 6) TG for thrust bearing of pump Motor: 1) Duplex type RTD with TT for radial bearing of motor DE 2) Duplex type RTD with TT for radial bearing of motor NDE 3) TG for radial bearing of motor DE 4) TG for radial bearing of motor NDE Motor Winding RTD's: 1) Duplex RTD's with TT for winding temperature detection - 6 nos. [2 per phase] / 12 nos. of simplex RTD's Gear Box (if applicable): 1) Duplex type RTD with TT for radial bearing of gearbox DE-pump side 2) Duplex type RTD with TT for radial bearing of gearbox NDE-pump side 3) Duplex type RTD with TT for thrust bearing of gearbox NDE-pump side 4) Duplex type RTD with TT for radial bearing of gearbox DE-motor side 5) Duplex type RTD with TT for radial bearing of gearbox NDE-motor side 6) Duplex type RTD with TT for thrust bearing of gearbox NDE-motor side 7) TG for radial bearing of gearbox DE-pump side	

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		3) No. of Junction Boxes: Each train of system shall be provided with following No. of Junction Boxes.: a) For BFP Process (Temperature) Signals -1 No. b) For BFP Process (Pressure) Signals -1 No. c) For Pump Bearing RTDs - 1 No. d) For Motor Winding & Bearing RTDs -1 No. (Generally this is provided by motor manufacturer, it is the integral part of motor) e) For Gear box bearing RTDs-1No. (If applicable) f) LO System-1 No. (DCS). (If applicable) g) LO System-1 No. (PLC). (If applicable) Plz note that all the Junction boxes shall be as per Annexure 15(a) .	
		14) Lateral Analysis: Bidder to note that there is no requirement of lateral analysis as per API guidelines, if the analysis is available for similar pump supplied by the bidder for identical features that affect the lateral analysis. Otherwise bidder to furnish the lateral analysis during detailed engineering stage.	
		15) Torsional Analysis: Bidder to note that there is no requirement of torsional analysis if the motor rating is below the API Guidelines. Otherwise bidder to furnish torsional analysis as per API guidelines during detailed Engineering stage.	
		16) Complete Unit Test [String Test]: Bidder to note that the complete unit test (string test) is to be included in the scope.	
		17) First Fill of Lubricant: NOT in scope of supply of Bidder	
		18) Duplex SS piping for flushing plan: Duplex Stainless steel piping shall be provided for flushing plan in line with CPCL specifications. (Refer clause no. 6.5.2.9 of Annexure-6)	
		19) All other items necessary for safe and smooth running of pump & Accessories required to make the supplied equipment complete in all respect.	
		20) SPARES: A) Commissioning Spares - Two sets of commissioning spares shall be quoted as per manufacturer’s recommendation. One set stands for requirement for one no. of each pump and drive assembly. Bidder to furnish the list along with the offer. Please refer price bid format. (Refer annexure-4) . Minimum 1 Set of O rings & gaskets for each pump & drive assembly, and 1 set of spare Strainer Elements for each pump. Bidder to furnish the list along with the offer.	
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Any commissioning spare consumed over and above the recommended commissioning Spares, during commissioning shall be supplied free of cost by the equipment vendor. B) Mandatory Spares As per the Price Bid Format, (Annexure-4). C) Special Tools and Tackles: The bidder shall furnish a complete 1 sets of all special tools, wrenches etc. with necessary tools boxes as required for operation and maintenance [disassemble, assemble, or maintaining the unit] of the BFP packages) supplied, as a part of scope of supply. Bidder shall furnish a list of such tools along with offer for the system. Prices for the special tools and tackles shall be part of main scope of supply. No separate price shall be offered for the same. Refer Annexure-4. 21) Notes: i) Any Control cables shall have <u>HR PVC type C insulation</u> and shall be <u>FRLS PVC type ST2</u> extruded inner sheathed ii) Cable lugs and Cable glands shall be supplied by vendor along with the main equipment for all the cables (including BHEL cables and vendor cables) being terminated at panel end. iii) Vendor shall furnish valid type test reports (from any recognized laboratory) not older than 5 years for BHEL review. iv) As per Page no. 22 of 45, Cl. 6.9.12 of Annexure-9 (Electrical Design Guidelines) of BHEL technical specification, plz note that: <i>"Insulation for motors with re-acceleration shall be designed for 140 % of rated insulation level to take care of any out of step voltages that might result during re-acceleration."</i> The same shall be taken care of. 5.0.0 OPTIONAL PRICES Please Refer to Attached Price Bid Format. 6.0.0 EQUIPMENT QUALIFICATION CRITERIA (EQC) Bidder to submit Equipment Qualification Criteria as per the applicable standard CPCL specification (Clause no. 3.6.1 of Annexure-5). Also, please refer to the enclosed proforma as Annexure-20. a) The vendor for the complete unit shall be an established manufacturer of Centrifugal boiler feed Pumps & he shall also be the manufacturer of the proposed pump having adequate engineering, manufacturing & testing facilities for pumps conforming to the relevant API standard. b) The vendor shall have engineered, manufactured, packaged, tested & supplied at least TWO identical or validly similar packages in terms of type of equipment, inlet volumetric capacity (m3/hr) & Drive rating (kW) from the proposed plant & at least ONE of these shall have successfully operated in the field for at least 8000 hours without any major overhaul. c) The Pump model offered shall be from regular manufacturing range of the manufacturer & shall meet the following service & manufacturing experience requirements. d) The Pump shall be identical in frame size & identical or validly similar in terms of Frame rating, Hydraulic performance (including NPSHR for centrifugal pumps), Inlet temp., pumping fluid, Actual inlet flow, differential head, operating pressure and temperature, speed, number and type of impellers/heads, mechanical design, materials, materials bearing span (applicable for between bearing centrifugal pumps), column length (applicable for vertically suspended pumps) etc etc. as compared to at least TWO UNITS designed, manufactured, tested & supplied from the proposed manufacturing plant in the last 15 years & at least ONE of these shall have successfully operated in the field for at least 8000 hours without any major problems as on the date of issue of enquiry. e) The bidder shall furnish Proven track record along with their offer to prove that the equipment offered meet the EQC for technical acceptance failing which the bids are liable for summarily rejection. The bidder may furnish additional information to justify that the EQC is being met. In addition, manufacturer's catalogue & general reference list shall also be furnished along with the offer.			
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7.0.0 TECHNICAL DETAILS/REQUIREMENTS:

7.1.0 Design Parameters for HRSG BFP

Sl. No.	Description	Unit	Rated Condition	Normal / BMCR condition	Capb. Cond-I	Capb. Cond-II
1	Temperature Of Fluid	Deg. C	105	105	105	105
2	Density of fluid	Kg/m ³	954.704	954.704	954.704	954.704
3	Capacity Of each pump	m ³ /hr	126	109	114	113
4	Pump Differential Head	mwc	834	773	911	822
5	Available Pressure at centre line of Suction nozzle of Pump	Kg/cm ² (a)	2.548	2.548	2.548	2.548
6	Deaerator pressure	Kg/cm ² (a)	1.23	1.23	1.23	1.23
7	Deaerator platform height	mtrs	18.75	18.75	18.75	18.75
8	NPSH _A at pump suction flange	mlc	13.810	13.810	13.810	13.810
9	NPSH _R at pump suction flange (maximum.)	mlc	12.810	12.810	12.810	12.810
10	NPSH _A - NPSH _R (Minimum)	mlc	1.0	1.0	1.0	1.0

Note:

1) Please note that the Pump Curve shall be selected so as to satisfy capability-1 condition also. Accordingly the actual rated head lying on the curve shall be higher than the rated head mentioned here. The Pump shall be selected as mentioned here and shall be cross-checked to satisfy the Normal Operating & other Capability conditions as indicated above. Accordingly, actual heads at Normal Operating, Guarantee & Capability conditions can be higher than the head indicated above.

2) Shut off head shall not exceed 120% of the rated head.

7.2.0 COOLING WATER PARAMETERS:

Working pressure (Max Allowable): 4.5 kg/cm² (g)

Mech design Pressure : 8 kg/cm² (g)

Max. Allowable pr drop in the system: 1.0 kg/cm²

Inlet Temp. : 33 °C (Normal)

Mechanical design Temp. : 65°C (Max.)

Max. Temp. Rise in cooler: 10 Deg. C

7.3.0 SITE DETAILS:

a) Customer : CPCL-Chennai

b) Customer's consultants : JACOBS

The Unit will be located in the Refinery III Complex of the Manali Refinery, Chennai, TamilNadu.

Maximum Ambient temperature: 45 Deg C

Minimum Ambient temperature: 18 Deg C

Average Ambient temperature: 35 Deg C

Design temperature for equipment: 65 Deg C

Relative Humidity: 80% at Maximum ambient temp.

Wind Velocity: 180 Kmph (as per IS:875 part III) with north east and south west direction.

Rainfall: for 24 hour period: 450 mm, for one hour period: 100 mm.

(Refer Annexure-16.)

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7.3.0 TECHNICAL PARAMETERS:

	Pump	HRSG Boiler Feed Pump with Drive Motor
7.3.1	BHEL Material code	PY9751150035
7.3.2	Number of Pumps	2 Nos.(1 W+1 S)
7.3.3	Drive	Motor
7.3.4	Direct drive	Yes Note: In case bidder is not able to quote a direct driven pump, then pump with gear box is also acceptable to us.
7.3.5	Parallel operation	No
7.3.6	Pump type	Horizontal, Centrifugal, Multistage, Barrel Casing
7.3.7	Pump Standard	API 610, 10 th edition Centrifugal pumps (Special purpose process service) duly taking into consideration of enclosed CPCL/JACOBS Specifications. (Annexure 5 & 6)
7.3.8	Coupling Standard	API 671
7.3.9	Mechanical Seal Standard	API 682, 3 rd edition
7.3.10	Drive Standard	IS 325, IEC-60034, duly taking into consideration of enclosed CPCL/JACOBS Specifications for High voltage motors. (Annexure -8,9 &10)
7.3.11	Variable Frequency Drive	Not Applicable
7.3.12	Strainer type	Conical -Type
7.3.13	Max allowable pressure drop in suction strainer 50% clogged condition	0.2 Kg/cm ²
7.3.14	Material of construction	
A)	Pump	S6, As Per API 610 ,10th Edition
B)	Suction strainer	Casing: Carbon steel Internals SS 316 / SS 304
C)	Flange	Refer Schematic diagram for BFP (Annexure-1)
D)	Pipe	Refer Schematic diagram for BFP (Annexure-1)

Note:

1. Other Details of Pump and motor shall be as per attached BHEL data sheet for Pump (Annexure-2&2a), Data sheet for Motor (Annexure-3&3a) and attached JACOBS specification for pump and motor (Annexure 5,6 & 10).

8.0.0 TESTING, INSPECTION & QUALITY PLAN:

8.1.0 AT MANUFACTURER'S WORKS

For details pls refer enclosed specification as Annexure-6, clause no. 7.0, Annexure-10, 17, 17a & 18.

All equipment covered under these specifications shall be subject to inspection and tests by the Purchaser/his authorized representative or third party during manufacturing, erection and commission. The approval of the Purchaser or passing of such inspection of test will not, however, prejudice the right of Purchaser to reject the equipment if it does not comply with specifications when erected or does not give complete satisfaction in service. The cost of all such tests as well as third party inspectors shall be borne by the Bidder.

Cables & accessories shall be tested and proven type. Type test certificates shall be submitted for approval.

Cables and accessories shall be routine tested in presence of Purchaser's representative as per applicable IS. Routine test certificates shall be furnished for approval.

Note: Bidder to bring out specific comments on the inspection requirements with respect to scope of supply. If bidder is taking deviation to specification, suitable justification for the same shall be provided.

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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.	11.0.0 SUB VENDORS:		
	1) HT Motors: BHEL-Bhopal 2) Other items: As per attached Annexure 22		
	Bidder shall follow Customer approved sub vendors list. Please refer to Annexure 22.		
	In case of any specific practical difficulty, bidder is requested to bring out the same with proper reason for not following vendor list.		
	For other items for which sub vendors are not specified, bidder can follow their standard vendors. However they have to ensure the Proven Track record of the sub vendors and Bidder to take prior approval of BHEL for the same.		
12.0.0 DOCUMENTATION:			
12.1.0 MASTER DOCUMENT LIST			
Pls refer Annexure-11			
1. A master documentation shall be prepared during kick off meeting identifying all the DOCUMENTS / DRAWINGS to be submitted by the bidder as part of documentation. 2. Bidder shall ensure submission of all documentation as per approved Master Document List. 3. Bidder to note that the dates of submission of all the documents shall be finalized by him considering the time required for approval of various documents at Purchaser's end. It shall be solely bidder's responsibility to get approval on the entire document from purchaser to meet project schedule.			
12.2.0 DRAWING APPROVAL / REVIEW CATEGORY:			
1) The master document list shall clearly identify the class of review to be performed against each document.			
2) Following classes of review shall be followed for all the documents engineered by the bidder			
• APPROVAL (A) Approval is mandatory and bidder cannot proceed without obtaining Purchaser's approval. • INFORMATION / RECORDS (I) This type of documents shall be submitted to Purchaser for his information. Bidder can proceed if Purchaser's comments are not received within 14 working days of receipt in Purchaser's office.			
However, if any deviation to contract specification for any design deficiency is detected in the course of review after stipulated period, it shall be the responsibility of the bidder to see that such deviations and deficiencies are corrected to ensure compliance to contract without any cost and time implication to purchaser			
12.3.0 DRAWINGS REVIEW AND APPROVALS			
Ref. Doc	12.3.1 Bidder to understand that efficient handling of drawings and documents to be prepared by him under the contract is the key to the timely completion of the Pump and drive package. By accepting the contract the bidder undertakes to ensure that all drawings and documents to be submitted by him to the Purchaser / End Customer shall be of professional quality and conforming to the contractual requirements.		
	12.3.2 Bidder to note that the dates of submission of all the documents shall be finalized by him considering the time required for approval of various documents at Purchaser's end. It shall be solely bidder's responsibility to get approval on the entire document from purchaser to meet project schedule.		
	12.3.3 Computer aided design and drafting shall only be used except in exceptional cases where manual drafting may be resorted to, if unavoidable.		
	12.3.4 All the dimensions should be in metric units.		

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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.	12.3.5	Each drawing submitted by the bidder shall be clearly marked with the name of the Owner, the unit designation, the specifications, title, the specification number and the name of the Project with revision No. and date. If standards, catalogue pages are submitted the applicable items shall be indicated therein. All titles, noting, markings and writings on the drawings shall be in English.		
	12.3.6	All documents before forwarding to Purchaser will have to be vetted in detail by bidder. Document received without vetting will be returned without review. Also any inaccuracies/mistakes found will not only be rectified by the bidder but the bidder shall remain liable for bearing charges towards efforts spent by Purchaser for discussing the same. Delay owing to these shall be to the account of bidder		
	12.3.7	The bidder shall thoroughly review and approve all sub-vendor documents, before forwarding to Purchaser		
	12.3.8	Only the approved drawings duly stamped and signed by a competent engineer of bidder shall be submitted to purchaser for review.		
	12.3.9	Documents submitted without meeting pre-requisite requirements will be returned without review.		
	12.3.10	Review of drawings and documents issued by bidder shall be carried out by Purchaser / End customer.		
	12.3.11	Approval/ review of the drawings/ documents by the Purchaser /End customer would be only limited to the review of compatibility with basic designs and concepts.		
	12.3.12	The approval and /or review by the Purchaser /End customer shall not be construed by the bidder as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications and drawings.		
	12.3.13	The sole responsibility of the correctness of Design, Engineering shall lie with the bidder, irrespective of the fact that the Drawings / Documents submitted are reviewed or not by the Purchaser /End customer.		
	12.3.14	The bidder shall correct all faulty designs & constructions detected at any stage of work (irrespective of the fact whether drawings related to such faulty designs & or constructions are approved by purchaser), without any cost and time implication to the Purchaser.		
	12.3.15	The Bidder shall be responsible for and shall pay for any alterations of the Work to be accrued out by other agencies due to any discrepancies, errors or omissions in the Drawings or other Particulars supplied by him whether such drawings or particulars have been approved by the BHEL/ End customer or not.		
	12.3.16	Revisions in drawings/documents shall be clearly marked within clouds. No revision without clouding shall be recognized and the same shall not be considered reviewed and approved. All revised drawings / documents shall be associated with comments compliance report,		
	12.3.17	Normally all drawings / documents shall be reviewed by the purchaser with 14 working days of receipt of drawing at Purchaser's end. 14 days shall be reckoned from the date of receiving the hard copies of the documents at purchaser's center.		
	12.3.18	However, for all documents where multi-disciplinary activity is involved, the bidder, after submission for Purchaser's review, shall in his own interest, visit Purchaser's office for discussion for expeditious review of documents.		
	12.3.19	In absence of visit of bidder's engineering team at Purchaser's office approval/review time shall be 15 working days.		
	12.3.20	During detailed Engineering stage, bidder to furnish list of drawings as per Master Document format (Annexure-11).		
	Ref.	Doc		

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12.4.0 NO. OF COPIES OF EACH DOCUMENT TO BE FURNISHED:

All the documents shall be submitted as given below:

SL NO.	DESCRIPTION	NO. OF COPIES / PIECES TO BE SUBMITTED	WHEN TO SUBMIT
1)	Initial drawings/documents under approval and information category.	Soft copy only	Within 2 weeks of placement of order
2)	BHEL shall furnish their observation on submitted documents	Soft copy only	Within 2 weeks of document submission
3)	*Revised drawings/documents incorporating BHEL's comments. *Vendor to incorporate all BHEL comments so that further revisions can be minimized.	Soft copy only	Within 1 weeks of receipt of commented Drawings from BHEL
4)	BHEL shall furnish their observation on submitted documents	Soft copy only	Within 2 weeks of document submission
5)	Final Drawings/documents	17	Within 2 months of placement of order.
6)	Erection Documentation	5	1 month before dispatch of equipment. The list of documents identified under master document list for erection to be furnished in 5 no's of folders
7)	Draft O & M Manuals without test certificates	2	At least 2 months before the delivery date of equipment
8)	Revised O & M Manuals with Test Certificates to be submitted to BHEL (Hyderabad)	17	Within one month before the delivery date of equipment
9)	Final O&M manuals in a CD	3	Within one month after dispatch of equipment

NOTE-2:

- The above schedule for drawings approval is indicative only. Bidder to furnish a bar chart for erection of Pump and drive as per the agreed delivery requirement of project. This schedule also shall indicate drawing submission and approval schedules meeting the delivery schedule of the equipment. Bidder and BHEL shall put all efforts to meet the planned schedules.
- The O&M manuals shall contain the following as minimum :-
 - The identification details of the equipment like BHEL P.O. No., Vendor's Job Identification No., full contact address with telephone, fax, & e-mail details.
 - Brief description of the system.
 - System unloading, storage erection, start up, commissioning, shut down requirements.
 - System operating and maintenance requirements.
 - Operational & environmental safety instructions.
 - Final data sheets and drawings.
 - Test reports and certificates.
 - O&M manuals, catalogues of the equipment & instrumentation.
 - Recommended 2 years operational spares
- The draft O&M manual may be submitted without test reports.

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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. 16.0.0 PRICE BID FORMAT: 16.1.0 Bidder to indicate his offer as per Price Bid format enclosed as Annexure-4. All the items included in the price bid format shall be quoted as per tender specification and pre-bid clarifications, if any. Responsibility of ensuring correctness & completeness of scope of supply as per specification requirement solely lies with bidder. The equipment supplied shall be complete in all respects. The bidder shall not be eligible for any extra payment in respect of such mountings, fittings, fixtures and accessories if required for the safe and reliable operation of the equipment. 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 in bidder scope Only. Only main items shall be considered for price bid evaluation. Optional items (RO –rate only) shall not be considered for price bid evaluation Prices quoted by the bidder shall remain firm till the successful handing over of the BFP package to end customer. Any request for upward revision of price during any intermediate stage before handing over the plant to end customer will be summarily rejected by BHEL. Bidder to quote only base rates for all the items, Applicable taxes and duties shall be indicated separately. The Priced Bid shall be submitted in Original (without any copy) duly signed and stamped on each page in a separate sealed envelope super scribing “Price Bid –Do not Open” This shall not contain any condition whatsoever failing which the Bids shall be liable to be rejected. In case of any correction, the bidder shall put its signature and its stamp. Eraser fluid will not be allowed for making any correction. Bidder shall confirm to the un-priced bid as part of their offer. 17.0.0 GENERAL: Even though, the requirements are specified in detail to the extent possible, bidder to apply good engineering practices in the design, selection of equipment, fabrication, painting, inspection & testing, dispatch of the system, wherever same is not clearly spelt out. 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 in Bidder scope only. Compliance with this specification shall not relieve bidder of the responsibility of furnishing material and workmanship to meet the specified conditions. Accordingly, bidder to furnish their comments, if any, on this specification in their offer.			
Ref. Doc			

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Note: The technical Data sheets attached as per the list of annexure shall be filled by the vendor and the same to be Submitted along with the offer.																																																																																							
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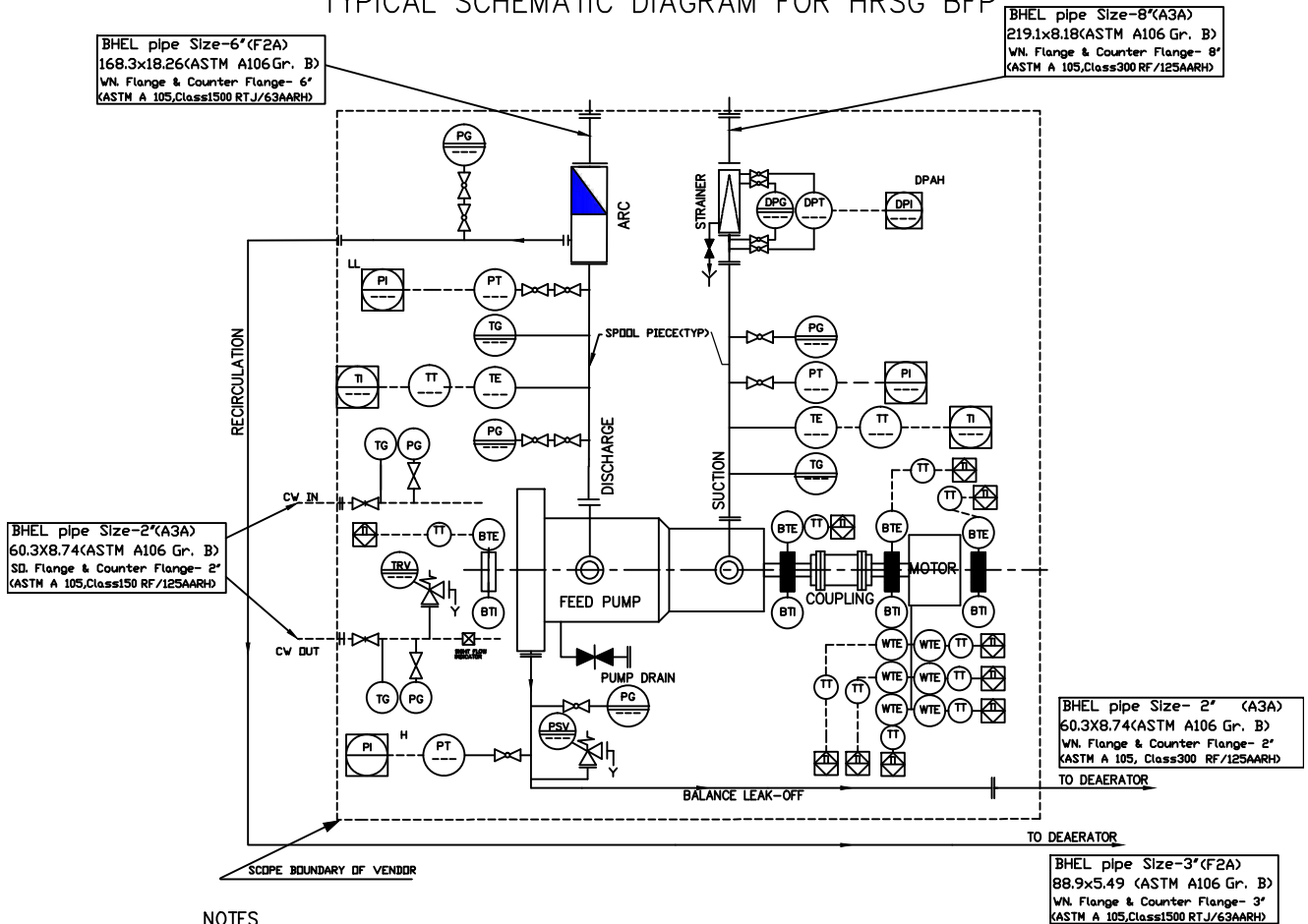
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		Rev. No.	Date	Revision Details	Revised By	Reviewed By	Approved By
		00	06.05.15	FRESH ISSUE	OM	GIRISH	SIVA PRASAD BABU
		Ref. Doc.					

ANNEXURE-1

P&ID FOR HRSG BOILER FEED PUMP WITH DRIVE

TYPICAL SCHEMATIC DIAGRAM FOR HRSG BFP



NOTES

1. Null
2. All counter flanges complete with studs/nuts/gaskets etc. shall be in the scope of vendor.
3. Bidder to confirm the sizes of BFP suction nozzle, discharge nozzle, ARC Valve, ARC Valve recirculation line, BLO line, SRV, CW In/Out let lines and pump drain.
Suitable reducers/expanders, counter flanges to be provided by pump supplier to meet BHEL line sizes at terminal point.
4. All the instruments shown in the scheme shall be mounted on a local gauge board (vendor scope).
5. Null
6. Interlocks & Protections realised in PLC, DCS (BHEL scope). However vendor shall provide the necessary writeup & logic diagram.
7. All temperature instruments shall be provided with thermowell.
8. All pressure instruments shall be with process isolation gate valve and an instrument isolation valve, with provision for vent and drain.
9. Tag Nos. after order placement.
10. The number of elements connected to each multipoint temperature transmitter shall be limited to 8 numbers with 20% spare.
11. Isolation valve in cooling water inlet shall be gate valve & cooling water outlet shall be globe valve.
12. Temperature relief valve on each individual cooling water outlet line shall be provided.
13. BHEL shall provide CW inlet & outlet at one location of the skid, however further distribution (to Pump, Motor, Gearbox, Lube Oil skid (if applicable) etc shall be included in bidder's scope of supply as indicated above)
14. Sight flow indicators shall be provided on each individual cooling water return line.
15. All the instruments shall be SIL-2 certified.
16. All temperature elements should be with temperature transmitters.
17. All JBs supplied by the bidder shall be as per annexure 15(a)
18. Separate JBs shall be provided for PLC and DCS, as applicable.
19. Refer Annexure 23, 12 & 13 of PEMC-05923, for details and type of instruments and JB.
20. All electrical instruments shall be terminated in a junction box.
21. Following JBs shall be applicable as minimum for each train:
 - For BFP Process (Temperature) Signals -1 No.
 - For BFP Process (Pressure) Signals -1 No.
 - For Pump Bearing RTDs - 1 No.
 - For Motor Winding & Bearing RTDs -1 No. (Generally provided by motor manufacturer, as integral part)
 - For Gear box bearing RTDs-1No. (If applicable)
 - LO System-1 No. (DCS). (If applicable)
 - LO System-1 No. (PLC). (If applicable)

ANNEXURE-2

BHEL DATA SHEET FOR BFP

PROJECT: RESID UPGRADATION PROJECT/GTG HRSG PCKG
CUSTOMER: CHENNAI PETROLEUM CORPORATION LIMITED (CPCL), MANALI-CHENNAI
CONSULTANT: M/S JACOBS ENGG INDIA PVT LTD, MUMBAI

DATA SHEET for < BOILER FEED PUMPS FOR HRSG - MOTOR DRIVEN>

Bidder's Offer No. & Dt. : <Bidder to indicate>

Bidder's Name : <Bidder to indicate>

Bidder's Doc. Rev. No. & Dt. :<Bidder to indicate>

BHEL Enq. No. :<Bidder to indicate>

BHEL Enq. Date : <Bidder to indicate>

Sl.no	Description	BHEL Requirement (if any)	<Bidder's> Offer
GENERAL DATA			
1	Service	Boiler feed water pump for HRSG	
2	Variant No.	03 of specification PY51150	
3	BHEL Material code	PY9751150035	
4	Number of Pumps	Two (1 W + 1 S)	
5	Location	Outdoor	
6	Duty	Continuous	
7	Drive	Motor	
8	Pumping fluid	Boiler feed water	
9	Deaerator pressure (suction tank) Kg/cm ² (a)	1.23 Kg/cm ² (a)	
10	Height of Deaerator platform, mtrs	18.75	
11	Deaerator operating temperature	105 Deg °C	
CONSTRUCTION FEATURES OF PUMP			
12	Pump Type	Horizontal, Centrifugal, Multistage,	
13	Barrel casing / Split casing	Barrel casing	
14	Pump Model No.		
15	No. of Stages of pump	Maximum 10 (if multistage),	
16	Rated Speed of Pump (rpm)		
17	Rated speed of drive (rpm)		
18	Design Standard of pump	API 610, 10th edition	
19	Mechanical Seal Standard	API 682,3rd Edition	
20	Balance leak off connection	Back to deaerator	
21	Recirculation connection	Back to deaerator	
22	Suction Specific Speed at rated flow	Pumps with suction specific speed >11000 (U.S. Units) shall not be used.	
23	Type of axial thrust balancing arrangement	Balancing piston/drum	
24	Type of main bearings for pump		
25	Main bearings lubrication		
26	Type of thrust bearings for pump		
27	Thrust bearing lubrication		
28	Direction of rotation of Pump		
29	Direction of rotation of Motor		
30	Design pressure of suction side	Kg/cm ² g (Same as discharge side)	
31	Casing Mounting	Centerline	
MATERIAL OF CONSTRUCTION			
32	Material of construction a) Barrel b) Shaft c) Casing d) Impeller e) Diffusers f) Wearing rings g) Balancing drum h) Shaft Sleeves i) Base Plate	API 610 S-6,As per API 610,10th Edition	
COUPLING			
33	Flexible coupling standard	API 671	
34	Type of coupling	Metallic, non-lubricated, flexible element type (i.e. either diaphragm or disc type) with spacer	

PROJECT: RESID UPGRADATION PROJECT/GTG HRSG PCKG
CUSTOMER: CHENNAI PETROLEUM CORPORATION LIMITED (CPCL), MANALI-CHENNAI
CONSULTANT: M/S JACOBS ENGG INDIA PVT LTD, MUMBAI

35	Non sparking type couplign guard	Yes	
36	Service factor for the coupling	1.5	
FORCED LUBE OIL SYSTEM			
37	LO system applicable [Yes/No]		
38	LO System Standard(If Applicable)	API 614(4th edition)	
39	LO System capacity	lpm	
40	415V AC power for AOP	kw	
41	415V AC power for heater	kw	
42	Lube oil requirement of motor, lpm (If required)		
GEAR BOX			
43	Gear Box standard	API-677 (for motor rating less than 750 KW) API-613 (for motor rating above 750 KW)	
FLUSHING & COOLING PLANS			
44	Flushing Plan - API-610 plan no.		
45	Duplex SS piping provided for flushing plan as per . SI no - 20 of PEMC - 05923		
46	Cooling Water Quantity-Pump	m ³ /hr	
47	Cooling Water Quantity-Los kid	m ³ /hr	
48	Cooling Water Quantity- Motor	m ³ /hr	
49	Cooling Plan (API-610 plan no.)	Bidder to furnish cooling plan	
50	Coolign water supply parameters	As per clause 7.2.0 of PEMC - 05923	
51			
52	ARC valve type	Modulating type	
53	ARC valve material of construction	Body:CS body ,Internals:SS	
54	ARC Valve size	The ARC valve size shall be as per Bidder's recommendation, however not less than Pump discharge nozzle size.	
55	ARC valve pressure drop	1.0 Kg/cm2 (maximum) & ARC Valves to be selected in such a way that the increase in pressure drop through the ARC Valve from rated flow of the pump to approx. 130% of the rated flow shall be limited to 1.0 kg/cm2 only. This is to ensure flexibility of operating system at marginally higher flows as per site conditions if any.	
SUCTION STRAINER			
56	Suction strainer type	Conical	
57	Suction strainer material of construction	Body: CS Internals: SS 316/SS 304	
58	Suction strainer size	Same as Suction pipe size Strainer with flanged ends, Ref. to P&I D	
59	Suction strainer mesh size	40 mesh or Bidder to suitably select	
60	Free flow area of the strainer element	6 times the BHEL inlet pipe area	
61	Strainer pressure drop	0.2 Kg/cm2 in 50% clogged conditions	
VIBRATION MONITORING PROBES			
62	Vibration Monitoring Probes	As per clause 4.0.0 [SI No.13] of PEMC - 05923	
BEARING & WINDING RTD'S AND TEMPERATURE GAUGES			
63	Bearing & Winding RTD's and Temperature Gauges	As per clause 4.0.0 [SI No.14] of PEMC - 05923	
PUMP PERFORMANCE CURVE			

PROJECT: RESID UPGRADATION PROJECT/GTG HRSG PCKG
CUSTOMER: CHENNAI PETROLEUM CORPORATION LIMITED (CPCL), MANALI-CHENNAI
CONSULTANT: M/S JACOBS ENGG INDIA PVT LTD, MUMBAI

64	Parallel operation	No	
65	Pump rated head	Bidder to select as per clause no 7.0.1 of PEMC-05923	
66	Pump shut off head	Shall not exceed 120% of rated head	
67	Pump shut off head/rated head	min 110% as per specification	
68	BEP of the offered pump, M3/Hr		
69	Thermal minimum flow , m3/Hr		
70	Stable minimum flow, m3/Hr		
71	Preferred operating range		
72	Allowable operating range		
73	Pump End of the curve flow, m3/hr		
74	Pump rated impeller dia, mm		
75	Pump max. impeller dia, mm		
76	Min. 5% head rise possible.	As per clause no 5.1.6 of API 610 10 th edition..	
77	Pump minimum impeller dia., mm		
78	BLO flow (m3/hr)		
79	BLO pressure (Kg/cm2 g)	During detailed engineering Stage	
80	BLO safety valve set pressure (Kg/cm2 g)	During detailed engineering Stage	
81	Suction safety valve set pressure (Kg/cm2 g)	During detailed engineering Stage	
82	Dry critical speed (rpm)	During detailed engineering Stage	
83	Wet critical speed (rpm)	During detailed engineering Stage	
84	GD2 value pump (Kgm2)	During detailed engineering Stage	
85	GD2 value coupling (Kgm2)	During detailed engineering Stage	
86	Weight (Kg) - Pump + base plate - Strainer - Drive - LO Skid	During detailed engineering Stage	
DRIVE RATING			
87	Drive	As per clause no 4.0.0 (A-2&3)	
88	BKW at the rated point		
89	BKW at end of curve		
90	Selected drive rating, KW		
91	Selected drive rating / BKW at rated poing [Min. 110%]		
92	Selected drive rating meets BKW at end of curve		
PUMP DESIGN PARAMETERS			
	Rated condition		
93	Flow (m ³ /hr)	126 m3/hr	
94	Differential Head (mlc)	834 mlc	
95	Temperature of pumping fluid	105 Deg °C	
96	Sp. Gravity of pumping fluid	0.9547	
97	Efficiency (Hot & Cold) %		
98	Available pressure on suction side of BFP ,Kg/cm ² (a)	2.548 Kg/cm2(a)	
99	NPSH(A) at pump suction nozzle(mlc)	13.810 mlc	
100	NPSH(R) (mlc)	Limited to maximum 12.810 mlc	
101	NPSH(A) - NPSH(R)	min. 1.0	
102	Pump BKW (Hot & Cold) kw	kw	
	Normal Operating		
103	Flow (m ³ /hr)	109 m3/hr	
104	Differential Head (mlc)	773 mlc	
105	Temperature of pumping fluid	105 Deg °C	
106	Sp. Gravity of pumping fluid	0.9547	
107	Efficiency (Hot & Cold) %		

PROJECT: RESID UPGRADATION PROJECT/GTG HRSG PCKG
CUSTOMER: CHENNAI PETROLEUM CORPORATION LIMITED (CPCL), MANALI-CHENNAI
CONSULTANT: M/S JACOBS ENGG INDIA PVT LTD, MUMBAI

108	Available pressure on suction side of BFP ,Kg/cm ² (a)	2.548 Kg/cm ² (a)	
109	NPSH(A) at pump suction nozzle(mlc)	13.810 mlc	
110	NPSH(R) (mlc)	Limited to maximum 12.810 mlc	
111	NPSH(A) - NPSH(R)	min. 1.0	
112	Pump BKW (Hot & Cold) kw	kw	
	Capability Condition-I		
113	Flow (m ³ /hr)	114 m ³ /hr	
114	Differential Head (mlc)	911 mlc	
115	Temperature of pumping fluid	105 Deg °C	
116	Sp. Gravity of pumping fluid	0.9547	
117	Efficiency (Hot & Cold) %		
118	Available pressure on suction side of BFP ,Kg/cm ² (a)	2.548 Kg/cm ² (a)	
119	NPSH(A) at pump suction nozzle(mlc)	13.810 mlc	
120	NPSH(R) (mlc)	Limited to maximum 12.810 mlc	
121	NPSH(A) - NPSH(R)	min. 1.0	
122	Pump BKW (Hot & Cold) kw	kw	
	Capability condition-II		
123	Flow (m ³ /hr)	113 m ³ /hr	
124	Differential Head (mlc)	822 mlc	
125	Temperature of pumping fluid	105 Deg °C	
126	Sp. Gravity of pumping fluid	0.9547	
127	Efficiency (Hot & Cold) %		
128	Available pressure on suction side of BFP ,Kg/cm ² (a)	2.548 Kg/cm ² (a)	
129	NPSH(A) at pump suction nozzle(mlc)	13.810 mlc	
130	NPSH(R) (mlc)	Limited to maximum 12.810 mlc	
131	NPSH(A) - NPSH(R)	min. 1.0	
132	Pump BKW (Hot & Cold) kw	kw	
	NOISE LEVEL		
133	Noise level	85 DBA at 1 m distance, in any direction for complete train	
	PERFORMANCE TEST STANDARD		
134	Performance test standard	API-610, 10th Edn. and as per clause 7.0 of annexure-6 of PEMC-05923	
135	Maximum Allowed Working Pressure	Kg/cm ² g	
136	Max. Allowed Casing Pressure	Kg/cm ² g	
137	Hydraulic test pressure of casing Kg/cm ² (g)	Kg/cm ² g	
	EQUIPMENT QUALIFICATION CRITERIA		
138	Duly filled in Equipment Qualification Criteria	As per clause 6.0.0 of PEMC - 05923	
	INTERCONNECTING PIPING & INSTRUMENTATION & JUNCTION BOXES		
139	Scope of Piping and instruments considered in line with P&I D [Yes/No]		
140	MOC of piping considered in line with P&I D [Yes/No]		
141	Required expanders/Reducers & counter flanges considered at all the terminal points in line with P&I D		
142	Junction boxes	As per clause 4.0.0. - 15 of PEMC - 05923	
143	Pump Suction nozzle - Size - Rating - Standard - Facing - Location		

PROJECT: RESID UPGRADATION PROJECT/GTG HRSG PCKG
CUSTOMER: CHENNAI PETROLEUM CORPORATION LIMITED (CPCL), MANALI-CHENNAI
CONSULTANT: M/S JACOBS ENGG INDIA PVT LTD, MUMBAI

144	Pump Discharge nozzle - Size - Rating - Standard - Facing - Location		
145	ARC valve inlet/outlet/recirculation sizes - Size - Rating - Standard - Facing - Location		
146	BLO nozzle - Size - Rating - Standard - Facing - Location		
147	Pump Cooling water inlet/outlet sizes - Size - Rating - Standard - Facing - Location		
148	LO Skid Cooling water inlet/outlet sizes(if applicable) - Size - Rating - Standard - Facing - Location		
149	Vent/Drain connection	During detailed engineering Stage	
ADDITIONAL REQUIREMENTS			
150	Lateral Analysis	As per clause 4.0.0. - 16 of PEMC - 05923	
151	Torsional Analysis	As per clause 4.0.0. - 17 of PEMC - 05923	
PAINTING			
152		As per clause 9.0.0 of PEMC - 05923	
PACKING AND FORWARDING			
153		As per clause 10.0.0 of PEMC - 05923	
Sub vendors			
154		As per clause 11.0.0 of PEMC - 05923	
Deviations from spec			
155	All the deviations offered, if any are complying with clause no. 14.0.0 of PEMC - 05923		
Enclosures			
156	Filled in Data sheet of Pump Enclosed [Yes/No]		
157	Filled in Data sheet of Motor Enclosed [Yes/No]		
158	PTR for pumps Enclosed [Yes/No]		
159	Performance curves of the pump at various operating conditions[Yes/No]		
160	Un priced price bid format enclosed [Yes/No]		

ANNEXURE-2(A)
JACOBS' DATA SHEET FOR BFP

JACOBS

CENTRIFUGAL PUMP
API 610 10TH EDITION / ISO 13709
PROCESS DATA SHEET
SI UNITS

JOB NO. 44NC-4602 ITEM NO. 21-G-501A/B
PROJECT: RESID UPGRADATION
P.O. NO. DATE:
INQUIRY NO. 44NC-4602-0501/M.04/0034
REV. NO. 8 REV. DATE: 23-Dec-13
PAGE 1 OF 5

REV.

1 APPLICABLE TO: ☒ PROPOSALS ☐ PURCHASE ☐ AS BUILT

2 FOR CPCL

3 SITE MANALI REFINERY, TAMILNADU

UNIT RESID UPGRADATION

SERVICE HRSG FEED PUMPS

4 NOTES: INFORMATION BELOW TO BE COMPLETED: ☐ BY PURCHASER ☐ BY MANUFACTURER ☒ BY MANUFACTURER OR PURCHASER

5 ☐ DATA SHEETS

6 REVISIONS

7 PUMP

8 MOTOR

9 GEAR

10 TURBINE

11 APPLICABLE OVERLAY STANDARD(S):

12 ☐ OPERATING CONDITIONS (5.1.3)

13 FLOW, NORMAL (m³/h) RATED (m³/h)

14 OTHER

15 SUCTION PRESSURE MAX./RATED / (MPa)

16 DISCHARGE PRESSURE (MPa)

17 DIFFERENTIAL PRESSURE (MPa)

18 DIFF. HEAD (m) NPSHA (m)

19 PROCESS VARIATIONS (5.1.4)

20 STARTING CONDITIONS (5.1.4)

21 SERVICE: ☐ CONT. ☐ INTERMITTENT (STARTS/DAY)

22 ☐ PARALLEL OPERATION REQ'D (5.1.13)

23 ☒ SITE DATA (5.1.3)

24 LOCATION: (5.1.30)

25 ☐ INDOOR ☐ HEATED ☒ OUTDOOR ☐ UNHEATED

26 ☒ ELECTRICAL AREA CLASSIFICATION (5.1.24 / 6.1.4)

27 CL T3 GR 2 DIV II A/ IIB

28 ☐ WINTERIZATION REQ'D ☐ TROPICALIZATION REQ'D

29 SITE DATA (5.1.30)

30 ☒ ALTITUDE 3.5 (m) BAROMETER (MPa)

31 ☒ RANGE OF AMBIENT TEMPS: MIN/MAX 18 / 35 (°C)

32 ☒ RELATIVE HUMIDITY: MIN / MAX / 80 (%)

33 UNUSUAL CONDITIONS: (5.1.30) ☐ DUST ☐ FUMES

34 ☐ OTHER

35

36

37 ☐ DRIVER TYPE

38 ☒ INDUCTION MOTOR ☐ STEAM TURBINE ☐ GEAR

39 ☐ OTHER

40

41 ☐ MOTOR DRIVER (6.1.1 / 6.1.4)

42 ☐ MANUFACTURER

43 ☐ (kW) ☐ (r/min)

44 ☐ FRAME ☒ ENCLOSURE

45 ☐ HORIZONTAL ☒ VERTICAL ☒ SERVICE FACTOR

46 ☐ VOLTS/PHASE/HERTZ / /

47 ☐ TYPE

48 ☐ MINIMUM STARTING VOLTAGE (6.1.5)

49 ☐ INSULATION ☐ TEMP. RISE

50 ☐ FULL LOAD AMPS

51 ☐ LOCKED ROTOR AMPS

52 ☐ STARTING METHOD

53 ☐ LUBE

54 BEARINGS (TYPE/NUMBER):

55 ☐ RADIAL /

56 ☐ THRUST /

57 ☐ VERTICAL THRUST CAPACITY

58 UP (N) DOWN (N)

59

60

LIQUID (5.1.3)

LIQUID TYPE OR NAME HRSG FEED WATER

☐ HAZARDOUS ☐ FLAMMABLE ☐ (5.1.5)

MIN. NORMAL MAX.

PUMPING TEMP (°C)

VAPOUR PRESS. (MPa)

RELATIVE DENSITY (SG):

VISCOSITY (mPa·s)

SPECIFIC HEAT, Cp (kJ/kg·K)

☐ CHLORIDE CONCENTRATION (6.5.2.4) (mg/kg)

☐ H₂S CONCENTRATION (mol fraction) WET (5.12.1.12c)

CORROSIVE / EROSION AGENT (5.12.1.9)

MATERIALS (5.12.1.1)

☒ ANNEX H CLASS (5.12.1.1) S-6

☐ MIN DESIGN METAL TEMP (5.12.4.1) (°C)

☐ REDUCED-HARDNESS MATERIALS REQ'D. (5.12.1.12)

☐ BARREL/CASE IMPELLER

☐ CASE/IMPELLER WEAR RINGS

☐ SHAFT

☐ DIFFUSERS

PERFORMANCE:

PROPOSAL CURVE NO. /r/min

☐ IMPELLER DIA. RATED MAX. MIN. (mm)

☐ IMPELLER TYPE

☐ RATED POWER (kW) EFFICIENCY (%)

☐ MINIMUM CONTINUOUS FLOW:

THERMAL (m³/h) STABLE (m³/h)

☐ PREFERRED OPER. REGION TO (m³/h)

☐ ALLOWABLE OPER. REGION TO (m³/h)

☐ MAX. HEAD @ RATED IMPELLER (m)

☐ MAX. POWER @ RATED IMPELLER (kW)

☐ NPSHR AT RATED FLOW (m) (5.1.10)

☒ MAX. SUCTION SPECIFIC SPEED: 11000 (5.1.11)

☒ MAX. SOUND PRESS. LEVEL REQ'D 75 (dBA) (5.1.16)

☐ EST. MAX. SOUND PRESS. LEVEL (dBA) (5.1.16)

☐ EST. MAX. SOUND POWER LEVEL (dBA) (5.1.16)

UTILITY CONDITIONS (5.1.3)

ELECTRICITY

DRIVERS

HEATING

SYSTEM VOLTAGE DIP ☒ 80% ☐ OTHER (6.1.5)

STEAM

DRIVERS

HEATING

COOLING WATER: (5.1.19) SOURCE

SUPPLY TEMP (°C) MAX. RETURN TEMP (°C)

NORM. PRESS. (MPa) DESIGN PRESS. (MPa)

MIN. RET. PRESS. (MPa) MAX. ALLOW. D.P. (MPa)

CHLORIDE CONCENTRATION: (mg/kg)

REVISION LOG

REV.

DESCRIPTION

DATE

BY

CHK'D

APP'D

A ISSUED FOR ENQUIRY 19-NOV-13 PK VN SNG

B Clients comments incorporated and issued for enquiry 23-Dec-13 PK VN SNG



**CENTRIFUGAL PUMP
API 610 10TH EDITION / ISO 13709
PROCESS DATA SHEET
SI UNITS**

JOB NO. 44NC-4602 ITEM NO. 21-G-501A/B
PROJECT: RESID UPGRADATION
P.O. NO. _____ DATE: _____
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REV.	REMARKS
1	REFER ATTACHED BEDS DOCUMENT FOR SITE DATA & UTILITY CONDITIONS.
2	Pumps shall have auto-start facility with motor sized for end-of-curve operation.
3	Pumps shall have minimum flow recirculation valves for pump protection.
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CENTRIFUGAL PUMP DATA SHEET
API 610 10TH EDITION / ISO 13709
BETWEEN BEARINGS (TYPE BB)
SI UNITSJOB NO. **44NC-4602** ITEM NO. **21-G-501A/B**
PROJECT: **RESID UPGRADATION**
P.O. NO. _____ DATE: _____
INQUIRY NO. **44NC-4602-0501/M.04/0034**
REV. NO. **B** REV. DATE: **23-Dec-13**
PAGE **3** OF **5**

REV.		CONSTRUCTION	SURFACE PREPARATION AND PAINT																											
1		CONSTRUCTION	SURFACE PREPARATION AND PAINT																											
2		ROTATION: (VIEWED FROM COUPLING END) ☐ CW ☐ CCW	☐ MANUFACTURER'S STANDARD ☒ OTHER (SEE BELOW)																											
3		PUMP TYPE: (4.1)	☐ SPECIFICATION NO. <u>REFER ATTACHED SPEC.</u>																											
4		☐ BB1 ☐ BB2 ☐ BB3 ☒ BB5	PUMP:																											
5		CASING MOUNTING:	☐ PUMP SURFACE PREPARATION _____																											
6		☐ CENTERLINE ☒ NEAR CENTERLINE	☐ PRIMER _____																											
7		☐ FOOT	☐ FINISH COAT _____																											
8		CASING SPLIT:	BASEPLATE: (6.3.17)																											
9		☐ AXIAL ☒ RADIAL	☐ BASEPLATE SURFACE PREPARATION _____																											
10		CASING TYPE:	☐ PRIMER _____																											
11		☐ SINGLE VOLUTE ☐ MULTIPLE VOLUTE ☐ DIFFUSER	☐ FINISH COAT _____																											
12		☐ BETWEEN BEARINGS ☒ BARREL	☐ DETAILS OF LIFTING DEVICES (6.3.20) _____																											
13		CASE PRESSURE RATING:	SHIPMENT: (7.4.1)																											
14		☐ MAX. ALLOWABLE WORKING PRESSURE _____ (MPa)	☐ DOMESTIC ☐ EXPORT ☒ EXPORT BOXING REQUIRED																											
15		@ _____ (°C)	☒ OUTDOOR STORAGE MORE THAN 6 MONTHS																											
16		☐ HYDROTEST PRESSURE _____ (MPa)	SPARE ROTOR ASSEMBLY PACKAGED FOR:																											
17		☐ SUCTION PRESS. REGIONS MUST BE DESIGNED	☐ SHIPPING CONTAINER (8.2.8.3) ☐ VERTICAL STORAGE (8.2.8.2)																											
18		FOR MAWP (5.3.6)	☐ TYPE OF SHIPPING PREPARATION ☐ N ₂ PURGE (8.2.8.4)																											
19		☐ NOZZLE CONNECTIONS: (5.4.2)	HEATING AND COOLING																											
20		<table border="1"><thead><tr><th>SIZE (DN)</th><th>FLANGE RATING</th><th>FACING</th><th>POSITION</th></tr></thead><tbody><tr><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td></tr></tbody></table>	SIZE (DN)	FLANGE RATING	FACING	POSITION																	☐ HEATING JACKET REQ'D. (5.8.9) ☒ COOLING REQ'D.							
SIZE (DN)	FLANGE RATING	FACING	POSITION																											
21			☒ COOLING WATER (C.W.) PIPING PLAN (6.5.3.1) _____																											
22		SUCTION	C.W. PIPING:																											
23		DISCHARGE	☐ PIPE ☐ TUBING; FITTINGS _____																											
24		BALANCE DRUM	C.W. PIPING MATERIALS:																											
25		PRESSURE CASING AUX. CONNECTIONS: (5.4.3)	☐ S. STEEL ☒ C. STEEL ☐ GALVANIZED																											
26		<table border="1"><thead><tr><th>NO.</th><th>SIZE (DN)</th><th>TYPE</th></tr></thead><tbody><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr></tbody></table>	NO.	SIZE (DN)	TYPE																									COOLING WATER REQUIREMENTS:
NO.	SIZE (DN)	TYPE																												
27		☒ DRAIN	☐ BEARING HOUSING _____ (m ³ /h) @ _____ (MPa)																											
28		☒ VENT	☐ HEAT EXCHANGER _____ (m ³ /h) @ _____ (MPa)																											
29		☒ PRESS. GAUGE	STEAM PIPING: ☐ TUBING ☐ PIPE																											
30		☒ TEMP. GAUGE																												
31		☒ WARM-UP	BEARINGS AND LUBRICATION																											
32		☒ BALANCE / LEAK-OFF	BEARING (TYPE/NUMBER) (5.10.1):																											
33		☒ MACHINED AND STUDDED CONNECTIONS (5.4.3.8)	☐ RADIAL _____ / _____																											
34		☐ CYLINDRICAL THREADS REQUIRED (5.4.3.3)	☐ THRUST _____ / _____																											
35		ROTOR:	LUBRICATION (5.11.3, 5.11.4):																											
36		☒ COMPONENT BALANCE TO ISO 1940 G1.0 (5.9.4.4)	☒ RING OIL ☒ HYDRODYNAMIC ☐ PURGE OIL MIST ☐ PURE OIL MIST																											
37		☐ SHRINK FIT -LIMITED MOVEMENT IMPELLERS (8.2.2.3)	☐ CONSTANT LEVEL OILER PREFERENCE (5.10.2.2): _____																											
38		COUPLINGS: (6.2.2)	☐ PRESSURE LUBE SYS. ISO 10438-3 ☐ ISO 10438-2 (8.2.6.1/8.2.6.5)																											
39		☐ MANUFACTURER _____ ☒ MODEL _____	☒ OIL VISC. ISO GRADE _____																											
40		☐ RATING (kW per 100 r/min) _____	☐ OIL PRESS. TO BE GREATER THAN COOLANT PRESSURE																											
41		☐ SPACER LENGTH _____ (mm) ☐ SERVICE FACTOR _____	☐ REVIEW AND APPROVE THRUST BEARING SIZE [8.2.5.2 d)]																											
42		DRIVER HALF-COUPLING MOUNTED BY:	☒ OIL HEATER REQUIRED: ☐ STEAM ☐ ELECTRIC																											
43		☐ PUMP MFR. ☐ DRIVER MFR. ☐ PURCHASER	INSTRUMENTATION (6.4.2)																											
44		☐ COUPLING WITH HYDRAULIC FIT (6.2.10)	☐ SEE ATTACHED API 670 DATA SHEET																											
45		☐ COUPLING BALANCED TO ISO 1940-1 G6.3 (6.2.3)	☐ ACCELEROMETER(S) (6.4.2.1) _____																											
46		☐ COUPLING PER ISO 14691 (6.2.4)	☒ PROVISION FOR VIBRATION PROBES (6.4.2.2)																											
47		☐ COUPLING PER ISO 10441 (6.2.4)	☒ RADIAL <u>2</u> PER BRG. ☒ AXIAL <u>2</u> PER BRG.																											
48		☐ COUPLING PER API 671 (6.2.4)	☐ PROVISION FOR MOUNTING ONLY (5.10.2.11)																											
49		☐ NON-SPARK COUPLING GUARD (6.2.14c)	☐ FLAT SURFACE REQ'D (5.10.2.12)																											
50		☐ COUPLING GUARD STANDARD PER _____ (6.2.14a)	☒ RADIAL BEARING METAL TEMP. ☒ THRUST BRG METAL TEMP.																											
51		BASEPLATES:	☐ TEMP. GAUGES (WITH THERMOWELLS)																											
52		☐ API BASEPLATE NUMBER _____ (ANNEX D)	☒ MONITORS AND CABLES SUPPLIED BY (6.4.2.4) <u>PUMP SUPPLIER</u>																											
53		☐ NON-GROUT CONSTRUCTION (6.3.13)	REMARKS																											
54		☐ OTHER _____	<u>SINGLE MECHANICAL SEAL WITH SEAL FLUSH PLAN 23 IS APPLICABLE.</u>																											
55		MECHANICAL SEAL: (5.8.1)	<u>VENDOR TO FURNISH FILLED IN DATA SHEET FOR THE SEAL.</u>																											
56		☐ SEE ATTACHED ISO 21049/API 682 DATA SHEET	<u>VENDOR TO PROVIDE SEAL VENDOR RECOMMENDATION.</u>																											
57			MASSES (kg)																											
58			PUMP _____ BASEPLATE _____																											
59			DRIVER _____ TOTAL _____																											
60			GEAR _____																											

CENTRIFUGAL PUMP DATA SHEET
API 610 10TH EDITION / ISO 13709
BETWEEN BEARINGS (TYPE BB)
SI UNITSJOB NO. **44NC-4602** ITEM NO. **21-G-501A/B**
PROJECT: **RESID UPGRADATION**
P.O. NO. _____ DATE: _____
INQUIRY NO. **44NC-4602-0501/M.04/0034**
REV. NO. **B** REV. DATE: **23-Dec-13**
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REV.	SPARE PARTS (TABLE 18)		QA INSPECTION AND TESTING (CONT.)			
1			TEST	NON-WIT	WIT	OBSERVE
2	☐ START-UP ☐ NORMAL MAINTENANCE		☒ HYDROSTATIC (7.3.2)	☐	☒	☐
3	☒ SPECIFY <u>REFER ATTACHED LIST</u>		☒ PERFORMANCE (7.3.3)	☐	☒	☐
4			☒ NPSH (7.3.4.2)	☐	☒	☐
5	OTHER PURCHASER REQUIREMENTS		☒ RETEST ON SEAL L'KGE (7.3.3.2d)	☒	☐	☐
6	☒ COORDINATION MEETING REQUIRED (9.1.3)		☒ RETEST REQUIRED AFTER FINAL HEAD ADJUSTMENT (7.3.3.5b)	☒	☐	☐
7	☒ MAXIMUM DISCHARGE PRESSURE TO INCLUDE (5.3.2)		☒ COMPLETE UNIT TEST (7.3.4.3)	☐	☒	☐
8	☐ MAX RELATIVE DENSITY		☒ SOUND LEVEL TEST (7.3.4.4)	☒	☐	☐
9	☒ MAX DIA. IMPELLERS AND/OR NO. OF STAGES		☒ CLEANLINESS PRIOR TO FINAL ASSEMBLY (7.2.2.2)	☐	☐	☒
10	☐ OPERATION TO TRIP SPEED		☒ NOZZLE LOAD TEST (6.3.6)	☐	☐	☒
11	☐ CONNECTION DESIGN APPROVAL (5.12.3.4/8.2.1.4)		☒ CHECK FOR CO-PLANAR MOUNTING PAD SURFACES (6.3.3)	☒	☐	☐
12	☐ INERT GAS INHIBITED STORAGE - SPARE CARTRIDGE (8.2.8.4)		☒ MECHANICAL RUN UNTIL OIL TEMP. STABLE (7.3.4.7.1)	☐	☒	☐
13	☐ TORSIONAL ANALYSIS REQUIRED (5.9.2.1)		☒ 4 h MECHANICAL RUN AFTER OIL TEMP. STABLE (7.3.4.7.3)	☐	☒	☐
14	☐ TORSIONAL ANALYSIS REPORT (5.9.2.6)		☒ 4 h MECH. RUN TEST (7.3.4.7.2)	☐	☒	☐
15	☒ PROGRESS REPORTS (9.3.3)		☐ TRUE PEAK VELOCITY DATA (7.3.3.4d)	☐	☐	☐
16	☐ OUTLINE OF PROCEDURES FOR OPTIONAL TESTS (9.2.5)		☐ BRG HSG RESONANCE TEST (7.3.4.6)	☐	☐	☐
17	☐ ADDITIONAL DATA REQUIRING 20 YEARS RETENTION (7.2.2.1f)		☐ REMOVE / INSPECT HYDRODYNAMIC BEARINGS AFTER TEST (8.2.7.5)	☐	☐	☐
18	☒ LATERAL ANALYSIS REQUIRED (8.2.4.1 / 8.2.4.1.3)		☐ AUXILIARY EQUIPMENT TEST (7.3.4.5)	☐	☐	☐
19	☒ DYNAMIC BALANCE ROTOR (8.2.4.2)		☒ CHARPY TEST (EN 13445/ASME VIII)	☐	☐	☐
20	☐ MANIFOLD PIPING TO SINGLE CONNECTION (6.5.1.6)		☐	☐	☐	☐
21	☐ VENT ☐ DRAIN ☐ COOLING WATER		☒ VENDOR KEEP REPAIR AND HT RECORDS (7.2.1.1c)			
22	☒ MOUNT SEAL RESERVOIR OFF BASEPLATE (6.5.1.4)		☒ VENDOR SUBMIT TEST PROCEDURES (7.3.1.2 / 9.2.5)			
23	☒ FLANGES REQ'D IN PLACE OF SOCKET WELD UNIONS (6.5.2.8)		☒ VENDOR SUBMIT TEST DATA WITHIN 24 h (7.3.3.3e)			
24	CONNECTION BOLTING		☐ INCLUDE PLOTTED VIBRATION SPECTRA (5.9.3.3)			
25	☐ PTFE COATING ☐ ASTM A 153 GALVANIZED		☒ RECORD FINAL ASSEMBLY RUNNING CLEARANCES			
26	☐ PAINTED ☐ SS		☒ COMPLETION OF INSPECTION CHECK LIST (7.1.6)			
27	☒ INSTALLATION LIST IN PROPOSAL (9.2.3L)					
28	QA INSPECTION AND TESTING					
29	☒ SHOP INSPECTION (7.1.4)					
30	☒ PERFORMANCE CURVE APPR.					
31	☐ TEST WITH SUBSTITUTE SEAL (7.3.3.2)					
32	☒ MATERIAL CERTIFICATION REQUIRED (5.12.1.8)					
33	☒ CASING ☒ IMPELLER ☒ SHAFT					
34	☐ OTHER _____					
35	☐ CASTING REPAIR PROCEDURE APPROVAL REQ'D (5.12.2.5)					
36	☒ INSPECTION REQUIRED FOR CONNECTION WELDS (5.12.3.4e)					
37	☒ MAG. PARTICLE ☐ LIQUID PENETRANT					
38	☒ RADIOGRAPHIC ☐ ULTRASONIC					
39	☒ INSPECTION REQUIRED FOR CASTINGS (7.2.1.3)(5.12.1.5)					
40	☐ MAG. PARTICLE ☐ LIQUID PENETRANT					
41	☒ RADIOGRAPHIC ☒ ULTRASONIC					
42	☐ HARDNESS TEST REQUIRED: _____ (7.2.2.3)					
43	☐ ADDITIONAL SURFACE / SUBSURFACE EXAMINATION (7.2.1.3)					
44	FOR _____					
45	METHOD _____					
46			REMARKS			
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Centrifugal pump — References

API 610 10TH EDITION / ISO 13709

☐ PRESSURE DESIGN CODES☐ WELDING REQUIREMENTS☒ PURCHASER DEFINED MATERIAL INSPECTIONS

REV.

1 APPLICABLE TO: ☒ PROPOSALS ☐ PURCHASE ☐ AS BUILT

2 FOR CPCL

UNIT RESID UPGRADATION

3 SITE MANALI REFINERY, TAMILNADU

SERVICE HRSG FEED PUMP

4 NOTES: INFORMATION BELOW TO BE COMPLETED: ☐ BY PURCHASER ☐ BY MANUFACTURER ☒ BY MANUFACTURER OR PURCHASER

5 PRESSURE VESSEL DESIGN CODE REFERENCES.

6 ☐ THESE REFERENCES MUST BE LISTED BY THE MANUFACTURER7 CASTING FACTORS USED IN DESIGN (5.3.4) (TABLE 3) ☐8 SOURCE OF MATERIAL PROPERTIES ☐

10 WELDING AND REPAIRS (5.12.3)

11 THESE REFERENCES MUST BE LISTED BY THE PURCHASER (DEFAULT TO TABLE 10 IF NO PURCHASER PREFERENCE IS STATED)

12 ☐ ALTERNATIVE WELDING CODES AND STANDARDS (5.12.3.1)

13 Welding Requirement (Applicable Code or Standard)

Purchaser-defined

Default per Table 10

14 Welder/operator qualification ☐15 Welding procedure qualification ☐16 Non-pressure-retaining structural welding such as baseplates or supports ☐17 Magnetic particle or liquid penetrant examination of the plate edges ☐18 Postweld heat treatment ☐19 Postweld heat treatment of casing fabrication welds ☐

21 MATERIAL INSPECTION (7.2.2.1) (7.2.1.3)

22 THESE REFERENCES MUST BE LISTED BY THE PURCHASER (DEFAULT TO TABLE 13 IF NO PURCHASER PREFERENCE IS STATED)

23 ☐ ALTERNATIVE MATERIAL INSPECTIONS AND ACCEPTANCE CRITERIA (SEE TABLE 13)

24 Type of inspection

Methods

For fabrications

Castings

25 Radiography ☐26 Ultrasonic inspection ☐27 Magnetic particle inspection ☐28 Liquid penetrant inspection ☐

REMARKS

ANNEXURE-3

BHEL data sheet for HV Motor

<DATA SHEET FOR HT DRIVE MOTOR FOR BFPS>

Drive Motor for "BFP for HRSG" (or) "BFP for UB" <Bidder to indicate>

Bidder's Offer No. & Dt. : <Bidder to indicate>

Bidder's Name : <Bidder to indicate>

Bidder's Doc. Rev. No. & Dt. : <Bidder to indicate>

BHEL Enq. No. : <Bidder to indicate>

BHEL Enq. Date : <Bidder to indicate>

Sl.no.	Description	BHEL Requirement (if any)	<Bidder's> Offer
1	Service	Drive for pump	
2	Variant No.	03	
3	No. of Motors	As per Pump Datasheet	
4	Manufacturer		
5	Reacceleration facility	Yes Reacceleration to be specified for identified motors to cover brief interruptions upto 5 seconds in normal power supply.	
6	Motor Standard	IS 325, IEC-60034 & JACOBS specifications	
7	Vibration & Temperature Monitoring System Std.	API 670 (4th edition)	
8	LO System Standard (If required)	API-614 (4th edition)	
9	Location	Outdoor (Canopy is required for all outdoor motors)	
10	Area classification for motor	Safe Area	
11	Make		
12	Model No.		
13	Type of Motor	TEFC, AC Squirrel Cage Induction Motor	
14	Mounting	Horizontal	
15	Designation and Frame Size	As per IS 325 & IS 1231	
16	Type reference		
17	Motor rating in KW		
18	No of poles / synchronous speed		
19	Type of Cooling	As per IS-325 Code	
20	Degree of Protection	IP55 as per IS	
21	Insulation:		
	a)Class of Insulation	Class F	
	b)Temp. rise by resistance method	Temperature rise ltd. to class B	
22	Type of enclosure		
23	Duty Cycle	Continuous- S1	
24	Phase	3 phase, 3-wire	
25	Rated values:		
	a)Voltage	6.6KV	
	b)Frequency	50 Hz	
26	Permissible variations:		
	a)Voltage	(+/-) 10%	
	b)Frequency	(+/-) 5%	
	c)Combined	(+/-) 10%	
27	Shaft orientation & mounting symbol		
28	Bearing:	2 pole motors above 750 kW rating shall be provided with sleeve bearings as a minimum.	
	a)Make		
	b)Type of DE bearing		
	c)Type of NDE bearing		
	d)Permissible temp rise for bearing [Deg C]		
	e)Type of lubrication of Bearing		
	f) DE & NDE Bearing life		
	g) Lubrication Schedule		
	h)Allowable vibration limit		
29	Winding:		
	a)Starter Winding connection during continuous running	Star	
	b)Type & No. of Terminals		
	c)Recommended temperature setting for stator winding [Alarm]		
	d)Recommended temperature setting for stator winding [Trip]		
30	6 nos duplex RTDs for winding temperature detection	Bidder to provide	
31	2 nos duplex RTDs for bearing temperature detection	Bidder to provide	
32	Dual dial type temperature indicator for bearings	Bidder to provide	
33	Grounding Pads on Motor Body/TB	Bidder to provide	

PROJECT: CAPTIVE POWER PLANT LEPETKATA
CUSTOMER: M/S BRAHAMPUTRA CRACKERS AND POLYMERS LIMITED.
CONSULTANT: M/S ENGINEERS INDIA LTD., NEW DELHI

Sl.no.	Description	BHEL Requirement (if any)	<Bidder's> Offer
34	Vibration & Bearing temperature monitoring system	Bidder to provide	
35	Space Heater: a)No & location	Required for all motors above 22kw	
	b)Volt & KW rating		
	c)Cable details	During Dteailed engg.	
36	Separate terminal boxes shall be provided for space heaters, resistance temperature detectors and vibration probes, neutral point of the star windings.	Bidder to Provide	
37	Dual dial type temperature indicator for bearings	Not applicable for LT Motor & Applicable for HT Motor	
38	Grounding Pads on Motor Body/TB	Required	
39	Full Load Current/No load current		
40	Full load Speed		
41	Ambient Temperature (Max)	45 C	
42	Allowable Temp. rise over ambient Temp.	75 C by resistance method	
43	Torque: a)Full Load Torque Kg.m b)Starting Torque as % of full load torque c)Pull Out Torque as % of full load Torque	Bidder to furnish [Refer Note-4] Minimum 110% upto 75 kw Shall not be less than 175% with no negative tolerance and shall not exceed 300%	
44	Starting Current as % of FLC	550% Inclusive of positive tolerances	
45	Weight of motor Kg		
46	Supply system Fault level: a)LT Motors b)HT Motors	50 kA 40 kA	
47	Motor Terminal Box	Phase segregated	
48	Terminal Box: a)Degree of protection b)Short time-Current [kA-RMS] c)Short time-Time [Sec] d)Dynamic[kA-Peak] e)Terminal Box location	IP 55 40 0.20 Right hand side viewed from the driving (coupling) end suitable for bottom cable entry, as per IS-325	
49	Terminal Box Quantity	Two nos. as per Clause 5.4 of annexure 10	
50	Voltage: a)Minimum permissible voltage during starting at FL b)Minimum permissible voltage for 5 mnt running without over heating		
51	Losses: a)Friction, Windage & stray losses (kw) b)Copper loss (kw) c)Iron loss (kw) d)Guaranted losses (kw)		
52	Safe Stall Time at 100% Rated Voltage under Hot Condition		
53	Motor GD Sq. Kgm sq		
54	Service Factor		
55	Vibration Level		
56	Cable Details: a)Type b)Size c)No. of cores	During Dteailed engg.	
57	Earthing Conductors: a)Material b)Size [mm]	GS	
58	Method of starting	DOL Alternatively soft start may be considered for starting of large HV motors, if essential / unavoidable, as per system design requirements / equipment design limitations.	
59	Power factor: a) At Rated Load b)Power Factor during Starting c)Power factor at 100%Load d)Power factor at 75% Load e)Power factor at 50% Load		

PROJECT: CAPTIVE POWER PLANT, LEPETKATA
CUSTOMER: M/S BRAHAMPUTRA CRACKERS AND POLYMERS LIMITED.
CONSULTANT: M/S ENGINEERS INDIA LTD., NEW DELHI

Sl.no.	Description	BHEL Requirement (if any)	<Bidder's> Offer
60	Efficiency:		
	a)Efficiency at 100%Load	As per Eff 2 class of efficiency	
	b)Efficiency at 75% Load	As per Eff 2 class of efficiency	
	c)Efficiency at 50% Load	As per Eff 2 class of efficiency	
61	Paint	Refer clause no 8.0 of annexure-8 of PEMC-05923]	
	Paint Shade	Shade 632 as per IS:5	
62	Time:		
	a)Time to attend Full speed @ Full load		
	b)Time to attend Full speed @ without load		
	c)Safe stall time under Hot/cold condition @ 100% of rated voltage		
	d)Safe stall time under Hot/cold condition @ 110% of rated voltage		
	e) Locked rotor wuth stand time hot/cold @ 80% of rated voltage		
	f) Locked rotor wuth stand time hot/cold @ 100% of rated voltage		
	g)Locked rotor wuth stand time hot/cold @ 110% of rated voltage		
	h)Starting Time with 100%/80% V with Load		
	i)Starting Time with 100%/80% V without Load		
	j)Hot thermal withstand time at 110% of the rated voltage		
	k)No of Consucutive Hot start		
	l)No of Consucutive Cold start		
	m)Slip @ 100% & 75% of load		
63	Energy efficient class	Eff 2	
64	Noise level	As per IS12065 (Limited to 85 Dba)	
65	Direction of rotation	Motors shall preferably be suitable for either direction of rotation.	
66	Permissible vibration limits [Mm/sec]	Shall be limited as per IS 12075-1986.	
67	Whether CTs required for differential protection		
68	CT particulars:		
	a)CT ratio		
	b)Class		
	c)Knee point voltage [KPV]		
	d)Max. Rct, Secondary winding resistance[ohm]		
	e)Max exciting current at 1/2 KPV [Amp]		
	f)Class of insulation		
69	Treatment against rust and corrosion	Bidder to provide	
70	Tropicalised(Yes/No)	Yes	
71	Suitable Cable Glands	Complete with double compression Nickel plated brass (or Aluminium, if specifically required) cable glands.	
	Cable lugs	Tinned copper lugs to be provided by the bidder.	
72	All performance figures are subject to tolerance	IS 325	
73	Thermal characteristics, Starting characteristics & negative sequence characteristics to be furnished.		
74	Dimesioned drawing to be furnished.		
Notes: 1. Separate Data Sheets shall be furnished for each category of motors - hard copy duly signed and with seal shall be furnished along with the offer. Soft copy shall also be furnished. 2. Data sheets in end customer formats also shall be furnished separately. 3. Bidder to fill up the column for bidder's data completely. Only for items like capability parameters, if not specified by BHEL, shall be indicated as "NA". Bidder to indicate his details wherein "<Bidder.....>" is indicated above. 4. The requirement for vacant spaces left in column for 'BHEL Requirement' shall be considered as per BHEL specification and subsequent correspondences. Only certain special requirements have been indicated in the 'BHEL Requirement' column.			

ANNEXURE-3(A)

JACOB'S DATA SHEET FOR HV MOTOR

	DATA SHEET FOR HV INDUCTION MOTOR		DOC. NO.	44NC-4600/0000/E.04/001B/A4			
			REQN. NO.				
			APPD. BY	RBD	RBD		
	PROJECT NO	44NC - 4600	CHKD. BY	PPP	PPP		
	PROJECT LOCATION	MANALI	PRPD. BY	VSL	ASR		
PROJECT TITLE	RESID UPGRADATION PROJECT	DATE	3-May-10	26-Jul-10			
CLIENT	CPCL	REV.	A	0	1	2	
A GENERAL							
1	DRIVEN MACHINE REF. NO.						
2	DRIVEN MACHINE TYPE						
3	NO. OF DRIVEN MACHINES						
4	APPLICABLE SPECIFICATION & STANDARDS	44NC-4600:ESS01B, IS 325 , IS 2148 AND OTHER NATIONAL / EQUIVALENT INTERNATIONAL STANDARDS					
B SERVICE CONDITIONS							
1	DESIGN AMBIENT TEMP. (MIN. & MAX)	18 DEG. C AND 45 DEG C					
2	ALTITUDE ABOVE M.S.L.	3.5 M					
3	RELATIVE HUMIDITY (MIN & MAX.)	80 % AT t_{max}					
4	MAX. RAIN FALL PER DAY	LATER					
5	LOCATION	INDOOR / OUTDOOR					
6	SITE ENVIRONMENT	CORROSIVE					
7	AREA CLASSIFICATION	ENCLOSURE					
		i) UNCLASSIFIED SAFE / ZONE 1 / ZONE 2					
		ii) GAS GROUP OF ENCLOSURE : I / IIA / IIB / IIC					
		iii) TEMPERATURE CLASS : T1 / T2 / T3 /T4 / T5 / T6					
C SYSTEM CHARACTERISTICS							
1	SYSTEM VOLTAGE , FREQUENCY , PHASES	KV, 50 HZ, 3 PHASE					
2	VOLTAGE VARIATION	± 10 %					
3	FREQUENCY VARIATION	± 5 %					
4	COMBINED VOLTAGE FREQUENCY VARIATION	± 10 %					
5	3 PHASE SYMMETRICAL FAULT LEVEL	MVA FOR SEC.					
6	GROUNDING	SOLID / NGR/ GROUNDING TRANSFORMERS					
7	EARTH FAULT LEVEL	KA					
D MOTOR TYPE & RATING							
1	TYPE						
2	RATED OUTPUT	KW					
3	RATED SPEED (SYN.)	RPM					
4	SPEED VARIATION	REQUIRED / NOT REQUIRED					
4.1	IF REQUIRED BY	VARIABLE SPEED AC DRIVE / MULTISPEED BY CHANGE OF MOTOR CONNECTION					
4.2	DRIVE CONTROL	CONSTANT TORQUE / VARIABLE TORQUE / CONSTANT HP					
5	DIRECTION OF ROTATION (VIEWED FROM COUPLING)	BI-DIRECTIONAL / CLOCKWISE / ANTI-CLOCKWISE					
6	RATED VOLTAGE	KV					
7	TYPE OF DUTY	S1/ S2/ S3/ S4/ S5/ S6/ S7/ S8/ S9/ S10					
8	CLASS OF INSULATION	STATOR : ROTOR :					
9	TEMP. RISE ABOVE TEMP. OF COOLING MEDIUM	Limited to Class at 100 % RATED LOAD					
10	TORQUE REQUIREMENTS (% OF FULL LOAD TORQUE)	PULL UP: % PULL OUT: % (The values shall not be less than specified in relevant standards lik IS/IEC, shall be adequate for load torque requirement)					
11	OVERLOAD REQUIREMENTS	% OVERLOAD FOR SEC./ MIN. (AS PER IS325 / RELEVANT IEC & TO SUIT THE REQUIREMENT OF DRIVEN EQUIPMENT.)					
12	METHOD OF STARTING & TYPE OF BREAKER	DOL / AUTO TRANSFORMER / SOFT STARTER					
13	LOCKED ROTOR CURRENT LIMITATION	(INCLUSIVE OF IS TOLERANCE)					
14	TYPE OF BRUSH GEAR						
15	NO. OF STARTS REQUIRED	1) SUCCESSIVE : HOT, COLD 2) PER HR. (EQUISPACED) NOS.					
16	WINDING TREATMENT	REQUIRED - ANTICORROSIVE EPOXY TREATMENT.					
FORM NO. E 001B DS.xls		APPLICABLE STANDARD SPECIFICATION : 44NC- 4600: ESS 01B					

	DATA SHEET FOR HV INDUCTION MOTOR		DOC. NO.	44NC-4600/0000/E.04/001B/A4			
			REQN. NO.				
			APPD. BY	RBD	RBD		
	PROJECT NO	44NC - 4600	CHKD. BY	PPP	PPP		
	PROJECT LOCATION	MANALI	PRPD. BY	VSL	ASR		
PROJECT TITLE	RESID UPGRADATION PROJECT	DATE	3-May-10	26-Jul-10			
CLIENT	CPCL	REV.	A	0	1	2	
E ENCLOSURE							
1	FEATURE OF PROTECTION (W.R.T. TO AREA CLASSIFICATION)	FLP / SAFE Ex'n'					
2	DEGREE OF PROTECTION	IP					
3	TYPE OF MOUNTING						
4	TYPE OF COOLING	TEFC OR CACA					
5	DATA FOR COOLING MEDIUM						
6	PAINTING - TYPE						
	- SHADE						
F MECHANICAL REQUIREMENT							
1	TYPE OF DRIVE / COUPLING	FLEXIBLE / DIRECT					
2	GD ² VALVE OF DRIVEN MACHINE W.R.T. MOTOR SHAFT	KgM2					
3	TORQUE / CRANK ANGLE DIAGRAM NO.						
4	TORQUE / SPEED CHARACTERISTIC CURVE						
5	SHAFT EXTENSION	STANDARD/ mm					
6	TYPE OF BEARINGS						
7	TYPE / METHOD OF LUBRICATION						
8	BED PLATE / SOLE PLATE REQUIREMENT						
G ACCESSORIES							
1	ANTI - CONDENSATION HEATERS	RATED VOLTAGE :					
2	EMBEDDED TEMP. DETECTORS , TYPE ,NOS. / pH.	PT100 DUPLEX 2 NOS. / PHASE. IF DUPLEX NOT POSSIBLE THEN PT100 SIMPLEX - 4 NOS. / PHASE					
3	SPEED SENSING DEVICE	NR					
4	VIBRATION DETECTORS	REQUIRED					
5	CURRENT TRANSFORMERS FOR DIFF. PROTECTION IN NEUTRAL TERMINAL BOX	REQUIRED FOR ALL MOTORS RATED 1500 KW AND ABOVE					
6	P.F. CORRECTION CAPACITOR						
7	SURGE PROTECTION						
8	BARRING DEVICE						
9	EARTHING	2 NOS. EARTH CONNECTIONS IN MOTOR FRAME & 2 NOS. IN TERMINAL BOX					
10	MAIN NAME PLATE	STAINLESS STEEL					
11	AUXILIARY NAME PLATE	REQUIRED / NOT REQUIRED					
H TERMINAL BOXES REQUIREMENTS		LOCATION VIEWED FROM COUPLING					
1	MAIN TERMINAL BOX , TYPE :	PHASE SEGREGATED		RHS/LHS			
2	SPACE HEATER TERMINAL BOX.	SEPARATE		RHS/LHS			
3	STATOR WINDING TEMPERATURE AND BEARING DETECTOR TERMINAL BOX	SEPARATE		RHS/LHS			
4	ROTOR TERMINAL BOX (IF APPLICABLE)						
5	NEUTRAL TERMINAL BOX	INTERCHANGEABLE WITH MAIN TERMINAL BOX					
I EXTERNAL CABLE : TYPE SIZE & NO./ LENGTH & TYPE OF TERMINATION							
1	STATOR						
2	ROTOR						
3	SPACE HEATER						
4	TEMPERATURE DETECTORS : WINDING						
	: BEARING						
FORM NO. E 001B DS.xls		APPLICABLE STANDARD SPECIFICATION : 44NC- 4600: ESS 01B					

	DATA SHEET FOR HV INDUCTION MOTOR		DOC. NO.	44NC-4600/0000/E.04/001B/A4			
			REQN. NO.				
			APPD. BY	RBD	RBD		
	PROJECT NO	44NC - 4600	CHKD. BY	PPP	PPP		
	PROJECT LOCATION	MANALI	PRPD. BY	VSL	ASR		
PROJECT TITLE	RESID UPGRADATION PROJECT	DATE	3-May-10	26-Jul-10			
CLIENT	CPCL	REV.	A	0	1	2	
N DATA TO BE FURNISHED BY MOTOR							
SUPPLIER WITH THE TENDER (CONTD..)							
2.11 MAIN TERMINAL BOX LOCATION & ORIENTATION							
REQUIREMENTS							
2.11.1	TERMINAL BOX ELECTRICAL REQUIREMENTS	<u>CABLE SIZE</u>	<u>TYPE & TERM</u>	FAULT kA & TIME			
2.12 BEARING LUBRICATION SYSTEM							
2.12.1	LUBE OIL PUMPS	PROVIDED / NOT REQUIRED					
2.12.2	TYPE OF PUMPS	SHAFT DRIVEN / AC MOTOR/ DC MOTOR					
2.12.3	IF MOTORISED, MOTOR RATINGS	SHAFT DRIVEN/ AC MOTOR/ DC MOTOR					
3 OPERATION PARTICULARS							
3.1	RATED FULL LOAD CURRENT	Amps					
3.2	MAX. CONTINUOUS LOAD	Amps					
3.3	MOTOR T/N CURVES AT 85% & 100%	ENCLOSED / NOT ENCLOSED		SHALL BE ENCLOSED.			
VOLTAGE SUPERIMPOSED WITH THE T/N CURVE OF							
DRIVEN EQUIPMENT							
3.4	SUCCESSIVE STARTS (specify limits)	HOT		COLD			
3.5	STARTING CURRENT - TIME CURVES AT 85%, 100%	ENCLOSED / NOT ENCLOSED		SHALL BE ENCLOSED.			
& 110% VOLTAGE							
3.6	STARTING TIME CALCULATIONS AT 85%, 100%	ENCLOSED / NOT ENCLOSED		SHALL BE ENCLOSED.			
& 110% VOLTAGE							
3.7	THERMAL WITHSTAND CURVE (HOT & COLD)	ENCLOSED / NOT ENCLOSED		SHALL BE ENCLOSED.			
3.8	EFFICIENCY & PF, SLIP, CURRENT VS LOAD CURVE	ENCLOSED / NOT ENCLOSED		SHALL BE ENCLOSED.			
3.9	STARTING CHARACTERISTICS	<u>AT 85% VOLTAGE</u>	<u>AT 100% VOLTAGE</u>	<u>AT 110% VOLTAGE</u>			
3.9.1	STARTING TORQUE (in KgM)						
3.9.2	STARTING CURRENT (Amps)						
3.9.3	STARTING TIME (SECS)						
3.9.4	STARTING POWER FACTOR						
3.9.5	HOT STALL TIME (SECS)						
3.9.6	COLD STALL TIME (SECS)						
3.9.7	ACCELERATION TIME						
3.9.8	TYPE TEST CERTIFICATE FOR SIMILAR MOTOR.	SHALL BE ENCLOSED.					
3.10	THERMAL TIME CONSTANT						
3.11	COOLING TIME CONSTANT						
3.12	PERFORMANCE	<u>EFFICIENCY</u>		<u>POWER FACTOR</u>			
3.12.1	NO LOAD						
3.12.2	50% LOAD						
3.12.3	75% LOAD						
3.12.4	100% LOAD						
3.13	RECOMMENDED NUMBER OF DOL STARTS AT EQUAL	<u>HOT</u>		<u>COLD</u>			
INTERVALS IN 1 HOUR							
3.14	PULL UP TORQUE						
3.15	PULL OUT TORQUE						
3.16	FULL LOAD SLIP						
3.17	ROTOR GD2						
3.18	NORMAL TEMPERATURE RISE AND	$\Delta T =$ K (AS PER IEC 34-1 & 2)					
MAX. HOT SPOT TEMPERATURE		T MAX = OC					
FORM NO. E 001B DS.xls		APPLICABLE STANDARD SPECIFICATION : 44NC- 4600: ESS 01B					

[illegible]

ANNEXURE-4

PRICE BID FORMAT

	BHARAT HEAVY ELECTRICALS LIMITED R.C.PURAM, HYDERABAD-502032				
	PROJECT ENGINEERING DEPT.				
	PRICE FORMAT (R00) FOR HRSG BFP PROJECT: RESID UPGRADATION PROJECT/GTG & HRSG PCKG CUSTOMER: CHENNAI PETROLEUM CORPORATION LIMITED (CPCL), MANALI- CHENNAI. CONSULTANT: M/S JACOBS ENGG INDIA PVT LTD, MUMBAI				
SL NO	ITEM DESCRIPTION	QTY	UNIT	UNIT RATE (RS.)	TOTAL (RS.)
	Bidder's Name : <Bidder to indicate> Bidder's Offer No. & Dt. : <Bidder to indicate> Bidder's Ref No. & Dt. :<Bidder to indicate> BHEL Enq. No. & date :<Bidder to indicate>				
A	MAIN OFFER				
A.1.	MATERIAL SUPPLY-PUMP				
	Horizontal, centrifugal, multi stage, Barrel casing design pump complete with all accessories as per Specification.	2	Set		
A.2	MATERIAL SUPPLY-MOTOR				
	Suitable drive motor complete with terminal box, canopy, space heater, cable glands, earthing lugs and all other accessories required as per specification.	2	Set		
A.3	Commissioning spares				
	Commissioning spares as per manufacturer's recommendation. Minimum 1 Set of O rings & gaskets for each pump & drive assembly, and 1 set of spare strainer elements for each pump 1 set stands for requirement for one no. of pump and drive assembly Bidder to furnish the list along with the offer. (Ref. Note-6)	2	Set		
A.4	Special tools & tackles				
	Special tools & tackles as per manufacture recommendations. 1 set standas for requirement for each pump, drive and other accessories. Bidder to furnish the list along with offer	1	Set		
A.5	Mandatory Spares: Note:(1 set stands for quantity required for the replacement of one pump)				
a	Mechanical seal (complete set)	1	Set		
b	Bearing liners	1	Set		
c	Segmented break-down bushings for stuffing box	1	Set		
d	Fully assembled rotor with impeller	1	Set		
e	Diffusers	1	Set		
f	Impellers wearing ring with necessary screws	1	Set		
g	Balancing device (stationery and rotary parts)	1	Set		
h	Low load recirculation control valve	1	Set		
i	Bearing Assembly for all bearings	1	Set		
j	Spare tubes for oil coolers together with expanders- one tube bundle	1	Bundle		
k	Filter elements	1	Set		

	BHARAT HEAVY ELECTRICALS LIMITED R.C.PURAM, HYDERABAD-502032				
	PROJECT ENGINEERING DEPT.				
	PRICE FORMAT (R00) FOR HRSRG BFP PROJECT: RESID UPGRADATION PROJECT/GTG & HRSRG PCKG CUSTOMER: CHENNAI PETROLEUM CORPORATION LIMITED (CPCL), MANALI- CHENNAI. CONSULTANT: M/S JACOBS ENGG INDIA PVT LTD, MUMBAI				
SL NO	ITEM DESCRIPTION	QTY	UNIT	UNIT RATE (RS.)	TOTAL (RS.)
	Bidder's Name : <Bidder to indicate> Bidder's Offer No. & Dt. : <Bidder to indicate> Bidder's Ref No. & Dt. :<Bidder to indicate> BHEL Enq. No. & date :<Bidder to indicate>				
I	Instrumentation: i) Pressure Gauges & Differential Pressure Gauges: 20% (Subject to min. of 1) of each type, range, material of construction and rating, whichever is higher. ii) Temperature Gauges: 20% (Subject to min. of 1) of each type /range of Temperature Gauges with Thermowell, whichever is higher iii) Level Gauges: A) For transparent gauges, 20% of illuminators with holder and reflector and 50% of bulbs B) In case of magnetic type level gauges, 1 set of float and 10% of bi-color rollers for each gauge to be provided in addition to above. C) 30% subject to minimum one number of glass of each type, size along with pair of Gaskets (Cushion & Wet Gaskets), whichever is higher D) 20% subject to minimum one number of Gaskets for Gauge Cocks/Valves Bonnet / Packing iv) SMART/FF Transmitters for Pressure (including PDT), Flow (DP), Level (DP) including remote seals and Temperature: 15% or minimum of 2, whichever is higher of each type, range (model no.), make and material of construction of whole unit. 100% spare for transmitter manifold O-ring shall be provided. v) Displacer Type Level Transmitters: 10% subject to minimum of 1 no. of each type of complete displacer transmitter head unit including torque tube assembly. vi) Servo Type Level Gauges: A) 10% or minimum one number of complete electronic unit assembly whichever is higher B) 10% or minimum one number of each type of displacer whichever is higher C) 10% or minimum one number of local indicators, which ever is higher. vii) Temperature Elements: 20% (subject to minimum of 1) of each type, range, length and make of Thermocouple with Thermowell, whichever is higher. Same philosophy to be followed for multi point thermocouples also but without thermowell. viii) RTD's: 20% (subject to minimum of 1) of each length of RTD with Thermowell, whichever is higher. ix) Skin Type Thermocouple: 10% (subject to minimum of 1) of each length & type of skin Thermocouple, whichever is higher. x) Ceramic Thermowell: 1 no. for each Tag. xi) Temperature transmitters: 15% or minimum of 2, whichever is higher of each type, range (model no.), make and material of construction of whole unit. 100% spare for transmitter manifold O-ring shall be provided. xii)Pressure Relief Valves: A) Disc, guide and nozzle: 10% of total quantity of identical pressure relief valves or minimum one number whichever is higher. B) Expansion Bellow: 20% of total quantity of identical pressure relief valves or minimum one number whichever is higher. C) Spring: 10% of total quantity of identical pressure relief valves or minimum one number whichever is higher. D) Gasket Set: 20% of total quantity of identical pressure relief valves or minimum one number whichever is higher. xiii)Junction Box & Cable glands: 10% subject to minimum one no. for each type, size whichever is higher. xiv) Panel mounted instruments: 10% or minimum one no. whichever is higher. xv) Machine Monitoring System: 10% or minimum 2 nos. of each type of probes (vibration, speed, displacement etc.) and transducers/ proximitor/ extension cables/ connector protective sleeves etc.				

		BHARAT HEAVY ELECTRICALS LIMITED R.C.PURAM, HYDERABAD-502032			
PROJECT ENGINEERING DEPT.					
PRICE FORMAT (R00) FOR HRSG BFP PROJECT: RESID UPGRADATION PROJECT/GTG & HRSG PCKG CUSTOMER: CHENNAI PETROLEUM CORPORATION LIMITED (CPCL), MANALI- CHENNAI. CONSULTANT: M/S JACOBS ENGG INDIA PVT LTD, MUMBAI					
SL NO	ITEM DESCRIPTION	QTY	UNIT	UNIT RATE (RS.)	TOTAL (RS.)
Bidder's Name : <Bidder to indicate> Bidder's Offer No. & Dt. : <Bidder to indicate> Bidder's Ref No. & Dt. :<Bidder to indicate> BHEL Enq. No. & date :<Bidder to indicate>					
B	OPTIONAL ITEMS				
B.1	Supervision charges for erection & commissioning at site	--			
a	Travel expenses from vendor works to site and back per visit /person	1	No.		
b	Per day charges per person for supervision of erection & commissioning at site including boarding, lodging, local transportation	1	No.		
B.2	2 Years Recommended Spares				
	Recommended spares list for two years normal operation along with unit price breakup for Pump, Drive & other accessories.	As per List	Set		
TOTAL					
Notes: 1) Main offer consists of those items which will be part of main order after successful bidder is identified. Optional Items consists of those items which need to be quoted by bidder but may or may not be ordered by BHEL. Bidders are instructed to provide the pricing details listed under Main offer and Optional items as per the prescribed format. 2) Prices quoted by bidders for items under main offer : Sl. No. A will be considered for evaluation of lowest and successful bidder. However presently there is no work order for A.5 (Mandatory Spares). Hence purchase order for A.5 (Mandatory Spares) shall be placed after receipt of Mandatory Spares order from Customer. 3) For all items including Optional items, prices to be furnished in the prescribed format for each individual item. No combined prices or common prices will be accepted and such bids may not be considered for evaluation. 4) Bidder must not change the above indicated item description, quantity & units. He should only fill the unit rates & total price. 5) The price format is only for basic price. All other commercial charges for packing, freight, transportation, insurance, taxes & duties etc., shall be separately indicated. 6) Any commissioning spare consumed over and above the recommended commissioning spares, during commissioning shall be supplied free of cost by the equipment vendor. 7) Reference document: BHEL spec no. PEMC 05923 Rev 00, its annexes and subsequent correspondences.					

ANNEXURE-5

DESIGN BASIS FOR ROTATING EQUIPMENT

SPECIFICATION NO: 44NC-46 00-0000 /M.06/0006/A4**TITLE:** ENGINEERING DESIGN BASIS
ROTATING EQUIPMENT - OSBL**PROJECT REFERENCE:**

- **Project No:** 44NC 4600
- **Project Location:** Manali, Chennai
- **Project Title:** Resid Upgradation project
- **Client:** Chennai Petroleum Corporation Limited
- **Project Manager Authorization:** R. P. Gaikwad **Date:**
- **Client Authorization:** **Date:**

				APPROVALS		
Rev. No.	Issue Date	Pages	Revision Description	By	Check	Approve
B	22-Apr-10	35	Client comments incorporated and Issued for Engineering	GAK	GHD	SNG
A	03-Mar-10	33	Issued for CPCL comment's	GAK	PDB	SNG
☒ Entire Specification Issued this Revision			SPECIFICATION ISSUED FOR:			
☐ Revised Pages Only Issued this Revision						
			☐ In-house Review	☐ Purchase		
			☐ Client Approval	☐ Construction		
			☐ Enquiry	☒ Engineering		

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1.0 APPLICABLE CODES AND SPECIFICATIONS

ASTM	American Society for Testing and Material
ASHRAE	American Society of heating, Refrigerating and Air Conditioning Engineers.
API	American Petroleum Institute
ASME / ANSI	American Society of Mechanical Engineers
AGMA	American Gear Manufacturer's Association
CTI	Cooling Tower Institute
NFPA	National Fire Protection Association
TEMA	Standards of Tubular Exchanger Manufacturer's Association
IBR	Indian Boiler Regulation Act
NFPA	National Fire Protection Association
CEMA	Conveyor equipment manufacturer association
ABMA	American Boiler Manufacturer's Association
HEI	Heat Exchangers Institute
ASME	American society of mechanical engineers
AWS	American welding society
IS 800	Code of practice for general construction in steel
IS 875	Code of practice for design loads for building and structures
IS 1893	Criteria for earth quake design of structures
AFBMA	Anti-Friction bearing manufacturers association
HIS	Hydraulic institute standard
MINAS	Minimals National Standard
OSHA	Occupational Safety Health Administration

II Statutory Regulations.

Factories Act
 Tariff advisory committee guidelines
 Petroleum act, Petroleum rules, guidelines from Oil industry Safety Directorate(OISD)
 Pollution (Air & water) laws.
 Civil aviation Rules
 Applicable international design standards
 Indian electricity Act
 CCOE (chief controller of explosive)
 CEIG (Chief electrical inspectorate general)
 TNPCB (Tamilnadu pollution control board)
 IBR (Indian Boiler Act)
 CEA (Central electric authority)
[Central pollution control board](#)

III Equipment codes and standards

	Item	International Standard
a)	Pumps	
	Centrifugal pumps for water service in utilities and offsites	IS 5120/Equivalent
	Centrifugal pumps for other services	API-610, 10 th Edition,

		2004
	Positive displacement pumps – Reciprocating	API-674, 2 nd Edition, 1995
	Positive displacement pumps – Controlled volume	API-675, 2 nd Edition, 1994
	Positive displacement pumps – Rotary	API-676, 2 nd Edition, 1994
	Shaft sealing systems for centrifugal and rotary pumps.	API-682, 3 rd edition, 2004
b)	Turbines	
	General purpose steam turbines	API-611, 5 th Edition, 2008
	Special purpose steam turbines	API-612, 6 th Edition, 2005
c)	Centrifugal compressors (Gas services)	API-617, 7 th edition, 2007
	Packaged integrally geared centrifugal air compressors.	API-672, 4 th Edition, 2004
	Reciprocating compressor – Utility and Instrument air service.	IS 6206 / Equivalent.
	Rotary type positive displacement compressors	API-619, 4 th Edition, 2004
	Others	
	Fans for other services	IS 4894(1987)/ BS 0848
	Special purpose gear units for Petroleum, Chemical and Gas industry service	API-613, 5th Edition, 2003
	General purpose gear units for Petroleum, Chemical and Gas industry service	API-677, 3rd edition, 2006
	Lubrication, shaft-sealing and control oil system for special purpose applications	API-614, 5th Edition, 2008
	Vibration, axial piston and bearing temperature monitoring systems.	API-670, 4th Edition, 2000
	Machinery installation and installation design	API-RP 686, 1st Edition, 1996
	Inspection of fans, blowers, gear boxes & agitators	OISD 122-Aug-1999
	Inspection and maintenance of mechanical seals	OISD 125-Aug-1999
	Vibration limits for rotating machines	ISO 1940
	Machine vibration.	ISO 10816
	Special purpose couplings for Refinery service	API-671 3rd edition
	Safety guards for equipment with moving parts	OSHA 3057

2.0 DESIGN PHILOSOPHY / CRITERIA – GENERAL

- 2.1 Selection of rotating equipment shall be based upon the following considerations:
- Suitability for the specified range of duty conditions.
 - Standard models under supplier are from regular manufacturing range.
 - Proven track record in similar service as specified under acceptance criterion.
 - Suitable for outdoor installation
 - Optimum operating and maintenance costs.
 - Maximum interchangeability of parts.
 - Ease of operation and maintenance.
 - Foreign vendor shall preferably have a liaison office in India
- 2.2 For design aspects not specifically covered by data sheets, specifications, codes and standards or regulations, the design shall be based on good engineering practices.
- 2.3 Contractor shall make all possible efforts to comply strictly with the requirements of this design basis. In case deviations are considered essential by the contractor (after exhausting all possible efforts), these shall be clearly brought out and consolidated under technical exception chapter at bidding stage. However, vendor specific deviation (if any) to applicable codes / specifications arise during detailed engineering then the same will be subject to PMC / Owner's approval.
- 2.4 The enquiry documents for procurement of rotating equipment shall be prepared by the contractor and shall as a minimum, contain the following documents:
- Job specifications which will describe special requirements / features of the subject equipment such as brief description of the system, process requirements, applicable codes and standards, basis of design, operating philosophy, start up and shutdown condition, site conditions, and utilities available during normal operation, start up, normal and emergency shutdown, special control and safety requirements, special lubrication and sealing systems, etc.
 - Scope of supply / work of equipment vendor, Contractor's scope of work, list of terminal points/battery limits, guarantee parameters with specified tolerances. For major packages/equipment contractor shall include in the specifications a scope break up table between equipment supplier and Contractor for design, engineering, supply, inspection, erection and commissioning activities and handing over.
 - Inspection and testing requirements, shop / site testing requirements with procedure, QA/QC guidelines.
 - Mechanical data sheets of driver, driven equipment, accessories and all auxiliaries etc., indicating operating parameters, performance requirements, construction features, material of construction, instrumentation and controls, inspection and testing etc., using respective API data sheet formats.

- Specifications shall clearly spell out the order of precedence of various documents viz. Job specifications, data sheets, P&IDs / drawings, codes/standards, standard specifications.
- Vendor data requirements, which shall be inline with the data, specified in the owner's specification and applicable API Standards.
- Experience record formats required to be filled by the equipment vendor as original equipment manufacturer (OEM).
- Mandatory spares list, O&M Spares, Commissioning spares.
- Drawings e.g. P&IDs of the equipment process and auxiliary systems, equipment layout drawing etc.
- Requirement of vendor's services during equipment installation, hook-up, pre- commissioning and commissioning schedule of activities.
- Requirements for special tools and tackles.

2.5 The equipment supplier shall fill in Experience record formats completely indicating information on operating conditions and construction features of the vendors past supply in sufficient detail to evaluate provenness of the equipment proposed.

2.6 The supplier of equipment shall be selected from the approved list of vendors specified elsewhere in bid document.

2.7 Unless otherwise specified in the process / equipment data sheets, number of spare equipment to be installed shall be as per the following equipment sparing philosophy.

Item		No. of standby equipment as % of working eqpt.	Remarks
a)	Pumps (continuous / critical equipment) Pumps (intermittent / non critical use)	100% Nil	
b)	Steam turbine	Nil	1No spare rotor assembly with set of coupling, bearing and seals required.
c)	Reciprocating compressor	50% *	
d)	Centrifugal Compressor (API 617)	Nil	1No spare rotor assembly required for each casing.
e)	Blower	100%	
f)	ID Fans	Nil	
g)	FD Fans	100%	

h)	Lube oil pumps, Seal oil pumps and Condensate pumps	100%	If pump is steam turbine driven then refer 2.7 (b)
Note *: Subject to minimum 1No of requirement. Fractions shall be rounded to next higher integral number.			

- 2.8 Electrical items, instrumentation and controls, piping, pressure vessels, mechanical equipment, heat exchangers etc., associated with rotating equipment shall comply with the design requirements as given in the respective engineering documents enclosed in the bid package.
- 2.9 The ratings of drivers (electric motor / steam turbine / diesel engine) shall comply with the requirements specified individually for each driven equipment.
- 2.10 Equipment layout shall incorporate adequate maintenance platforms, support structures, hand rails, material handling facilities for operational access, inspection, erection and maintenance of equipment. Non skid decking covering all walk and work areas shall be provided on top of base plate as required. Material handling facilities for normal maintenance of rotating equipments shall be followed as per following criteria.

Sr No	Type of rotating equipment	Type of maintenance facility	remark
	Centrifugal pump	Trolley mounted CP block with monorail	
	Reciprocating pumps	Trolley mounted CP block with monorail	
	Centrifugal compressor	EOT crane	Note 1
	Plant and instrument air compressor	EOT crane	Note 1
	Fan	Trolley mounted CP block with monorail	Note 1

Note 1: Electric motor driver shall be considered as a single component for maintenance except for single bearing electric motors where stator motor and rotor shall be considered as individual components.

- 2.11 Equipment design and engineering shall incorporate adequate safety features (as per applicable specifications of respective equipment as well as Health, Safety and Environment codes and standards applicable for the subject project) to provide protection to operating personnel, equipment and environment.
- 2.12 All electrical components and installations, instruments shall be suitable for the electrical area classification and grouping in which the equipment is installed.
- 2.13 Material exposed to sour environment as defined by NACE MR-0103/ MR-0175 shall be in accordance with requirements of the NACE standard. Ferrous materials not covered by NACE MR-0103/ MR-0175 shall be limited to yield strength not exceeding 90,000 psi and hardness not exceeding Rockwell C-22..

- 2.14 Noise level of continuous operating equipment (for Driver + Driven equipment + Auxiliary) shall not exceed 85 dBA when measured at 1M distance from the equipment skid in any direction.
- Note: This requirement is not applicable for intermittent operation equipment such as firewater pump, engine driven emergency generator, high speed Sundyne pumps, etc. For safety relief valve vents the noise level shall be limited to 105 dBA at 5m distance.
- 2.15 Acoustic enclosures are not preferred. However, it may be provided for equipment such as gas turbines, rotary screw compressors, Sundyne (pump and compressors) and root blowers to meet the specified noise levels with prior approval from PMC/Owner Requirement of silencers at fan/blower/compressor suction, relief valve outlets shall be accordingly decided.
- 2.16 All compressor sheds shall be provided with adequately sized EOT / HOT crane, depending upon the maximum weight of one component to be handled for maintenance of the compressor and its driver. Electric motor driver shall be considered a single component for maintenance except for the single bearing motors where the motor rotor and stator shall be considered as individual components.
- 2.17 Maximum allowable working pressure and temperature of the equipment shall not be less than the design pressure and temperature specified in the data sheet or not less than those specified in specifications, codes and standards.
- 2.18 Spare rotors where supplied shall be boxed in a metal containers for vertical storage with adequate corrosion protection. Nitrogen purging shall be considered.
- 2.19 Unless otherwise specified, equipment shall be driven directly or driven through gear box. However belt driven arrangement may be provided for the following equipments, installed in safe area.
Reciprocating compressors upto driver rating of 160 kW.
Reciprocating pumps (API 674) to driver rating of 160 kW.
V-belt shall not be used for equipment located in hazardous area i.e. Div.1 or Div.2 (NEC) area (Zone 1 or Zone 2 (IEC) area)
- 2.20 **All rotating equipment** and drivers (including gear units and couplings if any) shall be designed to perform satisfactorily under specified start up conditions, part load operation, maximum differential pressure operation and relief valve set pressure and upto full speed including any design margin specified considering future requirements. This shall also include operating conditions envisaged during regeneration cycle of plant and as specified in respective equipment data sheets.
- 2.21 Couplings shall be of non-lubricated diaphragm / metallic flexible membrane type with spacer for all equipment. However, coupling shall conform to API 671 for all the equipment with speed greater than 3600 rpm and / or driver rating greater than 160 kW. All coupling guards shall be of non-sparking type. Couplings shall be dynamically balanced separately with match marked coupling bolts/coupling halves. . Universal coupling (Hook Joint) shall be used for coupling diesel engine and vertical water pumps.

2.22

Centrifugal compressors, centrifugal integrally geared compressors, special purpose steam turbines, special purpose gear units, pumps and fans above 160 kW shall be provided with probes / detector and monitors in accordance with API 670 standard for measuring shaft radial vibration, axial position, and bearing temperatures.

The probes and monitors shall be Bentley Nevada BN 3500 model. Alarm (alert) and shutdown (danger) annunciation shall be provided for each of the monitored variables. This system shall comply with requirements specified in specification for instrumentation covered elsewhere in the Bid document. Separate keyphasors shall be provided for input and out shaft of gear box. 2oo3 logic shall not be applicable for high vibration trips.

2.23

In case of oil coolers the oil side operating pressure shall be higher than waterside operating pressure.

2.24

Unless otherwise specified, coolers (inter cooler and after cooler) shall be watercooled shell and tube with water on tube side type with removable tube bundle. Design pressure of the low pressure side shall be two third of the design pressure of high pressure side as a minimum. Process coolers shall be designed and constructed as per TEMA 'R' and coolers for air service shall be designed and constructed as per TEMA 'C'.

2.25

In case of oil coolers the oil side operating pressure shall be higher than waterside operating pressure. Unless otherwise specified, oil coolers and cooling water console coolers shall be water cooled shell and tube with removable bundle. The design of such coolers as per TEMA 'C' is acceptable. Cooling water shall be on tube side

2.26

Unless otherwise specified the inter and after coolers shall be designed with following considerations:

- The fouling resistance of $0.0004 \text{ hr m}^2\text{-}^\circ\text{C} / \text{kcal}$ shall be considered for water side.
- Tubes shall be preferably than 20mm (3/4") or 25 mm (1") outside diameter (OD). The minimum allowable tube wall thickness is 2.0 mm in case of admiralty brass and 2.5 mm in case of carbon steel tube. Coolant velocity in tubes shall be at least 1.0 m/sec.
- 'U' tube coolers are not preferred.

2.27

All exchangers shall be provided with test rings with back flush arrangement.

2.28

Unless otherwise specified, for centrifugal compressors and steam turbines the following shall be provided.

- Portable lube oil drain pump.
- Portable lube oil purifier for online purification (Alfa Laval make) with fine filter (1 micron) in return line.
- Fuel storage / transfer pump (as applicable)

2.29

Electrical motor drivers as per (IEC / IS) shall be rated for continuous duty (duty type SI) whereas motor as per American standards shall be designed to operate at a service factor of 1.0.

- 2.30 The rated BKW considered as the basis for sizing of the drivers shall include the positive tolerance as permitted in the applicable code or as specified i.e. the margin of 10%, 15%, 25% etc. as applicable for driver sizing shall be kept over and above the (rated BKW + tolerance).
- 2.31 In case of bladder type pulsation suppression devices for reciprocating pumps / accumulators for oil systems, gas charging assembly kit shall be supplied one for each service.
- 2.32 All rotating equipment base plates shall have jacking provision for levelling and screws for alignment. Only stainless steel shims shall be used for equipment alignment. Number of shims shall be minimum having thickness less than 1mm, rest SS packer plates shall be used to minimise number of shims.
- 2.33 In case of compressors, non-skid decking covering all walk and work areas shall be provided on top of the baseplates.
- 2.34 Thermal relief valves shall be provided for components that may be blocked in by isolation valves (including any cooling water return circuit piping of a cooler or jacket).
- 2.35 In case of centrifugal compressors and steam turbines (special purpose), the lube oil system shall comply with API-614.
- 2.36 Bearing housings for pumps and fans with oil lubricated bearings shall be provided with bearing guard type shaft seals to prevent oil leakage or contamination.
- 2.37 After completion of performance test, mechanical seals of pumps shall be removed and shall be reassembled at pump vendor's works with recommended secondary packing.
- 2.38 The installed mechanical components like gland plates, sleeve, etc. shall be of seal vendor's make only. In case pump manufacturer provides the same, the drawing shall be vetted by seal vendor.
- 2.39 All special tools and tackles including hydraulic equipment required for maintenance purpose for the rotary equipment should be provided along with main equipment.
- 2.40 Companion flanges for non-standards flanges shall be provided by manufacturer along with spiral wound gaskets of required grades and fasteners.
- 2.41 All heat exchangers / seal coolers using cooling tower water shall have following metallurgy.
- If cooling tower water is on tube side. Then tube shall be of Duplex SS (UNS 31803 or UNS32750)
 - If cooling water is on shell side , then shell and tubes both shall be of Duplex SS (tubes of UNS 31803 or UNS32750).

- 3.5.1.1 The Steam Turbines offered shall be from a regular and established manufacturer of general purpose Steam turbines having requisite design, engineering, manufacturing and testing facilities.
- 3.5.1.2 The Steam turbine model offered shall be from regular manufacturing range of the manufacturer.
- 3.5.1.3 Steam turbines shall be identical in frame size (Model number) and validly similar in power rating, rated speed, steam flow, steam inlet conditions, steam exhaust conditions, rotor dynamics, bearing span, mechanical design and materials as compared to at least two units designed, manufactured, tested and supplied from the proposed manufacturing plant and at least one of these units shall have successfully operated in the field for minimum 8000 hours without any major problem as on the date of issue of invitation to bid.
- 3.5.2 Turbine shall be preferably of multi-stage design. Single stage overhung design shall not be provided.
- 3.5.3 [Pressurized lube oil system shall be as per API 614.](#)
- 3.5.4 A sentinel valve / PSV shall be supplied on the turbine casing, [as applicable.](#)
- 3.5.5 A relief valve shall be provided on the turbine exhaust side.
- 3.5.6 Inspection And Testing
- 3.5.6.1 NDTs shall be carried out as per vendor's standard quality plan.
- 3.5.6.2 Following test shall be witnessed by third party inspection agency :
– Hydrostatic Test (All pressure parts and auxiliaries).
– Mechanical run test.

3.6 CENTRIFUGAL PUMPS (OTHER THAN WATER SERVICE)

3.6.1 Equipment Qualification Criteria

The pump vendor shall be an established centrifugal pump manufacturer having adequate engineering, manufacturing and testing facilities for pumps conforming to the relevant API standard. The pump model offered shall be from the existing regular manufacturing range of the pump manufacturer.

Pumps shall be identical or validly similar in terms of power rating. Hydraulic performance (including NPSHR for centrifugal pumps), inlet flow, differential head, operating pressure and temperature, pumping liquid, speed, number and type of impellers / heads. Mechanical design, materials bearing span (applicable for between bearing centrifugal pumps), column length (applicable for vertically suspended pumps) etc., as compared to at least 2 units of the proposed model designed, manufactured, tested and supplied from the proposed manufacturing plant in the last fifteen years and

at least one of these units shall have successfully operated in the field for atleast 8000 hours individually without any major overhaul as on the date of issue of invitation to bid.

- 3.6.2 Two stage pumps shall be of in between bearing types.
- 3.6.3 All pumps shall be designed for unsheltered outdoor location.
- 3.6.4 Pumps with suction specific speed >11000 (U.S. Units) shall not be used. Inducers shall not be used except for Sundyne or equivalent type of pumps (Low flow high head).
- 3.6.5 Pumps shall have continuously rising curves with shut off head of 110% of rated head. Pump supplier shall explore the possibilities to improve the margin by offering a suitable model or by providing other arrangements. Also shut off head shall not exceed 120% of rated head. Impeller diameter shall be selected such that minimum 5% increase and decrease in head at rated capacity is possible with the same casing by changing impeller. Impellers with minimum and maximum diameters for the particular casing model shall not be used.
- 3.6.6 No cast iron pressure containing parts shall be used for hydrocarbon service.
- 3.6.7 Pumps for high head, low flow duties (falling outside the range of two stage pumps without continuous bypass) shall be high speed integral gear driven pumps (Sundyne type)
- 3.6.8 Pumps where difference between NPSHA and NPSHR is less than 1 M are not acceptable. The said NPSHA value shall correspond to the maximum value of NPSHR from rated flow down to the recommended minimum continuous stable flow specified by the vendor.
- 3.6.9 For balancing axial thrust in multi-stage pumps, only the following arrangements shall be used.
- Opposed arrangements of impellers.
 - A balancing piston.
- 3.6.10 The maximum permissible running clearances shall not be less than twice the running clearances as specified in API 610.
- 3.6.11 Impeller of multi stage pumps shall also be positively locked against axial movement in the direction opposite to normal hydraulic thrust.
- 3.6.12 Mechanical seal for pumps shall conform to API-682. Pumps shall be provided with single mechanical seals (except for clean cold water service pumps where gland packing is acceptable). For services involving solid contaminants, hazardous / toxic services, light hydrocarbons such as LPG, sour services ($H_2S > 100$ ppm), NGL, Naphtha, Liquid gases and services involving liquids at or above auto ignition temperature, dual mechanical seal shall be used. All mechanical seals shall be designed for bi-directional rotation.
- 3.6.13 Pumps for vacuum service or having operating temperature of 200 °C and above shall be provided with stationary metal bellows seals.

- 3.6.14 For pumps that are not self-venting, or are vertical canned pumps or operates under vacuum, vent shall be provided connected to back to the vessel from which the pump draws suction.
- 3.6.15 For pumps handling C₅ or lighter fluid, 1" valved connection to the flare header for priming purpose shall be provided preferably between the check valve and the isolation valve.
- 3.6.16 Pumps handling non-congealing liquids at temperatures 200 °C and above shall be provided with API seal flushing plan 23 or 32 where single mechanical seals are provided (Plan 32 shall be as per sketch in Annexure – 1). The coolers associated with seal shall be adequately designed so that no local overheating takes place. Cooler outer shell temperature shall be maintained at 60 °C. If inadequacy is found during operation, the coolers of higher capacity shall be provided by pump vendor at no extra cost to Owner.
- 3.6.16.1 Cooler shall not be provided in seal flushing system where seal is flushed by congealing liquid.
- 3.6.16.2 For pumps provided with flushing plan 21 and 23, temperature indicator shall be provided in the flushing line.
- 3.6.16.3 Seal plans 52 x 53 (API-610) shall be as per sketch and specification enclosed in Annexure – 2.
- 3.6.17 For seal flushing, self flushing plan shall be used as far as possible.
- 3.6.18 For all API cooling water piping plans a sight flow glass shall be provided in the outlet lines.
- 3.6.19** In case multistage pumps require force feed lubrication the same shall conform to figure D.6 of API-610 10th edition.
- 3.6.20 The instruments shall be suitable for the specified area classification and shall be from approved vendors (specified elsewhere in the bid package).
- 3.6.21 The motor name plate rating for pumps under parallel operation / pumps with auto start requirement shall not be less than the maximum BkW indicated on pump data sheet (power end of the curve for the rated impeller) and the pump motors shall be suitable for start up under open discharge valve condition.
- 3.6.22 The motor nameplate rating for applications where the specific gravity of pump fluid is less than 1.0 shall not be less than the BkW of pump at minimum continuous stable flow with clean cold water of specific gravity 1.0.
- 3.6.23 Electrical motor drivers as per (IEC / IS) shall be rated for continuous duty (duty type S1) whereas motor as per American standards shall be designed to operate at a service factor of 1.0. Rating shall not be less than the following unless higher rating is dictated by the Note 1.

Motor Name plate rating**Motor MCR (% of pump rated BkW
Inclusive of +4% tolerance)**

Less than 22 kW	-	To suit the maximum BkW indicated on Pump data sheet or 125% or rated pump BkW, whichever is higher.
22kW – 55kW	-	115% of rated pump BkW
Higher than 55 kW	-	110% of rated capacity

Note:

1. The motor name plate rating for pumps under parallel operations / pumps with autostart requirement shall not be less than the maximum BkW indicated on pump data sheet (the power at end of the curve for the rated impeller) or shall have the specified margin as per this clause whichever is greater. The pump motors shall also be suitable for start-up under open discharge valve condition.

- 3.6.23 Coupling guard shall be perforated and of non-sparking material. The guard shall be open at the bottom to permit manual shaft rotation. The guard shall be sufficiently rigid to withstand deflections as a result of bodily contact of nominally 100 Kgs.
- 3.6.24 Whenever pumps have to be provided ARC valves the same shall be included in pump vendor scope.
- 3.6.25 Interchangeability: As far as possible pumps, mechanical seals and couplings shall be of identical make so that minimum levels of inventory can be maintained and maximum Interchangeability / standardisation can be achieved.
- 3.6.26 Monorails shall be provided for maintenance of pump motor units of driver rating 55 kW and above.
- 3.6.27 Pumps shall be protected from operation at shut off condition when a control valve is provided at discharge which operates based on LIC/ FIC and has fail close logic. Also when process minimum capacity is less than pump minimum continuous flow (MCF) then necessary flow instruments in pump discharge along with pump by pass back to suction vessel for pump protection shall be provided.
- 3.6.28 The type of bypass control shall be decided as below.
- | | |
|---|--|
| – For low capacity pumps (< 10m ³ /hr) and for pumps having continuous recirculation (pump minimum flow to be added to maximum pump flow to specify rated flow of pump). | Restriction Orifice. |
| – For medium and large capacity pumps | Automatic minimum flow recirculation valve/As per P&ID |
- 3.6.29 Regardless of process minimum flow requirements, high pressure multistage pump shall be provided with bypass arrangement from operational or equipment health considerations and same shall be separate for operating as well as standby pumps.

- 3.6.30 Equipment along with the drivers shall be procured from the respective driven equipment manufacturers as skid mounted units with all accessories, auxiliaries along with auxiliary piping.
- 3.6.31 For seal flushing plans, piping material shall be of stainless steel. Magnetic drain plugs shall be provided for all centrifugal pump bearing housings.
- 3.6.32 All pumps shall be provided with plugged connection for oil mist lubrication for future use. All critical and high temperature pumps shall be provided with metal seated high performance isolation valves conforming to API 598 with requirements of zero leakage followed as per API 6D and those for fire test as per API 607.
- 3.6.33 For motor driven centrifugal pumps machine monitoring will be provided for all pumps above 160 kW. Machine monitoring system will include following probes along with racks, modules, display unit.
- a. Velometer (X and Y) per bearing housing of pump, gear box, above 160 kW.
 - b. Velometer (X and Y) per bearing housing of motor above 750kW.
 - c. Bearing and winding RTD for motor above 160 kW
 - d. Radial and axial vibration probes per bearing for pump , gear box and motor (for hydrodynamic bearings)
 - e. Temperature probes per bearing for pump , gear box (for hydrodynamic bearings)
 - f. Key phasor for pump, gearbox above 160 kW
 - g. Key phasor for motor above 750 kW
- 3.6.34 Inspection And Testing (for each pump)
- 3.6.35.1 Material certificates for the following are required:
Casing, Impeller and Shaft.
- 3.6.35.2 The material inspection requirement for pressure containing parts shall be as per the following inspection category:
- Category A
This category is applicable for carbon steel and cast iron for services with process design pressure upto 40 bar and design temperature from 0 to 150 °C.
Inspection requirement: As per vendors standard quality assurance plan.
- Category B
This category is applicable for services within the design pressure range of 0-70 bar and temperature range of -29 °C to 300 °C. Inspection includes all the requirements of Category B together with radiographic or ultrasonic inspection of:
- Nozzle weld
 - Butt welds on pressure containing components.
- Ultrasonic inspection shall be carried out when radiography is not feasible.
- 3.6.36 Inspection shall also include dimensional check of pump, driver and auxiliaries (if any) duly mounted on the base plate in accordance with certified general assembly drawing. Following checks shall be carried out:

- 3.6.36.1 The following tests shall be witnessed by the third party inspection agency:
- Hydrostatic (for all pressure containing parts including auxiliaries)
 - Dynamic balancing test for impeller.
 - Performance (for 4 hours)
 - NPSH (if specified)
 - Dismantling inspection and reassembly, after the running test which shall include examination of mechanical seals, close – clearance parts and measurements of running clearances. In case of multistage pumps having hydrodynamic bearings, the bearing shall be removed inspected and reassembled.
 - Sound level test (during performance test)

3.7 CENTRIFUGAL PUMPS (WATER SERVICE)

3.7.1 EQUIPMENT QUALIFICATION CRITERIA

The pump vendor shall be an established centrifugal pump manufacturer having adequate engineering, manufacturing and testing facilities for pumps conforming to the relevant standard. The pump model offered shall be from the existing regular manufacturing range of the pump manufacturer.

Pumps shall be identical or validly similar in terms of power rating. Hydraulic performance (including NPSHR for centrifugal pumps), inlet flow, differential head, operating pressure and temperature, pumping liquid, speed, number and type of impellers / heads. Mechanical design, materials bearing span (applicable for between bearing centrifugal pumps), column length (applicable for vertically suspended pumps) etc., as compared to at least 2 units of the proposed model designed, manufactured, tested and supplied from the proposed manufacturing plant in the last fifteen years and at least one of these units shall have successfully operated in the field for at least 8000 hours individually without any major overhaul as on the date of issue of invitation to bid.

- 3.7.2 Pumps with constant speed drivers shall be capable of at least 5% head increase and 5% decrease at rated condition and pump rated speed by replacing with a new impeller or impellers. Offered impeller shall in no case be less than the minimum diameter.

- 3.7.3 Horizontal pumps of the close-coupled, the two stage overhung, or the single stage double suction overhung, type shall not be furnished.

- 3.7.4 Pumps where difference between NPSHA and NPSHR is less than 1 M are not acceptable. The said NPSHR value shall correspond to the maximum value of NPSHR from rated flow down to the recommended minimum stable flow specified by the vendor.

- 3.7.5 Pumps that have stable head / capacity curves (continuous head rise to shut-off) are preferred for all applications and are required when parallel operation is specified. When parallel operation is specified, the head rise shall be at least 10% of the head at rated capacity. In general, all pumps shall have continuously rising curves with shut off head of 110% of rated head. Pump supplier shall explore the possibilities to improve the margin by offering a suitable model or by providing other arrangements. Also shut off head shall not exceed 120% of rated head.

- 3.7.6 Vertical pumps and motors that could be damaged due to reverse rotation shall be provided with suitable device to prevent reverse action.

- 3.7.7 Impellers shall be cast one piece.
- 3.7.8 Shaft shall be provided with sleeves under the packing / seal. Sleeves shall be locked to the shaft. The material of sleeve shall be 12% chrome steel (hardened). Where the size of pump makes the use of shaft sleeve impracticable, the shaft shall be constructed of 12% chrome steel (hardened). For vertical pumps, shaft material shall be 12% chrome steel.
- 3.7.9 The following vibration limits shall be applied at rated speed and at flow +/- 10% of rated flow (ISO 1940 guidelines).
- 3.7.9.1 Horizontal pump
Unfiltered vibration velocity for horizontal pumps upto 3000 rpm with antifriction bearing or sleeve bearings when measured at the bearing housing in horizontal or vertical direction shall not exceed 7.6 mm/sec (0.3 inch / sec.)
- 3.7.9.2 Vertical pumps
Unfiltered vibration velocity for vertical pumps with antifriction and or sleeve bearings when measured at the top bearing housing of pump or top bearing housing of motor or mounting flange for measuring points upto 3m above the mounting base shall not exceed the following limit:
- | | |
|--|-----------------------------|
| Pumps greater than 1500 rpm (peak to peak) | = 10.1 mm/sec (0.4" / sec.) |
| Pumps upto and including 1500 rpm (peak to peak) | = 8.9 mm/sec. (0.35"/sec) |
- 3.7.10 Pumps for fire water application shall also meet the following additional requirements:
- Pumps shall meet the requirements stipulated by TAC/OISD/NFPA.
 - Pumps shall be direct-coupled except in the case of engine driven vertical turbine pumps wherein gear drives shall be used.
 - Pumps shall be capable of furnishing not less than 150% of rated capacity at a head not less than 65% of the rated head. Shut off head shall not exceed 120% of rated head in horizontal pumps and 140% in the case of vertical turbine pumps.
 - Difference between NPSHA and NPSHR at 150% of the duty point shall not be less than 1M.
 - For diesel engine drivers, the net continuous site power available after considering the duration due to site condition and power losses, due to other parasitic loads and engine driven auxiliaries shall be higher of the following 2 values:
 - 20% in excess of the maximum BKW (including +4% tolerance) required to drive the pump at rated condition.
 - Maximum BKW rated impeller as indicated by the manufacturer in the pump data sheets.
- 3.7.11 Electrical motor drivers as per (IEC / IS) shall be rated for continuous duty (duty type S1) whereas motor as per American standards shall be designed to operate at a service factor of 1.0. Rating shall not be less than the following unless higher rating is dictated by the Note 1.

Motor Name plate rating**Motor MCR (% of pump rated BKW
Inclusive of +4% tolerance)**

Less than 22 kW	-	To suit the maximum BKW indicated on Pump data sheet or 125% or rated pump BKW, whichever is higher.
22kW – 55kW	-	115% of rated pump BKW
Higher than 55 kW	-	110% of rated capacity

Note:

2. The motor name plate rating for pumps under parallel operations / pumps with autostart requirement shall not be less than the maximum BKW indicated on pump data sheet (the power at end of the curve for the rated impeller) or shall have the specified margin as per this clause whichever is greater. The pump motors shall also be suitable for start-up under open discharge valve condition.

3.7.12 For motor driven centrifugal pumps machine monitoring will be provided for all pumps above 160 kW. Machine monitoring system will include following probes along with racks, modules, display unit.

- Velometer (X and Y) per bearing housing of pump, gear box, above 160 kW.
- Velometer (X and Y) per bearing housing of motor above 750kW.
- Bearing and winding RTD for motor above 160 kW
- Radial and axial vibration probes per bearing for pump , gear box and motor (for hydrodynamic bearings)
- Temperature probes per bearing for pump , gear box (for hydrodynamic bearings)
- Key phasor for pump, gearbox above 160 kW
- Key phasor for motor above 750 kW

3.7.13 Inspection And Testing
Refer centrifugal pumps (other than water service).

3.8 FANS (CENTRIFUGAL / F.D. / I.D. FANS - GENERAL REQUIREMENTS)

3.8.1 Equipment Qualification Criteria

3.8.1.1 The Vendor shall be an established centrifugal fan manufacturer having adequate engineering, manufacturing and testing facilities for the same.

3.8.1.2 The fan model offered shall be from the existing regular manufacturing range of the fan manufacturer.

Centrifugal fan proposed shall be identical or validly similar in terms of impeller diameter, power rating, flow rates, differential pressure, operating pressure and temperature, gas handled, speed, mechanical design, bearing span, materials etc., as compared to at least 2 units designed, manufactured, tested and supplied from the proposed manufacturing plant at least 1 of these units shall have successfully operated in the field for at least 8000 hours without any major overhaul as on the date of issue of invitation to bid.

3.8.2 Fans, drivers and auxiliary equipment shall be designed and constructed for a service life of 20 years and atleast two years of uninterrupted continuous full load operation at the specified operating conditions.

- 3.10.11 Inspection And Testing
Following test shall be witnessed by the third party inspection agency.
- Hydrostatic test for pump fluid end.
 - Performance test.
 - Linearity and repeatability.
 - Dismantling and inspection after test.
 - R.V. Test
 - Diaphragm rupture detection (as applicable)
- 3.11 API 614 OIL SYSTEMS
- 3.11.1 All components external to the reservoir that retains oil under pressure shall be of steel components submerged in reservoir may be of cast iron. All piping including filters shall be in stainless steel.
- 3.11.2 The material of construction of main lube oil reservoir shall be decided as below.
For smaller ratings (less than 2 MW): Stainless Steel
For higher ratings : Carbon Steel with protective coating
(non peeling type) as recommended
by manufacturer.
- 3.11.3 A lube oil overhead rundown tank (SS construction) shall be provided sized for the coast down time for normal lube oil flow rate. The main lube oil tank capacity shall take care of rundown flow from overhead tank. The main lube oil tank shall be provided with oil heater.
- 3.11.4 In case of gas turbine or steam turbine driver, an emergency oil pump driven by DC motor shall be provided sized for cool-off period.
- 3.11.5 The lube oil system shall be provided with two (1W+1S) coolers and two (1W+1S) filters with change over facility.
- 3.11.6 For lube oil and seal oil system each system shall have one motor driven and one steam turbine driven pump (with mechanical governor). The lube oil pumps shall preferably have flooded suction. In case this is not possible due to layout constraints then NPSH requirements of pump shall be taken care of.
- 3.11.7 In case of oil seals, degassing facility shall be provided.
- 3.11.8 Inspection and testing
- 3.11.8.1 Following test shall be witnessed at lube oil system vendors works by the third party inspection agency:
- Hydrostatic test of assembled oil system and all pressure containing parts and auxiliaries.
 - Cleanliness.
 - Four hour run, check control, changeovers (coolers / filters), one and two pump operations.
- 3.12 SPECIAL PURPOSE GEAR UNITS

- 3.12.1 In case of alternators gears shall be designed for short circuit condition of the alternator.
- 3.12.2 Gears shall be of double helical or herringbone type.
- 3.12.3 Inspection And Testing
- 3.12.3.1 Following test shall be witnessed at gear vendors works by the third party inspection agency:
- Hardness verification
 - Contact check.
 - Bearing clearance.
 - Mechanical run test.
 - Vibration and noise test at full load.
- 3.13 SPARES AND SPECIAL TOOLS
- 3.13.1 Commissioning Spare Parts
- Commissioning Spare Parts shall be procured along with the main equipment as per equipment manufacturer's recommendations. The list of such recommended spares shall be obtained along with the offer. Any commissioning spare consumed over and above the recommended commissioning spares, during commissioning shall be supplied free of cost by the equipment vendor.
- 3.13.2 Special Tools/Tackles
- Special Tools/Tackles shall be procured along with the main equipment as per equipment manufacturer's recommendations. The list of such recommended special tools/tackles shall be obtained along with the offer.
- 3.13.3 Mandatory spares
- The bidder shall be advised to quote for all mandatory spare parts, as defined in MR, as applicable to proposed design of equipment, indicating their unit prices. The cost of mandatory spare parts shall be added to total cost for bid evaluation purposes.
- The quantity of mandatory spares to be specified in the equipment MR shall be as per ' Attachment – 1: - List of mandatory spare list for Rotating equipment '

ANNEXURE-6

STANDARD SPECIFICATION FOR CENTRIFUGAL PUMPS

DOCUMENT NO : 44NC-4600-0000/M.02/0001/A4

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1.0 SCOPE

- (i) This specification together with the data sheets and other specifications / attachments to enquiry defines the minimum requirements for vertical and horizontal centrifugal pumps including pumps running as hydraulic power recovery turbines and their accessories / auxiliaries for use in the petroleum, petrochemical, natural gas industries.
- (ii) In case Contractor considers requirements of additional instrumentation, controls, safety devices and any other accessories / auxiliaries essential for safe and satisfactory operation of the equipment, he shall recommend the same along with reasons in a separate section along with his proposal and include the same in his scope of supply.
- (iii) Except as modified herein, the centrifugal pumps shall be designed, manufactured, tested and supplied strictly in accordance with API standard 610 (10th edition).
- (iv) **Conflicting Requirements**
In case of conflict between this specification and the data sheets, job specifications (if any) and other attached specification the following order precedence shall govern:
 - 1. Equipment data sheets
 - 2. P&ID's, if any
 - 3. Job specification
 - 4. Engineering design basis
 - 5. Standard specifications.
 - 6. Applicable codes, standards.
- (v) However, all conflicts shall be referred to PMC / Owner for clarification and the decision of PMC / Owner shall be final and binding on the bidder without any cost and delivery implications.
- (vi) Except for new paragraph, the number and title of the paragraphs in this specification correspond to the respective sections and paragraphs of the above standard. Paragraphs not addressed in this specification shall be strictly in accordance to API Standard 610, tenth Edition, October 2004. The word in parenthesis following the number of title of a paragraph indicates the following:
 - (Addition) An addition to a part, section or paragraph referred to.
 - (Modification) An amplification or rewording has been made to a part of the corresponding section or paragraph but not a substitution replacing the entire section or paragraph.
 - (Substitution) A substitution has been made for the corresponding section or paragraph of the standard in its totality.
 - (New) A new section or paragraph having no corresponding section or paragraph in the standard.
 - (Deleted) This paragraph is deleted.

The above paragraph is in addition to API 610, 10th Edition.

4.0 CLASSIFICATION AND DESIGNATION**4.3 Units and governing requirements**

- 4.3.1 (Substitution)
SI units shall be used for drawings and maintenance dimensions.

5.0 BASIC DESIGN

5.1 General

5.1.6 (Addition)
It shall also be possible to achieve 5% head decrease by fitting a new impeller(s), which shall in no case be less than the minimum impeller diameter for pump casing as per family of characteristic curve.

5.1.10 (Addition)
Pumps where difference between NPSHA and NPSHR from minimum flow to maximum expected operating flow is less than 1 m are not acceptable.

Pumps fitted with inducers for reducing NPSHR are not acceptable. Vertical barrel pumps are preferred for safe operation in case of lower NPSHA decided by layout.

5.1.11 (Modification)
The pump suction specific speed shall be limited to 11000 (US units).

5.1.12 (Addition)
Correction factors as applicable shall be indicated by the manufacturer on the filled in data sheet

5.1.13 (Modification)
Pumps selected shall have stable head / flow rate curves (continuous head rise to shut off) in all operation cases.

Shut off head margin for the pumps shall be as follows:

Minimum 5% for pumps operating separately.

Minimum 10% for pumps operating in parallel.

However in either case the maximum allowable shut off head shall not be more than 20% of the rated head.

In case the margin between pump shut off head and duty point head is less than 5% the Contractor shall provide orifice plate at pump discharge to achieve this margin. The pump characteristics curves submitted with the bid shall show the effect of discharge orifice plate.

5.1.16 (Modification)
Unless otherwise specified on data sheet, the combined noise level of pumping unit shall not exceed 85 dBA at a distance of 1 m in any direction from any point around pumping unit at any point of operation.

5.1.19 (Addition)
Water-cooling shall be offered for the following temperature.
Bearings above 65 deg C.
Pedestals above 125 deg C.

5.1.22 (Modification)
Maximum inlet temperature 34 OC, maximum temperature rise 10 OC, fouling factor water side 0.0004 m2hrOC/kcal, maximum allowable working pressure 7 kg/cm2 (g). These parameters are superseded by project specific parameters if indicated separately.

5.1.23 (Modification)

Wherever required the type of threading provided shall be NPT. The size and details shall match with instrumentation engineering standard drawings.

5.1.32

(New)

The minimum continuous stable flow shall not be less than 20% of the flow at best efficiency point.

5.1.33

(New)

For balancing axial thrust in multi-stage pumps, only the following arrangements shall be used.

- Opposed arrangements of impellers.
- A balancing piston.

5.1.34

(New)

~~When the pump minimum continuous flow is higher than process minimum flow then the pump minimum flow shall be added to the rated capacity of pumps specified while selecting the pump. This shall be done only when continuous recirculation line with an orifice is provided at pump discharge. Required orifice to be supplied by Contractor.~~

5.2**Pump Types**

(Substitution)

Contractor shall avoid special design features for pumps unless otherwise specified in data sheet.

5.3**Pressure Casings**

5.3.6

(Substitution)

Unless otherwise specified in data sheet, dual pressure ratings shall not be used.

5.3.10

(Modification)

Metal jacketed or metal gaskets shall be furnished for radial split pumps for pumping temperature greater than 350oC.

5.3.15

(New)

Copper or copper bearing alloys shall not be used for the pumps in ammonia / urea service.

5.4**Nozzles And Pressure Casing Connections**

5.4.2.1

(Modification)

Multistage pumps shall have suction and discharge flanges of equal rating unless otherwise specified in data sheet.

5.4.3.10

(Addition)

Casing shall be provided with drain connection with nipple, threaded and seal welded and provided with a socket welded gate valve terminated at edge of the base plate. Gate valve shall be of 800# rating with material of construction equal or superior to the pump casing. For multistage pumps with more than one drain point, block valves at each drain point shall be provided and the piping shall be terminated at edge of the base plate with a flange. Unless made self-venting design, vent connections shall also be provided with a nipple, threaded and seal welded and terminated with a gate valve. Pressure gauge connection shall not be provided unless specifically required in the enquiry. Nipples shall meet the requirements of 5.4.3.5 and 5.4.3.6.

5.4.3.12 (New)
Unless otherwise specified in data sheet, pressure gauge connections shall not be provided.

5.7 Wear Rings And Running Clearances

5.7.1 (Modification)
Unless otherwise specified in data sheet renewable wear rings shall be provided on casing and impeller.

5.7.3 (Modification)
The part of sentence “or by tack welding” stands deleted.

5.8 Mechanical shaft seals

5.8.1 (Modification)
Seal category and related details shall be as per API 682 data sheet as attached herewith and as per seal Contractor’s recommendation.

5.8.12 (New)
Contractor shall furnish API 682 qualification test certificates for each type of seal to purchaser/ EPC.
Seal selection and compatibility of seal with process conditions is to be done by seal Contractor, unless otherwise specified in data sheet.
All seal system related components such as cartridges, seal failure device with level transmitter, seal housing, heat exchangers, drain and vent valves, shall be supplied by seal Contractor only.

5.10 Bearings and bearing housings

5.10.2.12 (Modification)
The words “if specified” stand deleted.

5.10.2.13 (New)
Bearing housing shall be equipped with flexible metallic hose connections in case of pressure lubrication system common for pump and driver to facilitate easy alignment.

5.12 Materials

5.12.1 General

5.12.1.1 (Modification)
The material of construction of pump parts shall be in accordance with the data sheet.

5.12.1.8 (Modification)
The words “if specified” stand deleted.

5.12.2.5 (Modification)
The words “if specified” stand deleted.

5.12.3 Welding

5.12.3.4 (Modification)
Radiographic inspection of nozzle welds is required.

6.0 ACCESSORIES

6.1 Drivers

6.1.2 (Modification)

The motor nameplate rating for applications where specific gravity of pumping fluid is less than 1.0 shall either be 100% of BkW of pump at minimum flow with clean cold water of specific gravity equal to 1.0 or shall have specified margin indicated, whichever is greater.

6.1.3 (Modification)

Electric motor rating shall meet the requirements as specified in motor data sheet and specification provided.

Electric motor drivers shall have a maximum continuous rating (MCR) (i.e. service factor equal to 1) not lower than the following:

Motor name plate rating : Motor MCR (% of pump rated BkW). To suit maximum
Upto 22 kW BkW indicated on pump data sheet or 125% of pump BkW at rated condition whichever is higher.

Motor name plate rating : Motor MCR (% of pump rated BkW). To suit maximum
between 22 and 55 kW BkW indicated on pump data sheet or 115% of pump BkW at rated condition whichever is higher.

Motor name plate rating : Motor MCR (% of pump rated BkW). To suit maximum
above 55 kW BkW indicated on pump data sheet or 110% of pump BkW at rated condition whichever is higher.

The electric motor shall be suitable for the hazardous area classification as specified in the data sheet.

6.1.8 (Modification)

Under the worst coincident conditions specified, (lowest inlet steam pressure, lowest superheat, highest exhaust pressure, lowest speed) the turbine shall be sized to continuously power the drive train of the pump with the rated impeller, adjusted for drive train losses.

6.2 Coupling and guards

6.2.3 (Modification)

Couplings shall be balanced as per ISO 1940-1 Gr. 2.5. Coupling fasteners shall be match marked, if required.

6.2.7 (Modification)

The coupling service factor shall not be less than 1.5 over driver nameplate rating.

6.2.14c) (Addition)

Coupling guard shall be non-sparking type only and shall be open at bottom to permit manual shaft rotation.

6.3 Baseplates

6.3.1 (Addition)

Fabricated steel base plates shall be provided. Cast iron baseplates are not envisaged.

6.3.19 (Modification)

Anchor bolts with all embedded parts shall be furnished by the pump manufacturer.

6.3.21 (New)
Pumps in corrosive service shall have provision to collect and drain the leakage from mechanical seal or packing through a drip pan of metallurgy equivalent or superior to pump casing. Leakage from drip pan shall be piped to baseplate with flanged connection with isolation valve for onward disposal by purchaser.

6.3.22 (New)
Cooling jacket shall be provided for pedestals where pumping temperature is greater than 500°F.

6.5 Piping and appurtenances

6.5.2 Auxiliary process fluid piping

6.5.2.3 (Addition)
Auxiliary process fluid piping material shall be seamless SS-316 as a minimum.

6.5.2.8 (Modification)
Flanges shall be used in places of socket welded unions.

6.5.2.9 (New)
Material for seal flushing liquid cooler shall be:
Tube or coil : Duplex SS
Casing (or shell) : Duplex SS

Cooling water shall be on the casing (shell) side. Valved vents and drains shall be provided on cooler on cooling waterside.

Cooling coil in the seal pot shall be of Duplex SS (grade UNS 31803 or grade 32750)

6.5.2.10 (New)
Contractor shall provide all instrumentation requirements as per API 682, for seal flushing plan as applicable. Switches are not acceptable in the plans.

6.5.3 Cooling water piping

6.5.3.3 (Modification)
Sight flow indicator shall have ball or flag for easy verification of water flowing through pipes.

7.0 INSPECTION, TESTING AND PREPARATION FOR SHIPMENT

7.1 **General**

7.1.8 (New)
Prior to start of test, manufacturer shall furnish the test certificate of calibration of measuring instruments, which shall be recalibrated every one year. Pressure gauges shall be calibrated prior to start of test and after completion of test.

7.2 **Inspection**

7.2.1.3 (Substitution)

The minimum material inspection requirement for pressure containing casings shall be as per the following inspection category.

Category - A

This category is applicable for carbon steel and cast iron for services with process design pressure upto 40 kg/cm² (g) and design temperature from 0 to 15°C.

Inspection requirement: as per Contractor's standard quality assurance plan.

Category - B

This category is applicable for services within the design pressure range of 0-70 kg/cm² (g) and design temperature range of -29 °C to 300 °C.

Inspection requirement includes visual inspection and magnetic particle or liquid penetrant inspection of following components as a minimum.

- Nozzle weld.
- Butt welds on pressure containing components
- Fillet welds on pressure containing components
- Shaft

Liquid penetrant inspection shall be performed only when specified and magnetic particle inspection is not feasible. Magnetic particle or liquid penetrant inspection shall be carried out in accordance with clause Table 13 as applicable.

Category – C

This category is applicable for services with process design pressure above 70 kg/cm²(g) or process design temperature below -29°C and above 300°C. Inspection includes all the requirements of category B together with radiographic or ultrasonic inspection.

- Nozzle weld.
- Butt welds on pressure containing components.

Ultrasonic inspection shall be carried out when radiography is not feasible. Radiography or ultrasonic inspections shall be carried out in accordance with clause Table 13 as applicable.

7.2.3

(New)

Inspection shall also include dimensional check of pump, driver and auxiliaries (if any) duly mounted on the base plate in accordance with certified general assembly drawing. This will include all main pump dimensions, baseplate dimensions, location of foundation bolt holes, size/position/rating of flanges, coupling guard arrangement, verification of the required material certificates and their traceability to the respective components. In addition, following checks shall also be carried out:

- A measurement of the actual running clearances throughout the pump.
- A check of the hardness of wear rings.
- A check for good workmanship and finish

7.2.4

(New)

During manufacturing, Contractor shall carry out dynamic balancing test for impeller – shaft assembly without coupling at rated speed and to be check balance with coupling hubs mounted. Necessary certificate for the same shall be submitted.

7.3

Testing

7.3.1 General

7.3.1.1 (Addition)

Unless otherwise specified the following tests shall be witnessed by the Purchaser/EPC/third party.

1. A witnessed hydrostatic test as per 7.3.2
2. A witnessed performance test as per 7.3.3.
3. A witnessed NPSHR test as per 7.3.4.2 when specified in the data sheet. NPSH test shall be done for one pump from each model.
4. Shop inspection per 7.1.4 a).
5. Dismantling inspection and re-assembly after the running test (witnessed)
6. Dynamic balancing of rotating assembly.
7. Sound level test (witnessed)

7.3.3 Performance test

7.3.3.3f) (New)

Shop driver shall be used for testing and the rating of the driver shall not exceed 150% of power that may be consumed while running at duty point with water or power at full valve open condition whichever is higher. The limitation of 150% is applicable only for medium voltage motors.

7.3.3.4c) (Addition)

The tolerances for guaranteed characteristics stand modified as under:

Rated head	zero negative tolerance
Shut-off head	zero negative tolerance. Positive tolerance permitted as long as shutoff head does not exceed 120% of rated head.
NPSHR	zero positive tolerance.

7.3.3.5a) (Addition)

Decision regarding trimming of impellers to meet the tolerances on differential head shall be taken only thereafter.

7.3.3.6 (New)

During the performance test, the equipment shall be checked for its sound level at minimum flow, at rated flow, at flow at best efficiency point and at 120% BEP flow. The maximum allowable value shall not exceed 85 dBA measured at 1m from pump surface or as specified in data sheet whichever is lower.

7.3.4 Optional tests

7.3.4.7 Mechanical run test.

- 7.3.4.7.1 (Modification)
Unless otherwise specified in data sheet, oil temperature stabilisation test shall be carried on test stand.
- 7.3.4.7.2 (Modification)
Unless otherwise specified in data sheet, pump mechanical run test for 4 hours shall be carried out at rated flow. This test shall be done only after oil temperatures are stabilised.
- 7.4 Preparation for shipment
- 7.4.7 (New)
Unless otherwise specified, the equipment shall be protected for storage of 12 months at site. If any extra precaution is to be taken by Purchaser for storage beyond 12 months the same shall be explicitly indicated in the operation and maintenance manuals.

~~8.0 SPECIFIC PUMP TYPES~~

8.2 Between bearing pumps

- 8.2.5.2.2 (Modification)
Thrust collar shall be integral part of shaft.
- 8.2.6.2 (Addition)
Except in case of shaft driven pumps, ~~if a positive displacement type of oil pump is supplied~~, a separate relief valve (not integral with the pump) shall be provided. The relief valve shall not be used for pressure regulation. If the type of pump is centrifugal then a non-return valve shall be provided at the discharge. Horizontal oil pumps shall not be installed on top of the oil reservoir.
The oil side operating pressure shall be higher than the waterside operating pressure to prevent contamination of oil in case of cooler failure.
Filters shall be equipped with continuous flow switch over valve and equalising line.
Oil system shall have drain rim or pan to catch oil spills.
A thermal relief valve shall be provided on cooling water return line for oil coolers.
- 8.2.6.6 (New)
All the instrumentation shall be supplied by the pump manufacturer. However, make type and specification shall be approved by purchaser/EPC.
- 8.2.6.7 (New)
Unless otherwise specified, heating element shall not be provided. However, if in the opinion of manufacturer such arrangement is required (especially in view of the lowest ambient temperature prevailing at job site) the same shall be supplied by the pump manufacturer with specific approval of the purchaser / EPC.
- 8.2.7.5 (Modification)
The words "if specified" stand deleted.
- 8.2.8.2 (Modification)
The words "if specified" stand deleted.

8.3 Vertically suspended pumps

- 8.3.2.3 (New)
Bowls and columns shall be flanged and bolted.

- 8.3.3.3 (Addition)
Multi-piece vertical pump line shaft shall not be joined by threaded couplings.
- 8.3.6.2 (Modification)
Pump thrust shall not be transferred to driver motor. Vertical pumps shall be provided with their own thrust bearing to carry rotor weight and pump generated axial forces.
- 8.3.6.4 (New)
For self-lubrication pumps, guide bushing shall be suitable for dry running during start-up.
- 8.3.8.1 (Modification)
For vertical pumps, not provided with non-reverse ratchet, Contractor shall describe the precaution taken to prevent damage due to reverse rotation.
- 8.3.10.5 (Modification)
The words “when specified” stand deleted.
- 8.3.13.5 (Modification)
The words “when specified” stand deleted.

9.0 CONTRACTOR’S DATA

- 9.1 General
(Substitution)
- (a) When specified, a co-ordination meeting shall be held at Purchaser/EPC’s office, preferably within 2 weeks of order.
 - (b) An agenda shall be prepared for this meeting and would include the following points related to technical aspects.
 - (c) Any clarifications required on purchaser/EPC’s order.
 - (d) Contractor data index and schedule.
 - (e) Contractor data review / approval modalities.
 - (f) Sub-Contractor lists proposed by Contractor.
 - (g) Utility requirements.
 - (h) Preliminary general arrangement and layout drawings and plant interface drawings.

9.2 Proposals

(Substitution)

The Contractor’s proposals shall as a minimum include the following:

- (a) All data sheets, drawings and documents listed under “PRINTS WITH QUOTE’ in the enclosed Contractor data requirement form.
- (b) Contractors confirmation / comments on post order Contractor data requirements (type of documents, number of prints and date needed) indicated in Contractor data requirement forms data sheets and specs.
- (c) List of recommended commissioning spares included in the offer.

- (d) List of mandatory spares (where specified by the purchaser/EPC) included in the offer.
- (e) List of spare parts for two years normal operation with separate quote.
- (f) This list shall be made separately for each items including auxiliaries and drivers in the form of a table and shall show
 - i. Part name, description and number.
 - ii. Quantity installed in one unit.
 - iii. Quantity recommended per unit for 2 years normal operation.
 - iv. Quantity recommended for number of units of an item as specified in the enquiry.
 - v. Quantity recommended as insurance for the number of units of an item specified in the enquiry.
- (g) An itemised list of special tools included in the offer.
- (h) Any start-up, shutdown or operating restrictions required to protect the integrity of the equipment.
- (i) Any limitations of Contractors test facility to carryout the specified tests.
- (j) A specific statement that the scope of supply, the offered equipment / systems and all its components are in strict accordance with the data sheets, job specifications, this specifications and all other attachments, except for specific deviations as listed in the proposal.

9.3 Contract data

- (Substitution)
- a) Drawings and data as required after purchase order shall be specified in Contractor data requirement.
- b) Contractor shall complete and forward a document 'Contractor data index and schedule' to the purchaser/EPC (destination and contact person as per offer).

This document shall list out in consolidated form all drawings and documents required by Purchaser/EPC (as specified in data sheets, specifications and Contractor data requirement forms enclosed with the offer / order).

Against each drawing / document, the Contractors drawing numbers, titles, revision, number, category (whether for information or approval) and schedule of submission shall be furnished.

This shall be the first document to be submitted within two weeks of order.

- c) All data / drawings / documents shall be in English language and in metric systems.
- d) Whether or not specified following shall be furnished, before shipment:
 - As built running clearances and when applicable, thrust bearing, radial bearing and seal running clearances.

- A supplementary list of spare parts other than those included in his original proposal. The supplementary list shall include recommended spare parts, cross-sectional or assembly type drawings, part numbers, materials, prices and delivery period. The Contractor shall forward this supplementary list to Purchaser/EPC promptly after receipt of the reviewed drawings and in time to permit order and delivery of parts before filed start-up.
 - A parts list for all equipment supplied. The list shall include pattern, stock, or production drawing numbers and materials of construction. The list shall completely identify each part so that Purchaser/EPC may determine the interchangeability of the parts with other equipment furnished by the same manufacturer name and part number.
 - At least 8 weeks before shipment, preservation, packaging and shipping procedures shall be submitted to purchaser /EPC for review.
- e) The number of prints and / or re-producible required and the times within which these are to be submitted are specified in the Contractor data requirement.
- f) General arrangement drawing
- A general arrangement drawing shall contain as a minimum the following information:
- i. Outline dimensions (minimum three views) (all principal dimensions)
 - ii. Allowable forces and moments on suction and discharge nozzles.
 - iii. Location (in all three plates), size, type, rating and identification of all interface connections including those of vents, drains, lubricating oil, sealing fluid, cooling water, steam and electrical / instrumentation.
 - iv. Direction of rotation viewing from the driving end.
 - v. Weight of each assembly / components.
 - vi. The weight and location of centre of gravity of the heaviest assembly / components that must be handled for erection.
 - vii. Maintenance clearances and dismantling clearances.
 - viii. Speeds of driven equipment and driver with driver rating. Location of driver terminal box (in case of electric motor driven).
 - ix. Layout of auxiliary equipment and operating platform, as applicable.
 - x. Make, type and size of couplings and the location of guards and their coverage.
 - xi. A list of reference drawings if any.
 - xii. A list of special weather protection and climatic features.
- g) Foundation drawing:

A foundation drawing shall indicate complete information required for foundation design including the following:

- i. Foundation bolt sizes, pipe sleeve details, pocket sizes and locations.
- ii. Grouting thickness and other necessary technical details.
- iii. Static weight of each skid / independently grouted item and location of center of gravity of each such skid / items in all three planes.
- iv. Weight distribution for each bolt / subsole plate location and total static weight.
- v. Dynamic loading caused due to various items grouted independently.
- vi. The direction and magnitude of unbalance forces and moments generated by each such item at the worst operating condition and short circuit moments of motor drivers.
- vii. GD^2 value of each item resolved to driver speed.
- viii. Maximum permissible amplitude of vibration on the foundation at base level.
- ix. Total mass of rotating parts.
- x. Suggested dynamic factor and ratio of foundation weight to weight of skid / equipment as per Contractor experience.

h)

Layout drawing (for multi skid packages)

This drawing shall include atleast the following information:

- i. Layout of all skid / equipment and their auxiliaries, vessels, control panels, exchangers etc. An optimised layout (considering the space allocated, site wind conditions, area classification, the type of equipment located in the vicinity etc.) indicating elevation and dimension of skids / equipment shall be furnished.
- ii. Minimum spacing required between the various skids / equipment and between the skids and the walls / columns / roof for an easy accessibility and maintenance).
- iii. Layout for water piping, trenches for water piping, cable tray / trenches layout.
- iv. Piping arrangement and piping support arrangement / location for piping in Contractors scope.
- v. Layout for auxiliary equipment and operating platform details.
- vi. Specification for crane / mono rail (including suggested mono rail layout) recommended for maintenance and height of the lifting hook from the centreline of equipment.

i)

Field alignment diagram

The diagram shall indicate the relative displacement to be kept between the centre lines of various equipment at the time of installation, so that under normal running conditions the equipment get fully aligned. This relative displacement should be decided on the basis of

centreline temperature rise data of driver, gear box / transmission system, driven equipment.

j) Heat exchanger drawings

Heat exchanger drawing and data shall construction details, cross sections and general arrangement drawings of heat exchangers.

Recommendations regarding provision for support and piping expansions.

k) **P&I Diagrams (with bill of materials)**

P&IDs along with bill of materials of each system in the Contractor's scope of supply or specified in the order shall be furnished. P&ID shall indicate the system details, location of various auxiliaries, instruments, controls and safety devices as required. Line sizes, piping class, valve sizes and class shall be clearly marked on the PID. Each item shall be identified by an item number / item tag number which shall correspond to the item number shown on the bill of materials. The bill of materials shall include item number, normal value, set value, range, quantity per unit, make and other specifications as applicable. Legends adopted shall be indicated either at the bottom of drawing or on a separate drawing. The legends shall be as per ISA.

l) **Cross-sectional drawing with bill of materials**

The cross sectional or assembly type drawings for all equipment furnished showing all parts, design assembly and running clearances and balancing data required for erection and maintenance shall be submitted. Each part shall be numbered which shall correspond to the part number on the bill of materials. The bill of materials shall include the part number, name of component, materials quantity installed per unit and sizes where applicable (say for bolts, nuts, rings, gaskets etc.). All bought out items shall also be indicated with make and brief specifications.

A separate cross sectional drawing showing installation and setting dimensions for the seals shall be furnished.

m) **Performance characteristic curves**

- i. Complete performance curves to encompass the map of operations with any limitations indicated thereon and shall include capacity vs. head, capacity vs. power consumption, capacity vs. efficiency, capacity vs. NPSHR.
- ii. All curves submitted prior to final performance testing shall be marked "predicted". Any set of curves resulting from the desk shall be marked 'tested'.
- iii. Certified test curves and data shall be submitted within 15 days after testing and shall include head, power recalculated to the proper specific gravity and efficiency plotted against capacity. If applicable, viscosity corrections shall be indicated. If NPSHR test is specified, the water NPSHR curve (drawn upto minimum continuous flow) shall also be included. The curve sheet shall include the maximum and minimum diameters of the impeller design supplied, the eye area of the first stage impeller the identification number of the impeller or impellers and the pump serial number.

n) **Data sheet**

Completely filled data sheets, first for 'as purchased' and then for 'as built' shall be

submitted. This shall be done by the Contractor correcting and filling out the data sheets and submitting copies to purchaser/EPC.

o) **Installation manual**

The Contractor shall provide sufficient written instructions, including a cross-reference list of all drawings to enable Purchaser/ EPC to correctly install, operate and maintain all the equipment. It shall include any special information required for proper installation that is not on the drawings, special alignment or grouting procedures, utility specifications (including quantity) and all installation data. It shall also contain the following information:

- i. Instructions for erecting, piping, aligning (including the expected thermally induced shaft centreline shift between normal site ambient temperature position and that at normal equipment operating temperature).
- ii. A description of rigging procedures, including the lifting of the assembled equipment, and methods of disassembly, repair, adjustment, inspection and re-assembly of the equipment and auxiliaries.
- iii. Pre-commissioning / commissioning / functional test procedures and acceptance criterion.

p) **Operation and maintenance manual**

q) **Technical data manual / Mechanical catalogue**

- i. Technical data manual / mechanical catalogue is a compilation of 'as built' drawings and data, manufacturing and test records, installation, operating and maintenance instructions.
- ii. Not later than two weeks after successful completion of all specified tests, the required number of technical data manual / mechanical catalogues for the equipment, any auxiliaries and instruments that are provided shall be furnished. The technical data manual / mechanical catalogue shall include the following document as a minimum:
 - (a) All drawings and data as listed in the Contractor data index and schedule. (for drawings, where Purchaser/EPC approval is required, the final certified drawings shall be attached). Sections of technical data manual / mechanical catalogue shall be organised in a manner that data and drawings related to one subject are grouped together such as mechanical, electrical, instrumentation etc.
 - (b) All manufacturing, inspection and test data and records.
- iii. Following information shall also included in the technical data manual / mechanical catalogue:
 - (a) Storage instructions for storing and preserving the equipment (including driver and all the auxiliary units) at the plant site before installation of the same.
 - (b) Instructions for preserving the equipment after it has been installed. This is particularly required in cases where a long time gap is expected between equipment installation and commissioning.

-
- (c) Field performance test procedures and acceptance criterion.

ANNEXURE-7

BASIC ENGINEERING DESIGN BASIS

SPECIFICATION NO: 44NC-4600-0000/P.02/0001/A4

TITLE: BASIC ENGINEERING DESIGN BASIS (PART B)

PROJECT REFERENCE:

- **Project No:** 44NC-4600
- **Project Location:** Manali, Chennai
- **Project Title:** RESID UPGRADATION PROJECT
- **Client:** Chennai Petroleum Corporation Limited
- **Project Manager Authorization:** R.P.GAIKWAD **Date:**
- **Client Authorization:** **Date:**

				APPROVALS		
Rev. No.	Issue Date	Pages	Revision Description	By	Check	Approve
C	15-07-10	81	Issued for Engineering	SPD	RMK	NSS
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☒ Entire Specification Issued this Revision			SPECIFICATION ISSUED FOR:			
☐ Revised Pages Only Issued this Revision			☐ In-house Review	☐ Purchase		
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1.0 INTRODUCTION

- 1.1 **Chennai Petroleum Corporation Limited (CPCL)** is implementing a Resid Upgradation Project to minimize the production of High Sulfur Fuel Oil and maximise the refinery distillate yield. As a part of the Resid Upgradation Project, a new Delayed Coker Unit is being planned. Additionally CPCL intends to revamp the existing OHCU from existing 1.85 MMTPA to 2.25 MMTPA to process straight run VGO, Visbreaker ~~Heavy Gas Oil~~ VGO and **additional** HCGO from new Delayed Coker. Additional matching auxiliary facilities such as Coker LPG CFC unit, Sour Water Stripper and ARU for matching capacity also have been envisaged. A new Sulfur Recovery Unit, to take care of additional sour gas and acid gas from the new augmented unit, will also be part of this project.



Jacobs Engineering India Pvt. Ltd has been retained as “Project management Consultant” for Resid up gradation project. The scope in broad includes following:

- PMC for all ISBL for
 - Delayed Coker units (DCU) And Coker LPG CFC unit
 - Sulphur Recovery Unit (SRU)
 - Sour Water Stripper (SWS)
 - Amine Recovery Unit (ARU)
- Preparation of Feed Packages
- Detailed Feasibility Report
- Basic Engineering for utilities and offsites
- EPCM for
 - OHCU revamp
 - Offsites and Utilities

The Design Basis presented here intends to provide the Engineering contractors and LSTK contractors with technical information required to complete the engineering design specifications of the complex in a uniform and consistent manner.

- 1.2 Basic Engineering Design Basis (BEDB) for all facilities contains technical information, which shall be binding on the process design (by Licensor or PMC), basic engineering and residual engineering of all units, utility systems and offsite facilities, as applicable to the agreed scope of work. The BEDBs for each facility are in two parts:

- Part-A:** Provides necessary data specific to process design of a particular unit.
Part-B: Defines overall project requirements, design data for common facilities and common design philosophies, with the intent of ensuring uniformity in design practices across the total complex.

This document constitutes Part-B of the Basic Engineering Design Basis.

2.0 DEFINITION OF PROJECT:

2.1 BRIEF DESCRIPTION

The project consists of design of a new delayed Coker Unit of 2.2 MMTPA capacity considering on-stream factor of 8000 hours per year. Besides this, new SRU, new SWS, new ARU, new Coker LPG CFC, revamp of the existing Hydrocracker is also included.

The provision of utilities will be made from the existing refinery and the balance will be generated in this project.

2.2 PROJECT TITLE: Shall be used for all documentation

Project name: Resid Upgradation Project

Owner: Chennai Petroleum Corporation Limited

Location: Manali, Tamil Nadu

2.3 DEFINITION OF FEEDSTOCKS:

Feed to delayed coker unit comprise of vaccum residue & propane deasphalted pitch. The feed to the revamped Hydrocracker in different scenarios will comprise of Straight Run Vacuum Gas Oils, Visbreaker Vacuum Gas oil, Deasphalted Oil and Heavy Coker Gas Oil. The Straight Run Vacuum Gas Oils will be from various crude sources like Arab Mix, Basra Light, Iranian Mix, Upper Zakum, Masila, Bombay High, Girassol, etc. For auxiliary units, products/by products from the main process units are considered as feed.

2.4 DEFINITION OF PRODUCTS:

	NAME	Storage	Mode of Despatch
PRODUCT #1	CRACKED LPG / OHCU LPG		To storage
PRODUCT #2	TREATED OFF-GAS		To fuel gas header
PRODUCT #3	DCU LIGHT NAPHTHA		To ISOM / DHDT
PRODUCT #4	OHCU LIGHT NAPHTHA		To HGU
PRODUCT #5	DCU HEAVY NAPHTHA		To DHDT
PRODUCT #6	LIGHT COKER GAS OIL		To DHDT
PRODUCT #7	HEAVY COKER GAS OIL		To OHCU
PRODUCT #8	PETROLEUM COKE		Coke Storage
PRODUCT #9	SULFUR		To Sulfur disposal



2.5 LIST OF FACILITIES

SI No	FACILITY	Unit number	Capacity
NEW DCU			
1.	Delayed Coker Unit	86	2.2 MMT/year
2	Cracked LPG CFC Unit	87	8.8 TPH
NEW SULPHUR BLOCK			
1	SRU	90	2 x 100 tpd
2	Sour Water Stripper (2 stage)	88	59.55TPH
3	Amine Regeneration Unit	89	250 TPH
ONCE THROUGH HYDRO CRACKER UNIT (REVAMP)		207 (Note 1)	2.25 M MT/year (After revamp)
ASSOCIATED OFF-SITE AND UTILITY FACILITIES			
	CW system	451	2 x 3800 m3/hr
	Raw & DM Water system	423	DM water : 3 x 150 m3/hr
	Compressed Air system	422	4500 Nm3/hr
	Condensate system & BFW system (for process units)	424	71 TPH of BFW
	FG system	425	----
	FO system	426	----
	HC / Acid Flare	429	418 TPH (Note 3)
	Steam & Power	21	Boiler (VHP): 150 TPH GT/HRSG: 20 MWe & 100 TPH VHP steam STG : 10 MWe
	Offsite Piping:	420	----
	Coke Yard:	401	78000 T Storage
	ETP	400	9580 m3/hr (Hold)

- Notes: 1. Unit no. of new train is 207A.
2. Deleted

SI No	FACILITY	Licensor
1.	Delayed Coker Unit	CB&I Lummus
2	Cracked LPG CFC Unit	EIL
3	SRU	Siir-tec Nigi
4	Sour Water Stripper (2 stage)	EIL
5	Amine Regeneration Unit	EIL
6	OHCU	Chevron Lummus Global

2.6 UNITS OF MEASUREMENT

2.6.1 MKS system of measurement shall be followed, **with the exception of piping/ tubing sizes, which shall be reported in inches.**

	Mks
Temperature	°C
Pressure (gauge)	kg/cm ² (g)
Pressure (absolute)	kg/cm ² (a)
Mass	kg
Length	m-mm
Liq relative density	sp gr T°C/15°C
Liq density	kg/m ³
Vap flowing density	kg/m ³
Furnace draft	mm of WC
Storage tank pressure	mm of WC
Vacuum	mm of Hg
Flowing mass	kg/hr
Flowing vapor	Am ³ /hr
Flowing liquid	m ³ /hr @ flowing temp.
Standard vapor	Nm ³ /hr at 0°C & 1.033 kg/cm ² a
Standard liquid	m ³ /hr at 15°C
Thermal conductivity	kcal/hr-m-°C
Heat Transfer coefficient	kcal/hr-m ² °C
Enthalpy, Entropy	kcal/kg
Heat Rate	10 ⁶ kcal/hr or MMkcal/hr
Viscosity	cP
Kinematic Viscosity	cS
Composition	Vol %
Power	kW

2.6.2 Material Balance in PFD shall be reported in following units:

(A) GASES: kg/hr

(B) LIQUIDS: kg/hr

3.0 PLANT LOCATION

The Unit will be located in the Refinery III Complex of the Manali Refinery. This section presents brief details.

3.1 Site Location

- State : Tamil Nadu
- Nearest Important Town : Chennai- 15 km
- Nearest Railway : Chennai central - 15 km
- Nearest Port : Chennai port- 13 km
- Nearest Airport : Chennai - 35 km (Meenambakkam airport)

3.2 Source of Water : From Chennai Metropolitan Water Supply & Sewerage Board and Recycled Water

3.3 Rainy season : October to December

4.0 METEOROLOGICAL DESIGN DATA

- 4.1 Refer Engineering Design Basis for complete details of meteorological design data. This section presents relevant data towards preparing process-engineering specifications.

Sl#	Parameter	Minimum	Normal / Average	Maximum / Design
(A) METEOROLOGICAL DATA				
1	Elevation above mean sea level, m	3.5		
2	Barometric pressure, mbar			
3	Ambient temperature, °C	$t_{\min} = 18$	$t_{\text{nor}} = 35$	$t_{\max} = 45$
4	Relative humidity, %	@ $t_{\min}$	@ t_{nor}	80% @ $t_{\max}$
5	Rainfall data (mm) (a) for 1-hour period (b) for 24-hour period			100 450
6	Wind data (a) wind velocity (b) wind direction			180 km/hr (as per IS:875 Part-III). North East & South West
(B) DATA FOR EQUIPMENT DESIGN				
1	Design dry bulb temperature, °C			38
2	Design wet bulb temperature, °C			29
3	Low ambient temperature for MDMT, °C			NA
4	Design air temperature for air cooled exchangers where <i>followed</i> by water cooling, °C			40
5	Design air temperature for air cooled exchangers where <i>not followed</i> by water cooling, °C			42
6	Coincident temperature and relative humidity for Air Blower / Air Compressor design.			80 % at 45 ° C
7	Min. Design temperature for equipment			65 ° C

5.0 ECONOMIC OPTIMIZATION CRITERIA**5.1 UNIT RATES FOR FEED, PRODUCT AND UTILITIES****Table-5.1 : Feed, Intermediate Product and Finished Product unit rates**

Sl#	FEED / PRODUCT	Rs / MT	US\$/MT
1.	VGO		
2.	VR		
3.	PDA PITCH		
4.	Hydrogen		
5.	LPG		
6.	Coker light Naphtha		
7.	Coker heavy Naphtha		
8.	LCGO		
9.	HCGO		
10.	Coke		
11.	HCGO		
12.	Light Naphtha		
13.	Heavy Naphtha		
14.	Kerosene		
15.	ATF		
16.	Diesel		
17.	Fuel Gas		
18.	Sulfur		

Table-5.2 : Utility unit rates

Sl#	UTILITY	UNIT	Rs/ Unit	US\$/unit
1	Power	KWh		
2	Very High Pressure steam	Ton		
3	High Pressure steam	Ton		
4	Medium Pressure steam	Ton		
5	Low Pressure steam	Ton		
6	Fuel Fired	Ton		
7	Recirculating cooling water	m ³		
8	Boiler Feed Water	Ton		
9	Demineralised Water	Ton		

5.2 OPTIMIZATION CRITERIA

A default criterion of a maximum 3-year straight-line payback for recovering incremental investment will be used.

In case designer / licensor has alternate criteria, the same can be discussed on a case-to-case basis.

5.3 PLANT LIFE

5.3.1 A default plant operating life as 15 years with 5% salvage value will be considered for economic calculations.

5.3.2 The default plant equipment design life shall be taken as follows:

- a) 30 years for heavy wall reactors and separators
- b) 20 years for columns, vessels, heat exchanger shells and similar services.
- c) 12 years for piping, furnace tubes, High Alloy exchanger tube bundles.
- d) 5 years for Carbon Steel / Low Alloy heat exchanger tube bundles.
- e) 15 years for reactors removable internals

6.0 UTILITY SPECIFICATIONS

6.1 UTILITY CONDITIONS AT UNIT BATTERY LIMITS

Utility pressure and temperature levels, as made available at battery limits of a process unit, are indicated in Table-6.1.

Table-6.1: Utility conditions at unit battery limits [All battery limits pressures are as measured at grade]

Sl	Parameter	Minimum	Normal	Maximum	Mech Design
1	VERY VERY HIGH PRESSURE (VVHP) STEAM				
	Pressure, kg/cm ² g	90	95	95	104/FV
	Temperature, °C	495	505	505	505
2	VERY HIGH PRESSURE (VHP) STEAM				
	Pressure, kg/cm ² g	44.8	48	54.9	58.0/FV
	Temperature, °C	379	425	435	440
3	HIGH PRESSURE (HP) STEAM				
	Pressure, kg/cm ² g	29.5	30.5	32.5	36.0/FV
	Temperature, °C	270	280	290	300
4	MEDIUM PRESSURE (MP) STEAM				
	Pressure, kg/cm ² g	9.5	10.5	12.5	15.0/FV
	Temperature, °C	200	220	240	280
5	LOW PRESSURE (LP) STEAM				
	Pressure, kg/cm ² g	2.7	3.5	4.0	7.0/FV
	Temperature, °C	Saturated	170	190	240
6	CONDENSATE RETURN				
	Pressure, kg/cm ² g		5.0		13
	Temperature, °C		140-150		210
7	SERVICE WATER				
	Pressure, kg/cm ² g		6.0		10.5
	Temperature, °C		Amb.		65
8	COOLING WATER				
	Supply Pressure, kg/cm ² g		4.5		8.0
	Return Pressure, kg/cm ² g		2.5		8.0
	Supply Temperature, °C		33		65
	Return Temperature, °C			45	65
9	DEMINERALISED WATER				
	Pressure, kg/cm ² g	7.0	8.0	9.0	14.0
	Temperature, °C	Amb.	Amb.	Amb.	65
10	BOILER FEED WATER (MP/HP)				
	Pressure, kg/cm ² g		19.0/38.0		29.0/55.0
	Temperature, °C		105-110		150/150
11	PLANT AIR				
	Pressure, kg/cm ² g	5.0	6.0	6.5	10.0

	Temperature, °C	Amb.	Amb.	Amb.	65
12	INSTRUMENT AIR				
	Pressure, kg/cm ² g	5.0	6.0		10.0
	Temperature, °C	Amb.	Amb.		65
13	FUEL GAS				
	Pressure, kg/cm ² g	2.5	3.0	3.8	7.0
	Temperature, °C		40		65
14	REFINERY FUEL OIL				
	Supply Pressure, kg/cm ² g		10.0	12.0	17.5
	Return Pressure, kg/cm ² g	2.5			
	Temperature, °C	80	165-200	220	250
15	SURFACE CONDENSATE (EX TURBINE)				
	Pressure, kg/cm ² g		6.0		15.0
	Temperature, °C		40		100
16	NITROGEN				
	Pressure, kg/cm ² g	5.0	6.0	7.0	9.5
	Temperature, °C	Amb.	Amb.	Amb.	65
17	BRIDLE COOLING WATER RETURN				
	Return Pressure, kg/cm ² g		2.5 (hold)		8.0 (hold)
	Return Temperature, °C			45	65

6.2 STEAM & CONDENSATE SYSTEMS

6.2.1 The following default philosophy shall be adopted towards design of equipment generating or consuming steam:

- Steam turbine drives and ejectors shall be rated based on MINIMUM steam conditions available at unit battery limits.
- All other steam consuming equipment including heat exchangers shall be rated based on NORMAL steam conditions.
- All steam generating equipment shall be rated based on delivering steam at MAXIMUM conditions to the header.
- NORMAL steam conditions shall be used for operating utility estimates, heat and material balances and battery limits connectivities.

6.2.2 Condensate recovery will be maximized from process consumers. All condensate generated in a facility will be considered as normally uncontaminated and will be directly reused for steam generation. Contamination detection by on-line analyzers sensing conductivity , pH and Hydrocarbons (HC), with an option of automated drainage upon detection, shall be done as per unit designer's advice.

- a) Condensate polishing to be considered for all condensate: ☐ yes ☐ no

- b) Condensate segregation and polishing to be considered for condensate other than surface condenser condensate: ☐ yes ☐ no
- c) Condensate de oiler to be considered for condensate other than surface condensate ☒ yes ☐ no

6.2.3 Condensate loss can be reduced in a number of ways. (Refer utilities BEDB Part-A also)

- a) Condensate recovery from line steam traps: ☐ yes ☒ no
- b) Condensate recovery from steam tracer traps: ☒ yes ☐ no
- c) Condensate recovery from storage tank heating coils: ☒ yes ☐ no
- d) For revamp unit existing philosophy to be followed:

Note : CPCL to review requirement of condensate recovery from line steam trap considering existing philosophy.

6.2.4 Condensate recovery from steam consumers shall be done as follows (Refer utilities BEDB Part-A also)

- ☐ Flash HP and MP condensate for recovery of LP steam. Return LP condensate under own pressure to utility system. Condensate return shall be two-phase.
- ☒ Flash HP and MP condensate for recovery of LP steam. Pump out LP condensate.
- ☐ Flash HP and MP condensate for recovery of LP steam. Cool LP condensate to 90°C in air cooled exchanger and return under own pressure to utility system.
- ☒ Flash LP condensate to atmospheric pressure with vent condensor, where viable and pump out atmospheric condensate.

6.3 WATER SYSTEMS

6.3.1 The quality of raw water / filtered water (utility water) / circulating cooling water / once-through cooling water / DM Water / Boiler Feed Water are as per Table-6.2

6.3.2 Backflush arrangement connection shall be as in figure-6.1.

Backflush arrangement shall be provided for:

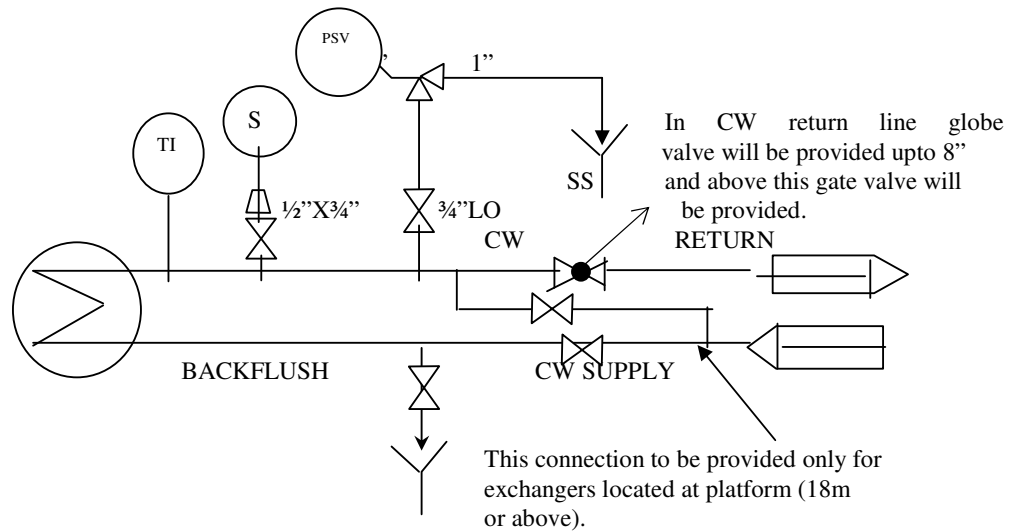
- ☒ All cooling water consumers
- ☐ Only overhead condensers
- ☐ Cooling water consumers with water line sizes greater than _____ " NB.
- ☐ Other:

6.3.3 All pump bridle cooling water lines (for bearing cooling, gland cooling, seal cooling) shall be minimum 1 1/2"NB.

- ☐ Return lines to be connected to cooling water return header.
- ☐ Return lines to be connected to separate header routed back to cooling tower sump.
- ☒ Return lines to be connected through open funnels to separate buried header leading to a sump within unit, from where the water can be processed in one of the following ways:
- ☒ Pump out return water to offplot facility: to cooling tower sump.

- Provide small FREP cooling tower within unit, full flow size, and recirculate.

Figure - 6.1
Typical cooling water piping and instrumentation at heat exchangers



Notes:

1. Sample point is to be provided at the highest point to facilitate venting.
2. Back flush lines to be provided with same size as main cooling water line when main line size is $\leq 6"$. One size lower to be provided for main line size $> 6"$. For much higher line sizes e.g "14" and above to be decided on case to case basis.

Table-6.2A: Water Quality

I	Parameter	DM Water	BFW	Cooling Water make up	Cooling Water
	PH	6.8-7.2/8.3-8.5	8.5-9.5	7.2 - 7.5	7.3 - 7.8
	Turbidity, NTU	Nil		< 2	<=30
	Total suspended solids,			< 10 mg/l	<=30 mg/l
	Total dissolved solids,			850-1050 mg/l	2500-3000 mg/l
	Conductivity micro mho/cm	< 0.3 at 25°C	0.3 max at 25°C	1300-1500 at 25°C	<=5000 at 25°C
	Mo Alkalinity,				
	Ca Hardness as CaCO ₃ ,			140-200 mg/l	500-750 mg/l
	Total Hardness as CaCO ₃ ,	Nil mg/l	Nil ppm	250-360 mg/l	850-1000 mg/l
	Total cation/anion as CaCO ₃ ,				
	Total Silica as SiO ₂ ,	< 0.02 mg/l	<0.02 ppm	20-25 mg/l	100-125 mg/l
	Colloidal Silica as SiO ₂ , mg/l				
	Sodium as Na,				
	Potassium as K, mg/l				
	Chlorides as Cl,			350-460 mg/l	800-1000 mg/l
	Free chlorine,				0.3-0.6 mg/l
	Sulphates as SO ₄ ,				<500 mg/l
	Organophosphates as PO ₄ , mg/l				5-6 mg/l
	Poly phosphates as PO ₄ ,				
	Nitrates as NO ₃ ,				
	Dissolved oxygen		0.005 ppmv		
	Total Iron as Fe,	Nil mg/l		0.3 mg/l	<=1.0 mg/l
	Copper + Iron,	<0.003	0.01 max		
	Lead as Pb, microgram/l				
	Mg , Hardness as CaCO ₃ ,			120-180 mg/l	350-450 mg/l
	Zinc as Zn,				1.0-1.5 mg/l
	Chromium as Cr, mg/l				
	Polymeric dispersant,				20-25 mg/l
	Zinc Sulphate as Zn,				
	Benzotriazole, mg/l				
	Dissolved Fe, mg/ l				
	Oil content,	Nil mg/l			<10 mg/l
	KMnO ₄ value at 100 °C,	Nil mg/l	Nil ppm		<30mg/l
	Hydrazine (residual),		0.02 ppm		
	Morpholine (residual),		1(approx) ppm		

Note-6.2: For further details on water qualities reference is to be made to Part-A utility system design basis.

Table-6.2B: Water Quality

I	Parameter	Treated Raw Water as DM water Make up	Desalinated water as DM water make up
	PH	7 - 7.8	7-7.8
	Turbidity, NTU	15	NA
	Total suspended solids,		
	Total dissolved solids,	NA mg/l	350
	Conductivity micromho/cm	NA	493
	Mo Alkalinity,	240 (as CaCO ₃)mg/l	2.9 (as CaCO ₃)mg/l
	Ca Hardness as CaCO ₃ ,	176 mg/l	1.3 mg/l (as Ca)
	Total Hardness as CaCO ₃ ,		
	Total cation/anion asCaCO ₃ ,	608	NA
	Total Silica as SiO ₂ ,	40	0.1
	Colloidal Silica as SiO ₂ , mg/l		
	Sodium as Na,	344 (as CaCO ₃) mg/l	135.3 (as CaCO ₃) mg/l
	Potassium as K, mg/l		
	Chlorides as Cl,	172 mg/l	142-220 mg/l
	Free chlorine,		
	Sulphates as SO ₄ ,	121 mg/l	12.5 mg/l
	Organophosphates as PO ₄ , mg/l		
	Poly phosphates as PO ₄ ,		
	Nitrates as NO ₃ ,	NA mg/l	0.2 mg/l
	Dissolved oxygen		
	Total Iron as Fe,	0.3 mg/l	NA
	Copper + Iron,		
	Lead as Pb, microgram/l		
	Mg , Hardness	NA mg/l	4.5 mg/l
	Zinc as Zn,		
	Chromium as Cr, mg/l		
	Polymeric dispersant,		
	Zinc Sulphate as Zn,		
	Boron, mg/l	NA	1 mg/l
	Dissolved Fe, mg/ l		
	Oil content,		
	KmnO4 value at 100 °C,	20 mg/l	NA
	Hydrazine (residual),		
	Morpholine (residual),		

6.4 COMPRESSED AIR & NITROGEN SYSTEMS

6.4.1 The specifications of plant air and instrument air are indicated in Table-6.3.

Table-6.3: Plant Air & Instrument Air quality

Sl	Parameter	Plant Air	Instrument Air
1	Dew Point at atmospheric pressure	water-free	(-)40°C
2	Oil Content, ppm	nil	nil

6.4.2 Inert Gas generation: Nitrogen shall be generated from a cryogenic air separation unit with the specifications as given below.

Table-6.4: Inert Gas quality

Sl	Parameter	Inert Gas	Nitrogen
1	Dew Point at atmospheric pressure		(-) 100°C
2	Oil Content, ppm		nil
3	Nitrogen purity, vol%		99.99
4	Oxygen content, vol ppm		3 max
5	Carbon dioxide content, vol ppm		1 max
6	Carbon monoxide content, vol ppm		nil

6.4.3 Unit and Offsite designers are required to indicate whether there is requirement of prioritized continuous demand or intermittent large demand of Plant Air, Instrument Air or Inert Gas.

6.8 ELECTRICAL SYSTEMS

6.8.1 Voltage levels are:

Table-6.7 : Voltage levels

Motor power range		Nameplate Voltage	Phase	Frequency (Hertz)
From	Through			
< 0.37 kW		240 V	1	50
0.37 kW	161 kW	415 V	3	50
> 161 kW		6600 V	3	50

6.8.2 Designer may specify reacceleration feature in some critical pump motor drives to ensure faster start-up or to minimize plant down time in case of process disturbances due to momentary voltage dips.

- ☐ No reacceleration feature is desired
- ☐ Reacceleration to be specified for identified motors to cover brief interruptions upto 5 seconds in normal power supply. Such pumps to be identified based on designers own experience.
- ☒ Re-acceleration feature is acceptable for critical pump motors of 415 V rating (LT) and auxiliary drives of HT motors such as Lube oil pumps, etc. For HT motors re-acceleration feature shall be provided wherever required for process consideration.. Provision for metering number of hours run shall be given for all HT motors and large LT motors.

6.8.3 Emergency power supply may sometimes be stipulated to aid in safe shutdowns or to minimize impact of normal power supply failure. Analysis of such emergency power supplies usually lead to a requirement of continuously running a diesel generator or to ensure backup motive steam drives in power plants. The requirement of emergency power shall be minimized through strategies such as steam turbine drives for standby pumps, steam turbine drive for some cooling water pumps etc. Nominal requirements of emergency power such as for local panels, frame heating of compressors etc., can be then examined and suitably implemented.

6.9 CAUSTIC STORAGE, PREPARATION, DISTRIBUTION

6.9.1 (a) Fresh caustic receipt

Fresh caustic (45% by wt.) will be received in Coker LPG CFC treating unit. **Caustic Unloading Bays will be provided for unloading Fresh Caustic in the CFC unit. Caustic will then prepared in the Coker LPG CFC unit and pumped to other consuming units. The consuming unit can be provided with a small pot for receiving the same.**



(b) Fresh caustic preparation

The caustic of highest concentration required in the project shall be also prepared in the same area as (a). This caustic is pumpable to all consuming units and separate solution making arrangement shall be provided if a unit requires lower strength.

(c) Fresh caustic distribution

- ☐ Pumped from central storage area directly to consuming units, whether needed continuously or needed in batches.
- ☐ Pumped from central storage area directly to intermittent batch consumers such as during catalyst regenerations.
- ☒ Stored in consuming units and pumped thereafter for continuous or regular batch consumers such as LPG contactors or injections.

6.9.2 Caustic handling equipment shall be of Carbon Steel construction and stress relieved (Not applicable for spent caustic)

6.9.3 Any process unit discharging spent caustic from a contactor with light hydrocarbons shall degas the stream in an atmospheric vessel floating with flare header and then pump this out to effluent treatment plant or to spent caustic storage. Spent caustic storage in unit area allows reuse of such caustic in other potential areas.

- ☒ Spent caustic storage in unit area for reuse by other consumers
- ☐ Spent caustic totally routed to effluent treatment plant

6.9.4 Battery limit conditions for caustic distribution shall be as per Table-6.8.

Table-6.8: Caustic streams

Sl#	Caustic stream	Operating condition		Mechanical Design	
		P, kg/cm ² g	T, °C	P, kg/cm ² g	T, °C
1	Fresh Caustic	Refer unit BEDB - Part A	Refer unit BEDB - Part A	6.5	65
2	Spent Caustic	Refer unit BEDB - Part A	Refer unit BEDB - Part A	By design	65

6.10 FLUSHING OIL SYSTEMS:

6.10.1 Normal flushing oil (FLO)

The following scheme for the flushing oil system is envisaged:

- No flushing oil tank and pumps will be provided in outside battery limits.
- OSBL flushing oil header will be provided with mainly CDU/VDU Gas oil, which will have hot or cold gas oil to the header. The main header also will have alternate source of FLO. The battery limit conditions for OSBL flushing oil are given in Table 6.9.
- For external flushing of pump's API seal plans, or for purging instruments in congealing service, the FLO pressure will be boosted. For this purpose, a separate vessel with (1+1) screw pumps will be provided independently with in the respective unit. The connection for make up flushing oil to vessel will be provided from maintenance Flushing oil header. **DCU LCGO can be considered for Flushing Oil**



(FLO) within the DCU Battery Limit.**6.10.2 Heavy flushing oil (HFLO)**

Straight run Vacuum Gas Oil from CDU/VDU will be taken as Heavy Flushing Oil for external flushing of hot, heavy fluid handling pump's API seal plan. To maintain the temperature of VGO about 80-110 C, the separate vessel with steam coil will be provided with in the unit. A separate set of screw pumps (1+1) will be provided to pump the flushing oil to necessary pressure level for pump seal flushing. The battery limit conditions for OSBL heavy flushing oil are given in Table 6.9.

Table-6.9 : Flushing Oil

Sl#	Stream	Operating condition		Mechanical Design	
		P, kg/cm ² g	T, °C	P, kg/cm ² g	T, °C
1.	Flushing Oil (Gas Oil)	6.0-16.0	40-103	27.0	141
2.	Heavy Flushing Oil (VGO)	4.0-6.0	70-80	27.0	100

7.0 GENERAL DESIGN PHILOSOPHY

7.1 Energy integration

7.1.1 Improvement in overall energy efficiency shall call for unit-level and total plant-level optimization of energy. Designer of a particular unit shall indicate the following at the outset of design activities:

- (a) The total energy consumption expressed as equivalent fuel oil (Btu/bbl or FOE%) and a comparison with Solomen bench marks or equivalent.
- (b) The preferred temperatures for hot feeds and products from an energy integration standpoint, if these are significantly different from that stipulated in unit BEDB.
- (c) Energy shall be preferentially recovered into process streams. Steam generation shall be considered thereafter to recover excess available energy. Steam generation levels shall be chosen to preferably match the corresponding steam level demand within unit.
- (d) Low-level energy recoverable for external consumption, say, for Boiler Feed Water preheat serving other units.

7.2 Vacuum Design

7.2.1 Vacuum design conditions shall be stipulated for:

- (a) Equipment operating normally under vacuum conditions
- (b) Equipment that are subjected to vacuum conditions during start-up, shutdown, regeneration or evacuation.
- (c) Liquid full vessels that can be blocked in and cooled down
- (d) Distillation columns and associated equipment that can be subjected to vacuum conditions through loss of heat input.
- (e) All steam users consuming steam during normal operation.
- (f) Pressure vessels containing liquids having vapor pressure at minimum ambient temperature less than atmospheric pressure.
- (g) Special consideration to be given (for vacuum design) to the design of vessels normally subjected to internal pressure and connected to compressor suction.
- (h) All equipment, except storage tanks, where steam out conditions are specified.

7.2.2 Vacuum design conditions are not to be specified for the eventuality of operator maloperation.

7.3 Feed, intermediate and product storage

7.3.1 The design specifications of tankage outside the unit battery limits shall be prepared by offsite designer, as defined in the relevant scope of work. Should the designer of a particular process unit have specific requirements towards feed, product or intermediate product tankage such as, inert gas blanketing and the required minimum purity of the inert gas, material of construction, etc., the same shall be conveyed during preparation of BEDB-Part A or relevant licensor document.

7.4 Aromatics handling

7.4.1 Special precautions could apply towards handling process streams containing aromatics.

Owner to indicate threshold values for applying special precautions:

- (a) Benzene content greater than **1** % weight.
- (b) C6 through C9 aromatics greater than **25** % weight.

7.4.2 The design and equipment provisions toward special precautions shall be:

- (a) Sampling points as defined in standard legend P&ID ☒ yes ☐ no
- (b) Dual mechanical seals for pumps ☒ yes ☐ no
- (c) Connecting the following to the unit closed blowdown system:
 - vessel and pump drains ☒ yes ☐ no
 - control valve, level gage and level instrument drains ☐ yes ☒ no
 - drains of equipment which can be isolated for maintenance ☒ yes ☐ no
- (d) Client will review on case to case basis for control valve, level gauge and level instrument drains.

7.5 Metallurgy

7.5.1 Metallurgy shall be specified by respective unit designer based on process considerations. If a unit designer has specific stipulations towards either an associated upstream or downstream unit for, say, piping metallurgy, exchanger tube metallurgy, etc., unit designer shall identify the same during the finalisation of BEDB. Piping metallurgy shall follow a unified overall Piping Material Specification (PMS).

7.5.2 For cooling mediums for heat exchangers, metallurgy can be selected for either long tube life at a higher initial cost or for shorter tube life at a lower initial cost with upgradations being decided in the course of operating the plant. In specific cases superior metallurgy is dictated by considerations such as seawater cooling, compatibility with NACE MR-01-03, etc., and shall be as per designer. Metallurgy as desired by the owner are as follows:

Type of service	Cooling Water	Tempered Water	Console Lube oil coolers
Tube	Note-1	carbon steel	Brass
Channel	Note-1	carbon steel	CS
Channel cover	Note-1	carbon steel	CS

Atmospheric column overhead trim condensers and stabilizer overhead condenser shall use SS tubes.

Hot well- Gunnite lined vessel.

Diplegs of vacuum system shall be SS.

Ejector condensor tubes MOC to be SB111 Alloy-443 (adm. brass)

Note-1: CPCL has indicated that SS 316 (Austenitic Stainless Steel) may not be suitable due to the Chloride levels in the Cooling Water. Hence, **metallurgy for the Coolers shall be chosen as Duplex Stainless Steel**

7.5.3 As a default all steam tracers shall be as required by PMS.

7.6 Corrosion Allowance

7.6.1 Minimum corrosion allowances shall be as follows :

sl#	Service	Corrosion Allowance
1	Carbon Steel pressure vessels	3.0mm
2	Carbon Steel atmospheric vessels	3.0mm
3	Alloy Steel vessels	1.5mm
4	Stainless Steel vessels	nil
5	Clad / lined vessels	3.0 mm clad thk
6	Carbon Steel / LAS Exchangers	3.0 mm
7	Carbon Steel storage tanks Shell	1.5 mm
	Roof	<u>3.0 mm</u>
	Bottom most shell course & Bottom plate	3.0 mm
8	Column Trays, CS	1.5 mm on both sides 5 mm
	SS410S	nil
	SS	nil
	Monel	nil
9	SS/HAS/Non-Ferrous exchangers	nil

7.7 Unit battery limit isolation philosophy for process lines

7.7.1 Double valve, spectacle blind, drain assembly and check valve towards unit side is to be provided at unit B/L for all hydrocarbons.

8.0 EQUIPMENT DESIGN PHILOSOPHY

8.1 Overdesign philosophy

Owner may wish to impose overdesign margins on equipment over and above the margins built in by unit designer as per designer's own practice. Such overdesigns can allow an owner to debottleneck operations in future, recognizing that these would also call for higher investment and that these could also hamper operation on account of turndown limitations or sub-optimal operations.

Normal overdesign margins to be used (unless otherwise required by the designer) are indicated in table 8.1.

Table-8.1 : Owner's overdesign margins and turndowns

		%turnup	%turndown
	Process Towers (atmospheric or above)	10%	
	Process Towers (vacuum)	10%	
	Fired Heaters (potentially coking services)	15%*	
	Fired Heaters (clean services)	15%*	
	Heat exchangers (fouling service): overdesign on duty	10%	
	Heat exchangers (fouling service): overdesign on flow	10%	
	Heat exchangers (clean service): overdesign on duty	10%	
	Heat exchangers (clean service): overdesign on flow	10%	
	Tower overhead exchangers: overdesign on flow & duty and reboilers	20%	
	Pumparound exchangers: overdesign on flow	20%	
	Recycle compressors	10%	
	Make-up compressors	10%	
	Pumps in general	10%	
	Reflux and pumparound pumps	20%	
	3-phase separators	10%	
	2-phase separators	10%	
	Crude preheat exchangers	15%	

* That may change case to case basis.

8.2 Selection Of Mechanical Design Conditions

Equipment and piping systems shall be designed for the most stringent coincident temperature and pressure conditions, accommodating the maximum expected working pressure and temperature without causing a relieving condition. The design shall be such that instrument safeguarding systems or availability of emergency power or steam are not

8.7 Pumps**8.7.1 Selection of type of pumps**

- a. All pumps within process battery limits shall be specified to conform to API Std. 610.
- b. Pump specifications shall assume unsheltered outdoor location. The piperack above the pumpbay may accommodate air-cooled heat exchangers, in which case, the unit has to be provided with a safety system to minimize accidental pump hydrocarbon leakages from being fanned out as an explosive vapor cloud.
- c. In special applications, low flow, high head, vertical impulse pumps can be specified, if found necessary.

8.7.2 Sparing of pumps

8.7.2.1 Process pump services in continuous service will, in general, be provided with installed spare. Intermittent pump services such as chemical unloading, batch make-up, etc., shall not be provided with installed spare. These shall be decided on a case-to-case basis and possibility of common spares shall be examined.

8.7.2.2 Where more than one operating pump is found necessary for a service, or when defined by owner, pump capacity and spare shall be as follows:

# Operating pumps	Rated capacity per pump	Spare pumps	Remarks
2	50% of total normal flow	1	
3	33% of total normal flow	1	
4	25% of total normal flow	2	

8.7.2.3 The option of specifying at least 2 operating pumps for specific services as an operational strategy may be exercised by the owner. The same will be reviewed at the design stage of respective units.

8.7.3 Specification of pump seals

8.7.3.1 Single ~~mechanical seals~~ shall normally be specified for centrifugal pumps unless other considerations prevail. Seal flushing where necessary, shall preferably be with the process fluid itself through an appropriate API seal plan for all clean liquids.

8.7.3.2 External seal flushing oil shall be made a requirement only when a self-flushing plan is infeasible. For refinery services, light seal flushing oil (FLO) and a heavy flushing oil (HFLO) will be available as defined in Section 6.11. If otherwise, pumps shall be specified such that pump vendor is completely liable for proper seal fluid selection and supply.

8.7.3.3 Dual mechanical seals shall necessarily be specified for the following pump services (ISBL):

- | | |
|---|-----------------------------------|
| ■ Process liquids: butanes and lighter | ■ yes ☐ no |
| ■ Process liquids with vapour pr. More than 15psia at Pumping temp. | ■ yes ☐ no |
| ■ Toxic process Fluid | ■ yes ☐ no |
| ■ Sour waters >100 ppm H ₂ S | ■ yes ☐ no |
| ■ Process streams temperature > autoignition temperature | ■ yes ☐ no |
| ■ Fouling service or environmentally hazardous service | ■ yes ☐ no |
| ■ Split seals instead of gland packing shall be considered for CW pumps. For Slurry | |

services, type of packing/seal shall be decided on case-to-case basis.

■ Pump operating at high pressure higher than or equal 50 barg ■ yes ☐ no

8.7.3.4 Instrumentation for pump seals shall be determined during detailed engineering.

8.7.3.5 For vacuum services, stationary bellow seal shall be specified.

8.7.4 Specification of drives

Motor drives shall be normally specified for pumps. Steam turbine drivers will be specified as required for critical services.

8.7.5 Minimum flow bypass (MFB) provisions & controls

8.7.5.1 Requirement of MFB for centrifugal pumps is usually determined in the course of detail engineering. In some instances, owner may want to specify a MFB from operational or equipment health considerations, regardless of actual MFB requirements determined by vendor data. Owner preferences for such MFBs are

■ Pumps with source vessel level control valves or temperature control valves at discharge ■ yes ☐ no

■ Low capacity pumps less than 10 m³/hr. ☐ yes ☐ no

■ differential pressure multistage pumps higher than or equal 35 bar ■ yes ☐ no

■ large pumps with driver power higher than 160 kW ■ yes ☐ no

■ for process reason (turndown), flowrate lower than or equal 30 per cent of max flowrate ■ yes ☐ no

8.7.5.2 The scheme for an MFB will usually be a spillback line with constant bypass flow through a restriction orifice and a globe valve. A separate MFB for each pump (operating as well as standby) shall be evaluated for high pressure, multistage pumps. Requirement of spill-back control valve shall be decided on case to case basis.

8.7.5.3 For large capacity pumps (capacity more than 100 m³/hr) , except recirculating service pumps, an automatic MFB with a protective minimum flow control shall be provided to save the pumping energy.

In case licensor has provided MFB for lower capacity pump then the licensor's requirement to be considered.

8.7.5.4 For low capacity pumps, where forward flow can go below the minimum pump flow during unit operation, minimum flow shall be added to maximum pump flow to specify rated flow of the pump.

8.7.6 Pump cooling:

Cooling water used for pump cooling (indirect) shall be disposed as indicated in Section 6.4.3.

8.7.7 Motor specification for auto start pumps:

For autostart pumps, electric motor shall be specified for end of the curve condition with discharge valve fully open conditions.

8.7.8 Shutdown of pumps by low low level in upstream vessel

Licensors will specify automatic shutdown of the process pumps (or more appropriate actions) by low low level switch (LSLL) only for process reason.

8.7.8 ~~Hot standby arrangement for standby pumps as follows.~~

Pumps with operating temperature more than 100° C shall be provided with hot standby arrangement, However in case licensors has provided hot standby arrangement for lower operating temperature then the licensor's requirement to be considered.

8.8 Compressors**8.8.1 Selection of type of compressors**

(a) Specification of a compressor shall assume installation under a compressor shed.

(b) Centrifugal compressors, conforming to API Standard 617, will be specified where suitable. Axial compressors are not preferred below capacities of 150,000 Nm³/hr. Centrifugal compressors shall not be spared but specifications shall be given for a spare rotor. Driver selection shall be based on process requirements, criticality of service, capital cost and owner's preference as per respective unit BEDB part A.

(c) Reciprocating compressors, conforming to API Standard 618, shall be specified with adequate spare capacity to allow maintenance of one machine while the plant remains onstream. Motor drivers shall be specified normally.

(d) Screw compressors, conforming to API Standard 619, can be specified in special cases where found to have an operating, economic or maintenance advantage over other choices. Screw compressors shall not be spared but specifications shall be given for a spare rotor. Driver selection shall be as for centrifugal compressors.

8.8.2 Compressor controls

For compressor antisurge / governor controls, owner's preference is:

☒ PLC in control room ☐ Conventional relay logics.

Preference:

☐ Only startup from local panel, normal control from control room.

☐ Startup and normal control from local panel, only critical parameters /trips in central control room.

☐ PLC shall be procured from DCS vendor.

☒ Machine interlocks shall be realized in owners' PLC and shall be procured from DCS vendor.

8.8.3 Compressor seals:

Owner's preference for compressor seals are:

☒ Dry gas seals ☐ Conventional liquid seals

8.8.4 Unit designers shall address issues such as common or individual compressor suction and interstage KODs, common or individual compressor interstage coolers, etc., as part of unit operability and cost saving factors.

8.8.5 Isolation of compressor

To reduce the consequences of a fire in compressor area, remote activated isolation valves will be installed in the suction and discharge of any compressor with a power higher than or equal 150 kW and handling flammable or toxic gases.

8.9 Steam Turbine drives**8.9.1 When to select a steam turbine drive?**

Steam turbine drives shall be specified in extremely critical services where even short-term failure of a drive can result in a shutdown from where an operational recovery is difficult, time-consuming or has a large economic penalty, such as irreversible catalyst poisoning.

Steam turbine drives shall also be specified for the following drives, that, among other considerations, shall ensure that a power failure does not automatically lead to a steam failure:

- | | | |
|---|---|-----------------------------|
| (a) Cogeneration / Steam generation plant BFW pumps | ☒ yes | ☐ no |
| (b) Cogeneration / Steam generation plant FD Fan | ☒ yes | ☐ no |
| (c) Cooling water pumps | ☒ yes | ☐ no |
| (d) Compressor lube oil & seal oil pumps | ☒ yes | ☐ no |
| (e) Hot well pumps | ☒ yes | ☐ no |
| (f) Emergency evacuation pumps | ☒ yes | ☐ no |
| (g) Other: # Category b, c & d lube oil pumps shall be driven through DC motor. | | |

8.9.2 Preferred type of steam turbine drive: back pressure or condensing?

- Backpressure steam turbine for a large driver in a unit can be evaluated only when there is a matching large consumer of the letdown steam within the same or immediately neighboring unit.
- When there is a large use of LP steam, a back pressure steam turbine to drive a pump/compressor shall be evaluated in the unit to minimize let down through pressure reducing station (PRDS) from MP steam level to LP steam level.

8.9.3 Condensing turbine exhaust

Steam condensing pressure at turbine exhaust shall be considered as 0.14 kg/cm²(a) for the purpose of basic engineering specifications. Only water cooling shall be considered for exhaust condensation. Cleanliness factor of 0.6 shall be considered for surface condensers.

8.10 IBR Requirements

8.10.1 Scope of IBR

Steam generators / steam users shall meet IBR regulations. Major IBR requirements are summarized below. (Please refer the latest edition of IBR for exact details.)

- a) Vessels: Any closed vessel exceeding 22.75 litres (five gallons) in capacity which is used exclusively for generating steam under pressure and include any mounting or other fittings attached to such vessels, which is wholly or partly under pressure when steam is shut-off.
- b) Piping: Any pipe through which steam passes and if:
 - i) Steam system mechanical design pressure exceeds $3.5 \text{ Kg/cm}^2 \text{ g}$ OR
 - ii) Pipe size exceeds 254 mm internal diameter
- c) The following are not in IBR scope:
 - i) Steam Tracing
 - ii) Heating coils
 - iii) Tubes of tanks
 - iv) Steam Jackets
- d) All steam users (heat exchangers, vessels, condensate pots etc.) where condensate is flashed to atmospheric pressure i.e. downstream is not connected to IBR system are not under IBR and IBR specification break is done at last isolation valve upstream of equipment.
- e) All steam users where downstream piping is connected to IBR i.e. condensate is flashed to generate IBR steam are covered under IBR
- f) Deaerator, BFW pumps are not under IBR and IBR starts from BFW pump discharge.

8.10.2 Material Certificate: [This section is only for information on IBR requirement]

- a) All item part of steam piping i.e. pipes, valves, fittings, traps, safety valves must have material certificates, countersigned by the local boiler inspectors.
- b) For imported items - Certificates issued by an authority empowered by Central Boilers Board (As listed in the Appendix C of IBR) or under the law in force in a foreign country in respect of boilers manufactured in that country may be accepted.
- c) All drawings coming under preview of IBR shall be certified by Local Boiler Inspector.

- d) All material test certificates should be signed by the owner or director of manufacturing company. In case of photo copy, it should be endorsed by boiler inspector on all pages (as desired by CPCL).

8.10.3 All datasheets of equipment which come under IBR scope shall have the annotation:
"IBR is applicable".

9.0 INSTRUMENTATION

9.1 Control Philosophy:

Process Control for new process units shall be facilitated through:

Distributed Control System (DCS)

Interlocks and shutdowns through Programmable Logic Controller (PLC)

For revamp units, existing DCS / PLC system shall be used by adding Input/Output modules or control station.

9.2 General requirements:

9.2.1 The following general requirements towards basic engineering design are recommended. Detailed instrumentation design philosophy would be developed in the course of detailed engineering.

- All symbols in P&ID shall be as per ISA
- Sensor / transmitter for shutdowns separated from that for control / indication
- Solenoid valve operation with interlock shutdown system only
- Push buttons shall be in auxiliary console and status indication will be provided in DCS. Status indication for some critical pumps to be provided in auxiliary console also.
- Emergency / bypass / process start up override switches shall be hardwired only
- Control room reset pushbutton shall be hardwired only
- Hardwired indicators or recorders shall not be used
- Shutdown signals shall be repeated in DCS.
- Analog inputs for shutdown and interlocks shall be connected directly to PLC without use of receiver switch or trip amplifier.
- Instruments shall have individual tappings from process lines.
- Independent tapping points shall be provided for instruments related to Trip and Control/Monitoring and local. They shall not be from the same tapping point from the main process line.
- All field transmitters to be 'SMART' type.
- DCS for continuous control
- Triple Modular redundant PLC for sequence control interlock logic
- Separate PLC for each block of process units.

9.2.2 Process Switch type shall be as follows :

- For Flow, level and pressure use transmitters with direct connection to system. All transmitters shall be 'SMART' type.
- For temperature signals, Thermocouple with temperature transmitters shall be used (open loop and closed loop)

9.2.3 Continuous flushing oil purge is recommended for flow, level and pressure transmitters in heavy residue services, except for bitumen product which can become off-grade. For some instruments (flow and pressure) in high temperature congealing service, flushing oil purge with diaphragm seal will be used. The requirement will be decided on case-to-case basis.

9.2.4 All temperature elements are assumed to have minimum line size expansion of 4" to be

implemented in the course of detailed engineering. These do not necessarily appear in Piping & Instrumentation Diagrams.

9.2.5 First isolation and drain valves shall be gate valves.

9.2.6 Condensate pots for transmitters and siphon for pressure gauges in steam service.

9.3 Level instruments:

9.3.1 Standpipes with a default size of 2" NB shall be considered for only clean, non-viscous and non-crystallizing services. Standpipes shall be used if more than 4 vessels nozzles are anticipated for mounting all the level instruments in a given service.

9.3.2 Owner's stipulations for standpipes:

- Standpipe shall not have instruments other than for level: ■ yes ☐ no
- Standpipe accommodating level gauge/transmitter shall be separate from standpipe/ vessel tapplings for level switches for alarm and trip: ■ yes ☐ no
- Standpipe shall not be connected to process lines: ■ yes ☐ no
- Separate isolation, vent and drain shall be provided for standpipes. ■ yes ☐ no

9.3.3 For Tank Level Gauges,

- | | | | |
|--|--------------------------------|--------------------------------|--|
| Feed tanks: | ☐ Servo | ☐ Float | ☐ Other: |
| ☐ Intermediate tanks: | ☐ Servo | ☐ Float | ☐ Other: |
| ☐ Product tanks: | ☐ Servo | ☐ Float | ☐ Other: |
| ☐ Highly viscous services | ☐ Servo | ☐ Radar | ☐ Other: <u>Float</u> |

It is desired that all gauges to be Radar type whenever possible. There should be provision for HTG/Servo gauges also.

Future provision for Tank Farm Management system will be given.

For highly viscous services: Float type

9.3.4 Specific selection of type of level instruments shall be:

- Diaphragm seals for congealing / high viscosity services: ■ yes ☐ no

9.3.5 All level instruments shall be 3" remote seal capillary diaphragm DP transmitter. All level transmitters except in tank level is to be provided with diaphragm.

External oil purge is to be provided for high viscous / congealing and high temperature services. External displacer type level transmitters shall be used for interphase level. In case of pump seal plan, level switches shall be as provided as per the seal plan during detailed engg. Level instrument for buried vessels like CBD, SBD etc., shall be of ultrasonic type / process radar type. Magnetic type level gauges shall be used.

9.4 Flow instruments:

General requirements for flow instruments:

- For only local indications, use calibrated differential pressure gauge across flow element
- Liquid flow measurement process data shall indicate flow in m³/hr at operating Pr.

and temp. and shall include density at standard conditions in addition to flowing density and normal / minimum / maximum flows, etc. DCS flow indications will be in m³/hr at standard conditions.

- Gas/ vapour flow measurement process flow data will be indicated in NM³/HR basis except steam service which shall be reported in kg/hr.

9.5 Startup / shutdown operation from control room

Emergency operations to be enabled from the control room:

- ☐ Single emergency shutdown of total complex: ☐ yes ☒ no
- Respective unit emergency shutdown:
(case to case basis by unit designer) ☒ yes ☐ no
- Fired heater emergency shutdown (control room and field): ☒ yes ☐ no
- Critical rotating equipment shutdown (control room and field): ☒ yes ☐ no
- All rotating equipment shutdown (control room and field): ☒ yes ☐ no
- Shutdown valves to fail-safe position: ☒ yes ☐ no
- All SOV (interlock SOV) shall be with Field Manual Reset or: ☒ yes ☐ no
control room reset
- Damper and gate operation (control room and field): ☒ yes ☐ no

9.6 Status indication lamps in control room:

- All continuously running rotating equipment in DCS
- Critical continuously running rotating equipment in hardwired console
- Alarm window in control room for all compressors.
- Bearing temperature detector annunciation in control room only for off-sites pumps.
- Alarm window shall be provided in control room Hard Wired Alarm Annunciator System for all critical equipments and critical process alarms.

9.7 Control valve manifold:

- 9.7.1 As a default, control valves up to 8" size and in steam service shall be provided with a manifold of block and bypass valves. Bypass valves shall be globe valves. Control valves not having block and bypass provision shall be provided with handwheel for manual operation.

The control valve inlet & outlet block valve size shall be same as corresponding line size.

The bypass valve size shall be same as control valve size.

Bypass line size shall be same as bypass block valve size.

If owner has any specific additional or different preferences, indicate:.

- 9.7.2 All control valves & shutdown valves shall be provided with ³/₄" drain valves, which can be provided as:

- upstream and downstream of all control valves
- ☐ upstream and downstream of fail close valves, upstream of fail open valves
- ☐ upstream and downstream of fail close valves, downstream of fail open valves
- ☐ upstream of all control valves
- ☐ drain valve shall be capped
- drain valve shall be blind-flanged

All control valves drain tip shall be at least 30 cm above the floor.

9.7.3 In no event shall shutdown valves be provided with block / bypass valves.

9.8 Pressure relief valves (PSV):

PSV will be installed on the equipment.

9.8.1 Preferences towards pressure relief valves:

- | | |
|---|-----------------------------------|
| ■ PSV for operational failures shall have installed spare: | ■ yes ☐ no |
| ■ PSV exclusively for non-operational failures (external fire or heat exchanger tube rupture) shall have installed spare: | ☐ yes ■ no |
| ■ Spared PSV shall have upstream and downstream isolation: | ■ yes ☐ no |
| ■ Spared PSV shall have only upstream isolation, if venting to atm.: | ■ yes ☐ no |
| ■ Unspared PSV shall have upstream and downstream isolation: | ■ yes ☐ no |
| ■ Unspared PSV shall have only upstream isolation: | ■ yes ☐ no |
| ■ Unspared PSV shall have no isolation: | ☐ yes ■ no |
| ■ PSV in IBR steam service shall have no isolation: | ■ yes ☐ no |
| ■ PSV in air service shall have only upstream isolation: | ■ yes ☐ no |
| ■ PSV for thermal relief valve shall not have installed spare: | ■ yes ☐ no |
| ■ PSV on spare equipment shall have downstream isolation only if connected to closed system: | ■ yes ☐ no |

9.9 Control philosophy for vendor package items

9.9.1 For all vendor package supplies, mode of monitoring, control and logics shall be decided during detailed engineering. Vendor Package Instruments shall be connected to Owner's DCS/PLC for control/monitoring and safety interlocks.

9.10 Standard Instrumentation:

9.10.1 *Packed towers:*

For column differential pressure indication two separate PT shall be provided and differential pressure shall be derived in DCS.

- | | |
|--|-----------------------------------|
| ■ Local differential pressure indication for each bed: | ☐ yes ■ no |
| ■ Local differential pressure indication for total section: | ☐ yes ■ no |
| ■ Control Room differential pressure indication for each bed: | ■ yes ☐ no |
| ■ Control Room differential pressure indication for critical beds: | ☐ yes ■ no |
| ■ Control Room differential pressure indication for total section: | ■ yes ☐ no |
| ■ 1+1 Basket strainers in lines going to packed beds: | ■ yes ☐ no |
| ■ Single basket strainers in lines going to packed beds: | ☐ yes ■ no |

9.10.2 *Heat Exchangers:*

- | | |
|--|-----------------------------------|
| ■ Isolation valves at both inlet & outlet in cooling water service: | ■ yes ☐ no |
| ■ Isolation valves at only inlet in cooling water service: | ☐ yes ■ no |
| ■ Isolation and bypass valves for process side of all exchangers: | ☐ yes ■ no |
| ■ Isolation and bypass valves for only exchangers, which can be taken out for maintenance when plant is running: | ■ yes ☐ no |
| ■ Thermowell at process inlet and outlet of each exchanger: | ☐ yes ■ no |
| ■ Thermowell at cooling water outlet of each exchanger: | ■ yes ☐ no |

- ☒ Local TI at process inlet and outlet of each service: ☐ yes ☒ no
☒ Control Room TI and PI at process inlet and outlet of: ☒ yes ☐ no
 each service

9.10.3 *Utility lines:* As a minimum, the following shall be provided in unit utility headers:

Table-9.1 : Standard utility line instrumentation

UTILITY	local PI	DCS PI	PAL/ PAH	local TI	DCS TI	TAL/ TAH	DCS FI	FAL/ FAH	DCS FQ	
MP STEAM	✓	✓	✓	✓	✓	✓	✓	✓	✓	
LP STEAM	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Condensate	✓			✓			✓		✓	
CW supply	✓	✓	✓	✓	✓	✓	✓	✓		
CW return	✓			✓	✓	✓				
Instrument Air	✓	✓	PAL	✓			✓		✓	
Plant Air	✓	✓		✓						
Inert Gas	✓	✓	✓	✓			✓		✓	
Fuel Gas	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Fuel Oil	✓	✓	✓	✓	✓	✓	✓	✓	✓	
DM Water	✓	✓	✓	✓			✓		✓	
Service Water	✓			✓			✓			
Flare	✓									

- For fuel oil, mass flow meter to be provided.
- For air flow Venturi shall be used.
- For cooling water header, magnetic flow meter shall be used.
- Temperature instruments and pressure instruments provided in buried lines / vessels shall be located above ground level.
- 3 transmitters shall be used for critical closed loops & ESD trips. Separate instrument tapping shall be provided for each instrument.
- Separate I/P converter shall be used for split range control.
- Auto reset SOV shall be used for drain tank, KOD & steam turbine auto cut-in.
- H, HH, L, LL shall be shown in the P&ID and the alarm values for the same shall be mentioned in the process data sheets.
- Cause & effect diagram with interlock nos. and write-up
- Configuration notes and calculations with write-ups for complex loops
- Fail safe position, TSO, leakage class, mechanical stopper (if any) shall be indicated in the Process data sheets. Similarly, fail safe position for Motor operated valves also to be indicated.

11.0 ENVIRONMENTAL CONTROL

- 11.1 Emission norms as stipulated by CPCB and other mandatory regulations shall be satisfied for the project. Liquid effluent shall conform to MINAS standards.
- 11.2 All unit designers have to necessarily furnish complete effluent characteristics in the format of Exhibit-I.
- 11.3 Noise level:
- i) 85 dB(A) at 1 meter from source
 - ii) 70 dB(A) at the fence

12.0 SAFETY

This section presents a short list of additional safety aspects that will be reflected, as appropriate, in the basic engineering design or in the detailed engineering stages. This list is not intended to be a complete enumeration of safety features for a project.

- 12.1 Push buttons for stopping critical motors, if identified, shall be provided at a safe location, away from the fire-zone of the respective motors. This is in addition to usual start/ stop push buttons provided for such motors. Stop button for critical pumps shall be provided in control room also. Crude offsites feed pump start switch shall be in control room.
- Air cooler stop push button to be located at grade level in addition to start / stop button near the fan at platform**
- 12.2 Gas detectors shall be provided in the critical process and offsites areas **based on leakage potential and OISD guidelines**. The requirement of steam / air curtain shall be based on designers requirement and as finalised to be consistent with rotating equipment seal selection and leakage potential.
- 12.3 Suction / discharge valves of suction filter should be close to the pump in order to avoid hydrocarbon wastage during filter cleaning and pump maintenance.
- 12.4 Flare line isolation valve at unit battery limits should be installed only in the horizontal line with stem in horizontal position or spindle down to avoid free fall of gate and blockage of flare system
- 12.5 Dip hatch for the tanks should have the aluminium guide extended upto top surface of the tanks (Short guides may cause serious hazards). Dip hatch cover should be ensured with a rubber gasket for non sparking.
- 12.6 Sprinkler system to be provided :
- air fin cooler located above any piperack or equipment .
 - Pumps in plant/ offsites operating above auto ignition, LPG, unstabilized naphtha.

- Fire proofing requirement.
- Auto start facility for new firewater pumps as part of additional fire fighting facilities to be provided

12.7 Emergency lighting system to be provided.

12.8 MOVs are to be provided for all HT motor pumps suction and discharge lines.

12.9 Harmful effects of liquids / gases handled in the plant on FRLS cables / PVC cables / XLPE cables / Aluminum / Copper / Brass to be considered and suitable precautions to be taken

12.10 Any specific requirement for lightning protection and protection against static charge is to be incorporated.

12.11 Pumps taking suction from vessels containing butanes and lighter and materials at operating temperature more than auto-ignition temperature will be protected by providing a fire safe remote operated valve on the suction line near the vessel.

12.12 Emergency trips if specified for HT motor will be wired directly to switch gear in addition to control room.

12.13 Fire alarm system shall be provided at strategic location with Pill boxes for fire MCP and field telephones. Indication of MCP location is to be provided at process control room and repeat indication at Fire Control Room

12.14 For lines other than process , the battery limit isolation philosophy to be as per reviewed with client and finalized.



12.15 All the valves are to be provided at approachable height with suitable platforms ensuring accessibility, safety and ease of operation.

12.16 Double isolation valves shall be provided on all vents and drains for high-pressure service (Piping class 900# and above) with end blind. **For OHCU follow licensor CLG's guidelines.**



13.0 PROCESS FLOW DIAGRAMS & PIPING & INSTRUMENTATION DIAGRAMS

13.1 The following standard legend P&IDs shall be adhered to across all process facilities:

(1) Standard Abbreviations and Symbols:

Drawing # P0001-00-0000-1101

Drawing # P0001-00-0000-1102

Drawing # P0001-00-0000-1106

13.2 Instrument requirements for P&IDs:

All designers are required to adhere to the following requirements in Piping & Instrumentation Diagrams:

- Control valve / Shut-down valve failure position & TSO shall be indicated
- Control valve sizes shall be indicated
- Pressure relief valve set points shall be indicated
- Pressure relief valve sizes with orifice designations shall be indicated
- Each interlock shall be serially numbered and cause & effect shall be furnished in each P&ID as notes or in separate P&ID.
- Minimum Flow stops, handwheels for control valves, as required shall be shown.
- Advanced or complex control loops shall be explained, mathematically if necessary
- Solenoid valves and limit switches shall be shown where stipulated
- Coupons and corrosion probes wherever required shall be shown
- Interface type level instruments shall be clearly identified in the P&ID.
- Pressure and temperature elements shall be shown for flow measurement (except mass flow meters) with pressure and temperature compensation, where stipulated.
- Block & Bypass valves shall be provided for Mass Flow meters, Integral Orifices, Positive Displacement meters and Rotameters & Magnetic Flow meter.
- In case of Special instrument like Magnetic Flow meter, Mass flow meter, Ultrasonic, Vortex flow meter, Ultrasonic LI, Process Radar for level etc. the same shall be represented in the P&ID.
- Start-up bypass & Process override for interlocks wherever required shall be specified in the P&IDs with notes.
- Location of auto/manual, start/stop, ESD switches and motor running indication shall be shown in P&ID.
- LEL/H2S/HC detector location is to be indicated in the P&ID.
- Split Range control valve shall be indicated in the P&ID.
- Split Range control valve shall be indicated in the P&ID.
- Double valving to be specified when design pressure is higher than 80 bar g.
- For critical service, 2 of 3 voting system to be considered for interlocks.

13.3 Preferred drawing size and media:

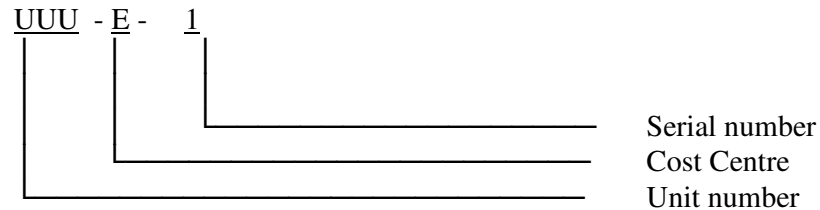
All P&IDs and PCDs shall preferably be drawn in drawing size ISO A1. The CAD software used shall be AUTOCAD Version 14.

Sizes/Dimensions as per ISO are as below:

Size	Dimension
A0	1165mm X 817mm
A1	817mm X 570 mm
A2	570mm X 390 mm
A3	396mm X 273 mm
A4	285mm X 198mm

14.0 NUMBERING SYSTEM**14.1 Equipment Numbering system:**

14.1.1 Equipment numbering shall be completely as per CPCL Requirement. The numbering system is:



14.1.2 The unit numbers have been defined in section 2.5. The Cost centres serving as equipment designations, are summarized in Table 14.1, covering the requirement of basic engineering. The serial number will be as follows:

a) Revamp Unit

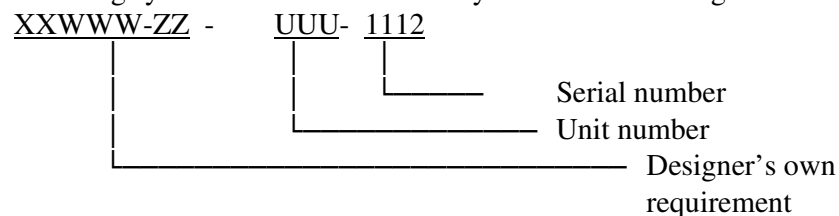
- *New service of equipment:* Equipment designations as in existing unit. The tag no. to start from 200 series. Equipment shall be shown with bold line
- *Replaced equipment* (service as existing): retain same no. with 100 added to it; however, if this tag no., in 100 series already exists, tag numbering philosophy similar to that for new equipment to be followed. Similarly, for equipments in 100 series getting replaced, the revised tag no. to be in 100 series but with last two digits starting after last equipment no. Equipment will be shown with bold line.
- *Modified equipment:* Retain no. as existing – to be shown same as replaced equipment.

b) New Units

- The serial number will be started from 1 onwards unless otherwise stated.

14.2 PFD/ P&ID's numbering system:

14.2.1 Specific to the numbering of Process Flow Diagrams and Piping & Instrumentation Diagrams, the following system shall be adhered to by all licensors / designers:



14.2.2 This numbering essentially ensures that the first part of the drawing number takes care of a licensor's or designer's own company numbering requirements while the second part of the number ensures a uniform philosophy for all PFD / P&ID serial numbers which will then be utilized for numbering instruments and lines as per 14.3 and 14.4 below.

14.2.3 In the four-digit drawing serial number, the digits shall be used as follows:

a) Revamp Unit:

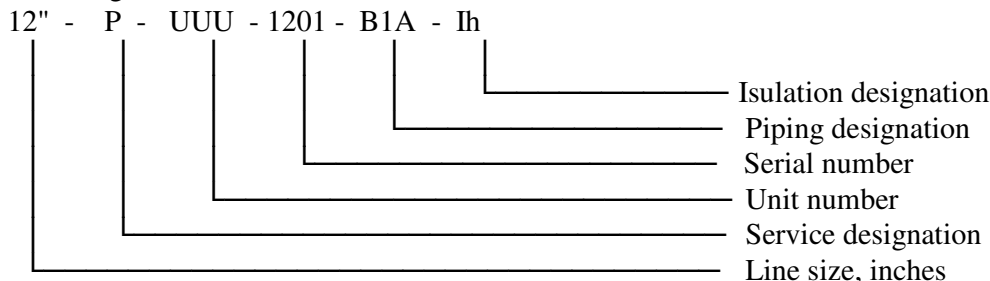
- For Construction / Destruction - Existing P&ID: same no. as existing
- For construction – New P&ID: serially numbered after the existing last P&ID.

b) New Units

- *First digit:* '0' for PFDs and '1' for P&IDs, '2' for PCDs, '3' for MFDs, '4' for CFDs.
- *Second digit:* '0' for iso size A0, '1' for iso size A1, so forth.
- *Last 2 digits:* Serial number starting from '01' for PFDs, MFDs
-

14.3 Line numbering:

14.3.1 Line numbering shall be as outlined below:



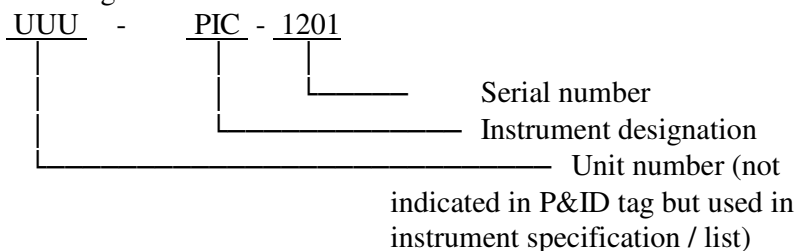
14.3.2 Service designation and insulation designation are listed in legend drawings .

14.3.3 In the four-digit line serial number, the digits shall be used as follows:

- First 2 digits:* Same as last 2 digits of P&ID serial number.'
- Last 2 digits:* Serial number starting from '01'.

14.4 Instrument numbering:

14.4.1 Instrument numbering shall be as outlined below:



14.4.2 Instrument depiction shall be as per ISA. The relevant table for the alphabetic depiction of instrument type is included in legend drawings.

14.4.3 In the four-digit instrument serial number, the digits shall be used as follows:

First 2 digits: Same as last 2 digits of P&ID serial number.
Last 2 digits: Serial number starting from '01'.

14.5 Document numbering system:

14.5.1 With the exception of the above documents, licensor / designer shall follow their respective company procedures for document numbering.

Legend: (applicable only for revamp of existing units)

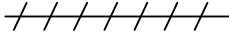
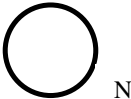
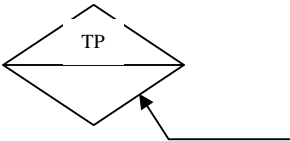
	Existing facilities
	New/ replaced / modified facilities
	Existing facility to be dismantled
	Existing instrument replaced new. Existing tag no. retained with suffix N added for the same.
	Tie-in point identification TP – Tie-in Point
xxxx four digit serial no. First two digit – last two digit of P&ID no. Last two digit – starts with serial no. '01'	

Table-14.1: Equipment designation*

Cost Centre	Description	Cost Centre	Description
RES	RCC Tanks	F	Fired boiler
C	Columns, general	X	Flare stack
C	Columns w/ uncoded internals	*	Waste heat boiler
CTR	Trays, general	*	Undefined package equipment
CW	Demister for columns	M	Scraper launcher
CPK	Packed internals for columns	M	Scraper receiver
E	Air cooled heat exchangers	TG	Turbo generator
EMF	Fans, Air cooled heat exchangers	G	Pump, Centrifugal
E	Shell & tube heat exch (S&T Hx)	G	Pump, Diaphragm
E	S&T Hx, AES, Floating head	G	Pump, Gear
E	S&T Hx, BEM, Fixed tubesheet	G	Pump, Centrifugal jacketed
E	S&T Hx, BEU	G	Pump, Metering

Cost Centre	Description	Cost Centre	Description
E	S&T Hx, AKT, Kettle	G	Pump, Reciprocating
E	S&T Hx, AEL, Fixed tubesheet	G	Pump, Centrifugal submerged
E	Double pipe	G	Pump, Vertical turbine
E	Plate heat exchanger	MG	Pump drive, Electric motor
F	Fired furnace, general	*	Pump drive, Steam turbine
F	Direct fired heater	*	Power recovery turbine
APH	Air preheater	R	Reactor
M	Incinerator	M	R/R mechanical mixer
M	Cyclones	*	R/R trays
T	Filter, general	*	R/R packed internals
H	Vacuum system	M	Storage bins
M	Evaporator, general	M	Storage hoppers
M	Static Mixer, general	M	Storage silos
M	Expansion joint, general	M	Storage tank mechanical mixers
M	Air mixer	*	Storage spheres
K	Compressor, Reciprocating	D	Storage tanks, general
K	Compressor, Centrifugal	D	Storage tanks, floating roof
K	Compressor, Screw	D	Storage tanks, cone roof
K	Compressor, Liquid Ring	C	Vessels, general
K	Compressor, Rotary	C	Vessels, horizontal w/ internals
K	Compressor, Twin lobe	C	Vessels, horizontal, no internals
K	Compressor, Diaphragm	C	Vessels, vertical, w/ internals
MK	Compressor Drive, Electric motor	C	Vessels, vertical, no internals
ST	Compressor Drive, Steam turbine	M	Mechanical mixer for vessels
AC	Air conditioning plant	CW	Demister for vessels
CH	Refrigeration plant	*	Packing for vessels
DM	DM water plant	M	Piping item, steam traps
*	Condensate polishing unit	M	Piping item, air traps
X	Chlorinator	M	Piping item, in-line strainers
*	Effluent treatment plant	M	Piping item, expansion joint
X	Inert gas generator	M	Piping item, valves
X	Air drier	*	Electrical, miscellaneous
CT	Cooling Tower	M	Silencer
X	Desuperheater	CE	Convection Section Exchanger

*

1) Unit numbering system- Unit No is given in table-2.5

2) Equipment numbering- The replaced equipment will have number in 100 series i.e 221-C-11 if replaced will have tag no of 221-C-111. Modified equipment will have number With suffix (N) i.e 221-G-1A/B if modified will have tag no of 221-G-1(N)A/B. For New units the tag no will start from 1 onwards.

15.0 STANDARDS & CODES

15.1. Boiler

- IBR 1950, (11TH Edition - 2010)

15.2. Pumps

- Centrifugal Pumps: API Std 610, 10th Edition, October 2004
- Reciprocating Pumps : API Std 674, 2nd Edition, June 1995
- Positive Displacement Pumps : API Std 675, 2nd Edition, October 1994

15.3. Fired Heaters

- API Std 560, 4th Edition August 2007
- Burners : API Publication 535, 2nd Edition, January 2006,
- OISD standard 111, Amended 1st edition, August 1999

15.4. Shell and Tube Heat Exchangers

- TEMA, 9th Edition, 2007
- API Std 660, 8th Edition, August 2007

15.5. Air-cooled Exchangers

- API Std 661, 6th Edition, February 2006

15.6. Pressure Relief Valves

- API RP 520 part I, 8th edition, January 2008
- API RP 520 Part II. 5th Edition, August 2003
- API Std 521 5th Edition, January 2007
- API Std 2000, 5th Edition, April 1998
- ASME Section VIII Division-I
- OISD Standard 106, Amended 1st edition, August 1999

15.7. Compressors

- Centrifugal Compressor : API Std 617, 7th Edition, July 2002
- Reciprocating Compressor : API Std 618 : 5th Edition, December 2007

EXHIBIT-IFormat for aqueous effluent data

Source / Originating Point	
Flow Rate (Average/Peak) M3/hr	
Frequency of flow	Continuous / Intermittent
Duration if Intermittent	hours / day
Temperature	°C
Colour/Odour	
Pressure	Kg/cm2a
Sp. Gravity	
Viscosity	CP,
Vapor Pressure	Kg/cm2(g)
pH	
BOD, 20°C	mg/lit
COD	mg/lit
Suspended Solids	mg/lit
Sp. Gravity of solids	
Particle size	Microns
Total Dissolved solid	mg/lit
Volatile matter	mg/lit.
Total Oil content	mg/lit
Sp. gr. of Oil	
Viscosity of oil	cP
Pour Point of oil	°C
Phosphates	mg/lit
Sulfateses	mg/lit
Chlorides	mg/lit
Fluorides	mg/lit
Nitrateses	mg/lit
Total Nitrogen	mg/lit
Free/Fixed Ammonia	mg/lit
Cyanides	mg/lit
Sodiumates	mg/lit
Calcium	mg/lit
Magnesiums	mg/lit
Phenolic Compounds	mg/lit
Heavy Metals	mg/lit
Chromium	mg/lit.
Nickel	mg/lit.
Lead	mg/lit.
Zinc	mg/lit.
Mercury	mg/lit.
Any other	mg/lit
Emulsified oil	
Chemical Composition	% wt.

EXHIBIT-IFormat for gaseous effluent data

Source/Originating Point	:	
Type of Emission (Fugitive/Stack)	:	
Flow rate	:	m3/hr
Type of Flow (Cont./Intermit)	:	
Frequency and Duration If Intermittent	:	
Height of Stack/Source	:	m
Diameter of Stack (TIP)	:	m
Temperature of Gases	:	°C
Pressure of Gases	:	Kg/cm2a
Mol. Weight of Gases	:	
Density of Gases	:	Kg/m3
Viscosity of Gases	:	CP
Exit Velocity of Gases	:	m/sec
Composition of Gases (WT%)	:	
Hydrocarbons (HC)	:	
CO (Carbon monoxide)	:	
CO ₂ (Carbon Dioxide)	:	
SO ₂ (Sulphur Dioxide)	:	
N ₂ S (Nitrogen sulphide)	:	
SO ₃ (Sulphur oxide)	:	
NOx (Oxides of Nitrogen)	:	
N ₂ (Nitrogen)	:	
O ₂ (Oxygen)	:	
H ₂ O (Water vapors)	:	
Any other component (Chemical Composition)	:	
Suspended particulates matter (SPM)	:	
Type of Particulate Matter	:	
Density & Bulk Density	:	Kg/m ³
Dust Load	:	g/m3
Nature of Dust	:	
Amorphous	:	
Crystalline	:	
Needle shaped	:	
Fibrous	:	
Metallic	:	
Particle Size Distribution (wt%)	:	
Upto 5 microns	:	
5-20 microns	:	
20-40 microns	:	
40-80 microns	:	
Above 80 microns	:	

EXHIBIT-I**Format for solid effluent data**

Source/Originating Point	:	
Quantity of Solid Waste	:	Kg/day
Continuous/Periodical	:	
Frequency & Duration, if periodical	:	
Temperature	:	
Density	:	
Physical Condition (Slurry/Sludge/ Powder/Lumps)	:	
Viscosity, If slurry/sludge	:	
Nature of Waste (Hazardous/Toxic/ Explosive/Corrosive/Abrasive/Radioactive)	:	
Calorific Value	:	Kcal/kg
Chemical Composition	:	Wt%
Volatile Matter	:	Wt%
Moisture Content	:	Wt%
Recycling of Waste Required	:	Yes/No
Recovery of Valuable component	:	Yes/No
Schemes of Reuse/Recycle	:	
Sale value of Waste	:	Rs./Ton
Availability of Land for Disposal	:	Yes/No
Leachate Characteristics (If Slurry)	:	

ANNEXURE-8

ELECTRICAL DESIGN BASIS

SPECIFICATION NO: 44NC-4600-0000/E.02/0001/A4

TITLE: ENGINEERING DESIGN BASIS - ELECTRICAL

PROJECT REFERENCE:

- **Project No:** 44NC-4600
- **Project Location:** Manali, Chennai
- **Project Title:** RESID UPGRADATION PROJECT
- **Client:** Chennai Petroleum Corporation Limited
- **Project Manager Authorization:** R.P.GAIKWAD **Date:** 21.08. 13
- **Client Authorization:** **Date:**

				APPROVALS		
Rev. No.	Issue Date	Pages	Revision Description	By	Check	Approve
F	21.08.2013	43	Issued for Engineering	DS	PPP	MSJ
E	12.07.2010	43	Issued for Engineering	ASR	PPP	RBD
D	04.06.2010	43	Issued for Engineering	ASR	PPP	RBD
C	01.05.2010	44	Client's comments incorporated & Issued for Engineering	ASR	PPP	RBD
B	27.04.2010	44	Client's comments incorporated & Issued for Engineering	PPP	VDV	RBD
A	04.03.2010	49	Issued for comments	PPP	VDV	RBD
☒ Entire Specification Issued this Revision ☐ Revised Pages Only Issued this Revision			SPECIFICATION ISSUED FOR: ☐ In-house Review ☐ Purchase ☐ Client Approval ☐ Construction ☐ Enquiry ☒ Engineering			

CONTENTS LIST

LIST OF ENCLOSURES	NO. OF SHEETS	ENCLOSED (YES / NO)
GENERAL INFORMATION	7	YES
110 KV SWITCHYARD	2	YES
EMERGENCY DG SET	1	YES
HT SWITCHGEAR	2	YES
TRANSFORMERS	1	YES
BUS DUCT	1	YES
POWER CONTROL CENTRE	3	YES
MOTOR CONTROL CENTRE	3	YES
VARIABLE FREQUENCY DRIVE	1	YES
H.V. MOTORS	2	YES
L.V. MOTORS	2	YES
CABLES & ACCESSORIES	2	YES
DISTRIBUTION BOARDS (LDB, ASB, LP & PP)	2	YES
LOCAL CONTROL STATIONS	1	YES
LIGHT FITTINGS	2	YES
UPS	2	YES
BATTERY & BATTERY CHARGER	1	YES
EARTHING	2	YES
ELECTRICAL INSTALLATION	1	YES
TELEPHONE SYSTEM	1	YES
PLANT COMMUNICATION SYSTEM	1	YES
HMI SYSTEM	1	YES

1. This document shall be read in conjunction with Engineering Design Guidelines (44NC-4600-0000/E.02/0002/A4).
2. This comprehensive design basis shall be referred by respective LSTK contractors for applicable / relevant equipment in their scope of package.
3. “**” indicates data to be furnished during detail engineering / Later.

A	GENERAL INFORMATION	
1.0	SITE CONDITIONS	
1.1	ALTITUDE: Above MSL	3.5 M
1.2	AMBIENT TEMP.	
1.2.1	MAXIMUM:	45 °C
1.2.2	MINIMUM:	18 °C
1.3	RECOMMENDED DESIGN TEMP. FOR ELECTRICAL EQUIPMENT'S (IS 9676)	45 °C
1.4	SOIL RESISTIVITY	LATER
1.5	SEISMIC ZONE (IS-1893 Part-1)	Zone –III
1.6	RELATIVE HUMIDITY	80 % at t _{max}
1.7	SITE ENVIRONMENT	Corrosive
2.0	ELECTRICAL DETAILS OF EXISTING GRID INCOMING SUPPLY	
2.1	NAME OF SOURCE SUBSTATION	New Power Plant (SS No. from CPCL)
2.2	NUMBER OF FEEDERS	Two
2.3	VOLTAGE & FREQUENCY AT POINT OF SUPPLY	6.6 kV, 50 Hz, TP
2.4	FLUCTUATION AT POINT OF SUPPLY	
2.4.1	VOLTAGE	± 10 %
2.4.2	FREQUENCY	± 3 %
2.5	FAULT LEVEL (SYMM) AT RECEIVING END.	Design Fault level – 40 kA for 1 sec.
2.5.1	MINIMUM (ACTUAL)	*
2.5.2	MAXIMUM (ACTUAL)	*
2.6	NEUTRAL EARTHING	Resistive grounding
2.7	EARTH FAULT CURRENT LIMITED TO	200 A
2.8	MINIMUM LOAD POWER FACTOR STIPULATED BY SUPPLY AUTHORITY	0.9
2.9	PARALLEL OPERATION OF INCOMERS	Momentary paralleling during change over only.

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2. This comprehensive design basis shall be referred by respective LSTK contractors for applicable / relevant equipment in their scope of package.
3. “*” indicates data to be furnished during detail engineering / Later.

A	GENERAL INFORMATION	
3.0	DETAILS OF ELECTRICAL DISTRIBUTION SYSTEM:	
3.1	PRIMARY DISTRIBUTION VOLTAGE LEVEL:	
3.1.1	VOLTAGE	6.6 kV, TP
3.1.2	FREQUENCY	50 Hz
3.1.3	PRIMARY DISTRIBUTION SYSTEM NEUTRAL EARTHING	Resistance Grounded
3.1.4	PARALLEL OPERATION OF INCOMERS	Refer 2.9 above.
3.2	INTERMEDIATE DISTRIBUTION VOLTAGE LEVEL	
3.2.1	VOLTAGE	6.6 kV
3.2.2	INTERMEDIATE DISTRIBUTION SYSTEM NEUTRAL EARTHING	Resistance Grounded
3.2.3	PARALLEL OPERATION OF INCOMERS	Refer 2.9 above.
3.3	L.T DISTRIBUTION VOLTAGE LEVEL	
3.3.1	VOLTAGE	415 V AC, TPN.
3.3.2	NEUTRAL EARTHING	Solidly Earthed
3.3.3	PARALLEL OPERATION OF INCOMERS	Momentary paralleling during change over only.
3.4	VOLTAGE AND FREQUENCY VARIATION	
3.4.1	A.C SYSTEM	
	a) VOLTAGE	± 10%
	b) FREQUENCY	± 3 %
3.4.2	D.C SYSTEM VOLTAGE	
	a) ELECTRICAL CONTROL, CRITICAL LIGHTING ETC.	110 V DC / 125 V for Critical Drives in GT-V
	b) CRITICAL DRIVES	As per Licensor's package requirement.
	c) INSTRUMENTATION.	Refer Instrumentation Design Basis.
	d) VARIATION (AT SYSTEM OUTPUT TERMINALS)	± 5%
3.5	VOLTAGE DROPS	
3.5.1	BUSDUCT TRANSFORMER SECONDARY & SWITCHGEAR	0.5 %

1. This document shall be read in conjunction with Engineering Design Guidelines (44NC-4600-0000/E.02/0002/A4).
2. This comprehensive design basis shall be referred by respective LSTK contractors for applicable / relevant equipment in their scope of package.
3. “*” indicates data to be furnished during detail engineering / Later.

A	GENERAL INFORMATION	
3.5.2	CABLE BETWEEN PMCC & MCC OR BETWEEN PMCC AND ASB - MCC OR ASB LOCATED NEAR PMCC - MCC OR ASB LOCATED REMOTE FROM PMCC	0.5 % 3 %
3.5.3	CABLE BETWEEN MCC & MOTOR - MCC LOCATED NEAR PMCC - MCC LOCATED REMOTE FROM PMCC	4.5 % 2 %
3.5.4	MAX. VOLTAGE DROP UPTO LV MOTOR TERMINAL DURING RUNNING DURING STARTING	5 % 15 %
3.5.5	MAX. VOLTAGE DROP UPTO HV MOTOR TERMINAL - DURING RUNNING - DURING STARTING	3 % 10 %
3.5.6	CABLE BETWEEN AUXILIARY SWITCHBOARDS AND POWER & LIGHTING DISTRIBUTION BOARD AND LIGHTING PANELS	2 %
3.5.7	CIRCUIT BETWEEN LIGHTING PANELS AND LIGHTING POINT FIXTURES	3 %
3.5.8	DC SUPPLY CIRCUITS / UPS CIRCUITS	5 % (For DC system) & 3% (For UPS circuits)
		Minimum Voltage available across any instrument in the field shall be as per instrumentation design basis. Distribution system for instrumentation supplies shall be designed accordingly. In case of any conflict between Electrical Design Basis and instrumentation design basis, the later shall govern regarding instrumentation power supply requirements.
4.0	VOLTAGE FOR LIGHTING DISTRIBUTION	(Through 0.415 kV / 0.433 kV Auxiliary Transformer for utility power & Lighting Circuits.).
4.1	NORMAL LIGHTING	
	a) VOLTAGE	240 V A.C. SPN
	b) FREQUENCY	50 Hz
	c) SOURCE	From LDB in Unit S/S.

- This document shall be read in conjunction with Engineering Design Guidelines (44NC-4600-0000/E.02/0002/A4).
- This comprehensive design basis shall be referred by respective LSTK contractors for applicable / relevant equipment in their scope of package.
- “*” indicates data to be furnished during detail engineering / Later.

A	GENERAL INFORMATION	
4.2	EMERGENCY LIGHTING	20 – 25 % of Normal Lighting
	a) VOLTAGE	240 V A.C. SPN
	b) FREQUENCY	50 Hz
	c) SOURCE	EPCC (Emergency power from DG set for respective Unit).
4.3	CRITICAL LIGHTING	
	a) VOLTAGE	110 V DC
	b) SOURCE	Battery Charger
	c) LOCATIONS	Escape Routes, Substations, Control rooms, Plant Area
4.4	LIGHTING TRANSFORMER TO BE PROVIDED	Yes (Common Δ / Y 415 V / 433 V Auxiliary transformer with star side solidly earthed through separate dedicated earth pit)
5.0	CONTROL SUPPLY FOR ELECTRICAL SYSTEM	
5.1	HIGH TENSION CIRCUIT BREAKERS	110 V DC
	a) SPRING CHARGING MOTORS	110 V DC
	b) CLOSING CIRCUITS	110 V DC
	c) TRIP CIRCUITS	110 V DC
	d) ALARM	110 V DC
	e) INDICATION	110 V DC
	f) RELAY AUXILIARY CIRCUIT	110 V DC
	g) HEATERS IN PANELS	240 V AC
	h) CONTROL CIRCUIT	110 V DC
	i) INCOMING SUPPLY HEALTHY	110 V AC (PT Sec.)
5.2	LOW TENSION CIRCUIT BREAKERS	110 V DC
	a) SPRING CHARGING MOTORS	110 V DC
	b) CLOSING CIRCUITS	110 V DC
	c) TRIP CIRCUITS	110 V DC
	d) ALARM	110 V DC
	e) INDICATION	110 V DC

1. This document shall be read in conjunction with Engineering Design Guidelines (44NC-4600-0000/E.02/0002/A4).
2. This comprehensive design basis shall be referred by respective LSTK contractors for applicable / relevant equipment in their scope of package.
3. “*” indicates data to be furnished during detail engineering / Later.

A	GENERAL INFORMATION	
5.3	f) RELAY AUXILIARY CIRCUIT g) HEATERS IN PANELS h) CONTROL CIRCUIT i) INCOMING SUPPLY HEALTHY LOW TENSION MOTORS CONTROLLED BY CONTACTORS a) COIL CIRCUIT VOLTAGE b) INDICATIONS c) ALARM d) SPACE HEATER CIRCUIT	110 V DC 240 V AC 110 V DC 110 V AC (PT Sec.) (Control Transformer with centre tap earthed.) 240 V AC 240 V AC 240 V AC 240 V AC
6.0	POWER SUPPLY TO LOCAL CONTROL PANELS FOR PACKAGE UNITS	415 V A.C, 50 Hz, 3 Phase 240 V AC, 50 Hz, 1 Phase - As Required
7.0	SOURCE OF SUPPLY FOR CRITICAL LOADS INCLUDING VFD	UPS: 110V AC
8.0	PAINTING FOR ELECTRICAL EQUIPMENT & STRUCTURES	
8.1	OUTDOOR EQUIPMENT	Epoxy based powder coated.
8.2	INDOOR EQUIPMENT	Epoxy based powder coated.
8.3	CABLE TRAY & STRUCTURAL STEEL	Epoxy based powder coated, Prefabricated, GI Ladder type / GI Perforated.
8.4	SHADES	RAL 7032 for SS Equipment. For ISBL Area Equipment – 632 as per IS:5.
9.0	GENERAL	
9.1	CORPORATE STANDARDS TO BE FOLLOWED	JACOBS Standard Specifications.
9.2	STANDARDS OTHER THAN 'IS' IF TO BE FOLLOWED	BS, IEC, OISD, IEEE, as applicable.
9.3	TIE UP WITH EXISTING SYSTEM IF APPLICABLE	New power plant to be hooked up with existing power plant at 6.6 kV/ 110 kV.

1. This document shall be read in conjunction with Engineering Design Guidelines (44NC-4600-0000/E.02/0002/A4).
2. This comprehensive design basis shall be referred by respective LSTK contractors for applicable / relevant equipment in their scope of package.
3. “*” indicates data to be furnished during detail engineering / Later.

A	GENERAL INFORMATION	
10.0	TYPE OF ELECTRICAL EQUIPMENT TO BE USED IN HAZARDOUS AREAS a) ZONE 0 b) ZONE 1 c) ZONE 2	No electrical equipment Ex'd' / Ex'p' Ex'n'
11.0	ACCURACY CLASS OF METERS a) REVENUE METERS b) kW METER c) AMMETER	CL. 0.5 CL. 0.5 CL. 1.0 Up to & including 160 kW – 415 V A.C, 50 Hz, 3 Phase, 3 wires
12.0	MOTORS	Above 160 kW – 6.6 kV A.C, 50 Hz, 3 Phase, 3 wire
13.0	INTERFACES PROCESS UNIT CONTROL ROOM ALARM SIGNALS	HMI Interface : Max. HMI Interface through soft link. Communication protocol – IEC 61850 / Modbus. Refer I/O list (Annexure – 1) for detailed signal (monitoring / control) communication requirement. - Normal supply failure - Feeder Trip, Motor Trip, Transformer Wdg. & / or Oil Temp. Alarm / Trip. - Load shedding operated. - VFD Trouble and critical VFD Alarms. - UPS trouble and critical UPS Alarms. - Battery charger fail / boost charging / critical battery charger Alarms.

- This document shall be read in conjunction with Engineering Design Guidelines (44NC-4600-0000/E.02/0002/A4).
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A	GENERAL INFORMATION	
	MARSHALLING CABINET LOCATION OF CURRENT TRANSDUCERS FOR 4 – 20 mA MOTOR CURRENT FEEDBACK REQUIRED IN DCS	DCS Interface : As per process requirement. Generally following interface is envisaged: • HT / LT Motors : Run / Stop / Trip indication • HT Motors : Current Status, Motor Ready to Start from DCS, Stop Command • VSD : Reference signal from DCS, Speed / Current signal from VFD to DCS. • Auto Start as per process requirement In each bus section / shipping section of switchboard for DCS & HMI interface. DCS

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	MOTOR CONTROL CENTRE	
1.0	TYPE	Double Front
2.0	EXECUTION	Draw out / Fixed
3.0	BUSBARS	415 V, 50 Hz, TPN, 50 kA for 1 sec.
3.1	MATERIAL	Aluminum / Copper
3.2	PVC SLEEVING.	Required / Not Required
3.3	BUS BAR SUPPORT	SMC / DMC
4.0	MASTER TERMINAL BOX FOR EACH SHIPPING SECTION FOR INTERCONNECTION TO DCS	Required / Not Required
5.0	LOCATION OF MAIN BUS BARS	Top / Bottom
6.0	TYPE OF MOTOR STARTER	
	a) DOL STARTER	All motor feeders
	b) STAR / DELTA STARTER	Not applicable
	c) ANY OTHER TYPE	VFD controlled as per process requirement.
7.0	MAXIMUM NO. OF FEEDERS PER VERTICAL SECTION	6 nos.
8.0	TYPE OF ASSISTED STARTERS FOR MOTORS	To be specified on case to case basis.
9.0	INCOMING FEEDERS.	
9.1	CIRCUIT BREAKER / SWITCH / SWITCH DISCONNECTOR FUSE	Load Break Switch without fuse for MCCs located near PCC feeding to the same MCC. ACB for MCCs located away (in different SS) from PCC feeding to the same MCC. (Max. rating of MCC to be limited to 1250 A).
9.2	METERS (AMMETER, VOLTMETER, KWH, PF).	A, V, kW, kWH (Part of multifunction meter)
9.3	AMMETERS, SIZE	Minimum 96 X 96 Sq. mm for I/C (Applicable for Analogue Instruments only)
9.4	PROTECTION	Not required for MCCs located nearer to PCC.

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	MOTOR CONTROL CENTRE	
10.0	OUTGOING FEEDERS	
10.1	MOTOR FEEDERS	
10.1.1	CONTROL DEVICES ON COMPARTMENT DOOR	Stop Push Button, BMR RESET PB, (Local / remote & auto/manual switches if required, to be provided in LCS)
10.1.2	INDICATION ON COMPARTMENT DOOR	ON / OFF / TRIP
10.1.3	AMMETER ON MOTOR FEEDERS	Not required. Where ever current feedback (4-20mA) is required for DCS, transducer to be mounted in switchgear
10.1.4	NO. & AMMETER SIZE ON MOTOR FEEDERS	NA
10.1.5	CURRENT TRANSFORMER SECONDARY FOR METER & RELAYS	1 A
10.1.6	CONTROL SUPPLY	240 V A.C SPN to be derived from Control Transformer
10.1.7	SPARE FEEDERS	20% spare feeders of each module size (minimum one number for each module size) in each bus section of switchboard
10.1.8	PAD LOCKING FOR ISOLATOR IN OFF POSITION.	Required
10.2	CONTROL TRANSFORMER FEEDER	Required
10.2.1	a) COMMON CONTROL TRANSFORMER FOR ENTIRE MCC	No
	b) STAND BY CONTROL TRANSFORMER WITH CHANGE OVER SWITCH	No
	c) CONTROL TRANSFORMER FOR EACH MOTOR FEEDER	No
	d) SEPARATE CONTROL TRANSFORMER FOR EACH BUS SECTION WITH CHANGE OVER SWITCH	Yes
10.2.2	FOUR POLE SWITCH / AUX. SWITCH IN ALL MOTOR FEEDERS FOR ISOLATING CONTROL SUPPLY	Auxiliary switch with control fuses required.
11.0	ELCB / (CBCT with ELR) FOR EACH FEEDER (*)	For all loads rated 5kW and above shall be provided with CBCT with ELR.

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	MOTOR CONTROL CENTRE	
12.0	OTHER ACCESSORIES	
12.1	CONTROL SUPPLY BUS BARS	Wire-Bus / Solid Bus
12.2	SPACE HEATER SUPPLY BUS BARS.	Wire-Bus / Solid Bus
12.3	SPACE HEATER FOR MCC	Required / Not Required
13.0	ENCLOSURE	
	a) MATERIAL	CRCA Sheet Steel / Cast Iron
	b) PROTECTION CLASS	Minimum IP 5X.
14.0	CABLE ENTRY	Bottom

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	VARIABLE FREQUENCY DRIVE	
1.0	VOLTAGE RATING OF VFD	415V
2.0	RECTIFIER CONFIGURATION	MINIMUM 12 PULSE
3.0	LOCATION OF VFD	SEPARATE PANEL / WITHIN MCC ENCLOSURE
4.0	INPUT ISOLATION TRANSFORMER	REQUIRED
5.0	OUTPUT CHOKE	REQUIRED / NOT REQUIRED
6.0	PROTOCOL COMMUNICATION	REQUIRED – MODBUS
7.0	VFD BYPASS	REQUIRED
8.0	REQUIREMENTS FOR CONTROL & MONITORING ON	
8.1	VFD	IN VFDs VFD/DOL SELECTOR SWITCH SHALL BE PROVIDED ON THE VFD PANEL ITSELF.
8.2	LOP	LOP SHALL INCLUDE START AND STOP PB, LOCAL / REMOTE SELECTOR SWITCH, READY TO START INDICATION, SPEED RAISE / LOWER PB, DIGITAL AMMETER AND DIGITAL SPEED INDICATOR.
8.3	DCS / SCADA	- ON / OFF CONTROL FROM DCS AND RUNNING INDICATION TO DCS. - LOCAL/REMOTE SELECTOR SWITCH SHALL BE PROVIDED IN LOP.
9.0	PROVISION OF SEPARATE THERMISTOR RELAY	REQUIRED
10.0	CLIENT SPECIFIC REQUIREMENTS	- VFDs shall be considered only if recommended by Process Licensers and if process requirement demands VFD. 110 V AC UPS Supply shall be considered for VFD Control supply.

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	H. V. MOTORS			
1.0	RATED VOLTAGE	6.6. KV		
2.0	VOLTAGE AND FREQUENCY VARIATION	± 10 %V, ± 5 %Hz		
3.0	COMBINED VOLTAGE AND FREQUENCY VARIATION	± 10 %		
4.0	CLASS OF INSULATION & TEMP. RISE	Class ‘F’ with temp. rise limited to Class ‘B’.		
5.0	ENCLOSURE PROTECTION CLASS	IPW 55 (with canopy for outdoor application)		
6.0	TYPE OF ENCLOSURE	Ex’d’ / Ex’p’/ Ex’n’		
7.0	TYPE OF COOLING (TEFC / CACA / CACW / TETV)	TEFC / CACA Note : - TETV (For HT motors where TEFC / CACA type cooling is not available)		
8.0	TEMPERATURE DETECTORS FOR WINDING (RTD)	Simplex / Duplex – 4 Nos. for simplex / 2 Nos. for Duplex / winding. RTDs shall be provided for motors rated above 750 kW. Refer Instrumentation specification for further details.		
9.0	a) TEMPERATURE DETECTORS FOR BEARING	Simplex / Duplex – One each for DE and NDE bearing. RTDs shall be provided for motors rated above 750 kW. Refer Instrumentation specification for further details.		
	b) DIAL TYPE LOCAL TEMP. INDICATOR FOR BEARINGS.	Required.		
10.0	FAULT WITHSTAND CAPACITY FOR MAIN TERMINAL BOX	40kA for 0.2 Sec.		
11.0	NEUTRAL TERMINAL BOX	Required / Not Required (PSTB)		
12.0	TYPE OF CABLE TERMINATION AT MOTOR END	Heat Shrinkable.		
13.0	NO. OF COLD /HOT STARTS	< 500 kW	500 kW – 1000 kW	>1000kW
	Cold Start	3	3	2
	Hot Start	2	2	1



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	H. V. MOTORS	
14.0	NO. OF COLD STARTS PER HOUR	2 Nos. (min) / hour, equally spaced
15.0	NO. OF HOT STARTS PER HOUR	1 Nos. (min) / hour, equally spaced
16.0	SPECIAL WINDING TREATMENT	Suitable for corrosive atmosphere with Epoxy Gel treatment on winding overhang.
17.0	SEPARATE TERMINAL BOX FOR a) SPACE HEATER b) RTDs	Required / Not Required Required for motors above 750 kW / Not Required
18.0	AUXILIARY NAME PLATE	Required (SS)
19.0	ADDITIONAL CANOPY	Required / Not Required
20.0	STARTING CURRENT LIMIT	Refer Cl.6.5.9 & 6.5.10 from Doc. 44NC-4600-0000/E.02/0002/A4.
21.0	COLOUR SHADE	632 as per IS 5
	(***) – To be decided during detail engineering based on voltage profile.	

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	CABLES & ACCESSORIES	
1.0	HIGH VOLTAGE	
1.1	VOLTAGE GRADE	6.6 kV UE.
1.2	EARTHED / UNEARTHED SYSTEM	6.6KV Low Resistance Earthed.
1.3	ARMoured / UNARMoured	Armoured (with armour designed based on short circuit withstand capacity)
1.4	CONDUCTOR MATERIAL	Aluminum / Copper
1.5	CONDUCTOR SCREENING	Semi conducting compound.
1.6	TYPE OF OUTER SHEATHING	Flame Retardant Low Smoke (FRLS) PVC
1.7	FAULT LEVEL WITHSTAND TIME	
	a) PLANT FEEDER	1 / 0.6 sec. (As Applicable)
	b) INCOMER FEEDER	0.6 / 1 sec. (As Applicable)
	c) FEEDER WITH INST. TRIPPING DEVICE.	0.25 sec. 0.19 sec. for motors
1.8	INSULATING MATERIAL	XLPE
1.9	INSULATION SCREENING	With semi conducting compound and with non-magnetic material (Cu. tape) for multi core cables.
1.10	TYPE OF CABLE TERMINATION (HEAT SHRINKING / PUSH ON / BITUMEN COMPOUND)	Heat shrinkable.
1.11	ANY SPECIAL REQUIREMENT	-
1.12	TYPE & MATERIAL OF CABLE LUGS	Heavy duty Crimping Type, Tinned Copper.
1.13	MAXIMUM / MINIMUM SIZE TO BE USED	300 mm ² for Multicore cable.
2.0	LOW VOLTAGE	
2.1	VOLTAGE GRADE.	1100 V
2.2	CONDUCTOR MATERIAL	Stranded Al/ Cu conductor. Copper up to 16 sq.mm. Aluminium / Copper for above 16 sq.mm. Copper conductor for UPS ACDB Outgoing feeders.
2.3	NO. OF CORES	3/3.5 / 4 Cores for power cables
2.4	ARMoured / UNARMoured	Armoured
2.5	INSULATING MATERIAL	PVC.
2.6	TYPE OF INNER SHEATH	Extruded, Flame Retardant Low Smoke (FRLS) PVC

F

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	CABLES & ACCESSORIES	
2.7	TYPE OF OUTER SHEATH	Extruded, Flame Retardant Low Smoke (FRLS) PVC
2.8	TYPE AND MATERIAL OF CABLE LUGS	Heavy duty Crimping Type, Tinned Copper.
2.9	TYPE OF CABLE GLANDS	
	a) MATERIAL	Nickel Plated Brass / SS
	b) INDOOR PANEL	Double compression type
	c) MOTORS IN FIELD	Double compression type
	d) PUSH BUTTON AND CONTROL PANELS IN FIELD	Double compression type
	e) EQUIPMENT IN ZONE - 2 AREAS	Ex (d)-Double compression type
	f) EQUIPMENT IN ZONE - 1 AREAS	Ex (d)-Double compression type
2.10	MAXIMUM/MINIMUM SIZE TO BE USED	Max. size of 300 mm ² cable.
2.11	CONTROL CABLES	2.5 mm ² stranded copper conductor, PVC insulated, FRLS cables. Twisted pair or shielded wherever electromagnetic / electrostatic interference is anticipated. Shielded cables for DCS interface.
2.11.1	SPARE CORES	20 %
2.12	TELEPHONE CABLES	Single/multi pair, PVC insulated, screened, Petroleum jelly filled, armoured, overall PVC sheathed, FRLS type.
	CONDUCTOR	0.9 mm dia. Copper conductor
	SPARE CORES	20 %
2.13	PLANT COMMUNICATION & FIRE ALARM CABLES	PVC insulated (Petroleum jelly filled for Plant Communication System), armoured, overall PVC sheathed, FRLS type.
	CONDUCTOR	1.5 mm ² Copper conductor
	SPARE CORES	20 %

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	LOCAL CONTROL STATIONS	
1.0	MATERIAL OF ENCLOSURE	Sheet steel / Cast iron / Cast Al. / FRP
2.0	PROTECTION CLASS OF ENCLOSURE	IPW 55
3.0	PROVISION OF AMMETERS FOR DRIVES	Required for all motors rated above 5.5 kW.
4.0	REQUIREMENT OF SEPARATE / INTEGRAL CANOPY	Integral / Non integral (FRP)
5.0	STOP PUSH BUTTON TYPE	Red, Mushroom Head, Stay-Put type, press to lock & turn to unlock
6.0	START PUSH BUTTON TYPE	Shrouded type (Green Colour)
7.0	PAD LOCKING REQUIREMENT	Required
8.0	A/M SELECTOR SWITCH	As per process requirement. Emergency push button for feed pump, MOVs, Fin Fan Coolers and any other drives as per Hazop and safety requirements.

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	UPS	
1.0	TYPE	IGBT
2.0	REDUNDANCY / TYPE OF REDUNDANCY	100 % / Parallel Redundant / Hot Standby
3.0	INPUT SUPPLY VOLTAGE	415 V, TPN, 50Hz
4.0	OUTPUT SUPPLY VOLTAGE	110 V SPN for Instrumentation loads, VFDs
	O/G FEEDERS	SFU with semiconductor type fuse
5.0	TYPE OF BATTERIES	Ni-Cd / Lead acid
6.0	BATTERY BACKUP TIME	For UPS battery back-up requirement of F&G system refer instrument tender document / Corrigendum. This clause shall be read for UPS battery back-up of F&G system in all relevant tender document of electrical
7.0	BATTERY EXECUTION	Common
8.0	STABILISER IN BYPASS LINE	Servo Controlled / Static
9.0	BYPASS TRANSFER CONTROL	Auto / Manual through Static Switch (Manual for maintenance Bypass). Auto transfer in case of DC & AC U/V or failure of both UPS modules.
10.0	VDU WITH PC/PRINTER ETC.	Required / Not Required
11.0	COMMUNICATION PORT	Required
12.0	SPARE CAPACITY	20 %

F

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	UPS	
13.0	SPECIAL REQUIREMENT	I/P isolation transformer required. Rating of largest branch circuit shall not exceed 25 % of the system rating. O/G cables to ACDB shall be copper cables Fault Diagnostic feature Current, Voltage signal, fault summary contact and ON-OFF status for HMI through serial link on Modbus Provision for online discharge of battery bank on load 20 % spare feeders to be provided in ACDB.

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	EARTHING	
1.0	EARTH PIT TYPE	Pipe / Plate Electrode
2.0	EARTHING MATERIAL	G.I (100 mm dia. minimum for Pipe Electrode/ 1200 x 1200 x 6.3 mm plate Electrode)
3.0	TYPE OF EARTHING CONDUCTOR FOR EQUIPMENT	
3.1	EARTHING MAIN GRID	G.I Strip
3.2	SWITCH YARD EQUIPMENT	
	a) TRANSFORMER NEUTRAL	G.I Strip
	b) EQUIPMENT	G.I Strip
	c) LIGHTNING ARRESTOR	G.I Strip
	d) STRUCTURE	G.I Strip
3.3	SUBSTATION EQUIPMENT	
	a) EQUIPMENT (PCC / MCC / HT SWGR. ETC.)	G.I Strip
	b) TRANSFORMER NEUTRAL	G.I Strip
3.4	PLANT EQUIPMENT	
	a) MOTORS & LCS	G.I. strip, Flexible G.I. wire rope or G.I. wires of appropriate sizes (double earthing for motors and LCS)
	MOTORS UPTO 3.7 KW	8 SWG solid wire
	MOTORS 5.5 KW TO 30 KW & WELDING RECEPTACLES	10 mm (3/8") wire rope
	MOTORS ABOVE 37 KW INCLUDING 37 KW INCLUDING HT MOTORS	16 mm (5/8") wire rope
	BUILDING COLUMNS	40 x 5 strip
	STORAGE TANKS (VERTICAL & HORIZONTAL)	40 x 5 strip
	LOADING RACKS	40 x 5 strip
	PIPE RACKS, VESSELS & HEAT EXCHANGERS	10 mm (3/8") wire rope
	SMALL EQUIPMENTS & INSTRUMENTS	8 SWG solid wire
	LIGHTING, POWER & INSTRUMENTATION PANELS	10 mm (3/8") wire rope

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	EARTHING	
	MAIN EARTH BUS/ LT & HT SWITCH GEAR INTERCONNECTIONS / POWER TRANSFORMER	As per calculation
	EHV & HV SUBSTATIONS	As per calculation
	PUSH BUTTON STATION	8 SWG solid wire
	STREET LIGHT POLES	10 mm (3/8") wire rope
	LIGHTING TRANSFORMERS	16 mm (5/8") wire rope
	b) STATIC EARTHING	G.I Strip
	c) LIGHTING FITTINGS	By 3 rd core of 3C x 2.5 YWY Lighting Cable.
4.0	LIGHTNING PROTECTION	
4.1	AIR TERMINAL MATERIAL	Copper
4.2	DOWN CONDUCTOR	G.I Strip
4.3	EARTH PIT	1 No. per down conductor

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	ELECTRICAL INSTALLATION	
1.0	MODE OF CABLE LAYING (TRENCH / BURIED / OVER HEAD TRAYS)	Cable Trays on Overhead Cable / Pipe Rack in ISBL. Cable Trench / Overhead tray on piperack / cable rack as applicable in OSBL area (SS to ISBL Area).
2.0	TYPE OF CABLE TRAY (PRE-FABRICATED / FABRICATED AT SITE WITH STRUCTURAL STEEL)	Pre -fabricated, Ladder type / Perforated
3.0	MATERIAL OF PRE-FABRICATED TRAYS	M.S., Epoxy painted/ G.I.
4.0	CABLE CLAMPING ARRANGEMENT (CLAMPS MADE OF STEEL / AL / NYLON ROPES)	Clamps made of Aluminum / Non Magnetic material
5.0	CABLE TAG (ALUMINIUM / S.S)	SS
6.0	CABLE MARKER FOR UNDERGROUND CABLE MATERIAL	Required Cast Iron at 30 m interval and at turnings.
7.0	SECURITY LIGHTING WITH STRUCTURAL TOWERS	Not Required
8.0	TYPE OF STREET LIGHT POLE REQUIRED	12 / 10 meters high swaged tubular as per IS 2713
	SOCKET OUTLETS - INDUSTRIAL / FLP TYPE	Industrial / Flameproof (for classified areas)
9.0	a) FOR WELDING (RATINGS & AREAS TO BE COVERED)	63 A, 415 V TPN + E
	b) FOR PORTABLE ELECTRICAL EQUIPMENT'S	20 A, 240 V, SPN + E
	c) FOR FANS & OTHER EQUIPMENT'S IN NON-PLANT AREAS	6 + 16 A, 240 V, SPN + E 20 A, 240 V, DP + E, Ex (d) type 20 A, 240 V, DP + E, Ex (e) type
	d) FOR HAZARDOUS AREAS	6+16 A, 24 V DP + E, Ex (d) type for manholes (As Applicable)

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SPECIFICATION NO: 44NC-4600-0000/E.02/0001/A4**TITLE:** ANNEXURE -1 TO
ENGINEERING DESIGN BASIS - ELECTRICAL
HMI I/O LIST**PROJECT REFERENCE:**

- **Project No:** 44NC- 4600
- **Project Location:** Manali, Chennai
- **Project Title:** RESID UPGRADATION PROJECT
- **Client:** Chennai Petroleum Corporation Limited
- **Project Manager Authorization:** R.P.GAIKWAD **Date:** 12.07.2010
- **Client Authorization:** **Date:**

				APPROVALS		
Rev. No.	Issue Date	Pages	Revision Description	By	Check	Approve
E	12.07.2010	6	Issued for Engineering	ASR	PPP	RBD
D	04.06.2010	7	Issued for Engineering	ASR	PPP	RBD
C	01.05.2010	7	Client's comments incorporated & Issued for comments	ASR	PPP	RBD
B	27.04.2010	7	Client's comments incorporated & Issued for comments	PPP	VDV	RBD
A	04.03.2010	7	Issued for comments	PPP	VDV	RBD
☒ Entire Specification Issued this Revision			SPECIFICATION ISSUED FOR:			
☐ Revised Pages Only Issued this Revision						
			☐ In-house Review	☐ Purchase		
			☐ Client Approval	☐ Construction		
			☐ Enquiry	☒ Engineering		

ANNEXURE I to DESIGN BASIS - ELECTRICAL HMI I/O LIST

FEEDERWISE I/O LIST

Sr. No.	Input Description	Input Type	Input Type	
			Hard	Soft
6.6 kV Incomer Feeder				
1	CB in Service & Closed	DI		✓
2	CB in Service & Open	DI		✓
3	Relay 86 operated & Reset	DI		✓
4	Relay 95 Operated & Reset	DI		✓
5	Relay 51Operated & Reset	DI		✓
6	Relay 51N Operated & Reset	DI		✓
7	Numerical Relay (51,51 N) Unhealthy	DI		✓
8	Relay 85 Operated & Reset	DI		✓
9	Numerical Relay (85) Unhealthy	DI		✓
10	Trip on under voltage activated	DI		✓
11	R Phase Current	AI		✓
12	Y Phase Current	AI		✓
13	B Phase Current	AI		✓
14	3-Phase Real Power	AI		✓
15	3-Phase Reactive Power	AI		✓
16	Frequency (Hz)	AI		✓
6.6 kV Bus Coupler Feeder				
1	CB in Service & Closed	DI		✓
2	CB in Service & Open	DI		✓
3	Relay 86 Operated	DI		✓
4	Relay 95 Operated	DI		✓
5	Relay 95A Operated	DI		✓
6	Relay 95B Operated	DI		✓
7	Relay 86A Operated	DI		✓
8	Relay 86B Operated	DI		✓
9	Relay 87A Operated	DI		✓
10	Relay 87B Operated	DI		✓
11	Numerical relay 51 operated	DI		✓
12	Numerical relay 51N operated	DI		✓
13	Numerical relay 87A operated	DI		✓
14	Numerical relay 87B operated	DI		✓
15	Numerical relay (51,51 N) Unhealthy	DI		✓
16	Numerical relay (87A) Unhealthy	DI		✓
17	Numerical relay (87B) Unhealthy	DI		✓
18	Trip on under voltage activated	DI		✓
6.6 KV 240V AC Supply Control				
1	AC Supply Incomer failed	DI		✓
6.6 KV 110V DC Supply Control				
1	DC Supply 1 failed	DI		✓
2	DC Supply 2 failed	DI		✓
6.6 KV Auto Transfer Scheme				
1	ATS selector switch in manual mode	DI		✓
2	ATS selector switch in independent mode	DI		✓
3	Auto Change over blocked	DI		✓
4	Synchro check relay healthy	DI		✓
5	Bus Coupler closed in manual mode	DI		✓
6	Momentary paralleling is in process and in manual mode	DI		✓

ANNEXURE I to DESIGN BASIS - ELECTRICAL HMI I/O LIST

FEEDERWISE I/O LIST

Sr. No.	Input Description	Input Type	Input Type	
			Hard	Soft
6.6 kV Bus PT				
1	Under Voltage operated	DI		✓
2	Load shedding scheme Stage-1 Operated	DI		✓
3	Load shedding scheme Stage-2 Operated	DI		✓
4	Load shedding scheme Stage-3 Operated	DI		✓
5	Load shedding scheme Stage-4 Operated	DI		✓
6	PT MCB Open	DI		✓
7	PT MCB Close	DI		✓
8	R-Y Bus Voltage	AI		✓
9	Y-B Bus Voltage	AI		✓
10	R-B Bus Voltage	AI		✓
6.6 kV Line PT				
1	Under Voltage operated	DI		✓
2	PT MCB Open	DI		✓
3	PT MCB Close	DI		✓
4	R-Y Bus Voltage	AI		✓
5	Y-B Bus Voltage	AI		✓
6	R-B Bus Voltage	AI		✓
6.6 kV X'mer Fdrs				
1	CB in service & Closed	DI		✓
2	CB in service & Open	DI		✓
3	Relay 86 Operated	DI		✓
4	Relay 95 Operated	DI		✓
5	Numerical Relay (50, 51) Unhealthy	DI		✓
6	Bucchloz Relay Alarm	DI		✓
7	Bucchloz Relay Trip	DI		✓
8	Winding Temperature Alarm	DI		✓
9	Winding Temperature Trip	DI		✓
10	Oil Temperature Alarm	DI		✓
11	Oil Temperature Trip	DI		✓
12	PRV Trip	DI		✓
13	MOG Alarm	DI		✓
14	Transformer emergency Trip operated & reset	DI		✓
15	Numerical Relay 50 Operated	DI		✓
16	Numerical Relay 51 Operated	DI		✓
17	R Phase Current	AI		✓
18	Y Phase Current	AI		✓
19	B Phase Current	AI		✓
20	3-Phase Real Power	AI		✓
21	3-Phase Reactive Power	AI		✓
22	Oil Temprature	AI		✓
23	Winding Temprature	AI		✓

ANNEXURE I to DESIGN BASIS - ELECTRICAL HMI I/O LIST

FEEDERWISE I/O LIST

Sr. No.	Input Description	Input Type	Input Type	
			Hard	Soft
6.6 kV Motor Fdrs				
1	CB in service & Closed	DI		✓
2	CB in service & Open	DI		✓
3	Relay 86 Operated	DI		✓
4	Relay 95 Operated	DI		✓
5	Numerical MPR Relay Unhealthy	DI		✓
6	Numerical MPR Relay Operated	DI		✓
7	Motor Trip from process	DI		✓
8	Trip on load shedding activated	DI		✓
9	Trip on under voltage activated	DI		✓
10	R Phase Current	AI		✓
11	Y Phase Current	AI		✓
12	B Phase Current	AI		✓
13	3-Phase Real Power	AI		✓
14	3-Phase Reactive Power	AI		✓
15	Hour Run meter	AI		✓
6.6 kV Power Fdrs				
1	CB in service & Closed	DI		✓
2	CB in service & Open	DI		✓
3	Relay 86 Operated	DI		✓
4	Relay 95 Operated	DI		✓
5	Numerical Relay Unhealthy	DI		✓
6	Numerical Relay Operated	DI		✓
7	R Phase Current	AI		✓
8	Y Phase Current	AI		✓
9	B Phase Current	AI		✓
10	3-Phase Real Power	AI		✓
11	3-Phase Reactive Power	AI		✓
0.415 kV Incomer Feeder				
1	CB in Service & Closed	DI		✓
2	CB in Service & Open	DI		✓
3	Relay 86 operated & Reset	DI		✓
4	Relay 95 Operated & Reset	DI		✓
5	Relay 51 Operated & Reset	DI		✓
6	Relay 51N Operated & Reset	DI		✓
7	Numerical Relay (51,51 N) Unhealthy	DI		✓
8	Relay 51G Operated & Reset	DI		✓
9	Numerical Relay (51G) Unhealthy	DI		✓
10	Relay 64R Operated & Reset	DI		✓
11	Numerical Relay (64R) Unhealthy	DI		✓
12	Trip on under voltage activated	DI		✓
13	R Phase Current	AI		✓
14	Y Phase Current	AI		✓
15	B Phase Current	AI		✓
16	3-Phase Real Power	AI		✓
17	3-Phase Reactive Power	AI		✓
18	Frequency (Hz)	AI		✓

ANNEXURE I to DESIGN BASIS - ELECTRICAL HMI I/O LIST

FEEDERWISE I/O LIST

Sr. No.	Input Description	Input Type	Input Type	
			Hard	Soft
0.415 kV Bus Coupler Feeder				
1	CB in Service & Closed	DI		✓
2	CB in Service & Open	DI		✓
3	Relay 86 Operated	DI		✓
4	Relay 95 Operated	DI		✓
5	Numerical relay (51,51 N) Unhealthy	DI		✓
6	Numerical relay 51 Operated	DI		✓
7	Numerical relay 51 N Operated	DI		✓
8	Trip on under voltage activated	DI		✓
9	R Phase Current	AI		✓
10	Y Phase Current	AI		✓
11	B Phase Current	AI		✓
12	3-Phase Real Power	AI		✓
13	3-Phase Reactive Power	AI		✓
0.415 KV 240 V AC Supply Control				
1	AC Supply Incomer failed	DI		✓
0.415 KV 110V DC Supply Control				
1	DC Supply 1 failed	DI		✓
2	DC Supply 2 failed	DI		✓
0.415 KV Auto Transfer Scheme				
1	ATS selector switch in auto mode	DI		✓
2	ATS selector switch in manual mode	DI		✓
3	ATS selector switch in independent mode	DI		✓
4	Auto Change over blocked	DI		✓
5	Synchro check relay healthy	DI		✓
6	Auto Change over scheme operated	DI		✓
7	Bus Coupler closed under ATS Scheme	DI		✓
8	Momentary paralleling is in process and in manual mode	DI		✓
0.415 kV Bus PT				
1	Under Voltage operated	DI		✓
2	Load shedding scheme Stage-1 Operated	DI		✓
3	Load shedding scheme Stage-2 Operated	DI		✓
4	Load shedding scheme Stage-3 Operated	DI		✓
5	Load shedding scheme Stage-4 Operated	DI		✓
6	PT MCB Open	DI		✓
7	PT MCB Close	DI		✓
8	R-Y Bus Voltage	AI		✓
9	Y-B Bus Voltage	AI		✓
10	R-B Bus Voltage	AI		✓
0.415 kV Line PT				
1	Under Voltage operated	DI		✓
2	Frequency Relay Operated	DI		✓
3	PT MCB Open	DI		✓
4	PT MCB Close	DI		✓
5	R-Y Bus Voltage	AI		✓
6	Y-B Bus Voltage	AI		✓
7	R-B Bus Voltage	AI		✓

ANNEXURE I to DESIGN BASIS - ELECTRICAL HMI I/O LIST

FEEDERWISE I/O LIST

Sr. No.	Input Description	Input Type	Input Type	
			Hard	Soft
0.415 kV Motor Fdrs				
1	CB in service & Closed	DI		✓
2	CB in service & Open	DI		✓
3	Relay 86 Operated	DI		✓
4	Relay 95 Operated	DI		✓
5	Numerical MPR Relay Unhealthy	DI		✓
6	Numerical MPR Relay Operated	DI		✓
7	Motor Trip from process	DI		✓
8	Trip on load shedding activated	DI		✓
9	Trip on under voltage activated	DI		✓
10	R Phase Current	AI		✓
11	Y Phase Current	AI		✓
12	B Phase Current	AI		✓
13	3-Phase Real Power	AI		✓
14	3-Phase Reactive Power	AI		✓
15	Hour Run meter	AI		✓
0.415 kV Power Fdrs				
1	CB in service & Closed	DI		✓
2	CB in service & Open	DI		✓
3	Relay 86 Operated	DI		✓
4	Relay 95 Operated	DI		✓
5	Numerical Relay Unhealthy	DI		✓
6	Numerical Relay Operated	DI		✓
7	Trip on under voltage activated	DI		✓
8	R Phase Current	AI		✓
9	Y Phase Current	AI		✓
10	B Phase Current	AI		✓
11	3-Phase Real Power	AI		✓
Miscellaneous Signals				
1	Critical DC Lighting "ON"	DI	✓	
2	UPS Charger Failure	DI	✓	
3	UPS Inverter Failure	DI	✓	
4	UPS Battery Discharged	DI	✓	
5	UPS Battery isolated	DI	✓	
6	Common fault UPS System	DI	✓	
7	110 V DC Supply Charger-1 Failure	DI	✓	
8	110 V DC Supply Charger-2 Failure	DI	✓	
9	110 V DC System on Battery	DI	✓	
10	Common Fault 110 V DC System	DI	✓	
11	UPS voltage	AI	✓	
12	UPS Current	AI	✓	
13	110 V DC System voltage	AI	✓	
14	110 V DC System Current	AI	✓	
15	Common Fault VFD	AI	✓	
16	VFD Bypassed.	AI	✓	

ANNEXURE-9

DESIGN GUIDELINES FOR ELECTRICAL

SPECIFICATION NO: 44NC-4600-0000/E.02/0002/A4

TITLE: ENGINEERING DESIGN GUIDELINES - ELECTRICAL

PROJECT REFERENCE:

- **Project No:** 44NC-4600
- **Project Location:** MANALI, CHENNAI
- **Project Title:** RESID UPGRADATION PROJECT
- **Client:** CHENNAI PETROLEUM CORPORATION LIMITED
- **Project Manager Authorization:** R.P.GAIKWAD **Date:** 21.08.13
- **Client Authorization:** **Date:**

Rev. No.	Issue Date	Pages	Revision Description	APPROVALS		
				By	Check	Approve
D	21.08.2013	45	Issued for Engineering	DS	PPP	MSJ
C	27.07.2010	45	Issued for Engineering	ASR	PPP	RBD
B	27.04.2010	42	Client's comments incorporated & Issued for Engineering	ASR	PPP	RBD
A	13.03.2010	45	Issued for comments	PPP	VDV	RBD
☒ Entire Specification Issued this Revision ☐ Revised Pages Only Issued this Revision			SPECIFICATION ISSUED FOR: ☐ In-house Review ☐ Purchase ☐ Client Approval ☐ Construction ☐ Enquiry ☒ Engineering			

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1.0 SCOPE

This Engineering Design Guidelines along with the Engineering Design Basis Document No. 44NC-4600-0000/E.02/0001/A4 shall form the basis for developing detailed design and engineering for electrical facilities included in Resid Up gradation Project. All data required in this regard shall be taken into consideration for acceptable, satisfactory and trouble free operation of the system as per good engineering practices.

2.0 STATUTORY REQUIREMENTS, CODES & STANDARDS

The design and the installation shall be in accordance with established codes, good engineering practices and shall conform to the statutory regulations applicable in the country. Contractor shall be responsible for obtaining necessary approvals from the statutory authorities e.g. CEA/ Electrical inspectorate, CCE, DGMS etc. as applicable before commissioning of electrical facilities.

2.1 The main codes, standards and statutory regulations considered as minimum requirements are as given below: -

Latest version as on date of award of contract shall be followed:

- Indian Standards
- OISD standards
- Indian Electricity Act
- Indian Electricity rules
- International Electro technical commission
- The Factory act
- The Petroleum Rules
- API Standards / IEEE
- Local Statutory rules and regulations

2.2 Some of the bare minimum relevant Indian Standards / OISD Standards are as listed below. However, system / equipment design shall be in line with latest edition of all applicable standards.

IS 5572 (2009)	Classification of hazardous areas (other than mines) having flammable gases & vapours for electrical installations.
IS 5571 (2009)	Guide for selection and installation of electrical equipment in hazardous areas (Other than mines).
IS 12360 (2010)	Voltage bands for electrical installations including preferred voltages and frequency.
IS 13234 (2012)	Guide for short circuit calculations in three phase AC Systems.
IS 3716 (2011)	Application guide for insulation co ordination.
IS 9676 (2009)	Reference ambient temperature for electrical equipment.
IS 3043 (2011)	Code of practice for earthing.
IS 732 (2010)	Code of practice for electrical wiring installations.
IS 6665 (2010)	Code of practice for Industrial lighting.
IS 5216 (2010) Part I	Recommendations on Safety procedures & practices in electrical work : General.
IS 5216 (2010) Part II	Recommendations on Safety procedures & practices in electrical work : Life saving techniques.
IS 7752 (2011)	Guide for improvement of power factor in consumer's installation.

IS 8478 (2011)	Application guide for on load tap changers.
IS 10028 (2011) : Part I	Code of practice for selection, installation and maintenance of transformer: Selection.
IS 10028 (2011) : Part II	Code of practice for selection, installation and maintenance of transformer: Installation.
IS 10028 (2008) : Part III	Code of practice for selection, installation and maintenance of transformer: Maintenance.
IS 10118 (2011) : Part I	Code of practice for selection, installation and maintenance of switchgear and control gear: General.
IS 10118 (2011) : Part II	Code of practice for selection, installation and maintenance of switchgear and control gear: Selection.
IS 10118 (2011) : Part III	Code of practice for selection, installation and maintenance of switchgear and control gear: Installation.
IS 10118 (2011) : Part IV	Code of practice for selection, installation and maintenance of switchgear and control gear: Maintenance.
IS 10561 (2011)	Application guide for power transformer.
IS 11064 (2011)	Guide for construction and use of rooms or buildings protected by pressurization for installation of electrical apparatus for explosive gas atmospheres.
IS 61241 (2009– Part 0, 2009– Part I)	Electrical apparatus with protection by enclosure for use in the presence of combustible dusts.
IS 14774 (2010) Part1 & 2	Resistance trace heating in potentially explosive atmospheres.
IS 5142 (2011)	Continuously variable voltage auto transformer.
IS 3646 (2008)	Code of practice for Interior illumination: part I, II, III.
IS 1944 Part I & II (2013)	Code of practice for lighting of Public through fares.
IS 60079 (2012): Part 0	Explosive atmospheres- General requirements
IS 60079 (2012): Part 1	Explosive atmospheres-Equipment protection by flameproof enclosures "d"
IS 60079 (2012): Part 2	Explosive atmospheres-Equipment protection by pressurized enclosure "p"
IS 60079 (2012): Part 15	Explosive atmospheres-Construction, test and marking of type of protection "n" electrical apparatus
IS 7689 (2010)	Guide for control of undesirable static electricity.
IS 2309 (2010)	Code of practice for the protection of buildings and allied structures against lightning.
IS 1646 (2012)	Code of practice for fire safety of buildings and electrical installations.
IS 3034 (2012)	Code of practice for fire safety of industrial buildings - Electrical generating & distributing stations.
IS 12459 (2012)	Code of practice for fire safety in cable runs.
IS 1554 Part I, Part II (2010)	PVC insulated (Heavy Duty) electric cables.

IS 7098 Part I, Cross Linked Polyethylene insulated thermoplastic sheathed cables.
Part II, Part III
(2010)

IS 5831 (2011) PVC insulation & sheath of electric cables.

IS 8130 (2011) Conductors for insulated electric cables and flexible cords.

IS 3975 (2009) Mild steel wires, formed wires and tapes for armouring of cables.

IS 10462 Part I, Fictitious calculation method for determination of dimensions of protective
Part II (2011) covering of cables.

SP 30 (2011) National Electrical Code (NEC) - BIS Publication.

OISD- STD-110 Recommended practices on static electricity.
(2012)

OISD- STD- 113 Classification of areas for electrical installation at hydrocarbon processing and
(2012) handling facilities.

OISD – STD- 147 Inspection and safe practices during electrical installations.
(2012)

OISD –STD- 149 Design aspects for safety in Electrical system.
(2012)

OISD-STD- 173 Fire prevention and protection system for electrical installation.
(2012)

OISD GDN 180 Lightning protection.
(2012)

2.3 Any other standard may be followed, provided, it is equivalent or more stringent than the standards specified above.

2.4 In case of any conflict / deviation amongst various Documents the order of precedence shall be as follows:

- Statutory regulations.
- Design basis / Engineering Design Guidelines.
- Job specification / Job specific drawings.
- Standard specifications/ Data Sheets, installation standards, etc.

3.0 ELECTRICAL SYSTEM DESCRIPTION

3.1 Total power requirement of proposed ISBL facilities (Coker Block, Sulphur Block, OHCU Revamp) and OSBL facilities shall be catered from proposed GTG-5, STG-3 units and existing power generation units as detailed in Key Single Line Diagram 44NC-4600-0000/E.01/0002/A0. Proposed GTG-5 & STG-3 Units will be synchronised with existing power plant units at 110 kV/ 6.6 kV.

3.2 Primary distribution to different substations for Resid Up gradation project is at 6.6 kV. Secondary distribution is at 6.6 kV and 0.415 kV for HT motors / distribution transformers and LT load respectively.

3.3 6.6 kV system is designed for 40 kA withstand for 1 second and 415 V system is designed for 50 kA withstand for 1 second.

3.4 CONSTRUCTION POWER

3.4.1 Details of Construction power shall be as listed elsewhere in FEED. LSTK contractors shall make their own arrangement for construction power distribution and power supply for construction office lighting purpose from the one point power supply made available to them.

- 3.4.2 LSTK contractor shall include adequately rated sub distribution boards, power supply cables, other associated material, trenches, overhead structures, road crossings etc. for feeding loads to carry out construction, fabrication activities, etc.
- 3.4.3 It shall be LSTK contractor's responsibility to maintain power factor more than 0.95 at all power distribution boards. Power factor improvement capacitors as required for maintaining a power factor more than 0.95 shall be supplied, installed and maintained by the LSTK contractor. The power distribution boards shall be provided with 30 mA ELCB / CBCT with ELR for all its feeders.
- 3.4.4 LSTK contractor shall provide adequate area lighting at site of construction, fabrication yards, office, etc. by means of high flood light masts, flood lighting poles, etc. which are to be supplied and maintained by the LSTK contractor.



4.0 AREA CLASSIFICATION

- 4.1 Following factors shall be considered for proper selection of electrical equipment for use in hazardous areas:

- Area classification (Zone 0 / Zone1 / Zone2)
- Gas Group classification (Gr. II A / IIB / IIC) – Characteristic of the gas / vapour involved
- Dust classification i.e. Group – The characteristic of the dust involved.
- Temperature classification (T1 to T6)
- Environmental conditions – selected electrical equipment shall be protected against corrosive and solvent agencies, water ingress, dusty, chemically polluted atmosphere as determined by the environmental conditions.

- 4.2 All electrical equipment installed in classified areas shall be selected as per IS 5571, OISD-113 and other relevant standards. For Zone 2 areas as a minimum Ex (n) type of equipment shall be used.

- 4.3 Selection of equipment for hazardous areas shall be as follows: -

Area Classified	Type of protection	Symbol
Zone 0	- No electrical equipment to be installed.	
Zone 1	- Flameproof enclosure	‘ d ‘
	- Pressurised	‘ p ‘
Zone 2	- All Equipments suitable for Zone 1	
	- Non Sparking	‘ n ‘

- 4.4 For pressurised electrical equipment installed in hazardous area, on failure of pressurisation system, electrical equipment shall be switched off with audio - visual alarm. Pressurised equipment shall be equipped with purge control unit and all necessary hard ware for interface requirement.

- 4.5 All equipment located outdoor shall be provided with minimum IPW55 protection as per IS 4691.

- 4.6 All electrical equipment for hazardous areas shall be certified by testing authorities like CIMFR, ERTL, PTB, BASEEFA, UL / FM, ATEX Certification as applicable for the service and the area of installation and shall be approved by CCE. All indigenous flameproof equipment Ex (d) shall be under BIS license & shall have markings as required by statutory authorities.

- 4.7 As an additional safety features, the following requirements for electrical equipment shall be followed.

- 4.7.1 All electric motors for agitators, mixers, and metering pumps handling flammable material shall be flameproof type Ex'd' irrespective of the area being classified as Zone-2 or Zone-1.

- 4.7.2 All electric motors for vertical oil sump pumps shall be flameproof type Ex-d.

- 4.7.3 Irrespective of the area classification (whether Zone-1 or Zone-2) all motors and lighting fixtures within the storage areas, pump house associated with storage areas and within the loading / unloading gantries shall be flameproof type Ex'd'.

- 4.7.4 Even though fired heaters in process units are not considered for area classification, all electrical equipment associated with fired heaters in process units shall, as a minimum be suitable for installation in Zone-2 area.
- 4.7.5 Motors for hazardous area application, when fed from frequency controller VFD panel shall have enclosure protection flameproof Ex'd' irrespective of area classification. For VFD with flameproof motor, combination may not need to be certified together if direct temperature control by embedded temperature sensors are provided, which will disconnect the motor.
- 4.7.6 All electrical equipment installed inside a compressor shed where hydrogen is being processed / handled shall be flameproof type (Ex'd') suitable for gas group-IIC for area being classified as Zone-1 and shall be non sparking type (Ex'n') suitable for gas group-IIC for area being classified as Zone-2. However in case CIMFR test certificate is not available for Ex'n' type as per latest edition of IS 8289, then flameproof type (Ex'd') suitable for gas group-IIC shall be supplied.
- 4.7.7 All electrical equipment installed for an analyser room shall be flameproof type Ex'd' suitable for gas group-IIA, IIB, IIC irrespective of the area being classified as Zone-1 or Zone-2.
- 4.7.8 All equipment inside the process units shall be as a minimum suitable for Zone-2 and shall be Non Sparking Ex (n) & temperature class T3 irrespective of area being safe. All Ex 'n' equipment shall be designed as per IS 8289 requirements with necessary certification available for the same.
- 4.7.9 Respective area classification / gas group shall be considered based on hazardous area classification.
- 4.7.10 Light fittings in hazardous areas shall be with EX'd' enclosure only, irrespective of zone classification of zone 1 or zone 2.



5.0 SYSTEM DESIGN PHILOSOPHY

- 5.1 Design of electrical installation shall ensure provision of a safe and reliable supply of electricity at all times. Safe conditions shall be ensured under all operating conditions including those associated with start up and shut down of plant as well as those arising out of failure of electrical equipment. The isolation of part of system of electrical equipment due to either maintenance or shut down shall not compromise safety. Power distribution system shall constitute substations, as far as practical located near load centres.
- 5.2 System shall be designed considering following aspects in general: -
- To facilitate inspection, cleaning and maintenance with care to safety in operation and personnel protection
 - To provide reliability and flexibility of service
 - Adequate provision for future extension and modification
 - Automatic protection of all electrical equipment through selective relaying system.
 - Availability of Electrical supply within design / permissible operating limits.
 - Maximum interchangeability of equipment
 - Desired level of operator interface to achieve co-ordinated efficient and fail-safe operation, data logging and maintenance of the equipment.
 - To decide redundancy, stand by, spares and overload capacities to achieve desired reliability and flexibility requirement.
 - Suitability for applicable environmental factors.
- 5.3 All electrical consumers within the battery limit shall be correctly identified and listed to have complete details of rating, efficiency, power factor, operating duty cycle (continuous, intermittent, standby), category of supply required (emergency, normal, critical), any special requirements such as Reacceleration, Auto cut in, VFD, Soft starter etc.

- 5.4 Required redundancy (based on specific process / operating needs) shall be built in substation which feeds power supply to process unit / important facilities so that in case of tripping of one feeder, the unit may not be adversely affected and continuity in operation is achieved.
- 5.5 While sizing the system, necessary consideration shall be given to restrict the system voltage drop within permissible limits during starting of large rated motor or group of motors with base load operating. At the same time, the short circuit current shall be kept within limits keeping in view of the market availability of switchgears. System design shall permit direct on line starting of all motors unless specified otherwise.
- 5.6 Load Grouping
- Electrical consumers shall be classified as 'normal / non-essential, emergency / essential or vital / critical loads as per the concepts defined below:
- 5.6.1 'Emergency' or 'essential' loads shall be identified on the criteria that, when failing in operation or when failing if called upon, will affect the continuity of operation, the quality or the quantity of product. For such load, reliable source shall be ensured. Such feeders shall be grouped on a separate Emergency PMCC and shall be fed from two different sources – one from normal source and other from emergency source.
- 5.6.2 Some of the loads which can be identified as emergency / essential load but not essentially limited to following:
- Electrical loads required for continuous operation of process plants / utility etc.
 - Electrical loads required for safe shut down of facilities
 - Emergency lighting
 - All communication facilities
 - Fire Alarm System / Fire fighting equipment
 - Level gauge / vessel lamp illumination
 - UPS / Battery charging equipment
 - DELETED
 - DELETED
- 5.6.3 'Critical' or 'vital' loads shall be identified on the criteria that, when failing in operation or when called upon, can cause an unsafe condition of the installation, jeopardize life or cause a major damage to the installation. For critical loads if any, UPS supply shall be provided to facilitate uninterrupted supply. The loads on UPS generally shall be VFD Control supply, PLC / DCS etc. Critical drives if any shall be provided with DC motors.
- 5.6.4 Some of the load which can be identified as critical / vital load but not essentially limited to following:
- Loads providing control and protection to plant equipment
 - Loads serving critical equipment for safety of plant, equipment and / or personnel
 - Critical Lighting
- 5.6.5 Non-essential service is a service, which is neither 'essential' nor 'vital'. Hence non-essential load does not require any special measure such as standby feeder or standby source to safeguard the continuity of service.
- 5.7 All the components of electrical system shall be designed to take into account following: -

- Maximum demand under most severe operating conditions
- Intermittent service loads, if any.
- 20 % spare for future addition.

5.8 SYSTEM VOLTAGES

Following factors shall be taken into account while selecting the voltage levels: -

- Short circuit level
- Availability of the switchgear with suitable current rating and short circuit rating.
- Existing available voltage levels in the refinery.
- Utilisation voltages of various equipment
- Provision of future extension.
- Size and location of loads
- Choice of voltage may also be affected by local regulations, standards
- Overall economy for optimum voltage selection.

5.9 PLANT UTILITY LEVELS:

Motors rated above 160 KW	: 6.6 kV TP, 50Hz
Motors rated up to and including 160KW	: 415V AC, TP, 50Hz
UPS system	: 110 V SPN
Lighting / Auxiliary boards	: 415 V AC, TPN, 50Hz
Normal lighting	: 240 V AC, SPN, 50 Hz
Telephone system	: 240 V AC, SPN, 50 Hz
Critical lighting	: 110V DC
Control supply	: For MCC, 240V SPN AC control supply to be derived from control Transformer in each bus section of MCC with change over scheme. 110V DC for HT Switchgears and breaker controlled PMCC/ MCC/ Auxiliary Boards – 2 sources with auto change over facility. 110V AC for DCS/ PLC control supply to be derived from UPS. 110V AC for control supply to VFDs for critical drives be derived from UPS. Control supply as required from UPS for excitation panel, AVR, Fire Alarm system and Plant Communication system.

5.10 VOLTAGE DROPS:

- 5.10.1 The maximum voltage drops in various sections of the electrical system shall be within permissible limits. Refer clause A 3.5 of Engineering Design Basis (44NC-4600-0000/E.02/0001/A4) for allowable permissible limits.
- 5.10.2 The voltage available at the motor terminals during start - up must be sufficient to ensure positive starting or re-acceleration of the motor (even with the motor fully loaded, if required) without causing any damage to the motor.

- 5.10.3 For HT Motors, the voltage available at motor terminals must not be less than 90% of rated value during start-up or re-acceleration.

For LT motors, the voltage available at the motor terminals must not be less than 85 % of the rated value during start-up or re-acceleration.



5.11 **DESIGN CRITERIA FOR CABLES:**

Sr. no.	Design Criteria	6.6 kV	415 V
5.11.1	Recommended limiting size of multi core cable (mm ²)	300 – 3 core 1000 – 1 core	300 – 3, 3½, & 4 cores 630 – 1 core
5.11.2	Short circuit withstand time	1 Sec. – Plant feeder 0.5 Sec. – Transformer feeder 0.2 Sec. – Motor feeder	Based on the relay co-ordination discrimination time
5.11.3	System Grounding	Low Resistance Grounded	Earthed (Solidly grounded)
5.11.4	Type of cable insulation	XLPE	PVC
5.12	SHORT CIRCUIT RATINGS		



All the switchgears shall be designed for following fault level withstand capacity.

6.6 kV switchgear - 40 kA for 1 sec.

415 V switchgear - 50 kA for 1 sec. (In case the upper limit of 6.6/0.433kV transformer is increased to more than 2000kVA, then if necessary, the fault level of the 415V switchgear shall be appropriately increased taking into account the impedance of the 6.6/0.433kV transformer and the fault contribution from motors)

In addition to thermal ampacity, high voltage cables shall also be suitable for rated short circuit withstand.

5.13 **INSULATION SYSTEM**

Following factors shall be considered while designing the Insulation of Electrical system

- System voltage
- System grounding
- Switching over voltages
- Lightning surges
- For HT motors (VCB controlled) surge arresters shall be provided.

- 5.14 For resistance grounded systems, the resistance value shall be chosen to limit the earth fault current to a value recommended by motor manufacturer for insulation protection and sufficient for selective and reliable operation of earth fault protection system. Earth fault current shall be limited to 200 A.

5.15 **PROTECTION AND METERING SCHEMES**

Selection and co ordination of Protection and metering system shall be such as to ensure:

- Selective, sensitive and reliable protection of equipment against damage due to internal or external faults or atmosphere discharge.
- Uninterrupted operation of healthy system
- Personnel & plant safety

- 5.15.1 Important plant feeders such as source feeders shall be provided with differential protection. The CT arrangement / locations provided for differential protection shall be such that overlapping zones are formed for differential protections provided for incomers, bus couplers, tie feeders etc so that the protection zone gets extended up to the last breaker / zone for which differential protection is provided.
- 5.15.1.1 Protective relays / releases shall be numerical and communicable type with open protocol (IEC 61850) of latest version suitable to communicate with HMI. 100% redundancy shall be provided for communication. Relays shall support features like remote relay parameterisation, disturbance recorder etc.
- 5.15.1.2 In general, fast acting relays (with time delays if required) shall be used and all fault tripping shall be done through high speed tripping relays.
- 5.15.1.3 Bare minimum Protection devices for power distribution system shall be as indicated below: -

Type of Relay	Transformer Feeder		Motor Feeder	Outgoing Feeder		Incomer	
	(LT winding ≥ 6.6 kV)	(LT winding ≤ 0.433 kV)	HT	HT	LT PCC/ PMCC	HT	LT PCC/ PMCC
51 IDMTL over-current relay	Yes	Yes	-	Yes	Yes	Yes	Yes
51N IDMTL earth-fault relay	Yes	Yes	-	Yes	Yes	Yes	Yes
51 G backup E/F relay (secondary neutral)	Yes	Yes	-	No	No	No	No
Motor protection relay with locked rotor feature 50, 50N, 46, 48, 49, 50L/R etc.	No	No	Yes	No	Yes (6)	No	No
64 R instantaneous restricted earth-fault relay (secondary side)	Yes	Yes	-	No	No	No	No
50 instantaneous over-current relay	Yes	Yes	-	No	No	No	No
50N instantaneous earth-fault relay	Yes	Yes	-	No	No	No	No
87 differential protection relay	Yes (1)	No	Yes (2)	No	No	Yes (10)	No
86 tripping relay	Yes	Yes	Yes (11)	Yes	Yes (11)	Yes	Yes
95 trip circuit supervision relay	Yes	Yes	Yes	Yes	Yes	Yes	Yes
63 Auxiliary relay (transformer)	Yes (17)	Yes (17)	-	No	No	No	No

27, 2 under-voltage relay with timer	-	-	Yes (9)	No	Yes (6, 9)	Yes (3)	Yes (3)
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All relays shall be with non-volatile memory, comprehensive unit providing protection, metering, control and communication with HMI. It shall be possible to set / operate the relay from the front facia.

Notes

- 1 For transformers rated 5 MVA and above and shall include primary & secondary bus duct / cables also in differential protection zone.
- 2 For motors rated 1500 kW and above differential protection shall be considered.
- 3 For switchgears where auto transfer feature is provided.
- 4 Instantaneous over current 50 and earth fault 50 N shall be provided only for transformer with delta primary.
- 5 Standby Earth fault protection (51 G) relay shall be located in downstream switchboard and shall trip the downstream feeder through Master Trip relay.
- 6 For motor feeders rated above 55 kW and fed from PCC.
- 7 Bus tie feeders / plant feeders shall be provided with 51, 51N, 86 and 95 relays.
- 8 Feeders shall be provided with timers for delayed tripping on bus under voltage.
- 9 One no. DC supply supervision relay (80) shall be provided for each incoming DC supply to the switchboard
- 10 One set of bus differential relays (87) and bus wire supervision relay (95) for each bus section shall be provided for HT switchboards. Bus differential protection IN / OUT selector switch shall be provided on panel with indication. Bus differential protection shall have overlapping zones.
- 11 Two sets of 86 relays shall be considered for each motor feeder. One for electrical tripping and other for process tripping. 86 relay for electrical trip shall be hand reset type. 86 for Process trip shall be self reset type.
- 12 Downstream breakers tripping on Inter trip from upstream shall be direct and shall not be through master trip Relay.
- 13 PT fuse failure relays shall be provided in HT / LT panels.
- 14 Value of stabilising resistor for Differential relay to be selected suitably based on actual fault level
- 15 Breaker contacts for critical logic (upstream / downstream tripping, changeover etc.) shall be provided directly from breaker auxiliary contacts and not from auxiliary contactors.
- 16 Memory / History of the Numerical relay shall not get erased due to loss of auxiliary supply of the relay. Preferably similar make of relays to be installed in one particular substation.
- 17 Transformer auxiliary protection: Buchholz, OT, WT, MOG, PRV trips to be provided.
- 18 For motors fed from VFD, VFD shall be equipped with all necessary Motor protections.

5.15.1.4

Capacitor Banks shall be provided with following protection:

- IDMTL over current with high set element for protection against short circuits
- Instantaneous earth fault
- Neutral phase displacement

- Under voltage
- Over voltage
- Built in fuse for each capacitor unit.

5.15.2 Metering instruments shall be provided to keep record of power consumption and supervision of all concerned parameters like current, voltage, power, frequency, power factor etc. All the instruments shall be flush mounted. Except voltmeter and ammeter, all the metering shall be a part of comprehensive metering and protection relay unit. If accuracy required for metering (Cl. 1) is not possible through relay, separate communicable, multifunction meters shall be provided.

	Feeder Type	A	V	Hz	MW	MWH	Hour Run	MVAR	MVAH	MVA	PF
	6.6kV Swgr Incomer	X	X	X	X	X	-	X	X	X	X
	6.6kV Swgr Bus Tie	X	-	-	-	-	-	-	-	-	-
	Transformer Feeder	X	-	-	X	X	-	-	-	-	X
	6.6kV Bus P.T.	-	X	-	-	-	-	-	-	-	-
	6.6KV Plant Feeder	X	-	-	X	X	-	-	-	-	-
	6.6kV Motor Feeder	X	-	-	-	X (kWh)	X	-	-	-	X
	6.6kV Capacitor	X	X	-	-	-	-	X	-	-	-
	PMCC/MCC Incomer	X	X	-	X	X (kWh)	-	-	-	-	X
	PCC/MCC Bus Tie	X	-	-	-	-	-	-	-	-	-
	PMCC Bus PT	-	X	-	-	-	-	-	-	-	-
	ACB Outgoing	X	-	-	-	X (kWh)	-	-	-	-	-
	LT Motor	X	-	-	-	X	-	-	-	-	X
	PCC/ASB Incomer	X	X	-	X	X (kWh)	-	-	-	-	-
	MCCB/SFU Outgoing (≥ 250 A)	X	-	-	-	X (kWh)	-	-	-	-	-
	LDB Incomer	X	X	-	-	X (kWh)	-	-	-	-	-
	DG Set	X	X	X	X (kW)	X (kWh)	X	-	-	-	-

Notes: -

1. All metering shall be a part of comprehensive relay. However, analogue type voltmeter and ammeter shall be separately provided.
 2. Field ammeters shall be provided for motor feeders above 5.5 kW.
- 5.16 Working & standby load shall be distributed on different bus sections.
- 5.17 **AUTO TRANSFER SCHEME**
- Changeover scheme for two incomers and one bus coupler shall generally be as follows:
- 5.17.1 Auto changeover between two incomers and one bus coupler shall be in such a way that any two breakers are "ON" at a time. Normally both the Incomers shall be closed with Bus coupler in open condition.
- 5.17.2 Bus coupler breaker is made "ON" automatically in case the incoming supply at incomer breaker No. 1 or 2 fails and the respective breaker trips on under voltage through delayed time under voltage relay. Time delay shall be settable in the range of 0.5 to 5 sec.. Breaker trip on under voltage shall be blocked in case of power failure on both the incomers. Following pre requisites shall be ensured while closing the bus coupler.
- Auto Independent Manual (A-I-M) Switch is in "Auto" mode.
 - I/C breaker is not tripped on fault
 - PT fuse / MCB is not operated.
 - Bus coupler trip circuit supervision relay is not operated.
 - Bus coupler is open and in service condition.
 - Other I/C is closed in service position.
 - No transient under voltage and simultaneous under voltage on both the I/C.
 - Voltage on Healthy bus is > 80 %
 - Residual voltage on the bus that has lost supply is less than 20 % of rated voltage.
- 5.17.3 After resumption of power to the I/C which is tripped on under voltage, following steps shall be followed to restore normal operating conditions.
- A-I-M switch shall be in Manual mode
 - PT selector switch shall be selected to Line PT of I/C to be closed and respective Bus PT.
 - Trip Selector switch to be set to trip B/C with pre set time setting.
 - Close the I/C through Synchro check relay in the circuit ensuring all synchronising conditions (Voltage, frequency, phase sequence) of both the supplies.
 - After closing of the I/C, if B/C fails to trip in preset time, I/C closed last should trip.
- 5.17.4 For planned / scheduled maintenance, change over scheme shall be in manual mode with momentary paralleling. Steps as described above shall be repeated for the same.
- 5.17.5 Independent mode shall be selected during dead bus transfer.
- 5.17.6 Normally change over at 6.6 kV switch boards shall be through manual / independent mode.
- 5.17.7 All Auto / Manual change over logic shall be built in numerical relays. Hard wired logic is not acceptable.

5.18 DC POWER SUPPLY

Unless otherwise specified, independent DC power supply systems shall be provided for following

- Electrical switchgear control
- Critical lighting
- Critical DC drives
- Plant shut down system including DC instrumentation

5.19 EMERGENCY POWER SUPPLY

5.19.1 Emergency power supply system shall be designed to feed the following types of loads as required:

- Electrical loads essential for safe shut down
- Emergency lighting
- Loads critical for process, plant and personnel safety.
- Loads identified for flare mitigation.
- Process plant instruments as required
- Communication equipment
- Fire detection and alarm systems
- DC supply systems
- UPS systems
- Fire fighting equipment

5.19.2 Emergency power supply could be from different source or Emergency Generator as per Project Design Data. Where Emergency Generator is envisaged, Emergency power supply shall be made available within a time period of 30 seconds from the instant of failure of normal supply.

5.19.3 Emergency generator shall not be continuously run in parallel with the normal power supply system. However, short time paralleling facility shall be provided for transferring load to normal power supply or other operational needs as required.

6.0 EQUIPMENT DESIGN PHILOSOPHY

This section describes bare minimum design requirements for electrical equipment. Criteria / requirements not specifically listed below however, required from the point of view of safety, reliability, satisfactory operation, good engineering practices etc. shall also be taken care of while designing the equipment.

6.1 HT SWITCHGEAR (6.6 kV)

6.1.1 All switchgears and associated equipment fed from generators and transformers shall have rating at least equal to the rating of respective generators and transformers feeding it, under any circuit configuration.

Generator Incomer shall be rated with respect to maximum power output of the generator set over entire operating temperature range.

Transformer Incomer shall be rated for the forced cooled rating of transformer or 120 % of ONAN rating as applicable

Bus bars shall be rated for Incoming Breaker rating.

Thermal rating of CTs in outgoing feeders shall be suitable for actual load.

Switchgear components rating shall be "In panel ratings" with necessary de-rating as required.

All the breaker contacts shall be silver plated.

- 6.1.2 All other switchgears not directly fed from generators and transformers shall have rating at least equal to the maximum demand under any circuit configuration plus a provision for 20 % future growth. Incoming of these switchgears shall be designed to cater to the complete load including 20 % margin for future load growth.
- 6.1.3 Rating of Bus coupler shall be suitable for following conditions:
- Maximum running load on either side of bus section.
 - Bus coupler rating equal to largest incoming circuit breaker rating.
 - Should not be less than bus bar current rating.
- 6.1.4 Minimum 20 % spare feeders or one no. of each rating and type, whichever is more, shall be provided in each switchboard.
- 6.1.5 Rated service short circuit breaking capacities (i.e. Ics) for all breakers shall be greater than or equal to maximum specified value of the short circuit current at the point of installation.
- 6.1.6 Switch board components such as circuit breakers, main horizontal and vertical bus bars, bus bar joints, bus bar supports etc. shall be designed to withstand the maximum specified short circuit current for a minimum time of 1 sec, unless otherwise specified. Bus bars shall be supported on insulators made up of non-hygroscopic, non-flammable material. Safety shutter, phase barrier (including that for cable chamber) bus bar seal-off bushing plate, support insulators etc shall have non-flammable high tracking index fibreglass / epoxy insulation system. Bus bar joints shall be silver-plated. Bus bar shall be insulated by using heat-shrinkable PVC Sleeves. 
- 6.1.7 All unused circuit breaker auxiliary contacts shall be wired up to the terminal block. Breaker contact multiplication if not avoidable shall be done through high burden relay. Contacts from the same high burden relay shall be used in tripping and closing (close permissive) circuit.
- 6.1.8 In case of HT vacuum circuit breaker, adequate provision shall be made for motor switching to limit the over voltage to 2.2 per unit of rated peak line to earth voltage. Required surge arrestors may be provided for this purpose.
- 6.1.9 Rating of Circuit breakers /contactors used in Motor feeder shall be at least 125% of the maximum continuous motor rating.
- 6.1.10 Circuit breakers / switch fuse units with vacuum contactors for capacitor units shall have a current rating of at least 140 % of total capacitor bank rated current. Circuit breakers capability to interrupt applicable capacitive current shall be specifically verified.
- 6.1.11 Running loads shall be uniformly distributed on each bus and it shall be ensured that running and standby loads are fed from two different bus sections.
- 6.1.12 HT switchgears shall be supplied with necessary earthing switches /earthing trucks/ earthing rods / breaker handling trolleys. Earthing truck – one of each frame size shall be considered on cable side and bus-bar side. Breaker trolleys – two nos of each frame size shall be considered. 
- 6.1.13 For tie feeders, receiving end circuit breaker shall have OFF control and ON / OFF indicating lamps for sending end circuit breaker.
- 6.1.14 For panel wiring, inter panel wiring; wires shall run preferably through metallic trough adequately supported along its run to prevent sagging due to flexibility or vibration. Control and power wires shall be routed through separate troughs.

- 6.1.15 Spare contacts available in relays, Auxiliary relays, breakers etc. shall be wired up to terminal block for owner's use. All terminal blocks shall be shrouded box clamp type and shall be located in such a way to ensure proper and ease of access for termination of cables / wires.
- 6.1.16 Switchboard vendor shall have valid (within 5 years) type test certificate with detailed report and drawings for the offered rating of switchboard.
- 6.1.17 For all other requirement refer ESS: 44NC-4600:ESS 006.

6.2 TRANSFORMERS

- 6.2.1 Transformers except lighting transformers shall be ONAN / ONAF, 3-phase, oil immersed double wound type suitable for outdoor installation. Auxiliary transformers shall be AN, dry type.
- 6.2.2 Transformer sizing shall be such as to take care of
- After diversity continuous maximum demand considering intermittent, stand by loads under most severe operating condition,
 - Starting of highest rated induction motor on DOL with other load in running condition,
 - System distribution losses (1- 1.5 %) and
 - Minimum 20 % margin for future growth.
- 6.2.3 For transformers without any force cooling, each transformer shall be rated equal to or greater than the 8 hour maximum demand of the load plus 20 % margin for future load growth.
- 6.2.4 For transformers having forced cooling, each transformer shall be rated equal to or greater than 8 hour maximum demand of the load plus 20 % margin for future load growth (built in ONAN rating) and shall be fitted with automatic forced air cooling fans for further up gradation by 20 % of it's ONAN rating..
- 6.2.5 While sizing the transformer following guidelines shall be followed for various types of loads i.e. continuous, intermittent and stand-by: -

Type of load

Diversity Factor to be Considered

Continuous

1.0

Intermittent

0.3 ¹⁾

Stand-by

0.1 ^{2) & 3)}

¹⁾ Loads which are required to be operated only during start-up of the plant and which are not required to be operated during normal operation of the plant need not be considered for transformer sizing (Diversity Factor = 0.0).

²⁾ Standby loads for intermittent loads which will come into operation only when the working intermittent load fails/trips need not be considered for transformer sizing (Diversity Factor = 0.0)

³⁾ Diversity factor of 0.1 for stand by loads need to be considered for only those loads/drives which are required to be started before switching off of the normal working loads/drives when there is a planned change over to standby system (other standby loads need not be considered for transformer sizing)

- 6.2.6 In general, rating and % impedance of each transformer shall be selected to limit the short circuit current to values within the current rating and rupturing capacity of switchgear available and also to ensure the voltage drop within permissible limit. The transformer impedances shall be as per Indian standards unless otherwise required.

- 6.2.7 100 % standby transformer shall be provided in substation, lighting system unless otherwise specified. In normal operation transformer shall be loaded to max. 40 % of it's rated capacity. Transformer shall be low loss type. Maximum efficiency shall occur at about 30 % - 45 % rating.
- 6.2.8 Power transformers shall be of low losses type. Usually no load & load losses shall be optimised for operation around 30 % - 45 % of their ONAN rating. Optimisation of design of Transformer shall be offered with due consideration to Capitalisation of losses.
- 6.2.9 Maximum rating of distribution transformers (6.6/ 0.433 kV) shall be normally limited to 2 MVA, whereas for power transformers (110 /6.9 kV) rating shall be limited to 30 MVA. However, for 6.6/0.433kV transformer, relaxation to maximum rating up to 2.5 MVA may be considered as a special case by Owner/PMC, if space availability and layout restriction dictates so and is subject to the condition that the overall size of all the related equipment is such that it can be accommodated in the available space and the equipment are rated for corresponding increased fault level and have valid type test certificates corresponding to the increased fault level.
- 6.2.10 One no. power transformer and one no. distribution transformer from each lot to be selected for type test in addition to routine test
- 6.2.11 For all other requirement refer ESS: 44NC-4600: ESS 004.
- 6.3 HT CAPACITOR BANKS**
- 6.3.1 HT capacitor banks shall be provided for system power factor improvement to 0.95. Power factor control shall be achieved at 6.6 kV bus. Power factor improvement shall be with automatic power factor controller. No. of capacitor banks shall be accordingly designed to provide smooth power factor control.
- 6.3.2 Capacitor banks shall be supplied with series reactor, Discharge resistor, RVT (residual voltage transformer) and fuses in individual capacitor unit.
- 6.3.3 Total unit shall be suitable for Indoor / outdoor installation based on the layout conditions.
- 6.3.4 Capacitor bank in conjunction with series reactor shall provide minimum net kVAR at rated nominal voltage. The insulation system shall be designed to withstand continuous over voltage of 110 %
- 6.4 LT SWITCHGEAR (PMCC / PCC / MCC / MLDB / ASB)**
- 6.4.1 All switchgears and associated equipment fed from transformers shall have rating at least equal to the rating of transformers feeding it, under any circuit configuration.
- Bus bars shall be rated for Incomer Breaker rating.
- Thermal rating of CTs in outgoing feeders shall be suitable for actual load.
- Switchgear components rating shall be "In panel ratings" with necessary de-ration as required.
- 6.4.2 Switchgears shall have rating at least equal to maximum demand under any circuit configuration and provision for 20 % margin future growth.
- 6.4.3 20 % spares feeders (minimum 1 no.) of each module size and type, whichever is more shall be provided in each bus-section.
- 6.4.4 Separate feeders shall be provided in the switchboard for each load / motor. However, max. 2 nos. welding receptacles may be looped from single feeder.
- 6.4.5 Service breaking capacities (Ics) for all breakers shall be greater than or equal to maximum fault level at the point of installation.
- 6.4.6 Air circuit Breakers shall be provided for all feeders rated above 630 A and switch fuse units shall be provided for all feeders rated upto and including 630 A. All breaker contacts shall be silver plated. Breaker service and test position limit switches shall be wired up to the terminal block and then shall be wired in the circuit.



- 6.4.7 Main bus bars shall be electrolytic Aluminium and of Uniform cross section with heat shrunk PVC colour coded sleeves through out it's length. Shrouds shall be provided on joints. Minimum clearance between live parts, between live parts / neutral to ground shall be minimum 19 mm. Clearances at components shall be as per individual component standards.
- 6.4.8 All the switchgear components shall be designed to withstand maximum expected short circuit level for a minimum time of 1 second.
- 6.4.9 CTs installed at incoming and outgoing feeders shall be easily accessible on opening the rear door of panel for easy maintenance, primary injection and CT replacement. All CT terminals shall be wired up to terminal block. CT secondary terminals shall be fully shrouded.
- 6.4.10 All motor feeders shall be provided with IEC type 2 co-ordination. Motors rated above 55 kW & up to and including 160 kW shall be SFU controlled with contactor and MPR and shall be fed from PCC.
- 6.4.11 MCC, Auxiliary Switchboard with Breaker / FSU incomers shall be provided with manual change over scheme. Electrical & mechanical interlock (castle key) shall be provided between Incomers & bus coupler.
- 6.4.12 Running loads shall be uniformly distributed on each bus and it shall be ensured that running and standby loads are fed from two different bus sections.
- 6.4.13 All loads rated 5 kW and above shall be provided with CBCT with ELR. 
- 6.4.14 All emergency / critical drives, irrespective of their ratings shall be provided with ammeters.
- 6.4.15 Enclosure shall be metal clad, self supported, floor mounted, single front, vermin proof, compartmentalized with minimum form of separation as 3b. Enclosure protection shall be IP52 minimum. Blanking plates for draw out modules (5 % in each switchboard) shall be provided with offered switchboard for maintaining enclosure protection in case of draw out modules being racked out for maintenance / repair / replacement.
- 6.4.16 Maximum rating of bus bars for MCCs / ASBs / LDBs should be limited to 1250 A max. Heavy duty type load break switches / ACB shall be used for Incoming and tie breakers and these shall have suitable mechanical interlocks.
- 6.4.17 Required number of secondary isolating contacts shall be provided with terminals including 20 % spares for future use. It shall be possible to test complete control, indication circuits, logics in both "TEST" as well as "SERVICE" positions. For motors provided with contactor module, sliding terminals provided to terminate control cables shall be provided only on side at front. Access for proper termination of power and control cables in all modules shall be ensured.
- 6.4.18 Spare contacts available in relays, Auxiliary relays, breakers etc. shall be wired up to terminal block for owner's use. All terminal blocks shall be shrouded box clamp type and shall be located in such a way to ensure proper and ease of access for termination of cables / wires.
- 6.4.19 For all other requirement refer ESS: 44NC-4600: ESS 002, 44NC-4600: ESS 003 & 44NC-4600: ESS 009.
- 6.5 NEUTRAL GROUNDING RESISTOR (NGR)**
- 6.5.1 Neutral grounding resistor shall be housed in a sheet metal enclosure and shall be naturally ventilated.
- 6.5.2 Value of the NGR shall be such as to limit the earth fault current, which does not harm the equipment (Generators, Motors and Transformers), and also ensures the protective relay operation.
- 6.5.3 NGR shall be able to carry at least 10 % of its rated current continuously, unless otherwise specified, and full rated current (100%) for a minimum duration of 10 seconds.
- 6.5.4 For all other requirement refer ESS: 44NC-4600:ESS 017.

6.6 BUS-DUCT

- 6.6.1 HT bus duct shall be phase segregated and LT bus duct shall be non-phase segregated type.
- 6.6.2 HT Bus bars shall be of Heavy duty Electrolytic grade tinned Copper & LT Bus bars shall be of Heavy duty Electrolytic grade Aluminium.
- 6.6.3 It shall be suitably supported at regular intervals and both bus bars and supports shall be adequately sized and clamped to withstand rated short circuit current without permanent deformation.
- 6.6.4 The bus insulators shall be of non-hygroscopic and non-inflammable material. Earth bus shall run along the full length of bus duct without any break.
- 6.6.5 Outdoor bus-duct shall be weatherproof to IP-55 and shall be provided with canopy.
- 6.6.6 Bus-duct shall be supplied with bus-bar flexible links for connection at both the ends and expansion joints for every 3m of bus-duct and bus-duct support materials.
- 6.6.7 Openings with cover at suitable locations shall be provided on bus-duct for accessing the bus-bars for maintenance.
- 6.6.8 For all other requirement refer ESS: 44NC-4600: ESS 007.

6.7 ANNUNCIATION PANEL

- 6.7.1 Audio visual annunciation panels shall be provided to monitor the switchgear and other electrical equipment.
- 6.7.2 Annunciation panel shall be of sheet steel construction with IP55 protection, floor mounted, free standing suitable for cable entries from bottom.
- 6.7.3 Terminals shall be suitable for termination of 2.5 mm² copper conductors. Terminal design must ensure secure and vibration proof connections. Terminals for each window shall be brought out separately to terminal chamber. Ample space shall be provided between terminals and gland plate.
- 6.7.4 Annunciation panel shall be complete with acknowledge, test and reset push buttons and hooter. 20 % spare windows shall be provided for future requirement.
- 6.7.5 Enclosure of Annunciation panel shall be provided with two nos. external earth terminals each complete with 2 plain and one spring washers and a nut.
- 6.7.6 Each window shall be provided with rear engraved Perspex nameplates with white letters on black back ground.

6.8 EMERGENCY GENERATOR

- 6.8.1 Emergency generator set shall be designed to start automatically on power failure and feed the selected loads. It shall be capable of taking care of the load variations (e.g. the starting of largest rated motor with specified base load). Rated performance of DG shall be at any loads from 0% to 100%. DG shall be designed to take care of load harmonics (Current Harmonics as per IEEE limits) without any derating. For machines rated up to 1250 kVA, harmonic distortion factor shall not exceed the value given in IS-13364 part -2. For machines rated above 1250 kVA, telephone harmonic factor as per IS 4722 shall be applicable.
- 6.8.2 Regulation of generator voltage shall be automatic and necessary instruments for metering viz. Ammeter, Voltmeter, frequency meter, kWH meter, Power factor meter, hour run counter etc. shall be included in control panel. Warning of abnormal conditions shall be provided prior to automatic trip to prevent unnecessary shutdown.
- 6.8.3 Unit shall be complete with necessary engine starting equipment, associated control panel and shall be suitable for remote starting. Emergency Generator shall have auto starting arrangement but only manual switching off feature. 'Fail to start' annunciation shall be provided in case the engine fails to start.

- 6.8.4 Emergency DG set shall be containerized type complying all pollution control norms and shall be suitable for open execution.
- 6.8.5 Load shall be automatically switched on to generator only after the requisite voltage build-up. The generator set shall be provided with all necessary protection including protection against overload, short circuit, ground fault etc. as applicable.
- 6.8.6 Emergency generator shall have at least 20 % spare margin for future growth.
- 6.8.7 For all other requirement refer ESS: 44NC-4600: ESS 059.

6.9 MOTORS

- 6.9.1 Motors shall be energy efficient with eff 2 class of efficiency.
- 6.9.2 In general, three phase squirrel cage induction motors up to 2500 kW shall be designed for direct on line starting.
- Motors rated above 3000 kW shall be suitable for assisted start like Soft Starter / VFD.
- Motors shall be totally enclosed fan cooled suitable for outdoor application.
- 6.9.3 Type of enclosure for motors (i.e. indoor/outdoor, industrial / Non Sparking / flameproof) shall be adequate for the application and area in which it is to be used.
- 6.9.4 Mechanical parameters such as duty, mounting type, shaft extension, direction of rotation, starting torque requirements etc. shall be adequate for the application. Sleeve or anti friction type bearings shall be used. Vertical motors shall have thrust bearings suitable for the load imposed by the driven machinery. Motors with sleeve bearings may require proximity probes to measure shaft vibration adjacent and relative to the bearings. Generally, all motors, except for application such as crane, hoist, turbine / engine starting, shall be designed for continuous duty with rated load.
- 6.9.5 When the motors and pumps are mounted on the common base frame, jackscrews with plate of suitable size shall be provided on all four sides of base frame. These jackscrews along with the plate are required for moving the motor during alignment.
- 6.9.6 All HT motors above 750 kW rating shall be provided with 6 nos. duplex RTDs (12 Nos. simplex, in case duplex type RTD is not possible to mount in the winding slots) for winding temperature detection and 2 nos. duplex BTDS for bearing temperature detection. Dual dial type temperature indicator without contacts for bearings shall also be provided. VFD driven LT motors shall be provided with PTC thermistors. Minimum 10% additional RTD points shall be provided and shall be wired up to terminal block.
- 6.9.7 Terminal box of HT motor shall be designed to withstand the specified short circuit current for 0.2 second without damage. A separate neutral terminal box shall be provided for making star connection and it shall be adequately sized to accommodate the current transformers for differential protection (for motors rated 1500 kW and above). Neutral Terminal Box shall be interchangeable type. Motor terminal boxes shall be suitable for termination of required size and No. of cables preferably without use of Junction Box.
- 6.9.8 All the motors shall have class 'F' insulation with temperature rise limited to class 'B'.
- 6.9.9 Type of motors that require variable frequency drive system shall be suitable for variable frequency range with temperature rise within limit and also shall be suitable for area classification. For hazardous area application motors with variable speed drive system shall be Ex'd' type. All motors operating on VFDs shall have embedded temperature detectors / thermistors for winding with thermistor relay which will trip the motor in case the temperature of winding exceeds the permissible limits. Flameproof motors operating on variable frequency drive system shall have CIMFR or equivalent authority certifying the suitability of drive motor with VFDs. For package items if Ex'd' type of motor cannot be provided for VFD driven motors then vendor shall consider Ex'e' / Ex'n' type of motor after getting clearance from PMC / Owner. However, combined testing of motor with VFD shall be carried out as per relevant IS / Statutory regulation and appropriate certification shall be obtained by the contractor."

6.9.10 Limiting Conditions for Motor start up (e.g. starting current limitation or method of starting):-

- Starting current of MV motors rated up to 2.5 MW shall be limited to 550 % (inclusive of + tolerance) @.

Motors rated above 2.5 MW up to 3.0 MW starting current shall be limited to 400 % (inclusive of + tolerance) @.

- Starting current of motors rated up to 75 kW shall be limited to 600% (inclusive of + ve tolerance) of normal current @.
- Starting current of motor rated more than 75 KW and up to 160 kW shall be as per IS-12615-2011 @

Actual requirements shall be decided during detail engineering based on system studies and system regulation requirement.

6.9.11 Any assisted type of starting method (e.g. soft starter, Auto transformer etc.) for HT / LT motors may be considered for regulation / motor drop within limits, ensuring proper acceleration of the driven equipment.

6.9.12 Re-acceleration for identified critical motors shall be provided to cover brief interruption up to 5 seconds in normal power supply. Insulation for these motors shall be designed for 140 % of rated insulation level to take care of any out of step voltages that might result during re-acceleration.

6.9.13 Outdoor motors shall be provided with FRP canopy.

6.9.14 Motors of above 22 kW rating shall be provided with space heater. For HT motor feeders, ammeter shall be provided in switchgear for space heater circuit.

6.9.15 HT motors shall be suitable for starting under specified load conditions with 85 % of the rated voltage at the terminals and LT motors shall be suitable for starting under specified load conditions with 80 % of the rated voltage at the terminals. Hot withstand time shall be minimum 2 seconds more than acceleration time at reduced voltage.

6.9.16 Induced voltage across the shaft ends of motor shall not exceed 250 mV (rms) for ball and roller bearings and 400 mV (rms) for sleeve bearings. Wherever it exceeds the specified limit, the non driving end bearing shall be insulated from the motor frame to avoid circulating current. The insulated bearing end shield or pedestal shall bear a prominent warning.

6.9.17 For heavy duty drives such as reciprocating compressors / agitators/ crushers etc. high starting torque motors shall be provided, and starting time shall be limited to ensure adequate protection by motor protection relay.

6.9.18 One no. motor from each lot for motors more than 1.5 MW rating, shall be subjected to type test.

6.9.19 For all other requirement refer ESS: 44NC-4600: ESS 01A & 44NC-4600: ESS 01B.

6.10 BATTERY CHARGER

6.10.1 Charger shall have dual parallel redundant modules of float cum boost charging unit.

6.10.2 Rating of the charger shall be adequate to trickle / boost charging of batteries and to feed the DC load requirement with minimum 20 % spare capacity.

6.10.3 20% spare outgoing feeders for future use shall be provided in each DCDB for each rating and type of feeder.

6.10.4 Voltage at DCDB bus irrespective of mode of operation (Charger feeding the load or Battery feeding the load) shall be within +/- 5 % of the rated voltage.

6.10.5 Logic development shall necessarily be using auxiliary relays. Changeover logic shall be ensured with close transition without any DC supply discontinuity to load.

6.10.6 Cell booster for required type of battery shall be sized and supplied with following minimum rating:
1.2 x 0.2 x AH of battery.



- 6.10.7 One summary fault contact shall be provided for remote alarm.
- 6.10.8 For all other requirement refer ESS: 44NC-4600:ESS 005 and refer SLD Scheme for DC System : 44NC-4600-0000/E.01/0008/A4.
- 6.11 **BATTERIES**
- 6.11.1 While sizing the batteries temperature correction, back-up time, design margin, ageing factor and maintenance factor shall be considered.
- Back up time – 1 Hr.
 - Design Margin – 20 %
 - Ageing Factor – 10 %
 - Maintenance Factor – 10 %
 - Temperature correction factor (as applicable) – As per IEEE recommendations.
- 6.11.2 Battery sets of required AH capacity and voltage rating shall be considered for DC System. Batteries shall be complete with batteries and battery racks.
- 6.11.3 Batteries shall be adequate to meet the requirements as per duty cycle, type of load and min. 20 % spare capacity for future requirement.
- 6.11.4 Isolator shall be provided for battery bank isolation near battery.
- 6.11.5 All batteries except for generator sets (GTG/ TGT/ DG) shall be Ni-Cd type. Batteries for generator sets shall be heavy duty VRLA type suitable for feeding DC motors.
- 6.11.6 For all other requirement refer ESS: 44NC-4600: ESS 005.
- 6.12 **UNINTERRUPTED POWER SUPPLY (UPS)**
- 6.12.1 UPS shall have duty and ratings of feeders adequate for the application and shall be suitable for indoor use. UPS system shall be sized to take care of the crest factor of the load current.
- 6.12.2 Each UPS unit shall have dual parallel redundant modules. Each module shall consists of rectifier transformer, rectifier-cum charger, inverter, filter circuit, static switches, bypass transformer, facility for manual transfer between inverter supply and bypass line, facility for bypassing inverter, static switch for maintenance, ACDB and Batteries. System shall be adequate to supply required rated output for one hour.
- 6.12.3 UPS unit shall be able to withstand without deterioration mechanical and thermal effects of the short circuit current. It shall also be able to withstand continuous over voltage of 10 % and surges from the power distribution, switching surges and over voltages due to system faults up to a maximum of 2.5 kV peak value.
- 6.12.4 Under normal operating conditions, the rectifier cum charger shall feed the inverter and charge the battery set. In case of mains failure, the battery shall supply the necessary power to the inverter. Inverter in turn shall feed the load through the static switch. If the inverter malfunction or get overloaded, the load shall be instantaneously transferred to the bypass line through the static switch. Normally, the inverter shall be operated in synchronised mode with the bypass line and manual transfer forward/ reverse shall be effected without any break. The overload capacity & current limiting shall be adequate for the application. Harmonic filters if required shall be considered at input side. Harmonics fed back to system shall be within permissible limits as stipulated in IEEE 519 and other relevant standards.
- 6.12.5 Fuse disconnecting switch shall be provided for each outgoing feeder of the UPS and the fuse shall be of fast clearing type. Fuse rating shall be selected to achieve co-ordination to protect the UPS during short circuit. The rating of the largest branch circuit shall not exceed 25% of the system rating.
- 6.12.6 UPS rating shall be adequately sized considering 20% spare capacity for future load.

- 6.12.7 20% spare outgoing feeders for future use shall be provided in each ACDB for each rating and type of feeder. Isolation transformer shall be provided wherever necessary in outgoing feeders of ACDB.
- 6.12.8 Redundant outgoing feeders shall be provided in ACDB wherever necessary for instrumentation requirement.
- 6.12.9 Three separate source supply shall be provided to UPS Incomers.
- 6.12.10 For all other requirement refer ESS: 44NC-4600:ESS 025
- 6.13 **LIGHTING, POWER & DC DISTRIBUTION BOARDS**
- 6.13.1 No. of LPs, PPs & DCDB shall be provided for complete lighting & power distribution adequate for the respective areas.
- 6.13.2 Lighting distribution boards fed through 415 V/ 433 V Auxiliary transformers with off circuit taps ± 10 % shall be planned for feeding the lighting system of the package units, Substation, Control Room etc.
- 6.13.3 Each Auxiliary transformer shall be sized to feed the Auxiliary load (Power panels and lighting load) with 20 % (as a minimum) spare capacity for future requirement.
- 6.13.4 DCDB shall be with one incomer. Components in DCDB / Busbars shall be designed for short circuit withstand considering contribution from Batteries, Charger etc.
- 6.13.5 Lighting distribution board shall have two incomers and one bus-coupler. Two incomers shall be fed from two bus-sections of PMCC.
- 6.13.6 Emergency lighting panels (20 - 25 % of total lighting requirement) shall be fed from Emergency PMCC. In normal operation, Emergency lighting panels shall be fed from normal source. Upon failure of normal supply, emergency lighting load shall be transferred to emergency source after the start of DG set.
- 6.13.7 No. of LPs shall be considered based on location / area served and total loading.
- 6.13.8 Plant lighting circuits shall be fed from dedicated lighting distribution boards installed in a safe area. For LPs, incomer shall be provided with MCB and outgoing shall be with MCBs + ELCBs for control and protection of lighting circuits.
- 6.13.9 Plant lighting circuits shall be single phase (P & N) rated 240 V AC. Each circuit shall be rated to 16A but not loaded more than 8 A. A minimum of 20% of MCBs of each panel shall be left as spares. Maximum loading per circuit shall be limited to 1250 – 1500 W during design stage. Each lighting panel shall have minimum 2 TPN circuits to feed area lighting.
- 6.13.10 Lighting distribution board shall include 20% spare outgoing circuits.
- 6.13.11 Adjacent lighting fittings shall not be fed from the same circuit.
- 6.13.12 Plant lighting circuits (excluding level gauge lighting) for open to sky areas shall be designed for auto/manual switching. In Auto mode switching shall be controlled through timer.
- 6.13.13 Auxiliary relays, A/M selector switch, Timer as required for remote switching ON / OFF of lighting system shall be included in lighting distribution board. Refer SLD Schemes – 44NC-4600-0000/E.01/0009/A4.
- 6.13.14 For all other requirement refer ESS: 44NC-4600: ESS 010 & 44NC-4600: ESS 011.
- 6.14 **VARIABLE FREQUENCY DRIVES (VFD)**
- 6.14.1 Microprocessor based variable frequency drive shall be communicable type and shall be able to communicate with HMI / DCS.
- 6.14.2 System shall be highly reliable, efficient and shall provide high power factor, low harmonic distortion, low noise level etc.
- 6.14.3 System shall be provided with complete bypass circuit to ensure the power supply reliability in case of VFD failure.

- 6.14.4 System shall be suitable for load characteristics, continuous speed control and shall be with soft start feature. Drive shall be able to accelerate the load over the full speed range (0 – 100 %) with incoming line voltage regulation of +/- 10 %.
- 6.14.5 System shall be designed for 150 % over current withstand for 1 minute. The system shall be equipped with an automatic restart facility with preset time within 0 – 15 seconds which will restart the system in case of voltage dip over 20 % or power interruptions less than 4 seconds and recovery of voltage to 95 % with a facility to block the automatic restart.
- 6.14.6 System shall be suitably designed with due care for long length of cables, output filters, chokes, motor insulation, cable voltage grades etc. In case the cable lengths from VFD to motors are very much on higher side, then suitable number of output reactors shall be provided as well as higher rating of VFD shall be selected.
- 6.14.7 VFD panel shall be selected for location in the clean air conditioned room preferably in the sub-station / MCC room. Required local control equipment shall have start, stop, speed raise and lower push buttons, ammeter, speed indicator, ON/OFF/READY status selector switches as required and shall be installed near the motor.
- 6.14.8 VFD panels shall of minimum 12 pulse design and shall be of proven model.
- 6.14.9 For all other requirement refer ESS: 44NC-4600:ESS 031 and Block diagram : 44NC-4600-0000/E.01/0015/A3.
- 6.15 **SOFT STARTERS**
- 6.15.1 Soft starters shall be solid state microprocessor control type with self torque adjustment (during controlled start) feature with bypass contactor.
- 6.15.2 Soft starter shall be designed with starting current limited to 350 % to 400 %. However it shall be ensured that this reduced starting voltage is suitable to develop necessary starting torque requirement of the respective motor. Soft starters shall be so designed that the minimum possible supply voltage drop shall occur keeping in mind the accelerating torque requirement of the drive motor & the load.
- 6.15.3 For HT motor drives soft starter can be connected to neutral side of motor. For the same, phase segregated terminal box shall be provided for the neutral side of the motor.
- 6.15.4 For LT motor drives, soft starter shall be connected to line side of the motor.
- 6.15.5 Motor torque Vs speed curve at reduced voltage (to motor terminals at starting) shall be superimposed on torque Vs speed characteristics of the driven equipment to confirm correct operation i.e. acceleration to rated speed. Acceleration time at reduced voltage (based on these Torque Vs speed curves) required for accelerating the drive to full rated speed shall be established. This acceleration time shall be sufficiently less than the hot withstand time of the motor.
- 6.15.6 Necessary bypass arrangement with built in logic shall be provided with all necessary protections and metering arrangement for steady state operation of the motor.
- 6.15.7 For all other requirement refer ESS: 44NC-4600:ESS 065
- 6.16 **LOCAL CONTROL STATIONS (LCS)**
- 6.16.1 Local control stations shall be of die cast Aluminium.
- 6.16.2 Type and number of switchgear components such as push buttons, selector switches, ammeters, lamps etc. shall be based on the functional requirements of the control scheme and the type of equipment.
- 6.16.3 Control stations shall be provided for each motor / heaters etc. in the field.
- 6.16.4 Enclosure of the control station shall be suitable for site conditions such as weather proof, dust proof, flame proof, corrosion resistant etc. All outdoor control stations shall be provided with FRP canopy.

- 6.16.5 Stop push button shall be of stay put type, red, Mushroom head, press to lock and turn to unlock type. However it can be of momentary type in case of drives such as lube oil pump etc, which are critical.
- 6.16.6 Two numbers of stop push buttons shall be provided for the motors, which are installed at elevated platforms, such as cooling tower fan/ Air fin coolers, MOVs etc. One of the push buttons shall be installed at ground level and the other near the motor.
- 6.16.7 Local control station shall be provided with ammeter for motors rated above 5.5 kW. Local control station for aux. Lube oil pumps, heater etc. shall be provided with ammeter irrespective of motor rating. LCS for all emergency / critical drives shall be provided with ammeters.
- 6.16.8 Weatherproof, Break glass, emergency push button station shall be provided near transformers to trip the transformer feeder in case of emergency. Push button shall be shrouded type.
- 6.16.9 Start push button shall be spring release (momentary) type, Shrouded and green in colour.
- 6.16.10 For all other requirement refer ESS: 44NC-4600:ESS 012 & 44NC-4600:ESS 013
- 6.17 **ACTUATORS FOR MOTOR OPERATED VALVE**
- 6.17.1 MOVs shall be provided with an integral control box consisting of reversible starter, local/remote selector switch, start/stop switches or push buttons, torque switches, limit switches etc, and shall be suitable for installation in classified areas. The mechanical design shall be such that in case of torque or limit switch failure, the motor shall be protected. Anti-condensation heater shall be provided for the actuator. The power supply for the control circuit shall be AC.
- 6.17.2 MOV shall be designed to start with 75% of the motor terminal voltage. The motor insulation class shall be class F, but the temperature rise shall be limited to a temperature equivalent to class B.
- 6.17.3 For all other requirement refer ESS : 44NC-4600:ESS 037
- 6.18 **CABLES (HT / LT)**
- 6.18.1 Cables shall be sized considering the following factors.
- Maximum continuous load current
 - Voltage drop
 - System voltage
 - Laying conditions
 - (Derating due to ambient air temperature, ground temperature, grouping and proximity of cables with each other, thermal resistivity of soil etc. shall be taken into account)
 - Short circuit withstand criteria as per Cl. 5.11 – design criteria for cables
 - Transformer cables shall be sized to continuously carry transformer full load current.
- 6.18.2 All cables shall be armoured with extruded FRLS PVC inner and outer sheath. Cable outer sheath should have the cable size embossed. Non magnetic material (Al) shall be used for Single core armour.
- 6.18.3 All HT power cables shall be made of stranded aluminium or copper conductor with dry cured XLPE insulation, FRLS PVC sheathed, armoured, conductor screen, insulation screen and construction as per IS 7098.
- 6.18.4 For HT Motors, power cables shall be unearthed grade with required number of runs of conductor cross section of 185 mm².
- 6.18.5 All LT power cables shall be 3 core / 3-1/2 core / 4 core with stranded aluminium / copper conductor with PVC insulation and construction as per IS 1554. For all LPs / PPs incoming power supply cable shall be 4 core of required cross section.

- 6.18.6 Power cables with conductor size up to and including 16 sq mm shall be with copper conductor, conductor size above 16 sq.mm. shall be aluminium or copper conductor as indicated in Design basis 44NC-4600-0000/E.02/0001/A4.
- 6.18.7 Cables connected in parallel shall be of the same type, cross section and terminations.
- 6.18.8 All control cables shall be of 2.5 sq. mm, stranded copper conductor. Control cables shall be twisted pair or shielded wherever electro-magnetic / electrostatic interference is anticipated. Insulation of cable cores shall be designed to limit Induced voltages between cores and shall prevent spurious operations of contactors, relays etc, shall not be damaging to those switchgear components.
- 6.18.9 All control cables shall have 20 % spare cores. All cores shall be identified with numerical core numbers printed on core instead of colours.
- 6.18.10 All power and control cables shall be in continuous lengths without any joints. Cables used for lighting and wires in conduits shall have appropriate junction boxes with adequately sized terminals. Cable joints if not avoidable, shall not be permitted in hazardous areas.
- 6.18.11 For lighting inside the building, minimum 2.5 sq.mm Cu conductor, PVC insulated wire shall be used in conduit system (for circuit and point wiring), with proper colour coding.
- 6.18.12 Fire Alarm system cables shall be Non petroleum Jelly filled cables. Plant Communication and Telephone system cables shall be Petroleum Jelly filled cables.
- 6.18.13 For all other requirement refer ESS: 44NC-4600:ESS 008

6.19 LIGHTING EQUIPMENT

- 6.19.1 Lighting fittings shall be of energy efficient type. Possibility of using Solar energy for suitable applications shall be explored while designing Lighting system.
- 6.19.2 All ballasts shall be with copper winding and capacitor for power factor improvement (to 0.95) shall be provided with fixtures as applicable.
- 6.19.3 Generally following types of fittings shall be used for the application mentioned. However, alternative / different type may also be used depending upon application where the fittings are to be installed.

6.19.4 Indoor areas:

Control room, administrative building, security office
canteen

Energy saving lighting fitting
equivalent to 2 x 36 W
Fluorescent mirror optic,
decorative fitting.

Sub-station, MCC room, store, workshop

Energy saving lighting fitting
equivalent to 2 x 36 W
fluorescent industrial type fitting.

D.G.room, compressor room etc. with mounting height
more than 6 meters

1 x 250W / 400W HPMV medium
bay/ high bay / Flood Light

Outdoor areas

Platforms, pump bays, skids, etc. where mounting height
upto 3 m to 3.5 m is possible

1 x 80 W / 125 W HPMV well
glass

Transformer bay pump bays, tank farm, switchyard, etc.

HPMV lighting fittings /
Fluorescent lighting fittings

- 6.19.5 HPMV & MLL lamps shall generally be used for outdoor plant lighting. Keeping in view the re strike time lag and to avoid complete darkness in case of a voltage dip/black out condition, necessary incandescent lamps may be judiciously distributed throughout the plant area. Safe area street and area lighting may employ sodium vapour lamps. Low pressure / High pressure sodium vapour lamps shall not be installed in hazardous areas.
- 6.19.6 Aviation warning lights shall be installed in accordance with the recommendation by the International Airport Authority of India. Fittings shall consist of a double lamp unit with automatic switchover to the stand-by lamp upon failure of the operating one. LED type, heavy duty, and weatherproof aviation warning light shall be used for chimneys.
- 6.19.7 All chemical handling facilities shall be provided with chemical resistant fixtures.
- 6.19.8 Floodlight fittings on lattice type structure/high masts shall be provided for illumination of tank farm / general area.
- 6.19.9 Fittings to be installed in the hazardous area shall be suitable for the zone and CIMFR certified with CCE approval.
- 6.19.10 All fittings to be installed outdoors shall have ingress protection of IP 65 minimum and shall be weatherproof and have a guard.
- 6.19.11 The material of construction shall be as follows :-
- Body – FRP in safe areas & Die cast Aluminium in Hazardous areas.
 - Gasket - EPDM or neoprene with u/v resistant and corrosion resistant properties.
 - Reflector - Aluminium stainless steel/chromium plated steel - mirror finished.
 - Hardware - Stainless steel (316)
 - Guard - Stainless steel (316)
 - Painting - Epoxy painting.
- 6.19.12 Fittings for indoor installation where clean, non-corrosive atmosphere or pressurisation is maintained manufacturer's standard material of construction is acceptable; otherwise the material mentioned above shall be applicable.
- 6.19.13 Control gear for well glass and medium bay / high bay fittings shall be in non integral control gear box. The material of construction shall be same as mentioned in clause 6.19.11 above.
- 6.20 **JUNCTION BOXES**
- 6.20.1 Junction boxes/Telephone Tag boxes shall be FRP construction with IP 55 degree of protection suitable for installation in classified areas, hazardous areas. It shall be suitable for terminating or looping armoured signal/power cables. JB's shall be provided with earthing stud. It shall be suitable for wall/column/structure/ceiling mounting.
- 6.20.2 Junction boxes installed in classified hazardous area shall be explosion proof Ex'd' only irrespective of area classification.
- 6.21 **CONVENIENCE / WELDING RECEPTACLES**
- 6.21.1 Enclosure of the convenience receptacle shall be suitable for site conditions such as weather proof, dust proof, flame proof, corrosion resistant etc. Necessary interlocks and earthing facilities shall be provided as per safety requirements. These receptacles shall be provided at selected locations in the plant.
- 6.21.2 5 pin Welding receptacles shall be provided at suitable locations to make sure the receptacle is accessible from any point of the process area with a trailing cable of 30 meters length. The welding receptacle shall be rated for 63A, 415V, 3 phase and shall have a scraping earth.
- 6.21.3 63A, 415V, 3 phase receptacle (with scraping earth) shall be provided at suitable location near major equipment like compressors, blowers etc to provide power for portable equipment.

6.21.4 20A, 240V, single phase, three pin sockets shall be provided at suitable locations to make sure that the receptacle is accessible from any point of the process area, with a trailing cable of 15 meters length and near any manholes of the equipment, near static/rotary equipment. However for hazardous areas 240/24V transformer shall be provided within socket to supply 24V to Hand Lamps.

6.21.5 Outdoor receptacles shall be provided with FRP canopies.

6.22 CABLE TRAYS

6.22.1 Cable trays shall be run on overhead cable rack or along the pipe rack to suit the site conditions.

6.22.2 Separate cable trays shall be selected for:-

- HT cables
- LT power cable
- LT control cable
- Instrumentation cables/communication cable
- Cable trays shall be sized considering single layer of cables. Only control cables shall be considered in two layers for cable tray sizing.



6.22.3 Trays shall not show deflection / bend / deformation after laying of cables.

6.22.4 All cable trays and accessories shall be GI. For tray system design, in addition to self load and wind forces, following guidelines for design shall be considered.

6.22.4.1 Support span : 2000 mm

6.22.4.2 Cable load for

- 150 mm wide cable tray : 30 kg/m
- 300 mm wide cable tray : 60 kg/m
- 600 mm wide cable tray : 90 kg/m
- 750 mm wide cable tray : 120 kg/m

6.22.5 In addition to this, 70 kg concentrated load at centre span shall be considered. All structural steel design shall be as per Indian Standards.

6.22.6 Bends, tees, reducers, crosses, droppers etc. shall have the required bending radii as recommended by the manufacturer with 10% allowance for various cable sizes with a minimum of 300 mm.

6.22.7 Instrument cables, communication cables and Fire Alarm cables shall preferably not be laid in the same trench/ tray along with electrical cables. In case these are laid in the same trench / tray, a clearance of minimum 300 mm from electrical cables shall be provided. The overall cable layouts shall be designed for minimum interference between signal and power cables. FO cables shall be laid through HDPE pipes in trench / trays. Instrument cables for DCS / PLC interface (low voltage signal cables, 110 V AC cables etc.) shall be laid in separate route. If same trench is used, necessary barriers / wall shall be provided between Electrical cables and Instrument cables.

6.23 CATHODIC PROTECTION EQUIPMENT

6.23.1 All underground Drums / Vessels shall be provided with Cathodic Protection.

6.23.2 Cathodic protections can either sacrificial anode type or impressed current type. Selection of the type of protection shall be based on the effectiveness of the system and overall economy

6.23.3 For all other requirements refer ESS : 44NC-4600:ESS 034.

6.23.4 Current density for bare conductors shall be considered as 25 mA / mm².



6.24 ELECTRICAL HEAT TRACING

- 6.24.1 Electrical heat tracing wherever identified shall be designed to suit the requirement. Type of heat tracer shall be SLSR / Power limiting / Constant Watt etc. and shall be based on the type of application and overall economy.
- 6.24.2 Electrical heat tracing shall be complete with control panel and all other required accessories. Necessary components shall be provided to limit the heat losses at flanges / junctions etc.
- 6.24.3 Electrical heat tracing system shall be fed through delta / star transformer with off load tap adjustment facility. Electric heat tracing shall not be employed in process plant areas unless specified otherwise. In utility / offsite areas electric heat tracing shall be used only if steam tracing is not available.
- 6.24.4 For all other requirements refer ESS : 44NC-4600:ESS 061

6.25 HMI SYSTEM

- 6.25.1 One No. workstation as Operator Workstation with 17" LCD TFT Monitor of latest model & One number laptop shall be provided as engineering workstation. System configuration shall be latest proven model and up gradable.
- 6.25.2 HMI shall allow minimum of the following functions
- Time Stamping
 - Feeder status monitoring
 - Data Logging and routine log report generation
 - Relay parameterisation
 - Event recording
 - Disturbance recording
 - Annunciation
 - View of historical data and generating trends
 - Preparation of maintenance schedule.
- 6.25.3 Following typical performance measures specified for the HMI shall also be followed:
- Hardwired analogue input acquisition : 500 ms
 - Analogue input acquisition from relay/ metering LAN : 1 s
 - Digital input acquisition from relay LAN : 1 s
 - Hardwired digital input acquisition : 100 ms
 - Operator initiated control command execution time : 2 s
 - CRT display recall time : 5 s
 - Retrieval of status or measurement to HMI : < 2 s
 - SOE resolution at RTU level : 1 ms
- 6.25.4 It is proposed to acquire electrical parameters such as current, voltage, frequency, real and reactive power, status of circuit breaker, few important protections viz. trip relay (86), trip circuit supervision relay (95), PT secondary MCB status etc. This data shall be acquired in the field of RTU.
- 6.25.5 It is proposed to acquire all data in soft wired form. All measurements pertaining to these systems shall be obtained through transducers / directly wired to relays.

- 6.25.6 Wherever numerical relays are used in 6.6 kV and 415 V systems, metering and protection related data acquisition in HMI shall be through relay and metering LAN which shall be dual redundant 19.6 kbps RS-485 networks with IEC 61850 / MODBUS protocol. LAN shall be so designed as to update all field data at least once every second.
- 6.25.7 All measurements of HMI shall have accuracy limit of $\pm 1.5\%$, of which 1% is attributable to CT/PT errors, and 0.5% is attributable to transducer / relay / meter, as applicable.
- 6.25.8 Supply, Erection And Commissioning:
- 6.25.8.1 System shall be designed with 20% spare I/O cards of all types at all locations with 20 % spare transducers and interposing relays. Redundancy shall be offered at all levels.
- 6.25.8.2 Data highway media shall be armoured fibre optic cable. The fibre optic cable shall be laid in pre-lubricated HDPE ducts. For fibre-optic HMI highway cable routing, same philosophy as for electrical cables shall be adopted. Wherever electrical cables are in overhead trays, HMI data highway cables shall also be routed in a separate tier of the tray. Wherever electrical cables are in underground trench, HMI data highway cables shall also be in separate lined trench and back filled with sand.
- 6.25.9 Generally scope shall include following.
- 6.25.9.1 Supply, erection and commissioning of HMI RTU and interface panels, Media converters, where required, Networking cabinet, signals transducers, interposing relays etc.
- 6.25.9.2 Necessary engineering (HMI Screen, Existing Database up dation, Reports, Modification in schemes to consider new loads etc.) in HMI system to get seamless HMI system.
- 6.25.9.3 All cabling work including supply, laying (in trenches / on trays), termination of cables with nickel plated brass cable glands, tinned Cu lugs, connectors as applicable for the following but not necessarily limited to following:
All I/O cables from switchboards, transformers, UPS etc to interposing relays / RTUs for AI, DI, DO signals
All power supply cables for RTUs, interposing relays, HMI etc
Relay LAN cabling including termination to HMI RTU, data highway cabling including termination, HDPE duct and box type tray for HDPE duct, wherever required
- 6.25.9.4 All communication networks from RTUs / Data concentrators to HMI.
- 6.25.9.5 Earthing of HMI equipment including "clean earth", wherever required.
- 6.25.10 HMI equipment shall be located in air-conditioned room. Heat Load of all equipment at these locations shall be estimated and accordingly shall be considered for Air conditioning system design.
- 6.25.11 All required items, work for completion of the job of HMI to fulfil the functional and operational requirements, though not explicitly mentioned (if any), shall be considered.
- 6.25.12 User-friendly windows based software shall be provided for interactive display of substation data in multi-window feature. Softwares shall have the capability to display substation single line diagrams, display for electrical system parameters, reports, alarm annunciation, daily and monthly data logging, continuous polling, relay programming, relay monitoring, data logging, relay supervision, tripping features, fault disturbance record of each relay, graphic representation and trending of data etc. The display shall have electrical system overview and detailed information about its sub system. All softwares shall be written for operating on a common operating system platform plant wide and shall be able to communicate with other existing systems. A change of operating platform for HMI, CPU during detail engineering shall not have any commercial implications. Audio / Visual Alarm annunciation shall be provided along with hooter.
- 6.25.13 HMI system shall have two distinctive passwords one for viewing of data, metering etc. (operator level) and second for authorisation for change in settings etc.

- 7.6.9 Recommended areas for AC emergency lighting :
- Control rooms
 - Fire stations
 - Staircases
 - Platforms with ladder changing directions
 - Strategic locations in process, where specific safety operations are to be carried out, such as Areas near heat exchangers, condensers, Barring gears of turbine.
 - Areas around drives fed by emergency supply.
- Any other specific areas requiring emergency lighting.
- 7.6.10 Generally 20 - 25% of normal lighting load shall be considered for AC emergency load.
- 7.6.11 Wiring for lighting and convenience outlets in outdoor areas shall be carried out with copper conductor, PVC insulated, armoured cables run along the column/platforms and structures. The armoured cable shall enter lighting fixture / JB through double compression gland for safe area and through flameproof glands for Ex(d) and Ex(e) equipment. Where required, suitable mechanical protection shall be provided for lighting fixtures (e.g. wire guard)
- 7.6.12 Lighting installations shall be designed to obviate stroboscopic effect.
- 7.6.13 Lamp fittings in structures shall be so located that maintenance and lamp changing can be effected without use of ladder or scaffolding.
- 7.6.14 The lighting fittings shall be situated in such a way that reflection on instruments / VDU etc. in control rooms and sub-stations is avoided.
- 7.6.15 All lighting fittings shall be wired using armoured PVC cable of suitable no. of cores and size. Necessary type and no. of junction boxes shall be provided for branch connections.
- 7.6.16 DC critical lighting shall employ incandescent lamps.
- 7.6.17 Adequate no. of ceiling fan points shall be provided in offices, rooms allocated for operating and maintenance personnel etc.
- 7.6.18 2 pole isolation devices shall be used for controlling fixtures in hazardous areas to isolate phase as well neutral.
- 7.6.19 For buildings with false ceiling, concealed conduit wiring below the false ceiling and surface conduit wiring above false ceiling shall be considered.
- 7.6.20 Adequate no. of pull boxes shall be used. No joints shall be allowed inside these pull boxes.
- 7.6.21 Battery room shall have flameproof fitting mounted on wall in order to facilitate easy replacement of fused lamps. Switches controlling the fittings and exhaust fan shall be installed outside the battery room.

8.0 INSTALLATION

- 8.1 Installation of all electrical equipment shall be carried out with high standard of workmanship, neat routing/layouts, and clearances/access as per recommendations by the manufacturer.
- 8.2 After installation, system equipment shall be tested for pre-commissioning test as recommended by the manufacturers & established practises. Further, commissioning tests shall be conducted to prove agreed performance within specified tolerance, temperature rise, noise and vibration.
- 8.3 For all other requirement refer standard specification doc. no. 44NC-4600: ESS 026.

9.0 FIELD TESTING & COMMISSIONING

Field tests as per the procedures approved by the Owner shall be performed on the electrical equipment before being put into service. Acceptance of the complete electrical installation shall be contingent upon inspection and test results. Field tests shall include but not be limited to the following:

- 9.1 A visual inspection at both ends of a cable/conduit run, and all intermediate joints to ensure that terminal chambers and other enclosures are clean, joints tight and sound, wiring correctly dressed and labelled and no obvious faults are present.
- 9.2 After visual inspection, all the covers shall be replaced and cover screw (and gaskets, if any) checked to be present and tight.
- 9.3 Electrical tests generally shall include:
- 9.3.1 An insulation test for each winding and circuit with a separate test for each core of power circuit.
- 9.3.2 Continuity test for all power, control circuits, windings etc..
- 9.3.3 Earth continuity test for all circuits.
- 9.3.4 An earth resistance measurement for each group of electrodes, and the earthing system as a whole
- 9.3.5 Lighting installation shall be tested for correct illumination levels with the fittings installed. Fittings shall be operated only with their designed size of a lamp or tube.
- 9.3.6 All protective relays and meters shall be tested and calibrated. All relays must be checked for settings.
- 9.3.7 After the above tests and inspection are completed, Control circuit shall be tested for correct operation under all operating combinations and proved correct before applying power to main circuits.
- 9.3.8 Main circuits shall be checked for correct phasing and rotation.
- 9.3.9 All motors except those having sealed prefabricated ball bearings shall be checked for proper lubrication prior to energisation and shall be tested for correct rotation. ECP (polymer cage) type bearings shall not be provided in motors. Only ECJ / ECM (steel / brass cage) type shall be accepted. Grease tube shall be of MS.
- 9.3.10 A close visual inspection of all electrical equipment in hazardous area shall be made to ensure that the equipment is both suitable and correctly installed.
- 9.3.11 Capacity test shall be carried out on UPS / batteries / battery charger after installation at site.
- 9.3.12 After completion of tests a joint test report shall be prepared for each test carried out on each equipment and shall be signed by authorised representative. A copy of such test reports shall form a part of completion report.
- 9.3.13 For all other requirement refer standard specification doc. no. 44NC-4600: ESS 026.
- 9.4 CEA APPROVAL
- 9.4.1 Application on behalf of the owner for submission to relevant authorities along with copies of required certificates complete in all respects shall be prepared and submitted by the contractor well ahead of time so that the actual construction / commissioning of the work is not delayed for want of the approval / inspection by concerned authorities. Inspection of the works by authorities shall be arranged by the contractor and necessary co ordination and liaison work in this respect shall be the responsibility of the Contractor. However statutory fees paid, if any, for all inspections and approvals for permanent establishment by such authorities shall be reimbursed at actual by the owner to the contractor on production of documentary evidence. Statutory fees for contractor's equipment, materials and workmanship shall not be reimbursed.
- 9.4.2 Any change / addition required to be made to meet the requirements of the statutory authorities shall be carried out by the contractor free of charge. The inspection and acceptance of the work by statutory authorities shall, however, not absolve the contractor from any of his responsibilities under this contract.

10.0 MAKE OF COMPONENTS

Sr. No	Component	Make
1)	Circuit Breaker (6.6 kV)	: Siemens/ ABB / Jyoti / Areva
2)	Circuit Breaker (LT)	: Siemens (3WL) / L&T (UPower) / Schneider (Merlin Gerin Master Pact Imported make)
3)	Heavy Duty Switch	: Siemens / L&T / Schneider / ABB / C & S / Indo Asian
4)	Switch Fuse Unit	: ABB / C & S / Havell's / Siemens / L & T / Indo Asian / Schneider
5)	Fuses	: Siemens / L&T / Cooper Bussman / Indo Asian Switchgear
6)	Power Contactors / Auxiliary Contactors	: Siemens / L&T / Schneider / ABB / Bharatia Industries Ltd. / C & S
7)	Overload relays	: Siemens / L&T / Schneider / ABB / Bharatia Industries Ltd. / C & S
8)	Earth Leakage Circuit Breaker	: Datar Switchgear Pvt. Ltd. / Indo Asian Switchgear / Legrand / Havell's / Schneider
9)	MCB	: Datar Switchgear Pvt. Ltd. / Indo Asian Switchgear / Legrand / Havell's / Schneider / Siemens
10)	Current transformer / Potential transformers (HT)	: Pragati / Kappa / Jyoti / Areva / ABB
11)	Current transformer / Potential transformers (LT)	: Pragati / Kappa / Jyoti / Silkans / Precise / AE / Gilbert Maxwell
12)	Control Transformer	: Kappa / Silkan / Pragati
13)	Push buttons and Indicating Lamps	: Siemens / Teknic / L&T / Bharatia Industries Ltd. / C & S.
14)	Meters	: AE / IMP / Rishabh / Areva / Meco
15)	Terminals	: Elmex / Connect Well.
16)	Relays	: ABB /Siemens/Areva
17)	Auxiliary Relays	ABB / Areva / Jyoti / Siemens / L & T/ Schneider
18)	Control / Selector switch	: Kaycee / Areva / Jyoti / L & T / Switron / Siemens
19)	Breaker Control switch	: Areva / Switron
20)	Timer	: Siemens / L&T / Schneider / ABB / Bharatia Industries Ltd.
21)	Interposing relays	: ABB/Allen Bradley /OEN
22)	Transducers	: ABB /Southern Transducers / Elster / Pyrotech Electronics / Meco
23)	WTI	: Perfect Controls / Precimeasure
24)	OTI	: Perfect Controls / Precimeasure
25)	Tap Changer Assembly	: BHEL / CGL / Easun Reyrolle
26)	Cable Glands for Hazardous Area	: Baliga / Comet / Flexpro / FEPL / FCG Power / FCG Flame proof Control Gears / Prompt Engineers / Sudhir Switchgears

PROJECT NO.: 44 NC-4600

SPEC.NO. 44NC-4600-0000/E.02/0002/A4

TITLE: ENGINEERING DESIGN GUIDELINES - ELECTRICAL

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|-----|-----------------------------|---|---|
| 27) | Cable Glands (Weatherproof) | : | Baliga / Comet / Flexpro / FEPL / FCG Power / FCG
Flame proof Control Gears / Prompt Engineers /
Sudhir Switchgears |
| 28) | LT Isolator | : | Siemens / L & T |
| 29) | Conduit | : | Nagarjuna / M. Chandra / Senco |
| 30) | Cable Lugs | : | Dowell / Crown / Niko / Forward Engineering |
| 31) | FRLS PVC Wires | : | Phinolex / Q- Flex / Kundan / Anchor / Orbit / Mardia |

ANNEXURE – I :List of reference standard specifications:

Ref. No.	Title
44NC-4600: ESS 01A	LV Induction Motors
44NC-4600: ESS 01B	HV Induction Motors
44NC-4600: ESS 002	L.V. Switchgear
44NC-4600: ESS 003	Motor Control Centres (MCC)
44NC-4600: ESS 004	Power and Distribution Transformers
44NC-4600: ESS 005	Battery & Charger
44NC-4600: ESS 006	HT Switchboards - Indoor Type (Up to 33kV)
44NC-4600: ESS 007	Bus Duct
44NC-4600: ESS 008	Medium and High Voltage Heavy Duty Cables
44NC-4600: ESS 009	Main Lighting & Power Distribution Boards
44NC-4600: ESS 010	Lighting Panels.
44NC-4600: ESS 011	Lighting and DC Distribution panels with MCBs
44NC-4600: ESS 012	Industrial Local Control Stations
44NC-4600: ESS 013	Flameproof Local Control Stations
44NC-4600: ESS 015	Capacitor Banks with Automatic Control Panels
44NC-4600: ESS 016	Control Panel
44NC-4600: ESS 017	Neutral Grounding Resistors
44NC-4600: ESS 024	Telephone System
44NC-4600: ESS 025	Static Uninterruptible Power Supply Unit (U.P.S)
44NC-4600: ESS 026	Electrical Installation
44NC-4600: ESS 027	Electrical Content of Package Unit
44NC-4600: ESS 029	Power Factor Improvement HV Capacitor Bank
44NC-4600: ESS 031	AC Variable Speed Drive System.
44NC-4600: ESS 032	Lighting Transformers
44NC-4600: ESS 034	Cathodic Protection System
44NC-4600: ESS 035	Conduit Installation for Conduits and Fittings Embedded in R.C.C. Work
44NC-4600: ESS 037	Motorized Valve Actuators
44NC-4600: ESS 038	Electrical Heaters
44NC-4600: ESS 039	Thyristor Control Panel for Electric Heaters

44NC-4600: ESS 059 3-Phase Alternating Current Generators Upto 1.5MVA For Standby Duty

Contd. ANNEXURE – I :List of reference standard specifications:

Ref. No.	Title
44NC-4600: ESS 061	Electrical Heat Tracing System
44NC-4600: ESS 062	Public Address System
44NC-4600: ESS 064	Electrical Control System (ECS)
44NC-4600: ESS 065	Soft Starter
44NC-4600: ESS 067	Flameproof distribution panel, plugs, sockets, lamps and Light fittings for Hazardous locations.
44NC-4600: ESS 069	Electrical system for E. O. T. Crane
44NC-4600: ESS 070	High Voltage Synchronous Motors
44NC-4600: ESS 076	Numerical Relays and MMI

7.3.8.9 Lighting poles & masts

7.3.8.10 Electronic equipments / DCS / PLC etc

7.3.9 All utility / process pipelines shall be earthed on entering or leaving the hazardous area, except where conflicting with the requirements of cathodic protection. In addition, steel pipe racks shall be earthed at every 25 meters. Earth continuity shall be ensured across all the flanges in process units & other hazardous areas. Equipment located remote from main earth network, may be earthed by means of individual earth conductors and earth electrodes.

7.3.10 Independent earthing loop for each S/S shall be connected with MEL

7.3.11 Earth pit engraved markers shall be provided for each earth pit.

7.3.12 Underground earthing strips to be provided with 50 % corrosion allowance.

7.3.13 For L.V. equipment earth loop impedance shall be such as to effect circuit disconnection in a time less than 1 second under solid earth fault conditions taking in to account the manufacturer's nominal time / current characteristics of protective device.

7.3.14 Earth resistivity measurements at different locations as required shall be carried out to establish average resistivity for earthing system design.

7.4 **STATIC EARTHING AND BONDING**

7.4.1 Vessels and pipelines, by the process of movement of flow of liquids, can lead to static charge generation due to friction, and these shall be properly bonded and earthed to system/safety earth to avoid accumulation of charge. Necessary earthing pads, earth strips, jumpers shall be provided.

7.4.2 Plant steel work shall be connected to the earth network at a minimum of two points.

7.4.3 Where equipment is mounted on steel structures and is in direct contact with plant steel work, no further bonding is necessary.

7.4.4 Where equipment is insulated from plant steel work two earthing connections shall be taken to the earthing network or to adjacent earthed steelwork.

7.4.5 Equipment shall normally be bonded to earthing system by bolted, connection such that removal of one connection shall not isolate any other item of equipment.

7.4.6 All pipelines shall be bonded together and connected to the earth network at the plot boundary and also the boundary between a hazardous and non-hazardous area.

7.4.7 Where the resistance across a flange connection exceeds 10Ω, GI bonding strap shall be fitted across the flange under one of the flange bolts.

7.5 **LIGHTNING PROTECTION**

7.5.1 All structures, columns, towers, vessels stacks and premises shall be checked for risk assessment as per IS 2309. Where lightning protection is found to be necessary, the recommendations of the standard shall be strictly followed. Self-conducting structures may not be provided with aerial rod and down conductors. They shall however be connected to the earthing system at minimum two points at the base. An independent earthing network shall be provided for lightning protection and this shall be bonded with the main earthing network only at the point of buried earth electrode.

7.5.2 Air terminations, ring, Faraday cage and down conductors shall be of G.I. strips/wires of adequate size and shape.

7.5.3 A dedicated system of an adequate number of electrodes shall be provided. These electrodes shall be pipe electrodes.

7.5.4 In hazardous areas, storage tanks upto 30m in diameter and the tallest structures and columns shall be directly connected as close to the base as possible to a minimum of two earth electrodes by 32 x 6 GI strip. Combined resistance shall not exceed 10Ω.

7.5.5 Storage tanks above 30m dia. shall be earthed with a minimum of three earth electrodes equally spaced round the tank

- 7.5.6 Any other tall structures, columns etc. which are considered to be likely recipients of lightning strokes by virtue of their height, relative to surrounding structures shall also be earthed as described above.
- 7.5.7 Separate lightning protection system shall be provided for tank farm areas considering high mast meeting the requirement of OISD standards and IS.
- 7.5.8 Where structure of equipment is not electrically continuous or made of poorly conducting material, down conductors and air termination shall be provided. Additional bonding shall be applied to structures as necessary in order that resistance from the highest point to earth does not exceed 10Ω .
- 7.6 **LIGHTING LAYOUTS**
- 7.6.1 Lighting layouts shall be designed to meet the illumination levels recommended in IS 3046.
- 7.6.2 Minimum illuminations levels as specified in CI 8.0 of Engineering Design basis – Electrical (44NC-4600-0000/E.02/0001/A4) shall be achieved while designing the lighting system.
- 7.6.3 Lighting design shall conform to relevant International Codes & Standards, IES Hand Book and shall take into consideration the requirements from point of view of safety and ease in operation and maintenance. Lighting design shall also take into consideration the requirements for green building concept as per guidelines given in Green Rating for Integrated Habitat Assessment (GRIHA). Maintenance factor of 0.8 shall be assumed for lighting illumination level calculation for normal areas. However, for dusty areas, maintenance factor as per relevant codes and standards shall be considered.
- 7.6.4 Generally plant lighting shall be classified as under:
- Normal lighting
 - Emergency lighting
 - Critical lighting
- 7.6.5 Normal & emergency lighting system shall be on 415 / 240 V system, where critical lighting shall be on 110 V DC.
- 7.6.6 Sufficient lighting shall be provided so as to enable plant operators to move safely within the accessible areas of plant and to perform routine operations.
- 7.6.7 Lighting requirements provided during the failure of power supply for normal lighting shall be broadly,
- To facilitate carrying out of specified operations, for safe shutdown of the plant.
 - To gain access and permit ready identification of fire fighting facilities.
 - Escape route for safe evacuation of operating personnel.
- 7.6.8 Recommended areas for critical lighting :
- Control rooms
 - Main substations
 - D.G./ T.G / G.T room
 - Central fire station
 - Fire water pump house
 - First aid centre
 - Emergency escape route.
 - Any other specific areas requiring critical lighting.

ANNEXURE-10

STANDARD SPECIFICATION FOR HV INDUCTION MOTORS



**STANDARD SPECIFICATION FOR
H.V. INDUCTION MOTORS**

DOCUMENT NO : 44NC- 4600 : ESS01B

Rev No.	Issue Date	Pages	Rev Description	Prepared By	Checked By	Approved By
0	03 May 2010	14	Issued for Engineering	VSL	PPP	RBD

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12.0	PACKING & DISPATCH
13.0	ATTACHMENTS / APPENDICES : NONE

1.0 SCOPE

- 1.1 This specification covers the Design, Manufacture, Testing and Supply of three phase squirrel cage induction motors of rating above 1000 V, upto and including 11 KV.
- 1.2 This specification shall accompany Data Sheets, Technical Specification which will stipulate specific requirements of motors. In case of contradiction between this specification and Data Sheets, the latter shall govern :
- Statutory regulations
 - Data sheets
 - Technical Specification
 - This specification
 - Codes & Standards

2.0 STANDARDS

- 2.1 Motors shall be manufactured in accordance with the latest Indian Standard Specification current at the time of order, including amendments, and in particular following :

IS 5	- Colors for ready mix paints & enamels
IS 325	- Three phase induction motors
IS 1079	- Preferred numbers
IS 1231	- Dimensions of three phase foot mounted induction motors
IS 1271	- Thermal evaluation and classification of electrical insulation
IS 2071	- Methods of high voltage testing
IS 2148	- Flameproof enclosures for electrical apparatus
IS 2223	- Dimensions of Flange mounted A.C. induction motors
IS 2253	- Designation for Types of construction and mounting arrangements of rotating electrical machines
IS 2254	- Dimensions of vertical shaft motors for pumps
IS 2968	- Dimensions of slide rails for electrical motors.
IS 4029	- Guide for testing 3 phase Induction Motors
IS 4691	- Degree of protection provided by enclosures for rotating electrical machinery
IS 4722	- Rotating electrical machines
IS 4728	- Terminal marking and direction of rotation for rotating electrical machinery.
IS 4729	- Measurement and evaluation of vibration of rotating electrical machine
IS 4889	- Method of determination of efficiency of rotating electrical machines

- | | | |
|----------|---|--|
| IS 5571 | - | Guide for selection of electrical equipment for hazardous areas |
| IS 6362 | - | Designation of methods of cooling of rotating electrical machines. |
| IS 6381 | - | Construction & testing of electrical apparatus with type of protection 'e' |
| IS 7389 | - | Specification for pressurized enclosures of electrical apparatus for use in explosive atmospheres. |
| IS 7816 | - | Guide for testing of insulation resistance of rotating machine |
| IS 8223 | - | Dimensions and output ratings for foot mounted induction motors with frame sizes 355-1000 |
| IS 8241 | - | Method of marking for identifying electrical equipments for explosive Atmosphere |
| IS 8289 | - | Specification for electrical equipment with type of protection 'n' |
| IS 8789 | - | Values of performance characteristics for 3 phase Induction motors |
| IS 9628 | - | Specification for three phase induction motor with type of protection 'n' |
| IS 12065 | - | Permissible limits of noise level for rotating electrical machines. |
| IS 12065 | - | Permissible limits of noise level for rotating electrical machines |
| IS 12075 | - | Mechanical vibration of rotating electrical machines with shaft heights 56mm and higher-Measurement, evaluation and limits of vibration severity |
| IS 12802 | - | Temp. rise measurement of rotating electrical machines. |
| IS 13408 | - | Code of practice for selection, installation & maintenance of the apparatus for use in potentially explosive atmospheres. |
| IS 13529 | - | Guide on effects of unbalanced voltages on the performance of three phase induction motors. |
| IS 13555 | - | Guide for selection & application of three phase induction motors for different types of driven equipments. |
| IS 14222 | - | Impulse voltage withstand levels for rotating electrical machines with form-wound stator coil. |
| IS 14568 | - | Dimensions & output series for rotating electrical machines, frame numbers 355 to 1000 and flange numbers 1180 to 2360 |

2.2 INTERNATIONAL STANDARDS

- | | | |
|-----------|---|---|
| IEC 60034 | - | Rotating Electrical Machines (All parts) |
| IEC 60072 | - | Dimensions and output ratings for rotating electrical machines. |
| IEC 60079 | - | Electrical Apparatus for Explosive Gas Atmospheres. |

- IEC 60085 - Thermal Evaluation and Classes of Electrical Insulation
 - IEC 60529 - Classification of degree of protection provided or enclosed.
 - IEC 60044-1 - Current Transformers
 - IEC 60281 - Roller Bearings – dynamic load ratings and rating life.
- 2.3 In case of imported motors, standards of the country of the origin shall be acceptable if these are equivalent to applicable Indian Standards.
- 2.4 In case Indian Standards are not available, standards issued by IEC/ BS/ VDE/ IEEE / NEMA or equivalent agency shall be applicable

3.0 CLIMATIC CONDITIONS

Ambient Conditions:

Motors shall be suitable for operating in humid & corrosive atmosphere found in refineries, fertilizers, petrochemical & metallurgical plants. Service conditions shall be defined as specified in the motor data sheet. If not specifically mentioned therein, a design ambient of 40°C and an altitude not exceeding 1000m above MSL shall be taken in to considerations.

4.0 ELECTRICAL SUPPLY SYSTEM

- 4.1 Characteristics of electric supply system will be specified in Data Sheets.

Variations in electric supply, under which motor shall be operated continuously without any adverse effects will be as follows, unless specified otherwise in the Data Sheets :

Voltage Variation	± 10%
Frequency Variation	± 5%
Combined Voltage & Frequency Variation	± 10%

- 4.2 Motors shall be designed to continue running through the following specific conditions against their specified loads and to recover to normal conditions when the voltage is restored to normal.

Induction motors : at zero voltage for 0.5 seconds, recovering instantaneously to atleast 85% normal volts.

5.0 DESIGN FEATURES

- 5.1 The offered equipment shall be brand new with state of the art technology and proven field track record. No prototype equipment shall be offered.
- 5.2 Vendor to ensure availability of spare parts and maintenance support services for the offered equipment at least for 15 years from the date of supply.
- 5.3 Vendor shall give a notice of at least one year to the end user of equipment before phasing out of product/ spares to enable the end user for the placement of order for spares & services.
- 5.4 GENERAL

-
- 5.4.1 All motors shall be suitable for continuous duty (S1) unless otherwise specified in Data Sheet. Intermittent rated motors shall conform to duty cycle specified in Data Sheet.
- 5.4.2 Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously with the variation in supply conditions as indicated in the data sheets
- 5.1.2 Motor body or frame shall be of close grained cast iron or of welded steel construction in case of large motors. The design of the body shall ensure ruggedness and damping of vibration. The rotor alongwith the fan and half coupling or other drive device (if fitted) shall be statically and dynamically balanced.
- 5.1.3 All parts of identical motors, such as rotors, bearings and end shields, etc. shall be fully interchangeable with specific reference to rotor.
- 5.1.4 Design and construction of the motors shall be such as to facilitate inspection, cleaning, maintenance and repairs.
- 5.1.5 Fans provided for fan-cooled motors shall preferably be of the bi-directional type, with protection against accidental contact. In case they are uni-directional, direction of rotation shall be clearly indicated on the non-driving end of the motor.
- 5.1.6 All motors shall have single bare shaft extension with key way and full key, except where noted otherwise, motor shaft shall be sized to withstand 10 times the rated design torque.
- 5.1.7 Fans for motors used in hazardous areas (Zone 1 and 2) shall be manufactured from non-sparking material and if non-metallic shall be painted with an electrically conducting paint, to prevent accumulation of static charge.
- 5.1.8 The coupling details shall be as follows:
- (a) Unless otherwise specified, all motors shall be coupled to the driven equipment through flexible coupling.
 - (b) The coupling half for the motor shaft shall be supplied by the driven equipment supplier. For this purpose, the Contractor / motor supplier shall co-ordinate all details of the coupling system with the driven equipment manufacturer, wherever required.
 - (c) Where rigid coupling is specified, the motor shaft shall have the desired class of accuracy.
 - (d) Wherever motor is to be coupled to a reciprocating compressor or pump requiring pulsating torque, Contractor/ Motor supplier shall carry out necessary co-ordination for the following:-
 - (i) Motor manufacturer shall ensure that the inertia of the driving and the driven machine assembly shall be such that the variation in the armature current shall not exceed $\pm 40\%$ of the rated current for Induction motors and $\pm 66\%$ of the rated current for synchronous Motors as per API – 618, while driving full load.
 - (ii) The measurement of armature current shall be done with the oscillograph.
 - (iii) The additional flywheel, if any, shall be assembled at such a distance from the motor so as to allow easy inspection of the windings.
- 5.1.9 Air to water heat exchanger shall have double tube plates, spray baffles and drip trays with siphon drains to prevent water reaching the windings.
- 5.1.10 Type of mounting required shall be as specified in Data Sheets.

5.2 ENCLOSURE

- 5.2.1 Enclosures for motors shall be as specified in Data Sheets. Degree of protection in accordance with IS-4691 shall also be as per Data Sheet.
Motors for outdoor installation shall be of weatherproof construction (IP 55) such that no additional protection is required to be provided by the Purchaser.
Vertical motors (IM V 1) shall be equipped with a rain cap over the fan cover.
- 5.2.2 Construction of enclosures for flameproof (Exd) motor and the terminal box shall conform to IS 2148 and shall be suitable for the group of gasses specified in Data Sheet.
- 5.2.3 Construction of enclosures for increased safety (Exe) motors shall conform to the latest Indian Standard Specification 6381 and shall be suitable for temperature class specified in Data Sheet
- 5.2.4 Vertical motors with downward shaft shall be provided with fully covering rain canopies. Vertical motors with upward shaft e.g. on fin-fan coolers, shall be adequately protected, (such as cowls/canopies) against ingress of water into the enclosure or the bearing housing even when standing still for long periods of time.
- 5.2.5 For hazardous area application motors with variable speed drive system shall be EExde type.
The total system shall be tested as a unit.

5.2.6 Cooling system

- 5.2.6.1 Self ventilated motors
All motors shall be self-ventilated, fan cooled. Fans shall be corrosion resistant or appropriately protected. They shall be suitable for motor rotation in either direction without affecting the performance of the motor. If this is not possible for large outputs, it shall be possible to reverse the fan without affecting the balancing of the motor.
Motors for installation in dusty atmosphere or in the presence of sand, fuels or other solid particles in suspension in the air shall be fitted with filters for the cooling air. The filters shall be easily accessible for the inspection and removable for cleaning and re-use.
- 5.2.6.2 Motors with forced ventilation
Motors with forced ventilation shall be provided with two motor driven fans each capable of supplying the full load quantity of cooling air required by the motor at full load.
The ventilation system shall include flanges for the air intake and mating flanges for the discharge ducts.
An airflow circulation indicator with electrical trip contacts, which operate if the flow of cooling air is interrupted or is inadequate, shall be provided.
- 5.2.6.3 Motors with closed circuit cooling with water to air heat exchangers
The material of heat exchangers shall be corrosion resistant and suitable for the type of water used. The heat exchangers shall be designed for minimum water pressure of 5 kg/cm² and with head losses not greater than 0.5 kg/cm².
The heat exchangers shall be arranged by the side(s) of the motor, if possible. Screens shall be provided to protect the motor windings from water leaks or leakage in the tubes. Suitable drains shall be fitted for draining water on case of leakage.
A cooling water flow circulation indicator with electrical trip contacts which close if the flow of cooling water is interrupted or is inadequate. The indicator shall be located on the discharge piping of the heat exchanger.

5.2.6.4 Motors with closed circuit cooling with air to air heat exchangers

The heat exchanger tubes shall be of steel or extruded aluminium. All exposed surfaces of the heat exchanger and of the motors shall be safeguarded against corrosion by immersion in varnish followed by banking.

Joints between the heat exchanger and the main body of the motor shall be sealed by weatherproof gaskets.

Filters shall be provided to prevent the ingress of dust and foreign particles. These shall be easily accessible for cleaning and replacement.

5.3 BEARING & LUBRICATIONS

5.3.1 All motors shall have ball and/or roller bearings or bearings of the sleeve type. Vertical motors shall have special thrust bearings.

5.3.2 All bearings shall be of reputed manufacture and of a type interchangeable with other makes and types. Ball and roller bearings shall have an L10 life of 40, 000 hours.

5.3.3 All bearings shall be provided with seals to prevent the ingress of dust, moisture and all other harmful substances.

5.3.4 For large capacity motors, the bearing shall be of the pedestal oil ring lubricated, sleeve type, fitted with liberally sized oil reservoir and level indicator. Sleeve bearings shall be designed with low bearing pressures and provided with drain plug. A thermometer with alarm and trip contacts shall also be provided.

5.3.5 Grease lubricated bearings shall be packed with suitable grease before the motors are despatched. These shall be provided with nipples, and relief valves or plugs, suitable for on-line greasing.

Bearing shall be capable of grease injection from outside without removal of covers with motors in the running conditions. The bearing boxes shall be provided with necessary features to prevent loss of grease or entry of dust or moisture. Where grease nipples are provided these shall be associated, where necessary, with appropriately located relief devices, which ensure passage of grease through the bearing. Pre-lubricated sealed bearings may be considered provided a full guarantee is given for 4 to 5 years of trouble-free service without the necessary of re-lubrication.

5.3.6 Wherever necessary, insulating pads between the bearing pedestals and bed plate shall be provided to eliminate shaft circulating currents. An earth terminal shall be provided on the drive and bearing pedestal.

5.3.7 For unlocked shafts, the end clearance on the motor shall exceed the coupling end float. Permissible limits of rotor movement shall be marked on the shaft.

5.3.8 Forced lubrication bearings

In this case the oil lubrication circuit may be common with or independent of the driven machine. In the later case, oil supply may be guaranteed by one of the following systems:

- (1) With a mechanical pump co-axial with the motor.
- (2) With a mechanical pump co-axial with the motor and supplemented by a separate motor pump for initial lubrication during start up and stopping operations.
- (3) With a separate motor driven pump. In this case the lubrication system shall consist of two identical motor driven pumps, one acting as standby.
- (4) The lubrication system with separate motor driven pumps under (2) & (3) shall be supplied with the following:
 - (a) Oil reservoir with resistance heater, if required by the type of oil or ambient conditions
 - (b) Motor driven pumps with check valves and bypass valves

- (c) Heat exchanger complete with accessories, if required
- (d) Oil filters with filtration efficiency of 10 microns
- (e) Control panel with accessories for operation and control of the lubrication system
- (f) Control devices, alarm and trip as follows:-
 - (i) An indicating pressure gauge fitted in the oil supply line to each bearing, for local control or checking of the lubricating oil pressure
 - (ii) One or more pressure switches with make break contacts for the interlocks required at start up and for tripping the motor
 - (iii) A thermostat with two electrical contacts for alarm and tripping in case of high oil temperature
 - (iv) A local flow indicator on the oil discharge line
 - (v) A thermostat for control of the electrical resistance heater provided for the oil
 - (vi) An indication thermometer for the temperature of the oil in the tank

5.3.9 Bearing insulation shaft voltage

Induced voltage at the shaft end of the motor at no load shall not exceed 250mV r.m.s. for roller and ball bearings and 400mV r.m.s for sleeve bearings. The non-driving end bearing shall be insulated from the motor frame to avoid circulating current.

The insulated bearing end shield or pedestal shall bear a prominent warning and manufacturer shall provide detailed drawing showing insulation arrange

5.4 TERMINAL BOX

5.4.1 Two separate terminal boxes shall be provided for SCR induction motors (unless otherwise specified in the Data Sheet), one for the line side terminals which will be suitable for power cable termination and the other for the neutral side terminals connected in Star in the terminal box. These shall have the same fixing dimensions so that their position can be inter marked at site, if required. The neutral end terminal box shall have adequate space and arrangement for mounting current transformers for differential protection, when specified in Data Sheets. In case of slip ring motors, one additional cable box shall be provided for power cable termination and connection to rotor winding terminals.

5.4.2 The terminal box for power cable termination shall be of phase segregated, pressure containing type. Terminal boxes of phase separated and pressure relief type may be provided, if specifically called for in the Data Sheets. One No. earth terminal shall also be provided inside cable box.

5.4.3 The terminal boxes shall have facilities and terminals suitable for the type and size of cable specified. In case of PVC or XLPE cables, the termination kit shall be housed in the terminal box and adequate space shall be provided for the same.

5.4.4 The terminal box shall be provided with pressure relief flaps/ devices for type. Ex 'e', Ex 'n' & industrial motors and shall be capable of withstanding the specified fault current for a period of 0.25 seconds.

5.4.5 An adequately sized earth terminal shall be provided in the motor terminal box for termination of the earth conductor

5.4.6 Identification of Terminals

Motor terminals as well as anti-condensation heater and temperature detector terminals shall be clearly identified as per IS 4728. A motor connection diagram shall also be affixed inside the terminal box on the cover.

5.4.7 Separate auxiliary terminal boxes shall be provided for anti-condensation heaters and temperature detectors. Caution nameplates with inscription "Caution-Live Heater / Detector

Terminals" shall be provided on auxiliary terminal boxes for heater and detector terminal boxes.

5.5 STARTING CHARACTERISTICS

5.5.1 Unless otherwise specified in data sheet, motors shall be designed for direct-on-line starting across full line voltage. Motors shall be designed for re-acceleration under full load after a momentary loss of voltage with the possibility of application of 100% of the rated voltage when the residual voltage has dropped down to 50% and is in phase opposition to the applied voltage.

5.5.2 All motors shall be suitable for starting under specified load conditions with 80% of the rated voltage at the terminals.

5.5.3 Minimum locked rotor thermal withstand time at rated voltage shall be 10 seconds under cold condition and 8 seconds under hot condition.

5.5.4 Unless otherwise specified, the hot thermal withstand time at 100% voltage shall be atleast 2 seconds more than the starting time at 80% of voltage.

5.5.5 All motors shall be capable of atleast two starts in quick succession after the motor windings have attained their maximum permissible temperature. If a more onerous duty is required, the same shall be indicated in the Data Sheet.

5.5.6 Starting current of squirrel cage motor with full voltage starting shall normally not exceed 550% of the full load current inclusive of positive tolerance.

5.5.7 Starting current at full voltage of slip-ring shall be limited by the rotor resistance starter to the values indicated in the Data Sheets. However, the value of locked rotor current shall not exceed that stated in 5.5.6 above. Motor manufacturer shall furnish appropriate value of external resistance required to limit the starting current as well as to obtain the required starting torque.

5.5.8 Starting torque and minimum torque of the motor shall be compatible with the speed torque curve of the driven equipment under specified operating condition. For heavy-duty drives such as blowers, compressors, etc. high starting torque motors shall be provided. In case where characteristics of driven equipment are not available while selecting the motor, minimum starting torque shall be 90% of rated value.

5.5.9 Motors driving high inertia equipment, the manufacturer shall provide calculations for acceleration time, torque speed curves for motor and current time curves. Necessary Data for the driven equipment such as torque-speed curves, moment of inertia etc., shall be furnished by others for this purpose.

In case of reciprocating compressor or similar equipment, the stator current pulsations shall be given by the manufacturer. In all cases, manufacturer shall ensure that the starting current withstand time of the motors shall be higher than the calculated starting time.

5.5.10 The manufacturer shall also furnish time tE for Exe and Ex n motors.

5.6 INSULATION AND WINDINGS

5.6.1 Motor shall be suitable for continuous running, without exceeding temperature limits when the motor terminal voltage drops to 80% of the motor rated voltage, for 5 minutes, commencing from hot condition

- 5.6.2 Winding of motors shall be treated or impregnated with suitable varnishes to render them non-hygroscopic and resistant to dirt and oil. Windings shall preferably be vacuum impregnated. Windings shall also be treated to make them resistant to acidic / alkaline vapours when the atmosphere is specified as corrosive.
- 5.6.3 H.V. & M.V. Motors shall have class 'F' insulation with class 'B' temperature rise, unless specified otherwise. Insulation of the motors should withstand high surges due to switching operations of vacuum / SF6 circuit breakers.
- 5.6.4 All insulating materials used in the construction of motors shall be non-hygroscopic. Coils shall be made of copper.
- 5.6.5 Insulation and impregnation of windings shall be carried out in a manner which will facilitate easy removal and replacement of coils. All coils shall be adequately supported to prevent movement under shock or short circuit stresses, or shocks due to electro-dynamic braking with phase reversal.
- 5.6.6 Joints shall be kept to a minimum, where joints are made, conductors shall be tinned to prevent oxidation, riveted and soldered or brazed.
- 5.6.7 All joints shall be supported adequately to relieve them from mechanical strain. Insulation level of the joints shall not be less than for the motor windings.
- 5.6.8 Leads from motor windings to the terminal box shall be adequately supported throughout and shall be kept away from sharp edges to prevent abrasion. Openings in the motor frame through which the leads are brought out shall be sealed to isolate the terminal box from the motor.
- 5.6.9 Windings shall be designed to withstand voltage surge as per applicable IS. The wave shape shall be as per IS.
- 5.6.10 In case of motors driving equipment with pulsating loads, special attention shall be paid to the joints of rotor bars and end rings to avoid premature failures due to induced fatigue stresses.

5.7 TEMPERATURE RISE

- 5.7.1 The temperature rise of motors for all types of enclosures when tested in accordance with IS 325 shall not exceed the limits specified therein, corresponding to the class of insulation used and on the basis of normal conditions of service stipulated in Data Sheets.

5.8 ROTORS

- 5.8.1 The rotor shall be of squirrel cage type, dynamically balanced to provide a low vibration level and long service life for the bearings. The accepted values of peak to peak vibration amplitudes for a motor at rated voltage and speed shall not exceed those given in IS: 12075. The shaft ends shall be provided with suitably threaded hole or holes to facilitate the assembly or removal of couplings and bearing races. Die cast aluminum rotors for motors in hazardous areas may be accepted provided the same are type tested and approved by competent authorities.
- 5.8.2 The first actual critical speed of stiff rotors shall not be lower than 125% of the synchronous speed. For flexible rotors this shall be between 60% and 80% of the synchronous speed; the second actual critical speed shall be above 125% of the synchronous speed.
- 5.8.3 The rotor shall be constructed so as to allow the removal or addition of material for balancing

5.9 EMBEDDED TEMPERATURE DETECTORS

5.9.1 Embedded temperature detecting sensors shall be provided as specified in data sheets. HT motors shall have 6 nos duplex RTDs for winding temperature detection, 2 nos bearing temperature detectors with suitable scanners. Dual dial type temperature indicator without contact for bearing shall also be provided.

5.9.2 Adequate precaution shall be taken to ensure that detector leads shall not be charged accidentally to motor potential. Film type arrestors will be fitted at detector terminals in terminal boxes to prevent danger to detecting equipment and personnel.

5.10 ANTI-CONDENSATION

5.10.1 Anti-condensation heaters shall be provided when specifically asked for. Heaters shall normally be suitable for 250 volts, Single Phase, A.C. supply, designed for continuous operation unless otherwise specified in Data Sheet. Heaters shall be metal encased with a low surface temperature. In addition, a removable, threaded, plug shall be provided to remove condensed moisture.

5.11 LIFTING HOOK

All motors shall be provided with lifting hooks or eye bolts.

5.12 EARTHING TERMINALS

5.12.1 Two earthing terminals comprising terminal studs, two plain washers, one spring washer shall be provided preferably on diagonally opposite sides of the frame.

5.12.2 All accessories used shall be hot dip galvanised.

5.13 PAINTING

5.13.1 Before despatch from the motor manufacturer's works, all motors shall have all bright parts coated with anti-rusting compound.

5.13.2 All motors shall be painted in an approve manner using two priming coats, one undercoat and one finish coat to the Purchaser's Painting Specification, and shall have all surface thoroughly cleaned and degreased prior to painting.

5.13.3 The Purchaser's Painting Specification will be issued to the Vendor when orders are placed. The final colour shall be to the Purchaser's requirements.

5.14 RATING PLATES, LABELS & MARKING

5.14.1 Rating plates shall be provided on all motors. These rating plates together with any labels giving necessary instructions, shall be of a design so that corrosion will not cause obliteration.

5.14.2 The Purchaser's Motor reference and bearing numbers and other details shall be marked on an auxiliary stainless steel nameplate if called for in Data Sheets.

5.15 VIBRATIONS

The motor vibration shall not exceed the value specified in the IS-12075 when measured on the bearing housings of motors in the horizontal, vertical & axial directions operated with no-

load at rated voltage and rated frequency. Motors with sleeve bearings shall be provided with proximity probes to measure the shaft vibrations.

5.16 NOISE LEVEL

The mean sound pressure level of motors shall not exceed 85 dBA at 1 meter, measured in accordance with IS-12065 or relevant IEC standard.

5.17 BEDPLATES & SOLEPLATES

When slide rails, bedplates or soleplates are supplied alongwith motor, the holding down bolts for the motor shall also be supplied.

6.0 SPECIAL TOOLS

A set of any special tools necessary for maintaining the whole of the requirement supplied shall be provided.

7.0 INSPECTION AND TESTING

7.1 Test Certificates shall be furnished for all motors indicated in the Data Sheets.

7.2 Routine tests as per IS 4722 shall be carried out on all motors. Type tests shall be carried out on H.V. / M.V. Motors. In case of identical motors, type tests may be carried out on the first of each rating and speed. The following additional tests shall be carried on H.V. / M.V. Motors :

- a) Readings of voltage, current, power input & slip at 75% and 50% full load
- b) Measurements to enable calculation of pull out torque
- c) Measurement of induced shaft voltage
- d) Polarisation index test
- e) Tan delta test

7.3 The Purchaser reserves the right to witness all tests and the Purchaser shall be given ten working days notice of all tests being carried out.

7.4 All apparatus, instruments etc. required for tests shall be provided by the manufacture and shall have been checked and tested for accuracy during the twelve months prior to the test.

7.5 The manufacturer shall submit the following certificates for verification by the Owner's Inspector:

- (a) Test certificate for the degree of protection of enclosure
- (b) Short circuit test for terminal box
- (c) Impulse test certificate
- (d) Test certificates issued by the recognized independent test house for hazardous area motors
- (e) Approval certificates issued by Statutory Authorities for Ex-d or Ex-e motors
- (f) BIS license & marking requirement as required by Statutory Authorities for Ex-d motors
- (g) Hydraulic test certificate for coolers

- 7.6 Thought the motors shall be accepted on the basis of the satisfactory result of the testing at shop, it shall not absolve the Vendor from liability regarding the proper functioning of the motors coupled to the driven equipment at site.

8.0 INFORMATION, DRAWINGS, LITERATURES

- 8.1 Vendor to furnish these as per Vendor Document Requirements attached with the specification. The drawings shall generally include the following :

- | | | |
|----------------------|---|--|
| GA drawings | - | Fully dimensioned, indicating foundation details, number and size of cable entries, frame sizes etc. |
| Terminal Box Drawing | - | Fully dimensioned, including arrangement of terminals |

Terminal Wiring Diagram

9.0 SPARES

The Vendor shall provide with his quotation, separate priced list of recommended commissioning and operating spares.

10.0 QUALITY ASSURANCE

- 10.1 Quality Assurance shall follow the requirements of Jacobs Engineering India Pvt. Ltd. QA documents.
- 10.2 Quality Assurance will commence at the enquiry stage and follow through to completion and acceptance, thus ensuring total conformity to Purchaser's requirements.

11.0 DEVIATIONS

- 11.1 Deviations from specification must be stated in writing at the quotation stage.
- 11.2 In the absence of such a statement, it will be assumed that the requirements of the specification are not without exception.

12.0 Packing & Dispatch

All the equipment shall be divided into several sections for protection and ease of handling during transportation. The equipment shall be properly packed for transportation by ship/ rail or trailer. The equipment shall be wrapped in polythene sheets before being placed in crates/ cases to prevent the damage to finish. Crates/ cases shall have skid bottom for handling. Special notations such as 'Fragile', 'This side up', 'Centre of gravity', 'Weight', 'Owner's particulars', 'PO no' etc shall be clearly marked on the package together with other details as per purchase order.

The equipment may be stored in outdoors for long periods before installation. The packing shall be completely suitable for outdoor storage in areas with heavy rains/ high ambient temperature, unless otherwise agreed.

ANNEXURE-11

MASTER DOCUMENT LIST AND BOM STANDARD FORMAT

MASTER DOCUMENT LIST													
System Name:			Supplier:		Project:			Supplier Doc. No.					
					Supplier Job No.		BHEL PO No.		Rev No.				
							Date		Date				
LIST OF SUPERCEDED DRAWINGS / DOCUMENTS					S					NO COMMENTS			1
LIST OF ACTIVE DRAWINGS / DOCUMENTS										COMMENTS AS MARKED CLEARED FOR MANUFACTURE			2
LIST OF DRAWINGS/DOCUMENTS UNDER PREPARATION					UP					COMMENTS AS MARKED			3
LIST OF DESEEN / APPROVED DRAWINGS					ADS					RETAINED FOR INFORMATION			4
SL. NO.	DRAWING/ DOCUMENTS	DWG. NO.	APPR (A/T)	SCHEDULE OF SUBMISSION	REV	SENT BY VENDOR (SOFT COPY)	HARD COPY RECEIVED FROM VENDOR	COMMENTS SEND TO VENDOR	STS	PENDING WITH (BHEL/VENDOR)	BHEL APP STATUS	REMARKS	
MECHANICAL													
1	PUMP WRITE-UP		A										
2	GAD of Pump		A										
3	Pump Cross Sectional Drawing		A										
4	Pump P&ID		A										
5	Motor GAD and Cross sectional Drawing		A										
6	Coupling Drawing & Details		I										
7	Strainer GA Drawing and details		I										
9	Mechanical Seal Drawing and details		I										
DATASHEET, OTHER DETAILS & CURVES													
1	Pump Data Sheet (BHEL Format)		A										
2	Pump Data Sheet (JACOBS Format)		A										
3	Motor Data Sheet (BHEL Format)		A										
4	Motor Data Sheet (JACOBS Format)		A										
5	Pump Performance curve		A										
6	Motor Curves		I										
7	NDE Test Procedure		A										
8	Painting procedure		A										
9	Performance Test Procedure		A										
10	Hydro Test Procedure		A										
11	ARC Valve details and document		I										
12	Packing List		I										
CALCULATION													
1	Strainer Area calculation		I										
2	Strainer Pressure Drop calculation												
MISCELLANEOUS													
5	BILL OF MATERIAL		A										
6	BILLING BREAKUP		A										
7	CABLE SCHEDULE		I										
8	JB SCHEDULE		I										
9	ELECTRICAL LOAD LIST		A										
10	QUALITY ASSURANCE PLAN		A										
11	SUB VENDOR LIST		A										

SL. NO.	DRAWING/ DOCUMENTS	DWG. NO.	APPR (A/T)	SCHEDULE OF SUBMISSION	REV	SENT BY VENDOR (SOFT COPY)	HARD COPY RECEIVED FROM VENDOR	COMMENTS SEND TO VENDOR	STS	PENDING WITH (BHEL/VENDOR)	BHEL APP STATUS	REMARKS
12	DYNAMIC LOAD DIAGRAM		I									
13	INSTRUMENT INDEX		I									
14	SIZING CALCULATION FOR PSV ELEMENTS (If any)		I									
15	INSTRUMENT I/O LIST		I									
16	LOGIC DIAGRAM		I									
17	PLC CONFIGURATION/ CONTROL LOGICS		I									
18	POWER CIRCUIT DIAGRAM FOR BFP SYSTEM		I									
19	CONTROL CIRCUIT DIAGRAM FOR BFP SYSTEM		I									
20	LUBE OIL HEATER CONTROL SCHEME (IF LUBE OIL SYSTEM IS APPLICABLE)		I									
21	MANDATORY SPARE PART LIST		I									
22	LUBE OIL SCHEDULE		I									
PROCEDURES & MANUAL												
1	OPERATION & MAINTENANCE MANUAL (Soft Copies & Hard copies)		I									
2	OVERALL SYSTEM OPERATION PHILOSOPHY		I									
3	STARTUP PROCEDURE		I									
4	SURFACE PREPARATION & PAINTING SPECIFICATION		I									
5	ERECTION PROCEDURE		I									
6	COMMISSIONING PROCEDURE		I									
7	FAT PROCEDURE		I									
8	INSPECTION/TESTS REPORTS/CERTIFICATE		I									
9	WELDING PROCEDURE (If any)		I									
10	BAR CHART FOR BFP PACKAGE		I									

(SUB-VENDOR PACKAGES)

(NOTE: ASSEMBLED UNITS AND ALL LOOSE DESPATCHABLE ITEMS IDENTIFIED IN THIS BOM)

[illegible]

MASTER DOCUMENT LIST (MDL)

System Name:	Supplier:	PROJECT:	Supplier Doc. No.:				
		Supplier Job No.:	BHEL P.O. No.		Rev. No.		Sh.
			Date		Date		1
							of

System: Mech./Elec.	Drg./ Doc. Name	Drg./Doc.			Cat A/I	Submission status to BHEL				BHEL Response status	Remarks
		Number	No. of sht	Rev. No.		Rev.0 Date	Rev.1 Date	Rev.2 Date	Final Rev.(R Date		
Instrum./Civil											
Mechanical											
M.01											
M.02											
M.03											
....											
....											
....											
Electrical											
E.01											
E.02											
E.03											
....											
....											
Instrumentation											
I.01											
I.02											
I.03											
Civil											
C.01											
Quality Q,01											
Q.01											
Erection											
E.01											
E.02											
E.03											
Procedures											
P.01											
B.O.M											
A-Approval					Prepared By:		Approved By:		Supplier Doc. No.:		
I-Information					Sign :		Sign :				
					Date :		Date :				

ANNEXURE-12

ENGINEERING DESIGN BASIS FOR INSTRUMENTATION

SPECIFICATION NO: 44NC-4600-0000/J.02/0001/A4**TITLE:** ENGINEERING DESIGN BASIS FOR INSTRUMENTATION**PROJECT REFERENCE:**

- **Project No:** 44NC-4600
- **Project Location:** Manali, Chennai
- **Project Title:** RESID UPGRADATION PROJECT
- **Client:** Chennai Petroleum Corporation Limited
- **Project Manager Authorization:** K.A. DEGVEKAR **Date:**
- **Client Authorization:** **Date:**

				APPROVALS		
Rev. No.	Issue Date	Pages	Revision Description	By	Check	Approve
0	06 Sept,13	31	Client comments incorporated & Re-Issued for Engineering	TRM	SPM	BSP
B	25 May,10	34	Client comments incorporated & Issued for Engineering	VMK	MSD	BSP
A	03 March,10	32	Issued For Comments	ADM	MSD	BSP
☒ Entire Specification Issued this Revision			SPECIFICATION ISSUED FOR:			
☐ Revised Pages Only Issued this Revision						
			☐ In-house Review	☐ Purchase		
			☒ Client Approval	☐ Construction		
			☐ Enquiry	☐ Engineering		

PROJECT NO.: 44 NC-4600**SPEC. NO. 44NC-4600-0000/J.02/0001/A4****TITLE: ENGINEERING DESIGN BASIS FOR
INSTRUMENTATION****REV. NO / ISSUE DATE - 0 / 06-Sept-13****Page 2 of 31****TABLE OF CONTENTS****1.0 GENERAL****2.0 DESIGN BASIS – GENERAL**

- 2.1 CODES, STANDARDS AND REGULATIONS
- 2.2 STANDARDS FOR INSTRUMENT CONNECTIONS, MATERIAL & ENCLOSURE
- 2.3 ENGINEERING UNITS
- 2.4 CLASSIFICATION OF HAZARDOUS AREAS
- 2.5 EXPLOSION PROTECTED CONSTRUCTION
- 2.6 TRANSMISSION AND CONTROL SIGNAL
- 2.7 INSTRUMENT POWER AND AIR SUPPLY
- 2.8 UNINTERRUPTED POWER SUPPLY (UPS)
- 2.9 VESSEL INSTRUMENT NOZZLE SIZES AND INSTRUMENT CONNECTION SIZES
- 2.10 INSTRUMENT SCALES / DISPLAY UNITS
- 2.11 INSTRUMENT COLOURS
- 2.12 CONTROL PHILOSOPHY
- 2.13 CONTROL ROOM / SATELLITE RACK ROOM GENERAL REQUIREMENTS

3.0 INSTRUMENT SPECIFICATION

- 3.1 FIELD INSTRUMENTS

4.0 INSTRUMENT PANEL

- 4.1 INSTRUMENT PANELS IN CONTROL ROOM
- 4.2 LOCALLY MOUNTED PANELS

5.0 DISTRIBUTED CONTROL SYSTEM (DCS)

- 5.1 MINIMUM FUNCTIONAL REQUIREMENT
- 5.2 OPERATOR CONSOLES
- 5.3 ENGINEERING CONSOLES
- 5.4 TYPES OF REPORTS REQUIRED
- 5.5 ACCESSORIES
- 5.6 TYPE OF CONTROLLER
- 5.7 SEQUENCE OF EVENT RECORDING
- 5.8 SCAN TIME REQUIREMENT
- 5.9 FOREIGN DEVICE INTERFACE REQUIREMENT
- 5.10 ADVANCE CONTROL FUNCTION REQUIREMENTS
- 5.11 TRAINING KIT
- 5.12 REDUNDANCY PHILOSOPHY
- 5.13 PROCESSOR LOADING PHILOSOPHY
- 5.14 SOFTWARE

6.0 OTHER INSTRUMENTATION SYSTEMS

- 6.1 FIRE & GAS DETECTION SYSTEM
- 6.2 INTEGRATED MACHINE MONITORING SYSTEM
- 6.3 BOILER DRUM INSTRUMENTATION
- 6.4 STACK MONITORING SYSTEM
- 6.5 CCTV SYSTEM

PROJECT NO.: 44 NC-4600**SPEC. NO.** 44NC-4600-0000/J.02/0001/A4**TITLE: ENGINEERING DESIGN BASIS FOR
INSTRUMENTATION****REV. NO / ISSUE DATE - 0 / 02-Sept-13****Page 3 of 31****7.0 INSTRUMENT PIPING AND WIRING SPECIFICATION**

- 7.1 INSTALLATION / TUBING HOOK-UP
- 7.2 INSTRUMENT AIR SUPPLY PIPING
- 7.3 INSTRUMENT CABLING
- 7.4 JUNCTION BOX
- 7.5 GROUNDING
- 7.6 HEAT TRACE

8.0 SPARE PHILOSOPHY**9.0 ATTACHMENTS**

- 9.1 Annexure I - Control room, satellite rack room, control monitoring & Interlock shutdown Requirements
- 9.2 Annexure II –Design Basis Notes
- 9.3 Annexure III –General Specification of Instruments
- 9.4 Instrument connection on vessels, stand pipes and tanks (4600-JSD-001).
- 9.5 Instrument connection on piping (4600-JSD-002).
- 9.6 Instrument connection on fired heater (4600-JSD-003).
- 9.7 Thermowell (4600-JSD-501).
- 9.8 Thermocouple / RTD assembly with Thermowell (4600-JSD-502).
- 9.9 Orifice Plate Dimensional details (4600-JSD-201).
- 9.10 Typical arrangement for instrument air distribution (4600-JSD-005).

PROJECT NO.: 44 NC-4600**SPEC. NO. 44NC-4600-0000/J.02/0001/A4****TITLE: ENGINEERING DESIGN BASIS FOR
INSTRUMENTATION****REV. NO / ISSUE DATE - 0 / 06-Sept-13****Page 4 of 31****1.0 GENERAL**

1.1 This design basis covers the general requirements for instrumentation design, fabrication and installation.

1.2 The following priority shall be applied when any contradictions are found between the various specifications or drawings.

1st priority	:	Process Licensor's documents
2nd priority	:	Job Specifications & Job Drawings
3rd priority	:	Engineering Design Basis
4 th priority	:	Standard Specifications, standard Drawings & Engineering standards

Note: In case of any conflicts most stringent requirements shall be followed, however it shall be obligatory on the contractor's part to bring such conflicts to the notice of owner/PMC, wherein owner/PMC decision shall be final.

Engineering design Basis shall supersede general specification of Instruments in case of any discrepancies.

1.3 LEGEND

Following marks shall be checked in the relevant square box.

☒	:	Applicable
☒	:	Mostly applicable
☒	:	Partially applicable
☐	:	Not applicable
☒	:	To be decided at the Detailed Engineering stage

2.0 DESIGN BASIS - GENERAL**2.1 CODES, STANDARDS AND REGULATIONS**

Applicable national / international standards

Design and terminology shall comply, as a minimum, with the latest edition prior to the date of purchaser's enquiry of following codes, standard practices and publications:

AGA (American Gas Association)

AGA Report no.3.1 Orifice Metering of Natural Gas and other related hydrocarbon fluids. (General Equations & uncertainty guidelines), Third edition (year-1990), 2nd printing-2003

AGA Report no.3.2 En-orifice metering of natural gas and other related hydrocarbon fluids part 2 Specification and Installation Requirements-Fourth Edition (year-2000), 2nd printing-2003

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AGA Report no.3.3 En-orifice metering of natural gas and other related hydrocarbon fluids
part 3 Natural gas application, Third Edition (year-1992), 2nd printing-
2003

AGA Report no.3.4 En-orifice metering of natural gas and other related hydrocarbon fluids
part 4 Background Development Implementation Procedure and
Subroutine Documentation for Empirical Flange- Tapped Discharge
Coefficient Equation, Third Edition (year-1992), 3rd printing-2003

AGA Report no.7 Measurement of Gas by Turbine meters. (Year -2006)

AGA Report no.-9 Measurement of Gas by Multi-Path Ultrasonic meters. (Year – 2007)

ANSI/ASME (American National Standards Institute/American Society of
Mechanical Engineers)

B 1.20.1 Pipe Threads (Year - 1983)

B 16.5 Steel Pipe Flanges and Flanged Fittings (Year- 2013)

B 16.20 Ring Joint Gaskets and Grooves for Steel Pipe Flanges (Year- 2012)

B 16.36 Orifice Flanges (Year- 2009)

~~B.16.37 Hydrostatic Testing~~

MC 96.1 Temperature Measurement Thermocouple (Year-1975)

MC 96.1 Color coding of Thermocouple Extension cable (Year-1975)

ANSI/FCI (American National Standards Institute/Fluid Controls Institute)

70.2 Control Valve Seat Leakage Classification (Year-2013)

API (American Petroleum Institute)

RP520 Sizing, selection and installation of pressure relieving system in
refineries.

Part I -Sizing and selection (Year- 2008)

Part II -Installation (Year- 2011)

RP521 Guide for pressure relieving and depressurizing systems. (Year 2007)

RP526 Flanged steel safety relief valves. (Year 2009)

RP527 Seat tightness of pressure relief valves (Year- 2007)

RP551 Process Measurement Instrumentation.

Part -1 – Process Control and Instrumentation (Year 1993, Revision-
2007)

RP552 Transmission Systems (Year -1994)

RP553 Refinery Control Valves (Year- 1998, Revision-2007)

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RP554	Process Instrumentation and Control (Year- 1995) Part 1-Process Control Systems Functions and Functional Specification Development, Second Edition (Year-2007) Part 2-Process Control Systems Process Control System design, First Edition (Year-2008) Part 3-Process Control Systems Project Execution and Process Control System Ownership, First Edition (Year-2008)
RP555	Process Analyzers (Year- 2001, Reaffirmed 2007)
STD.2000	Venting Atmospheric and low-pressure storage tank refrigerated & non-refrigerated (Year-2009)
STD. 670	Vibration, Axial-Position and Bearing-Temperature Monitoring Systems (Year-2010)
ASME	(American Society of Mechanical Engineers)
Section – VIII	Boiler and Pressure Vessel code rules for construction of pressure vessels (Year- 2013)
Section – I	Boiler and Pressure Vessel code. Section-1 'Power Boilers.' (Year- 2010)
PTC 19.3	Thermo-well design (Year – 2010)
ASTM	(American Society for Testing and Materials)
BS	(British Standards)
BS-5308	Part II Specification for PVC insulated cables. Year 1986
BS-7244	Flame arrestors (Year- 1990)
BS-1259	Intrinsically safe electrical apparatus & conduits
BS-6364	Specification for valves for cryogenic service –(Year-1984)
BS-50288-7	Multi-element metallic cables used in analogue and digital communication and control. Sectional specification for instrumentation and control cables (Year-2005)
CENELEC	Committee European de Normalisation Electro technique
DIN	German Standards
DIN 43760	Temperature Vs Resistance curves for RTDs (Year – 1987)
DIN-19234	Electrical Distance Sensors: DC interface for Distance Sensor and Signal Converter. (Year – 1990)
DIN 60947-5-6	Low Voltage switchgear & control gear (Year-2000-12)
DIN-10204	Inspection Documents for Metallic Products (year-2005)
IBR	Indian Boiler Regulations

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IEC	(International Electro-technical Commission.)
IEC 60079	Electrical apparatus for Explosive Gas atmosphere (Year -2011)
IEC 60079-1	Explosive atmosphere equipment protection by flameproof enclosure'D' (Year -2007)
IEC 60079-11	Explosive atmospheres – Part 11: Equipment protection by intrinsic safety "i" (Year -2011)
IEC60085	Thermal Evaluation and Classification of Electrical Insulation.(Year -2007)
IEC60332	Test on bunched wires or cables. Part III Cat. A (Year – 2000)
IEC60529	Classification of degree of protection provided by enclosures.- (Year-2001)
IEC60534-2-1	Industrial Process Control Valves-Flow capacity - Sizing equations for fluid flow under installed conditions (Year-2011)
IEC60534-2-3	Industrial Process Control Valves-Flow capacity – Test procedures (Year-1997)
IEC60584-2	Thermocouple – Tolerances (Year-1982)
IEC60751	Industrial Platinum Resistance Thermometer & Platinum Temperature Sensors. (Year-2008)
IEC61000-4-1	Electromagnetic compatibility-Part-4-1 Testing and measurement techniques - Overview of IEC 61000-4 series (Year-2006).
IEC61000-4-2	Electromagnetic compatibility-Part-4-2 Testing and measurement techniques - Electrostatic discharge immunity test (Year-2008).
IEC61000-4-3	Electromagnetic compatibility-Part-4-3 Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test (Year-2010).
IEC 61508	Functional safety of Electrical/Electronic Programmable Electronic Safety Related System (Year-2010)
IEC 61511	Functional safety: safety Instrumented systems for the Process Industry sector (Year-2003)
IEC 61158-2	Foundation Fieldbus Specifications (Year -2010)
IS	(Indian Standards)
IS-5	Colors for ready mixed paints (Year- 2007)
IS-319	Specification for free cutting Brass bars, rods and sections (Year -2007)
IS-1239-1	Mild steel tubes, tubular and other wrought steel fittings.(Year -2010)
IS-1239-2	Steel Tubes, Tubulars and Other Steel Fittings Part 2 Steel Pipe Fittings. (Year -2011)
IS-1271	Specification of Thermal Evaluation and Classification of Electrical Insulation. (Year -2012)
IS-1554	PVC insulated (heavy-duty) electric cables working Part I Voltage up to and including 1100V. (Year- 2007)
IS-2074	Ready mixed paints, air drying, and red oxide-zinc chrome. (Year 2006)
IS-2148	Flameproof enclosures for electrical apparatus for explosive Gas Atmospheres – Flame proof Enclosures 'd'. (Year- 2004)
IS-3624	Specification for pressure and vacuum gauges (year 1987)
IS-5780	Intrinsically safe electrical apparatus & circuits

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IS-5831	PVC insulation and sheath of electric cables. (Year -1995)
IS-7358	Specifications for Thermocouples (Year- 1984)
IS-8784	Thermocouple compensating cables. (Year- 1987)
ISA	(Instrument Society of America)
S-5.1	Instrument symbols and Identification (Year- 2009)
S-5.2	Binary logic for process operation (Year-1992)
S-7.1	Quality standards for instrument air.(Year-1996)
S-75.01	Flow equations for sizing control valves.(Year- 2012)
RP-75.08.01	Face to Face dimension of integral flanged globe control valve (Year-2007)
75.19.01	Hydrostatic Testing of Control Valve
ISO	(International Organization for standardization)
ISO 5167	Measurement of fluid flow by means of orifice plates, nozzles and venturi tubes inserted in circular cross-section conduits.-Year 2003
AG181	Foundation Fieldbus System Engineering Guidelines (Year-2012)
FF890-894	Foundation Fieldbus Specification Function Block Application process (Year-2012)
Other standards:	
NACE	National Association of Corrosion Engineers
MR-01-03	Sulphide stress cracking resistant metallic materials for oilfield equipment.
NEC	National Electric code.
NEMA	National Electrical Manufacturer's Association
NFPA	National Fire Protection Association.
NFPA-496	Purged and pressurized enclosures for electrical equipment. (Year 2013)
OSHA	Occupational Safety and Health Authority.
MPMS	Manual of Petroleum measurement standards.
SAMA	Scientific Apparatus Maker's Association.
OISD-STD-152	Safety System Instrumentation for process in HC Industry.(Year-2008)
OISD-STD-163	Process control room Safety. (Year- 2004)
OISD-STD-132	Inspection of Pressure relieving Devices. (Year -1999)

Apart from listed above OISD, latest standards applicable as on date of enquiry for Instrumentation of Packages like Turbine, Compressor, Diesel Engines and Fire protection system etc.

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2.2 STANDARDS FOR INSTRUMENT CONNECTIONS, MATERIAL & ENCLOSURE

Instrument connections, material of construction and type of enclosure protections shall be as per following codes & standards.

- Flange	ANSI	☒		
- Thread	NPT	☒		
- Material	ASTM	☒		
- Area Classification	CENELEC	☒		
- Explosion-proof	CENELEC	☒	IS-2148	☒ measure

2.3 ENGINEERING UNITS ☒ Metric unit

2.4 CLASSIFICATION OF HAZARDOUS AREAS

2.4.1 Process area ☒ Hazardous area, Refer hazardous area drawings
☐ Non hazardous area

2.4.2 Utility / Offsite area ☒ Hazardous area, Refer hazardous area drawings
☒ Non hazardous area, Refer hazardous area drawings

2.4.3 Control room Non hazardous area

2.4.4 Satellite Rack room (SRR): Hazardous area

2.5 EXPLOSION PROTECTED CONSTRUCTION

2.5.1 Type

- 2.5.1.1 Flame proof ☐
☒ Used for field switches such as Vibration Switches
☒ Used for field transmitters, Analysers requiring separate power supply
☒ Used for Local Control Panels in Hazardous area
(All internal components / instruments to be flame proof)
- 2.5.1.2 Intrinsically safe ☒ Used for Field Transmitters, I/P Converters, SMART Positioner, Proximity Switches, Solenoid Valves & analysers if available
- 2.5.1.3 Pressurized ☒ Pressurized panels to be used only for vibration monitoring System display unit.

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- | | | | |
|---------|---|--|---------------------------------------|
| 2.5.2 | Accessories | | |
| 2.5.2.1 | Isolating type Intrinsic safe barriers | ☒ Required (3 Port Isolation) | ☐ Not required |
| | - Analog Input | ☒ Required | ☐ Not required |
| | - Analog Output | ☒ Required | ☐ Not required |
| | - DC or RTD Input | ☒ Required | ☐ Not required |
| | - Pulse Input | ☒ Required | ☐ Not required |
| | - Digital Input (Proximity switches) | ☒ Required | ☐ Not required |
| | - Digital Output (Solenoid Valves) | ☒ Required | ☐ Not required |
| 2.5.2.2 | Interposing Relays | ☒ Required | ☐ Not required |
| | - Digital Input | ☒ Required | ☐ Not required |
| | - Digital Output | ☒ Required | ☐ Not required |
| 2.5.2.3 | Isolators
(4 wire Flameproof Instruments,
MCC analogue I/O) | ☒ Required | ☐ Not required |
| 2.5.3 | Explosion class and ignition group | | |
| 2.5.3.1 | Flame proof | ☒ Ex d (to suit specified hazardous area) | |
| 2.5.3.2 | Intrinsically safe | ☒ Ex 'ia' (to suit specified hazardous area) | |
| 2.5.4 | Weather proof class | ☒ IP-65 for field instruments | |
| | | ☒ IP-67 for field instruments in Buried line | |
| | | ☒ IP-55 for Local Control Panel | |
| | | ☒ IP-42 for control room mounted equipment | |
| 2.6 | TRANSMISSION AND CONTROL SIGNAL | | |
| 2.6.1 | Electronic | ☒ "Smart" for Field Transmitters & Positioners | |
| | | ☒ 4 to 20 mA dc | |
| | | ☒ Universal HART protocol | |
| | | ☒ Foundation Fieldbus (FF) | |

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Type	Tolerance	Duration after mains failure
110 V AC UPS	110v $\pm$ 10% 50Hz $\pm$ 3%	60 minutes
24 V DC (Bulk Power Supply)	24V $\pm$ 1V	N/A (24 V DC derived from 110 V AC UPS supply)

2.7.2 Power Supply Requirement**2.7.2.1 110 v AC, 50Hz UPS**

- Distributed Control System
- Supervisory computer
- Package units instruments
- Alarm annunciator
- Programmable Logic Controller
- Field instruments requiring power supply like mass flow meter ultrasonic flow meter analysers etc;
- Gas detection system
- Analyzers and analyzer system
- Chromatographs
- Local Panel
- Training Kit
- CCTV system

2.7.2.2 110 V DC

- Input interrogation voltage for MCC signals for HT motors only (Through interposing relays)

2.7.2.3 24 V DC (To be derived from 110 V AC UPS by equipment vendor)

- Inside DCS / PLC cabinets as required
- Solenoid valves
- I/P, Field Instruments Interrogation voltage

2.7.2.4 230V AC, 50 Hz

- Level gauge illumination
- Cabinets lighting (Control room mounted as well as local mounted)
MCC control voltage for DCS / PLC outputs to MCC (Through interposing relays
Control Voltage to be derived from MCC) (110V AC Non UPS or 230 VAC CPCL
to confirm)

2.7.2.5 415 VAC ,50 Hz

- Analyzer shelter air conditioning

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- 2.7.3 Instrument air
- 2.7.3.1 Supply from ☒ Instrument air receiver and through Air Dryer
- 2.7.3.2 Air Receiver holding time ☒ 30 minutes (From Air receiver normal operating pressure to minimum operating pressure of 4.0 kg/cm²g)
- 2.7.3.3 Operating pressures minimum: 4 kg/cm²g
 Normal: 5 kg/cm²g
 Maximum: 6 kg/cm²g
- 2.7.3.4 All pneumatic instruments shall be designed to withstand instrument air pressure of maximum 8 kg/cm²g
- 2.7.3.5 All pneumatic instruments to be sized considering minimum design pressure of 3.5 kg/cm²g.
- 2.8 UNINTERRUPTED POWER SUPPLY (UPS) [As per Electrical Specifications]
- 2.8.1 Emergency power source
 UPS with Battery back up ☒
- 2.8.2 UPS incoming Supply
 415V AC, 3 Phase, 50 Cycles/sec ☒ (Using 3 separate feeders)
 240V AC, 1 Phase, 50 Cycles/sec ☐
- 2.8.3 UPS Output
 110V AC, 50 Cycles / sec ☒
 110V DC ☐
- 2.8.4 Back-up holding time ☐ 30 minutes ☐ 45 minutes ☒ 60 minutes
- 2.8.5 Location of UPS ☒ Separate room ☐ Inside Control room
- Note** : DO NOT locate UPS cabinet along with Instrument system racks & cabinets.
- 2.9 VESSEL INSTRUMENT NOZZLE SIZES AND INSTRUMENT CONNECTION SIZES
- Instrument connections on vessels, stand pipes and tanks (4600-JSD-001) ☒
- Instrument connections on piping (4600-JSD-002) ☒
- Instrument connection on fired heater (4600-JSD-003) ☒
- 2.10 INSTRUMENT SCALES / DISPLAY UNITS
- 2.10.1 Display Units
- Flow (Liquid) ☐ kg/hr ☒ m³/hr at 15 Deg C
- Flow (Gas / Vapour) ☒ Nm³/hr

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Flow (steam)	☒ kg/hr	
Pressure (Gauge)	☐ Pascal	☒ kg/cm ² (g) / mm WC g
Pressure (Vacuum)	☐ Pascal	☒ kg/cm ² (a) / mm WC a
Temperature	☒ °C	
Viscosity	☒ cP	
Density	☒ kg/m ³	
Level	☒ %	

2.11 INSTRUMENT COLOURS**2.11.1 Frame or bezel of panel mounted instruments**

Black	☒
Manufacturer's standard	☐

2.11.2 Control valves and shutdown valves

2.11.2.1 Body	☒ Silver	☐ Manufacturer's standard
---------------	--	--

2.11.2.2 Actuator**- Control valve / On off Valve**

- Fail Open	☒ Green	☐ Manufacturer's standard
- Fail Close	☒ Red	☐ Manufacturer's standard

2.11.3 Other Instruments	☐ _____	☒ Manufacturer's standard
--------------------------	--------------------------------	---

2.11.4 Instrument panels (Control Room Rack Room mounted)

- Surface	RAL 7035
- Inside	Manufacturer Standard (Gray/White)

2.11.5 Local mounted panels

- Surface	RAL 7032
- Inside	Brilliant white

2.12 CONTROL PHILOSOPHY**2.12.1 Mode of plant operation : Unitwise****2.12.2 Type of plant : Expansion & New Units****2.12.3 Control Rooms / Satellite Rack Room (SRR) Requirement**

Refer Annexure I

2.12.4 Type of Control and Monitoring

Refer Annexure I

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2.12.5 Interlock and Shut down System

2.12.5.1	Logic Representation	As per ISA	☒	Other	
2.12.5.2	Interlock Execution	- Independent of Shutdown system	☐	With shutdown system	☒
		- Type of hardware	☐		
		DCS	☐		
		Relay	☐		
		PLC	☒		
2.12.5.3	Shutdown system	Dedicated unitwise	☒	Common for all units	☐
		-Type of hardware	☐		
		Relay	☐		
		PLC	☒		
2.12.5.4	PLC Configuration for shutdown	Dual Processor, single I/O			☐
		Dual Processor, Dual tested I/O			☐
		Triple Modular Redundant with hot stand-by without I/O ,QMR with hot stand-by with I/O module			☒
2.12.5.5	TUV Classification	Required	☒	Not required	☐
		SIL 3(as per IEC 61511)	☒		
2.12.5.6	PLC Scan Time	250 msec	☒		
2.12.5.7	Process bypass switch	Software	☐		
		As per P& I D	☒		
2.12.5.8	Maintenance Override switch		☒		
	Note: MOS for instrument interlock bypass signal be through software, dedicated PLC Operator console shall be provided.				
2.12.5.9	ESD switch location	As per P& I D	☒		

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2.12.6 Package Unit Philosophy

2.12.6.1 Operating Philosophy

Package Location	Control & Monitoring				Interlock & Shutdown		
	Local	CR	DCS	PLC	EM relays	DCS	PLC
Packages	#		##				###

-Vendor Supply

- Owners DCS/PLC

2.12.6.2 Logic implementation for Package units through

Plant PLC

Package vendor's

PLC

Any other

☒
☐

2.12.6.3 PLC configuration

- Dual Processor, single I/O

☐

- Dual Processor, Dual tested I/O

☐

For _____

For Non-critical applications such as Air compressor, DM Plant , cooling tower and GTG/HRSG.

- Vendor's standard

☐

for any special controls such as burner management etc.

Triple Modular Redundant with hot stand-by without I/O ,QMR with hot stand-by with I/O module

☒

2.12.6.4 Redundant Anti surge controller With Performance Controller

Conventional Single Loop controller DCS Special controller, CCC or equal

☐
☐
☒

(Location on Hardwired console)

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2.12.6.5	Speed Governor	Woodward	☒	(Control Room)
		Display Unit	☒	(Auxiliary Console)
		Configuration	☒	TMR
2.12.6.6	Machine monitoring	Bentley Nevada	☒	
		Series 3300 or equal	☐	
		Series 3500 or equal	☒	
		Note: The Vibration card shall be within built-in IS barrier type		
	Location of monitors	Rack Room/ SRR	☒	(Display Unit in Field Local Control Panel Purged section)
		Local panel	☐	
		Repeat Signal to LCP	☒	
		Reset Push Buttons	☒	(Location on Hardwired console)
		Trip Signal	☒	(Hard wired to PLC)
		Analogue Signals	☒	(4-20 m A Hard wired)
		RS -485	☒	
		Ethernet Port	☒	(For Configuration PC)
2.12.6.7	Local Control Panel	Weather proof	☒	As applicable
		Flame proof	☒	As applicable
		Instrument Type	☒	Electronic
		Lamps & Pushbuttons (24 VDC)	☒	Ex Proof
		Annunciator (24 VDC)	☒	Ex Proof
		Local Indicators	☒	IS Type

NOTE: Separate DCS analog output shall be used for Local indicator.

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2.13.1	UPS	☒ Required	☐ Not required
2.13.2	Emergency Lighting	☒ Required	☐ Not required
2.13.3	False Flooring Anti Static	☒ Required	☐ Not required
2.13.4	False Ceiling Anti Static	☒ Required	☐ Not required
2.13.5	Fire Alarm / Fighting System	☒ Required	☐ Not required
2.13.6	Room Air Conditioning	☒ Required	☐ Not required
2.13.7	A/C with pressurization	☒ Required	☐ Not required
2.13.8	Air Lock	☒ Required	☐ Not required
2.13.9	Emergency Exit	☒ Required	☐ Not required
2.13.10	Cable entry	☐ From top	☒ From bottom
2.13.11	Space for Future Expansion	☒ Required	☐ Not required
2.13.12	Protection from Radio Frequency and Electromagnetic Interference	☒ Considered	☐ Not considered
2.13.13	False Flooring Loading Data	☒ 1000 Kg/M ² static load (Minimum)	
		☒ 500 Kg moving load	
2.13.14	Type of Cable entries	☒ MCT blocks (MCT – Multi cable Transit)	☐ Pipe sleeves
2.13.15	Room Temperature Indicator (Digital)	☒ Required	☐ Not required
2.13.16	Chemical Filters	☒ Required	☐ Not required
2.13.17	Digital Hygrometers	☒ Required	☐ Not required
2.13.18	Corrosive Gas Monitors	☒ Required	☐ Not required
2.13.19	Clean Agent System (As per NFPA2001)	☒ Required	☐ Not required
2.13.20	Smoke Detection System	☒ Required	☐ Not required
2.13.21	Corrosion Monitor	☒ Required	☐ Not required
2.13.22	Linear heat detection for Cable Cellar	☒ Required	☐ Not required

3.0 INSTRUMENT SPECIFICATION**3.1 FIELD INSTRUMENTS****3.1.1 General Requirements**

Field Transmitters for Open & Close Loops	☒ Smart	☐ Conventional
	☒ Foundation	Field bus (Note-1)
Field Transmitters for Anti Surge loops	☐ Smart	☒ Conventional
Field Transmitters for shutdown loops	☒ Smart	☐ Conventional

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Signal for Smart Transmitters

☒ 4-20mA with superimposed
digital data (Universal HART)

Transmitter Rangeability

☒ 100:1

FF transmitter

☒ FISCO

☐ IEC-EX-ic

Note-1: For SRU blocks all open & close loops are Foundation Fieldbus .For Coker Block only non critical open loops are with Foundation Fieldbus & all critical open loops & all close loops shall be SMART with HART protocol.
For OHCU revamp & all utility packages in OSBL area all open & close loops shall be SMART with HART protocol.

3.1.2 Flow

3.1.2.1 Orifice assemblies (General Service, For line sizes $\geq 2"$)

- Calculation code

☒ ISO5167

☐

- Plate Type

☒ Square Edge

☒ other types as required to
suit application

- Drain, gas hole

☒ Required

☐ Not required

- Plate Material

☒ SS 316 as minimum grade

- Tap type

☒ Flange taps (for line sizes $\leq 14"$)

☒ D and D/2 Taps (for line size $\geq 16"$)



☒ Corner Taps (for line size $\leq 1 \frac{1}{2}"$ lines & also
conical entrance orifice)

☒ Other types as required to suit application

- Orifice flanges

Material

☒ According to piping specification

Rating

☒ Min. 300# rating

Jack bolts

☒ Required

☐ Not Required

Tap valves

☒ Required

☐ As per Piping
Specification

3.1.2.2 Meter Run to be used for line size $\leq 1 \frac{1}{2}"$

3.1.2.3 Variable area flow meters (Rotameter) Used for Line size $\leq 1 \frac{1}{2}"$

- Type

☒ Metal tapered tube

- Used for

☒ Local indicator

- Material and rating

☒ According to piping specification

- Construction

☒ Weatherproof

3.1.2.4 Coriolis type Mass flow-meters

- Application

☒ For highly viscous and rundown
& feed lines

☒ For Custody and Product Metering

- Accuracy

☒ within ± 0.1 % of reading

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- 3.1.2.5 Others types of flow meters
- Electro-magnetic flow meter ☒ For Cooling water
 - Turbine type flow meter ☐ High Rangeability Applications
 - Vortex meters ☒ As applicable
 - Ultrasonic meters ☒ Applications such as Flare flow Measurements,
high viscous & high temperature services
 - Venturi ☒ For Heater combustion air flow
- 3.1.3 Level
- 3.1.3.1 Guided Wave Radar
- Guided Wave Radar ☒ for Interface Level Measurement
- Probe Type ☒ Co axial
- Probe Material ☒ SS 316 min
- Mounted ☒ Externally with Chamber
- Overfill Protection ☒ Required
- 3.1.3.2 Level Measurement (Vessel / Process tanks) ☒ DP Remote Capillary type
- 3.1.3.3 Level Instrument (Radar Type)
- Applications ☐ Crude tanks- ☒ Intermediate tanks
 - ☒ Product Tanks
- 3.1.3.3 Level gauges (Gauge glass)
- Type ☒ Magnetic ☒ -Transparent
 - ☒ Other types as required to suit application
- 3.1.3.4 Other types of level instruments
- Ultrasonic type ☒ DM Plant & chemical tanks
 - Radar type ☒ For CBD
 - Nucleonic level Instruments- (Gamma Ray Type) ☒ For Coke Drum level measurement
- 3.1.4 Pressure
- 3.1.4.1 Pressure and differential pressure transmitters
- Type ☒ Capacitance ☒ any other type to suit application
 - Accuracy ☒ Above 760 mmWC: +/- 0.075 %
Less than 760 mmWC: +/- 0.15 %

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For Diaphragm Seal Type

☒ 500 mmWC: +/- 0.25 %
Less than 500 mmWC: +/- 0.5 %

- Material as minimum grade

Body

☐ Carbon steel ☒ SS 316

Element

☒ SS 316 ☐ _____

3.1.4.2

Pressure gauges, receiver gauges, differential pressure gauges.

- Measuring element type

☒ Bourdon ☒ Other types as required to suit application

- Dial size

☒ 150 mm ^Ø ☐ 100 mm ^Ø

- Accuracy

☒ ± 1% of FS ☐ _____

- Material as minimum grade

Element

☒ SS 316 ☐ _____

Case

☐ Aluminium ☒ SS

3.1.5

Temperature

3.1.5.1

Thermocouples

- Characteristics

☒ ANSI MC96.1

- Type

☒ ISA Type 'S' (For 800-1000 Deg C)

☒ ISA Type 'K' (For others)

Note : Type 'J' and 'E' not to be used.

- Element

☐ Single ☒ Duplex

- Class

☒ Class 1 ☐ Class 2

- Hot junction

☒ Grounded ☐ Ungrounded

- Probe diameter

☒ Metal sheath type 6 mm OD (min.)

- For Temp. Higher the 980 °C,
Refer table 7 of ANSI MC 96.1

☒

3.1.5.2

Resistance Temperature Detectors (RTD)

- Characteristics

☐ DIN 43760

☒ IEC 60751



- Type

☒ Pt 100

- Element

☐ Single ☒ Duplex

- Class as per DIN

☒ Class A ☐ Class B 2

- Lead wire

☒ 3 - wire ☐ 4 - wire

- Probe diameter

☒ Metal sheath type 6 mm OD (min.)

3.1.5.3

Thermowell (#)

- Type (Minimum 300# rating)

☒ Refer 4600-JSD-501 & 502

- Construction

☒ Drilled bar stock

- Material as a minimum grade

☒ SS 316 ☐ _____

-Wake frequency calculation shall be provided in excel format.

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- 3.1.5.4 Temperature Transmitters
- Field mounted remote type ☒ Required (For all Open, Close & ESD Loops)
 - Head mounted version ☐
 - Multipoint Temperature Transmitter ☐ Required ☒ Not Required
 - Accuracy:
 - > 350°C: + / - 0.25% of Range
 - 150 °C to 350°C: + / - 0.5% of Range
 - Below 150 °C: + / - 0.75% of Range
- 3.1.5.5 Temperature gauges
- Element ☒ Bi – metal  ☒ Filled type
 - Case connection ☒ Direct ☒ Capillary tube (For skid mounted)
 - Dial size ☒ 150 mm^ø ☐ 125 mm^ø
- 3.1.6 Control valves
- Type ☒ Globe ☒ Other types as required to suit application
 - Actuator ☒ Pneumatic diaphragm for Control Application
 - Connection (Min. 300# Rating) ☒ Flanged
 - Body material ☒ According to piping specification and rating
 - Positioner ☐ P/P positioner ☒ E/P positioner (SMART/FF)
 - Leakage class ☒ Class IV (Min)
 - Sizing calculations ☒ ISA S75.0 TSO (Class VI) ☒ As applicable
- 3.1.7 Shut down valves and/or on-off valves
- Type ☒ Ball ☐ Other types as required to suit application
 - Actuator (#) ☒ Pneumatic cylinder (Piston Cylinder with Spring Rtn.)
 - Connection (Min. 300# Rating) ☒ Flanged
 - Body material ☒ According to piping specification and rating
 - Partial Stroke Testing with Positioner ☒ Only for Coker Block

- For double acting cylinder air accumulator shall be used for achieving fail safe operation.

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- 3.1.8 Limit Switches
- Type of Limit switches ☒ Proximity type ☐ Micro switches
 - contact rating (for IS Barrier) ☒ 24 V DC , 1 AMP. ☐
- 3.1.9 Analysers
- Location of Analysers ☒ In safe Area ☒ In Hazardous Area
 - Analyser Shelters ☒ Envisaged ☐ Not envisaged.
- 3.1.10 Air Filter Regulator
- ☒ 5 micron
 - ☒ SS Body
- 3.1.11 Desuperheater
- ☒ With separate water control valve

4.0 INSTRUMENT PANEL

4.1 INSTRUMENT PANELS IN CONTROL ROOM

- 4.1.1 Panel construction
- Type ☒ Self-standing enclosed type
 - Graphic ☒ Non-graphic ☐ Semi-graphic
 - Cable entry from field ☐ From Top ☒ From Bottom
 - Color ☒ outside RAL 7035
 - ☒ Inside Brilliant white
- 4.1.2 Selector Switches / Auto-Manual stations
- Auto Manual station ☒ On Aux. Console # ☒ Field (Connected to MCC)
 - Selector Switch ☒ On Aux. Console # ☐ On PLC Console (Depending on criticality)
 - Start / Stop Emergency push button ☒ On Aux. Console # ☐ On Console
 - Process By-pass switch / Indication ☒ On Aux. Console # ☐ On PLC Console (Depending on criticality)
- # - As per P & I D.
Note: Auxiliary console shall be Mosaic Tiles Type.
- 4.1.3 Annunciator
- Type ☒ Microprocessor Based
 - Layout ☒ Collectively mounted ☐ Individually mounted
 - Unit type ☐ Conventional relay ☒ Solid state
 - Filter colour of alarm indication ☒ Red for shut-down ☐ Amber for alarm
 - ☒ OFF-white for alarm ☐ Green for motor running lights
 - Sequence ☒ A2A

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- Type ☒ Self-standing enclosed type
- Construction ☒ Weather proof ☒ Flame proof
- ☐ Purge type
- Annunciator Sequence ☒ F3A

5.0 **DISTRIBUTED CONTROL SYSTEM (DCS)****5.1** **MINIMUM FUNCTIONAL REQUIREMENTS**

- Control and Data Acquisition System ☒ History for all tags required for 30 days
- Data Logging and Report generation ☒
- Management Reports (Limited) ☒
- Plant Information Management System ☒
- Connectivity ☒
- Advanced Control ☒
- Data Storage and Archival ☒
- Asset Management system (HART+FF) ☒

5.2 **OPERATOR CONSOLES**

- Type of Monitor ☒ TFT
- Open System Connectivity ☒ YES
- Historic Trending on each Console for all points (PC, SV, MV) ☒

Refer Annexure I

5.3 **ENGINEERING CONSOLES**

Refer Annexure I

5.4 **TYPES OF REPORTS REQUIRED**

- Hourly ☒ Alarm History ☒
- Shift wise ☒ Alarm Summary ☒
- Daily ☒ MIS Reports ☒
- Rotating equipment running hour report ☒ Others _____
- Custom Built Reports ☒

5.5 **ACCESSORIES**

- Printers with printer server ☒ Required ☐ Not Required
- Laser Printer ☒ Colour ☐ Black & White

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Multi-Loop

☒

Single Loop

☐**5.7 SEQUENCE OF EVENT RECORDING**

Required

☒

Not required

☐

In DCS/PLC

☐

In Separate Unit

☒

Resolution

☒

PLC SCAN Time

**5.8 SCAN TIME REQUIREMENT
(For FF)**☒

500 msec (For close loops)

☒

1000 msec (For open loops)

5.9 FOREIGN DEVICE INTERFACE REQUIREMENT #

Programmable logic controller

☒

Analyzer system

☒

Chromatographs

☒

Tank Gauging System

☒

APC Computer

☒

Package PLCs (if any)

☒

Anti Surge Controller

☒

Vibration Monitoring System

☒

Woodward Governor

☒

GT Control System

☒

UPS

☒

On line corrosion Monitoring

☒

Fire & Gas System

☒

- All the third Party Interfaces shall be through dedicated redundant controller

5.10 ADVANCED CONTROL FUNCTION REQUIREMENTS

Through DCS

☐

Through Dedicated

☒

Supervisory Computer

**5.11 TRAINING KIT
(For DCS / PLC)**☒

Required

☐

Not required

5.12 REDUNDANCY PHILOSOPHY

- Controller Sub-system

Redundant

☒

1:1 redundancy

☒

- Data acquisition system

Redundant

☒

- Communication subsystem

Redundant

☒

1:1 redundancy

☒

- Power supplies

Redundant

☒

1:1 redundancy

☒

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Communication Bus Loading 60% maximum**5.14 SOFTWARE: All application software including**

Custom built graphics	☒
Alarm Summary Display	☒
Special calculations	☒
Ladder Logics	☒
Reporting	☒
Point Database	☒
Sequence Functions	☒
APC Connectivity	☒
Foreign Device Connectivity	☒
Documentation Software	☒
PC Connectivity	☒
SAMA Drawings	☒

6.0 OTHER INSTRUMENTATION SYSTEMS**6.1 FIRE & GAS DETECTION SYSTEM**

6.1.1	HC Detectors	☐	Catalytic diffusion	
		☒	IR type	
		☐	Any other _____	
	Output 4-20 mA HART for indication in DCS	☒	Vendor standard	☐
6.1.2	H ₂ S Detectors	☒	Electrochemical	
		☐	Semiconductor	
		☐	Any other _____	
6.1.3	H ₂ Detectors	☒	Catalytic Combustion	
		☐	Any Other	
6.1.4	Other Gas Detector	☒	As per Process Package	
6.1.5	Requirement of monitors	<input type="checkbox" value="D"/>	Location & Number	
6.1.6	Gas cloud movement software	☐	Required	☒ Not required
6.1.7	Local Indication + Indication in DCS	☒	Required	

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6.1.8 Fire Alarm system

Location ☒ Control room/SRR with repeater Panel

Type of Detectors ☒ Beam detectors, Smoke detectors, Heat detectors as per application

Provision of Manual Call Points ☒ Required

Interface with HVAC, CCTV, EPABX, PA SYSTEM ☒ Required

Note: Fire Alarm panel interface with EPABX & PA system is not required for Sulphur Block (LSTK-2)

Spare Capacity ☒ 30%



6.1.9 Fire & Gas System

☒ TMR /QMR PLC, Min SIL 3

6.2 INTEGRATED MACHINE MONITORING SYSTEM

Required ☒

For Monitoring ☒

For predictive maintenance ☒

6.3 BOILER DRUM INSTRUMENTATION

Type of level inst.	Conductivity	☐	DP	☐
Safety valves	Section I	☐	IBR	☒
Level measurement	2 out of 3	☒	Any other _____	☐
DP & Hydra Step (High Pressure Version) per drum (IBR Requirement)		☒		☐

6.4 STACK MONITORING SYSTEM

Separate for each stack ☒ Required (As per TNPCB norms) ☐ Not required

Common for all stacks ☐

Ambient Monitoring ☒ Required (As per TNPCB norms)

Note: Ambient monitoring system is not in LSTK-1 scope.



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(For Process Units)☒ Required☐ Not required

Recording Facility

☒ Required☐ Not required

Interface with Giant screen

☒ Required☐ Not required**7.0 INSTRUMENT PIPING AND WIRING SPECIFICATION****7.1 INSTALLATION / TUBING HOOK-UP****7.1.1 Instrument Installation**☒ **M**

Close coupled (Pre fabricated)

☐ **D**

Remote (Where instruments are not accessible)

7.1.2 Instrument Impulse Lines☒ **X**

Piping (Other than pre fabricated)

☒ **X**

Tubing (From Equal Tee) for ≤ 600#

7.1.3 Material of Tubing and fittings☒ **X**

SS 316 stainless steel (minimum)

7.1.4 Instrument valve manifolds for- Pressure Gauges
Pressure Transmitter☐

Integral

☒ **X**

Fabricated

- Flow Transmitters
(3-way manifold)☒ **X**

Integral

☐

Fabricated

- Others

☐ **D**

Integral

☒ **X**

Fabricated

7.1.5 Impulse Line valves (After first isolation valve provided by piping)

- Isolation Valves

☐

Gate

☒ **X**

Globe

- Vent /Drain valves

☒ **X**

Gate

☐

Globe

7.1.6 Valves Material☐SS 316
as minimum☒ **X**As per Piping
Material Spec**7.1.7 Signal Tubing size**☒ **X**

½" OD

7.1.8 Condensate Pot☒ **X**Required for steam & condensing vapour
Instruments

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7.2 INSTRUMENT AIR SUPPLY PIPING

7.2.1 Air supply method for local instruments

- ☒ Through Individual branch header and Individual air set.
- ☒ Refer Drawing 4600-JSD-005

7.2.2 Material

- Piping material ☒ SS
- Valve material ☒ SS 316

7.2.3 Air tubing size

- ☒ 6mm ☒ 12mm (based on requirement)

7.2.4 Air Tubing Material

- ☒ SS 316



7.3 INSTRUMENT CABLING

7.3.1 Cable Routing

- Main cable way
 - ☒ G.I. duct (FRP for DM Plant & Cooling Tower)
 - ☐ Ladder tray
 - ☒ Built up trench ☐ Directly buried
- Branch cable way
 - ☒ Branch Tray Perforated (60 mm, 100 mm, 150mm, 300mm size)
- FRP cable trays
 - ☒ For DM plant, Cooling Tower
- Fire Proofing of instrument cable duct & Main Cable Tray
 - ☒



NOTE: - Fire proofing of instrument cable duct & main cable tray is NOT REQUIRED for SRU Block & OSBL unit.



7.3.2 Cables

7.3.2.1 Type

- For DC mA signals, SOV
 - ☒ Single pair for individual run
 - ☒ Multipairs for main runs (Use 6 pair, 12 pair)
- For RTD cables
 - ☒ Single Triad for individual run
 - ☒ Multitriads for main runs (Use 6 Triad, 8 Triad)
- For T/C (or compensating cables)
 - ☒ Single pair ☒ Multi pair
- For Power Supply (2.5 mm²)
 - ☒ 2 or 3 core for individual run
 - ☐ (12, 24 core) For Multicore cables
- For FF Cables
 - ☒ Single pair for individual run
 - ☒ Multipairs for main runs (2 pair, 12 pair)

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7.3.2.2

Cable specification

All cables shall be of FRLS type. For Fire safe application Fire Resistant
DC mA signal , mV signal ,alarms & Solenoid Valves

- Rated Voltage ☒ 1100 V
- Core size ☒ 1.5 mm² for single pair
- ☒ 1.0 mm² for multi pair (up to 300m length)
- ☒ 1.5 mm² for multi pair (> 300m length)
- Core Material ☒ Copper
- Insulation Material ☒ Polyvinyl chloride (PVC),PE for H2 service
- Sheath Material ☒ Polyvinyl chloride (PVC)
- Individual screen for single pair ☒ Required
- Individual and overall screen for multi pair ☒ Required
- Armouring ☒ Required

AC Power Supply and On-off Switch Signals

- Rated Voltage ☒ 1100V
- Core size ☒ 2.5 mm² min. for Power supply
- ☒ 1.5 mm² for Solenoid Valves.
- Core Material ☒ Copper
- Insulation Material ☒ PVC
- ☒ XLPE (For Electrical Interface)
- Sheath Material ☒ PVC
- Armouring ☒ Required

Compensating cable / Extension wire for Thermocouple

- Applicable code ☒ ANSI MC 96.1
- Core size ☒ 1.5mm² or 16AWG for Single pair.
- ☒ 1.0 mm² or 18 AWG for multi pair.
(For length up to 300m)
- ☒ 1.5 mm² or 16 AWG for multi pair.
(For length > 300m)
- Insulation Material ☒ PVC (PE for H2 service)
- Sheath Material ☒ PVC
- Individual screen ☒ Required
for single pair
- Individual and over-
all screen for Multipairs ☒ Required
- Armouring ☒ Required ☐ Not Required

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- Cable Type ☒ Type A
- Core size ☒ 1.13mm² or 16AWG for Single pair & Multipairs
- Insulation Material ☒ XLPE or Polyolefin
- Individual screen ☒ Required for single pair
- Individual and over-all screen for Multipairs ☒ Required
- Armoring ☒ Required ☐ Not Required

7.4

JUNCTION BOX

- Hazardous areas ☐ Weather proof type for intrinsically safe
- & Non hazardous area ☒ Flame proof
- FF junction Boxes ☒ Flame proof
- For DM plant ☒ FRP

7.5

GROUNDING

- 7.5.1 Control room mounted panels body earth (Includes ☒ Separated dedicated
panel mounted bulk power supply earth) earthing pit
- 7.5.2 Field instrumentation (Circuit ground, shields, drain ☒ Separated dedicated
wires etc.) earthing pit

7.6

HEAT TRACE

- ☐ Not Required ☒ Required
- 7.6.1 Method ☒ Steam trace ☐ Electric heat trace
- 7.6.2 Material ☒ Copper tube (3/8 ")

8.0**SPARE PHILOSOPHY**

- 8.1 Spare instrument as Engineering Spares 10% or minimum one of each (range, type and material of construction) (Except for Control valves, Pressure relief valves. Displacer type instruments, Level Gauges, Analysers and Special Instruments) ☒
- 8.2 Spare Parts
 - For two years operation ☒
 - For Startup and Commissioning ☒
 - Consumable spares for six months operation ☒

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- | | | |
|--|---|-------------------|
| - System Spares
(Control Room wise) | Bus Capacity
No. of Nodes | 40%
30% |
| - Installed Spares | I/O Level | 20% |
| - Spare Space | I/O Level
Processor
Marshalling
Rack | 20%
20%
20% |
| - Mandatory Spares | 10% or minimum one of each type of module | |

Refer to mandatory spare list. For instruments not covered in that list, the philosophy as given in this clause to be followed.

9.0 ATTACHMENTS

- Annexure I -Control room, satellite rack room, control monitoring & Interlock shutdown requirements
- Annexure II –Design Basis Notes
- Annexure III –General Specification of Instruments
- Instrument connection on vessels, stand pipes and tanks (4600-JSD-001).
- Instrument connection on piping (4600-JSD-002).
- Instrument connection on fired heater (4600-JSD-003).
- Thermowell (4600-JSD-501).
- Thermocouple / RTD assembly with Thermowell (4600-JSD-502).
- Orifice Plate Dimensional details (4600-JSD-201).
- Typical arrangement for instrument air distribution (4600-JSD-005).

ANNEXURE-13

GENERAL SPECIFICATION FOR INSTRUMENTS

PROJECT NO.: 44 NC-4600**TITLE: ANNEXURE III - GENERAL SPECIFICATION FOR
INSTRUMENTS****SPEC. NO. ANNEXURE III TO 44NC-4600-
0000/J.02/0001/A4****REV. NO / ISSUE DATE - 1 / 06-Sept-13****Page 1 of 30****ANNEXURE III – GENERAL SPECIFICATION FOR INSTRUMENTS****TABLE OF CONTENTS**

1.0	SCOPE
2.0	INSTRUMENT CONCEPTS
3.0	FLOW INSTRUMENTS
4.0	LIQUID LEVEL INSTRUMENTS
5.0	PRESSURE INSTRUMENTS
6.0	TEMPERATURE INSTRUMENTS
7.0	CONTROL VALVES
8.0	SAFETY RELIEF VALVES
9.0	BREATHING VALVES, FLAME ARRESTERS AND VENTS
10.0	PRESSURE REDUCING AND DESUPERHEATER STATION
11.0	ANALYSER, GAS CHROMATOGRAPHS AND GAS DETECTION SYSTEM
12.0	ALARM ANNUNCIATOR SYSTEM
13.0	LOCAL CONTROL PANELS
14.0	LOCAL GAUGE BOARD
15.0	INSTALLATION MATERIALS
16.0	CLOSE CIRCUIT TELEVISION (CCTV) SYSTEM

1.0 Scope

- 1.1 The purpose of this specification is to define the general requirements for instruments and control equipment.
- 1.2 The purpose of this specification is to define the general requirements for instruments and control equipment.
- 1.3 This specification determines the minimum requirement for the instrumentation design according to the best engineering practices. Any deviation from these specifications will be indicated in the detailed specifications.
- 1.4 The related standards referred to herein shall be of the latest editions.

2.0 INSTRUMENT CONCEPTS

- 2.1 The Control shall be unitwise. All Instrumentation shall be Electronic type. All final Control elements shall be electronic pneumatic.
- 2.2 Pneumatic Instrumentation
- 2.2.1 Pneumatic Instruments shall operate on air supply of 1.4 kg/cm²g and shall have transmission and output signal of 0.2 to 1.0 kg/cm²g.
- 2.2.2 Instrument air quality shall be as per ISA-S7.1 and free from all corrosive, hazardous, flammable and toxic contaminants.
- 2.3 Electronic Instrumentation
- 2.3.1 All field mounted instruments shall be suitable for mounting in hot and humid tropical atmosphere.
- 2.3.2 Materials of construction for instruments shall be consistent with temperature, pressure and corrosion conditions and process requirements. In case where suitable material procurement is not feasible, fluid seals or purges will be considered.
- 2.3.3 The instruments like control valves, pressure relief valves, orifice flanges, level instruments, thermowell, etc., coming on pipes and vessels under IBR shall be certified by IBR or equivalent statutory body.
- 2.3.4 All controls shall be through DCS as envisaged in Design basis. Single Loop microprocessor based controllers should be used only in applications like anti-surge control.
- 2.3.5 The requirement of statutory approvals for usage of equipment/instruments/systems in electrically hazardous areas shall be as follows:
- a) The vendor shall be responsible for obtaining all statutory approvals, as applicable for all instruments and control systems.
 - b) Equipment/instrument/systems located in electrically hazardous areas shall be certified for use by statutory authorities for their use in the area of their installation. In general, the following certification shall be provided by the vendor:

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For all Flameproof/ protected by other methods, equipment / instrument/systems, which are manufactured abroad (outside India) and certified by any approving authority like ATEX, FM etc., certification by the Indian authorities -Chief Controller of Explosives (CCE), Nagpur, India is mandatory.

For all flameproof / protected by other methods, equipment / instrument/systems manufactured locally (within India), the testing shall be carried out by any of the approved testing houses -Central Mining Research Institute (CMRI) / ERTL etc. The item shall in addition bear the valid certification from CCE and also the manufacturer shall hold a valid Bureau of Indian Standards (BIS) license

2.4 Transmitters shall be used in place of switches. For Pump Seal Plan instrumentation, Guide Wave Radar Level transmitter and Pressure / Temperature transmitter shall only be used instead of switches.

2.5 All instruments shall be tagged with SS tag plate properly secured by screws or attached by stainless steel wires.

3.0 Flow Instruments

3.1 Orifice Plates

3.1.1 Flow measurement shall normally be carried out using thin square edged concentric orifice plate mounted between a pair of weld neck flanges of minimum 300 # ANSI rating for line size 2" and above.

3.1.2 Flange taps shall be used for line sizes upto 14" while D-D/2 taps shall be used for line sizes 16" and above. The material of the orifice plates shall be normally SS 316, as a minimum.

3.1.3 Orifice plate shall be fabricated strictly in accordance with Jacobs standard 4600-JSD-201. Orifice flange dimensions shall generally conform to ANSI B 16.5 modified as per AGA recommendation.

3.1.4 Eccentric and Segmental type of orifice plates shall be used in horizontal runs for services involving mixed phase gas-liquid or liquids with suspended solids.

3.1.5 Vent and Drain holes shall be provided wherever necessary.

3.1.6 Flow nozzles, Venturi & flow tubes may be used for better pressure recovery, and where very low inlet pressures are available.

3.1.7 All orifice flanges and connections shall be accessible from ground or from suitable operating platforms.

3.2 Calculations

3.2.1 Calculations shall in general be based on ISO 5167

3.2.2 ~~Calculation for conical entrance orifice shall be as per BS 1042 Part I.~~



3.3 Sizing

- 3.3.1 Maximum meter flow shall equal the nearest preferred factor greater than or equal to 1.43 x Normal flow, if only the normal flow is known. If maximum flow only is given, Maximum meter flow shall equal the nearest preferred factor greater than or equal to 1.1 maximum flow given. If rangeability larger than 30% to 90% is required, two measuring instruments with different ranges may be considered.

Orifice diameters should be selected so that the d/D ratio is between 0.20 to 0.70 for gas and steam and upto 0.75 for liquids

- 3.3.2 Orifice meter differential range shall normally be 2500 mm H₂O, dry calibration. Other preferred ranges will be 500 mm, 1250 mm, 5000 mm and 10,000 mm. For compressible fluids, the selected differential in inches of water shall not exceed the upstream static pressure in pound per square inch absolute.
- 3.3.3 Metering orifices shall not be installed in lines less than 1½" nominal diameter. If process lines are less than 1½", the lines shall be blown to the 1½" size for the meter run, keeping the d/D ratio within limits when the meter runs cannot be blown to 1½" calibrated meter runs may be used. If d/D ratio exceeds 0.75 for 5000 mm differential range, then the process line shall be blown for the meter run.

3.4 Meter Runs

- 3.4.1 Meter runs shall be for a maximum d/D ratio of 0.75 for all cases. The recommended practice shall be as per API MPMS Chapter 14.3 part 3. However where nominal pipe size is large and it is difficult to ensure straight run corresponding to d/D ratio of 0.75, straight run corresponding to actual d/D ratio for that particular orifice can be used.
- 3.4.2 Use of straightening vanes is not preferred longer meter runs shall be provided for custody transfer meters. Orifice plates shall be installed on horizontal lines where practical. Vertical meter runs may be used for down flow of vapour and up flow of liquids.
- 3.4.3 Restriction orifices and integral orifice transmitters do not require upstream or downstream straight pipe runs or orifices flanges.

**3.5 Meter Taps**

- 3.5.1 Meter taps shall be horizontal for liquids, condensable vapours and steam. The taps shall be on top for gas, non condensable vapour, or liquids which boil at or below the maximum design ambient temperature at operating pressure. Where piping clearances are a factor, taps may be located upto 45° below the horizontal centre line for condensable vapour, liquid and steam. The taps may be located upto 60° from vertical for gas and vapour. Generally atleast one pair of tapings are provided for all orifice flanges.

3.6 Differential Pressure Transmitter

- 3.6.1 Flow transmitter shall normally be smart type with HART protocol or with FF protocol an integral indicator for output indication.
- 3.6.2 Body shall be SS body minimum with stainless steel element unless other materials are required. For direct differential pressure transmitter the cover flanges shall have provision for HP and LP process connection on both sides, with one side blinded with drain plug.

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- 3.6.3 Over range protection equal to the body rating shall be provided.
- 3.6.4 For congealing services, 3" diaphragm type DP transmitters shall be used.
- 3.6.5 Three way valve / Five way valve manifold and oval flange adaptor shall be provided in place of isolation and equalizing valves in the impulse piping of flow transmitters for the service up to 600 # rating. However in case of high pressure service and any special requirement, piping manifold with single / double isolation valves and equalizing valve shall be considered.

3.7 Other Flow Measuring Device**3.7.1 Rotameter**

- 3.7.1.1 Variable area flow meters shall be as per ISA-RP 16.1,2,3,4,5 and shall be used for viscous or corrosive services or where rangeability in flow precludes the use of an orifice.
- 3.7.1.2 Accuracy of measurement shall be within 2% of full scale. Rotameter rangeability shall be more than 10:1.
- 3.7.1.3 Glass tube Rotameters shall be used for low pressure utility services for local indication and where line size is 1½" or less.
- 3.7.1.4 Glass tube Rotameters shall not be used if outlet line is connected to a line or vessel containing hazardous or toxic fluid unless a check valve is installed at the downstream side of Rotameter.
- 3.7.1.5 Metal tube Rotameters shall be used for all process fluids. External devices for indicating or transmitting shall be magnetically coupled to the float or extension.
- 3.7.1.6 Rotameters shall be installed vertically with block and bypass valves.
- 3.7.1.7 A straight length of 5 diameter upstream of Rotameter is desirable.
- 3.7.1.8 Rotameter end connections shall be as per piping specifications.
- 3.7.1.9 Purge meter units shall consist of a glass / metal tube Rotameter with needle valve at the inlet and a built-in check valve at the outlet. A differential pressure regulator shall also be supplied in applications where either the purge supplies or process pressures are likely to vary significantly.
- 3.7.2 Massflow meters shall be used for accurate flow integration for blending application, critical feed flow, custody transfer, high viscous fluids etc.
- 3.7.3 Meter run with Integral orifice meters shall be used for measuring small flows in line sizes less than 1½" and shall be installed with block and bypass valves.
- 3.7.4 Magnetic type flow meters shall be used for electrically conductive slurry, water or corrosive services and shall be installed with line size bypass, with block and clean out valves, at the lowest point in piping to ensure that meter run is always liquid filled.
- 3.7.5 Mass flow meters (in -line meters) shall be considered for highly viscous hydrocarbon streams such as asphalt, vacuum residue, tar, polymers. Etc.

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3.7.6 Ultrasonic flow measurement shall be considered for flare gas applications, for high temperature & viscous service.

4.0 Liquid Level Instrument

4.1 Level Gauge

4.1.1 All gauge glasses shall be generally steel armoured reflex or transparent type. Body material and cover material shall normally be forged carbon steel. 316 SS or other materials may be used if required, by process conditions. Tempered borosilicate glass with asbestos or other gaskets shall be used. All gauge glasses must have a rating equal to or more than the vessel design pressure and temperature.

4.1.2 Reflex type will be used for clean and colourless liquids, except liquids level interface. Transparent type will be used on acid, caustic, dirty or viscous, coloured liquids and liquid interface. Transparent type with mica or Kel-F shields shall be used for treated water, boiler and condensate services, and for corrosive liquids which will attack glass.

4.1.3 Transparent type glasses shall have integral illuminators operating at 230 VAC, 50Hz and suitable for the specified electrical area classification.

4.1.4 Frost shields shall be provided for cold services below 0 °C. Internal heating shall be provided for viscous liquids. Integral illuminators shall be used on transparent gauges, if required.

4.1.5 Visibility shall cover the operating level range and maximum and minimum ranges expected including start-up conditions as well as alarm and shutdown points.

4.1.6 The maximum visible length of a single gauge glass shall not exceed 1500 mm. Should a larger level gauging be required, multiple gauges, or preferably equal lengths, shall be used with 50 mm overlapping in visibility. Normally glass of 300mm (approx.) section length shall be used.

4.1.7 Gauge glass valves shall be forged off-set type with an integral ball check and back seating stem. Primary isolation valves are normally required in addition to the gauge glass valves.

4.1.8 For level gauging in very viscous liquids and liquids with crystals & interface level measurement, float operated magnetic gauges with 2" (50mm) flanged end connections, shall be used.

4.2 Guided Wave Radar

4.2.1 Guided wave radar type instruments shall be used for all interface measurement. Transmitter shall be SMART type with HART protocol or with FF protocol.

4.2.2 Instruments shall be with rotatable head construction. Probe material shall be 316 SS with. Other materials may be used if required by service conditions. Radiation fins or extensions shall be used for temperatures above 200°C or below 0°C.

4.2.3 Side -side connection shall normally be used. Chamber material shall be SS if the service calls for.

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4.2.4 Overfill protection shall be provided.

4.2.5 Probe type shall be co axial.

4.3 Differential Pressure Level Transmitter

4.3.1 In general capillary type differential pressure transmitters shall be considered for all level applications. Capillary for LP side and HP side will have direct mount diaphragm seal (Without capillary).

4.3.2 Transmitter shall be **SMART type with HART protocol or with FF protocol**.

4.3.3 Differential pressure transmitters for use on corrosive, viscous or fouling service shall generally be diaphragm seal type with remote filled capillary. Diaphragm material shall normally be stainless steel or any other special alloy. Transmitter body material & shall be SS body minimum.

4.3.4 The capillary and diaphragm fill fluid used shall be suitable for vacuum and high temperature applications in general.

4.4 Tank Level Instruments

4.4.1 Generally Radar instruments with digital transmission shall be used for offsite tanks. Body housing material shall be SS. The gauges shall be capable of measuring with an accuracy of ± 0.5 mm. Two numbers of tank side indicator one at top (Gauge Head) and other at tank datum shall be provided.

4.4.2 Multipoint Temperature measuring system shall be provided as indicated in the "job specification".

4.4.3 The tank side indicator for both types of gauges shall have hoisting facility.

4.4.4 Mechanical float type gauge shall have counter type tank side indicator.

4.4.5 The wetted material like float, displacer, tape, wire etc. shall generally be 316 SS.

4.5 Other Level Instruments

Other special type of level instruments like radar, ultrasonic type, nucleonic type shall be used as necessitated by application requirements.

4.6 Steam Drum Level Measurement

For high-pressure steam drum level application, additional conductive type ("Hydrostat" or equivalent) level instrument shall be provided in addition to DP type requirement.

4.7 Nucleonic Level Instruments

4.7.1 The nucleonic sources shall be constructed with sufficient shielding so that, no restrictions are placed on personnel accesses to the plant in which the device is installed.

4.7.2 Nucleonic level instruments shall be used only when there is no other practical choice of alternate measurement available or specifically recommended by Licensor / consultant.

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4.7.3 The source strength sizing calculation and installation drawing shall be reviewed and approved by owner/PMC.

4.8 Level Standpipe Philosophy

4.8.1 The usage of standpipe shall be considered for clean, non-viscous and non-crystallizing services. The size of standpipe shall be 3" minimum. Separate isolation valve to be considered for standpipe.

4.8.2 Connection of standpipe from the bottom of equipments shall be avoided.

4.8.3 When level gauges are used along with transmitter, the visible length of the level gauge shall be selected to cover the complete transmitter range.

4.8.4 Standpipe shall be used if there are more than 4 nozzles required for level instruments. All instruments shall be provided with separate isolation valve. Stand pipe accommodating level gauge / DCS transmitter shall be separate from standpipe / vessel tapping for interlock / trip transmitter. Also for 2oo3 logic, tapping from same stand pipe shall be avoided.

4.8.5 Maximum number of nozzles on the standpipe shall be limited as follows:

- 8 Nos. with no guided wave radar type / Displacer type level instrument on it
- 6 Nos. with guided wave radar type / Displacer type level instrument on it.

4.8.6 Multiple level gauges shall be used for visible length more than 1500 mm.

4.8.7 Separate standpipe shall be used for boot interface level measurement in addition to standpipe for horizontal vessel.

5.0 Pressure Instruments

5.1 Pressure Gauges

5.1.1 Pressure gauges shall have an accuracy of $\pm 1\%$ of full scale. These shall be normally furnished with bourdon tube element. For low pressure i.e. below 1 kg/cm²g bellows diaphragm actuation may be used. Standard dial size shall be 150 mm.

5.1.2 Dial shall be white, non-rusting plastic with black figures. The dial face shall be marked with pressure element material. Pointers shall have micrometer adjustment.

5.1.3 Connection shall normally be 1/2" NPT(M) bottom.

5.1.4 Dial gauge case housing shall be SS Material. Cases shall be weatherproof as per NEMA 4. Blow out discs shall be provided.

5.1.5 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.

5.1.6 Pressure elements for process service shall normally be 316 SS, with forged socket and tip of the same material. Elements above 70 kg/cm²g range shall be bores instead of drawn.

5.1.7 Movements shall be minimum of 304 SS.

5.1.8 Cases for gauges having ranges between 0-2 and 0-20 Kg/cm²g shall have blowout discs in the back of the case.

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5.1.9 Cases for gauges having ranges above 0-100 Kg/cm²g shall be of the solid front type having blowout backs.

5.1.10 Snubber shall be floating pin type, externally mounted and externally adjustable. It shall be used for all pulsating services.

5.1.11 Diaphragm seals, filled type or mechanical type shall be furnished where plugging of the element may occur or where suitable material is not available in highly corrosive services. When chemical seals are required, they shall be the clean out type with flushing connection.

5.1.12 Over range protection shall be provided to atleast 130% of range. For vacuum service, the element shall have under-range protection to full vacuum.

5.1.13 All pressure gauges shall be provided with shatter proof / laminated safety glass window and rear blow out disc.

5.1.14 In general, pressure gauge shall be closed coupled.

5.1.15 Auxiliary components for pressure gauge

Over range protector (gauge saver) shall be provided where a pressure gauge cannot withstand a protuberant pressure due to unavoidable operation. Over range protector whenever used shall be of SS316, as a minimum.

Pulsation dampener shall be provided for all pulsating services e.g. Reciprocating pump discharge piping etc. Pulsation dampeners shall be of minimum SS 316 and have connection ½" NPT (F) on both ends. Dampener shall be provided with integral screw head needle valve to adjust aperture externally.

Pigtail type siphon shall be provided for steam service. Siphons shall be made of minimum SS 316 having connections ½" NPT (M) on both ends.

5.1.16 Draft Gauges

In general, the draft gauges shall be provided for each process heater to measure draft at burners, and in the stack, if required by process.

Direct connected gauges for indication of very low pressures and vacuum in the range of 0-0.5 mbar to 0-150 m bar shall be vertical scale gauges utilizing a slack diaphragm (rubberized nylon or equivalent) as the sensing element.

Draft gauges shall be designed for 2-inch pipe mounting.

Where draft gauges are for used in the field, a suitable housing shall be provided.

The design of the draft gauge shall incorporate linearizing linkages where necessary to ensure a linear response of the indicating pointer.

Draft gauges shall be required to have an accuracy of +/-3% FS or better and shall be capable of withstanding pressures or vacuum equivalent to 100% overrange.

Process connection shall be ¼" NPT (F).

5.2 Pressure Transmitters

- 5.2.1 Pressure and Differential pressure transmitters shall be SMART type with HART protocol or with FF protocol with local indicator for output indication. Indication shall be in engineering units and percentage.
- 5.2.2 Transmitter body material shall be minimum SS Body with stainless steel element unless other materials are required. Process connection shall be ½" NPT(F).
- 5.2.3 Range shall be selected such that normal operating pressure is within 50% to 85% of calibrated range.
- 5.2.4 Over range protection shall be provided to at least 130% of range. For vacuum service, the element shall have under -range protection to full vacuum.
- 5.2.5 Diaphragm seal element with capillary shall be used for congealing, corrosive and highly viscous services.
- 5.2.6 The wetted parts materials of the transmitter shall be suitable for the service conditions but SS316 as a minimum.
- 5.2.7 Pressure taps in main piping lines shall preferably be located on top of the piping and in equipments shall preferably located in the equipment vapor space.
- 5.2.8 In general, pressure transmitter shall be close coupled, with provision for accessibility from grade, walkways, or platforms

6.0 Temperature Instruments**6.1 Thermowell**

- 6.1.1 Thermowells shall be of 316 SS bar stock (Minimum) or better material to suit the service conditions. The base of the thermowells shall be chosen to fit the instrument without air gap for minimum measuring lag. Thermowell flanges shall be of ASTM A182 F316, 1½" 300# as a minimum for pipe line mounted. For vessels & column Thermo well flanges shall be of ASTM A182 F316, 2" 300# as a minimum.
- 6.1.2 These shall be fabricated from bar-stock as per Jacobs standard 4600-JSD-501
- 6.1.3 Immersion length of thermowells for different line sizes shall be as follows:

Line Size	Immersion length (U)
4"to 6"	280mm
8" and above	320 mm
Vessels	400mm

Immersion length is based on 200 mm length between flange face and inner wall of pipe. In vessels, where fouling with vessel internals is expected, the immersion length shall be suitably modified. The immersion length shall consider thickness of refractory lining heater applications.

Any pipe line less than 4" nominal bore shall be blown to 4" size.

Built-up thermowells may be considered in low pressure and low velocity services like in fired heaters and also where longer thermowell immersion length is required (for greater than or equal to 500 mm).

Thermowell shall be designed to handle two phase flow velocity. Vibration analysis test to be carried out for thermowells to be used in high pressure two phase flow.

6.2 Temperature gauges

6.2.1 Dial thermometer shall be generally gas filled type, hermetically sealed with 150 mm dial size with a rigid stem only. **Bimetallic temperature gauges are acceptable.**



6.2.2 Case shall have back or bottom connection with adjustable gland to permit adjustment of thermometer into the well.

6.2.3 Only filled type with capillary extension shall be used in cases where vibrations are likely to be encountered. Capillary tubing shall be minimum of 304SS with stainless steel flexible armouring, and PVC covering over armour.

6.2.4 Thermometer stem adjustable gland with union connection and bushing shall be suitable for 1/2" NPT connection.

6.2.5 Range shall be selected so that normal operating temperature is approximately 70% of full scale, and maximum expected temperature 90% of full scale.

6.3 Thermocouple

6.3.1 Thermocouples assemblies shall be furnished with weatherproof screw type heads as per Jacobs standard 4600-JSD-502.

6.3.2 Thermoelectric properties and accuracy shall be as per ANSI MC 96.1.

6.3.3 Thermocouples shall be as far as possible only of 'K' type with 20 AWG duplex. For very low range (-ve Temp.) T type shall be used.

6.3.4 Magnesium oxide insulated grounded type thermocouples shall generally be used.

6.3.5 The design of thermocouple assemblies shall be such that replacement on line is possible.

6.4 Resistance Temperature Detectors

6.4.1 RTD assemblies shall be furnished with weatherproof screw type heads as per Jacobs standard 4600-JSD-502.

6.4.2 RTD calibration shall be as per **IEC 60751.**



6.4.3 RTD shall be platinum element with 100 ohms resistance at 0°C, 3 wire system shall be adopted in connecting the element.

6.4.4 RTD shall be used upto maximum temperature of -200° - 650°C.

6.4.5 In the case of Duplex thermocouple/ RTD, two independent electrical entries shall be provided, and unused entries sealed with blind plug.

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- 6.5.1 The thermocouple head shall be connected with thermowell with 3-piece union to ensure proper contact of TC junction to thermowell.
- 6.5.2 Head cover shall be screwed type, with SS retaining Chain fixed to body.
- 6.5.3 Head cover shall be weather proof and ex proof suitable to specified hazardous area classification.
- 6.5.4 Cable entry shall be 2 nos. 1/2" NPT (F) with one entry plugged with SS 304 plug.
- 6.5.5 Terminals shall have separate screws for connecting element and extension cable.
- 6.5.6 Special application thermocouple like Skin temperature measurement for heater or reactor etc shall comply with Licensor's specification.
- 6.5.7 For heater thermocouples, mineral insulated Inconel-600 sheath shall be considered for Non-sulphurous atmosphere and SS-416 shall be considered for at sulphurous atmosphere. Kanthal sheath material shall be used above 870 deg. C temperature.

6.6 Temperature Transmitters

- 6.6.1 Temperature transmitters shall be Remote mounted type (on 2" Pipe), Smart with HART protocol or Foundation Field bus protocol and integral output meter.
- 6.6.2 Head mounted transmitters shall not be used.
- 6.6.3 Conventional transmitter shall have universal input for thermocouple / RTD and output 4-20mA DC for 2 wire system.
- 6.6.4 Transmitter output signal shall be linear and directly proportional to the measured temperature with overall accuracy of as per design basis.
- 6.6.5 Transmitter shall have automatic cold junction compensation for thermocouples and thermocouple / RTD linear characterization.
- 6.6.6 Burnout protection (selectable UP scale / DOWN scale) must be provided for temperature transmitter.
- 6.6.7 Temperature transmitter shall be dual compartment type, with dual input provision and sensor diagnostic facility.
- 6.6.8 Temperature Switches shall not be used.

7.0 Control Valves**7.1 General**

- 7.1.1 Control valves shall normally be Globe type single seated or double seated. For clean services, guiding shall be top and bottom / cage type. For highly viscous services, cage guiding shall be avoided.

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7.1.2 Ball valves shall be considered for services where solids in suspension, high rangeability, low pressure drops and tight shut off are required.

7.1.3 Butterfly valves shall be considered for services where solids in suspension, low pressure drops and high capacities are required.

7.1.4 Angle valves shall be considered in services where flashing, coking, solids in suspension or very large pressure drops are encountered.

7.1.5 3-way valves when specified shall be of diverting or mixing type.

7.2 Body

7.2.1 Minimum control valve body size shall be 1". Reduced trim shall be used when capacity is smaller and fluid velocities are larger than permissible. Body sizes shall be limited to the following: 1", 1½", 2", 3", 4", 6", 8", 10" and 12".

7.2.2 The body material shall minimum be as per piping specification. Better material can be considered based on special considerations.

7.2.3 Body flange for globe valves shall be as per line specification. All control valves shall be suitable for ANSI flange connections. The Globe type valve shall have face dimension in accordance with **ISA-RP 75.08.01**



7.2.4 Radiation fins shall be used above 200 °C and extension bonnets will be provided below 0 °C.

7.2.5 Flanged bolted type gland stuffing boxes shall be used. Packing shall normally be Teflon on liquid and gas service upto 200 °C. Graphoil shall be used on steam service and temperature above 200 °C.

7.2.6 For services under vacuum and for special services (i.e. Oxygen, etc.), the packing to be used shall be determined case to case.

7.2.7 Bellow seal shall be used where it is required to isolate the packing from the process fluid or where no leakage to atmosphere can be tolerated like toxic, explosive and precious fluids.

7.2.8 The flow direction shall be clearly marked on the valve body.

7.3 Trim Design

7.3.1 Control valve plugs shall be top and bottom or cage guided for double ported valves and top guided / cage guided for single ported valves. Equal percentage trim shall generally be specified.

7.3.2 Valve Trim Characteristics

Equal percentage plugs shall normally be used when there are large variations in valve pressure drop.

Linear characteristic plug shall be selected for

a) Level control

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- b) Over pressure control in steam or gas service
- c) Small variations in valve pressure drop
- d) Operation by remote hand controller
- e) Split control and parallel control by two valves
- f) Small CV and low noise valves as designated by MFR

Quick opening trim shall be used for ON-OFF and Emergency Shutdown Valves.

NOTE: Whenever the trim characteristics are specified in the Licensor's data sheets that shall be followed

7.3.3 Material used for trim shall be minimum 316 SS, with guide bushing of hardened stainless steel like 440 C, 17-4 PH all upto a pressure drop of 10 kg/cm²g. For higher pressure drops or erosive and slurry services and in general for all steam services, flashing services, hard surfacing of plug seat rings and seating area of inner valve with stellite shall be used. Special cases may require 17-4 PH seat ring and 440C solid plugs or other materials like Hastelloy, Durimet, Monel, etc. For temperature above 300°C stellite facing shall be used for guide posts. Guide bushing shall always be harder by a minimum of 125 Brinnel than the guide post.

7.3.4 The valve seat leakage shall be as per **ANSI FCI 70.2**. All tight shut-off valves specified by licensors shall meet Class VI seat leakage class requirements.

7.4 Actuators

7.4.1 Diaphragm actuators shall generally be used with 0.2 -1.0 kg/cm²g spring range. For larger dP shutoffs, higher spring range / higher area shall be considered.

7.4.2 Piston actuators can be considered for severe pressure drop services.

7.5 Control Valve Sizing

7.5.1 The control valve sizing formulae shall, in general, be as per ISA. Control valve shall be sized for the available pressure drop at normal flow, but based on a flowing quantity equal to normal flow times over sizing factor of 1.5 or 1.1 times the maximum flow whichever is higher. The manufacturer's published Cv values shall be used to determine valve size. Valves in which considerable expansion takes place or substantial quantities of liquid flash to vapour, shall have body one size larger than trim.

7.5.2 The maximum and minimum control valve opening shall be between 80% to **20%** of full stroke at maximum and minimum flow conditions.

7.5.3 All valves in liquid services shall be checked for cavitations / flashing in the sizing calculations and special precautions shall be taken while selecting the type and trim material of control valves for cavitations and flashing services. Special anti-cavitations trim shall be used for cavitations services.



7.6 ON/OFF Valves

7.6.1 On / Off valves shall generally be ball type full port trim and line size body unless specified.

7.6.2 The actuators shall generally be "piston spring return" type, and the valve open / close response time of 10 seconds or less, except where faster action requirement is specified.

7.6.3 The On / Off Valves shall be "fire safe", based on service requirement.

7.7 Positioners

7.7.1 Electro-pneumatic valve positioners shall be provided for all control valves and for On-Off valves with partial stroke testing.

7.7.2 E/P positioner shall be Smart type, operating on input signal 4-20 mA DC, and with HART protocol or with FF protocol for diagnostic & remote calibration.

7.7.3 The valve manufacture shall provide the valve signature for diagnostic purposes.

7.8 Tubing

7.8.1 6 mm OD SS 304 Tubing with SS 316 compression fittings shall be used for interconnecting tubing of the control valve.

7.8.2 Separate air filter regulator shall be used for each E/P positioner.

7.9 Others

7.9.1 Hand wheel shall be considered where the block and by-pass valves are not provided in the process piping or when required by process. However no by-pass or hand wheel shall be used for shutdown valves.

7.9.2 Limit switches and any other electrical accessories shall conform to the electrical area classification and environmental conditions.

7.9.3 Limit switches shall be of Proximity type and intrinsically safe certified. Limit switches shall be provided both for close and open positions for all shutdown valves. The limit switches shall have junction box with 2.5 mm² screw terminals to facilitate field cable terminations for both open and close limit switches. "Open / Close" local indicators shall be provided for all ON/OFF valves.

7.9.4 Solenoid valves (Direct acting type) shall be used as the pilot valve to trip a shutdown valve, On/Off valve. Solenoid valves, wherever used, shall be universal type and shall be continuous rated type with class F coil insulation as per IEC 60085/IS 1271.

Solenoid valve shall be of SS body with SS316 trim, as a minimum. Positioners with inbuilt solenoid valve are NOT acceptable.

The solenoid valve operating voltage shall be 24 V DC and IS (intrinsic safe) type suitable for specified hazardous area classification. However in case of process unit whose control shall be from existing control room, the existing control philosophy shall prevail

Direct line mounted SOV shall not be considered.

7.9.5 The other auxiliary devices such as lock up relay, pilot relay, booster relay volume tank etc. shall be provided as parts of the actuating system in order to achieve the required stroke-speed, fail safe action etc. Volume tank shall be of SS material of construction.

7.9.6 All control valves in service for temperature less than -20°C , shall undergo cryogenic testing in line with BS-6364.

7.9.7 All control valve castings in H2 service for ANSI 600 # and above rating shall undergo Helium leak test.

7.10 Partial Stroke Testing

Partial stroke testing shall be performed to ensure satisfactory operation of on-off valve including all accessories on demand. The test shall be performed automatically by partially (around 10%) stroking the valve while these valves are in service. The test hardware and software shall meet the following minimum requirements;

a) Partial stroke test scheme shall be complete with an hardware and software's which shall include solenoid valves, valve positioner and logic solver. All components used in PST shall be fail safe and shall not affect the on-off valve performance under any circumstances.

b) The PST design shall ensure;

- i) The testing shall be carried out automatically at pre-defined intervals which shall be adjustable.
- ii) The shutdown demand shall always over-ride if PST is in operation at that time.
- iii) The valve shall not operate beyond a predefined maximum allowable stroke valve under any condition or failure. When valve positioner is used to realize PST, the positioner output shall be limited beyond the allowable value in case of valve struck condition.
- iv) Audit trail shall be available to indicate time and date of PST, test results (OK / fail), reason of failure, changes made etc as a minimum.
- v) Upward connectivity to purchaser's host system.

Vendor shall supply the complete testing assembly duly tubed / piped / Wired on a SS mounting plate of thickness 3.2mm suitable for 2" pipe stanchion mounting. Standard pre designed rigidly mounted components shall also be acceptable for PST assembly.

7.11 Self Actuating Valves

7.11.1 Self actuated regulators for flow, pressure and temperature shall be used for control where loads are reasonably constant and requirement for precision and accurate control are not stringent.

8.0 Safety Relief Valves

8.1 Design Requirement

8.1.1 All pressure relieving devices shall be designed in strict accordance with ASME Code for Boiler and Pressure Vessel, API RP 520 and IBR. Nomenclature used shall be in accordance with API RP-520 & 521.

8.2 Pressure Relief Valves

8.2.1 Percent Accumulation

Percent accumulation used in calculating sizes of relieving devices shall be as follows, unless otherwise specified in the Project Design.

- | | |
|---|---------------------------|
| a) Steam service (ASME SEC-I) | 3% |
| b) Steam service (IBR) | 5% |
| c) Gas or vapour services and liquids | 10% except as noted below |
| d) Fire exposure on unfired process vessels | 20% |
| e) Liquids for thermal relief of pipelines
& pump discharges | 25% |

8.2.2 Relief Valves General Features

8.2.2.1 Pressure relief valves shall be safety relief type except for thermal relief valves. Pressure relief valves shall be full nozzle full lift type.

8.2.2.2 Conventional valves with closed bolted bonnet, screwed cap and test gag shall be specified for services with constant back pressure.

8.2.2.3 Bellow seal valves with closed bolted bonnet, screwed cap and test gag shall be specified for varying back pressure.

8.2.2.4 Conventional valve with open bolted bonnet, test gag, lifting gear shall be specified for steam services.

8.2.2.5 Pilot operated relief valves may be specified for special services and where set pressure are closer than 10% of the operating pressure.

8.2.2.6 Base or modified nozzle type valves shall be specified for thermal relief service. Normal size shall be 3/4" x 1" with 0.38 cm² orifice for all liquids. Thermal relief valves shall be provided on the cold side of heat exchangers where "blocking-in" is possible.

8.2.2.7 For very low relief flows as in metering pump discharge, 1/4" x 1/4" valves shall be used.

8.2.2.8 Lifting levers shall be used for air service.

8.2.2.9 Pressure relief valve body casting and nozzle casting with inlet rating of 600 # and above in Hydrogen service shall undergo Helium leak test.

8.3 Material of Construction

8.3.1 The body material shall minimum be as piping specification. Better material may be considered based on special considerations. Nozzle and disc shall generally be 316 SS with machined stainless steel guide and spindle. Springs shall be carbon steel for -30°C to +250°C and shall be cadmium plated. Tungsten alloy steel springs shall be used above 250°C.

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8.4.1 Flanged connections shall be standard on sizes 1" and larger. Minimum rating shall be 150 pounds ANSI.

8.4.2 Where permissible, screwed connections shall be used on sizes ¾" and below.

8.5 Rupture Discs

8.5.1 Rupture disc shall be narrow face capsule type to fit inside the 1.0 of the bolt circle of standard flanges.

8.5.2 Where used as a primary relieving device, the burst pressure shall not exceed vessel pressure at burst temperature.

8.5.3 When installed upstream of a safety valve, a pressure gauge will be provided on the downstream of the disc to indicate any rupture of the disc and an excess flow check valve. Drain holes shall be provided where disc may be exposed to the atmosphere.

8.5.4 Materials shall be compatible with the vessel content consistent with bursting requirements Inconel discs shall be used above 100°C where possible.

8.5.5 Each rupture disc must be supplied with minimum 3 number of additional discs. This is in addition to discs required for carrying out burst testing at factory.

8.5.6 The bursting tolerance of the rupture disc shall be ±5% of the specified bursting pressure or less. Unless otherwise specified.

9.0 Breather Valves, Flame Arresters And Vents

9.1 Breather valves, flame arresters and vents shall be as per API S-2000.

9.2 Breather valve shall generally be soft seated dead weight type.

9.3 Flame arrester bank shall generally be retractable, draw-out type.

10.0 Pressure Reducing And Desuperheater Station

10.1 Desuperheater design shall ensure that temperature at the outlet shall be maintained with + /- 5 deg. C of desired outlet temperature, unless otherwise specified by the Licensor.

10.2 Separate liquid injection valve and steam valve, if provided must be installed along with block and bypass valve.

10.3 The body and trim material of construction shall be suitable for the service. In general trim including spray nozzle shall be Stellite.

10.4 The PRDS/ DS in steam application shall be IBR certified including valve in boiler feed water line.

10.5 The CV shall be calculated in accordance with manufacturer's calculation procedure and selected based on following points.

- Valve sizing shall be based on the maximum capacity of 1.25 times the normal flow or 1.1 times the max. Flow, whichever is greater.
- The minimum flow capacity shall be suitable for rangeability of 30:1. The valve stroke shall not be less than 20% opening at the minimum flow capacity.
- Fluid velocity at the outlet shall be selected suitably in consideration of the property of fluid, the differential pressure of the valve and the line size etc.
- Noise level at 1 meter down stream of DS and at distance of 1 meter from the pipe surface at normal flow shall not exceed 85 dBA.

10.6 A manual operator, limit switch, solenoid valve or any other auxiliary devices shall be provided.

10.7 Manufacturer Standard manual operator / Hand wheel shall be provided.

10.8 Direction of flow shall be permanently affixed on DS body.

11.0 Analyzers, Gas chromatographs and Gas Detection System

11.1 Analyser

11.1.1 On-line gas analysers shall be provided as specified by process Licensor.

Analyzer system shall generally consist of several of the following items:-

- a) Sample tap
- b) Sample transport system (piping to transport the sample)
- c) Sample conditioning system (filters, vaporizers, separators, etc)
- d) Programmer (for chromatographs only)
- e) Readout device
- f) Analyser
- g) Analyser cabinet (if required)
- h) Analyser shelter

11.1.2 Analyzers enclosure shall be weather proof to NEMA 4X and explosion proof suitable to the hazardous area in which they are to be installed.

11.1.3 Where appropriate, the analyser may be installed preferably in flameproof enclosure Ex'd' in order to comply with required area classification. Purged cabinets shall be avoided. In this case, the power supply shall be automatically switched off on loss of purged air flow or pressure inside the enclosure.

11.1.4 Analyzers installed locally shall be protected by means of a shed, which shall protect the analyser from rainwater and direct sunlight.

- 11.1.5 All components in contact with the sample shall be stainless steel minimum.
- 11.1.6 The Analyzer systems shall be supplied in fully assembled condition along with sample handling system in and Analyzer cabinets.
- 11.1.7 The sample system shall contain the necessary metering, condition, gauging and filtering devices to supply the analyser with a continuously representative and measurable sample. The material of construction shall be chosen to prevent reaction of material with sample, absorption of components from the sample and entrant of contaminants through osmosis or diffusion.
- 11.1.8 Flow indicators (permanently tagged with required values) shall be provided as required to maintain sample, sample by-pass, sample vent and utility flow rates.
- 11.1.9 For carrier, reference gas requirement, manifold arrangement with automatic change over arrangement shall be provided.
- 11.1.10 The design used shall provide maximum reliability, maximum on-line performance and minimum maintenance. Instrument shall be field proven. No prototype instrument shall be offered.
- 11.1.11 The Analysers shall meet Environmental Protection Agency (EPA) USA regulations or shall be TUV approved.
- 11.1.12 All Analysers shall be microprocessor based and shall have automatic calibration facility, self-diagnostic facility with local indication.
- 11.1.13 Analyzer shall give isolated 4 to 20 mA output, contact output and RS 485 serial interface for communicating with DCS.
- 11.1.14 Calibration gas shall be supplied for 6 months after Site Acceptance Test (SAT).
- 11.1.15 In case licensor's documents indicate any make / model no. for analyzers Contractor shall provide same or equivalent. When indicated by licensor as mandatory make / model for analyzer, contractor shall supply the same make & model.
- 11.1.16 **Analyzer Shelter**
- Analyzer system shall be installed in the shelter of SS material and insulated as per applicable standard. No RCC room is acceptable. Air conditioning system (HVAC) shall be suitable to specified hazardous area classification. Redundant (1 working+ 1 standby) configuration shall be provided.
- Analyzer shelter and analyzer location shall be designed to minimize sampling time and easy maintenance.
- Provision shall be made for keeping all the fast loop devices outside the shed.
- 11.2 **Gas chromatograph**
- 11.2.1 Gas chromatograph system shall consist of complete set of analyser (s) including sampling system, sample-conditioning system, internal power supplies, inter cabling, inter piping and other components required to provide a fully integrated and functional system.

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- 11.2.2 Gas chromatograph shall be of TDC type as far as practical.
- 11.2.3 Gas chromatograph shall be provided with a dedicated PC for analyser management and information system.
- 11.2.4 Gas chromatograph shall be provided with redundant RS 485 serial interface for communicating with DCS.
- 11.3 Gas detection system
- 11.3.1 The Gas detection system is required to monitor combustible gases. Gas detectors shall be Infrared (IR) type for hydrocarbons and catalytic combustion type for hydrogen. For toxic gas electrochemical type detector shall be used.
- 11.3.2 The gas detectors output shall be 4-20mA with HART and shall be directly connected to the PLC or separate F & G system as per job specification system. Separate gas detection panel is not envisaged.
- 11.3.3 All the mounting accessories, splash guards, junction box etc. shall be included in the scope of supply.
- 11.3.4 Sensor shall be SS 316 provided with sintered enclosure with necessary protection for dust, water splash & ambient condition & also it shall be easily replaceable.
- 11.3.5 Transmitter shall be intrinsically safe type & weather proof (NEMA 4X) enclosure. Intelligent smart transmitter with self-diagnostic Features &-auto-calibration features.
- 11.3.6 Calibration gas cylinders for each type of gas detector shall be sufficient for six months normal after commissioning.
- 11.3.7 1 no. of portable detector for each type of gas detector shall be provided. The portable gas detector shall be supplied complete with controller, audio visual alarm and shall be intrinsically safe for use in hazardous area Zone I, Gr. II C, T3. These units shall be supplied with rechargeable batteries and 230VAC, 50 Hz battery charger. These units shall be supplied complete with its accessories like carrying case, maintenance kit etc.
- 11.3.8 1 no. portable purge calibrator for each type of gas detector each consisting of a volume bottle containing a know gas / air mixture, a purge regulator, a flexible hose and adaptor cap (to fit the sensing head) is to be supplied to enable calibration of the sensor in the field without dismantling them. Volume bottle shall be sufficient for minimum six month after commissioning.
- 11.3.9 Flashing beacon and pneumatic hooters shall be supplied suitable to area classification as required. **Optionally 24 V DC voltage Exd Hooters suitable to area classification requirement are also acceptable.**

12.0 Alarm Annunciators System

Alarm annunciator shall be as per **ISA-18.1**, in general. The standard and first out sequences of alarm shall be Auto reset for control room mounted. Power supply shall be 110 VAC.

Annunciator will show selected abnormal conditions. The annunciator for the control room shall be hung from ceiling cabinet with back-lighted engraved windows and integral power supply. Solid state system with plug in type modules shall be used.

Field mounted annunciator circuit shall be Ex-proof. The power supply unit will be mounted in a safe area.

'Fail safe' type with normally break to alarm shall be used. Provision for make to alarm shall also be provided.

The design shall be such that transient signals of less than 330 ms duration are discounted. Alarm annunciation in Control Rooms shall have miniature windows. Electronic shall be Split type only to achieve the above. However, annunciator for local Panels, if any, conventional type can be followed. Test, acknowledge, reset pushbuttons shall be provided for the annunciation. The annunciator shall have solid state electronics.

13.0 Local Control Panels

- 13.1 All indication lamps, push buttons selector switches shall be Ex proof & annunciator alarm panels in flameproof enclosure shall be installed in local panels.

Field panels shall be Ex-proof / weatherproof considered depending upon the panel size and other criteria for hazardous areas.

- 13.2 Local control panels, in general, shall be of free standing, totally enclosed construction, fabricated from 4 mm thick cold rolled steel sheet..

Maximum dimensions shall be 2100 mm (H) x 1200 mm (W) x 800 mm (D) and shall be mounted on 100mm high channel base.

The panels shall be pickled / phosphated and shall undergo a seven-tank process before primer is applied. The panels shall be provided with 2 coats of red oxide primer and 2 coats of final stove enameled paint. Paint colour shall be any of the following (to be confirmed).

Opaline green IS 15275

Light admiralty gray IS 697

Sky blue IS 101

As approved by the OWNER.

(Shall be confirmed later)

13.3 Mounting Heights

Normal mounting heights of instruments (centre lines of instruments to floor) shall conform to the following, with minor adjustments depending on instruments selected:

- | | | |
|--------------------------------|------------|---------|
| a) Miniature and sub-miniature | Bottom row | 1100 mm |
| instruments (3 rows) | Middle row | 1350 mm |

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Top row 1600 mm

b) Annunciators 1950 mm

c) Electric push buttons/ 700 mm

Switches, Lamps etc.

13.4 Panel doors shall cover the total width and height of a panel section. All doors shall have continuous stainless steel plane hinges. Panels over 1200mm wide shall have double rear doors with heavy duty T-bar latches. Panels less than 1200mm wide shall have single rear door with heavy duty T-bar latch.

13.5 Panels shall be provided with 4 lifting lugs at the top. The panels shall be well sealed against ingress of dust and moisture. IP 51 as per IEC 529 for indoor applications and IP 54 for outdoor service.

13.6 Local control panel for the package units shall be installed within the battery limit of the package considering operational and maintenance requirements and accessibility. In case of skid mounted package; panel shall be located away from the skid.

In case local control panel is housed outdoor i.e. not in a local control room, it shall be designed to meet IP-55 requirements. In addition, panel must be provided with a rain cum sun shade canopy /shed.

13.7 It shall be possible to switch off incoming power to panel from panel front. All such power on/off switches shall be flameproof type.

13.8 All lamps, status as well as alarm, shall be provided with lamp test facility. One single lamp test push button shall be used for each panel.

13.9 Engraved identification plates shall be provided for all instruments on rear of the panel face. Instruments shall have integral nameplate on the panel front. Markers for wires, tubes, terminals, connectors, switches, circuit breakers, panel numbers etc. shall be permanently affixed on them.

13.10 Cable entry to the panel shall be only from the bottom. Suitable removable cable gland plate with double compression type cable glands shall be supplied along with the panel. All unused cable entries must be plugged.

13.11 All panels shall be equipped with an earth bus securely fixed along the inside base of the panels. Provision shall be made for future extension of the earth bus, if need arises.

13.12 Front of panel instrument name plate shall be black laminated plastic with white core. Name plate shall be provided on the rear of panel also.

13.13 The control panel shall be subjected to the following tests and checks:

- a) Check of panel alignment and mechanical operation check
- b) Verification of degree of protection as per IS/IEC 60947
- c) High Voltage Test (2000V for 1 minute)

- d) Verification of wiring as per approved drawings
- e) Routine tests and checks on all panel accessories

14.0 Local Gauge Board

- 14.1 Local gauge board shall be used to install skid mounted instruments like pressure gauges, temperature gauges and transmitters.
- 14.2 Local gauge boards, when provided shall have easy access at the rear and front for all instruments and accessories for maintenance and operation.
- 14.3 Gauge board shall be constructed from 4 mm cold rolled cold annealed steel sheet with other necessary steel supporting structure and shall be painted as per manufacturer standard.
- 14.4 Local gauge board shall be supplied with all instruments installed and completely in tubed/wired condition before shipment.
- 14.5 All pressure gauges shall be provided with block and bleed valves securely fastened. Identification tags shall be securely fastened for easy identification both at the front and rear.

15.0 Installation materials**15.1 Cables**

- 15.1.1 All cables shall have PVC insulated primary insulation except for H2 service for which insulation shall be PE. For electrical interface cables for which insulation shall be XLPE and foundation Fieldbus cables for which insulation shall be XLPL or Polyolefines of 85°C PVC as per IS-5831 type C and inner and outer jacket shall be 90°C PVC to IS-5831 type ST-2. Oxygen index of PVC shall be over 30% and temperature index shall be over 250°C.
- 15.1.2 Cables shall be fire retardant (FRLS) as per standard IEC 60332 Part III Cat. A.
- 15.1.3 The insulation grade shall be 600 V/1100 V as a minimum and shall meet insulation resistance, voltage and spark test requirements as per **BS EN 50288-7:2005**.
- 15.1.4 All cables shall be twisted & round armoured with galvanised steel wire/flat as per IS-1554 part-I.
- 15.1.5 Colour coding of thermocouple extension cables shall be as per ANSI standard. Outer colour shall be light blue for intrinsically safe cables.
- 15.1.6 Conductors shall be stranded electrolytic annealed copper except for T/C extension cables. Maximum dc resistance of the conductor of the cable shall be as per IS 8130.
- 15.1.7 The drain wire resistance including shield shall not exceed 30 ohms / km.
- 15.1.8 A pair of communication wire shall be provided for multipair cables. Each wire shall be 0.5 mm² of plain annealed single or multi-strand copper conductor with 0.4 mm thick 85°C PVC insulation. Insulation shall be green and red colour coded.

- 15.1.9 CONTRACTOR shall supply spare cables as per 'Spare parts list Philosophy'. In each multipair cable 20% pairs shall be kept as spare.
- 15.1.10 Run length of the cable shall be printed at least at every 5-metre interval.
- 15.1.11 Signal / alarm cables/Solenoid valve cables
- a) Single pair shielded signal cables shall be used between field instruments and junction boxes/local control panels.
 - b) Multipair individually and overall shielded signal/alarm cables shall be used between junction boxes/local control panels and main control room, in general.
 - c) Shield shall be aluminum backed mylar polyester tape bonded with the metallic side down helically applied with either side having 25% overlap and 100% coverage. The minimum shield thickness shall be 0.05 mm in case of single pair/triad and 0.075 mm in case of multipair/triad cable.
 - d) Drain wire shall be provided for individual pair and overall shield, which shall be 0.5-mm² multi, stranded bare tinned annealed copper conductor. The drain wire shall be in continuous contact with aluminum side of the shield.
 - e) All multi pair cables shall have 6 pair/12 pairs only while multi triad cable shall have 6 triads/8 triads only.
 - f) Minimum conductor size for single pair / triad is 1.5 mm² and multipair / multi triad is 1.0 mm².
- 15.1.12 Thermocouple extension cables
- a) Single pair shielded thermocouple extension cables shall be used between thermocouple head and junction boxes transmitters/ local control panel mounted instruments.
 - b) Multipair individually and overall shielded thermocouple extension cables shall be used between junction boxes and main control room mounted devices.
 - c) The type of thermocouple extension cables shall be compatible with thermocouple used. In addition the colour coding of the primary insulation shall be as per ANSI.
 - d) The cable shall have 16 AWG and 18 AWG solid conductors for single and multi pairs respectively.
 - e) All thermocouple extension cable shall be matched and calibrated in accordance with MC-96.1.
 - f) Shield shall be aluminum backed by mylar/polyester tape bonded together helically applied with the metallic side down with either side having 25% overlap and 100 % surface. Minimum shield thickness shall be 0.05 mm for single pair and 0.075 mm for multipair cable. Drain wire shall be 0.5-mm² multi-strand bare tinned annealed **copper** conductor. The drain wire shall be in continuous contact with the aluminum side of the shield.

- g) Inductance shall not exceed 4mH/Km.
- h) All multi-pair cables shall have 6 pairs/12 pairs only
- i) Minimum conductor size shall be 16AWG for single pair and 18AWG / 16AWG multipair cables.

15.1.13 Power supply cables

- a) All power supply cables shall be as per IS-1554 Part I and shall have copper conductors. Minimum conductor size shall be 2.5 mm². The cables shall be PVC insulated and armoured. The higher size conductors shall be used incase of long distance power cable where voltage drops more than 3 volts than required supply.
- b) Any other special cable required for instruments that should also be supplied as per requirements. CONTRACTOR shall ensure that these cables are armoured type and shall meet all other requirements.

15.1.14 Foundation Fieldbus Cables

- a) All FF cables (Multi pair and single pair) shall be 16 AWG (1.31mm²) type 'A' cable twisted in pair individually and overall shielded with Aluminum Mylar tape with drain wire and armoured. The conductor shall be made of 7 stranded annealed electrolytic tinned copper conductors. Each strand shall be 28 AWG (0.1288mm²).
- b) The signal attenuation and signal distortion through this cable shall be limited such as way that adequate signal quality shall be available at receiving end of segment as per ISA 50.02.
- c) Primary insulation of FF cables shall be cross-linked polyethylene or polyolefin.
- d) The FF cables shall be 1 pair, 2 pair, 3 pairs and 4 pairs. 1 pair shall be used for spur connectivity only. For trunk Multicables shall be used. At least one pair shall be provided as spare in multi cable. All cables shall be armoured.
- e) Parameters for FISCO and FNICO cable shall be as defined in IEC-61158-2 and in addition shall be meet the limitations required by technical specification as per **IEC 60079-11 & 60079-25**.

15.1.15 Foundation Fieldbus Electrical Characteristics

- a) The characteristic impedance of each twisted pair in cable shall be 100+20 Ohms. The Characteristic impedance may be determined by any of the methods described in ASTM D4566 at 31.25 KHz. Signal attenuation of each twisted pair shall be less than 3 db/km at 39 KHz.
- b) The difference in capacitance between one wire and the shield and other wire and shield not be more than 4 pF/meter average. Vendor to consider a minimum 30 meter length of cable of each type to test with these parameters.

- c) Minimum jacket resistance between cable's shield and the metal structure shall be $1 \text{ M} \Omega / 330 \text{ meters}$.
- d) L/R ratio of adjacent core shall not exceed $50 \mu\text{H}/\Omega$ for cables with 16 AWG (1.31 mm^2) conductors.
- e) Maximum propagation delay Variance from 0.25 fr to 1.25 fr equal to $1.7 \mu\text{s}/\text{km}$.
- f) Other specifications shall be in accordance to Type A cable as per IEC 61158-2 and in addition meeting the limitation required by FISCO technical specification **IEC 60079-11 & 60079-25**.

15.2 Cable glands

15.2.1 CONTRACTOR shall supply all cable glands required for glanding the above-mentioned cables both at field instrument and local control panel, junction boxes and at main control room.

15.2.2 All cables glands shall be of type 304 SS; double compression type suitable for armoured cables and have PVC shrouds.

15.2.3 Flame proof glands wherever required shall be supplied with Ex (d) certification.

15.2.4 The CONTRACTOR as per spare parts list philosophy shall supply spares against all these items.

15.3 Junction boxes

15.3.1 Separate junction boxes shall be used for IS and non-IS signals. Further it shall be segregated based on signal types given below.

- a) Analogue input/Analogue output
- b) Thermocouple
- c) Digital input
- d) Digital output
- e) SOV
- f) Power cable
- g) RTD
- h) Vibration signals
- i) Gas detectors

NOTE:

- 1) Direct cable shall be considered for pulse signals.

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2) Above mentioned types of junction boxes shall again be segregated based on signal from DCS or PLC.

15.3.2 CONTRACTOR shall supply junction boxes of die cast aluminum alloy (LM-6) body, and flameproof with Ex (d) certification. Junction Box shall be CCOE approved, for specified hazardous area class based on gas group service.

15.3.3 Junction boxes shall have terminals suitable for the cable sizes to be terminated but shall be minimum suitable for 2.5 mm² cable. 20% spare terminals shall be supplied in each junction box. The terminals shall be mounted on rails in the junction box.

15.3.4 Cross ferruling philosophy to be followed for wiring

15.3.5 Telephone sockets and plugs shall be provided in junction boxes.

15.3.6 Each junction box shall have minimum of 10% or 2 Nos. minimum spare entries. All spare entries shall be provided with SS plugs. All the cable entries shall be from bottom only.

15.3.7 The instrument signal cable shall be separated from power cables to protect from electrical noise. As minimum separation distances of 1 meter shall be maintained.

15.4 Instrument valves and manifolds

15.4.1 CONTRACTOR shall supply instrument valves and valve manifolds wherever required. All isolation and drain valves shall be gate valves. Equalising valves shall be globe valves.

15.4.2 Body rating and material shall be as per piping class or better and trim material shall be SS 316. All valves and manifolds shall be forged type only and of minimum 800 LBS rating.

15.4.3 Superior body and trim material shall be selected if required by process conditions. Packing material in general shall be of PTFE.

15.5 Impulse piping/tubing

15.5.1 In general flow transmitters, pressure transmitters and pressure gauges (except diaphragm seal type) shall be installed prefabricated close coupled.

15.5.2 CONTRACTOR shall supply ½ in. NB impulse lines as per piping specification for utility instruments, however final connection to instrument of impulse piping shall be made using 12mm OD X 0.065" thick ASTM A -269 TP 316 stainless seamless tubes and SS 316 compression fittings.

15.5.3 Steam tracing shall be 8 mm OD copper tubes of electrolytic grade copper.

15.5.4 Proper accessibility to be provided to installed field devices by providing ladder or platforms, for maintenance.

15.6 Pipes and tube fittings

15.6.1 CONTRACTOR shall supply SS 316 flareless compression tube fitting of three-piece construction of Swagelok / Parker or equivalent make only. The tube fittings shall be of minimum 3000 LBS rating.

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- 15.6.2 The fitting/ferrule hardness shall be in the range of RB 85-90 so as to ensure a minimum hardness difference of 5 to 10 between tube and fittings. The ferrule shall be of stainless steel material, in general.
- 15.6.3 Socket-weld type forged pipe fittings of suitable material and rating shall be supplied for pipe fittings. The minimum rating shall be 800 lbs. Weld neck fittings shall be used where socket weld types are not allowed by piping class.
- 15.6.4 All threaded fittings shall have NPT threads as per ANSI/ASME B16.11 only.
- 15.6.5 All the pipe fittings shall be of 800 LBS minimum rating.

15.7 Pneumatic Distribution

- 15.7.1 CONTRACTOR shall supply 6mm OD x 0.028-inch thick SS 304 tubes as per ASTM A 269 seamless type. Where air supply requirement is more such as large size on/off valves 12 mm OD tube shall be used.
- 15.7.2 CONTRACTOR shall avoid use of intermediate connectors and shall estimate single run length for each instrument location.
- 15.7.3 Isolation valves on instrument air service shall be packless gland type full-bore ball valves and body material shall be SS 316.
- 15.7.4 Instrument air manifolds are not acceptable.

15.8 Air filter regulators

- 15.8.1 Instrument air filter regulator of suitable size, range and capacity shall be supplied for each pneumatic instrument.
- 15.8.2 The body of the filter shall be SS.
- 15.8.3 The filter shall have 5 micron sintered bronze/ceramic filter element and shall be provided with manual drain and 2" nominal size pressure gauge.

15.9 Instrument Installations

- 15.9.1 Each instrument shall be installed accordance with appropriate installation drawing meeting the Consultant /Licensor requirements.
- 15.9.2 The mounting location of instrument shall be selected considering the accessibility for maintenance and trouble free operations.
- 15.9.3 Transmitter mounting brackets shall be SS, with L type used for vertical piping and flat type for horizontal mounting.

15.10 Cable trays and cable ducts

- 15.10.1 All cables on the Cable trays and cable ducts main pipe rack shall be laid in cable duct. Cable ducts shall be made of hot dip galvanized M.S. sheets & frames fabricated as per 'Instrument Cable Duct Fabrication Details 4600-JSD-004.

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15.10.2 All branch cables shall run on cable trays and on structural angle.

15.10.3 These cable trays shall be of perforated made of hot dip galvanized. Thickness shall be 2.0 mm for 60 mm wide tray, 3.0 mm for 100 to 400 mm wide and 4.0 mm for 500 mm wide tray. The width shall be so selected that 50% of tray space is available for future use.

15.10.4 Suitable cable clamps shall be supplied for binding the cables/tubes at every 500 mm.

15.11 Instrument support/structural steel

15.11.1 CONTRACTOR shall supply instrument stands, stanchions and other structural steel material required for supporting the cable trays, impulse lines and instruments. Angles used for cable dropping to Junction Box or to field device shall be galvanized. Stanchions shall be made out of MS pipe galvanized.

16.0 Close Circuit Television (CCTV) System

A CCTV monitoring system shall be provided for RUP units for the surveillance of the units. It is the responsibility of the CONTRACTOR to select proper models, which meet the technical requirements mentioned in Job specification. If there is any deviation then it shall be brought to PMC/OWNERS attention & written approval shall be taken. All cameras, Pan tilt & zoom & Camera Housing shall be supplied through OEM.

ANNEXURE-14

STANDARD SPECIFICATION FOR SHOP AND FEILD PAINTING

**CHENNAI PETROLEUM CORPORATION LIMITED
CHENNAI, INDIA****CPCL REFINERY - RESID UPGRADATION PROJECT****PART : III****SECTION : B.12****TITLE: GENERAL SPECIFICATION FOR SHOP AND FIELD PAINTING****DOCUMENT NO. : 44NC-4600-0000-V.02-0111-A4**

REV NO.	ISSUE DATE	PAGES	REV DESCRIPTION	PREPARED BY	CHECKED BY	APPROVED BY
0	09.03.2010	48	Issued as general specification	MS	CR	CR
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1.0 GENERAL

1.1 These technical specifications shall be applicable for the work covered by the contract and without prejudice to the various codes of practice, standard specifications, etc. It is understood that Contractor shall carry out the work in all respects with the best quality of materials and workmanship and in accordance with the best engineering practice and instructions of Engineer-in-Charge.

1.2△ Wherever it is stated in the specification that a specific material is to be supplied or a specific work is to be done, it shall be deemed that the same shall be supplied or carried out by the contractor. Any deviation from this standard without written deviation permit from appropriate authority will result in rejection of job.

2.0 SCOPE

2.1 Scope of work covered in the specification shall include, without being limited to the following

2.1.1 This specification defines the requirements for surface preparation, selection and application of paints on external surfaces of equipment, vessels, machinery, piping, ducts, steel structures, external & internal protection of storage tanks for all services. MS chimney without refractory lining and flare lines etc. The items listed in the heading of tables of paint systems is indicative only, however the contractor is fully responsible for carrying out all the necessary painting, coating and lining on external and internal surfaces as per the tender requirement.

2.2 Extent of Work

2.2.1 The following surfaces and materials shall require shop, pre-erection and field painting :

- a. All un-insulated C.S & A.S equipment like columns, vessels, drums, storage tanks, heat exchangers, pumps, compressors, electrical panels and motors etc., and tanks and equipment in ETP plant.
- b. All un-insulated carbon and low alloy piping fittings and valves (including painting of identification marks), furnace, ducts and stacks.
- c. All items contained in a package unit as necessary.
- d. All structural steel work, pipe, structural steel supports, walkways, handrails, ladders, platforms, etc.
- e. External surfaces of MS chimneys without refractory lining & flare lines.
- f. Identification color bands on all piping as required including insulated aluminum clad, galvanized, SS and nonferrous piping.
- g. Identification lettering / numbering on all painted surfaces of equipment / piping insulated aluminum clad, galvanized, SS and non-ferrous piping.
- h. Marking / identification signs on painted surfaces of equipment / piping hazardous service.
- i. Supply of all primers, paints and all other materials required for painting other than Owner's supply.
- j. Over insulation surface of equipments and pipes wherever required.
- k. Painting under insulation for carbon steel, alloy steel and stainless steel as specified. △

- l. Repair work of damaged / pre-erection / fabrication shop primer and weld joints at field.
 - m. Internal surfaces of RCC tanks and structures in Effluent Treatment Plant.
- 2.2.2 The following surfaces and materials shall not require painting in general. However, if there are any specific requirement by the Owner, the same shall be painted as per the relevant specifications:
- a. Un-insulated austenitic stainless steel
 - b. Plastic and / or plastic coated materials.
 - c. Non-ferrous materials like Aluminum, galvanized "piping", "gratings" and "Handrails" etc. except G.I. Tower.
- 2.3 Unless otherwise instructed final painting on pre-erection / shop primed pipes and equipments shall be painted in the field, only after the mechanical completion, testing on systems are completed as well as after completion of steam purging wherever required.
- 2.4 Changes and deviations required for any specific job due to clients requirements or otherwise shall be referred to Jacobs for deviation permit.

3.0 CODES & STANDARDS

- 3.1 Without prejudice to the provision of Clause 1.1 above and the detailed specifications of the contract, the following codes and standards shall be followed for the work covered by the contract.

Color coding	Color coding inspection manual for piping issued by CPCL (Ref. Annexure-2) 
IS-101	Methods of test for ready mixed paints and enamels.
ASTM	American standard test methods for paints and coatings.
ASA A 13.1-1981	Scheme for identification of piping systems: American National Standards Institution.

3.2 Surface Preparation Standards

Following standards shall be followed for surface preparations

- 3.2.1 Swedish Standard – SIS-05 5900-1967 (surface preparation standards for painting steel surfaces)
- This standard contains photographs of the various standards on four different degrees of rusted steel and as such is preferable for inspection purpose by the Engineer-in-Charge.
- 3.2.2 Steel Structures Painting Council, U.S.A (Surface Preparation Specifications (SSPC-SP).
- 3.2.3 British Standards (Surface Finish of Blast-Cleaned for Painting) BS-4232.
- 3.2.4 National Association of Corrosion Engineers, U.S.A (NACE).
- 3.2.5 Various International Standards equivalent to Swedish Standard for surface preparations are given in Table-I.
- 3.3 The contractor shall arrange, at his own cost, to keep a set of latest edition of above standards and codes at site.

3.4 The paint manufacturer's instructions shall be followed as far as practicable at all times. Particular attention shall be paid to the following :

- a. Instructions for storage to avoid exposure as well as extremes of temperature.
- b. Surface preparation prior to painting.
- c. Mixing and thinning.
- d. Application of paints and recommended limit on time intervals between coats.
- e. Suggested Quality assurance procedures.

4.0 EQUIPMENT

4.1 All tools, brushes, rollers, spray guns, blast material, hand power tools for cleaning, inspection instruments, e.g. surface profile gauges, holiday detectors, pin hole detectors, dry film thickness gauges, etc. and all equipments, scaffolding materials, shot blasting equipments like hooper, grit etc & air compressors, etc., required to be used shall be suitable for the work and all in good order and shall be arranged by the Contractor at site and in sufficient quantity. 

4.2 Mechanical mixing shall be used for paint mixing operations in case of two pack systems except that the Engineer-in-Charge may allow the hand mixing of small quantities at his discretion.

5.0 SURFACE PREPARATION, SHOP, COATING APPLICATION & REPAIR AND DOCUMENTATION

5.1 General

5.1.1 In order to achieve the maximum durability, blast cleaning is considered the most desirable method to achieve required profile however one or more of following methods of surface preparation shall be followed, depending on conditions of steel surface and as instructed by Engineer-in-Charge. Adhesion of the paint film to surface depends largely on the degree of cleanliness and surface profile of the metal surface. Proper surface preparation contributes more to the success of the paint protective system.

- a) Manual or hand tool cleaning
- b) Mechanical or power tool cleaning.
- c) Blast cleaning. NO sand shall be used. Only grit blasting shall be allowed. 

5.1.2 Mill scale, rust, rust scale and foreign matter shall be removed fully to ensure that a clean and dry surface is obtained. The minimum acceptable standard in case of manual or hand tool cleaning shall be St. 2 or equivalent, in case of mechanical or power tool cleaning it shall be St. 3 or equivalent in case of blast cleaning it shall be Sa 2-1/2 OR equivalent as per Swedish Standard SIS-055900-1967 or equivalent. Where highly corrosive conditions exist, then blast cleaning shall be Sa 3 as per Swedish Standard.

Remove all other contaminants, oil, grease, etc. by use of an aromatic solvent prior to surface cleaning.

5.1.3 Blast cleaning shall not be performed where dust can contaminate surfaces undergoing such cleaning or during humid weather conditions having humidity exceed 85%.

5.1.4 Irrespective of the method of surface preparation, the first coat of primer must be applied by airless spray gun on dry surface. No brush shall be used except for touchup. This should be done immediately and in any case within 4 hours of cleaning of surface. However, at times of unfavorable weather conditions, the Engineer-In-Charge shall have the liberty to control the time period, at his sole discretion and / or to insist on re-cleaning, as may be required, before primer application is taken up. In general, during unfavorable weather conditions, blasting and painting shall be avoided as far as practicable. $\triangle$

5.1.5 The external surface of RCC chimney to be painted shall be dry and clean. Any loose particle of sand, cement, aggregate etc., shall be removed by scrubbing with soft wire brush if necessary. Acid etching with 10-15% HCl solution for about 15 minutes shall be carried out and surface must be thoroughly washed with water to remove acid & loose particles then dry completely before application of paint.

5.2 Procedure of Surface Preparation :

5.2.1 Blast Cleaning

5.2.1.1 Air Blast Cleaning

The surfaces shall be blast cleaned using one of the abrasives Al_2O_3 particles, chilled cast iron or malleable iron and steel at pressure of 7 Kg /cm² at appropriate distance and angle depending of nozzle size maintaining constant velocity and pressure. Chilled cast iron, malleable iron and steel shall be in the form of shot or grit of size not greater than 0.055" maximum in case of steel and malleable iron and 0.04" maximum in case of chilled iron. Compressed air shall be free from moisture and oil. The blasting nozzles should be venturi style with tungsten carbide or boron carbide as the materials for liners. Nozzles orifice may vary from 3/16" to 3/4". On completion of blasting operation, the blasted surface shall be clean and free from any scale or rust and must show a grey white metallic luster. Primer or first coat of paint shall be applied within 4 hours of surface preparation. Blast cleaning shall not be done outdoors in bad weather without adequate protection or when there is dew on the metal, which is to be cleaned. Surface profile shall be uniform to provide good key to the paint adhesion (i.e. 35 to 50 microns). If possible vacuum collector shall be installed for collecting the abrasives and recycling.

5.2.1.2 Water Blast cleaning

Environmental, health and safety problems associated with abrasive blast cleaning limit the application of Air Blast Cleaning in many installations. In such case water blast cleaning is resorted to.

Water Blast Cleaning can be applied with or without abrasive and high pressure water blasting. The water used shall be inhibited with sodium chromate / phosphate. The blast-cleaned surface shall be washed thoroughly with detergents and wiped with solvent and dried with compressed air. For effective cleaning abrasives are used. The most commonly used pressure for high pressure water blast cleaning for maintenance surface preparation is 3000 to 6000 psi at 35-45 lit/minute water volume and pressures upto 1000 psi and water volume at 45 lit/minute provide maximum cleaning.

The water blast cleaned surface shall be comparable to SSPC-SP-12/nace No. 5. The operation shall be carried out as per SSPC guidelines for water blast cleaning. The indicative values for sand injection is :

Air	:	300 to 400 Cu. Ft. / min
Water	:	5-10 lit/min. with corrosion inhibitor
Sand	:	200-400 lbs/hr.
Nozzle	:	0.5 to 1" dia.

Special equipments for water blast cleaning with abrasives, now available, shall be used.

5.2.2 Mechanical or Power Tool Cleaning

Power tool cleaning shall be done by mechanical striking tools, Chipping hammers, grinding wheels or rotating steel wire brushes. Excessive burnish of surface shall be avoided as it can reduce paint adhesion. On completion of cleaning, the detached rust mill scale etc. shall be removed by clean rags and / or washed by water or stream and thoroughly dried with compressed air jet before application of paint.

5.2.3 Manual or hand tool cleaning

Manual or hand tool cleaning is used only where safety problems limit the application of other surface preparation procedure and there is approach problem in certain areas and hence does not appear in the tables of paint systems.

Hand tool cleaning normally consists of the following :

- a. Hand descaling and / or hammering
- b. Hand scraping
- c. hand wire brushing

Rust, mill scale spatters, old coatings and other foreign matter, shall be removed by hammering, scrapping tools, emery paper cleaning, wire brushing or combination of the above methods. On completion of cleaning, loose material shall be removed from the surface by clean rags and the surface shall be brushed, swept, dusted and blow off with compressed air/steam to remove all loose matter. Finally the surface may be washed with water and dried for effective cleaning.

5.3 Non-compatible shop coat 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., as shop coat, 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. However a non-compatible primer shall have to be removed before application of compatible paint system for the environment. The touch up primer and finishing coat(s) shall be identified for application by Engineer-in-Charge.

5.4 Shop coated (coated with primer & finishing coat) equipment should not be repainted unless paint is damaged.

5.5 Shop primed equipment and surfaces will 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 should be completely removed before application of selected paint system for particular environment.

5.6 For Package units / equipment, shop primer should be as per the paint system given in this specification. However, manufacturer's standard can be followed after review.

5.7 Coating Procedure and Application

5.7.1 Surface shall not be coated in rain, wind or in environment where injurious airborne elements exists, when the steel surface temperature is less than 5°F above dew point when the relative humidity is greater than 85% or when the temperature is below 40°F.

5.7.2 Blast cleaned surface shall be coated with one complete application of primer as soon as practicable but in no case later than 4 hrs. the same day.

- 5.7.3 To the maximum extent practicable, each coat of material shall be applied as a continuous film uniform thickness free of probes. Any spots or areas missed in application shall be recoated and permitted to dry before the next coat is applied. Applied paint should have the desired wet film thickness.
- 5.7.4 Each coat shall be in proper state of cure or dryness before the application of succeeding coat. Material shall be considered dry for recoating when an additional coat can be applied without the development of any detrimental film irregularities, such as lifting or loss of adhesion of the under coat. Manufacturer instruction shall be followed for inter-coat interval.
- 5.7.5 When the successive coat of the same color have been specified, alternate coat shall be tinted, when practical, sufficiently to produce enough contrast to indicate complete coverage of the surface. The tinting material shall be compatible with the material and not detrimental to its service life.
- 5.7.6 Deleted 
- 5.7.7 Airless spray application shall be in accordance with the following procedure : as per steel structure paint Manual Vol. 1 & Vol. 2 by SSPC, USA. Air less spray relies on hydraulic pressure rather than air atomization to produce the desired spray. An air compressor or electric motor is used to operate a pump to produce pressures of 1000 to 6000 psi, paint is delivered to the spray gun at this pressure through a single hose within the gun, a single paint stream is divided into separate streams, which are forced through a small orifice resulting in atomization of paint without the use of air. This results in more rapid coverage with less over spray. Airless spray usually is faster, cleaner, more economical and easier to use than conventional air spray.
- Airless spray equipment is mounted on wheels, and paint is aspirated in a hose that sucks paint from any container, including drums. The unit shall have inbuilt agitator that keep the paint uniformly mixed during the spraying. The unit shall consist of inbuilt strainer. Usually very small quantity of thinning is required before spray. In case of high build epoxy coating (two pack), 30:1 pump ratio and 0.020-0.023" tip size will provide a good spray pattern. Ideally fluid hoses should not be less than 3/8" ID and not longer than 50 ft. to obtain optimum results.
- 5.7.8 In case of gun choking, de-choking steps shall be followed immediately.
Brush application of paint shall be in accordance with the following :
- a. Brushes shall be of a style and quality that will enable proper application of paint.
 - b. Round or oval brushes are most suitable for rivets, bolts, irregular surface and rough or pitted steel. Wide flat brushes are suitable for large flat areas, but they shall not have width over five inches.
 - c. Paint shall be applied into all corners.
 - d. Any runs or sags shall be brushed out.
 - e. There shall be a minimum of brush marks left in the applied paint.
 - f. Surfaces not accessible to brushes shall be painted by spray, doubaers or sheepskin.
- 5.7.9 Manual application by sling (where 6 o' clock position of pipe is not approachable)
- A canvas strip (alternatively a tinplate strip) about 450mm wide and 1.5m long is held under the pipe by two men holding this sling move it up and down and walk slowly forward while fresh coating is poured on the pipe and they manipulate the sling so that an even coating is obtained all round the bottom. This work shall be done very carefully and by experienced personnel. There shall not be any formation of "Whiskers" and holes in the coating. The coating film shall be inspected by mirror.

- 5.7.10 For each coat the painter should know the WFT corresponding to the specified DFT and standardize the paint application technique to achieve the desired WFT. This has to be ensured in the qualification trial.
- 5.8 Drying of coated surfaces
- 5.8.1 No coat shall be applied until the preceding coat has dried. The material shall be considered dry for re-coating when another coat can be applied without the development of any film irregularities such as lifting or loss of adhesion of undercoats. Drying time of the applied coat should not exceed maximum specified for it as a first coat; if it exceeds the paint material has possibly deteriorated or mixing is faulty.
- 5.8.2 No paint shall be force dried under conditions which will cause checking, wrinkling, blistering formation of pores, or detrimentally affect the conditions of the paint.
- 5.8.3 No drier shall be added to paint on the job unless specifically called for in the manufacturer's specification for the paint.
- 5.8.4 Paint shall be protected from rain, condensation, contamination, snow and freezing until dry to the fullest extent practicable.
- 5.9 Repair of damaged paint surface
- 5.9.1 Where paint has been damaged in handling and in transportation, the repair of damaged coating of pre-erection / fabrication shall be as given below.
- 5.9.2 Repair of damaged inorganic zinc silicate primer after erection / welding.
- Quickly remove the primer from damaged area by mechanical scrapping and emery paper to expose the white metal. Blast clean the surface if possible. Feather the primer over the intact adjacent surface surrounding the damaged area by emery paper.
- 5.9.3 Repair of damaged pre-erection and shop priming in the design temperature of -90°C to 400°C
- Surface preparation shall be done as per procedure 5.9.2
 - One coat of F-9 shall be applied wherever damage was observed on pre-erection / pre-fabrication / shop primer of inorganic zinc silicate coating (F-9).
- 5.10 Paint Application
- 5.10.1 Shop priming / pre-erection priming with F9 or F12 shall be done only on blasted surface.
- 5.10.2 Shop priming / pre-erection priming with F9 shall be done only with airless spray.
- 5.10.3 For large flat surface field painting shall be done by airless spray otherwise brush can be used.
- 5.11 Documentation
- 5.11.1 A written quality plan with procedure for qualification trials and for the actual work.
- 5.11.2 Daily progress report with details of weather conditions, particular of applications, no. of coats and type of materials applied, anomalies, progress of work versus program.
- 5.11.3 Results of measurement of temperatures relative humidity, surface profile, film thickness, holiday detection, adhesion tests with signature of appropriate authority.
- 5.11.4 Particulars of surface preparation and paint application during trials and during the work.

- 5.11.5 Details of non-compliance, rejects and repairs.
- 5.11.6 Type of testing equipments and calibration.
- 5.11.7 Code and batch numbers of paint materials used.

TABLE-1 (FOR CLAUSE 5.0)
SURFACE PREPARATION STANDARDS

SR. NO.	DESCRIPTION	VARIOUS INTERNATIONAL STANDARDS (EQUIVALENT)				REMARKS
		Swedish Standard SIS-05-5900	SSPC-SP USA	NACE USA	BRITISH STANDARD BS-4232	
1.	Manual or hand tool cleaning. Removal of loose rust, loose mill scale and loose paint, chipping, scrapping, standing and wire brushing. Surface should have a faint metallic sheen.	ST.2	SSPC-SP-2	--	--	This method is applied when the surface is exposed to normal atmospheric conditions when other methods cannot be adopted and also for spot cleaning during maintenance painting.
2.	Mechanical or power tool cleaning. Removal of loose rust, loose mill scale and loose paint to degree specified by power tool chipping, descaling, sanding, wire brushing and grinding, after removal of dust, surface should have a pronounced metallic sheen.	ST. 3	SSPC-SP-3	--	--	
3.	Blast cleaning (air & water) There are four common grades of blast cleaning					
3.1	White metal Blast cleaning to white metal cleanliness. Removal of all visible rust. Mill scale, paint & foreign matter 100% cleanliness with desired surface profile.	SA.3	SSPC-SP-5	NACE #1	First Quality	Where extremely clean surface can be expected for prolong life of paint system.

3.2	Near white metal	SA 2 ½	SSPC-SP-10	NACE #2	Second Quality	The minimum requirement for chemically resistant paint systems such as epoxy, vinyl, polyurethane based and inorganic zinc silicate paints, also for conventional paint systems used under fairly corrosive conditions to obtain desired life of paint system.
3.3	Commercial Blast Blast cleaning until at least two-third pf each element of surface are is free of all visible residues with desired surface profile	SA 2	SSPC-SP-6	No. 3	Third Quality	For steel required to be painted with conventional paints for exposure to mildly corrosive atmosphere for longer life of the paint systems.
3.4	Brush-off Blast Blast cleaning to white metal cleanliness, removal of all visible rust, mill scale, paint & foreign matter. Surface profile is not so important.	SA 1	SSPC-SP-7	No. 4		

6.0 PAINT MATERIALS

Paint manufacturers shall furnish the characteristics of all paints materials on printed literature along with the test certificate for all specified characteristics given in this specification. All the paint materials shall be on first quality and conform to the following general characteristics. As per the tables 6.1, 6.2 and 6.3.

TABLE No. 6.1 PRIMERS

Sr. No.	Description	P-2	P-4	P-6
1.	Technical Name	Chlorinated rubber Zinc Phosphate primer	Etch primer / wash primer	Epoxy zinc phosphate primer
2.	Type and composition	Single pack, air drying chlorinated rubber based medium plasticised with unsaponifiable plasticizer, pigmented with zinc phosphate	Two pack polyvinyl butyral resin medium cured with phosphoric acid solution pigmented with zinc tetroxy chromate	Two component polyamide cured epoxy resin medium- pigmented with zinc phosphate.
3.	Volume Solids (approx.)	40%	7-8%	40%
4.	DFT (Dry Film thickness) per coat (approx.)	40-45μ	8-10μ	40-50μ
5.	Theoretical covering capacity in M ² /coat/litre (approx.)	8-10	8-10	8-10
6.	Weight per liter in kgs/liter (approx)	1.3	1.2	1.4
7.	Touch dry at 30°C (approx.)	30 minutes	2 hrs.	After 30 min.
8.	Hard dry at 30°C (approx.)	24 hrs.	24 hrs.	24 hrs.
9.	Over coating interval (approx.)	Min: 8 hrs. Max. : No limitations	Min: 4-6 hrs. Max. : 24 hrs.	Min.: 8 hrs. Max. : 3-6 months
10.	Pot life (approx) at 30°C for two component paints (approx.)	Not applicable	Not applicable	8 hrs.

TABLE No. 6.2
FINISH PAINTS

Sr. No.	Description	F-2	F-3	F-6A/F-6B	F-7
1.	Technical Name	Acrylic polyurethane finish paint	Chlorinated rubber based finish paint	Epoxy high build finish paint	High build coaltar epoxy coating.
2.	Type and composition	Two-pack aliphatic isocyanate cured acrylic finish paint	Single pack plasticized chlorinated rubber based medium with chemical and weather resistant pigments	Two pack polyamine (F-6A) / polyamide (F-6B) cured epoxy resin medium suitably pigmented	Two pack polyamide cured epoxy resin blended with coaltar medium, suitably pigmented.
3.	Volume Solids (approx.)	40%	40%	62%	65%
4.	DFT (Dry Film thickness) per coat (approx.)	30-40μ	40-45μ	100-125μ	100-125μ
5.	Theoretical covering capacity in M ² /coat/litre (approx.)	10-13	8-10	5-6	5.2-6.5
6.	Weight per liter in kg/liter (approx)	1.3	1.2	1.4	1.5
7.	Touch dry at 30°C (approx.)	1 hr.	30 minutes	3 hrs.	4 hrs.
8.	Hard dry at 30°C (approx.)	Overnight	8 hrs.	Overnight	48 hrs.
9.	Over coating interval (approx.)	Min : Overnight (12 hrs.) Max. : Unlimited	Min : Overnight Max. : Unlimited	Min : Overnight Max : 5 days	Min. : 24 hrs. Max. : 5 days
10.	Pot life (approx) at 30°C for two component paints (approx.)	6-8 hrs.	Not applicable	4-6 hrs.	4-6 hrs.

TABLE No. 6.3
FINISH PAINTS

Sr. No.	Description	F-8	F-9	F-11	F-12
1.	Technical Name	Self priming type surface tolerant high build epoxy coating (complete rust control coating)	Inorganic zinc silicate coating	Heat resistant synthetic medium based on two pack Aluminum paint suitable upto 250°C dry temp.	Heat resistant silicone aluminum paint suitable upto 500°C / 550°C dry temp.
2.	Type and composition	Two-pack epoxy resin based suitable pigmented and capable of adhering to manually prepared surface and old coating.	A two pack air drying self curing solvent based inorganic zinc silicate coating	Heat resistant synthetic medium based two pack Aluminum paint suitable upto 250°C	Single pack silicone resin based medium with Aluminum flakes.
3.	Volume Solids (approx.)	72%	60%	25%	20%
4.	DFT (Dry Film thickness) per coat (approx.)	100-125μ	65-75μ	20-25μ	20-25μ
5.	Theoretical covering capacity in M ² /coat/litre (approx.)	6.0-7.2	8-9	10-12	8-10
6.	Weight per liter in kg/liter (approx)	1.4	2.3	1.2	1.1
7.	Touch dry at 30°C (approx.)	3 hrs	30 minutes	3 hrs.	30 min
8.	Hard dry at 30°C (approx.)	24 hrs	12 hrs.	12 hrs.	24 hrs
9.	Over coating interval (approx.)	Min : 10 hrs Max. : 6 months	Min : 8 hrs at 20°C & 50% RH Max. : Unlimited	Min : 16 hrs Max : Unlimited	Min. : 16 hrs Max. : Unlimited
10.	Pot life (approx) at 30°C for two component paints (approx.)	90 min	4-6 hrs	Not applicable	Not applicable
11.	Temperature Resistance	-	-	250 °C	500 °C

TABLE No. 6.4 FINISH PAINTS

Sl. No	DESCRIPTION	F-14	F-15	F-16A/B
1	Technical name	Polyamine cured coal tar epoxy	Epoxy phenolic coating	Ambient temperature curing Poly Siloxane/ inorganic copolymer based aluminium coating suitable for under insulation coating of CS and SS piping for high temperature service
2	Type and composition	Specially formulated polyamine cured coal tar epoxy suitable for application under insulation	Two pack ambient temperature curing epoxy phenolic coating suitable for application under insulation	Amercoat 738 from Ameron Products, USA/ Berger 938 from Berger Paints Ltd., Kolkata or Intertherm 751 CSA from Akzo Nobel coating, Bangalore.
3	Volume Solids (approx.)	70%	65%	60%
4	DFT (Dry Film thickness) per coat (approx.)	125 urn	75-100 urn	75-100 urn
5	Theoretical covering capacity in M2/ coat/ litre (approx.)	5.5	6.5-8.5	6.0- 8.0
6	Weight per liter in kg/ litre (approx.)	1.5	1.7	1.3
7	Touch dry at 30°C (approx.)	4hrs	2 hrs	1hr
8	Hard dry at 30°C (approx.)	168hrs(7days)	168 hrs (7 days)	12 hrs
9	Over coating interval (approx.)	Min. 6 hrs Max.5 days	Min. 36 hrs Max. 21 days	Min. 16 hrs Max. Not applicable
10	Pot life (approx.) at 30°C for two component paints (approx.)	4 hrs	1.5 hrs	1hr
11	Temperature Resistance	-45°Cto150°C under insulation	-45°C to 150°C under insulation	Up to 400 deg. C for CS & SS surfaces under insulation

F-14 Specially formulated polyamide cured Coal-tar epoxy suitable for –45⁰C to 125⁰C for application under insulation.

F-15 Two pack ambient temperature curing epoxy phenolic coating suitable for –45⁰C to 125⁰C for application under insulation.

F-16A Engineered polysiloxane coating : Amercoat 738 from Ameron Products, USA

F-16B Engineered poly siloxane coating : Berger 938 from Berger Paints Ltd., Kolkatta

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 ambient temperature curing and air drying unless otherwise specified.
3. All paints 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.
4. Technical data sheets for all paints shall be supplied at the time of submission of quotations.
- 6.4 List of recommended Manufacturers

The paints shall conform to the specifications given above and best quality in their products range of manufacturers listed in Annexure-I.

7.0 PAINT SYSTEMS

The paint system should vary with type of environment envisaged in and around the plants. Three types of environment as given below are considered for selection of paint system. The paint system is also given for specific requirements.

PRIMERS & FINISH COATS COVERED IN TABLE NOS. 7.0 TO 15.0**PRIMERS**

- P-2 : Chlorinated rubber zinc phosphate primer
- P-4 : Etch primer / wash primer
- P-6 : Epoxy zinc phosphate primer

Finish Coats / Paints

- F-1 : First quality corrosion resistant synthetic enamel
- F-2 : Acrylic – Polyurethane finish paint
- F-3 : Chlorinated rubber finish paint
- F-6A : High build epoxy finish coating cured with polyamine hardner
- F-6B : High Build epoxy finish coating cured with polyamide hardner
- F-7 : High build coal tar epoxy coating
- F-8 : Self priming surface tolerant high build epoxy coating
- F-9 : Inorganic zinc silicate coating
- F-11 : Heat resistant synthetic medium based aluminium paint
- F-12 : Heat resistant silicone aluminium paint
- F-14 : Specially formulated polyamine cured coal for epoxy coating suitable upto 150 °C
- F-15 : Epoxy phenolic coating
- F-16A : Epoxy siloxane coating : Amercoat 738
- F-16B : Epoxy siloxane coating Berger 938

TABLE 7.1 : SHOP PRIMING, PRE-ERECTION / PRE-FABRICATION FOR STRUCTURES, PIPING & EQUIPMENT ETC.

Materials : CARBON STEEL, LOW TEMPERATURE CARBON STEEL & LOW ALLOY STEEL, STEEL

TYPE : UNINSULATED AND INSULATED

Sr. No.	Design Temperature in °C	Surface Preparation	Paint System	Total DFT in Microns (min.)	Remarks
7.1.1	-90 to 400	SSPC-SP-10	1 coat of F-9	65-75	No over coating is to be done
7.1.2	401 to 500	SSPC-SP-10	1 coat of F-12	40-50	Finish coat at site

TABLE 7.2 : REPAIR OF SHOP PRIMING, PRE-ERECTION / PRE-FABRICATION AFTER ERECTION / WELDING FOR ITEMS IN ALL ENVIRONMENTS

Materials : CARBON STEEL, LOW TEMPERATURE CARBON STEEL & LOW ALLOY STEEL

TYPE : UNINSULATED AND INSULATED

Sr. No.	Design Temperature in °C	Surface Preparation	Paint System	Total DFT in Microns (min.)	Remarks
7.2.1	-90 to 400	SSPC-SP-3 (for repair only) SSPC-SP-10	1 coat of F-9	65-75	
7.2.2	401 to 500	SSPC-SP-3 (for repair only) SSPC-SP-10	2 coats of F-12	40-50	

TABLE 7.3 : REPAIR OF ALL WELD JOINTS AND DAMAGES FOR STRUCTURES, PIPING AND EQUIPMENT AFTER ERECTION ON ABOVE GROUND OVERHEAD AREAS AT SITE

Materials : GALVANIZED STEEL, CARBON STEEL AND ALLOY STEEL

TYPE : UNINSULATED AND INSULATED

Sr. No.	Design Temperature in °C	Surface Preparation	Paint System	Total DFT in Microns (min.)	Remarks
7.3.1	-14 to 80	SSPC-SP-3	1 coat of F-8	100	
7.3.2	81 to 500	SSPC-SP-3	1 coat of F-12	20	

TABLE 8 : FIELD PAINT SYSTEM FOR NORMAL CORROSIVE ENVIRONMENT IN OFFSITE AREAS FOR STRUCTURES, PIPING, EQUIPMENT, FLARE LINES ETC. - UNINSULATED

Materials : CARBON STEEL, LOW TEMPERATURE CARBON STEEL & LOW ALLOY STEEL

TYPE : UNINSULATED

Sr. No.	Design Temperature in 0C	Surface Preparation	Paint System		Total DFT in Microns (min.)	Remarks
			Field Primer	Finish paint		
8.1	-90 to -15	SSPC-SP-10	Repair of pre-fabrication primer 1 coat of F-9 @ 65-75 μ DFT/coat	None	65-75	No over coating to be done. Follow repair procedure only on damaged areas of pre-erection / pre-fabrication primer / Coating F-9 / F-12 shall be ambient temperature curing type till operating temperature is attained for full curing.
8.2	-14 to 60	SSPC-SP-10	Repair of pre-fabrication primer 1 coat of F-9 @ 65-75 μ DFT/coat + 2 coats of P-2 @ 40 μ DFT/Coat 2x40=80	2 coats of F-3 @ 40 μ DFT/ Coat 2x40=80	225	
8.3	61 to 80	SSPC-SP-10	Repair of pre-fabrication primer 1 coat of F-9 @ 65-75 μ DFT/coat + 2 coats of P-6 @ 40 μ DFT/Coat 2x40=80	1 coat of F-6B@ 100 μ DFT/Coat	245	
8.4	81 to 250	SSPC-SP-10	Repair of pre-fabrication primer 1 coat of F-9 @ 65-75 μ DFT/coat	3 coats of F-12 @ 20 μ DFT/ Coat 3x20=60	125	
8.5	251 to 400	SSPC-SP-10	Repair of pre-fabrication primer 1 coat of F-9 @ 65-75 μ DFT/coat	2 coats of F-12 @ 20 μ DFT/ Coat 2x20=40	105	
8.6	401 to 500	SSPC-SP-10	Repair as per 7.2.2.	2 coats of F-12 @ 20 μ DFT / Coat 2x20=40	80	

NOTE 1 : For external surfaces of MS chimney with or without refractory lining 8.3, 8.4 and 8.5 shall be followed.

NOTE 2 : For external surfaces of RCC chimney: 2 coats of F-6B @ 100 μ DFT/Coat to obtain 2x100=200 μ DFT shall be applied after making surface preparation as per guidelines in 5.1.5. The DFT on concrete surfaces can be checked by Tool Gauge or by applying the same coating system simultaneously on a carbon steel panel of 12"x12" size and measure the DFT by normal Magnetic gauges/digital electronic gauges for ferrous surfaces.

NOTE 3 : Wherever required S.No.8.3 shall be used for -14°C to 80°C and S.No.8.2 will be deleted.

TABLE 8 A	:	FIELD PAINT SYSTEM FOR CORROSIVE ENVIRONMENT IN PLANT AREA
Materials	:	CARBON STEEL, LOW TEMPERATURE CARBON STEEL & LOW ALLOY STEEL
Surface	:	Un-insulated

Note : For all corrosive areas above ground where **H₂S, SO₂ fumes or spillages of acid/Alkali/Salt** are likely to come in contact with surfaces such as external surfaces of un-insulated columns, vessels, heat exchangers, blowers, piping, **pumps**, towers, compressors, and structural steel etc.

Sl. No.	Design Temperature in °C	Surface Preparation	Paint System		Total DFT in Microns (min.)	Remarks
			Field Primer	Finish Paint		
9.1	-90 to -15	SSPC-SP-10	Repair of pre-fabrication primer 1 coat of F-9 @ 65-75µ DFT/coat	None	65-75	Repair of pre-erection / pre-fabrication primer shall be done wherever damage is observed.
9.2	-14 to 80	SSPC-SP-10	Repair of pre-fabrication primer 1 coat of F-9 @ 65-75 µ DFT/coat + 1 coats of P-6 @ 40 µ DFT/coat	1 coat of F-6A@ 100 µ DFT/coat + 1 coat of F-2 @ 40u DFT/coat.	245	
9.3	81 to 400	SSPC-SP-10	Repair of pre-fabrication primer 1 coat of F-9 @ 65-75 µ DFT/coat	2 coats of F-12@20 µ DFT/coat 2x20=40	105	
9.4	401 to 500	SSPC-SP-10	Repair as per 7.2.2.	2 coats of F-12@20 µ DFT/coat 2x20=40	80	

TABLE 9 : **FIELD PAINT SYSTEM FOR HIGHLY CORROSIVE AREAS IN PLANT AREA**
EXTERNAL SURFACES OF UNINSULATED COLUMNS, VESSELS, HEAT
EXCHANGERS, BLOWERS, PIPING, PUMPS, TOWERS, COMPRESSORS,
STRUCTURAL STEEL ETC.

Materials : **CARBON STEEL, LOW TEMPERATURE CARBON STEEL & LOW ALLOY STEEL**
Surface : **Un-insulated**
Note : Exposed to spillage or fumes of HCL, H₂SO₄, salty water, water impingement, chloride etc

Sl. No.	Design Temperature in °C	Surface Preparation	Paint System		Total DFT In Microns (min.)	Remarks
			Field Primer	Finish Paint		
10.1	-90 to -15	SSPC-SP-10	Repair of pre-fabrication primer 1 coat of F-9 @ 65-75u DFT/coat	None	65-75	Repair procedure of pre-erection/fabrication primer shall be followed. No overcoating is allowed. Surface preparation is required only for repairing of damaged pre-erection/fabrication primer.
10.2	-14 to 80	SSPC-SP-10	Repair of pre-fabrication primer 1 coat of F-9 @ 65-75u DFT/coat + 1 coats of P-6 @ 40u DFT/Coat	2 coats of F-6A @ 100u DFT/Coat = 2x100=200 + 1 coat of F-2 @ 40u DFT/coat.	345	
10.3	81 to 400	SSPC-SP-10	Repair of pre-fabrication primer 1 coat of F-9 @ 65-75u DFT/coat	2 coats of F-12 @ 20u DFT/Coat 2x20=40	105	
10.4	401 to 500	SSPC-SP-10	Repair as per 7.2.2.	2 coats of F-12 @ 20u DFT/Coat 2x20=40	80	

TABLE 10 : PAINTING UNDER INSULATION FOR INSULATED (HOT, COLD & SAFETY) PIPING, STORAGE TANKS AND EQUIPMENTS IN ALL ENVIRONMENT

Materials : CARBON STEEL, LOW ALLOY STEEL, LOW TEMPERATURE CARBON STEEL & STAINLESS STEEL

Surface : Insulated

Sr. No.	Design Temperature in °C	Surface Preparation	Paint System		Total DFT in Microns (min.)	Remarks
			Field Primer	Finish paint		
9.1	Insulated carbon steel, low alloy steel and LTCS piping and equipment and tanks					
9.1.1	-45 to 125	SSPC-SP-10	Repair of pre-fabrication primer F-9 @ 65-75 μ DFT.	2 coats of F-14 @ 125 μ DFT/coat = 2x125=250 OR 3 coats of F-15 = 3x80=240	315	For other temperature ranges no painting is required under insulation
9.1.2	Operating temperature –45 to 125°C but design temperature 126-400°C	SSPC-SP-10	Repair of pre-fabrication primer F-9 @ 65-75μ DFT.	2 coats of F-12 @ 20 μ DFT / coat = 3x20 = 60	105-115	
9.2	Insulated stainless steel including Alloy-20 piping					
9.2.1	Below 00C to all minus temperature	Aluminium sheeting with aluminium foil and “Chloride free mineral sealant coating barium chromate” shall be applied.				If the piping & equipments are already erected then surface shall be prepared by cleaning with emery paper and wash / flush with chloride free DM water followed by wiping with organic solvent. All the coating materials for SS shall be free from leachable chlorides.
9.2.2	0 to 120	SSPC-SP-10 (15-25μ surface profile)	None	2 coats of F-14 @ 125 μ DFT / coat = 2x125 = 250 or 3 coats of F-15 = 3x80=240	250 or 240	
9.2.3	121 to 400	SSPC-SP-10	None	3 coats of F-12 @20μ DFT /Coat = 3x20=60 or 1 coat of Poly siloxane or coating (F-16 A/B) @ 75 microns DFT/coat	60	
9.2.4	401 to 600	SSPC-SP-10	None	2 coats of heat resistant silicone aluminium paint @ 20 microns DFT / coat = 2x20=40	40	
9.3	No painting is required for insulated Monel, Incoloy and Nickel lines					

**TABLE 11.0: FIELD PAINT SYSTEM FOR CARBON STEEL STORAGE TANKS
(EXTERNAL & INTERNAL) FOR ALL ENVIRONMENTS**

SL. NO.	Type of Tank	External Painting				Inside Pontoons		Inside Painting		
		Surface	Primer	Inter.	Finish	Surface	Primer	Surface	Primer	Finish
11.1	Floating Roof Crude Design Temp. -14 to 80degC	Shell, wind girders, appurtenances, roof tops of all above ground tanks including top side of floating roof of open tank and associated structural works, rolling and stationary ladders, spiral stairways, hand rails for all environments, shell above maximum liquid height.				Inside compartment of pontoons		Bottom plates, bottom course up to 1000 mm height, all structurals in that area, oil side surfaces of deck plates, oil side surfaces of pontoon boxes (above and below seal)		
		SSPC-SP-10	1 coat of F-9* @ 65µ DFT/coat + 1 coat of P-6 @ 40µ DFT/coat = 65+40=105µ	1 coat of F-6B @ 100µ DFT/coat	1 coat of F-2 @ 40µ DFT/coat = 40µ DFT	SSPC-SP-10	2 coats of P-6 @ 40µ DFT/coat = 2x40=80µ	SSPC-SP-10	1 coat of F-9* @ 65µ DFT/coat + 1 coat of P-6 @ 40µ DFT/coat	2 coats of F-6A @ 100µ DFT/coat
11.2	Floating Roof-HSD, Kero, Gas Oil Design Temp. -14 to 80deg. C	Shell, wind girders, appurtenances, roof tops of all above ground tank including top side of floating roof of open tank and associated structural works, rolling and stationary ladders, spiral stairways, hand rails for all environments, shell above maximum liquid height				Inside compartment of pontoons		Bottom plates, bottom course up to 500 mm height, all structurals in that area, oil side surfaces of deck plates, oil side surfaces of pontoon boxes (above and below seal)		
		SSPC-SP-10	1 coat of F-9* @ 65µ DFT/coat + 1 coat of P-6 @ 40µ DFT/coat = 65+40=105µ	1 coat of F-6B @ 100µ DFT/coat	1 coat of F-2 @ 40µ DFT/coat = 40µ DFT	SSPC-SP-10	2 coats of P-6 @ 40µ DFT/coat = 2x40=80µ	SSPC-SP-10	1 coat of F-9* @ 65µ DFT/coat + 1 coat of P-6 @ 40µ DFT/coat	2 coats of F-6A @ 100µ DFT/coat = 2x100=200µ
11.3	Floating Roof-MS/ Naphta Design Temp. -14 to 80deg. C	Shell, wind girders, appurtenances, roof tops of all above ground tank including top side of floating roof of open tank and associated structural works, rolling and stationary ladders, spiral stairways, hand rails for all environments, shell above maximum liquid height				Inside compartment of pontoons		Bottom plates, bottom course up to 4000 mm height, all structurals in that area, oil side surfaces of deck plates, oil side surfaces of pontoon boxes (above and below seal)		
		SSPC-SP-10	1 coat of F-9* @ 65µ DFT/coat + 1 coat of P-6 @ 40µ DFT/coat = 65+40=105µ	1 coat of F-6B @ 100µ DFT/coat	1 coat of F-2 @ 40µ DFT/coat = 40µ DFT	SSPC-SP-10	2 coats of P-6 @ 40µ DFT/coat = 2x40=80µ	SSPC-SP-10	1 coat of F-9* @ 65µ DFT/coat + 1 coat of P-6 @ 40µ DFT/coat	2 coats of F-6A @ 100µ DFT/coat = 2x100=200µ
11.4	Floating Roof cum fixed ATF Design Temp.	Shell, wind girders, appurtenances, roof tops of all above ground tank and associated structural works, rolling and stationary ladders, spiral stairways, hand rails for all environments, roof structurals, internal surface of cone roof				Inside compartment of pontoons, external surface of internal roof		Complete internal surface of the tank, oil side surface of internal floating roof tank		

	-14 to 80deg. C	SSPC-SP-10	1 coat of F-9* @ 65µ DFT/coat + 1 coat of P-6 @ 40µ DFT/ coat 65+40= 105µ	1 coat of F-6B @ 100µ DFT/ coat	1 coat of F-2 @ 40µ DFT/ coat Total DFT =245µ	SSPC-SP-10	2 coats of P-6 @ 40µ DFT/ coat = 2x40= 80µ	SSPC-SP-10	1 coat of F-9* @ 65µ DFT/ coat +1 coat of P-6 @ 40µ DFT/ coat = 65+40 =105µ	2 coats of F-6A @ 100µ DFT/ coat =2x100 =200µ Total DFT = 305µ
SL. NO.	Type of Tank	External Painting				Inside Pontoons		Inside Painting		
		Surface	Primer	Inter	Finish	Surface	Primer	Surface	Primer	Finish
11.5	Floating Roof- Dry/ Wet slop, amine, sour water, water draw off tanks Design Temp. -14 to 80deg. C	Shell, wind girders, appurtenances, roof tops of all above ground tank including top side of floating roof of open tank and associated structural works, rolling and stationary ladders, spiral stairways, hand rails for all environments, shell above maximum liquid height				Inside compartment of pontoons		Complete internal surface of the tank		
		SSPC-SP-10	1 coat of F-9* @ 65µ DFT/coat + 1 coat of P-6 @ 40µ DFT/ coat 65+40= 105µ	1 coat of F-6B @ 100µ DFT/ coat	1 coat of F-2 @ 40µ DFT/ coat Total DFT =245µ	SSPC-SP-10	2 coats of P-6 @ 40µ DFT/ coat = 2x40= 80µ	SSPC-SP-10	1 coat of F-15 @ 75µ DFT/ coat	2 coats of F-15 @ 75µ DFT/ coat= 150µ Total DFT= 225µ
11.6	Design Temp 81 to 400 deg.C	Shell, wind girders, appurtenances, roof tops of all above ground tank including top side of floating roof of open tank and associated structural works, rolling and stationary ladders, spiral stairways, hand rails for all environments, shell above maximum liquid height				Bottom plates, bottom shell course up to 500 mm height, all structures in that area, internal portion of the roof, roof supporting structure, inside of the shell above safe filling height				
11.6a.	Insulated Cone roof tanks	SSPC-SP-10	1 coat of F-9* @ 65µ DFT/coat	2 coats of F-12 @ 20 µ DFT/coat = 40µ Total DFT =105µ	SSPC-SP-10	1 coat of F-9* @ 65µ DFT/coat	1 coat of F-16 @ 100 microns DFT/coat Total DFT =165µ			
11.6b.	Un-Insulated Cone roof tanks	SSPC-SP-10	1 coat of F-9* @ 65µ DFT/coat	2 coats of F-12 @ 20 µ DFT/coat=40µ Total DFT =105µ	SSPC-SP-10	1 coat of F-9* @ 65µ DFT/coat	1 coat of F-16 @ 100 microns DFT/coat Total DFT =165µ			
11.7	Un insulated Cone roof tanks Design Temp -14 to 80deg. C	Shell, wind girders, appurtenances, roof tops of all above ground tank including top side of floating roof of open tank and associated structural works, rolling and stationary ladders, spiral stairways, hand rails for all environments, shell above maximum liquid height				Bottom plates, bottom shell course up to 500 mm height, all structures in that area, internal portion of the roof, roof supporting structure, inside of the shell above safe filling height.				

11.10	EG tanks Design Temp -14 to 80deg.C	Shell, wind girders, appurtenances, roof tops of all above ground tank including top side of floating roof of open tank and associated structural works, rolling and stationary ladders, spiral stairways, hand rails for all environments, shell above maximum liquid height			Internal shell, bottom plate and all accessories (Soil side of all plates to be blast cleaned to SSPC-SP-10 and painted with 3 coats of coal tar epoxy, 100 microns dft/ coat)		
		SSPC-SP-10	1 coat of F-9* @ 65µ DFT/coat + 1 coat of P-6 @ 40µ DFT/coat 65+40= 105µ	1 coat of F-6B @ 100µ DFT/coat	1 coat of F-2 @ 40µ DFT/coat Total DFT =245µ	SSPC-SP-10	3 coats of Vinyl chloride co-polymer coating @ 75 microns DFT/coat = 3x75=225 microns DFT

* F-9 is pre-fabrication primers

1. Soil side of all plates to be blast cleaned to SSPC-SP-10
 - a) Painted with 3 coats of coal tar epoxy, 100 microns DFT/coat for design temperature to 80 deg. C
 - b) One coat of inorganic zinc silicate (F-9) @ 65-75 microns + 1 coat of Intertherm 751 CSA @ 100 microns DFT/coat from Akzo Nobel coatings for design temperature from 81 to 400 deg. C.
2. Steam coil inside tank is not to be painted.

Note : During the application of the internal coating of the storage tanks, De-humidifier equipment shall be used to maintain the desired Relative Humidity, air temperature and surface temperature of metal, during the blast cleaning to avoid formation of flash rust and during the paint/coating application to avoid moisture entrapment in the paint/coating and for proper curing of the two component coatings(epoxy). The Relative Humidity shall be less than 60% and air temperature between 25-40 deg.C during the curing period of internal coatings.

TABLE 12.0 COATING SYSTEM FOR EXTERNAL SIDE OF UNDERGROUND CARBON STEEL PLANT PIPING AND TANKS

Sl. No.	Design Temp. °C	Surface Preparation	Paint System		Total DFT in μ (min.)	Remarks
			Field Primer	Finish Paint		
12.1	Carbon steel plant piping (underground)					
12.1.1	Yard coating					
12.1.1.1	25 to 60	SSPC-SP-10	1 coat of synthetic fast drying primer type-B as per AWWA-C-203 (1991)	4 mm thick coaltar coating wrapping as per AWWA-C-203 in 2 layers of each 2 mm thickness.	4 mm	CTE coating shall confirm to 120/5 as per BS:4164
12.1.2	Over the Ditch Coating					
12.1.2.1	25 to 60	SSPC-SP-10	1 coat of synthetic fast drying primer type-B as per AWWA-C-203 (1991)	2 layers of coal tar based tape coating	4 mm	
12.2	Carbon	plant piping (underground).				
12.2.1	61 to 225	SSPC-SP-10	1 Coat of F-15@ 75 μ DFT/coat	2 Coat of F-15 @ 75 μ DFT/coat	225	Cold and hot insulation shall be provided
12.2.2	221 to 400	SSPC-SP-10	1Coat of F-16 A/B @ 75 μ DFT/coat	1 Coat of F-16A/B @ 100μ DFT/coat	175	Cold and hot insulation shall be provided
12.2.3	1093	SSPC-SP-10	1 Coat of Engineered Siloxane coating @ 100-150 μ DFT	1 Coat of Engineered Siloxane coating @ 100-150 μ DFT	200-200	Two coats (100-150 μ DFT/coat) of Engineered Siloxane coating for underground high temperature service. Not recommended for caustic solutions
12.3	External side of un-insulated underground storage tanks:					
12.3.1	-40 to 80	SSPC-SP-10	1CoatofF-9@ 65-75 μ DFT/coat	3 coats of F-7 @100 μ DFT/coat 3x100=300	365	
12.3.2	81 to 180	SSPC-SP-10	1CoatofF-15@ 75 μ DFT/coat	2 Coat of F-15 @ 75u DFT/coat	225	
12.3.3.	181 to 400	SSPC-SP-10	1CoatofF-9@ 65-75 μ DFT/coat	2 Coat of F-16 @ 75 μ DFT/coat 2x75=150	215-225	

Note: CBD underground lines shall be hydro tested in segments and final welding shall be checked with suitable NDT. 

TABLE 13.0 PAINTING UNDER INSULATION FOR INSULATED (HOT, COLD & SAFETY) CARBON STEEL, LOW ALLOY STEEL, LOW TEMPERATURE CARBON STEEL & STAINLESS STEEL PIPING, STORAGE TANKS AND EQUIPMENTS IN ALL ENVIRONMENT.

Sl. No.	Design Temp. °C	Surface Preparation	Paint system		Total DFT in μ (min.)	
			Primer	Finish Paint		
13.1	Insulated carbon steel, low alloy steel and LTCS piping and equipment & tanks					
13.1.1	-45 to 125	SSPC-SP-10	Repair of pre-fabrication primer F-9 @ 65-75 μ DFT.	2 coats of F-14 @125 μ DFT/coat = 2x125=250 OR 3 coats of F-15= 3x80=240	315	For other temperature ranges no painting is required under insulation F-12 shall be ambient temperature curing type till operating temperature is attained for full curing. F-16 is completely ambient temperature curing.
13.1.2	Operating temperature -45 to 125°C but design temperature 126-400 °C	SSPC-SP-10	Repair of pre-fabrication primer F-9 @65-75 μ DFT	2 Coats of F-12 @20 μ DFT/coat 3x20=60 (or) one coat of Poly-siloxane coating @ 75 μ DFT/coat	125-135	
13.2	Insulated stainless steel including Alloy-20 piping					
13.2.1	Below 0°C to all minus temp.	Aluminum sheeting with aluminum foil and "Chloride free mineral sealant coating barium chromate" shall be applied.				If the piping & equipments are already erected than surface shall be prepared by cleaning with emery paper and wash/flush with chloride free DM water followed by wiping with organic solvent. No pre-erection primer to be applied. F-12 shall be ambient temp curing type till final curing is obtained during operating temp. F-16A/B is completely ambient temp curing type.
13.2.2	0 to 120	SSPC-SP-10 (15-25 surface profile)	None	2 coats of F-14@125 μ DFT/COAT 2x125=250 or 3 coats of F-15 = 3x80=240	250 or 240	

13.2.3	121 to 400	SSPC-SP-10	None	3 coats of F-12@20 μ DFT/COAT 3x20=60 or 1 coat of F-16A/B Poly Siloxane coating @ 75 microns	60-75	
13.2.4	401 to 600	SSPC-SP-10		3coatsofF-12@20 μ DFT/coat 60	60	
13.2.5	Cyclic service-196 to 480 excepting - 45 to 120	SSPC-SP-10	None	2 coats of DFT/coat F-16A/B Poly Siloxane coating @ 75 μ DFT/coat = 2x75=150	150	
13.3	No painting is required for insulated Monel, Incoloy and Nickel lines.					

TABLE 14.0 INTERNAL PROTECTION OF CARBON STEEL WATER BOXES AND TUBE SHEETS OF COOLERS / CONDENSERS

Water boxes, channels, partition plates, end covers and tube sheets etc.

Sl. No.	Design Temperature in °C	Surface Preparation	Paint system		Total DFT in Microns (min.)	Remarks
			Primer	Finish paint		
14.1	Upto 80	SSPC-SP-10	1 coat of P-6 @ 40 µ DFT/coat	2 coats of F-7 @125 µ DFT/coat 2x125=250	290	For C.S.
14.2	Upto 80 Non ferrous and brass tube sheets	SSPC-SP-3	1coat of P-4 @ 8-10 µ DFT/coat. 1coat of P-6 @ 40 µ DFT/coat.	2 coats of F-7 @125 µ DFT/coat 2x125=250	300	For non ferrous surfaces

TABLE 15.0 FIELD PAINTING SYSTEM FOR GI TOWERS/NON-FERROUS TUBE SHEET

Sl. No.	Design Temperature in °C	Surface Preparation	Paint System		Total DFT in Microns (min.)	Remarks
			Primer	Finish Paint		
15.1	Upto 80	SSPS-SP-3	1 coat of P-4 @ 8-10 µ DFT/coat + 1 coat of P-6 @ 40 µ DFT/coat	2 coats of F-2 @40 µ DFT/coat 2x40=80	130	Shade as per defence Requirements.
15.2	Upto 80 Non ferrous and brass tube sheets	SSPS-SP-3	1coat of P-4 @ 8 µ DFT/coat 1coat of P-6 @ 40 µ DFT/coat	2 coats of F-7 @125 µ DFT/coat 2x125=250	300	

TABLE 16.0 SHOP & FIELD PAINTING SYSTEM FOR EFFLUENT TREATMENT PLANT

Sl. No.	Design Temp. °C	Surface Preparation	Paint System		Total DFT in Microns (min.)	Remarks
			Primer	Finish Paint		
16.1	-14 to 80(for C.S./M.S. items): Screens, Walk way bridges, Baffles, Dual media filters (external) Vertical pumps, piping in treated effluent sump and pump house, external side lining of Slop oil MS tank	SSPS-SP-10	1 coat of F-9 @ 65-75u DFT/coat	3 coats of F-6A @100u DFT/coat 3x100=300	365	
16.2	-14 to 80(CS/MS Items) for Vertical pump and piping in, Bio-sludge sump and pump, Filter feed sump and pump, Process sump, Sanitary sump; Transfer sump, Sludge, MS Slop oil tank internal, scrapping mechanism in Clarifier, Screw pump	SSPS-SP-10	1 coat of F-9 @ 65-75u DFT/coat.	2 coats of F-6A @100u DFT/coat	265	
16.3	-14 to 80 deg.C :All R.C.C. surfaces such as tanks, structures, drains etc.) in Process sump, TPI separator (Process and Oil), Aeration Tank, Transfer sump etc.	Blast cleaning to SSPC-SP guide lines and Acid etching with 10-15% HCl acid followed by thorough water washing.	Epoxy screed lining	Epoxy screed lining	3mm	Epoxy screed lining shall be used as per specific instructions from Engineer-in-Charge at site.
16.4	Upto 60 deg. C C.S/M.S Dual media filters (Internal), Chemical dosing tanks(internal such as DAP, Urea)	SSPC-SP-10		Rubber Lining	4.5mm	

17.0 STORAGE

- 1 All paints and painting materials shall be stored only in rooms to be arranged by contractor and approved by Engineer-in-charge for the purpose. All necessary precautions shall be taken to prevent fire. The storage building shall preferably be separate from adjacent building. A signboard bearing the word "PAINT STORAGE - NO NAKED LIGHT - HIGHLY INFLAMABLE" shall be clearly displayed outside.

18.0 PIPING COLOR CODE

The color code shall be followed as given in Annexure-II.

- 19.0 IDENTIFICATION OF VESSELS, PIPING ETC.:** As per color coding given in Annexure-II

20.0 PAINTING FOR CIVIL DEFENCE REQUIREMENTS

- 20.1 Following items shall be painted for camouflaging if required by the client.

- a. All columns
- b. All tanks in off sites
- c. Large Vessels
- d. Spheres

- 20.2 Two coats of selected finishing paint as per defence requirement shall be applied in a particular pattern as per 20.3 and as per the instructions of Engineer-In-Charge.

20.3 Method of Camouflaging

- 20.3.1 Disruptive painting for camouflaging shall be done in three colors in the ratio of 5:3:2 (all matt finish).

Dark Green

Light Green

Dark Medium Brown

5:

3:

2

- 20.3.2 The patches should be asymmetrical and irregular.

- 20.3.3 The patches should be inclined at 30 Deg.. to 60 Deg. to the horizontal.
20.3.4 The patches should be continuous where two surfaces meet at an angle.
20.3.5 The patches should not coincide with corners.
20.3.6 Slits and holes shall be painted in dark shades.
20.3.7 Width of patches should be 1 to 2 meters.

21.0 INSPECTION AND TESTING

- 21.1 All painting materials including primers and thinners brought to site by contractor for application shall be procured directly from manufactures as per specifications and shall be accompanied by manufacturer's test certificates. Paint formulations without certificates are not acceptable.
- 21.2 Engineer-In-Charge at his discretion may call for tests for paint formulations. Contractor shall arrange to have such tests performed including batch-wise test of wet paints for physical & chemical analysis. All costs there shall be borne by the contractor.

- 21.3 The painting work shall be subject to inspection by Engineer-In-Charge at all times. In particular, following stage-wise inspection will be performed and contractor shall offer the work for inspection and approval of every stage before proceeding with the next stage. The record of inspection shall be maintained in the registers. Stages of inspection are as follows:

- (a) Surface preparation
- (b) Primer application
- (c) Each coat of paint

In addition to above, record should include type of shop primer already applied on equipment e.g. Red oxide zinc chromate or zinc chromate or Red lead primer etc.

Any defect noticed during the various stages of inspection shall be rectified by the contractor to the entire satisfaction of Engineer-In-Charge before proceeding further. Irrespective of the inspection, repair and approval at intermediate stages of work, contractor shall be responsible for making good any defects found during final inspection/guarantee period/defect liability period as defined in general condition of contract. Dry film thickness (DFT) shall be checked and recorded after application of each coat and extra coat of paint should be applied to make-up the DFT specified without any extra cost to owner, the extra cost should have prior approval of Engineer-in-charge.

21.4 **Primer Application**

After surface preparation, the primer should be applied to cover the crevices, corners, sharp edges etc. in the presence of inspector nominated by Engineer-In-Charge.

- 21.4.1 The shades of successive coats should be slightly different in color in order to ensure application of individual coats, the thickness of each coat and complete coverage should be checked as per provision of this specification. This should be approved by Engineer-In-Charge before application of successive coats.

- 21.4.2 The contractor shall provide standard thickness measurement instrument with appropriate range(s) for measuring.

Dry film thickness of each coat, surface profile gauge for checking of surface profile in case of sand blasting. Holiday detectors and pinhole detector and protector whenever required for checking in case of immersion conditions.

- 21.4.2 Prior to application of paints on surfaces of chimneys, the thickness of the individual coat shall be checked by application of each coat of same paint on M.S.test panel. The thickness of paint on test panels shall be determined by using gauge such as 'Elkometer'. The thickness of each coat shall be checked as per provision of this specification. This shall be approved by Engineer-In-Charge before application of paints on surface of chimney.

- 21.4.3 At the discretion of Engineer-In-Charge, the paint manufacturer must provide the expert technical service at site as and when required. This service should be free of cost and without any obligation to the owner, as it would be in the interest of the manufacturer to ensure that both surface preparation and application are carried out as per their recommendations.

- 21.4.4 Final inspection shall include measurement of paint dry film thickness, Adhesion, Holiday detection check of finish and workmanship. The thickness should be measured at as many points/ locations as decided by Engineer-In-Charge and shall be within + 10% of the dry film thickness, specified in the specifications.

- 21.4.5 The contractor shall arrange for spot checking of paint materials for Sp.gr., glow time (ford cup) and spreading rate.

22.0 GUARANTEE

- 22.1 The contractor shall guarantee that the chemical and physical properties of paint materials used are in accordance with the specifications contained herein/to be provided during execution of work.
- 22.2 The contractor shall produce test reports from manufacturer regarding the quality of the particular batch of paint supplied. The Engineer-in-Charge shall have the right to test wet samples of paint at random for quality of same, as per the paint materials specification. Batch test reports of the manufacturer's for each batch of paints supplied shall be made available by the contractor. The contractor shall stand guarantee for carrying out the rectification/repair/re-painting of the defects/ failures of painting found during the execution of painting job and till the expiry of the defect liability period of total project as per the directions of the Engineer-in-Charge of CPCL/JE

23.0 QUALIFICATION CRITERIA OF PAINTING CONTRACTOR

Painting contractor who is awarded the job under this standard must have necessary equipments, machinery, tools and tackles for surface preparation, paint application and inspection. The contractor must have qualified, trained and experienced surface preparator, paint applicator, inspector and supervisors. The contractor's supervisor, inspector, surface preparator and paint applicator must be conversant with the standards referred in this specification. The painting job shall be carried out by the approved agencies of paint manufacturers and supervised by the approved paint manufacturers own representative or paint manufacturer their scheme(supply and apply basis).

ANNEXURE-I**LIST OF RECOMMENDED MANUFACTURERS****Indian Vendors**

1. Asian Paints (I) Ltd., Mumbai
2. Berger Paints Ltd., Kolkata
3. Goodlass Nerolac Paints Ltd., Mumbai
4. Chemguard Coatings, Mumbai(For Ameron, USA Products only)
5. Chokugu Marine paints Pte. Ltd., Mumbai/Singapore
6. Deleted 
7. Sigma Coatings, Mumbai.
8. CDC Carboline Ltd., Chennai
9. Premier products Ltd., Mumbai
10. Coromandel Paints & Chemicals Ltd., Visakhapatnam
11. Anupam Enterprises, Kolkata
12. Grand Polycoats, Vadodara
13. Bombay Paints Ltd., Mumbai
14. Akzo Nobel Coatings and Sealants Pvt. Ltd., Bangalore
15. Cipy Polyurethanes Pvt. Ltd., Pune
16. Gunjan Paints Ltd., Ahmedabad
17. Advance Paints Ltd., Mumbai
18. VCM Polyurethane Paints (for polyurethane paints only)
19. Jotun Paints, Chennai(Singapore)
20. Chembond Chemicals Ltd., Navi Mumbai

Foreign Vendors

1. Sigma Coatings, Singapore
2. Ameron, USA
3. Kansai Paints, Japan
4. Hempel Paints, USA
5. Valspar Corporation, USA
6. Akzo Nobel/International Coatings, UK
7. Jotun Paints, Singapore

For De-humidification equipment (on Rental Basis)

1. Technical Drying Equipment (Asia) Pvt. Limited, Gurgaon, Haryana

The following are approved vendors for speciality items (phosphating chemical) only.

1. Mark-chem Incorporated, Mumbai.
2. Chemtreat India Ltd., Navi Mumbai

Annexure-II **1.0 Scope**

Requirement of colour scheme for the identification of content of the pipeline carrying hydrocarbons, water, air, gases and chemicals, etc in CPCL Refinery shall be as follows-

2.0 Identification

2.1 The system of colour coding consists of a ground colour and secondary colour bands superimposed over the ground colour. The ground colour identifies the basic nature of the service and the secondary colour band over the ground colour distinguishes the particular service. The ground colour shall be applied over the entire length of the un-insulated pipes. For insulated pipelines ground colour shall be provided as per the specified length and interval to identify the basic nature of service and secondary colour bands to be painted on these specified length to identify the particular service. The colour coding system is applicable for both process units and offsite pipelines

2.2 The following ground colour designation for identification of basis classification of various important services shall be as follows:

S.No	SERVICE	GROUND COLOUR
1	Hydrocarbons / Combustible liquids	Golden Brown
2	Fuel gas, Hydrogen, Hydrogen Sulphide, Nitrogen, Inert gas, Carbon monoxide, Carbon dioxide and Amine	Golden Yellow
3	Acids /Alkalies, Ammonia & Chlorine	Wild Lilac
4	Water OTHER THAN FIRE WATER	Aquamarine
5	Fire Water	Post Office Red
6	Air	Sky Blue
7	Flare	Heat Resistant Aluminium

3.0 Secondary Identification Band Colours

The narrow bands presenting the secondary colour which identifies the specific service shall be applied by painting. For some of the products, two bands with different colours are specified in order to distinguish the content of the pipeline more specifically.

4.0 Colour bands and identification lettering

4.1 The colour bands as specified in the attachment shall be followed for identifying the piping contents. The line number and the flow direction shall be stencilled on each pipe section and pipeline together with the colour coding, to provide the pipeline with unique traceability.

4.2 The colour band width requirements are ;

2" to 6" inclusive : 100 mm

Greater than 6" : 150 mm

In case of two band colours, both the bands shall be applied adjacently and the width of each band shall also be the same as mentioned above.

4.3 The interval of colour bands application shall be as below:

1. Plant area : at an interval of 15.0 metre
2. Off site area : at an interval of 30.0 metre

4.4 Colour Coding Bands shall be provided at the following locations in addition to the interval specified above

- On both sides of and adjacent to valves, tees, important fittings,
- Wall entries, Road crossings and both the sides of culverts
- Outboard of flanges to and from equipment such as vessels, tanks, exchangers, compressors and pumps.
- Unit battery limits

4.5 Size of Lettering and Direction Arrow shall be as follows:

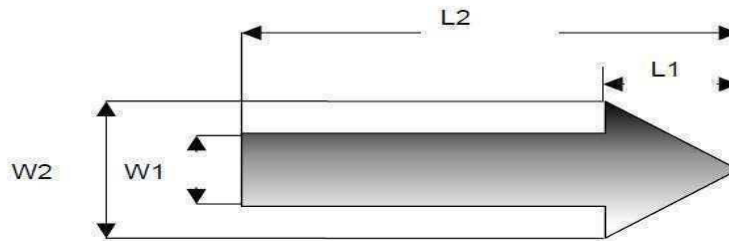
Lettering

<u>Pipe Diameter</u>	<u>Width x Height - Spacing</u>
2" to 6" inclusive	30 x 30mm - 10 mm min.
6" to 50" inclusive	80 x 80mm - 25 mm min.
greater than 50"	100 x 100mm - 30 mm min.

Direction Arrow

<u>Pipe Diameter</u>	<u>W1</u>	<u>W2</u>	<u>L1</u>	<u>L2</u> (in mm)
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2" to 6" inclusive	10	30	45	135
6" to 50" inclusive	40	80	90	270
greater than 50"	50	100	150	450



4.6 Two finish coat of relevant painting system shall be applied for banding.

4.7 The areas of the painted surfaces to which the colour coding bands, pipeline identification numbers and flow direction arrows are to be applied shall be degreased, water washed and lightly abraded, in order to ensure good adhesion of the applied paint to the existing topcoat paint.

5.0 Inspection: The contractor shall depute NACE certified Level -1 coating inspectors for the inspection of protective coating application jobs. It is the primary responsibility of the painting contractor to ensure proper surface preparation, using of correct paint material, ensuring proper mixing ratio and application methods. Any deviation from the standard procedure shall be strictly avoided and proper control over the painting jobs shall be ensured by the Inspector at all times.

6.0 Guarantee: The painting contractor shall stencil the date of painting in a legible manner in each area after completion of painting and provide a guarantee for a period of 3 years. Any deterioration noticed in the painting within 3 years shall be repainted as per the painting system at free of cost.

S.No	Service (Product)	Recommended Colour Band
	Ground colour : Golden Brown	
1	Crude Oil	Yellow
2	LPG	White and signal Red
3	Propylene	White and light blue
4	Butylene	White and Green
5	PBFS	White and purple
6	Naphtha	Green
7	Gasolene	Signal red
8	Diesel / Gas oil	Light blue
9	ATF	Blue and red
10	Kerosene	Blue and white
11	Fuel oil	Black
12	Asphalt	Black and red
13	Flushing oil	Purple and pink
14	Slop	Yellow and Red
15	Wax	Purple and light green
16	Lube oil	Purple
	Ground colour : Golden yellow	
17	Fuel gas	Pink
18	Hydrogen	Signal red
19	Nitrogen	Blue
20	Amine service	Green
21	CO2	White
	Ground colour : Wild Lilac	
22	Ammonia - Gas / Liquid NH3	Black
23	Chlorine	Yellow
24	Caustic	White
25	Hydrochloric acid	Blue
26	Sulphuric acid	Green

Surface	Part	Color	Remarks
Tanks		A.C. Grey	
Spheres		White	
Vessels, drums, heat exchangers etc.		D.A. Grey	
Furnace casing		Silver	
Machinery - Pumps.		Silver	
Compressors, blowers etc)			
Steam Turbine		Silver	
Generator'		Mfr. Std.	
Motor		Light grey	ISC 631
Packaged dosing system		Mfrs. Std	
DG Set		Mfrs. Std	
Cable duct		Silver	
Instrument Panel			
Instrument Panel including DCS Cabinet	Indoor		
	Front	Opaque Beige	With leather lone
	Other sides	Neutral Grey	With leather lone
	Inside	Neutral Grey	
Control Valve			
	C:S Body	Light grey	ISC 631
	SS Body	No paint	
	Low alloy body	Canary Yellow	ISC 309
Control Valve Actuators			
	Normally Closed	Brilliant Green	ISC 221
	Normally Open	Signal Red	ISC 537
Instruments. Transmitters		Mfrs Sid	

Sr. No.	Content	Final Color	ISC No:
1	Gantry girder and monorail	Brilliant Green	221
2	Stopper for gantry girder and monorail	Signal Red	537
3	Pipe rack structural steel and trestle including that for equipment and platform	Dark Admiralty Grey	632
4	Chequered Plates	Dark Admiralty Grey	632
	Ladder rungs, verticals and cage	Canary Yellow	309

6	Hand railing, middle rail, toe plate and vertical post	Canary Yellow	309
7	Platforms : Structural steel parts other than grating and hand railing	Dark Admiralty Grey	632
8	Staircase : Structural steel parts other than hand railing and steps using galvanized	Dark Admiralty Grey	632
9	Safety Gate	Signal Red	537
10	Miscellaneous Structural Part	Dark Admiralty Grey	632

- Notes : 1) Wherever Dark Admiralty Grey is **not available** due to the nature of the final coat of paint (eg: Coal Tar epoxy in high H2S environments) . Black can be used.
- 2) Canary Yellow for ladders etc. has been selected for visibility.

- Equipment number shall be stenciled in black (after initial painting if any) on each vessel, column, equipment, machinery till a visible location as directed by the "Engineer - in - charge "

Size of letters is as below:

- Column, vessel, exchanger, other stationary equipment : 150 mm height
- Pump**, Compressor and other machinery including **motors** : 50 mm **height HT**

Rotating equipment shall **have** tin arrow showing the direction of **rotation** painted on the equipment.

In case of small auxiliary equipment in packaged unit, separate identification by stenciling is not required as long as name plate or tag bearing item number is duly attached to the aux. equipment.

- Line number, service, source and destination shall be stenciled **in black** on respective pipe lines at
 - start and terminating points of line next to the color code
 - battery limit points next to the color code,

Additional stenciling of line numbers and service will be required and shall be provided on the lines at the direction of "Engineer- In - Charge"

Sizing of letters shall be :

OD of pipe	Height of letters
80- 150 mm	40 mm
150-250 mm	60 mm
> 250 mm	90 mm

Auxiliary piping in packaged units or on base plates of pumps / compressors with in the scope of vendors do not need numbering at site.

However, an auxiliary line with operational significance (where it is referenced specifically in the operation manual by a line number) shall be provided with a number by stenciling or other suitable means.

3. The following details are to be painted on the Tank shell in black color, letter size 50 mm high, at the entrance point of the staircase.

- Tank number
- Reference height
- Stile filling height
- Critical zone (in case of floating roof tanks only)
- Date of commissioning
- Date of last cleaning

4. The following details are to be painted on the tank shell near the top landing platform of the staircase, in letter size 50 mm high, black color.

- Reference height
- Stile filling height
- Critical zone (in case of floating roof tanks only)

5. The following details shall be painted on the tank at $\frac{2}{3}$ the height of the tank at a location facing the road, from where normal approach to the Tank is provided. In addition, the same details shall be provided on two additional points in the tank 120 degrees apart.

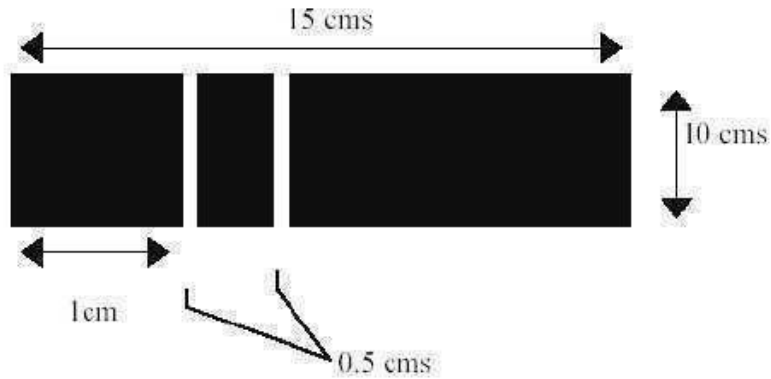
Tank number

- Capacity
- Service.

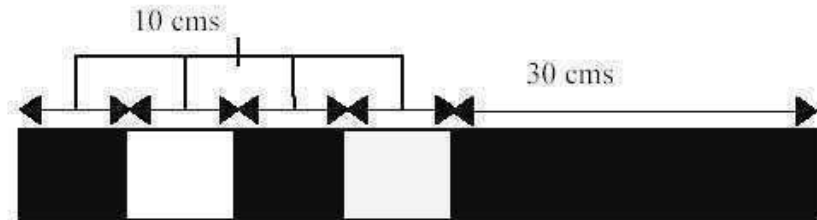
The size of the above lettering shall be 500 mm for 20 M high tanks and 300 mm for smaller tanks.

DGCA requirements for all shall be followed in addition to the above.

GRADE LABEL FOR TANKS



PIPELINES



BLACK



WHITE



GENERAL PIPELINE COLOUR

- 1.0 The part of the **standard** covers the method of identification of **STORED** piping material by color coding. This standard is applicable to storage during project Stage as well.
- 2.0 General guide lines of identification by color coding:
 - a) Piping shall be painted with one color or a combination of two color as enclosed.
 - b) Color identification is not required on galvanized material and nonferrous material such as Copper. Aluminum etc. because of their peculiar color and character

- e) Special items like bellow, strainers, steam Imps etc. should be lagged and hence do not require color identification.
- d) Color identification of Austenitic Stainless Steel is not desirable due to risk of contamination from paint material.
- e) Ends of piping to be welded shall not be painted. The color band shall start 2" from the pipe ends.
- f) Width of color strips shall be 25 mm for .V nominal pipe dia and above. Secondary color strip where required, shall be half the size of primary strips. For less than 3" size color strip shall be 12 mm < 1/2") or maximum practical.

Carbon Steels		
API 5L Gr B	Pink	Seamless
API 5L Gr B	Pink / White	Welded
A 106 Gr B	Red	IBR
A 106 Gr B	Yellow	Non IBR
Welded and seamless fittings	Red	IBR
Welded and seamless fittings	Yellow	Non IBR
Welded fittings	Yellow / White	Normalized
Miters	Silver	
Class 22 fittings	Silver / Pink	Stress relieved at shop
IS 3589- IS 12239	No Paint	Non critical
Alloy Steels		
P1, F1, WP1, WP1W etc.	Green / Red	
P12, F12, W12 etc	Green / Yellow	
P22, F22, WP22. etc	Green / Silver	
P11, F11, WP11 etc.	Green / Orange	
P5, F5, WP5 etc.	Green / Blue	
P9, F9, WR9 etc.	Green / Pink	

Color (In alphabetical order)	ISC No:
Black	
Brilliant Green	221
Canary Yellow	309
Dark Grey	632
Dark Violet	796
Fire Red	536
French Blue	166
Golden Yellow	356
Gulf Red	473
Jasmine Yellow	397
Light Brown	410
Light Grey	631
Light Orange	557
Sea Green	217
Signal Red	537
Silver	110
Silver Grey	628
Sky Blue	101
White	-

ANNEXURE-15

JACOB'S JOB SPECIFICATION FOR CONTROL AND INSTRUMENTATION AND DATA SHEETS FOR VARIOUS INSTRUMENTS

**CHENNAI PETROLEUM CORPORATION LIMITED
MANALI REFINERY, CHENNAI**

RESID UPGRADATION PROJECT

GAS TURBINE GENERATOR- V & HRSG PACKAGE

JOB SPECIFICATION – INSTRUMENTATION

DOCUMENT NO : 44NC-4602-0000/J.02/0103/A4

Rev No.	Issue Date	Pages	Rev Description	Prepared By	Checked By	Approved By
A	19 Nov. 2013	37	Issued for Client Approval	VMK	SPM	BSP
B	18 Dec. 2013	40	Client comments incorporated & Issued for Inquiry	VMK	SPM	BSP

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1.0 GENERAL

- 1.1 This job specification describes the scope of work, supply & responsibilities of package contractor for carrying out Instrumentation activities of **Gas Turbine Generator & HRSG Package** required for RESID UPGRADATION PROJECT of CPCL Chennai.
Henceforth the term contractor refers to “Gas Turbine Generator & HRSG Package Contractor”.
The term owner refers to M/s. CPCL.

- 1.2 The description & requirements indicated in this specification are concise by necessity and can not contain all details. However, it is the responsibility of the contractor to execute the job on a turnkey basis in accordance with the guidelines of this specification, its annexure, engineering design basis, standard specifications and engineering standards & drawings.

2.0 SCOPE OF WORK AND RESPONSIBILITY

Contractor's scope of work and responsibility shall be as follows,

- 2.1 Contractor shall be responsible for execution of complete work related to Instrumentation of GTG & HRSG Package on turnkey basis with scope of work which covers but not limited to Design & detailed engineering, procurement, review of vendor documents, supply, inspection, installation, site calibration, testing & commissioning of all the instruments including gas detector, analysers, vibration sensors etc. & all associated sub-systems. Contractor shall also be responsible for his own inter-departmental co-ordination as well as co-ordination with other contractors as necessary through out the entire execution of the project.
- 2.2 Codes and Standards
Contractor shall refer various codes and standards indicated in clause 2.1 of 'Engineering Design Basis – Instrumentation (44NC-4600-0000/J.02/0001/A4)' in addition to standards attached along with this package. As design basis attached with tender document is applicable to entire Resid up gradation project, contractor shall refer all applicable clauses of Engineering Design Basis-Instrumentation.
In general, contractor shall carryout engineering as per IEC/BIS standards. Any other standard, if necessary, can also be referred by contractor during the execution of the job, without diluting the basic requirements, however with prior information to Owner/PMC. In any case contractor must furnish a list of codes and standards other than those specified in this document which shall be followed by them during engineering.
- 2.3 Design and detail engineering
The contractor shall be responsible to carry out the design and detailed engineering based on the data provided in line with technical requirements specified elsewhere in this document. Scope shall also include sizing and sizing verification for all items including where data is dependent upon detailed engineering, detailing of basic engineering designs, detailing of system oriented items, preparation of data sheets, coordination drawings, engineering drawings, etc.
The design and engineering work shall also include review of post order vendor drawings and documentation for all instrumentation & system oriented items.
- 2.4 The size indicated on P&IDs for control valves and safety valves are indicative only. The final sizing for control valves, safety valves, orifice assemblies, flow meters etc. is contractor's responsibility. Any revision in line sizes because of sizing of above instruments shall be carried out by contractor without

any cost & schedule implications. Contractor shall be responsible to replace any undersized item free of cost.

- 2.5 Separate sub-vendor list is included elsewhere for instrumentation item. The list provided is for make only and not for model number. It is contractor's responsibility to select correct model number to suit the requirements and it shall have requisite proven track record. It may be possible that make and / or model number of some instruments are identified in P&IDs, in such cases P&ID shall be guiding. In case for certain instruments vendor list is not included, suggested vendor list will have to be got approved from owner / PMC.
- 2.6 Contractor shall be responsible for selection & supply of Instruments so as to meet and exceed the requirements. All effort shall be made to avoid multi-vendor items for the same type of equipment in order to achieve uniformity and also to avoid excessive spare inventory.
- 2.7 Contractor shall be responsible for satisfying the specific requests from the owner without any time & cost implications.
- 2.8 Contractor shall be responsible for providing complete project documentation package in requisite form and quantity which shall include all the engineering drawings & documents generated by them as well as their sub contractors & vendors.
- 2.9 Contractor shall be responsible for arranging training for owner's engineers & operators on special systems being supplied by them such as DCS/PLC & F&G System etc. at manufacturer's works.
Where as training on Machine Monitoring System & Analysers shall be arranged at site.
- 2.10 Contractor shall be responsible for obtaining all statutory approvals, as applicable for all instruments & other sub-systems.
- 2.11 Order of Precedence for any contradictions between the various specifications or drawings shall be followed as defined in clause No.1.2 of Engineering Design Basis for Instrumentation Doc No. 44NC-4600-0000/J.02/0001.
- 2.12 Contractor to note that single point 2 Nos. (Redundant) 110 VAC (**Ungrounded**), 50 Hz UPS and 230 VAC, 50 Hz Non UPS supply shall be made available. **Out of 2 Nos. 110 VAC feeder, one is from GT-IV UPS & the other one from Boiler VI UPS.** Cable size of the same shall be informed to successful bidder during detail engineering phase. Contractor shall provide suitable terminal connection of these cables in power distribution panel. Contractor to note that if 110 VAC grounded supply is required for any load then contractor to consider necessary **isolation transformer** for the same. **Contractor shall provide the PDB in SRR & laid the individual power cables from PDB to field to distribute 110 VAC, 50 Hz UPS and 230 VAC, 50 Hz non UPS power for the field loads (consumer) in package.**
- 2.13 Contractor to note that existing GT-IV operator console to be used for new GT V Package. Up-gradation of existing DCS/Governor system, if any, has to be carried out by GT contractor. Contractor to ensure that the make of control system for GT V shall be same as existing GT IV make.

DCS System – max DNA (M/s. Metso)

Governor Control System – Mark VI

PLC System – Mark VI (M/s. GE)

PLC system for BOP, BMS and F&G – M/s. Honeywell

- 2.14 Contractor to carry out site visit & should carry out necessary study of Existing Control system before bidding stage only.
- 2.15 Contractor shall be responsible to provide all required inputs related to system to system supplier in agreed formats only. Formats for system engineering inputs will be shared to successful bidder only.
- 2.16 Contractor shall participate DCS / PLC / Analyzer System / Governor Control System / MMS FAT at system vendor's place. Contractor shall co-ordinate with DCS/PLC vendor for loop checking, logic checking and commissioning. Contractor shall also participate in SAT of these systems.
- 2.17 Contractor to provide all the items related to instrumentation & control system required for safe and efficient operation of the GTG V & HRSG Unit. Instrumentation & control scope of supply and installation shall include but not limited to the following as minimum:

	DESCRIPTION	SUPPLY	INSTALLATION
1.0	Instruments		
1.1	All field mounted instruments (SIL 2 Complied)	By Contractor	By Contractor
1.2	1 No. Universal Hand Held Configurator similar to Emerson 475 or latest suitable for hazardous area classification for Transmitter	By Contractor	By Contractor
1.3	All skid mounted instruments (wherever required)	By Contractor	By Contractor
1.4	Local gauge board mounted instruments	By Contractor	By Contractor
1.5	Local panel mounted instruments (wherever applicable)	By Contractor	By Contractor
1.6	Analyzers – local or analyzer shelter mounted complete with sampling system with dual HVAC	By Contractor	By Contractor
1.7	Stack Analysers (NOX, SOX, HC, CO) shall be common for both main & bypass stack. However sample handling system shall be separate for both stacks. GT V stack gas analyser for both GT and HRGS shall be common make.	By Contractor	By Contractor
1.8	Separate SPM analyser for main & bypass stack	By Contractor	By Contractor
1.9	SWAS analysers like pH, conductivity, silica (multi channel type) etc. for steam water quality	By Contractor	By Contractor
1.10	O2 Analyser (In-situ Zirconia cell) with repeat indication in analyzer room.	By Contractor	By Contractor
1.11	All skid mounted instruments like anti surge controller, Woodward Governor etc.	By Contractor	By Contractor

	DESCRIPTION	SUPPLY	INSTALLATION
2.0	Panels/gauge boards/cabinets (as applicable)		
2.1	Local gauge boards	By Contractor	By Contractor
2.2	Local panels for		
	a) Process units & sub-packages as applicable	By Contractor	By Contractor
2.3	Remote panels for		
	a) Package units & sub-packages as applicable	By Contractor	By Contractor
	b) Any other items	By Contractor	By Contractor
2.4	Marshalling panel, MCC Relay Panel, Hardwire Consoles	By Contractor	By Contractor
2.5	Standalone Annunciation System with HWC	By Contractor	By Contractor
2.6	Power distribution cabinet in SRR VI	By Contractor	By Contractor
3.0	Special instruments and system oriented items		
3.1	DCS and PLC system	By Contractor	By Contractor
3.2	Integration with existing GT IV Systems.	By Contractor	By Contractor
3.3	Signal multipliers, trip amplifier, contact multipliers, receivers switches, interposing relays and other receiver instruments and auxiliaries etc. as required	By Contractor	By Contractor
3.4	SIL 3 fail safe PLC system for HRSG with auxiliary firing & BOP / BMS (rest of turbine control system)	By Contractor	By Contractor
3.5	Fire & Gas (with integral transmitter and display), hooters, Beacons, manual call point, interconnecting cabling, barriers and alarm unit etc.	By Contractor	By Contractor
3.6	1 No. portable detector common for O2, LEL, H2S and CO & 1 no. portable purge calibrator	By Contractor	--
3.7	Hood for gas detector (As per OEM's Standard)	By Contractor	By Contractor
3.8	Extension of existing PLC system for Fire & Gas Detection System which include following areas: - Control room, rack room, cable cellar, fire alarm & detection system - Fire alarm and detection system for BOP - CO2 system (Sensors, SOVs, CO2 cylinders, local panels, hooters & beacons shall be in GT vendor scope) - Fire alarm manual call points	By Contractor	By Contractor
3.9	Machine monitoring system including sensors /	By Contractor	By Contractor

	DESCRIPTION	SUPPLY	INSTALLATION
	transducers, monitors and interconnecting cables etc.		
3.10	Alarm Management Information System	By Contractor	By Contractor
3.11	Required modification (software & hardware) in existing GT IV operating stations.	By Contractor	By Contractor
3.12	Any other special instrument/system item specified in the package.	By Contractor	By Contractor
4.0	Junction Boxes		
4.1	For interconnection between field and local panels, Field & control room, JB's & control room, Local panel & control room etc.	By Contractor	By Contractor
4.2	Junction boxes as per clause no. 15.3.1 of annexure III of Engineering Design Basis. (44NC-4600-0000/J.02/0001/A4)	By Contractor	By Contractor
5.0	Cables		
5.1	Between field instruments and junction Box / Local panel	By Contractor	By Contractor
5.2	Between junction boxes and control room panel	By Contractor	By Contractor
5.3	Between local panel and control room	By Contractor	By Contractor
5.4	Between substation / MCC and Control room panel	By Contractor	By Contractor
5.5	Between DCS & Hard Wire Console	By Contractor	By Contractor
5.6	Interconnection between DCS & PLC	By Contractor	By Contractor
5.7	Between power distribution boards (AC/DC) in Control Room and field power distribution JB (Single point only)	By Contractor	By Contractor
5.8	Between power distribution JB (within package battery limit) and instruments / local panel	By Contractor	By Contractor
5.9	Termination and Glanding of all cables in LCP, Instrument and junction box within package battery limit.	By Contractor	By Contractor
5.10	Between skid Junction Boxes and LCP	By Contractor	By Contractor
5.11	Machine monitoring, analyser system cables. A) from field to Junction Box B) Junction Box to control panel C) Field to control room	By Contractor	By Contractor
5.12	Fire & Gas system cables	By Contractor	By Contractor

	DESCRIPTION	SUPPLY	INSTALLATION
	A) from field to Control Room		
	B) <u>from Control Room to Fire Station</u>	<u>By Other</u>	<u>By Other</u>
5.13	System cables (Serial links, prefab (CAT), co-axial etc.) Between existing GT IV control room building and field mounted analyzer shelters / cabinets, within control room as required.	By Contractor	By Contractor
6.0	Installation Materials		
6.1	Impulse tubing/piping, tube/pipe fittings, valves and valve manifolds, steam traps etc. as required.	By Contractor	By Contractor
6.2	Instrument air valves, pipes and fittings	By Contractor	By Contractor
6.3	Cable trays, cable duct, Trenches , conduits, cable glands, gland shrouds and accessories etc.	By Contractor	By Contractor
6.4	Instrument stanchions, supports, canopies/sunshields, supports for cable tray/duct, all consumables	By Contractor	By Contractor
7.0	Earthing system for, local panels, PDBs field instrumentation, JBs, including earthing strips, earthing cable.	By Contractor	By Contractor
8.0	Power supply distribution for instruments / local panels within package boundary limit	By Contractor	By Contractor
9.0	Special tools and tackles	By Contractor	-
10.0	Mandatory spares and commissioning spares	By Contractor	-
11.0	5 Years Annual Maintenance Contract (AMC)	By Contractor	By Contractor
12.0	Documentation required as per this package	By Contractor	-

Notes: -

1. The scope of supply and installation indicated above is to identify broadly the scope for major instrumentation items. Contractor to read the same in conjunction with various requirements, specifications and standards for the overall scope. However, wherever there is a need to interface/use the existing system as specified in relevant documents/drawing. The contractor to co-ordinate with the Existing system supplier for carrying out the required job.
2. New hardwired console windows and new annunciator windows for GTG-V shall be placed in existing GT-IV spare console.
3. If AMC is subcontracting the same shall be followed and order copy of the same to be provided to CPCL. It shall be considered for evaluation.

3.0 DESIGN AND CONTROL PHILOSOPHY

- 3.1 The instrumentation & control system shall be designed for safe, reliable, efficient & easy operation of Gas Turbine Generators (GTG), Heat recovery Steam Generators (HRSG) and their auxiliaries.
- 3.2 I & C system shall permit operation of the plant from existing GTG IV control room. **New system shall be located in new SRR VI (by other), near to existing GT IV substation building.** GT V system architecture shall be of latest series as GT IV. The interface between GT-IV and GT-V should be seamless. The existing maxstations of GT-IV with windows XP to be upgraded to windows 7 professional maxstations. Refer Indicative System Architecture Drawing (44NC-4602-0000/J.01/0101)
- 3.3 Contractor to note that SIL 3 certified ESD PLC (TMR/QMR) is envisaged for all trip and shutdown interlock. Contractor to identify and indicate shutdown/trip requirements to PMC/Owners for approvals with reasons.
- 3.4 Control system shall have integrated PLC (with TMR/QMR architecture) system which shall be used to carry out all interlocks & emergency shutdown functions. All interlocks/trips shall be implemented using 2oo3 philosophy.
Sequence of events functionality shall be incorporated in the PLC with time stamping at I/O card level. Separate sequence of event retrieval PC shall be provided.
- 3.5 **The logic for the packages shall be implemented & executed in Main DCS / PLC supplied by GT/HRSG contractor. Contractor shall provide separate junction boxes for DCS and PLC instruments as per P&ID.**
- 3.6 Operating voltage for control system shall be 110 V AC, 50 Hz from UPS.
- 3.7 **Contractor shall supply latest version of existing control systems of GT IV Turbine as indicated in System Architecture diagrams. Following are the details of existing systems,**
- Turbine Control Systems**
DCS System: MAX DNA (M/s. Metso)
PLC System: MARK VI (M/s. BHEL)
- Other Plant Area**
BOP PLC: M/s. Honeywell
BMS PLC: M/s. Honeywell
F&G PLC: M/s. Honeywell
- Following are the minimum system requirements for new GT V,**
- 3.8 The DCS system software shall operate on Windows 7 platform.
- 3.9 All analogue Input/output modules connected to DCS shall be HART type. Analogue inputs shall be interchangeable i.e. (2 wire, 3 wire & 4 wire)
- 3.10 DCS system shall be of latest evolutionary type with 'Open System Architecture'. For open system connectivity the system shall adopt following standards as a minimum:

- The system shall support Ethernet communication conforming to IEEE 802.3.
- The method of data access by any user on the plant wide network shall be by I/O tag name and not by any physical or logical address.
- Connection & transfer of data through TCP /IP for operating any window based process package should be possible without any addition of hardware / software.

3.11 The data base shall be global unit wise and shall be accessible by all TFT'S of each console or between consoles of same unit. However, a key lock/password protection shall be provided to selectively inhibit console response to key action.

3.12 Any addition/deletion of tag number should be possible without booting of the system or plant shutdown. Any changes in any portion of the database during running of the plant should be possible. Downloading of the changed software to the respective sub system should be possible in running condition of the plant. Saving, updation and taking back up of the database with respect to the latest changes made should be automatic and without affecting the plant running.

3.13 Controller shall have capability to hold output at its' last value during online downloading operation and the output should not go to fail safe value.

3.14 It shall be possible to tune control loops on selective basis, automatically using adaptive tuning. Tuning parameters computed by the system shall either be loaded automatically or manually by the operator.

The software for the loop tuning may reside/ run on any system hardware including controller subsystem, operator console subsystem etc. The tuning package shall ensure that the system shall not be disturbed whenever a loop is being tuned.

3.15 Control systems shall be designed with availability requirements of 99.99% as minimum, with a MTTR figure of 8 hours. The level of redundancy specified in the engineering design basis for instrumentation, clause 5.12 is minimum. Additional redundancy if required must be provided by contractor to meet these specified availability requirements. The redundancy requirement for various system components shall be as follows:

- | | |
|--------------------------------|----------------|
| - Controller system | 1: 1 redundant |
| - Input / output system | |
| - For closed Loops | 1: 1 redundant |
| - Critical Open Loops | 1: 1 redundant |
| - Interlocks & shutdown system | 1: 1 redundant |
| - Communication system | 1: 1 redundant |
| - Power supply | 1: 1 redundant |

3.16 Detailed P&ID's of the packages / sub packages shall be submitted by the contractor to Owner / PMC showing the complete scope and connectivity to the central control systems (DCS/PLC).

3.17 Controller Sizing & Loading Criteria for DCS

- Separate DCS controller subsystem shall be provided for GTG V & HRSG Package. No's of controllers for these subsystem shall be decided based on following criteria.
- Separate controller sub-system shall be provided for redundant serial interface requirements between DCS and foreign devices not more than 4 serial interfaces shall be connected to one controller. These serial interfaces shall not be combined with any process unit controller sub-system

- Separate gateway/Controller shall be provided for interfacing each PLC system.

3.18 Controller Sizing & Loading Criteria for PLC

No's of controllers for these subsystem shall be decided such that each Controller loading shall not exceed 60% when configured for scan time as specified & also maximum control loops in one controller shall not exceed 100 nos. Including installed spares and future space. Loading here is referred to the use of memory, CPU time and communication capacity.

3.19 The system shall be sized to have real time trending for all tags with time base of maximum 1 sec. and historical trending for all the tags with time base of 30 sec. for analog and 10 sec for digital tags for at least 40 days.

3.20 There must be a facility of zooming of all history trends with respect to time scale and parameter value.

3.21 DCS alarms in critical category shall require unique colour, grouping, or graphical display on the TFT and unique audible tone to clearly distinguish them from non-critical alarms. In addition, critical alarms to be provided on a separate alarm panel located above or near the operator station.

3.22 Contractor must furnish bus loading calculations for each subsystem i.e. Controller subsystem, console subsystem and communication subsystem. These loading figures shall be demonstrated by contractor at factory acceptance test and finally during site acceptance test. Contractor shall quote for hardware and software to meet these loading requirements. In case, actual loading is found to be higher than specified, contractor shall supply additional controller and hardware/software to meet the requirements without any cost and schedule implications.

3.23 **Wherever 3 transmitters are wired to PLC for 2oo3 logic, all 3 signals shall be repeated to DCS using signal isolators/repeaters.** In DCS Mid value shall be used for further processing. DCS shall have capability to sense bad value due to transmitter fault, open line or deviation in measured value more than specified limit and shall exclude such signal for mid-point calculation. Any transmitter fault shall be logged on event / message logger.

PV value of all three signals shall be made available on a separate pop up window accessible to operator by click of an icon on process graphic page.

3.24 Split range scheme to be incorporated in DCS by providing two separate 4-20mA outputs.

3.25 All controllers shall be configured so that 0% on the face plate indicates valve closed & 100 % indicates valve open. If the valve is fail open then the controller output signal shall be reversed.

3.26 For interfacing third party equipment's like analyser system, machine monitoring system etc., contractor must use protocols which are industry de-facto standards like MODBUS. Proprietary systems shall be avoided.

3.27 In addition to the system requirements as indicated above, following also shall be considered while designing the DCS system :

For PLC / foreign device interface with the DCS, the communication interface and interface software shall have speed and priority such that data transfer occurs within one (1) second of an event at PLC input or on a foreign device event even when both systems are operating under load.

The data to be transferred to and received from the DCS should be mapped into a separate section of memory.

- 3.28 It is contractor's responsibilities to co-ordinate with the supplier of foreign devices identified and establish communication for transfer of data with them. Unless the above communication is established, the control system shall not be considered commissioned.
- 3.29 The serial interface shall be through controller & data acquisition subsystem/ processor subsystem and the no. of serial links per serial interface module shall be restricted to 4 subject to meeting loading criteria. Further for Main PLC Systems and F&G System separate dedicated redundant serial interface module shall be provided.
- 3.30 Total no. of redundant gateways / serial interface modules shall be calculated and provided accordingly by vendor for each network meeting the other requirements of specification.
- 3.31 Time synchronisation
All the real time clocks in the systems including DCS, PLC etc. supplied by contractor shall be synchronized with each other. **GT-V system shall be time synchronized with the GT-IV control system.** The accuracy of the resolution of real time clock used as master clock for time synchronization of all the systems shall be better than resolution of the SOE system.
The real time clock within various systems shall be crystal controlled which shall be independent of line frequency. There must be a provision for manual synchronization of time for various real time clocks in the systems. Such change shall be possible through a menu driven facility.
- 3.32 PROGRAMMABLE LOGIC CONTROLLER
- 3.32.1 The standard specification for PLC defines the minimum requirements for PLC system design, configuration, inspection, testing, installation and commissioning.
- 3.32.2 The PTR requirements for PLC shall be similar to that for DCS.
- 3.32.3 PLC system with unit wise segregation up to controller level shall be used for all emergency shutdown interlocks related to package units of plant.
- 3.32.4** BOP, BMS & F&G PLC for new GT V shall be of same make as that of GT IV, i.e Honeywell Safety Manager. GT V's F&G PLC shall be an extension of GT IV's F&G PLC. **All interlocks and logics shall be executed in the main BOP / BMS / F&G PLC.**
- 3.32.5 GT V F&G PLC shall be sized to accommodate F&G detection signals from GT V, Boiler VI and OSBL.
- 3.32.6 All interlocks & emergency shutdown shall be configured & executed in a fault tolerant PLC based on Triple / Quadruple Modular Redundant architecture certified by TUV for AK5, SIL 3 as per IEC 61511.
- 3.32.7 In case of TUV certified systems, contractors must ensure the following ;
– All the model numbers of modules supplied shall be TUV approved.
– All software modules or firmware's shall be TUV approved.

- The relays used within the PLC shall be TUV SIL 3 approved only
- The system shall be engineered considering all guidelines provided in the TUV certification of the system. A copy of which shall be furnished to owner / PMC for information.
- The configuration and assembly of the complete system shall be carried out either by manufacturers or by an agency which have carried out the engineering of same make of TUV approved system in the past and has been authorised by the PLC vendor in writing with still maintaining their responsibility for safety such as authorisation certification shall be provided by contractor in such a case.
- All maintenance and operation related features as per TUV report are to be demonstrated during factory acceptance and site acceptance test.

3.32.8 Three (3) field transmitters where used to initiate interlock/ shutdown shall be wired to separate TMR/QMR analog input card of PLC & 2 out of 3 voting logic shall be configured on the analog inputs to enhance the system availability. The isolator's repeaters shall be used for all 3 inputs for connecting to DCS. Each isolator repeater shall be powered through separate feeder. **All analog input barriers shall be one input two output type.**

3.32.9 PLC shall have the capability to allow hot swapping of I/O as well as processor modules without causing any interruption to the process. Hot slot shall be provided for all TMR cards & hot slot with I/O module shall be provided for QMR cards.

3.32.10 PLC shall have built in capability to identify & analyse the sequence of events with a time stamping resolution same as PLC scan time or better.

3.32.11 The PLC scan time shall be of the order of 250 millisecond or better. In case any equipment requires faster scan time the same may be adopted for that application. Ladder logic and functional block diagram shall only be used for programming the PLC complying with IEC 61131.

3.32.12 The system shall have an automatic and on demand data back-up facility for the preservation of all data during a planned / unplanned outage. The entire control software shall be backed up including vendor software, control database, user-built programs, source code and data files. Back-up copies produced on bulk devices shall be removable for remote storage. On line backup shall not degrade system performance.

3.32.13 **For auxiliary firing, Operation of burner valves, ignitors shall be possible from BMS Local control panel at grade and also from Hardwired console in control room.**

3.33 SHUTDOWN INTERLOCK ALARMS & PLC-DCS INTERFACE

3.33.1 For all 2 out of 3 voting logics, in addition to individual and voted alarm, contractor shall provide a maintenance alarm indicating discrepancy shown by any of inputs.

3.33.2 Common alarm of each initiated shutdown will be hard wired from 'DO' of PLC to a hard wired alarm annunciator on auxiliary console. Contractor shall submit the list of hard wired alarms for Owner's /PMC's approval.

- 3.33.3 For all trip initiating alarm inputs, PLC to provide 'DO' to Aux. Console for hardwired annunciation. In addition common interlock alarm (XA) to be provided on Aux. Console annunciator. Also, DCS dynamic graphics to include these common alarms along with status indication of all initiating inputs (with colour change), through serial link on interlock graphic display.
- 3.33.4 Soft commands from DCS to shutdown interlock shall not be acceptable. Wherever pump stop commands or interlock trip commands (HS) are shown from DCS on P&ID's, these shall be considered on hardwired Aux. Consoles in control room and shall be wired to digital input of PLC. Interlock reset switch shall be provided on auxiliary console and shall be hardwired to digital input of PLC.
- 3.33.5 Critical pumps & compressors trip alarms and other alarms shall be hardwired to alarm annunciator on auxiliary console.
- 3.33.6 No hardwired Maintenance Override Switch (MOS) shall be used. This shall be incorporated in PLC Operator Station by soft tag. However, for enabling initial start-up, process bypass switches if required shall be considered by contractor on Auxiliary Hardware Console.
- 3.34 FIELD – RACK ROOM INTERFACE
- 3.34.1 Marshaling cabinets shall be supplied for DCS / PLC to provide required isolation and interconnection between various field signals and I/O subsystem. These shall be located in the rack room. Unit wise separate marshaling racks shall be considered for DCS & PLC systems. **Digital IS & NIS cabinets shall be separate.**
- 3.34.2 In general, intrinsically safe philosophy shall be followed for all inputs / outputs in hazardous area. Contractor must select external barriers, wherever applicable, on entity concept. All barriers shall be isolating type. All barriers should be provided with dual power supply. In case power rail system for barriers are used, then fused terminals shall be provided for all analog and digital signals from field and dual power supply to power rail to be provided.
- 3.34.3 Isolators shall be of latest / enhanced available versions with 3-port isolation of proven quality and of reputed make. Specifications similar to series 5000 of MTL or equivalent model of P & F isolators shall be considered as minimum. Approval of actual model number shall be obtained from Owner/ PMC before proceeding and any change required from the model selected shall be carried out by contractor without any implication.
- 3.34.4 Interposing relays shall be considered for digital input & output signals to & from MCC as well as for interface with field mounted flameproof instruments & accessories such as field switches & field indicating lamps etc. All relays shall be provided with freewheeling diodes. Only SIL-3 certified relays shall be used for ESD PLC and non SIL certified relays for DCS. Minimum no. of contacts for SIL 3 relays shall be 2 nos. and for **Non SIL relays 4 NO & 4 NC contacts.**
- 3.34.5 Isolators and relays shall be channel mounting type only (PCB mounted shall be avoided) in view of ease of maintenance. Stacked terminals shall not be used for the incoming field side termination. These shall be channel mounted type, suitable for 2.5 square mm conductor size. Terminals for internal wiring may be of stacked type (with minimum separation between stacking of 10mm) PCB mounted and with prefabricated cable connector for connections with I/O subsystem. All terminals and termination assemblies shall be of reputed make such as Phoenix contact.
- 3.34.6 Panel internal wiring shall be with stranded copper conductors of minimum 0.5 mm² in size and colour coded for various voltage levels and signal types (Refer standard specification

44NC-4600-0000/J.SS/0110) for easy identification and shall be segregated and separately routed to avoid effects of induced voltages.

- 3.34.7 Following types of cabinets shall be supplied. Unit wise separate cabinets for DCS & PLC shall be considered. All cabinets shall be of RITTAL make only. All cabinets shall be 800/1200(w) X 800 (D) X 2100 (H) mm only. Contractor shall ensure that all cabinets shall be packed & shipped in single sections only and no two cabinets shall be combined in view of limited entry / passage sizes of control room building.
- 3.34.8 **Analog Marshalling Cabinets**
Isolating IS interface units for 4-20 mA DC analog inputs & outputs shall be housed in these cabinets. These isolators shall be capable of supporting bi-directional digital communication with SMART field devices using universal HART protocol. Analog signal isolators shall be powered by 24 V DC & shall be of single Input/output channel type only. Isolator with built in signal repeater shall be used on analog inputs which are required to be connected to PLC as well as DCS. In all analog marshalling cabinets provision shall be kept for mounting hand held configurator / fieldbus tester for smart / Fieldbus transmitter.
- 3.34.9 **Marshalling cabinets for digital input signals**
Digital input signals shall be housed in these cabinets. These inputs shall be connected by IS barriers suitable for proximity detector input (NAMUR) or directly potential free / relay contact. These inputs shall be powered by 24 V DC & shall be of single input channel type only.
- 3.34.10 **Marshalling cabinets for digital output signals**
Digital output signals shall be housed in these cabinets. These output shall be connected by IS barriers suitable for solenoid valves or directly potential free / relay contact. These outputs shall be powered by 24 V DC & shall be of single output channel type only.
- 3.34.11 **Instrument Electrical Interface cabinet**
Separate Cabinet shall be provided for termination of electrical cables from MCC/PCC s to control system.
- 3.34.12 **Relay cabinets for feedback signals from MCC**
Potential free MCC contacts shall be wired in the 24 V DC coil circuit of interposing relays. Contact of the interposing relay shall be wired to digital input of PLC and/or DCS (as required) in the 24 V DC interrogation circuit. Each relay shall be with 2 NO+2 NC change over contacts & contact rating shall be 5 Amps @ 240VAC/110 V DC. Terminals & wiring carrying 110 V DC shall be segregated from 24 V DC wiring & terminals. Fuse type terminals shall be used.
- 3.34.13 **Relay cabinets for command signals to MCC**
Interposing relay shall be used to provide potential free closed contact representing enable command for wiring in the 240 V AC/110VDC control circuit of MCC for electrical drive wherever required. 240 V AC shall be sourced from MCC. The coil rating of the interposing relay shall be 24 V DC. Each Relay shall be with 2 NO+2 NC change over contacts & contact rating shall be 5 Amps @ 240 V AC for LT drives and 15Amps @ 110 V DC for HT drives. Terminals & wiring carrying 240 V AC/110 VDC shall be segregated from 24 V DC wiring & terminals. Fuse type terminals shall be used.
- 3.35 **Power supply distribution cabinet**
Separate Power supply distribution cabinet is required to be provided for various voltage levels i.e. 110 VAC, 24 V DC & 240 V AC. Power supply distribution cabinets shall house circuit breakers, switch fuse units (Only for current / voltmeters), bus bars, termination & wiring as well as bulk power supplies as required.
Redundant Bulk Power supply units with individual Diode Oring unit shall be placed in individual panels.

24VDC supplies to field devices and system components shall be from separate bulk power supplies.

- One 110 VAC PDB shall be considered for DCS loads (1 feeder at front, redundant feeder at rear)
- One 110 VAC PDB shall be considered for PLC loads (1 feeder at front, redundant feeder at rear)
- One PDB with 110 VAC feeder at front for field loads
- One 230 VAC feeder at rear for panel utilities.
- One PDB for 24V DC distribution.

3.36 Feeder Requirement:

Sr .No	Feeder	SYSTEM	Estimated LOAD (kVA)	No. of Feeder
1	400 Amp for GT V	Turbine DCS	3	1 Redundant
		Turbine PLC	3	1 Redundant
		BOP/BMS/F&G PLC	10	1 Redundant
		Stack Analyser / Shelter	6	1 Redundant
		Field Load	4	1 Non Redundant
		Local Control Panel	4	4 Non Redundant feeder of 1 KVA each
		Operating Consoles	2	1 Non Redundant
		Spare 1	3	1 Redundant
		Spare 2	4	2 Non Redundant
		Spare 3	2	1 Non Redundant

Above mentioned system load (kVA) is indicative only. Contractor to calculate actual system load based on the requirement.

3.37 System Cabinets

System cabinets supplied by system vendor shall house racks for installing controller sub system, I/O subsystem, power supplies & other system components along with their wiring. All system cabinets (DCS, PLC), **network Cabinets** shall be provided with toughened glass door at front side; all other specifications of cabinet shall be specified elsewhere in tender document.

3.37.1 The ferruling philosophy/type shall be decided during detail engineering based on overall philosophy for the refinery. Unless otherwise specified, cross-direct ferruling concept shall be used.

3.37.2 Cabinet lighting shall be 230 V AC non-UPS only and the lamps shall be white threaded type. One no. additional socket for 230 V AC shall be provided in each cabinet for use of other testing devices.

3.37.3 All field cables shall be first terminated in separate TB (marshalling terminals) and further the same shall be connected to the barriers / relays.

3.37.4 Marshalling cabinets for high powered trunk based Fieldbus system and 4-20mA signals shall be segregated.

3.37.5 Training kit, Document server, standalone SER, Document Server and OPC server are not applicable for DCS / PLC system.

3.38 INSTRUMENT – ELECTRICAL INTERFACE

3.38.1 Digital output commands from PLC shall be in the form of normally closed contact which opens on stop command. (Relays de-energised on stop command).

3.38.2 Instrument control cables shall be used for carrying all control signals to and from MCC. Signal segregation and proper distances shall be maintained in cables carrying 240 V AC / 110 V DC and analog signals. Contractor shall clearly define inter-departmental scope and shall be responsible for co-ordination within departments.

3.38.3 110 V AC UPS power shall be provided from UPS and battery.

3.38.4 Digital inputs to DCS

Following potential free contacts shall be provided at MCC

- Contact of the contactor for run status feedback of each drive
- Contact for stop status (indicating stop command from control room, field or logic operation)
- Contact of the electrical fault relay for each drive indicating electrical trip. These contacts shall be wired to digital inputs of DCS through interposing relays for status indication on DCS.

3.38.5 Analog inputs to DCS

4 to 20 mA DC analog signals shall be provided at variable speed drives (VSD) representing motor current and/or speed as applicable. These signals shall be connected to analog inputs of DCS for indication / derived alarm.

3.38.6 Analog outputs from DCS

4 to 20 mA DC analog signals shall be provided at marshalling rack for speed control of VSD.

3.38.7 Digital outputs from PLC

A potential free contact of interposing relay shall be provided at the rack room for issuing stop command from emergency shutdown logic (as shown on P & I D) to MCC / VSD.

3.38.8 Substation interconnection with PLC/DCS is to be made through unit multipair cable only. It should have dedicated laying route inside cellar room. All these cables should enter cellar through dedicated MCT blocks. **MCT shall be in OSBL vendor's along with the SRR.**

3.38.9 Separate Multi pair cables shall be laid for Motor run contacts to PLC / DCS. Similarly for Start & stop Commands from PLC, separate Multipair cables shall be laid. All these cables shall be laid in Electrical Cable Trench. RCC partition shall be provided in the Electrical cable trench for separation of these signals. Separate Junction boxes shall be considered for these signals & the same shall be provided at MCC end.

3.38.10 Electrical/Instrumentation Interface system to be submitted by contractor for PMC/OWNER approval.

3.39 COMPRESSOR CONTROLS (AS APPLICABLE)**3.39.1 General**

3.39.2 Contractor shall follow requirement of the instrumentation related portion of the following standards in the design of compressor instrumentation.

- API standard 617–(Centrifugal compressors for general refinery service– latest edition)
- API standard 618–(Reciprocating compressors for general refinery service–latest edition)
- API standard 672–(Integrally geared centrifugal compressor- latest edition)

3.39.3 All compressors shall be provided with local panels which shall be used for start-up and normal critical operations only in line with design basis and compressor vendor guidelines.

- 3.39.4 Panel shall only house switches / pushbuttons status lamps, important alarms and only critical indications and shall be weather proof & flame proof.
- 3.39.5 The logic for the compressors shall be executed only in unit PLC.
- 3.39.6 Anti-surge controller with performance monitor, speed governor, etc. as required shall be housed on auxiliary console & located in control room.
- 3.39.7 All process variables & alarms related to compressor, steam turbine & other associated equipment shall be made available for monitoring, data acquisition, report generation, diagnostics and analysis on the main plant distributed control system.
- 3.39.8 Contractor / equipment vendor shall add other instrumentation as required for safe operation of the compressors
- 3.39.9 Centrifugal compressors
- Turbine governor control and safeguard system
- Turbine governor control system shall be provided for speed regulation of turbine.
 - Turbine speed control shall be achieved by throttling VHP (i.e. very high pressure) steam to turbine by using Woodward 5009 governor. Speed controller shall be capable of accepting remote speed set point from anti surge controller & also to accept a trip command from compressor shut down system to shut off the steam to turbine.
 - Turbine shaft shall be provided with over speed switch to protect the turbine.
 - Local, remote and cascade control of speed set point
 - Bump less transfer among all the control modes
 - Manual operation with automatic over ride to allow direct valve positioning without endangering equipment safety
 - Self-test features and fault detection to produce alarm
 - Automatic start up and shut down sequence with set point ramping between appropriate safe idle speed and operating speed.
 - Interface to allow serial communication with DCS.
 - OP view (Operator Interface) Located at Aux. Console
- 3.39.10 Machine monitoring system for turbine and compressor :
- For machine monitoring, all sensors shall be connected to Bently Nevada series 3500 rack in control room and repeat indication to be provided in field. The BN 3500 series system and field LCP local Display unit shall be provided equipment wise (including segregation for redundant equipments). Localized purged enclosures shall be considered only for BN 3500 LCD Display unit. TDXNet shall be provided. Contractor to note that Data manager is not envisaged in this project. Potential Free Alarm & trip contacts and 4-20 analogue outputs shall be provided for repeat indication to DCS shall be hardwired, in addition Redundant RS 485 port shall be provided for modbus communication to DCS. BN I/O modules shall be with built in intrinsically safe barrier and proximities with screwed terminals for cable connection not push type connectors. Local control panel shall be provided with indicators for X-Y radial shaft vibration, dual thrust / axial position, speed, phase angle (key phaser) and bearing temperature. Mechanical safeguards for Turbine & Compressor shall be provided as required. Emergency trip switch / push button shall be provided on Local panel. Common MMS PC for machine diagnostic shall be located in Central control room with all necessary software. A complete hardware and software set for performing the rack configurations, diagnostics, ladder logic for the relay modules, bypass of channel, monitoring of channel etc. shall be provided. The above machine monitoring system is also applicable for pumps, sir blowers & rotary equipments as per rotary requirements.

For machine monitoring system vibration/temp/speed probe cables to be taken through flexible armoured conduit up to JB. All un-armoured cables shall be routed through GI Conduit pipe. Localized purged enclosures shall be considered only for BN 3500 LCD Display unit TDXNet shall be provided.

MMS shall have the following additional features:

- Redundant power supply and redundant communication cards.
- Input Output modules with in-built intrinsically safe barriers.
- 1 No. LCD monitor Display Unit
- Software and hardware, as applicable, for configuration and programming.

3.39.11 Surge Protection

CCC make 3++ redundant anti surge controller with performance controller shall be provided to achieve following functionality and shall have minimum features as indicated below.

- Advance surge control methods to allow compressor to safely operate closer to its surge limit without recycling.
- Built in loop-decoupling algorithms to allow controller to be tuned faster.
- Fast response time: controller shall be capable of calculation & adjoining compressors proximity to surge control line at least every 50 milliseconds by automatically adapting to changing inlet conditions.
- Controller shall be capable of selectively executing combination of closed loop & adaptive open loop response to avoid surge with additional safety response to limit the surge after single cycle(if at all it occurs) in order to prevent further surges.
- Bump less transfer between manual & automatic operating modes
- Automatic start up and shut down logic.
- Input fault detection & fall back strategies to keep compressor on line in the event of transmitter failure with alarm output for remote.
- Tracking & self-test features with alarms
- Anti-surge controller / performance controller shall be provided with serial link for connecting to DCS.
- Toolbox software shall be provided for anti-surge controller
- Anti-surge valve response time maximum. 10 seconds.

DCS shall have facility to work as back-up to anti surge controller when selected by operator. CCC performance evaluation parameters shall also have DCS back-up.

Contractor shall provide documentations including performance calculations procedure and anti-surge control software configuration.

3.39.12 Instrumentation related to lube oil & seal oil systems.

Lubricating oil & seal oil circuits shall be separate from each other with independent instrumentation and control to maintain required pressure and flow through the supply and return lines. Adequate interlocks shall be provided to safeguard the compressor from loss of seal oil & lube oil.

3.39.13 Reciprocating Compressors

- Pressure & Temperature instruments on suction & discharge of each stage.
- Instrumentation & safety valves related to inter-stage coolers & knock out drums.
- Compressor loading & unloading system to operate machines at various desired stages of design capacity.

3.40 FIRE & GAS SYSTEM

Contractor shall supply and install Manual call points, Hooters, Gas detectors, Fire detectors, etc. as required in GT/HRSG plant area and connect them as individual Inputs / Outputs to the existing GT-IV's F&G Honeywell Safety Manager PLC, located in GT-IV's SRR, using remote IO chassis / cards.

A dedicated chassis shall be considered for GT's CO2 system. GT/HRSG-V panels are to be placed in SRR VI. The GT-IV SRR is around 300m from SRR VI. GT/HRSG vendor shall supply system cabinets with remote IO chassis cards, FTA cabinets, barrier / relay cabinets, marshalling cabinets with all necessary hardware and cabling for GT/HRSG-V F&G system IOs, Boiler VI F&G system IOs and SRR VI's Fire alarm system.

All detectors shall be non-addressable type. GT/HRSG vendor shall co-ordinate with Boiler-VI vendor and OSBL contractor for termination of the F&G system cables laid by them up to the marshalling cabinets and powering ON and commissioning the F&G devices in Boiler area and SRR VI. GT/HRSG vendor shall configure all these IOs in the existing PLC and also in SOE PC, PCs in control room and Fire station. All Digital inputs shall be available in SOE. For all Analog inputs H / HH / L / LL alarms shall be available in the SOE. Any additional license / software / hardware required to accommodate these IOs in the PLC or SOE/Workstation PCs shall be provided by GT/HRSG vendor. The existing GT-IV F&G PLC is serially linked to GT-IV DCS, maxDNA. GT/HRSG vendor shall carry out required modification in the existing serial communication, DCS database and graphics for overall commissioning of the F&G PLC. Repeat indication of Critical F&G system signals in Boiler VI area shall be hardwired to Boiler DCS by other.

- Integrated Fire & Gas System for entire GT V & HRSG & its auxiliaries shall be provided.
- F & G system shall be PLC based with TMR/QMR configuration & min. SIL 3 certified.
- All fire, smoke, heat, gas detector/transmitter, manual call points, beacons etc. shall be provided as per specifications
- Contractor to note that, there will be common F&G system for GTG-V & Boiler Plant that will be engineered by GT-V & HRSG Contractor.
- Gas detector shall give analog signal 4-20mA HART. For Flame Scanners, flame intensity signal shall be connected to DCS / PLC.
- Contractor shall consider following F&G Count for OSBL and Boiler VI, in addition to GT- V,
 - I. Conventional Multi-criteria Smoke Detector - 38 Nos.
 - II. Conventional Multi-criteria Smoke Detector (Above false Ceiling) – 10 Nos.
 - III. Conventional Manual Call Point- 5 Nos.
 - IV. Response Indicator – 10 Nos.
 - V. LHS Controller – 5 No.
 - VI. Pressure switches and Solenoid valves for the Deluge valves - 3 nos.

3.41 ANALYSER SYSTEM

3.41.1 Contractor shall be responsible to supply complete analyser system inclusive of sampling system.

3.41.2 Details provided herein and as given in standard specifications for analysers 44NC-4600-0000/J.SS/0111 attached elsewhere with this package are the minimum requirements which shall be supplemented with international codes and practices to provide efficient and accurate method of measurement.

3.41.3 Scope of supply shall include unused carrier gas, calibration sample cylinders (separate than those used during calibration / commissioning) for zero as well as span calibration of each analyser for a period of one year after the system acceptance by owner.

3.41.4 For sample blends which deteriorate, contractor shall consider the deferred delivery of the cylinders. The cylinder material of construction and rating must be certified. The calibration

sample concentration must be certified for their guaranteed accuracy over a period of one year. All cylinders shall be sourced preferably from reputed Indian suppliers for easy replacement of empty cylinders.

- 3.41.5 Contractor's scope shall include provision of analyser shelters and shelter design shall be as per guidelines given in standard specification 44NC-4600-0000/J.SS/0111. Stack analyser room shall be brick construction room. HVAC need to be considered. 100% redundant split AC with blast proof capacitance shall be provided. Auto changeover of AC units is required. Necessary fire/gas detectors & alarms/hooters shall be provided.
- 3.41.6 The design of sample system shall ensure a clean representative and measurable sample for the selected analysers. System shall include sample probe, pressure reducing station, heat tracing, filters, regulators, safety valves, sample cooler etc. Analyser sample tubes to be heat traced with steam as well as electrical tracing. Normally electrical tracing shall be used with automatic changeover to steam tracing in case of failure.
The sample system design for analyser shall be submitted to Owner / PMC for review.
- 3.41.7 Auto calibration system for on line gas analysers complete with calibration gas cylinders, regulators, sample tubing, flow regulators, solenoid valves & control panels shall be supplied as part of the analyser system with provision for auto /manual selection.
- 3.41.8 All analysers shall be provided with 4-20 mA analog output signal corresponding to the gas measurement range & minimum two alarm contacts corresponding to configurable high/high-high set points. Sample return lines of all analysers shall be routed back to cooling tower sump or to nearest drain.
- 3.41.9 All analysers shall have serial ports with MODBUS protocol for connectivity to DCS using multi dropping.
- 3.42 PROCESS STREAM ANALYSERS
- 3.42.1 The pH, conductivity and other process stream analysers and cabinets shall be installed in the field with suitable rain / sun shed.
- 3.42.2 For pH measurement, differential electrode type sensors shall be used or alternatively, automatic flushing arrangement shall be provided for electrodes. Automatic flushing arrangement shall also be provided for conductivity electrodes.
- 3.42.3 BOP and HRSG SWAS analyser shall be common make.
- 3.42.4 DM Water to be used for SWAS analyser cooling. SWAS coolers shall be of SS material.
- 3.43 STACK GAS ANALYSERS
- 3.43.1 The stack Gas analyser shall be common for both main & bypass stacks. However sample handling system shall be separate for these stacks sample probe. SPM analyser shall be separate for main & bypass stack.
- 3.43.2 In addition to P&ID requirements, main stack shall be provided with flue gas monitoring analysers such as SO_x, NO_x, CO, CO₂, Oxygen, HC, particulate or any other measurement as per requirements of TNPCB guidelines and Ministry of Environment & forest Notification dated March 2008 or latest. Stack monitoring system shall have its own data collection system with dedicated PC & required software. Communication between data collection system & DCS is required.
- 3.43.3 The stack analysers shall be housed in analyser shelter except for Oxygen. Oxygen Analyser shall be (Zirconia) in-situ type. Repeat indication shall be provided in the analyser room. Location of this

analyser shelter shall be decided by the contractor considering vicinity to the stacks and maximum allowable transportation time allowed by EPA/TUV. Typically transportation time of one minute may be selected in the absence of any guideline. However, final clearance to be taken from Tamil Nadu State Pollution Control Board by contractor.

- 3.43.4 Stack gas analysers shall adopt dilution technique for drawing the sample from the stack. Contractor shall design the sampling system to meet requirement of effective analysis for selected analysers. Purge enclosures to meet the area classification shall be from OEM only. Analysers installing in ex-proof box with external purging is not acceptable
- 3.43.5 Analyser shelter shall be air conditioned and designed for unmanned operation.
- 3.43.6 GT V stack gas analyser for both GT and HRSG shall be common make. Stack gas analyser transmitter unit shall be common for GT-V & HRSG stacks. It shall be possible to select stack to be monitored. **Manual selection shall be possible from the DCS as well as Auto selection is also required based on operation of HRSG Unit.**
- 3.43.7 SWAS analyser like pH, conductivity, silica (**Multi channel type**) etc. for steam water quality. Wet & dry panel may be combined into a single panel & the same shall be located close to the sample take off. For these analysers, dry panel shall be in analyser shelter & wet panel shall be located outside the shelter with suitable protection.
- 3.43.8 SWAS Analyser in BOP / HRSG area shall be of same make. **F&G detection signals in analyser shelter shall be connected to F&G PLC.**
- 3.44 INSTRUMENTATION & SYSTEM EARTHING REQUIREMENTS
- 3.44.1 All powered instruments shall be provided with earthing connections.
- 3.44.2 All field instruments requiring 110V AC power supply shall be provided with individual earthing connection for connecting with local electrical safety earth.
- 3.44.3 All low powered instruments will be securely mounted on metallic structure / stanchion support & instrument casing earth shall be connected to the metal support with earthing wire. All the instrument stanchions within 10 metres area may be connected individually to local electrical safety earth or with a looping connection with both ends connected to local electrical safety earth.
- 3.44.4 Shield wires of all analog instruments will be connected to earth only at control room end. The instrument side shield shall be properly cut & insulated ensuring that it does not touch instrument casing or cable gland.
- 3.44.5 All junction boxes used for 4-20 mA analog, RTD & T/C cables shall be provided with separate terminal to terminate shields of single run cables & shields of the individual pair in multi-pair cable.
- 3.44.6 The junction box body earth terminal shall be connected to local electrical safety earth.
- 3.44.7 Contractor shall provide a separate earth electrode / pit for UPS grounding.
- 3.44.8 Rack room mounted system cabinets / marshalling racks (power supplies) shall be connected to separate redundant earth electrodes / pits.
- 3.44.9 Each marshalling rack with field signals of analog /RTD /TC type shall be provided with an insulated earth bus bar to terminate shields of multi-pair cables. This earth bus bar shall be connected to separate redundant earth electrodes/pits.
- 3.44.10 For control room mounted operator stations / engineering stations, separate insulated earth bus bar shall be considered. This shall be connected to separate redundant earth electrodes / pits.

- 3.44.11 A separate insulated earth bus bar shall be provided for terminating earth connections of safety barriers requiring ground connection or ground connection of earth leakage detectors. These isolated bus bars shall be connected to separate high integrity earth electrode.
- 3.44.12 The requirement of earth pits for control system shall be as follows:
- Earth pit E1 - for rack room mounted system cabinets / marshalling racks body earth
(Includes panel mounted bulk power supply)
Earth pit E2 - for Instrumentation earth (For circuit ground, shields, drain wire etc.)
Earth pit E3 – for Machine monitoring system (for circuit ground, shields, drain wire etc.)
- Above earth pits shall be constructed each with dual ground electrodes. This earthing system shall have a resistance to earth of 5.0 ohms or less. Refer Drawing No. 44NC-4600-0000/J.01/0017 for Typical earthing schematic for control room
- 3.44.13 Two nos. of insulated earth bus bars shall be provided for each control system of rack room for signal earth and cabinet / DC earth for further connection to E2 & E1, respectively.
- 3.44.14 One no. of separate insulated earth bus bar shall be provided below false floor of console room for console earth and further connection to E1.
- 3.44.15 All cabinets, panels & doors shall be connected together using 10 sq. mm. copper wire and shall be connected from both ends to insulated earth bus bar as indicated in clause 3.44.13 above. System DC bus ground shall be connected to earth by separate earth conductor (shall not be connected to chassis ground loop). **Earthing studs shall not be provided externally on the panel doors / sides.**
- 3.44.16 All signal earths from individual cabinets / panels shall be directly connected to insulated earth bus bar using 10 sq. mm. copper wires as indicated in clause no. 3.44.13 above.
- 3.44.17 All consoles shall be connected together using 10 sq. mm. Copper wire and shall be connected from both ends to insulated earth bus bar as indicated in clause 3.44.14 above.
- 3.44.18 Redundant earth connection cables shall be used to connect these bus bars to the earth pit using 35 sq. mm. as minimum. The resistance of these conductors shall be less than 0.5 ohms. Sizing of earthing conductor shall be based on 1/3 of maximum current.
- 3.45 REQUIREMENT OF SPARE TERMINATION & SPARE I/Os for DCS / PLC.
- 3.45.1 For Analog inputs/outputs and digital inputs which are routed through isolators, at least 20% spare I/O channels shall be accommodated within the installed modules & shall be completely wired (including installed isolators) up to the marshalling terminals.
- a) Actual Required I/O $\times 1.2$ = No. of installed modules (or next integer) / No. of channels /module
(e.g. $200 \times 1.2 / 32 = 7.5$ hence 8.0)
- b) No. of installed Modules $\times$ No. of channels module = No. of isolators (Installed & wired)
(e.g. $8 \times 32 = 256$)
- 3.45.2 Space shall be available for installing additional 20% spare isolators of each type. Provision of isolator mounting rail shall be made for these future spares. Marshalling terminals shall be installed to accommodate termination requirement of all channels of all isolators including future spares.
(e.g. $128 \times 0.2 = 25.6$ hence 26)Space for 26 isolators for future.
Marshalling terminals (e.g. $(128 + 26) \times 2 = 308$ Terminals installed)

- 3.45.3 In addition to above, spare slots to accommodate 20% more I/Os or minimum one module of each type shall be available in the I/O rack.
- $$\frac{\text{Actual required I/Ox 0.2}}{\text{No. of channels/module}} = \text{No. of spare slots in I/O rack (or next integer)}$$
 (e.g. $200 * 0.2 / 32 = 1.25$ hence 2.0)
- 3.45.4 Density of I/O modules in a I/O racks shall be decided such that total current consumption (internally drawn) of all channels in all the used modules shall not exceed 70% of the back plane current for that rack & current consumption inclusive of spare module (in future spare slot) shall not exceed 80% of the back plane current for the rack.
- 3.45.5 For digital outputs, at least 20% spare channels shall be accommodated within the installed modules & shall be completely wired including interposing relays. In addition to above, spare slots to accommodate 20% more outputs or minimum one module shall be available in the I/O rack.
- 3.45.6 Space shall be available for installing additional 20% spare relays of each type. Provision of relay mounting rail shall be made for these future spares. Marshalling terminals shall be installed to accommodate termination requirement of all relays including future spares.
- 3.46 Following guidelines shall be followed for field terminations at junction box.
- 3.46.1 Only one type (with respect to size) of junction boxes shall be used to accommodate 48 terminals (includes separate terminals for shield for each single run & 20 % maintenance spare).
- 3.46.2 In case of digital signals, junction box size shall be same. However, terminals for individual pair shield shall not be required.
- 3.46.3 Only one number of multicore / multipair cables shall be considered for each junction box along with one number of spare plugged entries.
- 3.46.4 As far as possible, use of 6 pairs / 12 cores cable shall be minimised.
- 3.46.5 **For cable estimation, contractor to consider following cable lengths,**
- From SRR VI to GT V battery limit 75 Mtr
 - From SRR VI to NPH substation 250 Mtr.
 - From SRR VI to NOPH substation 150 Mtr.
 - From SRR VI to GT IV switchgear building 350 Mtr.
- 3.47 **POWER SUPPLY DISTRIBUTION**
- 3.47.1 Power supply requirement for instrumentation & control system is as indicated against Clause 2.7.1 & 2.7.2 of Engineering design basis for instrumentation 44NC-4600-0000/J.02/0001.
- 3.47.2 System wise power supply distribution shall be arranged by contractor as per requirement. 20% installed spare feeders shall be considered for each supply level.
- 3.47.3 24 V DC power supply shall be derived from 110 V AC UPS power supply.
- 3.47.4 110 V DC Power supply as required shall be specified in electrical specifications.
- 3.47.5 Contractor shall take care of 240 VAC distributions as indicated in engineering design basis.
- 3.47.6 Refer Drawing No. 44NC-4600-0000/J.01/0015 & 44NC-4600-0000/J.01/0016 for Power Distribution schematic

- 3.48 The philosophy for control of electrical equipment / drives shall be as follows
- No rotary equipment shall be started from control room
 - Critical pumps & all compressors can be stopped from control room
 - No utility pumps shall be stopped from control room
 - Reset switch of a particular interlock shall be wired to 'Ready to start' lamp on the local panel of the pump or compressor which has tripped as a result of that shutdown interlock
 - **Command and Feedback signals for drives shall be from PLC. For critical drives, commands from DCS shall be hard wired to PLC. For non-critical drives, commands from DCS shall be serially linked to PLC. Feedback signals for all drives shall be serially linked to DCS.**
- 3.49 Contractor / DCS supplier shall furnish data sheets / compliance sheets for DCS indicating important parameters of each item to owner/PMC for approval before finalisation of order.
- 3.50 **CCTV / Ambient monitoring system are not required for this package.**

4.0 INSTRUMENTATION & CONTROL SYSTEM REQUIREMENTS

4.1 FIELD INSTRUMENTATION

- 4.1.1 The 'Engineering Design Basis for Instrumentation 44NC-4600-0000/J.02/0001 together with instrumentation standard specifications (44NC-4600-0000/J.SS/0101 to 44NC-4600-0000/J.SS/0114) define the minimum (but not limited to) requirements for design and selection of instrumentation.
- 4.1.2 The instrumentation selected for the units shall be rugged in design and must be with proven track record of satisfactory continuous operating satisfactorily in similar hydrocarbon industry like Refinery, Petrochemical and Gas Processing Plant under similar process conditions for at least 4000 hrs. from the bid opening date
- Prototype design or equipment of experimental nature or design undergoing testing etc. shall not be selected and supplied.
- 4.1.3 The selection of type of instruments is contractor's responsibility. For the instruments where type is already identified in the P&IDs, data sheets the contractor shall follow the same. However, during the engineering / procurement stage if it is found that a different type of instrument is most suited for a particular application then the same shall be referred to Owner/PMC for review / approval and if suitable, the changed instrument shall be supplied by the contractor without any cost & schedule implication. Contractor shall also be responsible for selecting and reviewing the type of instrument where instrument type is not specifically indicated in P&ID. Contractor shall be responsible to select instrument with latest technology and having proven track record as specified in standard specification for instrumentation work.
- 4.1.4 Contractor shall refer to piping material specifications for selecting the material for various instruments & instrument parts.
- 4.1.5 The material of the elastomers used in instrument shall be suitable for the specified service. Use of asbestos or asbestos bearing material shall be avoided.
- The Type and material of gaskets should be strictly as per piping specifications.
- 4.1.6 In general all instruments shall be intrinsically safe & certified to IEC Zone 1 Gas Group IIA/IIB temperature class T3 as a minimum. Wherever area classification is severer, the same shall be followed for instrumentation selection and certification. **Weather proof class for instruments installed in pits shall be IP68.**
- 4.1.7 As indicated in design basis, field process switches shall not be used.

- 4.1.8 Separate transmitters shall be used for control and trip functions.
- 4.1.9 All thermowell connection size shall be 1 ½" & rating shall be min. 300#
- 4.1.10 All field transmitters and control valve positioners shall be with 4- 20 mA DC SMART with HART protocol. **All transmitters shall have 2 nos. cable entries. One cable entry shall be plugged with SS plug. Transmitter's electronics boards / cards shall have conformal coating suitable for corrosion protection.**
- 4.1.11 Each SMART transmitter & positioner shall be configured to store its tag no., calibration range & other physical specifications/data which shall be useful for history record purpose.
- 4.1.12 All field transmitters shall be provided with integral LCD digital indicator capable of displaying PV value in engineering units and also in percentage. Separate intrinsically safe, field mounted loop powered digital indicators shall be provided at grade level for transmitters which are located at inaccessible locations, at high elevation (like RADAR instruments used for level measurement) or where specifically required for field operation of equipments / valves. Loop powered indicators for open loop transmitters shall be connected in series with the transmitter. For closed loop they shall be wired as separate AO through barrier in control room panel.
- 4.1.13 Separate intrinsically safe, field mounted loop powered digital indicators shall be provided at grade level for transmitters which are located at inaccessible locations, at high elevation or where specifically required for convenience of field operation, isolation of equipments / valves. Contractor to submit list of proposed remote loop powered indicators along with instrument location drawing to PMC/Owner.
- 4.1.14 All smart transmitters shall have rangeability of 1:100. Transmitter with lower rangeability shall not be supplied.
- 4.1.15 The response time of diaphragm seal transmitter shall be of the order of 3 seconds but in no case shall exceed 5 seconds
- 4.1.16 Draft transmitter open to atmosphere port to be connected with helical **SS** tube coil and the coil free end to be put inside a perforated pot with ceramic balls to avoid spurious tripping during high wind velocity.
- 4.1.17 **Pressure & DP transmitter body shall be provided with plugged vent & drain connection.** External manifold for vent & drain is not acceptable. For all type of transmitters glass filled Teflon O-ring to be used for oval flange. Bottom entry process connection is not acceptable. **3 way integral manifold shall be provided for all remote mounted DP transmitters and 2 way integral manifold shall be provided for all remote mounted Pressure transmitter.**
- 4.1.18 Pressure gauge casings should be made of SS only. Capillary for gauges and transmitters shall be minimum 3 meters in length.
- 4.1.19 **Mercury filled temperature gauges shall not be offered**
- 4.1.20 Pump discharge pressure gauges are to be either diaphragm seal type with capillary or with flexible armoured hoses are to be mounted at a distance on separate stanchions to minimise vibration
- 4.1.21 The square root extraction for the differential pressure based flow measurement will be carried out in DCS. **Transmitter shall indicate both DP & flow values.**
- 4.1.22 Orifice meter taps shall be as per clause no. 3.5.1 of annexure III of Engineering Design Basis.
- 4.1.23 **For mass flow meters, steam jacketing, wherever required, shall be part of original instrument design and shall be manufactured and tested at the manufacturer's works only. These meters shall be suitably insulated. Cables from sensor and transmitter shall be provided along with the**

instrument and flexible conduit as necessary. The instrument shall have terminals for each cable termination. Flying leads shall not be used. Contractor shall ensure that selected mass flow meter has a valid statutory certificate when used in custody transfer applications. Mass flow meters shall be used for measurement of naphtha and HSD for firing.

- 4.1.24 The Magnetic flow meter transmitter shall be four (4) wire micro-processor based. Magnetic flow meter shall be Pulsed DC type powered from transmitter. The transmitter shall be provided with integral digital LCD display with engineering units. The flow meter tube shall have PTFE liner. The liner shall hold tightly and rigidly against the flow meter tube without any air gap. Transmitter shall be remotely mounted. Required special signal cable between sensor and transmitter shall be supplied along with magnetic flow meter. Flow meter transmitter output shall be FF/4-20mA DC HART output. The supply voltage shall be 110VAC 50Hz

The flow meter shall meet the following requirement as minimum:

Material of Construction of Tube & Electrode: SS316

Flow meter Accuracy: +/- 0.5% of flow rate

Flow Meter Repeatability: +/- 0.1% of flow rate for liquid services

- 4.1.25 Ultrasonic flow meter shall be multi path, multi beam sensors type with flow tube, flanged end connections. The transmitter shall be provided with integral digital LCD display with engineering units. Flow meter transmitter output shall be 4-20mA DC HART output. The supply voltage shall be 110VAC 50Hz

- 4.1.26 Vortex flow meter wherever specified shall be based on KARMAN VORTEX operating principle to measure volumetric flow for high rangeability measurement requirement.

Contractor shall be responsible for proper selection of the material of construction of the meter body, bluff body and other wetted parts. In any case material of all wetted parts including bluff body and sensor shall be SS316 as a minimum. Meter body material shall be as per corresponding pipe specifications as minimum.

Flow meter shall meet following performance requirement unless specified otherwise in the process package.

Accuracy: Better than 1% of the full scale

Repeatability: +/- 0.2 % of the reading

Transmitter for the flow meter shall be remotely mounted in field. Transmitter shall be microprocessor based with SMART with 4 - 20 mA-output with HART protocol or FF as applicable.

Vortex flow meter including sensor, transmitter shall be certified for use in applicable hazardous area. Contractor shall provide straight pipe runs as per recommendations of flow meter vendor to meet the specified performance requirement.

- 4.1.27 For the vibration switches mounted in fan and motor body for interconnection with motor tripping etc, the calibration certificate for the settings are to be supplied. Suitable arrangement for checking and adjusting the calibration of such switches are also to be supplied along with the switches. All fin fan coolers, vibration switches shall be directly wired to MCC with repeat indication in DCS. Also the reset for vibration switches shall be provided in field.

- 4.1.28 Control Valves

Control valves shall normally be Globe type single seated or double seated. For clean services, guiding shall be top and bottom/cage type. For highly viscous services cage guiding shall be avoided .If cage valve are to be provided due pressure drop requirements, the same shall be with up-stream strainer arrangement to prevent plugging of cage.

Stroke timings, etc shall be taken care of by the contractor while selecting the control valve.

Block valve shall be line size and bypass valve control valve body size. Drain valve size shall be 3/4" gate valve and provided with Blind flange.

The actuator shall be selected considering instrument air supply pressure of 3.5 kg/cm²g as indicated in engineering design basis and selected size shall be 130% of calculated size.

Only SMART Positioners shall be used for all control valves and damper control. Usage of I/P converters shall be avoided.

Smart Positioners shall be provided with metallic casing/cover along with software for valve signature collection.

In addition to operational and maintenance data provided by the positioner like actual stem position, instrument input signal, pneumatic pressure to the actuator etc., the positioner shall also provide the cycle counting and store accumulation data to help keep control valve stem leakage in control. The positioner shall also have built-in manual stroke button for stroke open or close the valve for quick verification.

- 4.1.29 All pressure relief valves in hydrocarbon service shall be flanged only. Threaded relief valves shall not be acceptable.
- 4.1.30 All the shutoff valves shall be full bore Ball type. Positioners with partial stroke testing option are not required.
- 4.1.31 All shutdown valves shall be provided with proximity switches of intrinsically safe design for open & close indication in DCS. Proximity switches of ON-OFF valves shall be with metallic enclosure.
- 4.1.32 All solenoid coils shall be operating at 24V DC & enclosures shall be intrinsic safe suitable for use in applicable hazardous area. All solenoid valves shall be provided with reverse voltage protection diodes, SS body and with integral terminal box. Solenoids shall be de-energized to trip.
- 4.1.33 Position transmitter shall be provided for continuous position feedback in the DCS for all Dampers in air / flue gas ducts.
- 4.1.34 Over and above all the instruments supplied, vendor shall supply one boiler drum PT, LT & gauge glass for Boiler Alkali dry-out operation.
- 4.1.35 All local panels in hazardous area shall have all internal components including termination enclosure certified as flame proof. Monsoon weather protection shed shall be provided for field panel instruments like local control panel, field panels / rack mounted analysers system & others. All electronic modules/equipments shall meet the environmental classification G3 as per ISA S71.04. All switches / push buttons shall be intrinsically safe certified and shall be of STAHL / equivalent make. All panels shall be installed on the channel base using nuts/bolts. Welding of panel's base frame to channel base is not allowed.
- 4.1.36 For line mounted instruments on stainless steel piping classes, Intergranular Corrosion (IGC) test shall be carried out as per piping material specification requirements.
- 4.1.37 Contractor shall not install any junction boxes on package skid. Same shall be installed away from the high temperature zone. Contractor shall select proper sensor length and MOC of sensor cable related to vibration monitoring for ease of maintenance.
- 4.1.38 All instruments material of construction in chlorinator system shall be suitable for chlorine application. Pressure gauges & transmitters shall be diaphragm seal type. Diaphragm & wetted part material shall be tantalum as a minimum.
- 4.1.39 All instrument in IBR service or instrument installed on IBR pipeline or equipment classified under IBR service, shall be IBR certified
- 4.1.40 IBR certifications shall be provided by contractor in the appropriate format duly signed by IBR authority or their authorised agency.

4.1.41 Flame Scanners:-

- Flame scanner shall be explosion proof
- In addition to the flame intensity analog signal the following output contacts shall be available: Flame ON / OFF, Sca fault / Self check failed contact
- The flame scanner hardware shall be fail safe with dual microprocessor systems for the control unit.
- The flame scanner shall have integrated shutter drive for performing self checks.
- The flame scanner shall have programmable flame recognition threshold time.
- LED indications shall be available for operational readiness, flame signal / fault.
- Internal operating voltages and all safety related hardware are to be monitored.
- Flame scanner shall have self checking circuits.

4.1.42 Manual Call Point (MCP)

- It shall be a break glass unit with a minimum dimension of 100x100x80mm
- Enclosure shall be IP55
- The glass shall cover at least 30cm² area and shall have a thickness not exceeding 2mm.
- The box shall have a push button element kept in pressed condition by a glass sheet fitted in the front of the box.
- The enclosure shall be painted with fire red colour (shade 536 of IS-5) epoxy painting and an inscription "Break Glass in case of Fire", shall be painted in white letters or riveted on the enclosure by a steel nameplate. A suitable nickel-plated brass hammer, duly chained to the box with stainless steel chain shall be provided with each box for breaking the glass. Each box shall have a distinct identification number painted on it.
- The MCPs shall have flameproof enclosure conforming to IS 2148. Flameproof cable glands are to be used.

4.1.43 Ionization flame monitors shall be explosion proof with IP 65 enclosure.

4.1.44 Electronic water level indicator enclosure shall be IP 65 with SS body material. Contractor shall provide remote indicator for same as required. Display unit shall have bi-color indication.

4.1.45 Flush mounted diaphragm shall not be considered for level transmitter. Both HP and LP side of transmitter shall have capillaries.

4.2 OTHER REQUIREMENTS**4.2.1 Laying of the cables within control room building**

4.2.1.1 Cable entry to all equipments inside rack room shall be with bottom entry through cable cellar.

4.2.1.2 The cable in cellar shall be routed in pre-defined main trunk ducts below the roof level.

4.2.1.3 The cables up to the respective cabinets shall be routed from main trunk ducts through feeder/branch trays and opening in the roof to respective racks in rack room.

4.2.1.4 All Duct & cable trays shall be of GI. Fire proofing of duct and trays are not applicable.

4.2.1.5 Cable entry to all equipments inside console, Engineering and Computer (OPC Server) room shall be with Bottom entry through false floor

4.2.1.6 The signal and power cables should be segregated, Electrical Power cables shall not be routed through the cellar.

- 4.2.1.7 Cables glands shall be Flameproof Double Compression SS type
- 4.2.1.8 Cables (internal and external) shall be colour coded for ease of maintenance and type of conductor and insulation proposed shall be to the equipments required
- 4.2.1.9 Cable entry to all equipments inside console, Engineering and Computer (OPC Server) room shall be with Bottom entry through false floor
- 4.2.1.10 The signal and power cables should be segregated, Electrical Power cables shall not be routed through the cellar.
- 4.2.1.11 Cables (internal and external) shall be colour coded for ease of maintenance and type of conductor and insulation proposed shall be to the equipments required.
- 4.2.1.12 Cables shall have sufficient mechanical strength and shall be guarded against electrostatic, electromagnetic and radio-frequency interference. Each cable shall be properly identified with SS tag plates inside the control room.

4. 3 REQUIREMENT OF SPARE TERMINATION.

Following guidelines shall be followed for field terminations at junction box.

- 4.3.1 Only one type (with respect to size) of junction boxes shall be used to accommodate 48 terminals (includes separate terminals for shield for each single run & 20 % maintenance spare).
- 4.3.2 In case of digital signals, junction box size shall be same. However, terminals for individual pair shield shall not be required.
- 4.3.3 Only one number of multicore / multipair cables shall be considered for each junction box along with one number of spare plugged entries.
- 4.3.4 As far as possible, use of 6 pairs / 12 cores cable shall be minimised.

5.0 INSPECTION AND TESTING

- 5.1 All instruments and systems oriented items shall undergo factory testing and inspection by contractors authorised representatives, TP I/ owner and PMC.
- 5.2 In no case items shall be released without proper inspection / verification.
- 5.3 The inspection and testing shall be carried out as per related specifications, international codes and practices / standards, approved documents and / or any other document attached along with specifically suggesting testing to be carried out at manufacturer's works.
- 5.4 The material shall be despatched only after obtaining written despatch clearance.
- 5.5 No system or system oriented item & analysers shall be despatched without integrated factory testing witnessed by representatives of contractor / owner / PMC. The testing procedures shall be detailed out by the contractor based on testing requirements indicated in individual system specifications and shall be approved by Owner / PMC. Contractor must certify that the system is actually ready before calling the Owner / PMC for FAT. Also all the necessary documents and literature are to be submitted before calling for FAT.

- 5.6 **FAT for DCS, PLC, Analyzer System & Governor Control System shall be done at vendor's works:**
- 5.7 Testing and inspection for all items shall be carried out as per approved factory testing procedures. For items where no testing is witnessed by PMC / Owner, following test certificates shall be forwarded for review before despatch of such equipment.
- Verification of certificates as applicable for the material certificates, NDT reports like radiography / X-ray / Die-penetration, special testing reports etc, statutory certificates for intrinsic safety and explosion proof certificates of conformity etc.
 - Visual verification for quantity, quality and workmanship
 - Hydro testing and pneumatic testing as applicable
 - Functional and performance testing including calibration, accuracy, repeatability testing.
 - Seat leakage tests for control valves and hydraulic pressure test, actuator cycling and fail condition tests.
 - Test certificates for pressure relief valves set pressure, reseal pressure and seat leakage test
 - Radiographic test for control valves, pressure relief valves.
- 5.8 Contractor shall detail out performance specifications which shall be verified by contractor or contractor appointed agency/ Owner / PMC during factory testing.
- 5.9 Testing procedures shall be developed by contractor based on relevant codes, international standards and practices followed for various items unless otherwise indicated separately.
- 5.10 Inspection and testing requirements shall be as per inspection plan attached elsewhere in feed documents.
- 5.11 Contractor shall submit all test records / test results for records to owner / PMC as bound volume along with the test procedure for each test carried out.
- 5.12 Acceptable criteria for Radiography and other NDT requirements for all the instruments / instrument castings shall be in line with those specified in valve / piping specifications for the similar service. Valve data sheets / piping material specifications have been attached elsewhere in this package.
- 5.13 IBR Certifications shall be provided by contractor in the appropriate format duly signed by IBR authority or their authorised agency.
- 5.14 For in line mounted instruments on stainless steel piping classes, Inter granular Corrosion (IGC) Test shall be carried out as per piping material specification requirements.
- 5.15 **SYSTEM ACCEPTANCE TEST**
- The owner will take over the system including (all systems oriented items like MMS, Analyzers, field instruments etc.) from the contractor after the final acceptance test attended by Owner/ PMC, which is defined as successful uninterrupted operation of the integrated system for three weeks. Uninterrupted Operation shall be defined as follows:
- All field Instruments, analyzers, gas detectors, Machine protections etc shall be commissioned, fully operational & shall be proved as per process.
 - All control schemes including Complex schemes shall be taken in Auto / cascade mode
 - All interlocks shall be taken on line without bypassing the interlocks

- All constants, timer values shall be configured as per licensor / OEM recommendations.

System Vendor's personal shall be present during test. Any malfunction of the items supplied by the contractor shall be replaced /repaired as required. If any system failure is detected during system acceptance test, the acceptance test shall start all over again from the beginning after rectification of the same.

6.0 INSTALLATION REQUIREMENTS

- 6.1 All instruments shall be accessible from grade or a platform for operation and maintenance. In case of gas services, where the instruments are mounted above the process tapping, installation of platform shall be considered if accessibility is not available. Ladders shall be provided for all such platforms. Approach for all instrument tapping shall be considered in all piping, other requirements and from platforms so that all instrument tapping are accessible.
- 6.2 Impulse connection shall be fabricated out of pipe & pipe fittings up to the Tee connection near the instrument. Tubes with compression fittings may be used between instrument & the Tee connection to permit flexibility for removal of instrument.
- 6.3 All tube Fittings shall be Flareless double compression (four pieces) type & of reputed make such as Parker, Swagelok, and Ermeto.
- 6.4 For Pressure and Flow measurement in high pressure services (above 600#), 3/4" impulse pipes shall be used. Also, double isolation, double drain and double equalising valves shall be used. Blind flanges shall be used instead of caps.
- 6.5 The Impulse pipe for instrument installation shall be as per the piping material specifications of respective process line. Tubing when used between manifold and the instrument, it shall be 12 mm O.D. SS 316 tube and be suitable for the process fluid / conditions. No. manifold shall be used for close coupled installation and the same shall be realised with piping installations / valves. For all remote installations, no unions or couplings shall be used. Only break flanges shall be used. In installation of pressure and differential pressure instruments, all threaded piping joints shall be seal welded.
- 6.6 All Drain & Vent valves shall be Gate Valves & equalising valves shall are globe valves
- 6.7 Instrument or gas service are to be installed only above or at least parallel to the tapping with a slope in the impulse piping towards the tapping to achieve self draining condition. Steam tracing is required for Gas service also if the pipeline is steam traced.
- 6.8 Control valve to be put in line only after proper flushing of the lines.
- 6.9 Impulse piping is to be suitably painted.
- 6.10 Insulation of impulse lines shall be as per piping class.
- 6.11 Flushing oil purging is to be provided for high temperature vacuum services.
- 6.12 Schedule 80 seamless pipe with at least 3000lb rating should be used as a minimum for impulse piping.
- 6.13 For impulse piping of pressure gauges unions shall be used.
- 6.14 Contractor shall consider the following and develop instrument installation drawings accordingly.
- 6.14.1 Contractor shall use close couple installation with only flange joints and no unions shall be used in impulse lines. Unions can be used in branching of GI instrumentation air line only.

- 6.15 For steam tracing of instruments copper tube 3/8" OD and brass fittings shall be used. Tube fitting shall be double ferrule type.
- 6.16 Condensate pots shall be used for all steam services.
- 6.17 All steam traps required for steam tracing of instruments shall have block and bypass valves for steam trap maintenance.
- 6.18 Contractor shall be responsible to provide steam tracing scheme for pressure, flow, level instruments as required during detail engineering.
- 6.19 Guidelines for installation of multiple instruments for measurement of process parameter shall be as follows:
- 6.19.1 Separate tapping shall be provided for each pressure transmitter. Each instrument shall be provided with its own isolation and drain valve.
- 6.19.2 In case of installation of more than one transmitter on single orifice plate, separate set of tapings shall be provided on orifice plate.
- 6.19.3 For level instruments, separate nozzles shall be used on common standpipe up to 2 instruments. For more than 2 instruments, separate standpipes shall be provided as required. Maximum two instruments shall be provided on each standpipe.
- 6.19.4 For temperature instruments, separate thermowell shall be used for each instrument except in case of special fabricated thermowells with multiple elements as given in the tender document. **Temperature transmitters shall be placed on stanchions close to the Temperature elements and Signal cables shall be laid from the TTs to JB's.**
- 6.20 All instrument and control cables shall be of Fire Retardant Low smoke (FRLS) type. All junction boxes shall be of weather proof (IP-65 min.) and flame proof design as required. All JB's to have maximum one no. of multi core / multi pair cable. However, second entry shall be provided for multi core / multi pair cables duly plugged. **Also All unused cable entries (for single pair and multipair cables) in the JB shall be plugged with SS plugs.**
- 6.21 **All the Junction boxes shall be mounted outside the GT skid.**
- 6.22 Cable ducts shall be fabricated as per engineering standard 44NC-4600-0000/JSD/0004. The maximum cable duct width as per enclosed standard is 1200 mm only. However, for higher duct widths as required, Contractor shall design the same based on the standard provided and ensure that the loading requirements are met with.
Contractor shall be responsible to decide cable route, sizes and elevations during detail engineering.
Cable ducts shall be considered for routing on main pipe / cable racks. Perforated trays shall be considered for multi core / multi pair cables from junction box up to main racks. For cables between instruments and junction box, perforated tray or channels shall be considered. Single Instrument Cable Duct Bank shall be provided for crossing of Instrument Cable ducts through road. Contractor to ensure that mechanical/Pipeline shall not pass through Instrument Duct Bank.
- 6.23 Cable ducts shall be supported at the bottom longitudinally on both edges throughout its length by means of MS channels (minimum 125 mm) to avoid sagging due to cable weight.
- 6.24 All trays shall be made of GI.
- 6.25 Mounting of instrument (if remote mounted) / JB on the stanchion or instrument support shall be at the height of 1.5 metre from the grade level / finished floor level. **Structural steel like angles, pipes, plates etc. used for instrument / tray installation shall be of MS. Same shall be painted as per**

standard painting specification attached elsewhere in tender document. Instrument tag number shall be paint on respective stanchion.

- 6.26 Extension in the impulse piping of suitable length may have to be provided for those instrument installations where process fluid temperature is higher than the max. withstanding temperature of the instrument / diaphragm
- 6.27 The installation and erection materials like cables (signal, control, thermocouple extension and power), cable glands, junction boxes, instrument valves and manifolds, impulse pipe fittings, pneumatic signal tubes, instrument air line fittings and valves and cable trays/ducts required for installation of complete instrumentation shall be as per various standard specifications attached elsewhere in this package.
- 6.28 Contractor to provide / carryout following,
- Earth pits, earthing electrodes, earthing conductor etc. as per earthing philosophy.
 - Insulation and painting of instruments and impulse lines, as required, in-line with insulation and painting specification attached elsewhere in tender document.
 - Ceramic roping with cementing for steam traced impulse lines.
- 6.29 The stack analyser probe must have a suitable platform with it along with proper approach. The tapping point of the analyzers should have clear approach for maintenance and opening of tapping flanges.
- 6.30 Instrument Air Distribution.
- 6.30.1 Contractor to note that, the air supply line to a single point to process unit battery limit shall be provided by other. Further distribution of air to all control valves shut down valves etc. using necessary piping, tubing, isolation valve and fittings shall be in contractor's scope. Adequate nos. of unions shall be used in instrument air line distribution. Contractor shall work out the air supply distribution as required and air supply distribution details shall be indicated in relevant instrument location drawings.
- 6.30.2 SS pipes and fittings shall be used for instrument air distribution till the first block valves (ball valves –SS 316) i.e. for main Header & Branch Header. Further distribution shall be by 6 mm SS 316 tubes with tube fittings, air filter regulators etc. The connection of instrument air line to main air header shall be screwed and no. welding is allowed.
- 6.31 In addition to the above requirements and various standard specifications, following specific requirements also shall be taken care by contractor :
- 6.31.1 All Cables, junction boxes and instruments shall be provided with proper tags for easy identification.
- 6.31.2 All cable routing from proximity sensors (vibration monitoring) to the Junction Box shall be routed through conduits with proper clamping arrangement.
- 6.31.3 Instrument cables shall be routed in a separate duct and shall not be clubbed with electrical cables.
- 6.31.4 All instruments, local panels & junction boxes shall be provided with suitable canopy of FRP.

7.0 LOOP CHECKING AND COMMISSIONING

- 7.1 Contractor shall carry out site testing, calibration, loop checking and commissioning as per the guidelines indicated in standard specification for instrumentation work 44NC-4600-0000/J.SS/0101.
- 7.2 Contractor shall be responsible to develop detailed procedure for site testing, calibration, loop checking and commissioning along with all necessary calibration sheet / loop sheet formats as required. The same shall be submitted to owner / PMC for approval.
- 7.3 Contractor shall be responsible for calibration of all field instruments independently. Before proceeding for loop checking, the calibration results of individual elements shall be recorded on the pro-forma which shall be approved by Owner / PMC for correctness of installation, measurements and calibration results.
- 7.4 Contractor shall be responsible for providing all assistance to control system sub-vendor during loop checking. This shall include providing signals from the field instruments and checking valve operation with respect to the output from control system to enable control system vendor to verify loop performance.
- 7.5 Contractor's responsibility includes demonstration / proving of measuring signal levels of field instrument outputs to control room in the respective identified pair of cable. In case of any problem, rectification / re-calibration of field instruments, if found defective during loop checking shall be contractor's responsibility.
- 7.6 Loop testing shall be conducted to check the functional performance of all elements comprising the loop, thereby ensuring proper inter-connections and operations.
- 7.7 After the loop test is complete, contractor shall connect back any terminations and connections removed for loop checking.
- 7.8 Contractor shall be responsible to co-ordinate with all package system vendors during calibration and loop checking.
- 7.9 For special instruments such as analysers, package instruments, etc. Contractor shall ensure presence of vendor's technical personnel during field testing, calibration and loop checking.
- 7.10 Contractor shall be responsible for pre-commissioning and commissioning activities and provide sufficient man power with tools & tackles required for the successful completion of project.
- 7.11 For special instruments such as **DCS, PLC, AIMS**, Machine Monitoring System, analysers, ultrasonic meters, package instruments, etc. contractor shall ensure presence of vendor's technical personnel during field testing, calibration, loop checking and commissioning. It is the responsibility of contractor to co-ordinate and to make available the specialists services from OEM at the time of installation, testing and commissioning for the following instruments as a minimum.
- Governor System
 - **DCS, PLC, AIMS**
 - Machine monitoring system.
 - Analyzer
 - Gas Detection System.
 - Ultrasonic flow meter

8.0 CONTRACTOR DATA REQUIREMENTS (Drawing & Documents)

S. No.	Description	Review / Approval	Records	Remarks
1	Sizing calculations for Control Valves, Safety Valves, Flow elements, Self Actuated PCV, , thermowell vibration calculations etc.	✓		
2	Purchase Requisition for all instruments	✓		
3	Documents / drawings list and schedule	✓		
4	DCS / PLC System Architecture Drawing, Functional loop schematics/Control schematics	✓		
5	DCS/PLC Bus Loading Calculation		✓	
6	Cable / Tubing Schedule		✓	
7	Instrument duct / tray / trench layout, Cable layout	✓		
8	Drawings for Instrument Location, JB location, location of Gas Detector and associated beacons & hooters.		✓	
9	Instrument JB wiring drawings		✓	
10	Instrument Index		✓	
11	Installation Standards	✓		
12	Instrument mounting details and Dimensional Drawings for all Instruments, Valves		✓	
13	Analysers and Gas Chromatograph sampling system	✓		
14	Certificates (Statutory / Test calibration / Inspection)		✓	
15	Hazardous area certificates for Instruments		✓	
16	Erection Report		✓	
17	Logic check Report		✓	
18	Installation, operation and maintenance manuals for all instruments, valves, Analysers etc.		✓	
19	Calibration report formats.	✓		
20	Inspection, Testing & Calibration procedures for all instruments, valves, Analysers etc.	✓		
21	As-built drawings / documents for all instruments, Analysers & other special Instruments.		✓	
22	Power consumption for local panels, Analysers, 4 wire instruments		✓	
23	Instrumentation / Electrical interface details		✓	
24	Mandatory Spare List	✓		
25	Instrument air requirement		✓	

S. No.	Description	Review / Approval	Records	Remarks
26	LCP GA Drawing	✓		
27	Start Up & commissioning spares		✓	
28	Complete Catalogues with Part list for all vendor supplied instruments, control etc;		✓	
29	Power consumption list and UPS requirement, Power supply distribution/ feeder requirements	✓		
30	Loop Wiring Diagram		✓	
31	Point data base		✓	
32	I/O summary		✓	
33	I/O assignment	✓		
34	Logic Diagram	✓		
35	Interconnection cable details		✓	
36	Graphic display drawings	✓		
37	FAT / SAT procedures for DCS, PLC, Governor, analyzer and SAT for MMS System	✓		
38	Instrument data sheet (Electronic Water level Indicator, Flame scanner, Ionisation Flame Monitor, Stack gas & SWAS analyser system, DCS & PLC, Control & shutoff valves)	✓		

9.0 INTERFACE WITH OTHER LSTK CONTRACTORS

9.1 The contractor shall be responsible for all works associated with GTG & HRSG battery limits.

9.2 The contractor shall be responsible to co-ordinate with Boiler contractor for SRR VI and F & G related activities as systems of GTG and boiler units are going to installed in same SRR.

10.0 INTERFACE WITH OWNER

10.1 Apart from project interface with owner for various activities defined in this contract, contractor shall also be responsible to co-ordinate the following specific activities with owner.

- Carrying out any activity in existing refinery including co-ordinating work permits to carry out integration with running systems
- Carrying out any site survey during detailed engineering phase.

11.0 SPARE PHILOSOPHY

11.1 MANDATORY SPARES

Mandatory spares for instrumentation shall be specified in the mandatory spares list. (Refer Annexure IV – Mandatory Spare List) This spares list defines the minimum requirement. For items not covered in the list, the vendor to prepare the mandatory spares list and submit to PMC/owner for approval.

11.2 2-YEARS OPERATIONAL SPARES

Vendor shall provide all spares required for 2 years trouble free operation.

11.3 COMMISSIONING SPARES

Any kind of spares required for start-up & commissioning shall be provided.

12.0 TRAINING

Contractor shall provide training to owner personnel in the field of operation, engineering and maintenance for the system oriented items and special instruments. The number of persons required for training shall be as follows:

- Analyser & **MMS training at site** – minimum 1 day duration for 5 persons
- **Governor System (H/W and S/W Training) - minimum 4 days duration for 15 Operational personnel & 15 Engineering Personnel. Training for Engineering and operations shall be separate.**
- **DCS System (H/W and S/W Training) - minimum 4 days duration for 15 Operational personnel & 15 Engineering Personnel. Training for Engineering and operations shall be separate.**
- PLC System of turbine (H/W and S/W maintenance and engineering) - minimum 4 days duration for 15 **Engineering Personnel.**
- PLC System of BMS and BOP (H/W and S/W maintenance and engineering) - minimum 4 days duration for 15 **Engineering Personnel.**
- **MMS Training at site**

Contractor shall work out detail schedule of training programme and shall co-ordinate with owner for the schedule. All the training shall be provided by the manufacturer's experts in the respective fields.

13.0 POST WARRANTY MAINTENANCE CONTRACT (PWMC)

13.1 The Contractors shall provide offer for five years Comprehensive Post Warranty Maintenance Contract as part of offer for supply, installation and commissioning for following listed items (with spares) from the manufacturers/suppliers and consider the offer for PWMC for 5 (Five) years for evaluation of bids.

The offer for PWMC shall be valid for five years from date of expiry of the defect liability (i.e. warranty) period and year wise quote shall be provided. The warranty period shall be 12 months from date of Site Acceptance test or 36 months from the date of supply whichever is earlier.

Supplier shall provide total maintenance of the system including all hardware / software workstations, networking equipment and any related accessories, peripherals etc. supplied by the Contractor including all bought out items for,

- DCS System (MAX DNA)
- PLC System for Turbine
- PLC for BOP and BMS
- Analyzer system
- Antisurge controller / governor, if any.
- Machine Monitoring System
- **AIMS**
- **F&G System including CO₂ system.**

The PWMC includes complete servicing, regular & preventive maintenance and breakdown maintenance whenever required for above listed items. This also includes the supply spare parts (including consumables & reagent, chemicals, etc.) required for repair or replacement of the all items supplied including all bought out items.

- 13.2 Regular Visits: The suppliers certified Field Service engineer shall visit the site once in fifteen days for routine maintenance hardware / software checks, inspections, full system checkouts, preventive maintenance adjustments and carry out corrective actions for the complete system. The software check shall include minor modifications to improve existing application performance, backup operations and software updates (latest releases). For items vii to ix, the service engineer regular visit requirement shall be once in four months. For analyzer and gas detector systems, the routine visit shall also include
- Calibration of analyzer periodically or as required
 - Servicing analyzer including sample handling system
 - Regular replacement / replenishment of analyzer consumable (inc. cylinders) & reagents
- The duration of stay of engineer shall be limited to 3 days (8 hours per day) per visit. However, if any problem reported is not solved during the visit, engineer shall visit again and the visit shall not be counted as a regular visit.
- 13.3 Preventive Maintenance Visits: The engineers of the suppliers of the above listed items shall visit once in a year for Preventive Maintenance Visits of the complete system subject to availability of shutdown. The engineer shall carryout as a minimum complete overhaul of the system, inspection of hardware, fault prediction, inspection of power supply quality, environmental and operating condition checks, calibration checks, major repairs / replacement and detailed reporting.
- 13.4 Emergency Visits: The Engineers of the suppliers of the above listed items shall report to site within 24 hours after receipt of a written intimation / telephone call / E-mail or fax from CPCL for restoring the system with necessary spares. The engineers deputed shall be well qualified and experienced.
- 13.5 Shutdown Visit: During annual shutdown / turnaround of the plant supplier engineer shall visit and carryout all the system shutdown maintenance and system check required.
- 13.6 The supplier shall explicitly define in PWMC offer, the various checks to be carried out by the engineer for the above listed items during various visit listed herein. Also a standard document consisting of standard procedures and formats for carrying out various activities of Annual Maintenance Contract shall be furnished. These lists of checks are subject to CPCL approval.
- 13.7 The service engineer shall maintain a Service Logbook at the site indicating the activities carried out during preventive & breakdown maintenance and also submit service / calibration reports based on the maintenance / repairs carried out; modules / parts repaired / replaced along with fault analysis.
- 13.8 The supplier shall include detailed proposal related to Maintenance Services with necessary tools and tackles. Travel, boarding and loading for service engineer shall be included in these packages itself.
- The supplier shall maintain at his premises or of the other agencies charged with maintenance a stock of necessary spares required. In event of breakdowns, repairing or replacement should be possible within 24 hours maximum without any lead-time for procurement of spares.
- During warranty period, supplier shall carryout the regular, emergency. Services provided during the warranty period shall be without any additional cost.

14.0 ATTACHEMENTS

Annexure I – Additional Requirement for DCS & PLC
Annexure II – Tagging Philosophy for Junction Boxes, Panels & Cables
Annexure III – Mandatory Spare List
Annexure IV– Certificate for Logistic Support

SPECIFICATION NO: 44NC-4600-0000/JSS/0106/A4**TITLE:** STANDARD SPECIFICATION FOR PRESSURE INSTRUMENT**PROJECT REFERENCE:**

- **Project No:** 44NC-4600
- **Project Location:** Manali, Chennai
- **Project Title:** RESID UPGRADATION PROJECT
- **Client:** Chennai Petroleum Corporation Limited
- **Project Manager Authorization:** B.B. DARAK **Date:**
- **Client Authorization:** **Date:**

				APPROVALS		
Rev. No.	Issue Date	Pages	Revision Description	By	Check	Approve
0	12- Mar-10	8	Issued For Feed	ADM	MSD	BSP
☒ Entire Specification Issued this Revision			SPECIFICATION ISSUED FOR:			
☐ Revised Pages Only Issued this Revision			☐ In-house Review	☐ Purchase		
			☐ Client Approval	☐ Construction		
			☒ Enquiry	☐ Engineering		

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1.0 PURPOSE

The purpose of this specification is to define the minimum requirements of Design and manufacture of Pressure Instruments.

2.0 SCOPE

The scope of work shall include design, manufacture, testing and supply of Pressure Instruments. The inspection requirements shall be as per the inspection and test plan.

3.0 TECHNICAL REQUIREMENTS

3.1 PRESSURE & DIFFERENTIAL PRESSURE TRANSMITTERS

3.1.1 Field transmitters for flow, pressure, differential pressure and level applications shall be yoke mounted SMART type unless specified otherwise. These transmitters shall be certified intrinsically safe in general, with 2 wire system having 4-20 mA DC output with superimposed digital signal having simultaneous analog and digital communication. Communication protocol shall be Universal HART only. Transmitter shall be capable of delivering rated current into external load of at least 600 ohms when powered with 24V DC nominal voltage.

3.1.2 Transmitter housing shall be of 304 SS unless otherwise specified. Transmitter shall be certified as intrinsically safe (E Ex 'ia') and Weatherproof (IP 65).

3.1.3 Pressure/ Differential Pressure Transmitter shall have electronic capacitance or any other type of proven secondary sensor meeting all functional specifications. Inductive type measuring principle is not acceptable. Element material for transmitter shall be SS316L as a minimum, and shall be able to withstand over pressure of at least 1.5 times the maximum working pressure.. The transmitter shall be so constructed that in case of a pressure sensing element failure, the process material will not enter the wiring conduit.

3.1.4 Transmitters shall be provided with external zero adjustment and shall have integral vent/drain.

3.1.5 All transmitters shall be provided with integral digital LCD display with engineering units.

3.1.6 The transmitter shall be microprocessor based and it shall incorporate a non-volatile memory, which shall store complete configuration data of transmitter. All necessary signal conversions, including conversion to produce output with the required protocol shall be carried out in the transmitter electronics. The design of electronic parts shall be in compliance with the electromagnetic compatibility requirements as per IEC 801.

3.1.7 Transmitter shall also run complete diagnostic routine. In the event of detection of failure, the output shall be driven to predefined value.

3.1.8 Built in temperature sensors shall be provided to compensate for process temperature and ambient temperature variations.

3.1.9 Transmitter rangeability shall be 100:1. The transmitter shall be able to assure an accuracy of +/- 0.1% of span for a rangeability of 1:10, unless otherwise specified in the job specification. The accuracy shall include the combined effect of linearity, hysteresis

and repeatability. Effect of static pressure on the transmitter in either direction shall be negligible.

- 3.1.10 Transmitter shall be selected so as to have calibrated range within turndown ratio of 1:10. The normal pressure shall be read at no greater than 75 percent of the calibrated range for transmitter reading steady pressures. For fluctuating services the normal pressure shall be read at 60 percent of the range. In case of differential pressure transmitter with remote seals, adequate care shall be taken to consider head pressure effect of capillary fill fluid while selecting the transmitter.
- 3.1.11 The response time of smart transmitters shall commensurate with process. It shall be equal or better than the half of the scan time of control loop specified elsewhere in the bid package.
- 3.1.12 HART protocol of latest version shall be used and shall be suitable for HART maintenance system with corner stone software or equivalent with the following features as minimum:
- 3.1.12.1 It shall allow multi masters (two for example, primary and secondary) for configuration, calibration, diagnosis and maintenance. The primary could be control system or host computer and the secondary could be the hand held communicator or a maintenance computer.
- 3.1.12.2 It shall be capable of implementing universal commands. It must be possible to communicate all the commands of HART maintenance system to field transmitters and smart transmitters shall be selected accordingly.
- 3.1.13 Unless recommended otherwise by compressor manufacturer, field transmitters used in anti-surge control loop shall be non-smart and flameproof types. The flameproof transmitters shall have their calibration adjustment from out side without any need to remove the cover.
- 3.1.14 Retrofit type of smart transmitters is not acceptable.
- 3.1.15 Process connection for standard pressure & differential pressure transmitter shall be ½" NPTF and 1 1/2 " flanged for diaphragm seal type. Diaphragm seal element with capillary shall be used for congealing, corrosive and highly viscous services at high operating temperatures. Capillary shall be SS armored with PVC cover , 3 metre in length and with ID selected to have minimum lag. Flushing rings shall be provided with screwed vent & drain connections duly plugged.
- 3.1.16 Field communicator
- It shall be possible to perform routine configuration, calibration, display process variable, diagnostics etc. from a hand held portable calibrator which can be connected at any location in the transmitter loop. It shall be possible to perform all the above functions on line. The loop function shall remain unaffected while communication is going on between transmitter and the field communicator. No output interruption should occur. Field communicator shall meet the following requirement.
- 3.1.16.1 They shall be battery powered with replaceable and rechargeable batteries. Re-charger power supply shall be 230 V AC +/-10%, 50 Hz +/- 3Hz.

- 3.1.16.2 It shall be possible to connect the communicator at any of the following places for purpose of digital communication:
- Marshalling cabinet serving the transmitter in safe area, control room.
 - Junction box serving the transmitter, in hazardous area, field.
 - Directly at the transmitter, in hazardous area field.
- 3.1.16.3 Plug in type connections shall be provided with field communicator. Necessary interconnection cable and any other accessories required for connection shall be supplied by vendor.
- 3.1.16.4 Offered communicator shall be dust proof certified intrinsically safe and suitable for outdoor location. Carrying case shall be supplied with each communicator. Each communicator shall be provided with recharging unit.
- 3.1.17. All transmitters shall be provided with integral two valve/ three valve/ five valve manifold as per the specific requirements.
- 3.1.18. Pneumatic transmitters shall operate on air supply of 1.4 Kg/cm²g of force-balance principle, and shall have transmission and output signal of 0.2 to 1.0 Kg/cm²g.
- 3.1.19. Design materials, connections and accessories not specified herein shall be in accordance with the vendor's standards, suitable for the specified service conditions.
- 3.2 PRESSURE GAUGES & DIFFERENTIAL PRESSURE INDICATORS
- 3.2.1 Gauges shall conform to the requirements of BS 1780 gauges of the elastic element type, unless otherwise specified.
When specified as pneumatic receivers, gauges shall conform to the requirements specified in paragraph 3.2.18 herein.
- 3.2.2 Pressure gauge dial shall be white, non-glaring and non-rusting plastic with black figures. Dial size shall be 150 mm. Dial cover shall be of shatterproof glass. The dial face shall be marked with pressure element material. Pointers shall have micrometer adjustment. Pressure gauges shall have feature like screwed bezels, externally adjustable zero, over range protection and blowout disc.
- 3.2.3 Pressure gauge sensing element shall be of SS 316 and movement of SS 304, as a minimum except where the process requires a special material. For general use gauges shall use a bourdon tube as measuring element. The movement shall be either rotary geared or cam and roller type. The movement mounting shall be integral with the bourdon tube socket.
- 3.2.4 For low pressure and vacuum services pressure gauges with capsule sensing element to be used.
- 3.2.5 The elastic element material, unless specified otherwise, shall be as follows:
- 3.2.5.1 For ranges 60 kg/cm² g and less, AISI-316 seamless drawn stainless steel tube, argon arc welded at AISI-316 forged or wrought stain less steel tube anchorage and tube end piece.
- 3.2.5.2 For ranges above 60 kg/cm² g, AISI-316 bored stainless steel otherwise as above.
- 3.2.6 Cases shall normally be of 304SS and weatherproof to IP-65 as per IEC-529 / IS-2147.
-

- 3.2.7 Safety blow out discs shall be provided for all gauges and shall be located in the back or side of the case. For pressure gauges with maximum operating pressure below 60 Kg/cm²g, the minimum size of blow out disc shall be 1" and for maximum operating pressure 60 Kg/cm²g and above, pressure gauge shall be solid front type with full area blow out disc. All pressure gauges on toxic service shall be solid front type.
- 3.2.8 Pressure gauges shall have an accuracy of $\pm 1\%$ of full scale as a minimum. Differential pressure gauges may have an accuracy of $\pm 2\%$ of full scale.
- 3.2.9 Gauges shall be able to withstand, over-range pressure of 1.3 x calibrated range for at least 30 minutes as standard without zero or calibration shift. Over-range protection such as gauge savers shall be provided where the process pressures may exceed 1.3 x full scale deflection. Gauge savers if provided shall be of non bleed type with internal pressure release/block.
- 3.2.10 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.
- 3.2.11 Process connection shall normally be 1/2" NPTM bottom, except for diaphragm seal where 1 1/2" flanged connection shall be used in general. Connection shall normally be 316SS unless special material required. Socket stem shall extend a minimum of 1 1/4" beyond gauge case and shall be provided with wrench flats.
- 3.2.12 Surface mounted gauges shall be provided with threaded removable bezel rings. Flush mounted gauges shall be provided with bezel rings that are hinged for easy opening with the gauge in position. Bezel rings shall be metallic.
- 3.2.13 Diaphragm seals, filled type shall be furnished where plugging of the element may occur or where suitable material is not available in highly corrosive services. When chemical seals are required, they shall be provided with fabricated vent and drain arrangement. Diaphragm seal device shall be furnished completely assembled with the pressure gauge. Remote seal (with capillary) to be used wherever required for access and visibility. Use of Schaffer diaphragm type gauges will be avoided as far as possible.
- 3.2.14 The diaphragm seal devices shall be stainless steel. Diaphragm rings and top housings shall be of carbon steel unless special material is required.
- 3.2.15 Liquid filled gauge shall be used where extreme vibration of the gauge is expected. Glycerin or other suitable case filling liquid with non colouring property shall be used.
- 3.2.16 An inert liquid shall fill the entire system between the diaphragm of the diaphragm seal device and the elastic element. Unless otherwise specified, filling liquid shall be suitable for an ambient temperature range of -18°C to 204°C.
- 3.2.17 Receiver pressure gauges for local/ local panel output indication shall have 100 mm dial with stainless steel element and 1/4" NPTM connection.
- 3.2.18 Pneumatic indicating receiver gauges shall conform to the applicable parts of this specification except as follows: -
- Elastic elements shall be bronze designed for a 0.2 to 1 kg/cm² g (3 to 15psig) pressure range, but shall be able to withstand 1.4 kg/cm² g (22 psig). Dials shall be graduated for the range specified on the data sheet, with an additional scale graduated 0.2 to 1 kg/cm²

g (3 to 15 psig) linear. The dial range shall correspond to the 0.2 to 1 kg/cm² g (3 to 15 psig) element range in the data sheet specified. (For example, when the range specified is 0-100, the "0" marking on the dial shall correspond to 0.2 kg/cm² g (3 psig) and the "100" marking to 1 kg/cm² g (15 psig).

3.2.19 Over range protector and pulsation dampner, whenever used, shall be of SS 304 as a minimum. Pulsation dampner shall be used for all pulsating services. It shall be floating pin type, externally mounted and externally adjustable.. Gauge savers shall be used in all pump service applications. Pig tail syphons shall be provided for steam applications unless liquid filled impulse line is used.

3.2.20 Gauges shall be supplied with engraved labels stating tag no.

3.2.21 Design materials, connections and accessories not specified herein shall be in accordance with the Vendor's standards, suitable for the specified service conditions.

3.3 PRESSURE & DIFFERENTIAL PRESSURE SWITCHES

3.3.1 Pressure switches shall have either diaphragm or bellow type of primary element with SS316 material of construction as a minimum. Switch shall be sealed microtype with contact rating suitable for specific application. The switch mechanism shall be designed to prevent spurious operation by vibration. Pressure switch design with Reed type switches shall not be selected.

3.3.2 The primary element and the diaphragm shall be made of 18 Cr/8 Ni. stainless steel, unless otherwise specified.

3.3.3 Receiver pressure switches shall have SS316 bellows as primary element with ¼" NPT (F) connection.

3.3.4 The primary element shall be designed to withstand an over-range pressure of 25% greater than the full scale.

3.3.5 Pressure switches shall be provided with a positive means of protection against process fluids entering the electrical housing in the event of element failure.

3.3.6 Pressure switches shall be blind type with ½" NPT (F) process connection and shall be operative in full specified range. The switch differential shall be selected as per operating conditions, it shall be less than 60% of difference between set value and operating value. Diaphragm seal type pressure switches with flanged end connections shall be specified for applications on corrosive / congealing services.

3.3.7 Diaphragm seals shall be furnished where plugging of the element may occur or where suitable material is not available in highly corrosive services. When chemical seals are required, they shall be of the clean out type with flushing connection. Diaphragm seal device shall be furnished completely assembled with the pressure switch.

3.3.8 Pressure switches shall have repeatability of $\pm 0.5\%$ of full scale as a minimum.

3.3.9 The switching set point shall be adjustable over the whole range, with an internally calibrated scale.

3.3.10 Switches shall be hermetically sealed "single pole, double throw" (SPDT).

-
- 3.3.11 The switches shall be furnished with a separate terminal block of the Vendor's standard, suitable for electrical connection to the field cabling.
- 3.3.12 Switches shall be specified such that the on/off differential does not prevent the switch resetting inside normal operating pressure ranges.
- 3.3.13 Over rage protection and pulsation dampner requirements and design shall be as per clause 3.2.19
- 3.3.14 Design materials, connections and accessories not specified herein shall be in accordance with the vendor's standards, suitable for the specified service conditions.

4.0 RELATED DOCUMENTATION

NIL

5.0 ATTACHMENTS

NIL

SPECIFICATION NO: 44NC-4600-0000/JSS/0107/A4**TITLE:** STANDARD SPECIFICATION FOR TEMPREATURE INSTRUMENT**PROJECT REFERENCE:**

- **Project No:** 44NC-4600
- **Project Location:** Manali, Chennai
- **Project Title:** RESID UPGRADATION PROJECT
- **Client:** Chennai Petroleum Corporation Limited
- **Project Manager Authorization:** B.B. DARAK **Date:**
- **Client Authorization:** **Date:**

				APPROVALS		
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			☒ Enquiry	☐ Engineering		

PROJECT NO.: 44 NC-4600**SPEC. NO. 44NC-4600-0000/JSS/0107/A4****TITLE: STANDARD SPECIFICATION FOR TEMPERATURE
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5.0	ATTACHMENTS

1.0 PURPOSE

The purpose of this specification is to define the minimum requirements of design and manufacture of Temperature Instruments.

2.0 SCOPE

The scope of work shall include design, manufacture, testing and supply of temperature instruments. The inspection requirements shall be as per the inspection & test plan.

3.0 TECHNICAL REQUIREMENTS**3.1 THERMOWELLS**

- 3.1.1 All temperature elements shall be provided with thermowells machined out of bar stock bar up to 600 mm length & of minimum 316 SS material. Thermowell design shall be as per attached Standard Drawings (Document No. 4600-JSD-501) for flange rating up to ANSI 600#. For thermowells above 600# rating, contractor may use their own proven design(s) recommended by various manufacturers suitable for the specified pressure-temperature conditions. The flange material for thermowell shall be 316 SS as a minimum. In case of corrosive and erosive services stellited thermowell shall be provided. The thermowell design shall ensure no air gap between the tip of the element and thermowell to minimise measurement lag. The internal diameter of thermowell shall be suitable for sensing element / bulb OD.

For very high-pressure applications, welded type thermowells may be used.

- 3.1.2 The inside diameter of the finished thermowell shall be concentric with all other diameters with a tolerance of 0.2 mm.
- 3.1.3 The thermowell shall be machined and rifle drilled to a smooth finish after welding and heat treatment. Surface finish of the stem shall be 10-15u inch (0.254-0.381 microns).
- 3.1.4 All re-entrant angles shall be machined to a minimum radius of 3 mm.
- 3.1.5 Built-up thermowells shall be used in low pressure and low velocity services like in fired heaters and also where thermowell immersion lengths greater than 600 mm are required. In all such cases, all welded joints shall undergo 100% radiography testing. For joints where radiography is not possible, dye penetration test may be carried out.
- 3.1.6 Thermowells shall be assessed for resonance effects. Where Thermowells are installed in lines subjected to high fluid velocities (exceeding 6 m/s for liquids and 120 m/s for vapours / gases), combined stress and frequency calculation shall be carried out by a proven method. In case the thermowell design fails vibration analysis, an alternate design may be used by the contractor. All such design alongwith calculations shall be submitted for purchaser's review.
- 3.1.7 Immersion length 'U' of thermowells shall be as follows:

Line Size	Immersion length
From 4" to 6"	280 mm
From 8" onwards	320 mm

Vessels / columns 400 mm

Immersion length is based on 200 mm length between flange face and inner wall of pipe. In special applications, where thermowell nozzle sizes are larger or where temperature is to be measured at any specific location, contractor shall decide the immersion length based on actual requirements.

3.1.8 Any pipe line less than 4" nominal bore shall be blown to 4" size to install thermowell.

3.2 TEMPERATURE GAUGES

3.2.1 Local temperature gauges shall be liquid / vapour / gas filled type in general and shall be manufactured as per relevant SAMA Class. As a minimum, case compensation to be provided. Bimetallic gauges shall be considered if required as per licensor package or specified in job specification. The temperature bulb shall be of 316 SS construction as a minimum.

3.2.2 All local temperature gauges shall have 150 mm dial size with adjustable head. Dial shall have black numerals on a white background. Negative temperature shall be red numerals on a white background. The bulb size shall be selected to suit the thermowell. Provision shall be made for adjustment of thermometer pointer without removing it from the shaft.

3.2.3 All gauges shall be of weatherproof construction as per IP65.

3.2.4 In vibrating service filled type temperature gauges with capillary extension shall only be used. Capillary tubing shall be of SS304 as a minimum with stainless steel flexible armouring and PVC covering over armour.

3.2.5 Temperature gauges shall have accuracy of $\pm 1\%$ FSD (Full scale deflection).

3.2.6 Bi-metallic thermometers shall only be used where errors in excess of one percent of span are acceptable. Bi-metallic dial thermometers shall be every angle, with external pointer adjustment. Case material shall be of SS304. Stem diameter shall be manufacturer's standard. Bimetallic type dial thermometers shall be avoided where excessive vibrations are encountered, such as compressors.

3.2.7 Thermometer stem adjustable gland with union connection and bushing shall be suitable for 1/2" NPTF connection.

3.3 TEMPERATURE ELEMENTS

3.3.1 For remote temperature indication / recording / control / switch, etc. thermocouples or resistance temperature detector (RTD) shall be used depending on the process requirements. Elements shall be spring-loaded, mineral insulated and shall have 316 SS sheath as a minimum.

3.3.2 Thermocouple assemblies shall be furnished with weatherproof screwed-in type heads. The terminals shall be colour coded as per element colour code.

3.3.3 Thermocouples shall comply with ANSI MC 96.1 and shall be as per IEC-584-2 / IS - 7358. They shall have a wire size of 18 AWG for single and 20 AWG for duplex thermocouples for most of the applications, in general. However, following guidelines shall be followed for selecting single thermocouple wire size as a minimum.

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Type	8 AWG	14 AWG	18 AWG	24 AWG
T	-	>371 °C	For all other temperatures	-
E	>871 °C	>649 °C	For all other temperatures	-
K	>1260 °C	>1093 °C	For all other temperatures	-
S	-	-	-	<1482 °C

Thermocouples shall be magnesium oxide (MgO) filled grounded type, unless specified otherwise. The thermocouple wires shall be joined together by welding to form the hot junction. The type of thermocouple shall be selected based on temperature. Following guidelines shall be followed: -

Copper-Constantan (ISA-Type-T)	:	(-) 200 to 200°C
Chromel-Constantan (ISA-Type-E)	:	200 to 600°C
Iron-Constantan (ISA-Type-J)	:	0 to 600°C
Chromel-Alumel (ISA-Type-K)	:	600 to 1200°C
Platinum Rhodium-Platinum (ISA-Type-S)	:	600 to 1600°C

Grounded junction to be used where fast response is required.

- 3.3.4 The design of thermocouple assemblies shall be such that replacement on line is possible.
- 3.3.5 Thermocouple sheathing material shall be 316 stainless steel as a minimum, and shall be constructed from a seamless tube with a wall thickness of at least 1mm. Inconel 600 sheath shall be selected for temperatures greater than 600 °C.
- 3.3.6 RTD (Resistance Temperature Detector) shall be platinum element 3 wire type with 100 ohms resistance at 0°C calibrated as per IEC 751 / DIN 43760. RTD shall be used within a temperature range of -200 to 650°C. Three-wire system shall be adopted in connecting the element.
- 3.3.7 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.
- 3.3.8 Twin element sensors, if used, shall have two separate cable entries. Multipoint temperature element shall be provided with integral junction box.
- 3.3.9 The special thermocouples such as reactor thermocouples, reactor / vessel skin thermocouples etc. shall be designed by contractor based on specifications / details provided elsewhere in the contract document.
- 3.3.10 For heater tube skin thermocouple, where applicable, assembly shall meet the heater design requirements and shall be provided with expansion loops. The sheath material shall be selected based on temperature and sulphur content and shall be as per API recommendation. Skin type thermocouples shall be Pad / Knife-edge type.

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3.3.11 Class 'A' / Class '1' tolerance as per IEC 751 / 584-2 shall be specified for RTD / thermocouple for temperature measurement in all closed loop, interlocking and shutdown applications. Also, all such loops shall be provided with remote mounted 2 wire temperature transmitters.

3.3.11 Class 'A' / Class '1' tolerance as per IEC 751 / 584-2 shall be specified for RTD / thermocouple for temperature measurement in monitoring open loops. The elements in these cases will be directly connected to DCS.

3.3.12 The overall diameter of the sheathed element shall not deviate by more than 2% of the specified diameter.

3.3.13 The head assembly shall be of metallic construction, with a removable threaded cover and gasket. The cover shall be attached to the head with a short length of rust resistant chain. The enclosure shall be suitable for given hazardous area classification & weather protection to IP 65 Minimum.

3.3.14 Assembly shall include nipple-union-nipple (1/2") to allow approximately 6" (150 mm) between top of well and bottom of head, when made up (as per drawing 4600-JSD-502).

3.4 TEMPERATURE TRANSMITTER

3.4.1 Field mounted temperature transmitters shall be specified for thermocouples / RTD for closed loops, interlock and shutdown system. Transmitters shall be 2-wire, 24 VDC, 4-20 mA with HART protocol. The other features of smart transmitters shall be same as those covered in standard specification for pressure instruments (44NC-4600-0000/JSS/0106).

3.4.2 Temperature transmitters shall have a built-in linearising function to produce an output linear to temperature range. Integral digital indicator shall be provided.

3.4.3 Temperature transmitters shall have an accuracy of $\pm 0.1\%$ of FSD as a minimum.

3.4.4 Burn out protection shall be provided with temperature transmitters and trip amplifiers. Upscale or downscale protection shall be decided based on its application to ensure fail safe operation.

3.4.5 Transmitters shall be separately mounted (yoke / surface).

4.0 RELATED DOCUMENTATION

Nil

5.0 ATTACHMENTS

4600-JSD-501 (Thermowell)

4600-JSD-502 (Thermocouple / RTD Assembly with Thermowell)

SPECIFICATION NO: 44NC-4600-0000/J.SS/0108/A4**TITLE:** STANDARD SPECIFICATION FOR CONTROL VALVES,
SHUTDOWN VALVES & SELF-ACTING REGULATORS**PROJECT REFERENCE:**

- **Project No:** 44NC-4600
- **Project Location:** Manali, Chennai
- **Project Title:** RESID UPGRADATION PROJECT
- **Client:** Chennai Petroleum Corporation Limited
- **Project Manager Authorization:** B.B. DARAK **Date:**
- **Client Authorization:** **Date:**

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☐ Revised Pages Only Issued this Revision						

PROJECT NO.: 44 NC-4600**SPEC. NO. 44NC-4600-0000/J.SS/0108/A4****TITLE: STANDARD SPECIFICATION FOR CONTROL
VALVES, SHUTDOWN VALVES AND SELF-ACTING
REGULATOR****REV. NO / ISSUE DATE - 0 / 12-Mar-10****Page 2 of 9****TABLE OF CONTENTS****1.0 PURPOSE****2.0 SCOPE****3.0 TECHNICAL REQUIREMENTS**

3.1 CONTROL VALVES, SHUTDOWN VALVES & SELF-ACTING REGULATORS

3.2 ACTUATORS

3.3 POSITIONERS

3.4 OTHER ACCESSORIES

3.5 INSPECTION & TESTING

4.0 RELATED DOCUMENTATION**5.0 ATTACHEMENTS**

1.0 PURPOSE

The purpose of this specification is to define the minimum requirements of design and Manufacture of Control Valves, Shutdown valves and self acting regulators.

2.0 SCOPE

The scope of work shall include design, manufacture, testing and supply of control valves, shutdown valves and self-acting regulators. The inspection requirements shall be as per the inspection plan.

3.0 TECHNICAL REQUIREMENTS**3.1 CONTROL VALVES, SHUTDOWN VALVES & SELF-ACTING REGULATORS**

- 3.1.1 Control valve type / design selection shall be made with consideration of following conditions
- Pressure drops, which exceed 10 bars.
 - Flashing or cavitating liquids.
 - Steam service where pressure drop exceeds 5 bar.
 - Corrosive fluids.
 - Control valves on erosive services (slurries).
- 3.1.2 Control valves shall normally be globe type, single seated or double seated. Other valve types like butterfly ball, rotary plug, angle or 3 way etc., shall be selected as per service requirements. Flanged control valves shall be used. Body material, body rating shall be as per piping specifications as a minimum. The flange rating shall be 300# as a minimum or higher as per piping specifications. Valve bodies and other pressure parts, except diaphragms and housings shall be of forged or cast carbon steel conforming to ASTM A-181, or BS 1503-161 Gr.B and ASTM A-216 or BS 1504-161 respectively, unless otherwise specified. Valve bodies of carbon steel with equivalent or better physical properties will be acceptable provided forged materials are not high manganese sulphur steels (free machining).
- 3.1.3 Minimum control valve body size shall be 1" in general. Reduced trims can also be considered. Body size shall be limited to 1", 1-1/2", 2", 3", 4", 6", 8", 10" and 12". Higher sizes may be used wherever necessary. Flanged connections shall conform to the dimensions and pressure temperature ratings of ANSI B16.5.
- 3.1.4 The control valve shall be delivered complete with actuator and accessories pre-assembled. All accessories such as positioner, air filter regulator and solenoid valve shall be securely pre-tubed and mounted on the actuator such that they shall be removable for maintenance without disturbing other components. Noise from control valve during operation shall be limited to OSHA specified level or better. The maximum allowable noise is 70 dBA SPL (Sound Pressure Level). Source treatment for noise, shall be preferred by using special trims like anti-noise trims, in case, noise exceeds the specified level. Other methods based on merit is permissible.
- 3.1.5 Leakage Class-VI shall be considered wherever tight shut-off is specified depending upon the availability with respect to temperature, pressure drop and stelliting requirement. If Class-VI is not available because of high temperature, pressure drop then stelliting Class-V is also acceptable. For all shutdown valves, the leakage class shall be class VI minimum. Control valve leakage shall conform to ANSI B16.104 or ANSI/FCI 70.2

- 3.1.6 Control valve sizing shall be carried out as per ISA S75-01. The selected valve Cv shall permit up to 150% of normal flow or 110% of maximum flow, whichever is higher. In general, control valves shall be sized so that the valve opening is as noted below:

At max. flow : about 80% open
At normal flow : about 70% open
At minimum flow : about 20% open

Equal percentage control valves shall normally be sized between 60 & 80% open for normal flow. Linear control valves shall normally be sized to be between 50% and 70% open for normal flow.

For 2-phase flow the control valve Cv shall be the computation of the Cvs of the liquid phase and the vapour phase utilising relevant correction factors based on the individual process conditions.

- 3.1.7 Flanged bolted type gland packing boxes shall be used, unless otherwise specified. Gland packing shall normally be self-lubricating type. Packing shall be PTFE on liquid and gas service upto 200°C . and Grafoil for 200°C and above. Asbestos and graphite as wetted material, either in packing or seal is not allowed.

- 3.1.8 Bellows seal shall be used where it is required to isolate the packing from the process fluid or where no leakage to atmosphere can be tolerated like toxic, explosive and precious fluids.

- 3.1.9 As a minimum, trim material shall be SS 316. Trim shall be with guide bushing of hardened stainless steel like 440 C, 17-4 PH. all upto a pressure drop of 10 kg/cm². For higher pressure drops or erosive and slurry services and in general for all steam services, flashing services, hard-surfacing of plug seat rings and seating area of inner valve with stellite shall be used. Special cases may require 17-4 PH seat ring and 440 C solid plugs or other materials like Hastelloy, Durimet, Monel, etc.

Where tight shutoff is required, soft seat trims shall be used, provided temperature limits are not exceeded. All soft seat trim valves shall be of fire safe design.

For temperature above 300°C stellite facing shall be used for guide posts. Guide bushing shall always be harder by a minimum of 125 Brinell than the guide post.

Trim characteristics shall be equal percentage type unless required otherwise. Control valve lugs shall be top and bottom guided for double seated valves and top guided for single-seated valves. The standard construction for globe body control valve shall be single seated with top guiding for low ΔP applications and cage guided for high pressure drop applications generally. Hardened plug and seat rings shall be selected for erosive services, for steam services with $\Delta P \geq 5$ bar or where ΔP exceeds 10 bar Trim shall be coated with stellite 6 or colomony. Anti-cavitation trim shall be selected wherever cavitation is expected in the valve.

- 3.1.10 For liquid services in which high pressure drops occur, the application of a conventional trim with standard flow direction often results in very high velocities and cavitation. Where this is the case, preference should be given to hardened trim materials and / or, for single-seated valves, change of flow direction through the valve. If reverse flow direction is applied, special attention shall be paid to marking the correct flow direction on the valve body.

Where hardened trim materials and / or change of flow direction is not adequate or feasible, valves with anti-cavitation trims shall be considered.

The anti-cavitation valve shall be of the globe or angle-body design, the fluid velocity shall be controlled by using a valve trim having specially designed multiple orifices in series and / or in parallel. Designs other than the above require the written approval of the Consultant.

For applications where valves with anti-cavitation trims are not available, i.e. miniature-type control valves with a very low capacity (Cv factor), two valves in series should be considered, however, this procedure requires the written approval of the Consultant.

- 3.1.11 The allowed stroking time of the control valves shall be evaluated on the basis of the process control requirements.

For analogue control systems (control valves equipped with positioners), the maximum stroking time should be 10 seconds or less for valve sizes DN 100 and smaller, and shall be 15 seconds or less for valve sizes DN 150 and larger. Deviation from the above stroking times requires the written approval of the Consultant.

For critical analogue control systems, such as surge control of compressors, the stroking time shall be less than 5 seconds.

- 3.1.12 Self actuating regulators for flow, pressure and temperature shall be used where loads are constant and requirements of precision and accurate controls are not stringent.

- 3.1.13 Colour coding for all valve bodies and actuators shall be as per engineering design basis.

- 3.1.14 End connections may be lug type or with flange. Normally butterfly control valve disc travel is specified as 0 to 60° for 0.2 to 1.0 signal range. The valve shall be sized so that the maximum flow is achieved at approximately 45° opening. The effect of reducers, where applicable shall be considered (i.e. Fp factor).

- 3.1.15 All Shutdown valves shall be flanged Ball valves only, unless otherwise specified. Normally "floating ball" design shall be specified; where "trunnion mounting" has to be used, special check has to be made for its suitability for service conditions especially for viscous and solidifying type liquids and slurries. Valves shall be full bore type.

- 3.1.16 All shutdown valves shall be equipped with quick exhaust type solenoid valves / pilot valves to achieve fast closing in less than 5 seconds.

- 3.1.17 All valve bodies for use on oxygen service are to be degreased and suitably protected for transit to prevent ingress of dust and grease. The body casting shall be completely machined internally to remove any casting imperfections and provide a smooth surface in order to reduce the probability of initiating metallic combustion.

- 3.1.18 All valves on stream service shall comply with statutory requirements as per Indian Boiler Regulations (IBR). Vendor shall submit Form - III C of IBR duly filled.

- 3.1.19 For all shutdown valves on fire safe applications, air volume tank shall be provided for storage of air volume for minimum 3 full strokes of the valves. All valve accessories such as solenoid valve, limit switches, volume tank etc shall also be enclosed in a certified fireproof enclosure. The cable used for actuation of the valve shall also be fire resistant (Fire survival to IEC-331).

3.2 ACTUATORS

- 3.2.1 Actuators shall be adequately sized to control with shut-off pressure differential applied. The maximum differential pressure for actuator sizing shall be assumed as maximum upstream pressure with valve fully closed and downstream atmosphere pressure where specifically not mentioned in the design data sheet. Valve actuator(s) shall be selected to ensure that they are capable of operating the valve(s) with out-of-balance forces as would be caused by pressure equivalent to the full static pressure upstream and normal atmospheric pressure downstream. The actuator shall be designed considering 3.5 Kg/cm²g air pressure to deliver 25% more force / torque than the max. torque requirement to operate the valve under all operating conditions including when the valve is pressure balanced up stream and downstream with the body cavity vented.
- 3.2.2 Valve actuator shall be pneumatic spring opposed diaphragm type, in general. Piston type actuators may be used for very high shut off pressure requirements. Additional equipment necessary to meet fail safe condition shall also be included in case double acting piston type actuator is selected. In either case, actuator shall be able to withstand maximum shut-off pressure with the minimum instrument air pressure specified. Valve actuators of the spring opposed diaphragm type shall be furnished, with readily adjustable enclosed springs of corrosion resistant finish. The adjusting mechanism shall be designed to ensure permanence of the spring adjustment.
- 3.2.3 Other types of actuators such as piston type actuators, with or without helper springs, and/or fail safe capacity tanks, are subject to consultant's approval.
- Double acting piston cylinder actuators, where used, shall also be provided with volume tank, safety valve, NRV, pressure gauges etc. Volume tank shall be designed for 3 full stroke operations of the valve in addition to backup for control valve operation for a preset time as indicated in project specifications.
- Emergency shut-off valves shall be fitted with a fail-safe spring return mechanism, the spring-opposed actuators should preferably be of the multiple spring type (redundancy).
- Cylinder actuators shall be provided with adjustable limit travel stops in both directions. Bolt adjustment type limit stops shall be applied with a locking facility, e.g. a locking nut to prevent tampering. Piston and Cylinder actuators shall have O-ring sealing and shall be designed for low shaft and piston friction.
- 3.2.4 Actuator / diaphragm cases shall be made from steel as a minimum. Yoke material shall be high-tensile strength cast, or ductile iron as a minimum. Diaphragms shall be nylon reinforced neoprene or Buna N rubber. Cooling fins and extension bonnets where fitted shall be of the same material as the body. Finned cooling and/or extensions shall be used for cryogenic and high temperature services as applicable.
- 3.3 POSITIONERS
- 3.3.1 Smart Electro-pneumatic positioner shall be used for all control valves. Valve positioners shall be fully assembled complete with all necessary tubing. Air supply, output and signal gauges of 2" (50mm) nominal diameter shall be provided as standard. All accessories shall be tubed having MOC as per project specification with double ferrule type tube fittings. All pneumatic connections shall be 1/4" NPT (F) unless otherwise specified
- 3.3.2 Valve positioner shall be provided with an adjustable mechanism to vary the relationship between valve stroke and controlling air pressure span. Positioners shall be capable of

providing a full stroke of the control valve, in either direction, in not more than 10 ~ 15 seconds or as specified.

- 3.3.3 Separate I/P convertor and pneumatic positioner shall not be used. Separate air filter regulator shall be provided for each control valve.

3.4 OTHER ACCESSORIES

- 3.4.1 Hand wheels shall be provided as per requirement indicated in P&ID and project specifications. Handwheels shall override automatic operation. No hand wheels or bypass valve shall be provided for Shutdown valves.

- 3.4.2 Valve stem position indicators shall be fitted as standard showing open, closed and incremental stroke positions. Direction of flow indication shall be permanently indicated on the valve body and shall be clearly visible in the final installed position.

- 3.4.3 The limit switches for shut down valve and control valve wherever applicable shall be of intrinsically safe, proximity type. Separate switches shall be supplied for open and closed position. All the emergency shutdown valve shall have limit switches to indicate the valve position as per P&ID. The enclosure of limit switches shall be as per the respective area classification. All valve with limit switches shall also have visual indication of the valve 'OPEN' or 'CLOSE' conditions.

- 3.4.4 Solenoid valves, wherever used, shall be 3 way universal type and shall be continuous rated type with class F coil insulation as per IEC 85 / IS 1271. These shall be of SS body with SS316 trim, as a minimum. The solenoid coil lead wires shall be neatly terminated on the Solenoid valve terminal box. Flying leads from the solenoid valve are not acceptable. Solenoid vents shall have bug screens. All pneumatic tubing for interconnection of solenoids etc shall be as per project specification.

- 3.4.5 Secured instrument air (SIA) shall be applied for spring less actuators, to drive the control valve to a safe position in the event of an air failure. The secured instrument air supply system shall maintain sufficient air pressure in the buffer vessel for at least 30 minutes or 3 full valve strokes if that takes longer. Unless otherwise specified in the requisition, the capacity of the secured instrument air buffer vessel shall be sized for a minimum instrument air supply pressure of 4.2 bar g.

The secured instrument air buffer vessel capacity sizing calculation shall be submitted to the Consultant for approval.

- 3.4.6 Air lock relays of proven make and design shall be used as required.

3.5 INSPECTION & TESTING

Test Procedure shall include but not be limited to the following:

- 3.5.1 Dimensional /Physical Test

- 3.5.2 Hydrostatic Body Test. - Duration 3 mins.

All valves when completely assembled shall be hydrostatically tested for a sufficient time for the body, gland and joints to be scrutinized for leakage. Parts under test shall be unpainted and shall have been processed with rust remover and protected against further rust prior to test.

3.5.3 Seat Leakage Test. - as per ANSI B16.04, 1976 / FCI 70.2

The leak test shall be conducted on the closed valve with zero diaphragm pressure for 'close on air failure' and with 18 psig (1.2 bar. g) diaphragm pressure for 'open on air failure'. The leakage test shall be carried out at both minimum and maximum pressures.

3.5.4 Diaphragm head test.

3.5.5 Helium Leak Test - for control valves with bellows seal.

The valve shall be stroke tested and checked for correct action on removal of supply pressure. On 300 mm valves and below, all actuators and accessories shall be completely assembled to the valve and tested at the vendors works. Assemblies shall be "type tested" under full line pressure conditions including testing under full line pressure with valve closed and body cavity vented and opening torque measured.

3.5.6 The Vendor shall provide a certified record of all tests carried out and each test record shall contain the following:

- Purchase Order Number and Valve Tag Number
- Valve body size and inner valve (Trim size) size
- Vendor's serial number
- Observations of the tests done
- Bench settings for valve stroke
- Date of Test

3.5.7 Whenever fire safe requirement is specified for a shutdown valve, the valve body and actuator shall meet the testing requirements as per API 617 latest revision. Also for all valves on cryogenic service, i.e. valves installed in piping classes used for temperatures below -29 °C, design and testing shall be as per BS 6364.

3.5.9 Control valves / shutdown valves requiring certain specified operating timings, shall be tested before despatch for the operational time verification.

3.5.10 A 316 SS nameplate shall be securely fastened to the valve in a visible and accessible place. Nameplates shall show as a minimum, the following:

- Instrument Tag Number
- Vendor's Name
- Valve Model Number
- Order/Requisition Number
- Body & Trim Material
- Stem Packing Material
- Body Size and Rating
- Design CV (For Control valve and Regulator)
- Trim Characteristic or Cam Code/type as necessary
- Air-Fail Action
- Hazardous Area certifying authority certificate Number

PROJECT NO.: 44 NC-4600**SPEC. NO. 44NC-4600-0000/J.SS/0108/A4****TITLE: STANDARD SPECIFICATION FOR CONTROL
VALVES, SHUTDOWN VALVES AND SELF-ACTING
REGULATOR****REV. NO / ISSUE DATE - 0 / 12-Mar-10****Page 9 of 9**

- Actuator size / spring range - air supply pressure

4.0 RELATED DOCUMENTATION

ANSI B16.10	Control Valve dimensions
ANSI / ISA S75.01	Flow equations for Sizing Control Valves
ANSI / ISA S75.02	Control valve Capacity test Procedure
ANSI / ISA S75.03	Face to Face dimensions for Integral flanged globe style control valve bodies (ANSI 125, 150, 250, 300 & 600)
ANSI / ISA S75.04	Face to face dimensions of flangeless Control valves (ANSI 150, 300 and 600)
ANSI / ISA S75.05	Control Valve terminology
ANSI / ISA S75.11	Inherent flow characteristics and rangeability of control valves
API Std. 598	Valve Inspection and Test, 5 th Edition
ISA	Handbook for Control valves

5.0 ATTACHMENTS

Nil

SPECIFICATION NO: 44NC-4600-0000/J.SS/0109/A4

TITLE: STANDARD SPECIFICATION FOR SAFETY / THERMAL RELIEF VALVES, RUPTURE DISCS AND BREATHER VALVES

PROJECT REFERENCE:

- **Project No:** 44NC-4600
- **Project Location:** Manali, Chennai
- **Project Title:** RESID UPGRADATION PROJECT
- **Client:** Chennai Petroleum Corporation Limited
- **Project Manager Authorization:** B.B. DARAK **Date:**
- **Client Authorization:** **Date:**

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PROJECT NO.: 44 NC-4600**SPEC. NO. 44NC-4600-0000/J.SS/0109/A4****TITLE: STANDARD SPECIFICATION FOR SAFETY /
THERMAL RELIEF VALVES, RUPTURE DISCS AND
BREATHING VALVES****REV. NO / ISSUE DATE - 0 / 12-Mar-10****Page 2 of 8****TABLE OF CONTENTS**

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1.0 PURPOSE

The purpose of this specification is to define the minimum requirements of design and manufacture of Safety / Thermal relief valves, Rupture Discs and Breathing valves.

2.0 SCOPE

The scope of work shall include design, manufacture, testing and supply of Safety / Thermal relief valves, Rupture Discs and Breathing valves. The inspection requirements shall be as per the inspection plan.

3.0 TECHNICAL REQUIREMENTS**3.1 RELIEF VALVE AND DESIGN**

3.1.1 The vendor shall be responsible for the selection and sizing of the safety relief valves in accordance with the supplied process data.

3.1.2 Safety relief valves shall be designed, manufactured and sized in accordance with the recommendations of API RP526, API 527, API 520, API 521, ASME code for 'Boilers and Pressure Vessels' and Indian Boiler Regulations.

3.1.3 The calculated result should be used to select a relief valve whose effective flow area is the nearest size larger than the calculated area, as limited by the standard orifice areas available.

3.1.4 Where Safety relief valves are provided on ASME coded boiler and pressure vessels, they shall be manufactured in accordance with ASME VIII and shall carry the ASME VIII code stamp.

3.1.5 Lifting lever shall be specified for steam and air service

3.1.6 The percentage accumulation in case of pressure relief / safety valves shall be as follows
Steam Service

- | | |
|--|-------------|
| - ASME SEC I | 3% |
| - IBR (Before steam let-down station) | 5% |
| - IBR (Distribution & Utilities) and ASME Section VIII | 10% |
| - Gas, Vapour or liquid | 10% |
| - Liquid for thermal Relief | 20% or less |
| - Fire exposure on unfired vessels | 21% |

3.1.7 Safety Relief valves shall be of the direct spring loaded type. Pressure relief valves shall be full nozzle full lift type except for thermal relief valves.

3.1.8 The spring in a pressure relief valve in service for pressures up to and including 250 psi (1720 KPa) shall not be reset for any pressure more than 10% above or 10% below that for which the valve is marked. For higher pressures, the spring shall not be reset for any pressure more than 5% above or 5% below that for which the valve is marked.

3.1.9 Conventional valves shall be specified for constant back pressure while bellows seal type valves shall be specified for variable backpressure more than 10% of set pressure or for toxic / hazardous or corrosive fluids where conservation of the fluid is of utmost

importance. Pilot operated pressure relief valves shall be used for special services and where set pressure is closer than 10% of the operating pressure, in general.

- 3.1.10 All Valves shall be flanged to ANSI B16.5 R.F. serrated finish unless otherwise specified. Flanged connection shall be for standard sizes 1" or larger. Minimum flange rating shall be 150 # ANSI. Where permissible, screwed connections shall be used on sizes ¾" and below.
- 3.1.11 For API coded tanks pressure/vacuum relief valves shall be pallet/weight loaded, or pilot operated. During hydrostatic testing of the equipment / pipe lines / systems Safety relief valve shall be removed and replaced by a blind flange.
- 3.1.12 Valve seat tightness shall be in accordance with the requirements of API STD 527.
- 3.1.13 The body material shall, as a minimum, be as per piping specifications. Nozzle and disc material shall be SS316 as a minimum with machined stainless steel guide and spindle. Whenever semi nozzle designs are unavoidable, body material shall be at least same as nozzle material. The spring material of pressure relief valves shall be as follows unless otherwise specified in the datasheet, or required by the corrosive characteristics of the service:
- | | | |
|-----------------------|---|---------------------------------------|
| -29°C to 250°C | : | Cadmium / Nickel-plated carbon steel. |
| above 250°C to 540 °C | : | Tungsten alloy steel. |
| below -29°C | : | Stainless steel 316. |
| Above 540 °C | : | High Speed Steel |
- 3.1.14 Pilot Operated Safety / Relief Valves
- Pilot operated safety/relief valves use the process pressure acting on the topside of the disk as the closing force. The pilot valve, which is a spring loaded valve, connects the cavity above the disk either to the process or to the atmosphere, or a low-pressure system. Internal sensing for pilot shall be avoided as far as possible by providing remote pilot sense ports. The pilot operated safety/relief valve can operate at process pressure close to the set pressure because of the high positive closing force which increases with the process pressure. Normally pilot operated valves should be provided with soft seals, which give a better valve tightness. The design features of a pilot operated valve allows for larger orifice sizes than the maximum 8T10 size for spring loaded valves. A field connection for checking the set pressure shall be provided.
- 3.1.15 Mechanical requirements
- 3.1.15.1 The design shall incorporate guiding arrangements necessary to ensure consistent operation and tightness.
- 3.1.15.2 The spring shall be designed so that the full lift spring compression shall be no greater than 80% of the nominal solid deflection. The permanent set of the spring (defined as the difference between the free height and height measured 10 mins. after the spring has been compressed solid three additional times after presetting at room temperature) shall not exceed 0.5% of the free height.
- 3.1.15.3 The valve seat shall be fastened to the valve body such that the valve seat shall not lift. test gag shall be provided for all pressure relief valves.
- 3.1.15.4 Valves shall be provided with provision for sealing of all external adjustments.

- 3.1.15.5 On valves where the design allows liquid to collect on the discharge side of the disk, the valve shall be provided with a drain at the lowest point.
- 3.1.15.6 Stems shall be of AISI 416 except if the body is austenitic stainless steel, when it shall be of 18.8% Cr.Ni.
- 3.1.16 Steam service
- 3.1.16.1 Pressure Relief Valves on steam service shall be provided with a lifting device to ensure the valve is free. Pressure tight packing shall be provided around the lifting lever assembly, so that leakage will not occur when the valve is opened or under back pressure.
- 3.1.16.2 The lifting device shall not hold the valve disk in the open position when the exterior lifting force is released.
- 3.1.16.3 Safety Relief Valves on steam service shall meet the requirements of the Indian Boiler Regulations.
- 3.1.16.4 Valves for steam service shall be flanged to ANSI B16.5. Serrated R.F. and shall have an open bonnet i.e. only with a yoke in place of a closed bonnet. They shall be provided with a weather hood \ when used in outdoor service.
- 3.1.16.5 Steam services above (750°F) 399°C shall be provided with a cooling spool between the body and bonnet to minimise conduction of heat to the spring.
- 3.1.16.6 Vendor shall furnish sizing calculations based on IBR formula. In this connection, vendor shall indicate the 'C' value as accepted by IBR.
- 3.1.17 Thermal Expansion Relief Valves
- 3.1.17.1 Relief valves without blow down ring shall be used for liquid thermal expansion purposes.
- 3.1.17.2 3/4" x 1" threaded (NPT) modified nozzle type valves with typically 0.38 cm² orifice size shall be specified for thermal relief. If the piping specification does not allow screwed connection then flange connection shall be used.
- 3.1.18 Relief Valve Installation
- 3.1.18.1 Safety and Safety Relief Valves shall always be mounted in a vertical position directly on nozzles having a well-rounded approach that provides smooth, unobstructed flow from the vessel or line to the valve.
- 3.1.18.2 Safety valves shall not be mounted on nozzles having an inside diameter smaller than the inlet connection to the valve, or on excessively long nozzles.
- 3.1.18.3 Discharge pipe work shall be piped upwards such that vapours or liquids are discharged vertically.
- 3.1.18.4 For optimum safety valve performance, discharge piping shall be supported independently of the valve.

- 3.1.18.5 For steam service slip joint drip pan elbows should be used, with the drip pan drain piped away to a safe location.
- 3.1.18.6 The installation of safety and safety relief valves shall be in accordance with the recommendations of API RP 520 Part II.
- 3.1.19 Relief Valve Testing
- 3.1.19.1 Steam service valves shall be tested with steam. Where this facility is not available air may be used. When steam valves are tested with air all necessary corrections for differential in popping pressure between steam and air shall be determined by the vendor and submitted to the purchaser for approval.
- 3.1.19.2 For steam service valves not covered by API Std. 527, when leak tested there shall be no visible or audible leakage from the valve outlet when the inlet pressure is held at 95% of the set pressure after popping and reseating.
- 3.1.19.3 Valves marked for general service may be tested with air.
- 3.1.19.4 Liquid service valves shall preferably be tested with water but may be tested with air.
- 3.1.19.5 Valves shall be tested to demonstrate the popping point and tightness.
- 3.1.19.6 Pressure relief valves shall be type tested for capacity with 5% blowdown as per ASME Sec VIII UG 131 and actual blowdown of the individual valves shall meet the process requirement. All Valves shall be provided with such type test certificates.
- 3.1.19.7 For all relief valves test records and test certificates to fully cover component materials and the valve test details shall be provided.
- 3.1.20 Relief Valve Marking And Nameplates
- 3.1.20.1 The marks shall be placed on the valve or on a plate securely fastened to the valve. The marks shall be made in such a way that they will not be obliterated in service.
- 3.1.20.2 The markings shall include the following as a minimum for Safety / Thermal Relief Valves:-
- Valve Tag number
 - Vendors name
 - Vendors design or type number (Model Number)
 - Size (mm)
 - Set Pressure kg/cm²g
 - Orifice (standard letter designations)
 - Cold setting
 - Back pressure (constant or variable)
 - Capacity at overpressure
 - Year of manufacture
 - ASME or IBR symbol as required.

3.2 BREATHER VALVE SIZING & DESIGN

- 3.2.1 The breather valves shall have follow the listed specifications as a minimum during design. There shall be sufficient margin between the set pressure of breather valve and

tank's design pressure / vacuum. Also, there should be sufficient difference between the set pressure of N2 blanketing system and breather valve.

3.2.2 Breather valves shall generally be soft seated, dead weight type and shall have self-draining body construction. The seating surfaces shall be shielded from condensates and the design shall prevent tendency of pallet to stick to the seat.

3.2.3 Vacuum breakers shall, in general, be sized and designed as per API 2000.

3.3 RUPTURE DISC DESIGN

3.3.1 Rupture discs shall be reverse buckling type, in general and shall be supplied in pre-torqued holder assembly which shall fit inside the inner diameter of the bolt circle of standard flanges. Disc and holder material shall be compatible with the process fluid. Inconel discs shall be used above 100°C if compatible with the process fluid.

3.3.2 When rupture disc is used upstream of a pressure relief valve, a pressure gauge shall be provided on the downstream of the disc to indicate any rupture of the disc in addition to an excess flow check valve. In addition combination capacity factor of 0.9 shall be used for sizing unless the combination has been tested and approved for any other combination capacity factor. For such discs, a zero manufacturing tolerance shall be considered.

3.3.3 The total tolerance of the rupture disc shall be $\pm 5\%$ of the specified bursting pressure or less, unless otherwise specified. This shall include both the manufacturing tolerance and burst tolerance of the disc. All rupture discs shall be with 'J' bolt and tell tale assembly consisting of pressure indicator, pressure switch and excess flow check valve.

Rupture discs on ASME coded pressure vessels shall carry the ASME UD stamp.

3.3.4 Rupture Disc Testing

3.3.4.1 All discs shall be tested by bursting 2 discs of every batch with a 'batch' being defined as a set of discs having the same size, material and set pressure.

3.3.4.2 All rupture discs and holders shall be provided with test records and test certificates to fully cover component materials and the disc test details.

3.3.5 Rupture Disc & Breather Valve Marking And Nameplates

3.3.5.1 The marks shall be placed on a plate securely fastened to the disc and disc holder. The marks shall be made in such a way that they will not be obliterated in service.

3.3.5.2 The markings shall include the following as a minimum for Rupture Discs / Breather Valves:

- Tag number
- Vendors name
- Vendors design or type number (Model Number)
- Size (mm)
- Set Pressure (Set pressure for Vacuum / Gauge Pressure for Breather valves)
- Set Pressure at room temperature (Not applicable for Breather valves)
- Back pressure (constant or variable) (Not applicable for Breather valves)
- Capacity at overpressure (Not applicable for Breather valves)

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- Year of manufacture

3.3.5.3 ASME or IBR symbol as required. (Not applicable for Breathing valves)

4.0 RELATED DOCUMENTATION

Standard name	Description
API RP 526	Flanged steel safety relief valves.
API 527	Commercial seat tightness of safety Relief Valves with metal to metal seats
API 520	Design and installation of pressure relieving systems in refineries parts I & II.
API 521	Guide for pressure relief and depressurising systems.
ASME CODE SECTION VIII	Boiler and Pressure vessel code Div.1 and Div. 2
IBR	Indian Boiler Regulations.

5.0 ATTACHMENTS

Nil

SPECIFICATION NO: 44NC-4600-0000/J.SS/0112/A4

TITLE: STANDARD SPECIFICATION FOR CABLES AND RELATED ACCESSORIES

PROJECT REFERENCE:

- **Project No:** 44NC-4600
- **Project Location:** Manali, Chennai
- **Project Title:** RESID UPGRADATION PROJECT
- **Client:** Chennai Petroleum Corporation Limited
- **Project Manager Authorization:** B.B. DARAK **Date:**
- **Client Authorization:** **Date:**

				APPROVALS		
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0	12- Mar-10	10	Issued For Feed	ADM	MSD	BSP
☒ Entire Specification Issued this Revision ☐ Revised Pages Only Issued this Revision			SPECIFICATION ISSUED FOR: ☐ In-house Review ☐ Purchase ☐ Client Approval ☐ Construction ☒ Enquiry ☐ Engineering			

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1.0 PURPOSE

The purpose of this specification is to define the minimum requirements of design and manufacture of instrument cables and related accessories.

2.0 SCOPE

The scope of work shall include design, manufacture, testing and supply of instrument cables and related accessories. The inspection requirements shall be as per the inspection plan.

3.0 TECHNICAL REQUIREMENTS**3.1 INSTRUMENT CABLES**

This specification covers the requirements for instrument signal cables, thermocouple extension and compensating cables, RTD cables and power / control cables.

3.1.1 Single pair shielded signal / alarm cables shall be used between field instruments / switches and junction boxes / local control panels.

3.1.2 Single pair shielded thermocouple extension cables shall be used between thermocouple head and junction boxes / transmitters / local control panel mounted instruments.

3.1.3 Single triad shielded signal cables shall be used between RTD head and junction boxes / transmitters / local control panel mounted instruments.

3.1.4 Separate Multipair/ multitriad cables shall be used between junction boxes/ local control panel and control room as per following applications.

- 4-20 mA signals
- Thermocouple signals
- Resistance Temperature Detectors (RTD) signals
- Switch contacts / Proximity switch contacts
- Gas detectors

3.1.5 Power cables shall be used between power supply distribution boards and power consumers such as control panels, DCS / PLC cabinets, any instruments requiring power supply, etc.

3.1.6 Control cables shall be used for solenoid valves and interfacing with MCC / VSD panels.

3.1.7 For solenoid valve signals and power supply to instruments, junction boxes shall be used.

3.1.8 The cable design shall generally follow BS 5308 Part-2 for various cables listed in clause 3.1.4 above. Thermocouple cables design shall comply with ANSI MC 96.1. The power and control cables shall be generally as per BS 6346. For these cables, equivalent IEC/IS specifications are also acceptable.

3.1.9 The insulation grade shall be 1100 V for all cables.

- 3.1.10 The primary insulation shall be PVC with temperature rating 85 deg.C. Inner and outer sheath / jacket shall be made of extruded flame retardant PVC with temperature rating 90 deg. C. In case of flame retardant low smoke cables oxygen index of PVC shall be over 30% and temperature index shall be over 250 Deg.C.
- 3.1.11 All cables shall be armoured and suitable for operation when installed as follows:
- Directly buried in the ground
 - Fastened to cable ladder rack or tray in the open air
 - In underground ducts
 - In overhead closed cable ducts
- 3.1.12 Running length of the cable shall be printed at least at every 5 metre interval. For multipair/ multitriad cables, pair identification shall be provided with numbers at interval of not more than 250 mm as per vendor's standard.
- 3.1.13 Contractor shall ensure a minimum of 20% of quantity of each type of cables supplied as spare including any special cable and in each multipair cables 20% pairs shall be kept as spare.
- 3.1.14 A pair of communication wire shall be provided for multipair / multitraid cables. Each wires shall be 0.5 mm² of plain annealed single or multi-strand copper conductor with 0.4 mm thick 85 Deg.C PVC insulation. Insulation shall be green and red colour coded.
- 3.1.15 All cables shall be fire retardant.
- 3.2 DESIGN AND TESTING STANDARDS
- 3.2.1 Instrument signal, RTD and thermocouple cables

DESCRIPTION	STANDARDS
Conductors	BS 6360 for instrument signal and RTD cables and ANSI MC 96.1 for thermocouple cables.
Insulation: PVC	BS-5308 / IS-6474 Part 1 • Primary insulation shall be as per IS-5831 type C / IEC 502 • Fire retardant (FR) shall be as per standard IEC 332 Part 3 Cat. A. • Fire resistance cables shall be as per standard IEC 331 Cat. A • Fire retardant and low smoke (FRLS) shall be as per standard ASTM D-2863, 2843 and IEC 383, 332.
Armour:	IS-1554 Part I / IEC-502 / BS 5308 / BS 1442
Inner & Outer Sheath-PVC:	• Inner / outer jacket be as per IS-5831 Type ST-2 / IEC 502 / BS 6746 • Fire retardant (FR) shall be as per standard IEC 332 Part 3 Cat. A. • Fire retardant and low smoke (FRLS) shall be as per standard ASTM D-2863, 2843 and IEC 383, 332.
Testing of the instrument signal and RTD cables.	BS 5308
Testing / Calibration of thermocouple cables.	ANSI MC96.1 / IEC-584-2
Dimensions:	BS 5308

3.2.2 Power and control cables

DESCRIPTION	STANDARDS
Conductors	IS : 8130 / BS 6360
Insulation-PVC	- Primary insulation shall be as per IS-5831 type C / IEC 502 / BS 6746 - Fire retardant (FR) shall be as per standard IEC 332 Part III A. - Fire resistance cables shall be as per standard IEC 331 Cat. A - Fire retardant and low smoke (FRLS) shall be as per standard ASTM D-2863, 2843 and IEC 383, 332.
Armour	IS : 1554 / 3975 / BS-1442
Inner & Outer Sheath-PVC	- Inner / outer jacket be as per IS-5831 Type ST-2 / IEC 502 / BS-6746 - Fire retardant (FR) shall be as per standard IEC 332 Part III A. - Fire retardant and low smoke (FRLS) shall be as per standard ASTM D-2863, 2843 and IEC 383, 332.
Testing and Dimensions of the cables	IS : 1554 Part I, BS 6469 / BS 6346

3.3 CABLE CONSTRUCTION

The various mechanical / electrical parameters indicated here are indicative and the contractor shall be responsible to select / design the cables as per applicable standards.

3.3.1 Instrument signal cables (4 – 20 mA or switch contacts):

ITEMS	DESCRIPTION
Conductor i) Single Pair ii) 6/ 12 Pair	7 stranded / 0.53 mm dia (1.5 mm²) stranded annealed tinned copper conductors of electrolytic grade copper, PVC insulated. 7 stranded / 0.43 mm dia (1.0 mm²) annealed tinned copper conductors of electrolytic grade copper, PVC insulated. 7 stranded / 0.53 mm dia (1.5 mm²) annealed tinned copper conductors of electrolytic grade copper, PVC insulated.
Insulation, inner & outer sheath	PVC
Pairs	Two insulated conductors shall be uniformly twisted together to form a pair at least 10 twists per metre.
Maximum resistance	DC Shall not exceed 12.3 ohms/ km at 20°C for cables with 1.5 mm ² conductor and 18.4 ohms / km at 20°C for cables with 1.0 mm ² conductor.
Mutual capacitance	The mutual capacitance of the pair or adjacent cores shall not exceed 250 pF / m at a frequency of 1 kHz. The capacitance between any core and screen shall not exceed 400 pF / m frequency of 1 kHz.
L/R ratio of adjacent cores /pairs	Shall not exceed 40 µH / Ω for cables with 1.5 mm ² conductor and 30 µH / Ω for cables with 1.0 mm ² conductor.
Shield	Shield shall be aluminium backed mylar / polyester tape bonded

	together with the metallic side down helically applied with either side having 25% overlap and 100% coverage. The minimum shield thickness shall be 0.05 mm in case of single pair and 0.075 mm in case of multipair cable.
Drain wire	Drain wire shall be provided for individual pair and overall shield with 0.5 mm ² multistranded bare tinned annealed copper conductor continuously in contact with aluminium side of shield. The drain wire resistance including shield shall not exceed 30 ohm/km. Electrostatic noise rejection ratio shall be over 76 dB.
Colour coding	- Core insulation : Black & Blue - Inner jacket : Black - Outer jacket : Light blue for intrinsically safe application and black for others

3.3.2 RTD cables:

ITEMS	DESCRIPTION
Conductor 1 Triad 6/ 8 Triad	7 stranded / 0.53 mm dia (1.5 mm²) annealed tinned copper conductors of electrolytic grade copper, PVC insulated. 7 stranded / 0.43 mm dia (1.0 mm²) annealed tinned copper conductors of electrolytic grade copper, PVC insulated. 7 stranded / 0.53 mm dia (1.5 mm²) annealed tinned copper conductors of electrolytic grade copper, PVC insulated.
Insulation, inner & outer sheath	PVC
Triads	Three insulated conductors shall be uniformly twisted together to form a Triad at least 10 twists per metre.
Maximum DC resistance	Shall not exceed 12.3 ohms/ km at 20°C for cables with 1.5 mm ² conductor and 18.4 ohms / km at 20°C for cables with 1.0 mm ² conductor.
Mutual capacitance	The mutual capacitance of the triad or adjacent cores shall not exceed 250 pF / m at a frequency of 1 kHz. The capacitance between any core and screen shall not exceed 400 pF / m frequency of 1 kHz.
L/R ratio of adjacent triads	Shall not exceed 40 $\mu\text{H} / \Omega$ for cables with 1.5 mm ² conductor and 30 $\mu\text{H} / \Omega$ for cables with 1.0 mm ² conductor.
Shield	Shield shall be aluminium backed mylar / polyester tape bonded together with the metallic side down helically applied with either side having 25% overlap and 100% coverage. The minimum shield thickness shall be 0.05 mm in case of single triad and 0.075 mm in case of multitriad cable
Drain wire	Drain wire shall be provided for individual pair and overall shield with 0.5 mm ² multistranded bare tinned annealed copper conductor continuously in contact with aluminium side of shield. The drain wire resistance including shield shall not exceed 30 ohm/km. Electrostatic noise rejection ratio shall be over 76 dB.
Colour coding	- Core insulation : Black, Blue and Brown - Inner jacket : Black - Outer jacket : Light blue for intrinsically safe application and black for others

3.3.3 Thermocouple cables:

ITEMS	DESCRIPTION
Conductor i) Single pair cable ii) 6/ 12 pair cable	- Single stranded, 16 AWG or 1.5 mm² solid conductors with PVC insulation. - Single stranded, 18 AWG or 1.0 mm² solid conductors with PVC insulation. Conductor material should be as follows: T type T/C – Copper Constantan (TX) J type T/C - Iron Constantan (JX) K type T/C – Nickel / Chromium Nickel / Aluminium (KX).
Insulation	PVC for general application and PE for IEC Gr. IIC hazardous area application.
Pairs	Two insulated conductors shall be uniformly twisted together to form a pair at least 10 twists per metre. The lay length of adjacent pairs / Triads in case of Multipair cables shall not be equal, to reduce cross-talk.
Mutual capacitance	The mutual capacitance of the pair or adjacent cores shall not exceed 250 pF / m at a frequency of 1 kHz. The capacitance between any core and screen shall not exceed 400 pF / m frequency of 1 kHz.
L/R ratio of adjacent pairs	Shall not exceed 40 $\mu\text{H} / \Omega$ for cables with 1.5 mm ² conductor and 30 $\mu\text{H} / \Omega$ for cables with 1.0 mm ² conductor.
Core inductance	Shall not exceed 4 mH/km. However, for J-type thermocouple inductance could be 8 mH/km.
Shield	Shield shall be aluminium backed mylar / polyester tape bonded together with the metallic side down helically applied with either side having 25% overlap and 100% coverage. The minimum shield thickness shall be 0.05 mm in case of single pair and 0.075 mm in case of multi pair cable
Drain wire	Drain wire shall be provided for individual pair and overall shield with 0.5 mm ² multistranded bare tinned annealed copper conductor continuously in contact with aluminium side of shield. The drain wire resistance including shield shall not exceed 30 ohm/km. Electrostatic noise rejection ratio shall be over 76 dB.

Note: All thermocouple extension cable shall be matched and calibrated in accordance with IEC-584-2 / ANSI MC 96.1

3.3.4 Control cables.

ITEMS	DESCRIPTION
Conductor 2 Core / Multi-core type	7 stranded / 0.53 mm dia (1.5 mm²) annealed tinned copper conductors of electrolytic grade copper with PVC insulation.
Insulation, inner & outer sheath	PVC
Maximum resistance DC	Shall not exceed 12.3 ohms/ km at 20°C for cables with 1.5 mm ² conductor
Core Identification	IS : 1554 / BS 6746

3.3.5 Power cables.

ITEMS	DESCRIPTION
Conductor	7 stranded / 0.67 mm dia. (2.5 mm ²) annealed tinned copper conductors of electrolytic grade copper with PVC insulation. The size of the conductor specified here is minimum. However, the exact size of the conductor shall be selected based on the length of cable and power consumption. For higher conductor sizes, aluminium can be considered.
Insulation	PVC
Core Identification	IS-1554 / BS 6746

3.3.6 Special Cables**3.3.6.1 Ethernet cables**

EIA/TIA 568 A Category 5, 4 pair 0.5 mm² (24 AWG) solid conductors, with plastic foil wrapping. Overall screen to consist of aluminium bonded polyester tape and tinned copper wire. Overall sheath shall be light grey PVC.

3.3.6.2 Fibre optic cable

62.5 / 125 micron multimode, graded index, glass silica fibre core, mechanical protection provided by corrugated steel / polyester laminated tape layered over inner sheath. Overall sheath shall be green polyethylene.

3.3.7 Any other special cables such as co-axial cable or cables with glass insulation, required for instruments shall also be supplied as per requirements. Vendor shall ensure that these cables are armoured type and shall meet all other requirements specified in clause 3.3.1 through 3.3.5, as applicable.

3.4 CABLE DRUMS

3.4.1 Cables shall be drummed in continuous lengths on cable drums. For protection during transport and storage, battens shall be fitted around the entire periphery of the drum.

3.4.2 Drum identification labels shall be attached on the outside and inside of the drum flange. Labels shall be protected by transparent plastic envelopes and give the following information as minimum:

- Drum identification number
- Voltage grade
- Cable construction (eg PVC, SWA, PVC)
- Number of cores and cross-sectional area
- Cable quantity
- Purchaser's order number and item number
- Total weight of cable and drum

3.5 CABLE GLANDS

- 3.5.1 Cable glands required for glanding all cables at both ends shall be supplied by contractor.
- 3.5.2 A minimum of 20% of cable glands shall be supplied as spare.
- 3.5.3 Cable glands shall be of nickel-plated brass and double compression type suitable for armoured cables.
- 3.5.4 All cable glands shall be weatherproof to IP-55. Flameproof glands wherever required shall be supplied with Ex(d) certification.
- 3.5.5 For all field items and junction box end, NPT threaded cable glands shall be used and for control room / control panel end, cable glands shall be ET threaded types.

3.6 JUNCTION BOXES

- 3.6.1 Junction boxes shall be of die-cast aluminium alloy (LM-6) body. All junction boxes shall be weatherproof to IP 55 as a minimum. Flame proof junction boxes wherever required shall be supplied with Ex (d) certification. All flame proof JB's shall be provided with labels for isolating power supply before opening cover. All JB's for intrinsic safe signals shall be identified on name plate accordingly.
- 3.6.2 Junction box shall have screwed covers.
- 3.6.3 Junction box sizes shall be standardized to two types accommodate 44 terminals and 88 terminals. This includes separate terminals for shields and 20% spare terminals. All terminals shall be suitable for 4mm² conductors.
- 3.6.4 Each JB shall be provided with 2 multi-cable entries with one plugged with weather proof, explosion proof plugs as required.
- 3.6.5 Plugs shall be Ex (d) certified for flameproof junction boxes.
- 3.6.6 Telephone sockets and plugs shall be provided in all junction boxes.
- 3.6.7 In general separate junction boxes shall be used for the following:
- Thermocouples
 - RTDs
 - Smart transmitters
 - Non Smart transmitters
 - I/P convertors
 - Switches / Push Buttons
 - Solenoid valves
 - Power
 - Alarm
 - Shutdown
 - Gas detector
- (Separate JB's for intrinsic safe and non-intrinsic safe circuits)
- In general all alarm signals shall be taken to DCS and all shutdown signals to PLC. Accordingly separate junction boxes shall be provided to Alarm and Shutdown signals.

3-way junction boxes shall be used for connecting the field transmitter, field mounted analog I.S. indicator in series with control room receiver.

3.7 MULTI CABLE TRANSIT

3.7.1 The cable entry into the control room, local control rooms, analyser rooms/ shelters shall be through Multi Cable Transit Blocks (MCT). The MCT's shall be sized, supplied and installed at site by contractor. The required cutout sizes and act frames sizes shall be calculated and shall be co-ordinated with control room contractor.

3.7.2 The MCT frames shall be of Standard RGB type of Brattberg or Roptex or equivalent and of steel construction. The maximum height of frame shall not exceed 600 mm unless otherwise specified. The MCT frames provided should be suitable to withstand blast intensity for which blast proof control room has been designed. The MCT shall be supplied complete with insert blocks, spare blocks, stay plates, end-packing etc.

3.7.3 Contractor shall size and provide MCT considering 50% spares for each cable size/cable OD. Contractor shall also provide 50% spare insert blocks in each cable size / O.D. as loose supply. Intrinsically safe cables, low power cables, non-intrinsically safe cables and power cables for instruments (110 V AC or above) shall be suitably separated from the other cables within the MCT frame and shall be routed through separate MCT blocks.

3.7.4 Separate MCT frame shall be considered for electrical cables. The MCT shall be installed as per the recommended practice of supplier. No spare space shall be left uncovered in the frame and shall be filled with dummy block of suitable size.

4.0 RELATED DOCUMENTATION

Nil

5.0 ATTACHMENTS

Nil

SPECIFICATION NO: 44NC-4600-0000/J.SS/0113/A4**TITLE:** STANDARD SPECIFICATION FOR IMPULSE PIPING & TUBING**PROJECT REFERENCE:**

- **Project No:** 44NC-4600
- **Project Location:** Manali, Chennai
- **Project Title:** RESID UPGRADATION PROJECT
- **Client:** Chennai Petroleum Corporation Limited
- **Project Manager Authorization:** B.B. DARAK **Date:**
- **Client Authorization:** **Date:**

				APPROVALS		
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			☐ In-house Review	☐ Purchase		
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1.0 PURPOSE

The purpose of this specification is to define the minimum requirements of design and manufacture of instrument tubes and fittings.

2.0 SCOPE

The scope of work shall include design, manufacture, testing and supply of instrument tubes and fittings. The inspection requirements shall be as per the inspection plan.

3.0 TECHNICAL REQUIREMENTS**3.1 INSTRUMENT VALVES AND MANIFOLDS**

3.1.1 Contractor shall supply instrument valves (miniature type) and valve manifolds wherever required.

3.1.2 Body rating shall be as per piping class or better. All valves and manifolds shall be forged type only.

3.1.3 Valve body and trim material shall be 316 SS unless otherwise specified. Superior trim material shall be selected as required by process conditions. Packing material in general shall be of PTFE.

3.1.4 For instrument air isolation valves, body material shall be nickel or cadmium plated carbon steel.

3.1.5 Contractor shall supply a minimum of 20% instrument valves and manifolds as spare.

3.2 IMPULSE PIPING / TUBING

3.2.1 Contractor shall supply 1/2" OD x 0.049" thick ASTM A 269 TP 316 stainless steel fully annealed, cold drawn and seamless tubes as a minimum for impulse lines upto 600# class. Higher thickness according to pressure rating shall be considered for higher pipe classes.

3.2.2 Monel or other tubing shall be used where 316 SS is not suitable for the service.

3.2.3 SS tubes shall have a hardness of Rockwell RB 70-79.

3.2.3 Steam tracing shall be 10 mm OD hot annealed copper tubes of electrolytic grade copper with wall thickness of 1 mm as per ASTM B68M copper no. C12200.

3.2.4 Instrument air distribution shall be done with 6 mm OD tubes of SS.

3.2.5 Contractor shall supply a minimum of 20% of pipe / tubes as spare.

3.2.6 All piping shall be 1/2" NB with material and class as per piping class of the pipe on which the instrument is connected. The piping shall also be 3/4" NB, 1 1/2" NB as the case may be. In case of vessel/ equipment / reactor piping shall be corresponding equivalent piping class.

3.3 PIPES AND TUBE FITTINGS

3.3.1 Contractor shall supply flareless compression type of tube fitting and of three-piece construction with design similar to Swagelok / Parker Hannifin / Ermeto etc.

- 3.3.2 The fitting / ferrule hardness shall be in the range of RB 85-90 so as to ensure a minimum hardness difference of 5 to 10 between tube and fittings. The ferrule shall be of stainless steel material, in general.
- 3.3.3 Socket-weld type forged pipe fittings of suitable material and rating shall be supplied for pipe fittings. The minimum rating shall be 3000 lbs. Weld neck fittings shall be used where socket weld type is not allowed by piping class.
- 3.3.4 Instrument air fittings shall be of SS only.
- 3.3.5 All threaded fittings shall have NPT threads as per ANSI / ASME B16.11 only.
- 3.3.6 Contractor shall supply a minimum of 20% of each type of pipe / tube fittings as spare.
- 3.3.7 All pipe fittings shall be according to piping material specification as per piping class of the pipe on which instrument is connected. In case of vessel / equipment / reactor, PMS of equivalent piping class shall be considered.
- 3.4 PNEUMATIC SIGNAL TUBES
- 3.4.1 Contractor shall supply 6 mm OD SS tubes for pneumatic signal tubes.
- 3.4.2 Contractor shall avoid use of intermediate connections and shall estimate single length for each instrument location.
- 3.4.3 Contractor shall supply a minimum of 20% length of these tubes as spares.
- 3.5 INSTRUMENT AIR LINES FITTINGS AND VALVES
- 3.5.1 Seamless galvanised, inside and outside, carbon steel pipes used for instrument air distribution shall be as per IS:1239 J3A pipe class.
- 3.5.2 Galvanised forged screwed carbon steel screwed fittings of 2000 lbs rating fittings shall be used.
- 3.5.3 Isolation valves on instrument air service shall be packless gland type full bore ball valves.
- 3.5.4 Contractor shall supply a minimum of 20% of air pipe, fittings and valves as spare.
- 3.6 AIR FILTER REGULATORS
- 3.6.1 Instrument air filter regulator of suitable size, range and capacity shall be supplied for each pneumatic instrument.
- 3.6.2 The body of the filter shall be anodised aluminium.
- 3.6.3 The filter shall have 25 micron sintered bronze / ceramic filter element and shall be provided with manual drain and 2" nominal size pressure gauge. Other filter size shall be considered based on recommendation of I/P transducer vendor.
- 3.6.4 Contractor shall supply a minimum of 20% of air filter regulators of each size and range as spare.

4.0 RELATED DOCUMENTATION

Nil

5.0 ATTACHMENTS

Nil