

		CUSTOMER :		PROJECT TITLE		SPECIFICATION : NUMBER :						
		QUALITY PLAN		QUALITY PLAN		SPECIFICATION : TITLE						
BIDDER/ VENDOR		SHEET 5 OF 9		NUMBER PED-506-00-Q-007. REV-03		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)						
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	SYSTEM	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	SECTION VOLUME III		
										AGENCY	P	W
1	2	3	4	5	6	7	8	9	10	11		
2.0	IN PROCESS											
2.1	STATOR FRAME WELDING (IN CASE OF FABRICATED STATOR)	1.WORKMANSHIP & CLEANNESS	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	3/2	2	-	
2.2	MACHINING	2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-	
		1.FINISH	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	2	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-	
		3.SHAFT SURFACE FLOWS	MA	PT	-DO-	RELEVANT SPEC./ ASTM-E165	MANUF'S SPEC./ BHEL SPEC./	-DO-	2	-	1	
2.3	PAINING	1.SURFACE PREPARATION	MA	VISUAL	100%	MANFR'S SPEC./BHEL SPEC./ SAME AS RELEVANT STAND	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-	
		2.PAINT THICKNESS (BOTH PRIMER & FINISH COAT)	MA	MEASUREMENT BY ELCOMETER	SAMPLE	-DO-	-DO-	-DO-	2	-	-	
		3.SHADE	MA	VISUAL	-DO-	-DO-	-DO-	Log Book	2	-	-	
		4.ADHESION	MA	CROSS CUTTING & TAPE TEST	-DO-	-DO-	-DO-	Log Book	2	-	-	
BHEL		PARTICULARS		BIDDER/VENDOR								
		NAME										
		SIGNATURE										
		DATE										

		QUALITY PLAN		CUSTOMER :		PROJECT		SPECIFICATION :	
				BIDDER/ VENDOR		TITLE		NUMBER :	
QUALITY PLAN		QUALITY PLAN		NUMBER PED-506-00-Q-007, REV-03		TITLE		SPECIFICATION :	
SHEET 6 OF 9		SYSTEM		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)		FORMAT		VOLUME III	
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	LOG OF RECORD	REMARKS
1	2	3	4	5	6	7	8	9	10
2.4	SHEET STACKING	1.COMPLETENESS 2.COMPRESSION & TIGHTENING 3.CORE LOSS & HOTSPOT	MA MA MA	MEASUREMENT MEASUREMENT ELECT.TEST	SAMPLE 100% -DO-	MANUF'R'S SPEC. -DO- -DO-	MANUF'R'S SPEC. -DO- -DO-	Log Book Log Book Log Book	2 - - 2 - - 2 1* 1
2.5	WINDING	1.COMPLETENESS 2.CLEANLINESS 3.IR-HV-IR 4.RESISTANCE 5.INTERTURN INSULATION 6.SURGE WITH STAND AND TAN. DELTA TEST	CR CR CR CR CR CR	VISUAL -DO- ELECT. TEST -DO- -DO- -DO- -DO-	100% -DO- -DO- -DO- -DO- -DO-	MANUF'R'S SPEC./BHEL SPEC. -DO- -DO- -DO- -DO- -DO- -DO-	MANUF'R'S SPEC./BHEL SPEC. -DO- -DO- -DO- -DO- -DO- -DO-	Log Book Log Book Log Book Log Book Log Book Log Book Log Book	2 - - 2 - - 2 - 1 2 - 1 2 - - 2 - 1 2 - 1
2.6	IMPREGNATION	1.VISCOSITY 2.TEMP. PRESSURE VACUUM 3.NO. OF DIPS	MA MA MA	PHY. TEST PROCESS CHECK -DO-	AT STARTING CONTINUOUS -DO-	-DO- -DO- -DO-	-DO- -DO- -DO-	Log Book Log Book Log Book	2 - - 2 - - 2 - 1
BHEL									
PARTICULARS		BIDDER/VENDOR							
NAME									
SIGNATURE									
DATE									
BIDDER'S/VENDORS COMPANY SEAL									

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

QUALITY PLAN			CUSTOMER :		PROJECT		SPECIFICATION :					
SHEET 8 OF 9			BIDDER/ VENDOR		TITLE		NUMBER :					
COMPONENT/OPERATION			SYSTEM		QUALITY PLAN		SPECIFICATION :					
CHARACTERISTIC CHECK			CAT.		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)		TITLE					
SL. NO.	TESTS	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	SECTION	REMARKS		
1	2	3	4	5	6	7	8	9	10	11		
3.0	TESTS	1.TYPE TESTS INCLUDING SPECIAL TESTS AS PER BHEL SPEC. 2.ROUTINE TESTS INCLUDING SPECIAL TEST AS PER BHEL SPEC. 3.VIBRATION & NOISE LEVEL 4.OVERALL DIMENSIONS AND ORIENTATION 5.DEGREE OF PROTECTION 6. MEASUREMENT OF RESISTANCE OF RTD & BTD 7. MEASUREMENT OF RESISTANCE, IR OF SPACE HEATER 8. NAMEPLATE DETAILS 9.EXPLOSION FLAME PROOF NESS (IF SPECIFIED) 10. PAINT SHADE, THICKNESS & FINISH	MA	ELECT.TEST	1/TYPE/SIZE	IS-325/ BHEL SPEC./ DATA SHEET	IS-325/ BHEL SPEC./ DATA SHEET	TEST REPORT	2	1* 1	* NOTE - 1	
			MA	-DO-	100%	-DO-	-DO-	-DO-	2	1\$ 1	\$ NOTE - 2	
			MA	-DO-	100%	IS-12075 & IS-12065	IS-12075 & IS-12065	-DO-	2	1\$ 1	\$ NOTE - 2	
			MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPC. REPORT	2	1 -		
			MA	ELECT. & MECH. TEST	1/TYPE/ SIZE	RELEVANT IS	BHEL SPEC. AND DATA SHEET	TC	2	- 1	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3	
			MA	-DO-	100%	-DO-	-DO-	-DO-	2	1\$ 1	\$ NOTE - 2	
			MA	-DO-	100%	-DO-	-DO-	-DO-	2	1\$ 1	\$ NOTE - 2	
			MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPC. REPORT	2	1\$ 1	\$ NOTE - 2	
			MA	EXPLOSION FLAME PROOF TEST	1/TYPE	IS-3682 IS-8239 IS-8240	IS-3682 IS-8239 IS-8240	TC	2	- 1	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3	
			MA	VISUAL & MEASUREMENT BY ELKOMETER	SAMPLE	BHEL SPEC. & DATA SHEET	BHEL SPEC. & DATA SHEET	TC	2	1\$ 1	SAMPLING PLAN TO BE DECIDED BY INSPECTION AGENCY \$ NOTE - 2	
BHEL			PARTICULARS			BIDDER/VENDOR						
			NAME									
			SIGNATURE									
			DATE									
											BIDDER'S/VENDORS COMPANY SEAL	

		QUALITY PLAN		CUSTOMER :		PROJECT TITLE		SPECIFICATION : NUMBER :			
				BIDDER/ VENDOR SYSTEM		QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03 ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)		SPECIFICATION : TITLE			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	SHEET 9 OF 9	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	SECTION AGENCY	VOLUME III REMARKS
1	2	3	4	5	6	7	8	9	10	11	
NOTES: 1 DEPENDING UPON THE SIZE AND CRITICALLY, WITNESSING BY BHEL SHALL BE DECIDED. 2 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON. 3 IN CASE TEST CERTIFICATES FOR THESE TESTS ON SIMILAR TYPE, SIZE AND DESIGN OF MOTOR FROM INDEPENDENT LABORATORY ARE AVAILABLE, THESE TEST MAY NOT BE REPEATED. 4 WHEREVER CUSTOMER IS INVOLVED IN INSPECTION, AGENCY (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER. <u>Legends for Inspection agency</u> 1. BHEL/CUSTOMER 2. VENDOR (MOTOR MANUFACTURER) 3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER) P. PERFORM W. WITNESS V. VERIFY											
BHEL				PARTICULARS	BIDDER/VENDOR						
				NAME							
				SIGNATURE							
				DATE							
BIDDER'S/VENDORS COMPANY SEAL											

		QUALITY PLAN		CUSTOMER :		PROJECT		SPECIFICATION :				
				BIDDER/ : VENDOR		TITLE		NUMBER :				
								SPECIFICATION				
SHEET 1 OF 2		SYSTEM		QUALITY PLAN		TITLE						
NUMBER PED-506-00-Q-006, REV-01		ITEM AC ELECT. MOTORS BELOW 55KW (LV)		SECTION					VOLUME III			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY	REMARKS		
1	2	3	4	5	6	7	8	9	P	W	V	11
1.0	ASSEMBLY	1.WORKMANSHIP	MA	VISUAL	100%	MANUF'S SPEC	MANUF'S SPEC	-DO-	2	-	-	
		2.DIMENSIONS	MA	-DO-	-DO-	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	-DO-	2	-	-	
		3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/COLOUR CODE	MA	VISUAL	100%	MFG.SPEC./ RELEVANT IS	MFG.SPEC. RELEVANT IS	-DO-	2	-	-	
2.0	PAINTING	1.SHADE	MA	VISUAL	SAMPLE	MANUF'R'S SPEC/BHEL SPEC./RELEVANT STANDARD	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-	
3.0	TESTS	1.ROUTINE TEST INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	IS-325/ BHEL SPEC./ DATA SHEET	SAME AS COL.7	TEST REPORT	2	1		NOTE -1 & NOTE-3
		2.OVERALL DIMENSIONS & ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPN. REPORT	2	1	-	NOTE -1 & NOTE-3
BHEL		PARTICULARS		BIDDER/VENDOR								
		NAME										
		SIGNATURE										

		QUALITY PLAN		CUSTOMER :		PROJECT		SPECIFICATION :			
				BIDDER/ :		TITLE		NUMBER :			
				VENDOR		QUALITY PLAN		SPECIFICATION :			
				SYSTEM		ITEM AC ELECT. MOTORS BELOW 55KW (LV)		TITLE :			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY	REMARKS	VOLUME III
1	2	3	4	5	6	7	8	9	10	11	
NOTES: 1 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON 2 WHERE EVER CUSTOMER IS INVOLVED IN INSPECTION, (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER. 3 FOR EXHAUST/VENTILATION FAN MOTORS OF RATING UPTO 1.5KW , ONLY ROUTINE TEST CERTIFICATES SHALL BE FURNISHED FOR SCRUTINY. <u>Legends for Inspection agency</u> 1. BHEL/CUSTOMER 2. VENDOR (MOTOR MANUFACTURER) 3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER) P. PERFORM W. WITNESS V. VERIFY											
BHEL		PARTICULARS		BIDDER/VENDOR							
		NAME									
		SIGNATURE									
		DATE				BIDDER'S/VENDORS COMPANY SEAL					

[illegible]

BASIC TECHNICAL FEATURES

FOR HT/LT MOTORS

(FOR BHEL-PEM SCOPE PACKAGES)

					PROJECT	2X660MW ENNORE SEZ SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS,CHENNAI						
REV	DATE	ALTD	CHD	APPD		OWNER	TAMIL NADU GENERATION & DISTRIBUTION CORPOARATION LIMITED					
02	13.05.15	RKG/AB	SL	RG								
REVISED AS PER TANGEDCO COMMENTS DATED 10.04.2015						OWNER'S CONSULTANT	DESEIN PRIVATE LIMITED, DESEIN HOUSE,NEW DELHI					
REV	DATE	ALTD	CHD	APPD		EPC CONTRACTOR	BHARAT HEAVY ELECTRICALS LIMITED POWER SECTOR PROJECT ENGINEERING MANAGEMENT NOIDA(U.P) INDIA					
01	13.03.15	BKR-SD-	SL-SD-	RG-SD-								
REVISED AS PER TANGEDCO COMMENTS DATED 13.02.2015						BHARAT HEAVY ELECTRICALS LTD. POWER SECTOR PROJECT ENGINEERING MANAGEMENT NOIDA		DEPT CODE	DRN	NAME BKR	SIGN	DATE
								E	DSGN	BKR	-SD-	13.01.15
								CHD	SL	-SD-	13.01.15	
								APPD	RG	-SD-	13.01.15	
					TITLE	BASIC TECHNICAL FEATURES FOR HT/LT MOTORS		DRAWING NO. PE-DC-412-565-E003				
							SHEET 1 OF 7		REV. 02			



2 x 660 MW ENNORE SEZ STPP

**BASIC TECHNICAL FEATURES
FOR HT / LT MOTORS
(FOR BHEL-PEM SCOPE PACKAGES)**

Doc. No.	PE-DC-412-565-E003
Rev. No.	02
Dated	13-05-2015
Page	2 of 7

1.0 This document covers the basic technical features of high tension (HT) and low tension (LT) squirrel cage induction AC motors employed for driving auxiliaries of BHEL-PEM scope packages in **2 x 660 MW ENNORE SEZ STPP**.

2.0 CODES AND STANDARDS

The motors shall generally conform to IS 325/IEC-60034. LT motors above 10 kW with continuous duty (S1) shall be energy efficient IE3 conforming to IS-12615: 2011.

3.0 DESIGN REQUIREMENTS

3.1 General Requirements

The design ambient temperature shall be 50 deg C.

3.2 Supply system and rated voltage of motors

KW rating	Supply system	Rated voltage of motor
Above 1500 kW	11 KV	11 KV
Above 160 kW up to & including 1500 kW	3.3 KV	3.3 KV
From 200W up to & including 160 kW	415 V	415 V
Below 200W	240V	240V

3.2.1 Supply voltage & variations shall be as follows:-

Voltage variation (AC Supply) (+/-) 10%
Frequency variation (+) 3% to (-) 5%
Combined V & F variation 10% (sum of absolute values)

3.2.2 Motors shall be capable of running continuously at rated output for each of the conditions specified.

3.3 Motor Rating

Motor ratings shall be adequate to meet the requirements of the drive equipment. Motors shall be continuously rated at the design ambient temperature of 50 degree C and relative humidity of 85%. Maximum continuous motor ratings shall have at least a 10% margin above the maximum load demand of the driven equipment under entire operating range including voltage & frequency variation.

3.4 Starting Requirements

3.4.1 Motor shall start smoothly and rapidly. Motor characteristics such as speed, starting torque, break away torque and starting time shall be properly co-ordinated with the requirements of driven equipment. The accelerating torque at any speed with the minimum starting voltage shall be at least 10% of the motor's full load torque.

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- 3.4.2 Motors shall be capable of starting and accelerating the load with direct on line starting without exceeding acceptable winding temperature.

Minimum Starting Voltage requirement for all motors (except mill motors):

1. 85 % of rated voltage for motors up to 1000 kW
2. 80 % of rated voltage for above 1000 kW and up to 4000 kW
3. 75 % of rated voltage for above 4000 kW

- 3.4.3 The locked rotor current of the HV (11 kV) motors (except MDBFP motors) shall not exceed 650% of full load current inclusive of tolerance as per IS: 325 and for MV (3.3 kV) motors locked rotor current shall not exceed 700% of full load current inclusive of tolerance as per IS: 325. For LT motors (except energy efficient motors) locked rotor current shall not exceed 700% of full load current inclusive of tolerance as per IS: 325. For LT energy efficient motors above 10kW with S1 duty, locked rotor current shall be as per IS: 12615-2011.

- 3.4.4 The following frequency of starts shall apply to HV (11 kV), MV (3.3 kV) & LT motors

- i) Two nos. consecutive cold starts in quick succession with third start after 5 minutes in cold condition.
- ii) Two nos. consecutive hot starts in the interval of 15 minutes in hot condition.

- 3.4.5 Locked motor withstand time of motors under hot condition at highest voltage limit shall be as follows:

- a) For motors with starting time up to 20 sec.
 - at least 2.5 sec. more than starting time.
- b) For motor with starting time above 20 secs but not exceeding 45 secs.
 - at least 5.0 sec. more than starting time.
- c) For motors with starting time above 45 secs.
 - at least 10% more than starting time.

The starting time of the motor referred above is at minimum permissible voltage. For motors and in cases where the above requirements are not complied with, speed switches of approved make & type shall be provided to bypass the locked rotor protection for a pre-selected time during starting of motors. The speed switches shall have one NO & one NC contacts having maximum interrupting capacity of 5 Amps at 240V AC and 0.25 amps at 220 V DC.

3.5 Running Requirements

- 3.5.1 Motors shall run satisfactorily at a supply voltage of 80% of rated voltage for 5 minutes with full load without injurious heating to the motor.
- 3.5.2 Pull out torque at rated voltage shall not be less than 205% of full load torque. It shall be 275% for crane duty motors.

3.6 Stress during bus Transfer:



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3.6.1 Motors shall withstand the voltage and torque stress developed due to the application of 150% of the rated voltage for at least 1 sec. caused due to vector difference between the motor residual voltage and the incoming supply voltage during occasional auto bus transfer.

3.6.2 Motor windings shall be adequately braced to satisfactorily withstand the mech. Stresses during above condition.

3.6.3 Motors shall be capable of withstanding heavy in-rush transient current caused by bus transfer without damage.

3.6.4 Motor and driven eqpt. Shafts shall be adequately sized to satisfactorily withstand transient torque under above condition.

3.7 Noise level

The maximum noise level for motors shall be in line with IS 12065.

3.8 Vibration

The maximum vibration for motors shall be in line with IS: 12075.

3.9 Crane duty motors will be of squirrel cage induction motor and shall suit the duty class S4, cyclic duration factor 40% and 300 starts. Crane duty motors shall be provided with VVFD for speed control.

1

4.0 CONSTRUCTIONAL FEATURES

4.1 Degree of Protection

4.1.1 Indoor motors shall conform to degree of protection IP: 54 as per IS: 4691. Outdoor motors shall conform to degree of protection IP: 55 as per IS: 4691 and shall be of weather-proof construction. Canopy shall be provided for outdoor motors. CW motors (in case of screen prot. Drip proof) shall conform to degree of protection IP: 23 as per IS: 4691. The degree of protection for terminal boxes shall be IP 55 for outdoor area & IP 54 for indoor area as per IS 4691.

4.1.2 The stator laminations shall made from suitable silicon steel/magnetic steel sheet varnished on both sides and pressed to form a rigid core.

4.1.3 The rotor shall be of rigid cage construction with die cast aluminium / copper alloy / copper bars firmly wedged in bar slots and brazed to the end rings. The rotor cage shall be designed to operate satisfactorily under respective starting and load duty cycle.

4.2 Enclosure and Cooling

4.2.1 Motors shall generally have totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) enclosures or Closed Air circuit Air (CACA), the method of cooling conforming to IC-0141 or IC-0151 or IC-0161 of IS: 6362 up to 3000 kW motor. CW Motors may be screen protected drip proof (SPDP).

4.2.2 Motors shall not be provided with any electric or pneumatic operated external fan for cooling the motors.



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4.2.3 Frames shall be designed to avoid collection of moisture and all enclosures shall be provided with facility for drainage at the lowest point.

4.3 Class of Insulation

HV/MV/LT motors shall have class F insulation. The temperature rise of all motors shall be limited to the limits applicable to Class 'B' insulation. In case of continuous operation at extreme voltage limits, 10deg C rise above the temperature limits specified in IS: 325 shall be permissible.

4.4 Bearings

4.4.1 Horizontally mounted motors shall have grease lubricated ball/roller or sleeve bearings. For HV/MV motors, the bearings shall be regreasable type and for LV motors, these bearings can be either sealed life lubricated type or regreasable type as per manufacturer's standard.

4.4.2 The vertical motors shall have a combined thrust and guide bearing on top and guide bearing at bottom. If the ball or roller bearings can take vertical thrust, thrust and guide bearing need not be provided.

4.4.3 After taking all motor driven equipment loads and thrust (if any) into account, the bearings shall be suitable for min. 20,000 working hours. Re-greasable bearings shall be provided with grease nipples and relief holes for on-line re-greasing and shall be suitable for 8000 working hours without changing of the grease.

4.4.4 The bearings of solidly coupled motors shall be of the same type as those of the driven equipment.

4.4.5 For motors below 15 kW shall be provided with sealed ZZ bearing.

4.4.6 Motors rated above 1000kW shall be provided with insulated end shield on non-driving end to prevent flow of shaft current.

4.5 Terminals and Terminal Boxes

4.5.1 Motors of rating 90 kW and up to 160kW will be controlled by air circuit breaker with numerical protection. For all motors of rating up to 90kW shall be provided with MCCBs. The terminal box of motors for HV (11 kV), MV (3.3 kV) & LT motors shall be designed for the maximum fault current for a duration of at least 0.25 secs. **11kV & 3.3kV motors terminals shall be able to withstand 44kA for 0.25 seconds.**

1

4.5.2 Unless otherwise specified or approved, phase terminal boxes of horizontal motors shall be positioned on the left hand side of the motor when viewed from the non-driving end.

4.5.3 For HV/MV motors, the main terminal box shall be of phase-segregated type with clamping arrangement for the terminals.

4.5.4 Connections shall be such that when the supply leads R, Y & B are connected to motor terminals A B & C or U, V & W respectively, motor shall rotate in an anticlockwise direction when viewed from the non-driving end. Where such motors require clockwise rotation, the supply leads R, Y, B will be connected to motor terminals A,C,B or V, W & U respectively.

4.5.5 Permanently attached diagram and instruction plate made preferably of stainless steel shall be mounted inside terminal box cover giving the connection diagram for the desired direction of rotation and reverse rotation.

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- 4.5.6 Motor terminals and terminal leads shall be fully insulated with no bar live parts.
- 4.5.7 Separate terminal boxes shall be provided for space heaters and temp. Indicators. If this is not possible in case of LT motors, the space heater terminals shall be adequately segregated from the main terminals in the main terminal box. Detachable gland plates of thickness 3 mm (hot/cold rolled sheet steel) or 4 mm (non-magnetic material for single core cables) with double compression tinned brass glands shall be provided in terminal boxes.
- 4.5.8 Phase terminal boxes shall be suitable for 360 degree of rotation in steps of 180 and 90 degree for HT and LT motors respectively.
- 4.5.9 Cable glands and cable lugs as per selected cable sizes shall be provided in line with cable erection philosophy. For single core cable termination, gland plates shall be of non-magnetic material.
- 4.6 Grounding

Two separate earthing terminals suitable for connecting G.I. strip grounding conductor shall be provided on opposite sides of motor frame. Each terminal box shall have a grounding terminal.

4.7 General

- 4.7.1 Motors provided for similar drives shall be interchangeable.
- 4.7.2 An arrow block shall be screwed on the body of the motors on the non-driving end to indicate the direction of rotation of the motors.
- 4.7.3 Motors for Fuel oil unloading and drain oil pumps located in hazardous areas shall be with flame-proof enclosures in accordance with IS 2148 / IEC 60079.

a) Fuel oil area: Group - IIB.

b) Hydrogen generation plant area: Group - IIC

- 4.8 Neutral terminal box of motors rated 1000kW and above shall provision of mounting Neutral CTs of PS class identical to the CTs to be provided at switchgear end. Further the neutral terminals of HV motors rated below 1000kW shall be accessible.

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5.0 ACCESSORIES

5.1 SPACE HEATERS

All motors rated 30KW and above shall be provided with space heaters to maintain the motor internal air temperature above the dew point. Space heaters shall be suitable for a supply of 240V AC, single phase, 50 Hz.

The leads from space heaters of each motor shall be brought out to a separate terminal Box. Space heaters shall be mounted inside the motor in accessible places so that their removal and replacement is simple.

5.2 RESISTANCE TEMPERATURE DETECTORS (RTDs)

- 5.2.1 HV/MV motors stator windings shall be provided with 12 nos. Simplex 3 wire Platinum RTDs with 100 ohms resistance at 0 deg C for remote monitoring of winding temperature. The leads from RTDs of each motor shall be brought out to a separate terminal Box.

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5.2.2 For HV/MV motors, each bearing shall be provided with 1 no. Duplex 3 wire Platinum RTDs with 100 ohms resistance at 0 deg C for remote monitoring of bearing temperature. The leads from these RTDs shall be brought out to a separate terminal Box or the terminal box same as for winding RTDs.

5.3 DIAL TYPE TEMP. INDICATORS

5.3.1 For HV/MV motors, each bearing shall be provided with dial type thermometer with adjustable alarm contact and resistance type temperature detector. The indicators shall have 2 nos. NO contacts rated for 5A, 240 V AC and 0.5 A, 220 V DC for alarm/trip purpose.

5.4 Vibration monitoring pads

5.4.1 Provision shall be made in all HV/MV motors for mounting vibration detectors.

6.0 NAME PLATE

Motors shall have stainless steel name plate with all particulars as per IS: 325. In addition bearing identification number and type of lubricant is to be indicated.

7.0 PAINTING

Motor including fan shall be painted with corrosion proof paints of colour shade Siemens grey (RAL 7032).

8.0 TESTING

8.1 Type Tests

For HT & LT Motors, type test reports for type tests as per IS: 325/ IS: 12615 conducted on equipment similar to those proposed to be supplied and carried out within last five years shall be submitted. However, if such reports are not available, one motor of each type shall be subjected to type tests for free of cost.

8.2 Routine Tests

All motors shall be subjected to routine tests as per IS: 325/ IS: 12615 in the presence of customer or customer representative.



**2X660 MW ENNORE SEZ
COMPRESSED AIR SYSTEM
TECHNICAL SPECIFICATION
(C&I PORTION)**

SPECIFICATION No: PE-TS-412-555-A001

VOLUME: II B

SECTION : C-4

REV. 00

DATE: 15.12.2016

SHEET: 1 OF 1

**SECTION: C-4
TECHNICAL SPECIFICATION (C&I PORTION)**

C & I SPECIFICATIONS FOR PLC BASED COMPRESSED AIR SYSTEM

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GENERAL & SPECIFIC TECHNICAL REQUIREMENT

	SPECIFICATION FOR CONTROL & INSTRUMENTATION FOR AUX PACKAGES	SPECIFICATION NO.:	
		VOLUME	
		SUB SECTION	
		REV. NO.	DATE :
		SHEET	OF

GENERAL REQUIREMENT

1.0 Bidder shall provide complete and independent control & instrumentation system with all accessories, auxiliaries and associated equipments for the safe, efficient and reliable operation of auxiliary systems.

2.0 The quantity of instruments for auxiliary system shall be as per tender P & ID wherever provided of the respective system as a minimum, for bidding purpose. However, Bidder shall also include in his proposal all the instruments and devices that are needed for the completeness of the plant auxiliary system/ equipment supplied by the bidder, even if the same is not specifically appearing in the P & ID. During detail engineering if any additional instruments are required for safe & reliable operation of plant, bidder shall supply the same without any price implication.

3.0 Measuring instruments/equipment and subsystems offered by the bidder shall be from reputed experienced manufacturers of specified type and range of equipment, whose guaranteed and trouble free operation has been proven. Further all the instruments shall be of proven reliability, accuracy, and acceptable international standards and shall be subject to employer's approval. All instrumentation equipment and accessories under this specification shall be furnished as per technical specification, ranges, makes/ numbers as approved by the employer' during detail engineering.

4.0 The necessary root valves, impulse piping, drain cocks, gauge-zeroing cocks, valve manifold and all the other accessories required for mounting/ erection of these local instruments shall be furnished, even if not specifically asked for, on as required basis. The contacts of equipment mounted instruments; sensors, switches etc for external connection including spare contacts shall be wired out to suitably located junction boxes.

5.0 The customer specification attached as Specific Technical Requirement will supercede the Data sheets, if there is any mismatch.

	2X660 MW ENNORE TPP	
	SPECIFIC TECHNICAL REQUIREMENTS (C&I) AIR CONDITIONING SYSTEM	
Specific Technical Requirements (C&I): 1. Integrated microprocessor based control system along with suitable operator interface shall be provided for each Instrument Air Compressor & Service Air Compressor. The individual compressor shall be microprocessor based and one number redundant PROGRAMMABLE LOGIC CONTROL (PLC) shall be provided for overall control of all compressors. The PLC system shall have hot redundant processors, and shall also have redundancy in communication system and power supply. The PLC shall be provided for overall monitoring, control and operation, loading, unloading and auto standby start of compressors, dryers, control valves, solenoid valves, field instruments, etc. One no. OWS (24" LED), One no. OEWS (24" LED), One no. B/W Laser Jet Printer (LJP) & one no. A3 sized Dot Matrix Printer (DMP) shall be provided along with the PLC. 2. The communication between PLC and Main plant DCS shall be redundant and type of soft-link shall be MODBUS on RS-485. For communication between main plant DCS and PLC, the PLC end shall be considered as server and DCS shall be considered as client. PLC shall have provision for hardwired signal exchange with DCS for monitoring of major equipment's status and abnormal conditions only. 3. PLC control system shall be time synchronized with the Master clock system of the main plant to ensure uniform time indication throughout the Plant. The required provision (IRIG-B) shall be made by the bidder at the PLC end to achieve the same. 4. The software and hardware for offered PLC system shall be of latest version and shall be upgradable. Bidder to ensure the availability of spares and service support for the offered PLC system for minimum 15 years after guarantee period. 5. Provision for redundant soft interfacing and Hardwired interfacing shall be included for signal exchange between Compressed Air System's PLC and individual compressor's Microprocessor based control panel. The common PLC shall have redundant interfacing(not in daisy serial link) with each individual compressor's microprocessor based control system, and HW signals required for command, status, local/remote operation, interlock & protection of complete processor package. 6. All electrical actuators shall be conventional of integral starter type.		

	2X660 MW ENNORE TPP	
	SPECIFIC TECHNICAL REQUIREMENTS (C&I) AIR CONDITIONING SYSTEM	
7.	The make/model of various instruments/items/systems shall be subject to approval of owner/purchaser during detailed engineering stage. No commercial implication in this regard shall be acceptable. In case of any conflict and repetition of clauses in the specification, the more stringent requirements among them are to be complied with.	
8.	The solenoid valves shall have limit switches for open/close feedback.	
9.	Interface of MCC, HT SWGR, Actuators etc. with PLC based control system shall be as per Drive Control Philosophy attached in the specification. The attached philosophy is for DCS based control system. However, the same is applicable for PLC as well.	
10.	All the instruments/drives shall be terminated on JB's/Panels in field. JB's/Panels shall be in Bidder's scope. RTD's shall be of duplex type. Temperature transmitters are envisaged for RTD for monitoring services/application only. These shall be hooked-up to the PLC.	
11.	Each Compressor's winding temp RTD signals, bearing temp RTD signals and VMS signals shall be hardwired to the microprocessor based control system and PLC directly from the field/VMS panel.	
12.	Scope of Instrumentation cables (Screened Control Cables), Fibre Optic cable & Control cables shall be as per Electrical Cable scope matrix in Electrical portion of specification.	
13.	Power supply required for instruments and compressor's control system shall be derived from 415 V, 3 phase, AC supply provided for the compressor. No other power supply shall be provided.	
14.	UPS (Common) for PLC & OWS shall be in bidder's scope with 2X100% configuration. UPS shall have 2X100%, heavy duty Ni-Cd Fiber plated type battery bank with 60 min back up.	
15.	BHEL shall provide vibration monitoring system for each compressor motor, bidder to hook-up vibrations signals from instrument/panel to PLC for necessary interlock and protection.	
16.	Bidder shall provide Customer training on the proper application and maintenance on PLC Hardware & Software at Vendor's work or at Ennore SEZ site. Duration of the training, number of persons & the topics to be covered shall be discussed & mutually agreed during contract finalization stage.	

	2X660 MW ENNORE TPP	
	SPECIFIC TECHNICAL REQUIREMENTS (C&I) AIR CONDITIONING SYSTEM	
17.	Following documents to be furnished by the bidder along with the bid: • Duly stamped and signed copy of PLC system configuration drawing • Duly stamped and signed copy of Quality Plan. • Product catalogues and specifications for PLC as well as HMI application. • Requirement of electronic earthing, if any, for PLC based control system	
18.	Complete Industrial grade furniture required for placing OWS, swivel chairs, printers, keyboards, computers etc. shall also be furnished by bidder. The exact details shall be finalized & approved by owner/purchaser during detailed engineering.	
20.	Bidder to comply with codes and standards as mentioned in the specification.	
21.	Bidder shall provide the necessary hardware & software required for connecting the PLC system to Bidder's remote service centre, through which the diagnostics & fault analysis of the PLC system can be carried out. The method of connection shall be as per Bidder's standard practice. However, it is preferred to have the connection through a single point in the PLC system.	
22.	Bidder shall provide an unlimited warranty on all equipment and software for three years after the start of the warranty period, i.e. after satisfactory completion of initial operations. This warranty shall include repair, replacement or correction of identified software or hardware discrepancies at no cost to OWNER.	
23.	PLC network shall have Intrusion Detection System (IDS) and Intrusion Prevention System (IPS) with following features: In order to inspect all inbound and outbound network activity and identify suspicious patterns that may indicate a network or system attack from someone attempting to break into or compromise a system on the Station LAN Network, the recommended IDS/IPS should contain the following combined features. Any feature can be selected depending on whether it is to be configured as IPS or IDS. - Able to analyze, detect and report on security related events. - Able to inspect traffic and to drop malicious traffic based on the configuration of security policy. - Able to inspect the content of network packets for unique sequences/signatures.	

	2X660 MW ENNORE TPP	
	SPECIFIC TECHNICAL REQUIREMENTS (C&I) AIR CONDITIONING SYSTEM	
	iv. Able to detect and prevent known types of attacks such as worm or Trojan infections and hacks. v. Able to prevent denial of service (DOS) and Distributed Denial of Service attacks. vi. Able to prevent abnormal behaviors by monitoring and learning normal network behaviors. vii. Keeps up-to-date on new threats and vulnerabilities. viii. Should provide user friendly interface to queries and reports on threats and event data so that security administrators can gain a better understanding of their ability to protect their network. ix. Should provide detailed activity logs for auditing. x. Able to detect known threats via deep-packet inspection. xi. Able to detect unknown threats via anomaly scanning. xii. Able to detect unknown threats via behavior pattern to protect from zero day. 24. All local gauges, transmitters and switches shall be mounted on suitable enclosures, racks subject to owner's approval. All transmitters shall be HART compatible. 25. Bidder to delegate /depute their persons/experts as per owner/consultants' requirement. 26. Bidder must offer general tools and tackles and special calibration instruments required during start-up, trial run, operation and maintenance of the system. 25. The above given scope is indicative & minimum. Any item/ equipment not indicated above however required for the completeness of the system is to be supplied by bidder without any technical, commercial and delivery implication to BHEL.	

GENERAL

1. The specification hereunder provides a general guideline for Control & Instrumentations to be provided for the Plant auxiliary systems and Off Site Plants. Bidder shall provide functionally independent & geographically distributed PLC (Programmable Logic Control) based control & Instrumentation system with all control equipment, instruments, accessories, cables and erection hardware for safe, efficient and reliable operation of the plant.
2. Each of the Plant Auxiliaries & off site systems shall be provided with annunciation system. It shall be an integral part of the control system. All the field contact for this purpose shall be acquired through control system. The annunciation sequence/logic shall conform to ISA sequence ISA-2A. The window lamps for the system shall be driven through output modules of the control system.

3. Remote Terminal Units (RTUs) have been envisaged for data acquisition function. Bidder shall provide necessary RTUs comprising of Input / Output modules, Processor etc., signal cable for interface with PLC panel, communication cables, and erection hardware's and other software & hardware for complete functioning of the off - site plants.
4. The instrumentation to be provided for each of the plant auxiliary & Off Site Plant systems shall be as per the technical specification document / drawings wherever provided for the respective systems as a minimum requirement for bidding purpose. However, for completeness of each of the plant auxiliary & Off Site system and its associated equipment, Bidder shall also provide all the necessary instruments to the process requirement even if it is not specifically indicated in the given technical Specification document / drawings.
5. The instrumentation, operation and control philosophy proposed is specific to the plant design. Any improvement over the proposed typical Control & Instrumentation scheme shall be accepted so long as it does not deviate from the basic intent and general philosophy enumerated herein and elsewhere in this specification.
6. Plant auxiliaries / Off Site Plants shall be operated from their respective local control panels or Operating work stations located in the local area control rooms. Some of the auxiliaries will have operational facility from central control room as well as from local panels. All the PLC's of Ash Handling, DM-RO plant, Service water pump house, Compressor Plant, Condensate polishing unit, Fire Water Pump house etc., shall have digital data communication connectivity with DDCMIS already detailed/discussed in chapter 4. The control system for each of the Plant auxiliaries, Off Site Plant and their Man machine interface requirement and DDC MIS interfaces in the central control room shall be as follows:
 - i. Considering the high ambient noise and electromagnetic interference prevailing in power plant, it is recommended that all links between off-site controls and plant DDC MIS shall be based on Dual Optical Fiber Communication (OFC) medium. Necessary ports / converters shall be provided at both ends.
 - ii. PLC and RTU shall be designed for operating in a non air-conditioned harsh environment also. Communication media shall be optical fiber cable with MODBUS / OPC protocol between DDCMIS and PLC as per requirements. Optical cable, PLC end Modem/Converter and DDCMIS end Modem/Converter shall be supplied by bidder at both end. Optical cables shall be routed through GI conduit pipes. Communication protocol between the Modems shall be RS485/Modbus and the maximum communication time for receipt of signal at DDCMIS end should not exceed 2 seconds. The Communication links shall be as per chapter 4.

- iii. In addition Hard wired signal interfacing shall also be provided for any signal required for interlock, control & protection. Similarly cable for hard ware signal transfer between DDCMIS and PLC/relay based control system shall be supplied, laid terminated by the bidder including preparation of cable schedule. Quantum of hard wired signals for linking each PLC based system and DDCMIS shall be decided during detailed engineering..
7. Bidder will provide necessary separate industrial grade parallel redundant UPS power supply with 60 minutes battery backup for each PLC, Operating station & printer etc. Bidder shall provide necessary separate industrial grade parallel redundant 24 volts DC charger with 60 minutes battery backup for each PLC without Operating station . Bidder shall have to provide necessary cabling for redundant power supply to UPS / charger.
8. Whenever control system is PLC based, annunciation system shall be driven by PLC via Digital output. Mimic LED shall also be driven from PLC digital output. For other relay based control systems, solid-state annunciation system shall be provided. Mimic acrylic sheet thickness shall be min 6-7 mm.
9. For each PLC system, without OEWS (Operating Engineering Work Station), Laptop along with software shall be provided for engineering (Laptop shall be separate for each PLC with out OWES).
10. PLC system without OEWS (Operating & Engineering Work Station) shall have panel mounted push buttons, lamps, H.W. annunciation, indicators, Ammeters and MIMIC etc for operation & control purpose except specifically requirements of control desk mentioned for any package listed above.
11. All the PLC control system shall be of same make, model & same family and shall be supplied directly from manufacturer/vendors. PLC system supplied /engineered by system houses shall not be acceptable. It is preferred to have same family of Plant DDCMIS .
12. All remote I/O cards shall be with IP-65 protection class and should withstand upto 70 deg.C temperature.
13. All cables terminated in the terminal block, power distribution scheme instruments shall be ferruled. Ferruling shall be double cross ferruling (i.e.) source and destination addresses shall be marked on both sides of the tube ferruling.
14. Any Package not listed above shall be PLC (redundant hot standby controllers) controlled with one no. OWS, one no. OEWS (Operating & Engineering Work Station) and one no. A4 B/W LJP.

15. Bidder shall provide local panel for local start/ stop monitoring of auxiliaries and equipment as per requirement . The requirement shall be decided during detailed engineering. All local panel shall be NEMA 4X with canopy.
 16. Bidder shall provide ammeters, voltmeters, PB indicating lamp, mimic, electrical scheme, indicators, chartless recorders and HW annunciators on the desk/ panels as requirement and shall be decided in detailed engineering.
 17. PLC supplier shall prepare graphic for the complete plant with proper tag nos. for drives, binary inputs, analogue inputs, status of drives etc for the soft link for DDCMIS as per format of DDCMIS.
 18. Each PLC/Microprocessor based system/electrical system shall be time synchronized with master clock system. Redundant Time synchronisation signals shall be provided for each control system, wherever redundant controllers/processors are provided.
 19. Each subsystem PLC shall be provided with HW interfacing with main system PLC for signals used for command, interlocks, protections and other important process parameters.
 20. Control, operation & monitoring of electrical distribution system, namely PCC, Bus coupler, Incoming, breakers etc. for respective plant BOP package shall be controlled & operated from its respective PLC operating station/ backup control desk as well as from respective switchgear unit. Control system for the same shall be implemented in the respective PLC envisaged in the local control room. Bidder shall consider all transducers for monitoring of voltage, current, Kwh, power factor at respective PLC operating station and backup control desk. All signals shall be hardwired only.
 21. The technical particulars & requirements of PLC, OWS, Printers, LVS and all other related hardwares/software shall be as per Vol. V, Chapter 4.
 22. The technical particulars & requirements of UPS & 24 V DC systems shall be as per Vol. V, Chapter 7.
- (Refer PLC System Configuration Drawings, # 114 -01-0000, 0101, 0105, 0107, 0111, 0113, 0114 & 0116, In case any ambiguity between System Configuration Drawings & above Annexure A, Annexure A shall prevail for finalizing the PLC configuration).

3.00.00 COMPRESSED AIR PLANT

3.00.01 CONTROL PHILOSOPHY

The Compressed Air plant is envisaged with Microprocessor based System for individual compressor and One number redundant **PROGRAMMABLE LOGIC CONTROL** system with one no. OWS & one no. OEWS, One no. B/W LJP & one no. A3 sized DMP for all compressors as defined in the Vol. V, Annexure A shall have to be complied.

The control system shall be fully automatic. The control system together with the power supplies and other accessories will be located within the centralized local panel. The system shall include Binary Logic (interlocks, protection and sequential logic control). The control system shall be capable of communicating with the central control room through PLC gateway for the purpose of achieving functions of remote control & monitoring

The PLC shall be preferably from plant DDCMIS family.

The PLC system shall be provided as detailed in Chapter 4 of this specification..

Open and Close limit switch feed backs of valves are to be connected to PLC for remote viewing and for interlocks and protection.

Remote and local indications of various parameters to the process requirement shall be provided. (The same can be decided during detailed engineering)

The OLCS and CLCS philosophy shall be as per the chapter 4 of this volume.

3.00.02 OPERATIONAL REQUIREMENT

1. Operation of the compressors and driers shall be performed from PLC based control panel to be located at the compressor room (air conditioned area). The Control panel shall house PLC Hardware, Alarm Annunciator driven by PLC programmed sequence, Indicators, Indication lamps, Switches, local / remote selector switch, Start / Stop push buttons, Auxiliary Relays, Motor current meter etc.. Selector switch shall be provided in the control panel to achieve three positions for "Base duty", "Stand by duty" and "Stop".
2. All pressure and temperature conditions used for tripping the compressor shall be provided with pre-trip annunciation in the remote control desk/panel.
3. All initiating devices, relays and other hardware required to achieve annunciation, control and interlock system shall be provided by the bidder.
4. Auto switching on standby compressor, incase of tripping of running compressor or on falling of air pressure.

3.00.03 **IMPORTANT SAFETY INTERLOCKS**

The safety interlocks shall be furnished by the vendor during detail engineering and will be reviewed and approved by owner.

3.00.04 **SPECIAL INSTRUMENT REQUIREMENT**

On the discharge line of each compressor, Vortex flow meter will be provided for the measurement of airflow of each compressor.

With acknowledgement to the fact that the entire area is vibration prone, capillary type instruments like temperature and pressure gauges and switches be mounted on Local Panel to avoid vibration. Instead, Duplex copper - constantan (T) type thermocouples / RTDs shall be provided for remote monitoring.

Bidder shall provide Dew point measuring instrument at the each common header in addition to the on line Moisture analyzer at each compressor outlet.

3.00.05 **ANNUNCIATION SYSTEM**

The Alarm Annunciation on the local control panel shall provide annunciation for the conditions furnished by vender during detail engineering subject to approval of owner.

3.00.06 **MONITORING & CONTROL**

Bidder shall consider instruments as per P&ID requirements as well as his recommended instruments for Control and monitoring.

1. Loading / unloading indication.
2. Remote and local Remote start & stop.
3. Remote and local Cooling water pressure & temperature at I / L & O / L of intercooler & after cooler.
4. Remote and local Open & Close indication of valve at inlet of cooling water line.
5. Remote and local 1st. stage and 2nd. Stage discharge pressure and temperature.
6. Remote and local Air pressure and temperature at each cooler outlet (1st Stage, After Cooler).
7. Remote and local Pressure on each air header at various locations distributed throughout the plant.
8. Cooling water flow at I / L and O/L, Lubricating oil pressure, Moisture separator temperature are preferred to be used for interlock and protection.
9. Motor current
10. Zero load, 50% load, 100% load control for energy savings.
11. On line Dew point monitor at each compressor outlet and at each header shall be provided.
12. Any other instrument recommended by the OEM.
13. Remote and local Cooling water Header Inlet and outlet temperature at DDCMIS.
14. Cooling water flow low alarm to each compressor

15. Control of moisture separator circuit shall be implemented in PLC. Auto drain valves and solenoid operated valves through timers of PLC are to be paralleled at the bottom of reservoir tank.
16. Instrument & service air header Flow meter, pressure transmitters.

CHAPTER-2

DESIGN CRITERIA

2.00.00 Design Criteria

2.01.00 General Requirements

2.01.01 The design criteria given in this section supplements the requirements stated in other sections of this specification and the drawings enclosed herewith. These shall be fully met by all equipment/systems and accessories furnished as per this specification.

2.01.02 All equipment/systems and accessories furnished as per this specification shall be from the latest proven product range of a qualified manufacturer meeting the requirements given in this Specification. The Bidder shall furnish satisfactory evidence regarding successful operation and high reliability of the proposed equipment/systems in coal fired utility stations for similar applications for meeting this requirement as specified elsewhere.

2.01.03 The equipment and systems shall be designed and constructed to meet all specification requirements, and perform accurately and safely under the environmental and operating conditions described or implied in this specification without undue heating, vibration, wear, corrosion or other operating troubles. It will be the responsibility of the Bidder to fully acquaint himself with the functional requirements and operating conditions, for equipment systems and accessories offered for this project. Additional features shall be provided where required to meet the service conditions, functional or descriptive requirements stated in individual specification for these equipment/systems.

The bidder's detailed design and scope of supply shall include all components and systems, whether included in the system descriptions or not, required to provide a complete and fully functional facility.

These specifications are on per unit basis.

2.01.04 The equipment, systems and accessories furnished as per this specification shall be designed and constructed to meet all specification requirements and performance specifications during the continuous service life of the plant. The equipment or components that cannot meet this life expectancy or specified design and operational requirements during the entire service life shall be identified and their expected failure rate shall be indicated by the Bidder in his proposal. When no such information is furnished the equipment shall be deemed to have been certified by bidder suitable for the above service life and requirements.

During execution of the project or at the time of dispatch, any latest product is launched or introduced then the same shall be supplied with out any price implication.

Technical specifications specified for all type of hardwares, instruments, equipments & software are the minimum requirements to be met and confirmed by bidder. All the

hardwares and softwares shall be latest, with advanced features and field proven at the time of supply / dispatch as available in the market with out any price implication.

Bidder shall offer latest system available at the time of supply / dispatch & shall also confirm that DDCMIS/PLC system/microprocessor based control system, MIS, ERP system etc. hardware / software shall be upgraded free of cost (for hardware up to commissioning of the project and software up to handing over of the project), whenever at later stage such upgradation takes place for his system offered by him or by his collaborator.

In addition to above requirements, Bidder shall also undertake to upgrade the system hardware if required by owner, at par with the new version, for a period of 5 years after commissioning at a reasonable extra cost and The future updated version of any type of software shall be supplied free of cost as and when such software is upgraded, on request by owner until 5 years from the date of commissioning of the unit.

- 2.01.05** Even after the guarantee period, the Bidder shall be responsible for providing spare parts and other required support at reasonable cost during the service life of the plant as indicated above. Any exception to these requirements shall be clearly indicated in the Schedule of Technical Deviations.

Bidder shall also guarantee supply of spares for at least 15 (Fifteen) years after commissioning of the plant. In case of future up-gradation of a product in terms of hardware, bidder shall remain committed to upgrade the supplied system at Par with the new version as per scheduled agreed with owner for a period of 5 years from the date of commissioning of the unit. Beyond this period, for up to 15 years, Bidder shall be obliged to indicate whether it will be possible to upgrade the system by replacing certain pieces/components of hardware by suitable new generation equipments.

- 2.01.06** All requirements of auxiliary equipment for instruments and control devices including thermocouples and wells, resistance elements and wells, transmitters, special wiring and piping accessories, air filter and pressure regulators, separation chambers, condensation pots and all other special devices required for installation in instrument piping and wiring system shall be furnished complete as required for each individual element, instrument or system unless specifically stated otherwise in this specification.

- 2.01.07** Each pneumatic device requiring air supply and intended for field mounting shall include a filter regulator air set with gauge, to owner's approval.

- 2.01.08** Process fluids shall not be piped directly to instruments located in Control Room (CR) and Control Equipment Room (CER) unless otherwise specified herein.

- 2.01.09** All parts subject to high pressure, temperature or other severe duty shall be of materials and construction suitable for the service conditions and long operating life.

- 2.01.10** Components of instruments, control devices, accessories, piping etc. Which contact with steam, condensate or boiler feed water shall be manufactured from copper free materials which do not react with media at operating parameters.

- 2.01.11** Temperature measurements shall have fail safe protection feature against open circuits of sensors. Apart from fail safe protection against open circuit, temperature measurement shall have protection against rate of rise of temperature more than pre-defined value.
- 2.01.12 All motorised valves of 200NB or more than 200NB size shall be provided with integral motorised bypass valves on all process lines.
- 2.01.13 All the LP heaters & HP Heaters shall be provided with upstream, downstream & bypass motorized valves.
- 2.01.14 All the work stations, PC, OWS, Printers, Laptop, Servers as mentioned anywhere in this NIT/specification shall meet the minimum technical requirements specified in chapter 4, Vol. V.
- 2.01.15 Each communication Network shall be industrial grade and shall be provided with industrial grade managed type Ethernet switches, external surge protection system/devices and industrial firewall. Industrial grade managed type Ethernet switches shall be provided with in built diagnostic features, 20% spare ports & in built redundant power supply.
- 2.01.16 Bidder to note that all type of hardwares & electronic modules like controllers, I/O cards, communication modules and interface modules etc used in PLC shall be of same family and sourced/supplied from their Principal's works.
- 2.01.17 Valve end position (Open & Close) shall be monitored for the manual critical valves, wherever provided.
- 2.01.18 Design criteria for continuous on line analytical measurements of important plant media such as water, steam and flue gas shall be based on microprocessor based instruments only.
- 2.01.19 All the instruments/equipments/electrical items shall be provided & designed with maximum star rating as available in line with energy conservation policies notified by BEE, GOI at the time of supply.
- 2.01.20 In Fire Protection & Detection system, Loop wiring & Panel networking shall be designed meeting the NFPA Style 7 requirements.
- 2.01.21 All the instruments/equipments/electrical items shall be provided & designed with maximum star rating as available in line with energy conservation policies notified by BEE, GOI at the time of supply.
- 2.01.22 All process parameters (i.e. pressure, temperature & flow) shall be indicated in the P&IDs on all important process lines.
- 2.01.23 All approval/Inspection are to be carried out by Owner or owner appointed agency only.
- 2.01.24 Incomer/outgoing feeders for any Distribution Board's rated upto 63A shall be with fast acting semi conductor fuse & MCB controlled, from 63A to 400A shall be MCCB

Controlled. Above 400A it shall be breaker controlled. Each feeder shall be provided with LED indication.

- 2.01.25 All tag nos. shall follow KKS numbering. For 2 x 660 MW, First unit's tag nos shall have prefix 10, Second unit's tag nos shall have prefix 20 and common system, Tag nos. shall have prefix 00.

2.02.00 Environmental Conditions

- 2.02.01.01 Instruments for location in outdoor/indoor/air-conditioned areas shall be designed to suit the environmental conditions indicated in specification elsewhere and shall be suitable for continuous operation in the operating environment of a coal fired utility station without any loss of function, or departure from the specification requirements covered under this specification.

- 2.02.01.02 All equipment/systems for air conditioned areas shall also be designed and constructed to operate indefinitely without loss of function, departure from specifications or damage during periods of air conditioning failure in summers even if such temperature may rise up to 55 deg. C.

- 2.02.01.03 The period for which the equipment/system can function satisfactorily without A/C (Air Conditioning) shall be mentioned by the bidder.

2.03.00 Power Supply and Air Supply

2.03.01 Power Supply

A. UPS (Uninterrupted Power Supply System)

1. The parallel redundant UPS system furnished by the Bidder shall meet the power requirements of reliable 240 V AC, 50 Hz power supply for DDCMIS, DCS, microprocessor based control system, indicators, recorders, monitoring system, analytical instruments, SWAS, TSI, LVS, VMS & OWS, Printers, Sol. Valves, CCTV, Security System, PADO etc. as specified in various chapter for BTG packages. Separate parallel redundant 'UPS' of adequate capacity shall be supplied for PLC package and microprocessor based system provided with BOP & offsite packages as specified in specification elsewhere.
2. All major equipment/systems shall be served from UPS through redundant two 100% capacity feeders (from 2x100% ACDB) with a automatic change over at load point to ensure un-interrupted supply even on loss of one feeder as described elsewhere in the specifications.

B. 24 V DC Power Supply system

1. For 24 V DC power supply requirements, Bidder shall furnish the separate parallel redundant 24 V DC charger system for each unit for MFT control panels, Turbine protection panels, and Solenoid valves in BTG package.

2. Parallel redundant 240 V AC to 24 V DC convertor with 50% sharing shall be provided for 24 V DC power supply in each cubicle separately as per requirements for DDCMIS, DCS, PLC package and microprocessor based system provided with BTG & BOP packages as per chapter 4 & Annexure A.

Detailed specification of UPS & 24 V DC system are specified elsewhere in the specification.

C Power Supply Monitoring Facility

1. The power supplies for all control panels are **to be monitored for under voltage/over voltage**. Necessary **alarms are to be initiated** for under voltage/over voltage.
2. **Loss of single power source** in case of redundant power supplies is to be **alarmed in DDCMIS/PLC for all control panels by providing voltage monitoring relays**.

2.03.02 Air Supply

2.03.02.01 Clean, dry, oil free instrument Quality air of the following quality shall be provided by bidder for various pneumatic instruments/control drives & accessories:-

- | | | |
|--------------------------|---|-----------------------------------|
| 1. Nominal pressure | : | 7Kg/cm ² gauge |
| 2. Range of pressure | : | 3.5 to 8.5 Kg/cm ² (g) |
| 3. Dewpoint | : | + 2°C at the above pressure. |
| | | - 40 deg.C at NTP |
| 4. Maximum particle size | : | 5 microns |

2.03.02.02 Pneumatically operated equipment offered by the Bidder shall be designed to operate with the above air supply and adequately cater to their respective duty within the full range of pressure variation. Wherever required, moisture separator for vital instruments/actuator/analyzer may be provided in the airline by bidder.

2.03.02.03 The Bidder shall indicate system wise requirement of instrument air along with his proposal and same shall be included in the compressor capacity as supplied.

2.04.00 Instrument Standard Scales and Ranges

2.04.01 Instrument Scales

Instrument scales will be black graduations in white dials and where practicable with scale divisions based on multiples of 10. The smallest division shall preferably be a whole number approximately 1% of the scale range if not otherwise impracticable.

All scales and charts shall be calibrated and printed in Metric Units as follows:-

Metering bases and chart units

1. Temperature - Degree centigrade (deg. C)

2.	Pressure	-	Kilograms per square centimeter (kg/cm ²)
3.	Draught	-	Millimeters of water column (mm wcl.)
4.	Vacuum	-	Millimeters of mercury gauge (mm Hg) or water column (mm wcl)
5.	Flow (All gases)	-	Tonnes/hour or Cubic meters per hour.
6.	Flow (Steam)	-	Tonnes/ hour
7.	Flow (liquid)	-	Tons/hr. or Litres/minute or cubic meters/hour
8.	Flow base	-	Based - 760 mm Hg, 16 deg.C
9.	Density	-	Grams per cubic centimeter

Pressure instrument shall have the unit suffixed with 'a' or 'g' to indicate absolute or gauge pressure.

Scales and charts of all instruments shall have linear graduations and the Bidder shall offer devices for square root extraction or other functional operations required for this purpose. Local indicator scales may be non-linear if approved by the Owner.

2.04.02 Instrument Ranges

Instrument ranges will be selected to have the normal reading preferably at 75% of full scale. Deviation indicators shall have the null position at mid scale. Ranges of pressure gauges shall be selected to allow normal operation in the middle one third of the scale. The normal operating parameters shall be identified with a clear green mark.

When compensation is required to implement the functional requirements and descriptive requirements of control systems furnished under these specifications, the following compensation ranges shall apply:

Measurement	Temperature Range °C	Pressure range Kg/Sq.cm
1. Feed water Flow	150 to 300	300 to 400
2. Secondary airflow	0 to 500	
3. Primary airflow	0 to 500	
4. Steam flow	200 to 650	50 to 300

Where temperature compensation networks are furnished, they shall produce corrections which are in accordance with theoretical requirements over the specified variations, over a flow range from 10 percent to 100 percent of maximum flow, subject to a plus or minus tolerance of one-half of one percent of the maximum flow.

2.05.00 Choice of Hardware

2.05.01 General

The primary objective for the design of instrumentation and control systems shall be to assist in the attainment of maximum unit availability.

Instrument sensing, transmission, measuring system shall be of latest microprocessor based/solid state electronic type with signal transmission in current mode with 4-20 mA level except for local instruments.

All instruments and control devices located on control panels shall be of miniaturized design, suitable for modular flush mounting on control panels with front draw out facility and flexible plug-in connections at the rear.

The interrogation voltage level for plant annunciation, interlock and protection systems shall be adequate to ensure high signal to noise ratio. but should not exceed 60V DC. The logic system shall be adequately protected from signal and power line borne noise and surge voltages and shall satisfy stipulations in specification.

All instrument contacts unless otherwise specified shall be rated for interrupting 5 AMP at 240V AC, 50 Hz and 0.5 Amp at 220V DC. Potential free contacts at output of interlock and protection system for interlocking with electrical switchgear & motor control centers shall be capable of interrupting at least 10 Amps at 240V, 50Hz and 2 Amp at 220V DC.

2.05.02 Operability & Maintainability

The design of the control systems and related equipment shall adhere to the principle of "fail safe" operation at all system level. "Fail Safe Operation" signifies that the loss of signal, loss of power or failure of any component will not cause a hazardous condition and at the same time prevent occurrence of false trips.

The types of failure which shall be taken into account for ensuring operability of the plant shall include but not limited to:-

1. Failures of sensors or transmitters producing high or low signal
2. Failure of controller other modules during automatic operation.
3. Loss of motive power to final control element
4. Loss of control power.
5. Loss of Instrument Air.

The Bidder shall ensure proper operability of all instruments and control modules and also take into account protections to minimise accidental mal operations, in the operator interfaces and configuration of panel boards offered.

2.05.03 Established Reliability

All components and systems offered by the Bidder shall be of established reliability. The minimum target reliability of each component shall be established by the Bidder, considering its failure rate & meantime between failures & meantime to repair (MTTR), such that the availability of the complete system i.e DDCMIS, DCS & PLC etc is assured for 99.7%.

Further the Bidder shall ensure that all equipment/parts of his system, that are not listed under recommended spares shall have the general service life for 15 years as per manufacturer standard practice.

In order to ensure the target reliability the bidder shall perform necessary availability tests and burn in tests for major systems. Surge protection for electronic control systems, annunciation system and other solid state systems conforming to SWC test per ANSI C 37.90a (IEEE standard 472) and selection of proper materials, manufacturing processes, quality controlled components and parts, adequate de-rating of electronic components and parts shall be ensured by the Bidder to meet the reliability and life expectancy goals.

Continuous self checking features shall be incorporated in system design with automatic transfer to healthy/redundant circuits to enhance the reliability of the complete system.

In general, failure of equipment used for alarm purpose will cause switching to the alarm state.

Mean Time between Failure (MTBF) of the instruments shall be considerably higher than the equipments/system, they shall cater to in order to avoid shutdown on account of instrumentation failure.

All instruments and control equipments shall ensure high reliability, low down time and ease of maintenance.

2.05.04 Provenness, Standardization and Uniformity of Hardware

All C&I equipments furnished must have proven performance of working in the power plant, at least two sets of such equipment installed in a power plant of capacity as specified in BQR have been running successfully for at least two years. No prototype components shall be used. The Bidder shall state the application, the performance of the equipment furnished, including accuracy, repeatability, drift due to time and temperature, etc. and give the equipment list and the examples and statements for their application in his proposal.

To ensure smooth and optimal maintenance easy interchangeability and efficient spare parts management of various C&I instruments/equipment like vibration monitoring systems, all 4-20mA electronic transmitters/ transducers, control hardware, control valves, actuators and other instruments/ local devices etc. being furnished by the Bidder for main plant areas (eg. boiler/turbine etc.) and other plant and station auxiliaries, Off site/BOP packages for similar applications, the Bidder shall ensure that they are of the same make, series and family of hardware.

The bidder shall obtain & furnish the certification from his tieup partners (as consortium or other wise) that their design, engineering, procurement, manufacturing, erection, commissioning and shop test facility are adequate to meet the specified technical & performance/quality requirements for execution & commissioning of the package offered to the satisfaction of owner.

2.05.05 Redundancy Criteria for Sensors and Signals from MCC/SWGR

Redundancy of components and systems shall be dictated by availability criteria described under DDCMIS/DCS/PLC to ensure the system availability target as well as safety considerations in critical applications are fully met.

Bidder shall also introduce redundant control equipments or instruments wherever it is felt by owner that the introduction of the same shall lead to reduction of downtime of plant and equipments, in addition to the case/criteria clearly defined/identified in the specification.

Triple redundancy or dual redundancy for signals from MCC/SWGR, sensors and transmitters will be used for critical control /Protection application, critical monitoring application & other control/interlock applications. Where correction/ compensation for the measured signal are involved, the computed signal shall be the one transferred for control purposes. The measured value indicated shall be the duly corrected/ compensated signal.

Sensor/signals/measurements redundancy required (2 out of 3 or 1 out of 2) requirement have been specified in respective control system specifications and as specified elsewhere in the technical specification. However, sensor/signals/measurements utilization will be decided during detailed engineering. It is mandatory to use sensors/signals/measurements with 2 out of 3 logic for critical control & protection (Analog & Binary) application/service and sensors with 1 out of 2 logic for all other control & interlock (Analog & Binary) application/service as explained below

2.05.05.01 Triple measurement scheme

Triple measurement scheme for analog inputs employing three independent transmitters connected to separate tapping points shall be employed for the most critical measurements. The same shall be used in analog control functions including, the following but not limited to, furnace draft, feed water flow, Feed Water Temperature, feed water pressure before Economiser, Discharge Flow of each BFP, BFP discharge Temperature, Boiler Separator level control, Steam Pressure, Main steam & RH steam temp. control, SH spray Flow, RH spray Flow, throttle pressure, PA/SA Air Flow, PA/SA Air Temperature, PA header pressure, Mill Air Flow, Mill outlet Temperature, Feeder Speed Control, Spray water flow, SH, RH & Aux. Steam Desuperheater inlet & outlet Temp at each stage, SH Platen Steam Temperature before Desuper heater, SH Platen Steam Temperature after all super heaters, RH steam Temperature at Turbine end, Main steam Temperature at turbine end, turbine first stage pressure, deaerator level, Deaerator Flow after Last LPH, Hotwell level, GS steam Pressure, condensate flow before recirculation line, turbine speed, Turbine Control Valve position, Power measuring device, HP/LP Heater level, PA header pressure, SCAPH temp. Control, HP Bypass controls, LP Bypass controls, Light Oil Pressure, Heavy Oil Pressure, Atomising Steam Pressure, Heavy Oil Temperature, Hydrogen gas pressure of generator, and all other trip & protection logics etc.

For MFT/FSSS/BMS/Turbine protection/ Generator/Unit tripping, triple sensors shall be provided.

For Binary and analog inputs required in major equipment (Furnace, Turbine, tripping/protection of any HT drive etc.) protection triple-sensing devices shall be provided. Binary and analog inputs, which are, required for protection of more than one equipment as well as protection signals for HT Drives (fed by a supply feeder of ratings 3.3 kV onwards)/MDBFP/TDBFP etc., triple sensing devices shall be provided.

Triple sensors shall be provided for Instruments required for auto starting of HT driven pumps or pump tripping due to very low level of water/discharge pressure very low and

Trip of any auxiliary which will lead to substantial (50%) loss of unit availability. For lube oil protection of all the HT drives, **2 out of 3 logics and necessary pressure transmitters for lube oil pressure** shall be provided by bidder accordingly.

Left and right side shall be treated as individual path / individual parameter, and each side/path shall have own triple redundancy accordingly.

2.05.05.02 Dual measurement scheme

For binary and analog inputs required for other modulating control, protection and interlock purpose of other equipment and other critical monitoring application etc., min. dual sensors shall be provided.

Dual sensors shall be provided for instruments required for auto starting of LT driven pumps or LT driven pump tripping due to very low level of water/discharge pressure very low.

Dual sensors shall be provided for instruments required for Heat rate measurements & PADO calculations.

Dual measurement scheme for analog inputs employing two independent transmitters/ temperature element, connected to separate tapping points shall be employed for the remaining measurements used for analog control functions.

2.05.05.03 All the instruments/ sensors/transmitters/switches meant for redundant applications shall have completely separate and independent impulse pipes/ root valves etc. No redundant instrument shall share a single process tapping. There will be separate and independent tapping for every individual instrument.

2.05.06 Back-Up Instrumentation

- i. No full backup discrete hardwired based control or hardwired manual operation is envisaged in the 660 MW Unit control room for main plant. Bidder shall however perform a failure analysis to establish that the plant can be safely shutdown or can be brought to a safe operating condition without any damage to equipment and / or personnel during the unlikely event of catastrophic failure of DDCMIS/DCS.
- ii. Since nowadays the reliability and availability of control system is enhanced due to the redundancy path, **backup panel with mosaic and vertical type (not L type)** is to be provided with as minimum as possible for safe guarding the main equipments BTG and auxiliaries.
- iii. Hence in addition to the LVS and OWS, a limited operation from backup unit control vertical panel with mosaic is envisaged for emergency operation and to provide safe shut down of plant/equipments. The backup Unit control vertical panel with mosaic shall housed Conventional Push-button (ILPB) stations, Console inserts (SG & TG), Trip Push Buttons, Ammeters, CCTV for Furnace Flame, chartless recorders & digital display units for Boiler, Turbine & Generator Process/electrical parameters. Also bidder to refer details in Chapter 6.

- iv. **Back up panel system** shall be designed for handling **the situation in clause 2.12.00 for failure of HMI.**
- v. **For electrical layout, complete backup panel with mosaic** shall have to be provided for complete on/off operations with necessary meters, DDU's, synchronoscope etc. as specified elsewhere in specification.
- iv. Control panel cum desk with HW annunciation windows, ILPBs, Ammeters, PBs, voltmeters, indicators, mimic, recorders etc. shall be provided as per Annexure A – Control System Philosophy for BOP packages. Profile/Overall GA of backup control panel cum desk for BOP packages shall be same as indicated in drawing no. 114-05-0105 attached with NIT.

2.06.00 PROTECTION, CLASS OF CABINETS / PANELS, ENCLOSURES ETC.

- a) All panels, desks cabinets, consoles & enclosures furnished at least comply with the requirements of protection classes as indicated below.
 - 1. In-door Air-conditioned (A.C.) areas - IP32/42 (min.)
 - 2. In-door Non A.C. areas:
 - (a) Ventilated enclosures - IP42
 - (b) Non Ventilated. IP 54
 - 3. Out-door IP55 / IP65
(As per the requirement)
- b) Distribution boxes, junction boxes, cold junction compensation boxes, terminal boxes and all other field mounted equipment to be furnished as per this specification shall have weather protection conforming to IP 65.
- c) The design of panels, cabinets, enclosures and packaging density of components mounted therein shall be such that the temperature rise does not exceed 10 deg. C above the ambient under the worst conditions.
- d) The panels housing electronic hardware shall be provided with flame and smoke detectors by bidder.
- e) Enclosures for peripheral equipments like printers, etc. shall take care of noise and shall ensure minimum possible noise disturb to the working personnel.

2.06.01 Guards, barriers and access doors, covers of plates shall be marked to indicate the hazard, which may occur upon removal of such devices. Danger or caution signs shall be used to warn of specific hazards such as voltage or current. The marking shall be permanently affixed to the equipment.

2.07.00 System Documentation

Master document/drawing list along with dates within 3 months shall be submitted by bidder after award of contract for each package for approval of owner. The Bidder shall provide drawings, system overview & description, hardware/software details, Technical literature, functional & hardware schemes, bill of material, parts list, Inter connection diagrams, data sheets, erection/installation/commissioning procedures, Instruction/operating manuals, etc. for each of the C&I system/sub-systems/equipment, supplied under this package. The documentation shall include complete details of the C&I systems/sub-systems/equipment to enable review & approval by owner during detailed engineering stage and to provide information to plant personnel for Operation & Maintenance (including quick diagnostics & trouble shooting) of these C&I systems/sub-Systems/equipments at site. Following minimum documents shall be submitted by bidder during detailed engineering for review and approval:

DATA / DETAILS TO BE FURNISHED		
S.no	Description	Category
1	C&I System Design Basis Report incorporating Control philosophy / operation philosophy / Design philosophy / Redundancy philosophy.	A
2	Codes and application standard followed for the project.	A
3	Process & Instrumentation Diagrams (PID) indicating local gauges, transmitters, analysers for (alarm, control etc.)	A
4	Engineering documents For DDCMIS/DCS & PLC based control systems: a. Bill of Quantity for DDCMIS/DCS/PLC based system b. I/O Assignment for DDCMIS/DCS, each PLC based control system including nest loading. c. Instrument Schedule with set points d. I/O List e. Drive List/ Solenoid Valve List f. Annunciation List g. SOE list. h. Process mimics/graphics indicating Analog and digital parameters i. List of logs with point assignment j. Time Synchronisation System k. Historical Storage and Retrieval (HSR) system details. l. List of Displays m. Plant Performance Calculation & Optimisation package Details n. Controller partitioning Diagram o. Data sheet for HART management system p. Drive Control Philosophy & MCC Interface diagrams	A
5	Detailed technical catalog about the Analog / Digital input and output modules, drive control modules, main control processor, operator consoles, printers etc, shall be furnished for scrutiny.	A
6	Modulating Control and Sequential Control Schemes with Write ups	A
7	Logic diagrams (SAMA format) for Main Plant, Utility & Aux. Plants along with system description / functional write-up.	A
8	System Architecture/System Configuration Drawing for DCS/ Each PLC based Offsite Package including MMI, interface with Third party systems, Master clock and Local Control Desks/Annunciator panel	A
9	Back up panel/Unit control panel, Annunciator window layout and inscription.	A

10	LVS data sheets, GA drawings along with catalogs	A
11	Field Instruments data sheets along with catalogs	
12	System Configuration Diagram with DDCMIS/DCS interfacing details for special monitoring & analysis systems like vibration analysis, PADO, Management information system, Security & Surveillance system, Flame Analysis , Tube Leak Detection etc.	A
13	Vendor Data sheets for C&I system equipment including DDCMIS/DCS / PLC based control system.	A
14	Sub-vendor's drawings and documents for all main & BOP packages	A
15	Central Control room layout / SWAS room layout / Local Control Room & all control panel layout including Unit control panel.	A
16	G.A.(General Arrangement) and Internal arrangement drawings of all control panels/ cabinets / local panels with all dimensional details, wiring diagrams and terminal details.	A
17	Sampling schemes including SWAS schemes.	A
18	Interconnection diagram, cable schedule, MCC Interfacing diagram.	A
19	UPS/24 V DC system Single Line Diagram, UPS/24 V DC Load List, UPS Datasheets, G.A drawings of UPS/24 V DC system, Panel Specification, Operation Philosophy, Wiring Diagrams, Battery Sizing Calculations, Battery Data Sheets, Battery Stack GA Drawings and 24VDC system	A
20	Heat load and power consumption data for PLCs and DCS. UPS and +24VDC	A
21	JB Schedule, LIE/LIR for Transmitter Groupings (P, DP, F, L and transmitters)	A
22	Data Sheets, sizing calculation, for Control valves & its Accessories, Data Sheets, sizing calculation, for Flow elements, BOQ, QAP, Internal TC, Technical catalogs, O&M Manuals Solenoid Valves Data Sheets for Solenoid valves, Control Valve noise calculation (both hydro-static & hydro-dynamic).	A
23	Installation sketches (Individual Instrument Hook Up Drawing and Installation isometric drawings.)	A
24	Hardware & software design manual (covering exhaustive details of complete DDCMIS/DCS / PLC based control system)	A
25	QAP(Quality assurance plan) for all major equipment.	A
26	Mandatory Spares and Recommended Spares List.	A
27	Detailed technical literature of each type of instrumentation equipment offered shall be furnished.	A
28	Detailed manufacturer's cable specification/data sheets with GA drawing for offered cable shall be furnished.	A
29	Factory Acceptance Test (FAT) procedure/Site Acceptance Test (SAT) Procedure / Availability test procedure / PG test procedure for C&I equipment including DDCMIS/DCS / PLC control systems.	A
30	Duly signed schedule of performance guarantees, List of softwares included.	A
31	All test certificates including degree of protection certificates for all packages and Explosion proof certificates for oil services.	A
32	Confirmation certificate for the latest version of software and hardware offered.	A

33.	Thermowell Sizing calculation.	A
34.	Vendor data sheets/GA drawings/Catalogue for each C&I system as specified in NIT.	A
35.	All other documents not specifically mentioned here but required for completion of engineering work and proper coordination shall be unit wise. All other documents specifically called for in various sections of specification.	A/I as finalized by TANGEDCO
36.	Data sheet/specifications of components/modules etc. in respect of each and every electronic card/module as employed on the microprocessor based control system and equipment including conventional instruments, peripherals etc.	A
37.	All type tests for the C&I systems/sub-systems/equipment as stipulated in QA section shall be included.	I
38.	Plant Process Simulator System documents and data sheets	
	Above "A" stands for "Approval" and "I" stands for "Information".	
If any documentations/ data sheets are required by the owner during evaluation stage or detailed engineering stage. Bidder is supposed to provide the complete information and satisfy the owner without any ambiguity.		

2.08.00

System Expandability

Modular System design shall be adopted to facilitate easy system expansion. The system shall have the capability and facility for expansion through the addition of controller modules, I/O cards, hand/auto stations, push button stations, peripherals like Large Video Screen (LVS), operator workstations (OWS), printers etc. while the existing system is fully operational. The system shall have the capability to add any new control loops, groups/subgroups, in control system while the existing system is fully operational.

2.09.00

On Line Maintenance

It shall be possible to remove/replace online various modules (like I/O module, interface module etc.) from its slot for maintenance purpose without switching off power supply to the corresponding rack. System design shall ensure that while doing so, undefined signaling and releases do not occur and controller operation in any way is not affected (including any control loop trip to manual, etc) except that information related to removed module is not available to controller. Further, it shall also be possible to remove/replace any of the redundant controller module without switching off the power to the corresponding rack and this will not result in system disturbance or loss of any controller functions for the other controller. The on-line removal/insertion of controller, I/O modules etc. shall in no way jeopardise safety of plant and personnel.

2.10.00

Fault Diagnostics

The DDCMIS/DCS/PLC shall include on-line self-surveillance, monitoring and diagnostic facility so that a failure/malfunction can be diagnosed automatically down to the level of individual channels of modules giving the details of the fault on the programmer station displays and printers. The faults to be reported shall include fault in main & standby

power supplies, sensor fault, Controller fault, any channel fault in 2V3 channels, failure of links to PLCs, LAN etc. These faults and Controller faults shall be reported as colour change on system status display and messages on programmer LVS/OWS as well as through local indication on the faulty channel/ module and on respective rack/ cubicle. The diagnostic system shall ensure that the faults are detected before any significant change in any controller output has taken place. Failure of any I/O modules, Controller etc. shall be suitably grouped and annunciated to Annunciation facia on LVS/OWS/BUP.

2.11.00 Fault Tolerance & Controllability

- 2.11.01 The DDCMIS/DCS/PLC shall provide safe operation under all plant disturbances and on component failure so that under no condition the safety of plant, personnel or equipment is jeopardised. Control System shall be designed to prevent abnormal swings due to loss of Control System power supply, failure of any Control System component, open circuits/short circuits, instrument air supply failure etc. On any of these failures the controlled equipment/parameter shall either remain in last position before failure or shall come to fully open/close or on/off state as required for the safety of plant/personnel/equipment and as finalised during detailed engineering. System shall be designed such that there will be no upset when Power is restored.
- 2.11.02 The system shall be designed to permit the operator to supplement but not inhibit the protective functions.
- 2.11.03 The control system furnished under this specification shall not inhibit a greater capacity output than the rated capacity of the unit, if permitted by the main plant equipment and required by the Owner.
- 2.11.04 The controlled variable response rate & controllability shall be limited by the characteristics of main equipment, which is being controlled, and DDCMIS/PLC shall not impose any limitations in the response rate or controllability. Controlled process variables shall return to normal values in a stable manner and without control loop interactions or cycling of generation when generation matches with load demand.
- 2.11.05 No single failure either of equipment or power source shall be capable of rendering any part/system/sub-system of DDCMIS/PLC inoperative to any degree.

2.12.00 STATION BLACKOUT

Availability of all equipments, drives, emergency power supplies, controls, logics required for the protection/safe operation/shutdown of the boiler/turbine and auxiliaries during emergency blackout shall be ensured by bidder. All the related drives, controls shall operate automatically on the occurrence of blackout. All such drives, controls required during emergency and black out shall be provided with continuous power supply source (each type of power supply depending upon requirements, sizing shall be done considering this requirements) to ensure availability and shall be designed for fail safe mode. All the required controls shall be available as the system to be powered from plant UPS. The UPS sizing shall consider this requirement.

2.13.00 ELECTRICAL NOISE CONTROL

The equipment furnished by the Bidder shall incorporate necessary techniques to eliminate measurement and control problems caused by electrical noise. Areas in

Bidder's equipment which are vulnerable to electrical noise shall be hardened to eliminate possible problems.

The Bidder shall be fully responsible for detailed recommendations on the type, size, shielding, input balancing, ripple amplitude and frequency, isolation and grounding for field inputs and for equipment furnished by the Bidder to achieve an installation with minimum noise from all sources.

The Bidder shall carefully review the Electrical Field Construction and cabling specifications given in Section-9 of this volume. If the performance of the equipment furnished by the Bidder is likely to be adversely affected in any manner because of these cabling and electrical field construction practices, the Bidder shall bring this to the attention of the Owner along with his proposal.

Any additional equipment, services required for effectively eliminating the noise problems shall be identified by the Bidder and shall be included in his lump sum proposal.

The Bidder shall be fully responsible for satisfactory elimination of any noise problems that evidence themselves following the installation of the equipment. All expenses incurred in the elimination of noise problems shall be borne by the Bidder.

2.14.00

SURGE-PROTECTION DESIGN CRITERIA FOR SOLID STATE/MICRO PROCESSOR BASED EQUIPMENTS/DCS/DDCMIS/PLC/UPS etc.

- i. All solid-state equipment shall be able to withstand the noise and surges inherent in a powerhouse. The equipment shall be designed to successfully withstand without damage to components and/or wiring, application of surge withstand capability (SWC) wave whose shape and characteristics are defined in ANSI publication C37.90a - 1974 entitled "Guide for surge withstand capability (SWC) Tests".
- ii. All solid state equipments, power supply to electronic cards, power supply to controllers, PLC panels, DDCMIS panels, SMPS power supply, UPS, battery chargers etc shall have external surge protection device with Plug ability and life indication as per IEC 61643-1:1998-02 and E DIN VDE 0675 part 6:1996-03/A2: 1996-10, to withstand max. 40 kA, 8/20 u Sec of Surge. The connection of the devices should be made as per TT configuration wherever applicable.
- iii. Signal lines shall have surge protection devices with pluggability and testability as per IEC 61643-21:2000-09 and E VDE 0845 part 3-1:1999-07, to withstand max. 20 kA, 8/20 u Sec of surges.
- iv. For data lines, communication lines, Ethernet/Can networks/LAN, Coaxial lines modular surge protection device should be used as per IEC 61643- 21:2000-09 to withstand a min of 2.5 kA, 8/20 u Sec of surges. The surge protection device should be used with the corresponding connector as being used for the lines i.e. RJ45, D-Sub, BNC, N-Type etc.

"The Bus systems (like Profibus/ Modbus etc) or the Serial Port Systems (like RS-232/ RS-485 etc) shall be protected with suitable surge protection devices, confirming to the latest IEC-61643-21 guidelines. The surge handling capacity of

device shall at least be 10 KA, 8/20 μ Sec between core-core and 20 KA, 8/20 μ Sec between core-ground. The device shall be pluggable & on-site testable".

- v. All electronic cards/modules shall also be protected from failure against accidental/inadvertent application of high voltage upto 500V DC (common mode) even though these modules may be designed to operate at lower voltage levels such as 24V/48V.
- vi. In the case of DC powered system/subsystem/instrument, the design shall ensure protection against reverse polarity.
- iv. The Bidder shall provide details of production tests being carried out to fully satisfy the Owner that the proposed equipment meets the above requirements and to assure that the products furnished shall be of the desired grade.

2.15.00 General Tools and Tackles, Special Calibration Instruments:

Bidder must offer general tools & tackles and special calibration instruments required during start-up, trial run, operation and maintenance of the plant.

2.16.00 PG TEST POINTS

2.16.01 Pressure, temperature and flow test points shall be provided in line with latest performance test code requirements.

2.16.02 In addition, pressure and temperature test points shall be provided for the following services:

- (a) At the discharge of all pumps and fans
- (b) At the inlet and outlet of the heat exchangers for the fluid media involved
- (c) Adequate number at the Combustor at different zones
- (d) At the inlet and outlet of each control valve

2.16.03 Pressure test points shall be complete with root valves and shall terminate with a nipple.

2.16.04 Temperature test points shall be provided with thermowell with a cap and chain.

C&I DELIVERABLES

LIST OF DELIVERABLES OF PEM - C&I DEPARTMENT FOR AC SYSTEM							
2X660MW ENNORE SEZ TPP							
DOCUMENT NUMBER PE-GL-412-145-I100							
Sl.No.	DRAWING NO.	DRAWING/DOCUMENT TITLE	CAT	CUSTOMER	FROM	USER	REMARKS
INSTRUMENTATION							
1	PE-V9-412-555-1901	INSTRUMENT DATA SHEETS	A	-	VENDOR	C&I	
2	PE-V9-412-555-1902	INSTRUMENT SCHEDULE	I	-	VENDOR	C&I	
3	PE-V9-412-555-1903	INSTRUMENT INSTALLATION/ HOOK UP DIAGRAMS	A	-	VENDOR	C&I	
4	PE-V9-412-555-1904	FIELD JB TERMINATIONS /GROUPING DOCUMENT	I	-	VENDOR	C&I	
5	PE-V9-412-555-1905	QUALITY PLANS (CV,FE, Tx and Analyser)	A	-	VENDOR	C&I	
PLC PANEL							
1	PE-V9-412-555-1906	PLC CONFIGURATION DRAWING	A	A	VENDOR	C&I	
2	PE-V9-412-555-1907	PLC PANEL GA (INTERNAL & EXTERNAL) DRAWING	A	-	VENDOR	C&I	
3	PE-V9-412-555-1908	CONTROL SCHEMES (BLOCK LOGIC)	A	-	VENDOR	C&I	
4	PE-V9-412-555-1909	PLC INPUT / OUTPUT SIGNAL LIST	I	-	VENDOR	C&I	
5	PE-V9-412-555-1910	UPS BATTERY CHARGER/ BATTERY DATASHEET & SLD	I	\$\$	VENDOR	C&I	
6	PE-V9-412-555-1911	UPS SIZING CALCULATIONS	I	-	VENDOR	C&I	
7	PE-V9-412-555-1912	BATTERY SIZING CALCULATIONS	I	-	VENDOR	C&I	
8	PE-V9-412-555-1913	CONTROL DESK LAYOUT / GA DRAWING	A	-	VENDOR	C&I	
9	PE-V9-412-555-1914	PLC OWS/PRINTER FURNITURE BOM	A	-	VENDOR	C&I	
10	PE-V9-412-555-1915	PLC CONTROL ROOM LAYOUT DRAWING	A	-	VENDOR	C&I	
11	PE-V9-412-555-1916	PLC CATALOGUE	I	-	VENDOR	C&I	
12	PE-V9-412-555-1917	PLC QUALITY PLAN & FAT PROCEDURE	A	-	VENDOR	C&I	
13	PE-V9-412-555-1918	LIST OF SIGNAL EXCHANGE WITH DDCMIS (BOTH HARDWIRED & SERIAL INTERFACE IN BHEL FORMAT)	A	,	VENDOR	C&I	
14	PE-V9-412-555-1919	PROCESS GRAPHIC MANUSCRIPTS PLC	I	-	VENDOR	C&I	
15	PE-V9-412-555-1920	PROCESS GRAPHIC MANUSCRIPTS FOR DDCMIS	I	-	VENDOR	C&I	
16	PE-V9-412-555-1921	CABLE SCHEDULE (IN BHEL EXCEL FORMAT) & CABLE INTERCONNECTION DETAILS	I	-	VENDOR	C&I	
17	PE-V9-412-555-1923	PANEL & ELECTRONIC EARTHING REQUIREMENT	I	-	VENDOR	C&I	
18	PE-V9-412-555-1924	PANEL HEAT DISSIPATION DATA	I	-	VENDOR	C&I	
19	PE-V9-412-555-1925	MANDATORY SPARES BILL OF MATERIAL	A	A	VENDOR	C&I	
20	PE-V9-412-555-1926	PLC O & M MANUAL	I	-	VENDOR	C&I	
21	PE-V9-412-555-1927	PLC EARTHING SCHEME	I	-	VENDOR	C&I	
Notes:							
		412 - Project No.					
		555 -SI. No of MAX Package (COMPRESSED AIR SYSTEM)					
		\$\$ - If Vendor BBU Item, then Approval by BHEL - If Customer BBU Item, then Approval by Customer					

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

SPECIFICATION

FOR

MOTORISED

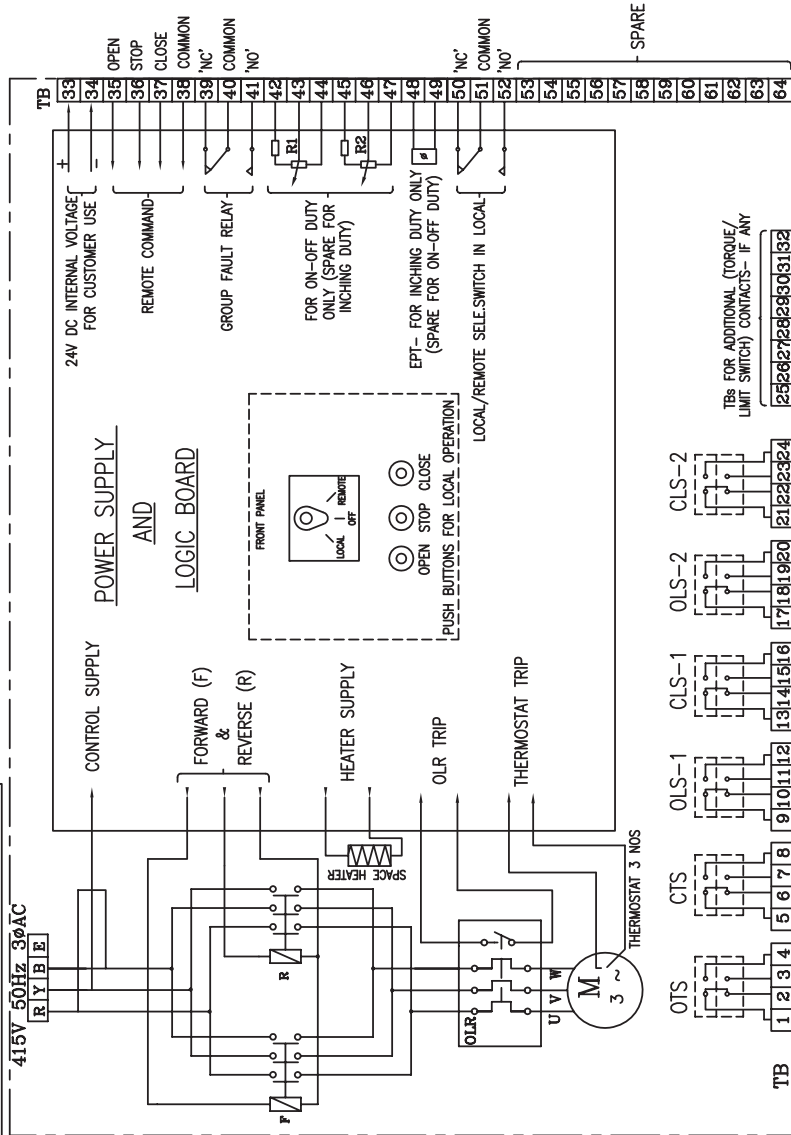
VALVE ACTUATOR

	Data Sheet FOR MOTORISED VALVE ACTUATOR		SPECIFICATION NO.: PE-ID-412-145-I902	
			VOLUME II B	
			SECTION D	
			REV. NO. 01	DATE: 04.07.15
		SHEET	1 OF	3
Data Sheet A & B				
DATA SHEET-A (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
GENERAL*	* PROJECT	2x 660 MW ENNORE STP		
	OFFER REFERENCE			
	* TAG NO. SERVICE			
	* DUTY	☐ ON / OFF ☐ INCHING		
	* LINE SIZE (inlet/outlet): MATERIAL			
	* VALVE TYPE	☐ GLOBE ☐ GATE ☐ REG. GLOBE ☐ BUTTERFLY		
	* OPENING / CLOSING TIME			
	* WORKING PRESSURE			
	AMBIENT CONDITION	SHALL BE SUITABLE FOR CONTINUOUS OPERATION UNDER AN AMBIENT TEMP. OF 0-55 DEG C AND RELATIVE HUMIDITY OF 0-95%		
	VALVE SEAT TEST PRESS	BIDDER TO SPECIFY		
	REQUIRED VALVE TORQUE	BIDDER TO SPECIFY		
	ACTUATOR RATED TORQUE	BIDDER TO SPECIFY		
CONSTRUCTION AND SIZING	CONSTRUCTION	TOTALLY ENCLOSED, WEATHER PROOF, IP:68		
	MECHANICAL POSITION INDICATOR	TO BE PROVIDED FOR 0-100% TRAVEL		
	BEARINGS	DOUBLE SHIELDED, GREASE LUBRICATED ANTI-FRICTION.		
	GEAR TRAIN FOR LIMIT SWITCH/TORQUE SWITCH OPERATION	METAL (NOT FIBRE GEARS). SELF-LOCKING TO PREVENT DRIFT UNDER TORQUE SWITCH SPRING PRESSURE WHEN MOTOR IS DE-ENERGIZED.		
	SIZING	OPEN/CLOSE AT RATED SPEED AGAINST DESIGNED DIFFERENTIAL PRESSURE AT 85% OF RATED VOLTAGE. FOR ISOLATING SERVICE THREE SUCCESSIVE OPEN-CLOSE OPERATIONS OR 15 MINS. WHICHEVER IS HIGHER. FOR INCHING SERVICE - 150 STARTS/HR MINIMUM & FOR REGULATING SERVICE - 600 STARTS/HR MINIMUM.		
HANDWHEEL	* REQUIRED	☒ YES ☐ NO		
	* ORIENTATION	☐ TOP MOUNTED ☐ SIDE MOUNTED		
	*TO DISENGAGE AUTOMATICALLY DURING MOTOR OPERATION.			
ELECTRIC ACTUATOR	ACTUATOR MAKE/MODEL	BIDDER TO SPECIFY		
	MOTOR MAKE / MODEL / TYPE / RATING (KW)	BIDDER TO SPECIFY		
	@ MOTOR TYPE	SQUIRREL CAGE INDUCTION MOTOR, STARTING CURRENT LIMITED TO SIX TIMES THE RATED CURRENT- INCLUSIVE OF I.S. TOLERANCE		
	ACTUATOR APPLICABLE WIRING DIAGRAM	☐ ENCLOSED (BIDDER TO CONFIRM) A: ☐ DRG. NO. 3-V-MISC-24227 R00 B: ☐ DRG. NO. 3-V-MISC-24550 R00 C: ☐ DRG. NO. 3-V-MISC-24283 R00 D: ☐ DRG. NO. 4-V-MISC-90271 R11 E: ☐ For Thyristor based Integral starter, Bidder/Vendor to furnish wiring diagram		
	COLOUR SHADE	☐ BLUE (RAL 5012) ☐ DURING DETAIL ENGG.		
	PAINT TYPE (## Refer Notes)	☐ ENAMEL ☒ EPOXY ☐		
	SHAFT RPM	BIDDER TO SPECIFY		
	OLR SET VALUE	BIDDER TO SPECIFY		
	@ STARTING / FULL LOAD CURRENT	BIDDER TO SPECIFY		
	NO. OF REV FOR FULL TRAVEL	BIDDER TO SPECIFY		
	@ PWR SUPP TO MTR / STARTER	415V, 3PH, AC		
	@ CONTROL VOLTAGE REQUIREMENT	TO BE DERIVED FROM THE POWER SUPPLY TO THE STARTER ☐ 230 V ☐ 110 V		

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR		SPECIFICATION NO.: PE-ID-412-145-I902		
			VOLUME II B		
			SECTION D		
			REV. NO.	01	DATE:
		SHEET	2 OF		3
Data Sheet A & B					
DATA SHEET-A (TO BE FILLED BY PURCHASER)				DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
	@ ENCLOSURE CLASS OF MOTOR	☐ IP 67 ☐ FLAME PROOF			
	@ INSULATION CLASS	CLASS-F TEMP. RISE LIMITED TO CLASS-B			
	@ WINDING TEMP PROTECTION	☒ THERMOSTAT (3 Nos., 1 IN EACH PHASE) ☐ -----			
	SINGLE PHASE / WRONG PHASE SEQUENCE PROTECTION	REQUIRED			
INTEGRAL STARTER	INTEGRAL STARTER	☒ REQUIRED ☐ NOT REQUIRED			
	TYPE OF SWITCHING DEVICE	☒ CONTACTORS ☐ THYRISTORS			
	TYPE	☒ CONVENTIONAL ☐ SMART (NON-INTRUSIVE)			
	STEP DOWN CONT. TRANSFORMER	☒ REQUIRED			
	OPEN / CLOSE PB	☒ REQUIRED ☐ NOT REQUIRED			
	STOP PB	☒ REQUIRED ☐ NOT REQUIRED			
	INDICATING LAMPS	☒ REQUIRED ☐ NOT REQUIRED			
	LOCAL REMOTE S/S	☒ REQUIRED ☐ NOT REQUIRED			
	STATUS CONTACTS FOR MONITORING	☒ REQUIRED ☐ NOT REQUIRED			
	INTEGRAL STARTER DISTURBED SIGNAL	REQUIRED (MOTOR THERMOSTAT TRIP, O/L RELAY OPERATED, CONT./POWER SUPPLY FAILED, PHASE LOSS, S/S IN LOCAL/OFF MODE, STOP PB OPTD, TORQUE OPEN/CLOSE CUTOFF)			
INTERPOSING RELAY/OPTO COUPLER (Applicable for integral Starter)	TYPE OF ISOLATING DEVICE	☐ INTERPOSING RELAY ☐ OPTO COUPLER ☐ EITHER			
	QUANTITY	☒ 2 NOs. ☐ 3 NOs.			
	DRIVING VOLTAGE	☒ 20.5 – 24V DC ☐ _____ V DC			
	DRIVING CURRENT	☒ 125mA MAX ☐ _____ mA MAX			
	LOAD RESISTANCE	☒ > 192 ohms - <25 k ohms ☐ > _____ ohms - < _____ ohms			
TORQUE SWITCH (Not Applicable for Smart Actuator) (\$\$ Refer Notes)	MFR & MODEL NO.	BIDDER TO SPECIFY			
	OPEN / CLOSE	☒ 1 No. ☐ 2Nos. / ☒ 1 No. ☐ 2Nos			
	CONTACT TYPE	2 NO + 2 NC			
	RATING	5A 240V AC AND 0.5A 220V DC			
	CALIBRATED KNOBS(OPEN&CLOSE TS)	REQUIRED FOR SETTING DESIRED TORQUE			
	ACCURACY	+3% OF SET VALUE			
LIMIT SWITCH (Not Applicable for Smart Actuator) (\$\$ Refer Notes)	MFR & MODEL NO.	BIDDER TO SPECIFY			
	OPEN : INT : CLOSE	☐ 1 No ☒ 2 Nos.	2 Nos. (ADJ.)	☐ 1 No. ☒ 2Nos.	
	CONTACT TYPE	2 NO + 2 NC			
	RATING (AC / DC)	5A 240V AC AND 0.5A 220V DC			

	Data Sheet FOR MOTORISED VALVE ACTUATOR		SPECIFICATION NO.: PE-ID-412-145-I902	
			VOLUME II B	
			SECTION D	
			REV. NO. 01	DATE: 04.07.15
		SHEET 3 OF 3		
Data Sheet A & B				
DATA SHEET-A (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
POSITION TRANSMITTER	POSITION TRANSMITTER (For inching duty & other specific applications)	☒ REQUIRED ☐ NOT REQUIRED		
	MFR & MODEL NO.	BIDDER TO SPECIFY		
	TYPE	☐ ELECTRONIC (2 WIRE) R/I CONVERTER ☒ ELECTRONIC (2 WIRE) CONTACTLESS		
	SUPPLY	☒ 24V DC ☐		
	OUTPUT	☒ 4-20mA		
	ACCURACY	$\pm 1\%$ FS		
SPACE HEATER	@SPACE HEATER	REQUIRED		
	@ POWER SUPPLY (NON INTEGRAL)	230V AC, 1 PH., 50 Hz		
	@ POWER SUPPLY (INTEGRAL)	BIDDER TO SPECIFY		
	@ RATING			
TERMINAL BOX	ACTUATOR/MOTOR TERMINAL BOX	REQUIRED		
	ENCL CLASS ACTUATOR/MOTOR T.B.	@ ☒ IP 68 @ ☐		
	@ EARTHING TERMINAL	REQUIRED		
	PLUG & SOCKET (9 PIN) (FOR COMMD, LS/TS FEED BACK, PoT)	☐ REQUIRED ☒ NOT REQUIRED ☐ 2 NOS. ☐		
CABLE GLANDS	@ POWER CABLE GLAND	SIZE:-----		
	@ SPACE HEATER CABLE GLAND	SIZE:-----		
	OTHER CONTROL CABLE GLANDS	QUANTITY & SIZE :Cable gland suitable for 8Px0.5 sq mm & 2P x 0.5 sq mm Cable.		
WEIGHT	TOTAL WEIGHT (ACTUATOR + ACCESSORIES)	BIDDER TO SPECIFY		_____ Kg.
NOTES: SCOPE: DESIGN, MANUFACTURE, INSPECTION, TESTING AND DELIVERY TO SITE OF ELECTRIC ACTUATOR FOR INCHING OR OPEN / CLOSE DUTY. CODES & STANDARDS: DESIGN AND MATERIALS USED SHALL COMPLY WITH THE RELEVANT LATEST NATIONAL AND INTERNATIONAL STANDARD. AS A MINIMUM, THE FOLLOWING STANDARDS SHALL BE COMPLIED WITH: IS-9334, IS-2147, IS-2148, IS-325, IS-2959, IS-4691 AND IS-4722 - ACTUATOR SHALL HAVE HARDWIRED CONTACTS FOR FOLLOWING SIGNALS (a) ACTUATOR IN LOCAL MODE (b) ACTUATOR IN REMOTE MODE. - BIDDER TO ENSURE AVAILABILITY OF SPARE 1NO + 1NC LIMIT SWITCH & TORQUE SWITCH.  - SS TAG NAME PLATE SHALL BE PROVIDED. - TEMPERATURE RISE SHALL BE RESTRICTED TO 70 DEG. C FOR AMBIENT TEMPERATURE OF 50 DEG C. - CABLE GLANDS OF DOUBLE COMPRESSION TYPE, NI PLATED BRASS MATERIAL SHALL BE PROVIDED. - THE TORQUE SWITCHES SHALL BE PROVIDED WITH MECHANICAL LATCHING DEVICE TO PREVENT OPERATION WHEN UNSEATING FROM THE END POSITIONS. THE LATCHING DEVICE SHALL UNLATCH AS SOON AS THE VALVE LEAVES THE END POSITION. IF SUCH PROVISION IS NOT POSSIBLE, THE TORQUE SWITCHES SHALL BE BYPASSED BY END-POSITION LIMIT SWITCHES WHICH OPENS ON VALVE LEAVING END POSITION. THESE LIMIT SWITCHES ARE ADDITIONAL TO THE NUMBER OF LIMIT SWITCHES SPECIFIED ELSEWHERE. - THE MOTOR SHALL OPERATE SATISFACTORILY UNDER THE +/- 10% SUPPLY VOLTAGE VARIATION AT RATED FREQUENCY, -5% TO +3% VARIATION IN FREQUENCY AT RATED SUPPLY VOLTAGE, SIMULTANEOUS VARIATION IN VOLTAGE & FREQUENCY THE SUM OF ABSOLUTE PERCENTAGE NOT EXCEEDING 10%. - THE MOTOR SHALL BE SUITABLE FOR DIRECT ON LINE STARTING. \$\$ TORQUE SWITCH & LIMIT SWITCH SHALL ACT INDEPENDENT OF EACH OTHER. TANDEM OPERATION IS NOT ACCEPTABLE. ## EPOXY PAINT IS RECOMMENDED FOR COASTAL AREAS.				
NOTES* = TO BE FILLED BY MPL (LEAD AGENCY). @ = TO BE FILLED BY ES				

DRAWING NO. 3-V-MISC-24227



SWITCH TERMINALS FOR CUSTOMER USE

- NOTE:-
1. ALL TORQUE AND LIMIT SWITCHES (OTS, CTS, OLS1&2, CLS1&2) ARE WITH 2NO+2NC CONTACTS '1NO+1NC' IS TERMINATED IN TBS 1-24, REMAINING CONTACTS ARE FOR INTERNAL USE.
ANY SPARE CONTACTS WHICH ARE NOT USED INTERNALLY ARE TO BE TERMINATED IN TBS 25-32
 2. CTS - TORQUE SWITCHES FOR CW ROTATION (CLOSE)
 3. OTS - TORQUE SWITCHES FOR CCW ROTATION (OPEN)
 4. OLS-1, OLS-2 - LIMITSWITCHES FOR POSITION OPEN
 5. CLS-1, CLS-2 - LIMITSWITCHES FOR POSITION CLOSE
 6. EPT - ELECTRONIC POSITION TRANSMITTER (POTENTIOMETRIC TYPE, FOR INCHING DUTY)
 7. R1-R2-POTENTIOMETER 2 x 100 OHMS (FOR ON-OFF DUTY)
 8. FOR COMMANDS & EPT EITHER INTERNALLY GENERATED 24 VDC OR EXTERNAL SUPPLY OF 24VDC CAN BE USED
 9. M - MOTOR 3Ø 415V 50 Hz AC SUPPLY

CONTACT DEVELOPMENT DIAGRAM

OTS	1-2	OPEN AT OVER TORQUE DURING OPENING TRAVEL
	3-4	CLOSE AT OVER TORQUE DURING OPENING TRAVEL
CTS	5-6	OPEN AT OVER TORQUE DURING CLOSING TRAVEL
	7-8	CLOSE AT OVER TORQUE DURING CLOSING TRAVEL
OLS-1	9-10	OPEN
	11-12	STOP
CLS-1	13-14	CLOSE
	15-16	COMMON
OLS-2	17-18	OPEN
	19-20	STOP
CLS-2	21-22	CLOSE
	23-24	COMMON
SWITCH NO.	TERMINAL NO.	INTERMEDIATE POSITION
	a	b
FULL OPEN	FULL CLOSE	FULL CLOSE

INDICATES CONTACT CLOSED
INDICATES CONTACT OPEN

CONTACT RATING: 5A AT 250V AC & 0.5A AT 220V DC

VALVES	OPEN			CLOSE		
	MAIN	BACK UP	MAIN	BACK UP	MAIN	BACK UP
GATE VALVE OF 100 mm AND ABOVE IN 1500 CL AND ABOVE RATINGS	OLS	OTS *	CLS	OTS	CLS	CTS
ALL OTHER GATE & GLOBE VALVES	OLS	OTS *	CLS	OTS	CLS	CTS
# - CLS NOT TO BE CONNECTED IN TRIP CIRCUIT						
* - BYPASS OTS FOR INITIAL 5% OF TRAVEL (FOR GATE VALVES ONLY)						

TYPE OF PRODUCT ELECTRICAL VALVE ACTUATORS (AC) WITH INTEGRAL STARTERS
OR NAME OF CUSTOMER/PROJECT (DRAWN FOR INTERMEDIATE POSITION OF VALVES)



BHARAT HEAVY ELECTRICALS LTD.,
UNIT: HIGH PRESSURE BOILER PLANT,
TRUCHIRAPALLI-620014.

DEPT	VL	SCALE	WEIGHT (KG)	REFERENCE INFORMATION	NO. OF TIMES
365-121					

DRN	N.P.ESWAR	SIGN	N.P.	DATE	NO. OF VAR
CHD	D.DINAKARAN	SIGN	D.D.	07.10.04	07.10.04
APPD	KARUNACHALAM	SIGN	K.A.	07.10.04	07.10.04
REFERENCE INFORMATION					
CARD CODE	WIRING DIAGRAM (TERMINAL PLAN)	DRAWING NO.	3-V-MISC-24227	REV	0
TITLE	FOR ACTUATOR WITH INTEGRAL STARTER	U 01			

**SPECIFICATION
FOR
MEASURING INSTRUMENTS**

CHAPTER-3

FIELD AND MEASURING INSTRUMENTS

3.00.00 FIELD & MEASURING INSTRUMENTS (PRIMARY & SECONDARY INSTRUMENTS)

3.01.00 GENERAL REQUIREMENTS

3.01.01 Instruments, control devices and other equipment accessories covered under this specification shall be furnished in accordance with I&C specification sheets and drawings enclosed herewith and the requirements of all applicable clauses of this specification.

3.01.02 The instrumentation and control equipment shall conform to all applicable codes and standards including those referred in Cl. no. 1.08.00 in this Volume. All equipment and systems shall also fully comply with the design criteria stated in chapter-2 of this part.

3.01.03 The instrumentation/control equipment and accessories shall be from the latest proven design for which the performance and high availability have been demonstrated by a considerable record of successful operation in power station service for similar applications. The bidder shall furnish sufficient evidence to fully satisfy the Owner in this regard.

3.01.04 For plug in type instruments, The plug & sockets shall be polarized to prevent wrong connections and have facility for secure coupling in plug-in position to prevent loose connections.
Signal/Electrical connection shall be screwed connection with double compression type Nickel-plated brass cable glands for Explosion proof area, Flame proof area and high vibration prone area.

3.01.05 Every instrument requiring power supply shall be provided with a pair of easily replaceable glass cartridge fuse of suitable rating. Every instrument shall be provided with a grounding terminal and shall be suitably connected to the panel grounding bus.

3.01.06 All field instruments shall be weatherproof, drip tight, dust tight and splash proof suitable for use under outdoor ambient conditions prevalent in the subject plant. All field-mounted instruments shall be mounted in suitable locations where maximum accessibility for maintenance is achieved. The enclosures of all electronic instruments shall conform to IP-65 unless otherwise specified (Explosion proof for NEC article 500, class 1, Division 1 area & flame proof) and an anti corrosive paint shall be applied to the field mounted enclosures / instruments. All the field instruments shall also be provided with SS tag nameplate and double compression type Nickel-plated brass cable gland. Gaskets, Fasteners, Counter and mating flange shall also be included wherever required with the field instruments.

3.02.00 Following minimum requirement of field instruments shall be fulfilled by Bidder (In addition, Redundancy criteria for field instruments shall be as specified elsewhere in specification): -

- i. Level switches / pressure switches / flow switches/any other process switches etc. for OLCS / Alarms / Interlocks / Protection. Pressure switches at inlet, outlet

of individual pumps and discharge header of pumps for protection and auto start / stop & alarms.

- ii. Level switches for sump/tank level high/normal/ low/very low interlocks.
- iii. Level Transmitters (Type as per Owner approval) for open sump/tank/bunker/vessel/heaters.
- iv. Stand pipes on both side of tank for all level instruments (LT, LS & LG).
- v. Flow elements with flow transmitter & Flow meter for flow measurement of process medium like Steam, Water, Air, Flue Gas, Fuel oil, open channel liquid, solid fuel, ash flow, DM water, Raw water, Instrument and Service air etc. as decided by owner.
- vi. Pressure gauges and temp. Gauges at inlet and outlet of each heat exchanger and cooler.
- vii. DPG, DPT & DPS across the filters/strainers.
- viii. Tapping points/test points shall be provided.
- ix. All primary Instruments, hardwares & JB's etc used for measurement for HFO, LDO & Turbine Lube Oil system shall be flame proof (IEC-79.1, Part I). All primary Instruments, hardwares & JB's etc used for measurement for Hydrogen shall be intrinsically safe and explosion proof as per NEC article 500, class 1, Division 1 area I.
- x. All Thermocouples & RTDs shall be Duplex.
- xi. All Field Instruments used in acid or alkaline atmosphere shall be with standard Anti corrosion coating i.e. the combination of Polyurethane and epoxy resin baked coating (ANSI/ISA-71.04).
- xii. All primary instruments installed at "Minus level or Floor" shall be with protection class of IP 68.
- xiii. Transmitters (all type) for monitoring & controls purpose.
- xiv. Pull cord, belt sway, zero speed switches, emergency stop P B for conveyers, other limit switches, cable gland etc. of CHP which produce spark shall be provided with dust and flame proof enclosure conforming to IS-2148.
- xv. Lockable Deinterlock switches shall be provided for CHP as per requirement.
- xvi. Bidder shall provide electronics weighing in motion system as per IS-11547, hermetically sealed load cell of precision strain gauge type, 100% over load protection of cell and 250% overload protection for the construction; one calibrator attachment with two weighers.

- xvii All field mounted push button, selector switch etc. shall be as per IEC or NEMA 4X protection.
- xviii All limit switch shall be conform to IEC-60947-5-1.
- xix At APH, **temperature measuring device of different lengths forming grid** shall be provided to have average temperature for variable flow of flue gas, secondary air and primary air. These temperatures may be connected to nearest remote I/O panel.
- xx. On both left and right sides of furnace, separate lines shall be laid and provided with **furnace pressure transmitters having wide range** than the furnace pressure transmitter.
- xxi. Temp. Transmitters are envisaged with RTD & Thermocouples for monitoring services/application only. However any RTD & Thermocouples are used for control, interlock & protection application, same shall be directly wired to DDCMIS/DCS/PLC using instrumentation & Extension cables respectively.
- xxii. As for the water flow/ steam flow measurements, **necessary flow elements/transmitters are chosen in the process line and supplied such that their algebraic summation shall be mass balanced for calculating the system efficiency.**
- xxiii. Contacts less, electronic 2-wire position transmitters shall be provided for all inching type motorised valve and dampers.
- xxiv. For CW sump level, Raw water reservoir level, Turbine oil tank, coal bunkers, Ash Silo, LDO/HFO tank, DM water tanks, CS tank, Acid and alkali applications, only non contact type level transmitters like Acoustic, Ultrasonic, Radar based shall be provided by bidders as specified in NIT and as approved by owner.
- xxv. Considering the type of application, wireless technology to bring signals to DDCMIS may be adopted by interfacing with OPC gateway to avoid cabling for smart level transmitters specified above at sr. no. xxiv. However Wireless technology as adopted by Bidder shall be reliable and field proven in power plants and same shall be approved by Owner.
- xxvi. For Turbine oil, HFO/LDO applications & H2 Gas application, zener protection on power supplies shall be included.
- xxvii. Where the process fluids are corrosive, viscous, solid bearing or slurry type, diaphragm seals shall be provided. Parts below the diaphragm shall be removable for cleaning. The entire volume above the diaphragm shall be completely filled with an inert liquid suitable for the application. For HFO, LFO Applications, SS capillary with thin wafer element with ANSI RF flanged ends are to be provided. For hazardous area, explosions proof enclosure as described in NEC article 500 shall be provided.

FIELD INSTRUMENTS SHALL BE SUPPLIED & OFFERED AS PER DATA SHEETS SPECIFIED BELOW:

3.03.00 TRANSMITTERS, SWITCHES, GAUGES AND PANEL MOUNTED INSTRUMENTS

3.03.01 Pressure, Differential Pressure, DP type Level and Flow Transmitters (PT, DPT, LT & FT)

Smart Transmitters of the electronic type shall be furnished.

All Transmitter shall be installed in closed LIE in the boiler area. Similarly transmitter for TG shall also be in LIE except the transmitters located in covered area on TG floor and these shall be mounted in LIR.

Transmitters shall be equipped with mounting brackets suitable for a mounting in transmitter enclosures.

In general, Transmitters are envisaged to be grouped at several places as to be decided during detailed engg. stage. For this purpose, suitable enclosures complete with all tubing, fittings, purge meters, loop cable trays etc. shall be provided.

Type/Construction	:	Sealed capacitance/ Inductance/ Silicon resonance type
Material		
- Body	:	Die cast Aluminum with epoxy coating for air & flue gas SS316 for other services
- Diaphragm	:	316 SS
- Measurement element	:	Teflon seal
- Valves	:	Carbon steel for non-corrosive Applications SS316 for corrosive applications.
Output signal	:	4 to 20 mA Amp. DC (Two wires) HART Compatible
Local Indicator	:	LCD indicator (5 digit) with scale of Engg. unit
Overall Accuracy	:	$\pm 0.04\%$ or better of Span for BTG package $\pm 0.065\%$ or better of Span for BO P packages $\pm 0.2\%$ or better of span for remote seal type transmitter.
Turn down ratio	:	100:1 in general
Stability	:	$\pm 0.15\%$ of URL for 5 years.
Response time	:	150 msec.
Power supply	:	24V DC nominal
Drive capability	:	600 Ohms nominal
Enclosure Class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
Span and Zero	:	Locally adjustable, non-interacting

Zero suppression / elevation	:	At least 100% of Span
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Connection

- Process	:	1. Half (1/2) inch NPT (F) Quarter (1/4) inch NPT with/without oval flanges
- Electrical	:	Suitable for Plug in type connection (Both side of transmitter), unused entry with blind plug.

Accessories

- For Absolute Pressure Transmitters:	:	Two (2) valve SS316 manifold
- For Gauge & Vacuum pressure transmitter	:	Three (3) valve SS316 manifold
- For DP, level & flow transmitter	:	Five (5) valve SS316 manifold
- For oil and corrosive liquids	:	Separator diaphragm seals
- For all transmitters	:	Mounting bracket

Manifold should not be mounted on the transmitter, Manifold shall be non integral and standalone type. Snubbers/Pulsation dampers shall be used where the process media is unstable for measurement such as the discharge of a pump. Over range protection shall be used where necessary. The coil syphons & condensate pots shall be used for steam services. Transmitters shall be provided with suitable drain & vent points.

3.03.01.01 Transmitters & other HART based instruments shall be supplied along with 3 Nos. of universal type hand held/portable pressure calibrators. Temperature transmitters shall be supplied along with 3 Nos. of hand held/portable mV source generators.

3.03.02 PRESSURE SWITCHES (PS) & DIFFERENTIAL PRESSURE SWITCHES (DPS)

Applicable Standards	:	IS3624 - 1966/ISA-RP-8.1 except as modified in spec.
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Type/Construction	:	Bourdon/Sealed Diaphragm Piston Actuated preferable. Indicators with contacts are not acceptable.
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Materials

- Bellows	:	316 SS
- Bourdon tube	:	316 SS
- Movement	:	316 SS
- Enclosure	:	Die-cast aluminum with stoved enamel black finish. Epoxy coating shall be provided for corrosive atmosphere.
- Protective Diaphragm	:	Teflon

Accuracy	:	± One (1) percent or better
Repeatability	:	± 0.5(half) percent or better
Setting & Differential	:	Adjustable

Contact

- Number	:	DPDT /2 SPDT
- Type	:	Auto reset with internal Adjustable snap action micro switch
- Rating	:	5 Amp, 240V AC / 0.2 Amp, 220V DC
Connection - instrument	:	Half (1/2) inch NPT Male Process
Electrical	:	Suitable for Plug in type connection. All the switches are internally connected and brought to the surface with Amphenol male/female connection. Cabling need not be terminated inside the switch. Cable ends are to be soldered in connector and to be inserted for easy maintenance.
- Over range protection	:	One Fifty (150) percent of full scale
Enclosure Class	:	IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)

Accessories

- 3 / 5 valve manifold	:	As applicable for all switches
- Self cleaning type pulsation dampners/Snubber (Material SS316)	:	Pump and compressor discharge lines
- Syphon	:	For all steam lines
- Protective separating diaphragm	:	For fuel oil & corrosive liquid lines.
Mounting	:	Local (in LIE/LIR for BTG package).

3.03.03

PRESSURE & DIFFERENTIAL PRESSURE GAUGES (PG & DPG)

Applicable standard	:	IS:3602-1966, IS/3624, ASME B 40.1
Type/Construction	:	
-760 mm to 1.0Kg/cm ²	:	Bellows/Diaphragm
-Above1.0Kg/cm ²	:	Bourdon Tube
- Suction side of pumps	:	Compound gauge

Materials

- Bourdon tube	:	316 SS
- Bellows	:	316 SS
- Movement	:	316 SS
- Case	:	SS 316/ Die-cast aluminum with stoved enamel black finish. Epoxy coating

		shall be provided for corrosive atmosphere.
- Protective Diaphragm	:	Teflon
Dial size	:	150mm with shatter proof glass
Scale Details	:	Graduations in black lines on white dial, on white dial, 270 Deg. pointer deflection scale provided with glass cover. Smallest scale division shall be one (1) percent of full scale value or smaller. Pointer stop for all gauges.
Accuracy	:	± One (1) percent or better
Connection - Instrument Process	:	1/2 inch NPT Male Bottom
Mounting	:	Local
	:	1/2 inch NPT Male (Back entry) mounted on local gauge board.
Enclosure Class	:	IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)

Accessories

- 3 way needle valve/manifolds	:	For all gauges
- Self cleaning type	:	Pump and compressor discharge lines
Pulsation dampener/snubber (S316)	:	
- Syphon	:	For all steam lines
- Protective separating	:	For fuel oil and corrosive liquid lines

Other particulars

- External Zero adjustment	:	For all gauges
- Safety device	:	
Ranges 5 to 20 Kg/cm ²	:	Rubber blow out disc with open front construction.
Ranges above 20 Kg/cm ²	:	Neoprene safety diaphragm at the back with solid front construction.
- Over range protection	:	One Fifty (150) percent of full scale

Other Requirments

:	Movement mechanism shall be glycerin filled for oil services & vibration prone area.
:	For Fuel oil & corrosive liquid lines diaphragm type sensors required. Armored capillary of 10 M for Fuel oil & Corrosive liquid service.

- : Contact type pressure gauges are not acceptable for interlock & protection.
- : For condensate storage tank the pressure gauge in terms of 0-10000 mm wc or suitable range having **dial size of 300mm or bigger size** shall be provided.

3.03.04 TEMPERATURE TRANSMITTERS

Type	:	SMART type configurable from control room through HART protocol (HMS System).
Display type	:	Indicating type (5 digit LCD Display),
Accuracy	:	$\pm 0.10\%$,
Ambient temperature error	:	0.1% per 10°C change
Output	:	4-20 mA DC (2 wire system) HART compatible signals for analogue monitoring inputs to the distributed control system (DDCMIS), DCS & PLC.
Protection class	:	NEMA 4/IP66 or equivalent degree of protection for enclosure)/ (Explosion/Flame proof for NEC Class-1, Division 1 area)/ flame proof (IEC-79.1, Part I). As applicable).
Material of accessories	:	SS316.
Stability	:	$\pm 0.1\%$ or ± 0.1 deg C of reading (whichever is great) for 2 years in case of RTD inputs and for 1 year in case of Thermocouples inputs.
Operating Voltage	:	16 – 48 V DC
Calibration	:	as per NIST monograph 125 for T/C & European Curve Alpha = 0.00385 for RTD .
Ref. Junction compensation	:	Provided
Span/zero adjustment	:	Locally adjustable, Non interacting
Auto calibration	:	Provided
Burn out protection upscale	:	Provided
Input - output isolation	:	Provided
Circuit ungrounded	:	Provided

Any RTD & Thermocouples shall be directly wired to DDCMIS/DCS/PLC for metal temperature application, bearing & winding temp application only.

The Temperature transmitter shall accept Universal dual inputs of all types of thermocouples & RTD, 0-5V input signals etc.

Temp. Transmitter shall be extremely stable against Ambient temperature variation, The accuracy figure shall be inclusive of effect due to ambient temperature variation.

Considering the application & distance involved for monitoring parameters **wireless technology** shall be adopted by interfacing with DDCMIS through OPC connectivity. However Wireless technology as adopted by Bidder shall be reliable and field proven in power plants and same shall be approved by Owner.

3.03.05

RESISTANCE TEMPERATURE SENSORS WITH THERMOWELLS

Applicable Standard	:	ASME PTC 19.3 - Latest Revision DIN EN 60751: 1996, BSEN/IEC60751: 2008
Element	:	Platinum, R0=100 ohm 4-wire Duplex for Process Temp. Measurement Platinum, R0=100 ohm 3-wire Duplex for Bearing & Winding Temp. Measurement
Sheath Material/ Insulation	:	316SS/Compacted Magnesium Oxide
Sheath O D	:	8 MM
- Gauge	:	18 AWG
Terminals	:	Spring loaded high temperature ceramic base with silver plated brass for high vibrating locations.
Calibration	:	As per DIN Standard – 43760, Class A
Head	:	Hex Head, Die Cast Aluminum (Screwed) with galvanized SS chain
Response Time	:	6-10 Sec bare & 30 Sec. With protective sheath/thermowell
Accuracy	:	± 0.35 degree C or Class-A whichever is better.
Electrical connection	:	Gold plated Plug in type. Double entry – one unused entry with blind plug
Enclosure Class	:	IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)

THERMOWELL

Applicable Standard	:	ASME PTC 19.3 TW - 2010
- Construction	:	Tapered drilled from Bar stock (Straight for Air & Gas systems)
- Material	:	- 316 SS/F11/F22/F91 - water and steam Services depending upon process parameters. - Inconel for air & flue gas services For furnace zone, impervious ceramic protecting tube of suitable material along

with Incoloy supporting tubes and adjustable flanges.

For Mill classifier outlet long life solid sintered tungsten carbide material or better of high abrasion resistance.

Bidder shall provide calculation for thermowell as per ASME – PTC-19.3 2010. “All Thermowells in high velocity steam service shall be checked for Strouhal’s frequency limit to arrive at a safer size and design of Thermowells”.

- Process Connection	:	(i) M 33 x 2 (ii) SS316 Flanged, for Air & Gas systems, with mating flanges, fasteners, gaskets etc.
- Extension	:	Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends
Immersion length	:	Within ± 10 mm of center line of pipe and as per ASME – PTC-19.3 - 2010
Extension neck length	:	Minimum 100 mm above insulation of pipe and Minimum 160 mm when there is no insulation on pipe.
IBR Certification	:	For high pressure service, Steam Temp., Fuel oil temp. measurement as per IBR rules and regulations
Note	:	Extension /Compensating/paired cable exposed to atmosphere in the conventional method melts away due to high temperature at the top of mill or due to coal burning. Hence The terminals of temperature sensors shall not be at the top of mills itself. The temperature sensors wires are to be laid up to JB though SS tube of required diameter and the head shall be placed nearer to the JB.

3.03.08 TEMPERATURE SWITCHES (TS)

Type/Construction

- Switch : Industrial type inert gas filled with capillary and separable thermowell and contacts directly connected to Bourdon element/vapor pressure sensing, gas filled bellows type preferred.
- Thermowell : Bar stock

Material

- Bulb : 316 SS
- Capillary : Armored Stainless Steel
- Bourdon : 316 SS
- Bourdon Movement : SS 316
- Casing : Die-cast aluminum with stoved enamel black finish Epoxy coating shall be provided for corrosive atmosphere.
- Setting and Differential : Adjustable
- Accuracy : $\pm$ One (1) percent of setting and differential
- Repeatability : One half(1/2) percent of setting.
- Contacts
- Number : DPDT/2 SPDT
- Type : Auto reset with internal Adjustable snap action micro switch
- Rating : 5 Amp, 240V AC / 0.2 Amp, 220V DC
- Connection
- Pipe : M33 x 2
- Extension : Threaded union (SS316) 1/2" NPT (F)

with two nipples of SS 316 having 1/2"NPT(M) threads at both ends

Thermowell : To suit Temp. switch with same design criteria as specified for RTDs.
Electrical : Suitable for Plug in type.

All the switches are internally connected and brought to the surface with Amphenol male/female connection. Cabling need not be terminated inside the switch. Cable ends are to be soldered in connector and to be inserted for easy maintenance.

Other Particulars

- Capillary length : As per requirement (min 10 meters)
- Immersion Length : Within + ten (10) mm of center line of pipe with adjustable nuts.
- Extension neck length : Minimum 50 mm above insulation of pipe /As per approved hookup drawings.
- Packing glands : Yes
IBR Certification : For high pressure service, Steam Temp, Fuel oil temp. measurement as per IBR rules and regulations
N.B : Switches designed for cross ambient operation shall be used in applications where the ambient temperature will approximate or exceed the switch set point.

3.03.09 TEMPERATURE GAUGES (TG)

Applicable standard : IS : 3602,BS:5235 ISA:RP:8.1 except as modified in this specification

Type/Construction

- Thermometer : Industrial type, Gas in Filled type with separable thermowell
- Thermowell : Bar stock

Material

- Bulb : 316 SS
- Capillary : Armoured SS (Applicable for capillary Type)
- Casing : SS 316/ Die-cast aluminum with stoved enamel black finish. Epoxy coating

		shall be provided for corrosive atmosphere
Dial Size	:	150mm with shatter proof glass
Scale Details	:	270 degree dial rotation/deflection. Graduations in black lines on white dial provided with glass cover. Smallest scale division shall be one (1) percent of full scale value or smaller. Pointer stop for all gauges
Accuracy	:	$\pm$ One (1) percent or better
Response time	:	Maximum 15 seconds without thermowell and 30 seconds with thermowell
Connection		
- Pipe	:	M33 x 2
- Thermowell	:	To suit instrument with same design criteria specified for RTDs.
- Process Connection	:	(i) M 33 x 2 (ii) SS316 Flanged, for Air & Gas systems, with mating flanges, fasteners, gaskets etc.
- Extension	:	Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends
Other Particulars		
- Capillary length	:	5Meters/10 Meters as required
- Immersion Length	:	Within + ten (10) mm of center line of pipe with adjustable nuts.
- Extension neck length	:	Minimum 50 mm above insulation of pipe /As per approved hookup drawings.
- Stop at Maximum value	:	For all gauges of scale
- Pointer	:	Externally adjustable
	:	In general, Contact type Temp. gauges are not acceptable for interlock & protection.
		Contact type Temp. gauges are acceptable for interlock & protection in case of bearing temp. only.
- Over range protection	:	150 percent (%) of full scale
Enclosure Class	:	IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)
IBR Certification	:	For high pressure service, Steam

Temp., Fuel oil temp. measurement
as per IBR rules and regulations

3.03.10 TEST THERMOWELLS (TW)

Applicable Standard	:	ASME PTC 19.3 TW - 2010
Type/Construction	:	Machined from Bar Stock
Material	:	316 SS/F11/F22/F91
Connection	:	
- Pipe	:	M33 x 2
- Test Instrument	:	To suit test instruments
Accessories	:	Plug with chain
IBR Certification	:	For high pressure service, Steam Temp., Fuel oil temp. measurement as per IBR rules and regulations Bidder shall provide calculation for thermowell as per ASME – PTC- 19.3 TW - 2010.

Test wells shall be provided on main steam, reheat steam, extraction steam, feed water, condensate, spray water lines and other piping as required to meet ASME test requirements.

3.03.11 DIRECT MOUNTED LEVEL TRANSMITTERS (LT)

Displacer type level transmitter shall not be used in the process anywhere in the plant.

3.03.12 Ultrasonic Level Transmitter (for Water sump/Tank level, Raw water reservoir level, Cooling water fore bay level measurements)

Principle of Operation	:	Detection of reflected ultrasonic pulse
Measuring Ranges	:	Up to 30 meters (typical)
Signal Processing	:	Microprocessor Controlled Signal Processing
Operating Freq.	:	10 KHz to 50 KHz (typical)
Display	:	Head mounted alpha-numeric back lit LCD/LED
Calibration & Configuration	:	Accessible from front of panel & HART calibrator.
Diagnosis	:	On-line
Status	:	For power, Hi / Lo / V. Hi / V. Lo- level indication, fault etc.
Construction	:	Plug-on board
Power supply	:	240 V AC 50 Hz / 24V DC
Signal Output	:	4-20 mA DC with HART (isolated) - 600 Ohm load.
Hysteresis	:	Fully adjustable preferred
Output contacts	:	2SPDT Potential free changeover contacts @ 8A 230V AC.
Accuracy & Repeatability	:	± 0.25% of span or better
Resolution	:	± 0.1% of span
Temperature Compensation:	:	To be provided with Transducer.

Operating temp.	:	Transmitter-50 deg C and Sensor – 80 deg C
MOC Sensor	:	Body- PVDF and Face – Polyurethane
Humidity	:	1% to 95% non condensing.
Enclosure	:	IP-67 Epoxy painted die cast Aluminum or SS316L housing.
Cable Connection	:	3/4" ET
Mounting	:	2" – 4" NPT or flanged
Accessories	:	Cable gland, prefab cable, mounting accessories like EPDM seal, SS316 flanged etc.
		Additional separate local display unit with large Alphanumeric back light LCD/LED & to be provided for the applications which will be decided during detailed engineering.

3.03.13 CAPACITANCE TYPE LEVEL TRANSMITTER

The total system shall consist of capacitance probe, pre-amplifier and transmitter

Type	:	Capacitance type
Probe	:	a) Rod or suspended electrode. b) Rope type probes may be used only where required probe length is greater than 3 meters
Probe Mounting	:	Stainless steel 1-1/2 ANSI RF Flange / ¾" NPT (M)
Material of construction	:	316 SS
Insulation	:	PTFE Part/Full as per service.
Transmitter	:	The transmitter shall receive output of the preamplifier and convert it into 4-20 mA DC output signal.
Accuracy	:	± 1% of Full scale
Repeatability	:	± 0.5 % of Full scale
Load	:	Min 600 Ohms
Enclosure	:	Powder/Epoxy coated Die cast aluminum. with neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
Ambient temperature	:	0-60 °C.
Mounting	:	Wall / Surface
Supply voltage	:	240V AC, 50Hz / 24V DC
Response time	:	100 m sec or better
Cable connection	:	¾" ET
Accessories	:	Counter flange, Cable gland, prefab cable if any
Preferable features	:	Alarm output contacts with adjustable set point facility

3.03.14 GUIDED WAVE RADAR/RADAR LEVEL TRANSMITTER

Type	:	Guided wave Radar (Contact type)/Radar (Non contact type) as finalized by owner.
Application	:	For Turbine Lube oil tank, HFO & LDO tank level,

		Condenser Hotwell, LP heaters, C/D tank level, Stator water expansion level, and other Low pressure, Vacuum vessels.
Environment Class	:	Highly abrasive with Gases and Fumes
Orientation	:	Vertical
Probe Type	:	Flexible Single lead with chuck
Probe Material	:	SS 316L
Connection Size & Type	:	2" Flanged ANSI 300 lb SS316L material
Connection material	:	SS 316L
Accuracy	:	+/- 5 mm
Resolution	:	± 1 mm
Type (Transmitter)	:	SMART, 2 Wire
Operating Principle	:	Time Domain Reflectometry
Output	:	4-20 mA, DC with HART protocol and 600 Ω output load.
Electrical Connection	:	½" NPT
Enclosure Class	:	IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)
Electrical Power	:	11-42 V DC
Housing material	:	Die Cast Aluminum
Vent & Drain Plug material	:	SS
Side Flange Material	:	SS
Local Display	:	Provided (LCD Digital)
Units of Measurement	:	Length M
Electromagnetic compatibility:	:	EN-61326

3.03.15 3 D TYPE ACOUSTIC WAVE LEVEL TRANSMITTER

Type	:	Acoustic Wave Level Transmitter (3 D type)
Application	:	Coal and Ash Bunker Level, Volume & Mass.
Temperature compensation	:	Required for high temp applications
Operating Principle	:	Non - Intrusive acoustic wave transmission & Reflection
Frequency Range	:	3 – 10 KHz
Accuracy	:	+/- 0.25 % for even surface & ± 0.5% for uneven surface.
Resolution	:	1 mm
Output	:	4-20mA DC with HART
Display Unit:		
Type	:	Head mounted LCD Display with Engg. Units
Location	:	Suitable location at bunker / Silo operating floor area
Protection Class	:	IP 65 or better// flame proof (IEC-79.1, Part I) As applicable).
Material Of construction:		

Housing	:	Polypropylene
Flange	:	Polypropylene
Sizes:		
Flange Size	:	2" ANSI 300 # RF SS
Electrical connection size	:	½" NPT (F)
Accessories	:	i. Double compression type Nickel Plated Cable glands
		ii. Suitable Mating Flange, necessary gaskets,
		iii. Local display unit and Suitable mounting brackets, necessary mounting hardware for Local display unit.
		iv. Complete software as required to have 3 D view on monitors.

3.03.17 LEVEL SWITCHES (LS)

Type/Construction	:	a) External float cage type with magnetic switch actuator for tanks and vessels. b) Electrode/Capacitance (for oil tanks) c) Displacer -Top mounted for all clean water sumps. d) Conductivity type for high Pressure and high temperature enclosed vessel like drain pot, HP heaters etc.
Materials		
- Body	:	Cast Carbon Steel/Die cast Aluminum suitable for specified pressure and temperature ratings
	:	For corrosive liquids suitable anti-corrosive coat/lining shall be provided.
- Float/Displacer	:	316 SS
- Wire rope	:	316 SS
Differential	:	± 12 mm minimum (Adjustable)
Contacts		
- Number	:	DPDT/2 SPDT
- Type	:	Snap action micro switch Auto reset with internal Adjustable
- Rating	:	5 Amp 240V AC 0.2 Amp 220V DC
Connection - Process	:	One (1) inch SCRD NPT Female Or One (1) inch ANSI Flanged Four(4) inch ANSI Flange for sump services.
Electrical	:	Suitable for Plug in type connection

Temperature/pressure rating : As per service conditions
 Accessories : Counter flanges, still pipe of requisite length with anticorrosive coating for sump services.

Nuclear, capacitance, or ultrasonic type level switch for bulk material applications shall be provided.

3.03.17.01 Conductivity Type Level Switch

Type	:	Conductivity discrimination.
Mounting	:	Flanged – on standpipe.
Probe MOC	:	Stainless steel with high purity ceramic.
Probe rating	:	> Maximum design pressure of vessel.
Input	:	Four independent channel with selectable switching threshold for water conductivity.
Relay Output	:	Four isolated output relays for Hi, Lo, Hi-Hi, Lo-Lo.
Contact type & rating	:	2SPDT or 1 DPDT @ 5A 30V DC.
Faults Detection	:	Power Fail/Electrode Connection Open circuit/short circuit to ground, Ground failure. In built Fail Safe Logic.
Indicator	:	One Red LED for steam/ one Green LED for water/ Two no. LED one each for Process & system fault.
Power supply	:	Dual 240V AC, 50 Hz, 1Ph. From UPS
Enclosure	:	IP-65, corrosion resistant & wall mounting type.
Accessories	:	i. PTFE cable from probe to electronics unit. Electronic unit shall be separate. Head mounted electronic unit is not preferred. ii. Mounting accessories iii. standpipe iv. Washer & gasket
Test pressure	:	Two times rated pressure

3.03.17.02 Capacitance Type Level Switch

Type	:	Capacitance type
Probe	:	a) Rod or suspended electrode b) Rope type probes may be used only where required probe length is greater than 3 meters.
Probe Mounting	:	Stainless steel 1-1/2 ANSI RF Flange / 3/4" NPT (M)
Material of construction	:	316 SS
Insulation	:	PTFE Part/Full as per service.

Enclosure	:	Powder/Epoxy coated Die cast Aluminium. with neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
Ambient temperature	:	0-60 °C.
Mounting	:	On Top
Supply voltage	:	240V AC, 50Hz from UPS/ 24V DC
Relay output	:	2SPDT
Contact rating	:	5A min. at 240V AC on resistive load
Response time	:	100 m sec or better
Cable connection	:	¾" ET
Accessories	:	Counter flange, Cable gland, prefab cable and stainless steel name plate engraved with alpha-numeric.

3.03.17.03 RF TYPE LEVEL SWITCH

A. Electronic Controller

1.	Input Supply	:	240 V AC from UPS
2.	Construction	:	Cast Aluminum Housing
3.	Relay Output	:	2 Nos. Relay Changeover Potential Free Contacts(2SPDT)
4.	Contact Rating :	:	5A at 240 V AC & 0.25 at 220 V DC
5.	Class of Protection	:	IP-66
6.	Ambient Temperature	:	55 Deg. C(Max)
7.	Local Indication	:	Local LED Indications
	Green	:	Normal Level
	Red	:	Alarm Level
	Yellow	:	Probe Healthy
8.	Cable Connection	:	¾" ET(2 Nos.) for Supply and Output 5/8" ET(1 No.) for Probe Connection
9.	Repeatability	:	100%

B. Sensing Probe

1.	Type of Probe	:	Rigid
2.	Material	:	Stainless steel SS 316
3.	Probe Head Housing	:	Cast Aluminum
4.	Insulation (B/W Active & Shield And Shield & Ground)	:	PTFE
5.	Probe Head Protection	:	IP-66
6.	Mounting	:	Side Mounted
7.	Cable Connection	:	5/8" ET(1No.)
8.	Process Connection	:	40 NB BSP THREADED
C.	Signal Cable	:	Coaxial cable for Connection Between Sensing probe and electronic Controller(@ 10 Mtrs. Per Level Probe)

D. Application : Ash Silos

3.03.18

LEVEL INDICATORS (Gauge Glass) (LI)

Type/Construction : **a) Reflex**
b) Tubular (For tanks open to atmosphere only)

Material.

a) Glass : Tempered borosilicate resistant to thermal shock

b) Case : Carbon steel

c) Integral cocks and : i) Forged carbon steel with drain valves stainless steel internals
ii) Rubber lined corrosion resistant 316 stainless steel (for Demineralised and Osmosis water service)

d) Fittings : i) Forged carbon steel
ii) Rubber lined 316 steel/PVC for corrosive liquids Demineralised and Osmosis water service)
iii) 304 Stainless Steel for non-corrosive liquids

e) Packing : Teflon

Dial size/scale : 150 mm /1.5 Meters maximum length with

Scale details : Aluminum/SS316 scale Graduated in mmwc

Connection : 25 Nb/40 Nb ANSI Flanged

Accessories : a) Integral cocks
b) Drain valves
c) Bolts, nuts and gaskets
d) Illuminating lamps as required
e) Periscope as required

Tests : Tested at two hundred (200) percent of the maximum process pressure

Other details : For larger lengths, additional gauge glasses shall be provided with minimum of 50 mm overlap.

3.03.19

FLOAT & BOARD TYPE LEVEL GAUGE

Type of Instrument : Mechanical Type (Float Operated)

Service/ Application : As per service requirement

Measuring Range : as per requirement

Material Specification

a) Float Material : SS316 having 2 nos. Guide wires

b) Float Wire Pulley : Shall comprise of 2 nos. Cast Aluminum Pulley housing Assembly with SS 304 pulley and pulley shaft. Steel ball bearings shall be provided in pulley housing for easier float movement. Float wire material shall be

		SS316L. Between 2 pulleys, 1" NB G.I. short pipe with tentative length as per P&ID
c) Guide wire Assembly	:	CS chamber with spring and adjuster having 1" Class 150 ANSI RF MS flange. Guide wire rope shall be SS316L.
d) Counter Weight	:	MS counter – weight with Aluminum Pointer and Brass assembly Pull Chain.
e) Scale	:	SS 316/Aluminum material in mm with 1 % accuracy.
Nozzle Details	:	For float wire pulley assembly, one tapping and for guide wire assembly two tapping at the top of the tank; Size 1" NB (Top Mounting Type)
Process Connection	:	Flanged as per ANSI B 16.5 to suit 1" NB nozzle (Nozzle length - 150 mm for float wire, 100 mm for guide wire)
Accessories (to be supplied with the instrument)		
a) Counter flange	:	All mating Flanges, Nozzle
b) Mounting Accessories	:	All mounting accessories
c) Tag Plate	:	To be provided (material SS316)

3.03.20

MASS FLOW METER

Sensor

Measuring Principle	:	Coriolis Mass flow.
Primary Element	:	Flow Tube of 316SS or better
Heating Arrangement	:	Integral with Flow meter.
Temperature Control For Heating	:	To be provided.
Process Connection	:	ANSI RF Flanged and rating as per process requirement.
Drain	:	Self-draining facility
Accessories	:	Counter flanges, Mounting nuts, bolts, gaskets etc.

Transmitter

Measured quantities	:	Mass Flow rate, Total Mass Flow, Density, Temperature as minimum.
Input Signal Processing	:	Digital Processing.
Display	:	Digital Display (LCD).
Output	:	2 Nos. isolated output of 4-20mA DC selectable from four measured quantities.
Load	:	< 750 ohms.
Power supply	:	240V AC, 50 Hz. From UPS
Accuracy	:	0.15% of measured value for Liquid 0.5% of measured value for Gas
Repeatability	:	0.05%
Housing	:	IP 65 (Explosion proof for NEC Class-1, Division 1 area)
Hazardous duty Version	:	FM Standards.

Nameplate	:	Tag number, service engraved in stainless steel tag plate
Accessories	:	a) As required for field mounting, Handheld configurator & complete Software, External zero adjustment facility b) Mounting U-bolts, nuts, bolts, prefab cable etc.
Application	:	HFO main line, LDO lines, HFO recirculation lines etc.

3.03.21 Turbine Flow meter

Sensor

Type	:	Turbine (in line full-bore, based on magnetic pick of pulses)
Output Signal	:	Pulse
Material of Construction	:	a) Body : AISI 316 b) Rotor: AISI 431 or 410 c) Bearings: Tungsten Carbide / Stellite Sleeve
Flow rate range	:	As required.
Linearity	:	0.25% or better.
Repeatability	:	0.02% or better.
Ambient temperature	:	50 deg C
Mounting	:	On-Line mounting with ANSI RF flanges of stainless steel.
Enclosure	:	IP 65

Transmitter

Electronics	:	Solid State
Power Supply	:	240V AC, 50Hz. UPS
Input	:	Input from Sensor
Display	:	4 1/2 digit LCD
Output	:	Isolated 4-20mA DC HART
Measuring Accuracy	:	0.5% of full scale range
Totalized Value	:	Required
Housing	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
Nameplate	:	Tag number, service engraved in stainless steel tag plate
Accessories	:	a) clamping strip, bracket, prefab cable etc. and Calibration or configurator kit.

3.03.22 VORTEX FLOW METER

Sensor

Type	:	Vortex
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Output Signal	:	Pulse
Material of Construction	:	AISI 316
Sensor Seal	:	PTFE / higher based on temperature
Flow range	:	As required.
Linearity	:	0.25% or better.
Repeatability	:	0.02% or better.
Ambient temperature	:	50 deg C
Mounting	:	On-Line mounting with flanges of stainless steel.
Enclosure	:	IP 65
Accessories	:	Nuts, bolts, gaskets etc.
Transmitter		
Electronics	:	Solid State
Power Supply	:	240V AC, 50Hz. UPS
Input	:	Input from Sensor
Display	:	4 1/2 digit LCD
Output	:	Isolated 4-20mA DC HART
Measuring Accuracy	:	0.5% of full scale range
Totalized Value	:	Required
Housing	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
Nameplate	:	Tag number, service engraved in stainless steel tag plate
Accessories	:	Clamping strip, bracket, prefab cable etc. Special tool kit for calibration/ configuration .

3.03.23 Flow Transmitter (Ultrasonic)

Type	:	ULTRA SONIC, 2-wired
Sensing element	:	Non-contact
Output	:	4-20mA with HART Protocol
Accuracy	:	± 0.1% FS
Supply	:	24 V DC
Enclosure class	:	IP-65
Transmitter		
Mounting	:	On Nozzle
Mounting position	:	Top mounted
Housing	:	Plastic
Display	:	Head mounted LCD Display and remote LCD display
Process connection	:	NPT/Flanged
Electrical connection :	:	NPT
Turn Down ratio	:	1:100
Measuring range	:	Adjustable (as per process requirement)
Totaliser	:	Required
Accessories	:	As per process requirement Additional separate local display unit with large Alphanumeric back light LCD/LED & to be provided for the applications which will be decided during

detailed engineering.

3.03.24 **Positive Displacement Flow Transmitter**

Positive displacement flow transmitters shall be offered. An electronic totalizer shall be provided for each flowmeter and the location of the totalizers shall be acceptable to the Owner. Air eliminators shall also be provided to ensure maximum accuracy.

Type	:	Hall Effect Sensor
Body Material	:	AISI 316L/Die Cast Aluminium.
Wetted part Material (Like Piston, Bearing, gear etc)	:	AISI 316L/Die Cast Aluminium.
O ring material	:	PTFE / higher based on temperature
Flow range	:	As required.
Accuracy	:	$\pm 0.5\%$ or better of reading
Repeatability	:	$\pm 0.03\%$ or better.
Ambient temperature	:	50 deg C
Mounting	:	On-Line mounting with flanges of stainless steel.
Electronics	:	Solid State
Power Supply	:	230V AC, 50Hz. UPS
Display	:	4 1/2 digit LCD for Flow rate & totalized value.
Output	:	Isolated 4-20mA DC
Turn Down ratio	:	1:30
Totalized Value	:	Required
Housing	:	IP-65/ (Explosion proof for NEC Class-1, Division 1 area)/ flame proof (IEC-79.1, Part I). As applicable).
Nameplate	:	Tag number, service engraved in stainless steel tag plate
Accessories	:	a) Clamping strip, bracket, prefab cable, battery etc.

- Nuts, bolts, gaskets, mesh etc.
- b) Special tool kit for calibration/configuration.

3.03.25 **Electromagnetic Flow meter**

Electromagnetic flow meters shall have separate transmitter having accuracy $\pm 0.2\%$ with zero stability feature, suitable for process medium with ≤ 5 micron Siemens conductivity, flanges material SS-316, electrode & measuring tube material SS-316, liner material Teflon and enclosure IP-66, local digital display configurable as totaliser, 4-20 mA output signal HART compatible with zero and span field adjustable. Application – DM Water and for other application as decided by owner.

3.03.26 **FLOW GAUGES (FG)**

- | | | |
|-------------------|---|---|
| Type/Construction | : | a) On-line type Rotameter for 50 Nb and below lines |
| | | b) Bypass type Rotameter for above 50 Nb lines. |

Material

- For On-line type

- | | | |
|---------------|---|--------------------|
| Metering Tube | : | Borosilicate glass |
| Float | : | 316 SS |
| Packing | : | Teflon |
| End fittings | : | 304 SS |

-For Bypass type

- | | | |
|--------------------------|---|---|
| Metering Tube | : | Borosilicate glass |
| Float | : | 316 SS |
| Packing | : | Teflon |
| End Fittings | : | 304 SS |
| Orifice Plate | : | 316 SS |
| Carrier ring | : | 304 SS |
| Flanges & Mating flanges | : | Same as pipe material, 200 lbs ANSI - RF |
| Impulse pipe | : | Same as pipe material |
| Fittings | : | 2000 ANSI, SW ends to match with pipe material. |
| Dial Size/Scale length | : | 250 mm |
| Scale Details | : | Direct reading type engraved on detachable Aluminum scale |
| Accuracy | : | $\pm$ Two (2) percent |
| Reproducibility | : | Half (1/2) percent |
| Rangeability | : | 1:10 |
| Connection | : | SCRD NPT |

Accessories	:	a) Isolating valves (for Bypass type only)
		b) Bolts, Nuts and Gaskets as required
Tests	:	Shall be tested at two hundred (200) percent of the maximum process pressure

3.03.27 SIGHT FLOW GLASS INDICATORS

Type/Construction	:	Flapper type.
Materials	:	
Body	:	Carbon steel/SS316 as per process requirement
Glass	:	Toughened Borosilicate
Gaskets	:	Neoprene
Bolts & nuts	:	SS
Flappers / Rotating Wheel	:	316 SS
Flappers / Rotating Wheel holder	:	304 SS
Process Connection	:	SW (Socket Welded)
Accessories	:	Scale, Bolts, Nuts, Cover plates and Gaskets as required
Tests	:	Tested at two hundred (200) percent of the maximum process pressure.

3.03.28 SOLID FLOWMETER

Type	:	Online Impact type Microprocessor Based
Measuring Principle	:	The system measurement is basically pertains to the measurement of horizontal deflection using LVDT, created by the impact of solid flow up on online sensing plate. The horizontal deflection being proportional to the impact forces, LVDT convert this horizontal movement into electrical signal. The inbuilt integrator convert this signal into time based flow rate indication & provide totalized flow also.
Sensing plate	:	316 SS
Sensing head	:	Sensing mechanism shall be mounted outside the process flow line.
Enclosure	:	316 SS
Enclosure protection	:	IP 67 class
Accuracy	:	+/-1%
Repeatability	:	+/- 0.2%
Drift	:	Both zero & span $\pm$ 2% / month
Output	:	4-20mA DC isolated, load 600 ohm (min)
Digital communication	:	yes, (HART) facility
Power supply	:	240 V AC, 50Hz. UPS
Ambient condition	:	Temperature -60 ⁰ C, RH-95% Environment – Highly Dusty

Accessories : Shall be complete with all the accessories including digital display for flow rate, integral vents, baffles for air separation, etc. which ever required for satisfactory operation.

Note:-

1. The above on line flow meter shall not create any obstruction on flow.
2. User's list shall be submitted to support on proven satisfactory performance for similar process application.

3.03.29

Instrument Air System

The instrument Air Supply System for various pneumatic Control & Instrumentation devices like pneumatic actuators, power cylinders, I/P converters, pneumatically operated valves etc. shall be complete in all respect with necessary Air Filter Regulators, valves, piping/tubing etc.. Each pneumatic instrument shall have an individual air shut off valve. The pressure-regulating valve shall be equipped with an internal filter, a 50 mm pressure gauge and a built in filter-housing blow down valve.

Filter shall be of minimum 5-micron size & sintered bronze material.

On collection of water in the drains of instrument air lines, mechanical automatic drains and periodically solenoid operated drains (with electronic timer - 15m, 30m, 60m and 2 Hours & Timing adjustable) are to be provided.

For mechanical type & Electrical type, the locations to be provided in the instrument air lines of boiler area, Chimney area, turbine area etc., shall be decided during detailed Engineering.

Bulk header nearby the crowded applications shall be provided and from this bulk header individual air lines with necessary isolation valves are laid to the application.

These bulk header are to be provided with **mechanical / electronic based automatic Drains**.

Individual moisture separator for O₂ analyzer or vital application shall be provided nearby the instrument so as to enhance the cell life or the performance of vital final control elements.

3.03.30

Air Filter Regulator (AFR)

Constant bleed type AFR with an accuracy of ± 1.0 % inlet pressure range of 5-8 kg/ cm² and suitable spring ranges (AFR) for use with positioners in control valves, control damper, E/P converters and shut off valves for phosphor bronze filter element; Filtering particles above five microns. Weather and water proof enclosure. Material of accessories will be SS316.

Air filter regulators shall be provided in the :

- (a) Air supply line to valve positioners / power cylinders
- (b) Air supply line to electric to pneumatic converters.

- (c) Air supply line to pneumatic interlocked block valves.
- (d) For each instrument rack, field instruments enclosure for purging.

3.03.31 Electro-Pneumatic Convertors (E/P)

Two wire type E/P convertors with an accuracy of $\pm 0.25\%$ accepting 4-20 mA dc signals from control system and converting to 0.2 to 1 kg/cm² air pressure to operate valve positioner of all final control elements; Housed in cast aluminum casing (with polyurethane paint); NEMA 4 or equivalent degree of protection for enclosure. Material of accessories will be S.S. E/P convertors shall have fail freeze (stay put) feature also. Process connection shall be 1/4" NPT (F) and Electrical connection shall be 1/2" NPT (F). Zero/span adjustment facility shall be provided. The E to P converters shall **retain the pneumatic signal (last value) even in failure of control signal** and shall have **self volume boosters**. Necessary air lock devices and pressure switches for air pressure low alarming shall be provided.

3.03.32 Solenoid Valves

Solenoid valves shall be provided with control valves / pneumatic control valves hooked up with process interlock requirements and where direct tripping is involved. The number of ways for solenoid valve shall be provided as indicated below:

- (a) Two (2) way solenoid valves shall be provided, where process line of less than 50 mm with low pressure and temperature application.
- (b) Three (3) way solenoid valve shall be provided commonly, where the pressure is admitted or exhausted from a diaphragm valve or single acting cylinder, e.g., Pneumatic operated spray water block valve.
- (c) Four (4) way solenoid valve shall be provided for operating double acting cylinders, e.g., Pneumatically operated on-off type dampers.
- (d) For operation of the fuel oil corner nozzle valves, fuel oil trip valves etc., **double coil solenoid valve** (latch coil & relatch coil) shall be adopted.
Single coil usage requires always power and loss of power leads to closure of above valves resulting the unit trip or loss of generation.
- (e) Solenoid Valve coils shall be Class-H high-temperature or Class-F construction as applicable and shall be designed for continuous duty. Three-way solenoid valves shall be designed for universal operation so that the supply air may be connected to any port. Solenoid enclosures shall be NEMA-4/ (Explosion proof for NEC Class-1, Division 1 area)/ flame proof (IEC-79.1, Part I) As applicable). Body material of solenoid valve shall be Die Cast Aluminum or SS316.
- (f) All solenoid shall be with varistor, LED indication, surge suppress diode and circuits.

3.03.33 Power Cylinders (Pneumatic)

Mounting Type	:	a)	Fixed position mounting (End mounting).
	:	b)	Trunnion mounting
Control Signal	:		0.2 to 1 Kg/Sq. cm. from I/P converter for modulating purposes. 24V/48VDC operated solenoid valve operating on pneumatic line.

		The Pilot solenoid will have separate coils for open closing purpose.
Supply Air	:	0-7 Kg / Cm ² .
Selection	:	Based upon thrust / torque, stroke length, angular movement, full-scale travel time, repeatability, space factor etc. Provision for air-to-open and air-to-close operation.
Casing	:	IP-65.
Accessories (as required)	:	a) Air lock relay b) Hand wheel. c) Air filter regulator with gauge. d) Volume Booster. e) Limit Switches. f) Positioner with Input, Output and supply pressure gauges. g) Pilot Solenoid Valve (Double Coil type) h) Position Transmitter (4-20 mA DC linear output, LVDT or non contact type).
Fail-safe operation	:	Stay put, open or close position on pneumatic / electrical power supply failure as per process safety criteria.
Repeatability	:	Better than 0.5% of full travel.
Hysteresis	:	Less than 1% of full travel.

3.03.42

Junction Boxes

v.	Type	:	Flame proof/weather proof
vi.	Enclosure	:	IP-65/Explosion/Flame Proof as per area classification.
vii.	Material	:	FRP with protective Coating
viii.	Cable entry	:	Bottom or Side
ix.	Cable glands	:	Double compression type – Nickel plated brass with PVC hoods.
x.	Mounting	:	Indoor/Outdoor
xi.	No. of terminals	:	As required with standardization with 20% spare of each size & type.
xii.	Terminals	:	Phoenix/Wago (screw less cage clamp type spring loaded)
xiii.	Grounding	:	Two terminals for body and shield ground
xiv.	Door	:	Hinged, lockable type.
xi.	Suitable mounting clamps and other accessories shall be in scope of bidder.		
xii	The brackets, bolts, nuts, screws, glands, lugs required for erection shall be of brass, included in bidder scope of supply. High voltage & insulation resistance test shall also be conducted.		
Xiii	M6 Ni plated Brass earthing stud shall be provided (external 2 nos. internal 1 no.)		
xiv	Gasket (Normal)- Neoprene thickness 6.0 mm		

3.03.43

Interposing Relays (IPR)

Electromagnetic type IPRs with modular design, plug-in type connections, suitable for channel/DIN rail mounting in cabinets; coil rating 24V D.C; 2 set of silver plated change over contacts rated for 0.5A 220 V DC/8 A 240 V AC. Free wheeling diode across relay copper coil and self reset type status LED indicator flag (electronic) shall be provided. Manual forcing/override facility is required. The test voltage for relay shall not be less than 4 KV with operating temperature from –20 deg. C to 60 deg. C. The relay shall have the necessary approvals like V0 inflammability class in accordance with UL94", IEC60664/IEC60664A/DIN VDE 0110. Facility to stimulate IPR manually shall be provided. The VA burden of relays shall be suitable to match the capacity of output modules. Interposing relay & sockets for mounting the interposing relay shall be of same make only.

3.03.44

RECORDERS (CHARTLESS)

Type	:	Micro-processor based, Digital TFT display type
- No. of Channels	:	Forty Eight (48) point).