QUALTIY PLAN

CLAUSE No. CHAPTER NAME

MOTOR QA OF MOTOR ABOVE 50KW

TESTS/CHECKS / TEMS/COMPONENTS	Visual	Dimensional	Make/Type/Rating /General Physical Inspection	Mech/Chem. Properties	NDT /DP/MPI/UT	Metallography	Electrical Characteristics	Welding/Brazing(WPS/PQR)	Heat Treatment	Magnetic Characteristics	Hydraulic/Leak/Pressure Test	Thermal Characteristics	Run out	Dynamic Balancing	Routine & Acceptance tests as per IS-4722 /IS- 9283/IS 2148/IEC60034\IEC 60079-1/ IS-12615	Vibration	Over speed	Tan delta, shaft voltage & polarization index test	Paint shade, thickness & adhesion
Plates for stator frame, end shield, spider etc.	Y	Y	Y	Y	Y				Y										
Shaft	Y	Y	Y	Y	Y	Y			Y										
Magnetic Material	Y	Y	Y	Y			Y			Y		Y							
Rotor Copper/Aluminium	Y	Y	Y	Y			Y		Y										
Stator copper	Y	Y	Y	Y			Y		Y			Y							
SC Ring	Y	Y	Y	Y	Y		Y	Y	Y										
Insulating Material	Y		Y	Y			Y					Y							
Tubes, for Cooler	Y	Y	Y	Y	Y				Y		Y								
Sleeve Bearing	Y	Y	Y	Y	Y				Y		Y								
Stator/Rotor, Exciter Coils	Y	Y	Y				Y	Y											
Castings, stator frame, terminal box and bearing housing etc.	Y	Y	Y	Y	Y			Y											
Fabrication & machining of stator, rotor, terminal box	Y	Y			Y			Y	Y										
Wound stator	Y	Y					Y	Y											
Wound Exciter	Y	Y					Y	Y											
Rotor complete	Y	Y					Y						Y	Y					
Exciter, Stator, Rotor, Terminal Box assembly	Y	Y					Y												

Accessories, RTD, BTD, CT, Space heater, antifriction bearing, gaskets etc.	Y	Y	Y																
Complete Motor	Y	Y	Y												Y	Y	Y	Y1	Y

Note:

1. The manufacture is to furnish a detailed Quality Plan indicating the practices & Procedure followed along with relevant supporting documents during QP finalization. However, following methodology to be followed for Inspection Categorization:

Note for LT Motor:

i) Motor rating up to 50 KW: Inspection CAT- III : Acceptance of Motor up to 50 KW is based on COC of the Manufacturer and Main Contractor confirming as follows:
"It is hereby confirmed that the above mentioned motor /motors was/ were manufactured taking care of NTPC specific requirements regarding ambient temp., voltage frequency variation, hot s
KVA/KW, temperature rise, distance between center of stud gland plate and tested in accordance with approved drawing /data sheets."

ii) Motor rating above 50 KW & less than 75 KW: Inspection CAT- II as per NTPC approved MQP: Acceptance of Motor rating above 50 KW & less than 75 KW is based on NTPC rev
report as per IS:12615 **-** 2018 (including latest revision) duly witnessed by main contractor along with COC of the Manufacturer and Main Contractor confirming as follows:
"It is hereby confirmed that the above mentioned motor /motors was/ were manufactured taking care of NTPC specific requirements regarding ambient temp., voltage frequency variation, hot s
KVA/KW, temperature rise, distance between center of stud gland plate, space heater and tested in accordance with approved drawing /data sheets."

iii) Motor rating 75 KW & above: Inspection CAT-I: As per NTPC approved MQP.

2. Additional routine tests for Flame proof motors shall be applicable as per relevant standard
3. Makes of major bought out items for HT motors will be subject to NTPC approval.
4. Y1 = for HT Motor / Machines only.
5. For LT Motors, stator core stack length & grade, no load loss and winding resistance w.r.t. type tested motor for IE2/IE3 shall be checked/verified in addition to Compliance of relevant standard IS:12615/IEC requirement. In case actual results are not within the tolerance limit as declared by manufacturer during QP submission, the motor shall be subjected to efficiency test.

SUB-VENDOR LIST

11	**LT MOTOR**	**CAT - I**								
					ABB	FARIDABAD	A*	* SUBJECT TO VERIFICATION VISIT	UPTO 55KW	
					ABB	BANGALORE	A		UPTO 690V, 475kW	
					JYOTI LTD.	VADODARA	A			
					TIPM	JAPAN	A		UPTO 15 KW (NON FLAME PROOF)	
					HYOSUNG	SOUTH KOREA	A			
					WEG	BRAZIL	A			
					HYUNDAI	SOUTH KOREA	A			
					LHP	SOLAPUR	A		UPTO 400KW FROM B-16 WORKS. UPTO 200KW FROM B-11 WORKS.	
	Refer Note-7				CGL	AHMEDNAGAR	A		RQP, FOR FLAME PROOF MOTOR	
					TMEIC	JAPAN (NAGASAKHI)	A			
					NGEF	BANGALORE	A		UPTO 15 KW	
					BHARAT BIJLEE	MUMBAI	A		RQP, FOR FLAME PROOF ALSO	
					KEC	BANGALORE/ HUBLI*	A		*UPTO 90KW, RQP, FOR FLAME PROOF ALSO	
					MARATHON	KOLKATA	A		RQP (UPTO 690V & 600 KW) FOR FLAME PROOF ALSO	
					ABB	SWEDEN	A		UPTO 55KW	
					HAVELL	NEEMRANA	A		UP TO 90KW	
					KAWAMATA	JAPAN	A		UP TO 75 KW	
					HEM Industries	DAMAN	A		UP TO 30 KW	
					TIPS	JAPAN	A		UP TO 45KW	

Note - 7:	**i) For Motors less than 50 KW: CAT-III.** Acceptance of Motor less than 50 KW is based on COC of the Manufacturer and the Main Contractor confirming as follows: "It is hereby confirmed that the above mentioned motor /motors was/ were manufactured taking care of NTPC specific requirements regarding ambient temp., voltage & frequency variation, hot starts, pull out torque, starting KVA/KW, temp. rise, distance between centre of stud & gland plate and tested in accordance with approved drawing /data sheets". **ii) For Motors 50 KW and less than 75 KW : CAT- II.** Acceptance of Motor is based on NTPC review of Routine Test inspection report as per **IS: 12615** / applicable standards duly witnessed by main contractor along with COC of the Manufacturer and the Main Contractor confirming as follows: "It is hereby confirmed that the above mentioned motor /motors was/ were manufactured taking care of NTPC specific requirements regarding ambient temp., voltage & frequency variation, hot starts, pull out torque, starting KVA/KW, temp. rise, distance between centre of stud & gland plate, space heater and tested in accordance with approved drawing /data sheets". **iii) For Motors 75 KW & above : CAT- I** . AS PER NTPC APPROVED QUALITY PLAN (To be submitted seperately for NTPC review & approval).

SUB-VENDOR LIST CONTINUED

ITEM CODE	ITEM/SERVICE DESCRIPTION	SL NO.	VENDOR CODE	VENDOR NAME	ADDRESS	PHONE	REMARKS
ES11	CABLE GLANDS	1	E1201	ALLIED TRADERS & EXPORTERS	C-124 A, SECTOR-2, NOIDA -201 301, UTTAR PRADESH, INDIA	Mr. Vijay Mohan Sood +(91)-(120)-2525694 +(91)-(120)-3052594 +(91)-(11)-23287156 vijay_mohansood@yahoo.com	
	CABLE GLANDS	2	E1017	ARUP ENGG & FOUNDARY WORKS	391/119,PRINCE ANWAR SHAH ROAD, CALCUTTA-700068	033 2473 0850	
	CABLE GLANDS	3	E1206	BALIGA LIGHTING EQPT.PVT.LTD.	63A,CP RAMASWAMY ROAD, ALWARPET,P.B.No 6910, CHENNAI-600018	44-24995505,22680990-4	
	CABLE GLANDS	4	E1036	COMMET BRASS PRODUCTS	NUTAN CHEMICAL COMPOUND, WALBHAT ROAD, GOREGAON, MUMBAI-400063	91-022-26852961/62/63 comet@vsnl.net	
	CABLE GLANDS	5	DW08	DOWELLS	M/S. DOWELLS ELECTRICALS 47/47A, SATGURU INDUSTRIAL ESTATE. OFF AAREY ROAD, GOREGOAN (EAST). MUMBAI 400 063.	CEO : Mr. Jayantibhai S. Patel TEL: 022-32504770./022-29270876/ 022-29270878.	
	CABLE GLANDS	6	E1044	ELECTROMAC INDUSTRIES	27/28AF NEW EMPIRE IND.ESTT., R.KRISHNA MANDIR RD.JB NGR ,ANDHERI(E),MUMBAI-400059	91-22-28324829 / 66919034 devang@electromacglands.com	
	CABLE GLANDS	7	I01	INCAB	HARE STREET,KOLKATA,WEST BENGAL-700001	91-33-2480161/62/63/64 Fax : 91-33-2485766	
ES12	CABLE LUGS	1	E1040	DOWELLS	M/S. DOWELLS ELECTRICALS 47/47A, SATGURU INDUSTRIAL ESTATE. OFF AAREY ROAD, GOREGOAN (EAST).	CEO : Mr. Jayantibhai S. Patel TEL: 022-32504770./022-29270876/ 022-29270878.	
	CABLE LUGS	2	E1149	UNIVERSAL MACHINES LTD.	4,B.B.D.BAG (EAST) 90,STEPHEN HOUSE,5TH FLR CALCUTTA-700001	033 2282 2540	
ES16	GI CONDUITS	BIS APPROVED MAKE					
ES17	GI CONDUIT (EPOXY PAINTED)	BIS APPROVED MAKE					

Note:-
Make of all the equipment/instrument under this specification shall be subjected to Owner (End Customer)/BHEL approval in the event of order. The bidder may propose name of additional sub-vendors make based on their experience, which will be subject to Owner (End Customer)/BHEL approval.
Owner (End Customer)/BHEL approval reserves the right to accept/reject any make or sub-vendor after award of contract. Approval and rejection of makes shall not have any price & time implication to the purchaser after award of contract.

Annexure-E.4

Technical specification of miscellaneous items

TECHNICAL SPECIFICATION OF CABLE GLANDS AND LUGS

Cable glands shall conform to BS:6121. Cable glands shall be made of heavy-duty brass machine finished and nickel chrome plated. Thickness of plating shall not be less than 10 microns. All washers and Hardware shall also be made of brass with nickel chrome plating. Rubber components shall be of neoprene or better synthetic material and of tested quality.

Cable lugs/ferrules shall be solderless crimping type suitable for power and control cables as per the DIN 46239. Aluminium solderless crimping lugs/ ferrules shall be used for Aluminium cables and Copper lugs/ferrules shall be used for Copper cables. Bimetallic washers or bimetallic type lugs shall be used for bimetallic connections

TECHNICAL SPECIFICATION OF JUNCTION BOX

Junction box shall be made of Fire-retardant material. Material of JB shall be Thermoplastic or thermosetting or FRP type. The box shall be provided with the terminal blocks, mounting bracket and screws etc. The cable entry shall be through galvanized steel conduits of suitable diameter. The JB shall have suitable for installing glands of suitable size on the bottom of the box. The JB shall be suitable for surface mounting on ceiling/structures. The JB shall be of grey color RAL 7035. All the metal parts shall be corrosion protected. Junction box surface should be such that it is free from crazings, blisterings, wrinkling, colour blots/striations. There should not be any mending or repair of surface. JB's will be provided with captive screws so that screws don't fall off when cover is opened. JB's mounting brackets should be of powder coated MS. Type test reports for the following tests shall be furnished:

a) Impact resistance for impact energy of 2 Joules (IK07)as per BS EN50102
b) Thermal ageing at 70deg C for 96 hours as per IEC60068-2-2Bb
c) Class of protection shall be IP 55
d) HV test

Terminal blocks shall be 1100V grade, of suitable current rating, made up of unbreakable polyamide 6.6 grade. The terminals shall be screw type or screw-less (spring loaded) / cage clamp type with lugs. Marking on terminal strips shall correspond to the terminal numbering in wiring diagrams. All metal parts shall be of non-ferrous material. In case of screw type terminals, the screw shall be captive, preferably with screw locking design. All terminal blocks shall be suitable for terminating on each side the required cables/wire size. All internal wiring shall be of cu. Conductor PVC wire.

TECHNICAL SPECIFICATION OF FLEXIBLE CONDUITS

Flexible Steel Conduits shall be water proof and rust proof made of heat resistant steel with temperature rating of 150 Deg.C. Conduit diameter shall be uniform throughout its length. Internal surface of the conduit shall be free from burrs and sharp edges. Conduits shall be complete with necessary accessories for proper termination of the conduit with junction boxes.

Annexure-E.5

Load data format

TAG	LOAD TITLE	RATING (KW / A)		FULL LOAD CURRENT FLC(A)	UNIT (U)/STN. (S)	Nos.		VOLTAGE CODE*	FEEDER CODE$	CLASS OF SUPPLY #	EMER. LOAD (Y)	CONT.(C)/ INTT.(I)	STARTING TIME> 5 SEC (Y)	LOCATION OF DRIVES/LOADS	RATING & FLC CHECKED FROM MOTOR/VALVE APPROVED DATASHEET (Y/N)	BOARD NO.	CABLE		BLOCK CABLE DRG. No.	CONTROL CODE	REMARKS	LOAD No.	KKS NO.
		NAME PALTE	MAX. CONT. DEMAND (MCR)			RUNNING	STANDBY										SIZE CODE	Nos					
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24

NOTES: 1. COLUMN 1 TO 15 TO BE FILLED MANDATORILY.

2. ABBREVIATTIONS : * VOLTAGE CODE (9):- (AC) A=11 KV, B=6.6.KV, C= 3.3 KV, D=415 V, E = 240 V (1 PH), F = 110 V (DC) : G =220V, H = 110 V, J = 48 V, K = +24V, L= -24V

: $ FEEDER CODE (10) :- U = UNIDIRECTIONAL STARTER, B = BIDIRECTIONAL STARTER, S = SUPPLY FEEDER, D = SUPPLY FEEDER (CONTACTOR CONTROLLED)

CLASS OF SUPPLY---- CLASS-IV= 415V/240V NORMAL SUPPLY, CLASS-III= 415 V EMERGENCY DG SUPPLY, CLASS-II=415/240V UPS SUPPLY, CLASS-I = 220V DC SUPPLY

BHEL	LOAD DATA (ELECTRICAL)	JOB NO.	528	ORIGINATING AGENCY		
		PROJECT TITLE	2X660 MW R SG	NAME		DATA FILLED UP ON
		SYSTEM / S	HVAC PACKAGE	SIGN.		DATA ENTERED ON
		DEPTT. /SECTION		SHEET 1/2	REV. R0	DE'S SIGN. & DATE

Annexure-E.6

Cable Schedule Format

ANNEXURE E.6

CABLE SCHEDULE FORMAT

UNITCABLENO	FROM	TO	PURPOSE	CABLE SCOPE (BHEL PEM/ VENDOR)	REMARKS	CABLESIZE	PATHCABLENO	TENTATIVE CABLE LENGTH

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in BHEL

1. For the purpose of clarity, it may please be noted that the information given in regard to the cables to be routed through WinPath as per the system elaborated below is called "Cable List", while the term "Cable Schedule" applies to the cable list with routing information added after routing has been carried out.

2. The cable list shall be entered as an MS Excel file in the format as per enclosed template EXT_CAB_SCH_FORMAT.XLS. No blank lines, special characters, header, footer, lines, etc. shall be introduced in the file. No changes shall be made in the title line (first line) of the template.

3. The field properties shall be as under:
    a. UNITCABLENO: A/N, up to sixteen (16) characters; each cable shall have its own unique, unduplicated cable number. In case this rule is violated, the cable cannot be taken up for routing.
    b. FROM: A/N, up to sixty (60) characters; the "From" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    c. TO: A/N, up to sixty (60) characters; the "To" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    d. PURPOSE: A/N, up to sixty (60) characters; the purpose (i.e. power cable/ indication/ measurement, etc.) to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    e. REMARKS: A/N, up to forty (40) characters; Any information pertinent to routing to be specified here (e.g., cable number of the cable redundant to the cable number being entered). Information in excess of 40 characters will be truncated after 40 characters.
    f. CABLESIZE: A/N, 7 characters exactly as per the codes indicated below shall be specified here. The program cannot route cables described in any other way/ format.
    g. PATHCABLENO: Field reserved for utilization by the program. User shall not enter any information here.

4. One list shall be prepared for each system/ equipment (i.e., separate and unique cable lists shall be prepared for each system).

5. The cables shall be described as per the scheme listed below:

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in BHEL

A	NN	A	NNN
|	|	|	|
Cable Voltage Code (see B below)	No. of cores (e.g. 01,03,3H, 07)	Cable code (See C below)	Cable size (e.g. 035,185,2.5, 0.5)

please refer below examples:

i) 3C x 120 sq. mm. (1.1kV) PVC FRLS, Unarmoured Aluminium cable, the voltage code shall be D03G120
ii) 3C x 2.5 sq. mm. (1.1kV) PVC FRLS, Unarmoured Copper cable, the voltage code shall be D03C2.5
iii) 3.5C x 120 sq. mm. (1.1kV) PVC non-FRLS, Armoured Aluminium cable, the voltage code shall be D3HF120

(A) SYSTEM VOLTAGE CODES:

(ac) A = 11KV, B = 6.6KV, C = 3.3KV, D = 415V, E = 240V, F = 110V
(dc) G = 220V, H = 110V, J = 48V, K = +24V, L = -24V

(B) CABLE VOLTAGE CODES:

A = 11KV (Power cables)
B = 6.6KV (Power cables)
C = 3.3KV (Power cables)
D = 1.1KV (LV & DC system power & control cables)
E = 0.6KV (0.5 sq. mm. Control cables)

(C) CABLE CODES

PVC Copper

A = Armoured FRLS	B = Armoured Non-FRLS
C = unarmoured FRLS	D = Unarmoured Non-FRLS

PVC Aluminium

E = Armoured FRLS	F = Armoured Non-FRLS
G = unarmoured FRLS	H = Unarmoured Non-FRLS

XLPE Copper

J = Armoured FRLS	K = Armoured Non-FRLS
L = unarmoured FRLS	M = Unarmoured Non-FRLS

XLPE Aluminium

N = Armoured FRLS	P = Armoured Non-FRLS
Q = unarmoured FRLS	R = Unarmoured Non-FRLS

S = FIRE SURVIVAL CABLES
T = TOUGH RUBBER SHEATH
U = OVERALL SCREENED
V = PAIRED OVERALL SCREENED
W = PAIRED INDIVIDUAL SCREENED
Y = COMPENSATING CABLES
I = PRE-FABRICATED CABLES
Z = JELLY FILLED CABLES

6. Once a cable list has been given to BHEL for routing, any subsequent changes required in the cable list (which may be in the form of addition of cables, deletion of cables, change of type or size of cable, etc.) must be informed as specific changes (as a separate file MS Excel of the same format as the original file) to the cable list given earlier if the cable list has been routed and cable schedule generated. The routing status of the cable list shall be got confirmed from BHEL by the agency that has prepared the cable list before the changes are intimated. In case BHEL confirms that the cable list in question has not been taken up for routing, and the revised cable list is acceptable,

the same may be sent. Since cable routing through the program involves adding each cable list to the project cable schedule database, the original cable schedule shall not be furnished to BHEL with revisions incorporated within.

C&I TECHNICAL SPECIFICATION

C&I SPECIFIC TECHNICAL REQUIREMENT

APPLICABLE FOR KORADI,KORBA WEST,UKAI,YAMUNANAGAR,RAGHUNATHPUR

	KORADI THERMAL POWER STATION 2 x 660 MW UNITS - 11 & 12 PROJECT	SECTION: C SUB SECTION : C&I
	C&I SPECIFICATION FOR COMPRESSED AIR SYSTEM	

1. **Complete C&I system** for Compressed Air System is in bidder scope of supply. Items not specifically mentioned however required for the completeness of the system shall be supplied by bidder.

2. Operation and control of compressed air system shall be as per design philosophy/customer specification given elsewhere in the specification. Integrated microprocessor based control system along with suitable operator interface shall be provided for each Instrument Air Compressor, Service Air Compressor & their Dryers. All PT, DPT, TE and other instruments inside & outside the compressor skid shall also be hooked-up to this system.

   MODBUS (on RS-485) link on Fibre Optic cable shall be provided between plant DCS & this microprocessor system for monitoring of all the parameters and status feedback of drives of compressed air system. In addition to the soft link, provision for hardwired START, STOP and LOAD & UNLOAD commands from DCS to all the compressors & their status feedbacks (including Critical/Start/Stop signal) to DCS shall also be provided. All necessary hardware and software at bidder's end shall be under the bidder's scope.

   Bidder to confirm all the above requirements stated above in their scope of supply. Bidder to furnish the configuration diagram of control system of compressor showing communication with DCS along with the bid. Bidder to furnish writeup & recommended Logics for overall control of Air compressors. Bidder to furnish signal exchange list between DCS and compressed air system in BHEL format attached elsewhere.

3. Bidder shall provide complete Instrumentation for control, monitoring and operation of entire CAS package. The requirements given below are to be read in conjunction with detailed Technical specification Enclosed in the specification. Further in case of any discrepancy in the requirement within the same Section noted by the bidder in the specification, the same will be brought to the notice of BHEL in the Form of pre-bid clarification. In absence of any pre-bid clarification, the more stringent requirement as per interpretation of customer/BHEL shall prevail without any commercial implication.

4. The instrumentation to be provided for CAS 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 the system and its associated equipment, Bidder shall also provide all the necessary instruments to the process requirement even if not indicated in the given technical Specification document /drawings. During detail engineering if any additional instruments are required for safe & reliable operation of plant, bidder shall supply the same without any technical, commercial and delivery implication to BHEL.

5. The make/model of various instruments/items/systems shall be subject to approval of owner/purchaser during detailed engineering stage. No commercial and delivery 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, BHEL discretion will prevail.

6. All local gauges as well as transmitters and sensors for parameters like pressure, temperature, flow etc. as required for the safe and efficient operation and maintenance under the scope of specification shall be provided. The necessary root valves, impulse piping, drain cock, gauge zeroing cocks, valve manifolds, instrument racks and all the other accessories required for mounting / erection of these local instruments, transmitters and sensors shall be supplied by bidder even if not specifically asked for. Also, the proposal shall include the necessary cables, flexible conduits, instrument racks, junction boxes and accessories for the above purpose. Double root valves shall be provided for all pressure tapping where the pressure is 40kg/cm2 and above. Single root valve for below 40Kg / Cm2. The contacts of equipment mounted instruments; sensors, switches etc. for external connection including spare contacts shall be wired out to suitably located junction boxes.

7. All field instruments/analyzers/actuators/sov/control valves etc. shall be hooked with DDCMIS based control system as per requirement mentioned elsewhere in the specification.

8. Instruments used for PG test: All test instrumentation as required for the Performance Guarantee Test shall be provided by the Bidder free of cost. Special / Precision instruments required for Performance Guarantee Test shall, however, be arranged by him and shall be returned to him after successful completion of the tests. All test instrumentation shall be in accordance with the applicable code. The instruments for PG test shall meet the minimum requirements specified in ASME PTC or subsequent clauses in this chapter whichever is better.

9. Each Compressor's Winding temp RTD signals, bearing temp RTD signals and vibration monitoring system signals (for both X & Y directions on each of the bearings) shall be hardwired to Microprocessor based control System and DCS directly from field/VMS panel.

10. Vibration monitoring system is envisaged for compressed air system which is in BHEL scope. However, mounting of vibration sensors/probe, bidder to provide vibration pad for mounting of sensors and a notch/slot for mounting of key phasor.

11. All transmitters shall be smart type and shall have 4-20mA DC signal with superimposed digital communication having proven HART protocol to facilitate configuration, zero adjustment, calibration and diagnostic from remote location. The calibrated range shall be so selected that the normal parameter shall generally be between 50 to 75 % of the range, depending on expected excursion. All microprocessor-based transmitters shall have the same type of protocol.

12. Time synchronization of compressor microprocessor system with the DCS has to be done. Bidder to provide necessary hardware/software at their end.

13. All local gauges, transmitters and switches shall be mounted on suitable enclosures, racks (closed for outdoor area/ open for indoor areas) subject to owner's approval. The racks/enclosure shall be in Bidder's scope of supply.

14. All the instruments/drives/control elements shall be terminated on JBs/Panels in field. JBs/Panels and other erection hardware shall also be in Bidder's scope. Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 12-15 mtrs) and trunk cable. Junction boxes shall be IP-65 enclosures with knock-out holes and cage-clamp type terminals

15. All electric actuators, pneumatic control valves, Junction Boxes, Solenoid boxes and Local control panels which are not installed inside building, suitable canopy shall be provided and design of canopy shall be approved by Employer during detailed engineering.

16. Transmitters shall be normally used for switching application as well by setting limit values in DCS. Direct acting switches shall be used only if recommended by equipment manufacturers. Temperature switches shall be avoided altogether.

17. RTD's shall be of duplex type. Both the elements of duplex temperature sensors shall be terminated to junction boxes.

18. Electronics located outside control room areas shall be tropicalized and enclosed in dust & weather proof cabinets suitable for the environment.

19. 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. Any cable in Bidder's scope shall be as per specification.

20. Electrical Actuators with non-integral starter shall be provided for all on/off and inching type valves along with necessary interface units for linking to corresponding Control System as applicable, typical Hook-up diagram of drives is included for reference. Non-contact type electronic 2-wire position

transmitters shall be provided for all inching type motorised valves. The detailed specification is attached elsewhere in the specification.

21. The solenoid operated valves/Dampers/Gate shall have a limit switch for open/close feedback. Solenoid Valve shall be rated for 24V DC only.

22. Interface of MCC, HT SWGR, Solenoid valves, field instruments, Actuators etc. with DDCMIS based control system shall be as per Drive Control Philosophy enclosed in specification.

23. The specifications for instruments mentioned in the specification are minimum requirements. 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.

24. Instruments for which specification are not attached, vendor's data sheet for such items will also be subject to customer/BHEL's approval during detail engineering without any commercial and delivery implication.

25. The bidders shall specifically mention any deviation they would like to take on the C&I specification. In absence of only deviation, a No deviation certificate is to be furnished.

26. Bidder to provide input/output list, drives list, junction box schedule and termination details, recommended control logics, write-up etc. the list of documents to be submitted after award of contract is to be referred by bidder.

27. Instrument installation and accessories required for the same shall be in Bidder's scope and shall be submitted after award of contract. However, any instrument/ analyser installation not covered in the same shall be subject to customer and BHEL approval during detailed engineering.

28. Instruments and control equipment shall be guaranteed to meet the performance, functional and accuracy requirements enumerated in the specification. All field wiring should be through conduits. All fittings, cable glands etc. shall be strictly as per NEC recommendation article, 500 to 503.

29. Instruments must have separate tapping lines. Sharing of the same tapping pipe for redundant instruments or various different instruments is not acceptable.

30. All the instruments having contact with the process fluids which are corrosive, viscous, solid bearing or slurry type, shall be provided with diaphragm seals. 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.

31. Bidder to provide at least 20% spare unused terminals in Junction boxes, LIE/LIRs, termination/marshalling cabinets etc.

32. 230 V AC UPS Power supply shall be provided by BHEL at a single point(for both units), further distribution to various instruments/equipment of the system shall be in bidder scope. Bidder to include necessary power distribution board, change over circuit in his scope. Any power supply other than the above, if required by any instrument/equipment has to be derived by the bidder from the above supply & all necessary hardware for the same shall be in bidder scope. Further, Bidder to furnish electrical load/ UPS load data during detailed engineering in BHEL format.

33. Bidder's presence is required for 3 Man days (excluding travel time) at EDN Bangalore during FAT of DDCMIS for certifying correctness & completeness of implementation of Control logic. Intimation regarding FAT shall be given 2 days in advance. All the expenses like boarding, lodging and travel, air fare etc. shall be in bidder's scope.

34. Bidder shall furnish Instrument Schedule, I/O list, Drive list, Cable Schedule, Cable interconnection (DCS end terminal details shall be provided to vendor during detail engineering to incorporate in cable interconnection), JB grouping, Control Scheme, Annunciation list, SOE list, List of Instruments/devices for HART in BHEL approved format. Also reusable database format like MS Excel, MS Access etc. of these documents shall also be provided by Contractor in BHEL approved format. Soft copy of the formats shall be provided to the successful bidder.

35. Local control panel if any required for operation shall be in bidder scope

36. Redundancy of instruments to be provided by bidder shall be as follows:

1) Triple redundancy for all analog and binary inputs required for protection of system/drives.
2) For all other control functions dual redundancy of the sensors shall be provided by the bidder.

For measuring instruments type, specification, redundancy and quantities that are connected to Skid Mounted systems, integral to Equipment , bidder's standard and proven practice can be accepted.

37. Bidder to comply with codes and standards as mentioned in the specification.

38. Instrument installation shall be as per the attached "Standard Hook-up diagram of instrument." However, any instrument/ analyser installation not covered in the same shall be subject to Customer and BHEL approval during detailed engineering.

39. Bidder shall provide erection hardware as per installation drawings.

40. Bidder to provide mandatory spares as per mandatory spares list attached elsewhere in the specification.

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

42. Number of pairs to be selected for Screen /Control cable
a) F-Type: 2P/4P/8P/12P (Size: 0.5sqmm2)
b) G-Type: 2P/4P/8P/12P (Size: 0.5sqmm2)
c) Core Cable: 3CX2.5sqmm2/ 5CX2.5sqmm2/ 12CX2.5sqmm2

43. In addition to requirements specified here, all C&I systems/ sub-systems/ equipment/ devices shall also meet other requirements stipulated under other Sub-sections/ parts/ sections of specification.

44. All equipment shall be installed above ground. Below ground installation will not be allowed, but if a below ground installation is unavoidable, then proper maintenance space and dewatering arrangement has to be provided. Collection of oil and dirt in that area has to be avoided and it should be easy to clean such a place.

45. Bidder shall provide the proper user license for all kind of software and hardware (where applicable), used in the project. All the hardware and software items shall be the latest updated version with minimum 3 years proven running records under the same capability of this project.

46. All software and firmware user licenses shall be valid for entire life of power plant. User should not have to pay any recurring license fee during the usage period of the system. License will be provided on permanent basis and for any upgradation of software (for operating system & Firmware) for minimum fifteen years without any financial implication to the owner.

47. Further, Bidder to meet the provenness criteria for all the supplied C&I items mentioned elsewhere in the specification.

48. In case of any conflict and repetition of clauses in the specification, BHEL discretion will prevail.

49. In case of HT motors, winding temperature for each stator winding and bearing temperature of motors & driven equipment shall be monitored for abnormal rise. Each compressors wiring temp RTD signals, bearing temp RTD signals, and vibration monitoring system signals(for both X & Y directions on each of the bearings)shall be hardwired to microprocessor based control system & DCS directly from field/ VMS panel.

	UKAI THERMAL POWER STATION 1 x 800 MW	SECTION: C SUB SECTION : C&I
	C&I SPECIFICATION FOR COMPRESSED AIR SYSTEM	

1. **Complete C&I system** for Compressed Air System is in bidder scope of supply. Items not specifically mentioned however required for the completeness of the system shall be supplied by bidder.

2. Operation and control of compressed air system shall be as per design philosophy/customer specification given elsewhere in the specification. Integrated microprocessor based control system along with suitable operator interface shall be provided for each Instrument Air Compressor, Service Air Compressor & their Dryers. All PT, DPT, TE and other instruments inside & outside the compressor skid shall also be hooked-up to this system.

   MODBUS (on RS-485) link on Fibre Optic cable shall be provided between plant DCS & this microprocessor system for monitoring of all the parameters and status feedback of drives of compressed air system. In addition to the soft link, provision for hardwired START, STOP and LOAD & UNLOAD commands from DCS to all the compressors & their status feedbacks (including Critical/Start/Stop signal) to DCS shall also be provided. All necessary hardware and software at bidder's end shall be under the bidder's scope.

   Bidder to confirm all the above requirements stated above in their scope of supply. Bidder to furnish the configuration diagram of control system of compressor showing communication with DCS along with the bid. Bidder to furnish writeup & recommended Logics for overall control of Air compressors. Bidder to furnish signal exchange list between DCS and compressed air system in BHEL format attached elsewhere.

3. Bidder shall provide complete Instrumentation for control, monitoring and operation of entire CAS package. The requirements given below are to be read in conjunction with detailed Technical specification Enclosed in the specification. Further in case of any discrepancy in the requirement within the same Section noted by the bidder in the specification, the same will be brought to the notice of BHEL in the Form of pre-bid clarification. In absence of any pre-bid clarification, the more stringent requirement as per interpretation of customer/BHEL shall prevail without any commercial implication.

4. The instrumentation to be provided for CAS 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 the system and its associated equipment, Bidder shall also provide all the necessary instruments to the process requirement even if not indicated in the given technical Specification document /drawings. During detail engineering if any additional instruments are required for safe & reliable operation of plant, bidder shall supply the same without any technical, commercial and delivery implication to BHEL.
5. The make/model of various instruments/items/systems shall be subject to approval of owner/purchaser during detailed engineering stage. No commercial

and delivery 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, BHEL discretion will prevail.

6. All local gauges as well as transmitters and sensors for parameters like pressure, temperature, flow etc. as required for the safe and efficient operation and maintenance under the scope of specification shall be provided. The necessary root valves, impulse piping, drain cock, gauge zeroing cocks, valve manifolds, instrument racks and all the other accessories required for mounting / erection of these local instruments, transmitters and sensors shall be supplied by bidder even if not specifically asked for. Also, the proposal shall include the necessary cables, flexible conduits, instrument racks, junction boxes and accessories for the above purpose. Double root valves shall be provided for all pressure tapping where the pressure is 40kg/cm2 and above. Single root valve for below 40Kg / Cm2. The contacts of equipment mounted instruments; sensors, switches etc. for external connection including spare contacts shall be wired out to suitably located junction boxes.

7. All field instruments/analyzers/actuators/sov/control valves etc. shall be hooked with DDCMIS based control system as per requirement mentioned elsewhere in the specification.

8. Instruments used for PG test: All test instrumentation as required for the Performance Guarantee Test shall be provided by the Bidder free of cost. Special / Precision instruments required for Performance Guarantee Test shall, however, be arranged by him and shall be returned to him after successful completion of the tests. All test instrumentation shall be in accordance with the applicable code. The instruments for PG test shall meet the minimum requirements specified in ASME PTC or subsequent clauses in this chapter whichever is better.

9. Each Compressor's Winding temp RTD signals, bearing temp RTD signals and vibration monitoring system signals (for both X & Y directions on each of the bearings) shall be hardwired to Microprocessor based control System and DCS directly from field/VMS panel.

10. Vibration monitoring system is envisaged for compressed air system which is in BHEL scope. However, mounting of vibration sensors/probe, bidder to provide vibration pad for mounting of sensors and a notch/slot for mounting of key phasor.

11. All transmitters shall be smart type and shall have 4-20mA DC signal with superimposed digital communication having proven HART protocol to facilitate configuration, zero adjustment, calibration and diagnostic from remote location. The calibrated range shall be so selected that the normal

parameter shall generally be between 50 to 75 % of the range, depending on expected excursion. All microprocessor-based transmitters shall have the same type of protocol.

12. Time synchronization of compressor microprocessor system with the DCS has to be done. Bidder to provide necessary hardware/software at their end.

13. All local gauges, transmitters and switches shall be mounted on suitable enclosures, racks (closed for outdoor area/ open for indoor areas) subject to owner's approval. The racks/enclosure shall be in Bidder's scope of supply.

14. All the instruments/drives/control elements shall be terminated on JBs/Panels in field. JBs/Panels and other erection hardware shall also be in Bidder's scope. Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 12-15 mtrs) and trunk cable. Junction boxes shall be IP-65 enclosures with knock-out holes and cage-clamp type terminals

15. All electric actuators, pneumatic control valves, Junction Boxes, Solenoid boxes and Local control panels which are not installed inside building, suitable canopy shall be provided and design of canopy shall be approved by Employer during detailed engineering.

16. Transmitters shall be normally used for switching application as well by setting limit values in DCS. Direct acting switches shall be used only if recommended by equipment manufacturers. Temperature switches shall be avoided altogether.

17. RTD's shall be of duplex type. Both the elements of duplex temperature sensors shall be terminated to junction boxes.

18. Electronics located outside control room areas shall be tropicalized and enclosed in dust & weather proof cabinets suitable for the environment.

19. 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. Any cable in Bidder's scope shall be as per specification.

20. Electrical Actuators with non-integral starter shall be provided for all on/off and inching type valves along with necessary interface units for linking to corresponding Control System as applicable, typical Hook-up diagram of drives is included for reference. Non-contact type electronic 2-wire position transmitters shall be provided for all inching type motorised valves. The detailed specification is attached elsewhere in the specification.

21. The solenoid operated valves/Dampers/Gate shall have a limit switch for open/close feedback. Solenoid Valve shall be rated for 24V DC only.

22. All regulating duty control valves shall be equipped with smart positioner having integral I-P Converter and valve position transmitter.

23. Interface of MCC, HT SWGR, Solenoid valves, field instruments, Actuators etc. with DDCMIS based control system shall be as per Drive Control Philosophy enclosed in specification.

24. The specifications for instruments mentioned in the specification are minimum requirements. 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.

25. The bidders shall specifically mention any deviation they would like to take on the C&I specification. In absence of only deviation, a No deviation certificate is to be furnished.

26. Bidder to provide input/output list, drives list, junction box schedule and termination details, recommended control logics, write-up etc. the list of documents to be submitted after award of contract is to be referred by bidder.

27. Bidder to perform tests of C&I items/instruments/systems as per Quality plans/type test attached in the specification. However, if any test not specified in the quality plan but specified in specification Tests for I&C equipment included elsewhere in specification will have to perform by Bidder without any cost implication. In case of any conflict and repetition of clauses in the specification, the more stringent requirements among them are to be complied with.

28. Instrument installation and accessories required for the same shall be in Bidder's scope and shall be submitted after award of contract. However, any instrument/ analyser installation not covered in the same shall be subject to customer and BHEL approval during detailed engineering.

29. Instruments and control equipment shall be guaranteed to meet the performance, functional and accuracy requirements enumerated in the specification. All field wiring should be through conduits. All fittings, cable glands etc. shall be strictly as per NEC recommendation article, 500 to 503.

30. Instruments must have separate tapping lines. Sharing of the same tapping pipe for redundant instruments or various different instruments is not acceptable.

31. All equipment / instruments envisaged for sea water applications, shall be provided with wetted parts made of Monel/ Hastelloy C or any other material (if provenness experience of the proposed material for such applications is established by contractor).

32. For coastal areas, all equipment / instruments/ accessories shall be provided with durable epoxy coating for housings and all exposed surfaces of the equipment / instruments/accessories.

33. For coastal areas, all impulse piping / air supply piping / local instrument enclosures and racks/ accessories shall be provided with durable epoxy coating for all exposed surfaces.

34. For coastal areas, all conduits / cable sub trays / cabling accessories shall be provided with durable epoxy coating for all exposed surfaces.

35. All the instruments having contact with the process fluids which are corrosive, viscous, solid bearing or slurry type, shall be provided with diaphragm seals. 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.

36. Bidder to provide at least 20% spare unused terminals in Junction boxes, LIE/LIRs, termination/marshalling cabinets etc.

37. Level transmitters for applications where transmitter location is not accessible, the transmitter shall have separate sensor unit and electronic unit for such applications. It shall be possible to mount the electronic unit at accessible location.

38. 230 V AC UPS Power supply shall be provided by BHEL at a single point, further distribution to various instruments/equipment of the system shall be in bidder scope. Bidder to include necessary power distribution board in his scope. Any power supply other than the above, if required by any instrument/equipment has to be derived by the bidder from the above supply & all necessary hardware for the same shall be in bidder scope. Further, Bidder to furnish electrical load/ UPS load data during detailed engineering in BHEL format.

39. Bidder's presence is required for 3 Man days (excluding travel time) at EDN Bangalore during FAT of DDCMIS for certifying correctness & completeness of implementation of Control logic. Intimation regarding FAT shall be given 2 days in advance. All the expenses like boarding, lodging and travel, air fare etc. shall be in bidder's scope.

40. Bidder's presence is required for 6 Man days (in two visits 3 days each excluding travel time) at site during commissioning of DDCMIS for assistance related to process correctness. All the expenses like boarding, lodging and travel, air fare etc. shall be in bidder's scope.

41. Bidder shall furnish Instrument Schedule, I/O list, Drive list, Cable Schedule, Cable interconnection (DCS end terminal details shall be provided to vendor during detail engineering to incorporate in cable interconnection), JB grouping, Control Scheme, Annunciation list, SOE list, List of Instruments/devices for HART in BHEL approved format. Also reusable database format like MS Excel, MS Access etc. of these documents shall also be provided by Contractor in BHEL approved format. Soft copy of the formats shall be provided to the successful bidder.

42. Local control panel if any required for operation shall be in bidder scope

43. Redundancy of instruments to be provided by bidder shall be as follows:
1) Triple redundancy for all analog and binary inputs required for protection of system/drives.
2) For all other control functions dual redundancy of the sensors shall be provided by the bidder.

44. Bidder to comply with codes and standards as mentioned in the specification.

45. Instrument installation shall be as per the attached "Standard Hook-up diagram of instrument." However, any instrument/ analyser installation not covered in the same shall be subject to Customer and BHEL approval during detailed engineering.

46. Bidder shall provide erection hardware as per installation drawings.

47. Bidder to provide mandatory spares as per mandatory spares list attached elsewhere in the specification.

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

49. Number of pairs to be selected for Screen /Control cable
a) F-Type: 2P/4P/8P/12P (Size: 0.5sqmm2)
b) G-Type: 2P/4P/8P/12P (Size: 0.5sqmm2)
c) Core Cable: 3CX2.5sqmm2/ 5CX2.5sqmm2/ 12CX2.5sqmm2

50. In addition to requirements specified here, all C&I systems/ sub-systems/ equipment/ devices shall also meet other requirements stipulated under other Sub-sections/ parts/ sections of specification.

51. All equipment shall be installed above ground. Below ground installation will not be allowed, but if a below ground installation is unavoidable, then proper maintenance space and dewatering arrangement has to be provided. Collection of oil and dirt in that area has to be avoided and it should be easy to clean such a place.

52. Bidder shall provide the proper user license for all kind of software and hardware (where applicable), used in the project. All the hardware and software items shall be the latest updated version with minimum 3 years proven running records under the same capability of this project.

53. All software and firmware user licenses shall be valid for entire life of power plant. User should not have to pay any recurring license fee during the usage period of the system. License will be provided on permanent basis and for any upgradation of software (for operating system & Firmware) for minimum fifteen years without any financial implication to the owner.

54. Further, Bidder to meet the provenness criteria for all the supplied C&I items mentioned elsewhere in the specification.

55. In case of any conflict and repetition of clauses in the specification, BHEL discretion will prevail.

GENERAL TECHNICAL REQUIREMENTS (C&I)

1. **Complete Control & Instrumentation system along with necessaries fittings & accessories** for Compressed Air System is in bidder scope of supply. Items not specifically mentioned however required for the completeness of the system shall be supplied by bidder without any commercial and time implication. The requirements given are to be read in conjunction with detailed Technical specification. Further in case of any discrepancy in the requirement, the more stringent requirement as per interpretation of customer shall prevail without any technical, commercial and delivery implication.

2. The control system for Compressed Air System shall be DCS based. Conventional controls (hardwired 4-20mA/DI/DO) are envisaged for this package.

   Instruments used for PG test: Al test instruments as required for Performance Guarantee Test shall be provided by the bidder free of cost. All test instruments shall be in accordance with the applicable code. The instruments for PG test shall meet the minimum requirements specified in ASME PTC or subsequent clauses in the specification, whichever is better.

3. Operation and Control of CAS shall be as per Design Philosophy/ Customer specification given elsewhere in the specification. Integrated microprocessor based control system along with suitable operator interface shall be provided for each Instrument Air Compressor, Service Air Compressor & their Dryers. All instruments inside & outside the compressor skid shall also be hooked-up to this system.

4. DDCMIS shall have redundant soft interfacing with each individual compressor's microprocessor based control system. In addition to the soft link, provision for hardwired START, STOP and LOAD & UNLOAD commands from DCS to all the compressors & their status feedbacks to DCS shall also be provided. Through redundant fiber optic cable, the bus is to be connected to DDCMIS of Central Control Room.

   Bidder to confirm all the above requirements above in their scope of supply. Bidder to furnish the configuration diagram of control system of compressor showing communication with DCS along with the bid. Bidder to furnish signal exchange list between DCS and compressed air system in BHEL format attached elsewhere.

5. Compressors operation and bearing temperature / vibration monitoring in main DCS shall be through redundant bus serial link interface between Compressor control system and DCS.

6. 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. Any cable in Bidder's scope shall be as per specification.

7. Vibration monitoring system is envisaged for compressed air system which is in BHEL scope. However, mounting of vibration sensors/probe, bidder to provide vibration pad for mounting of sensors and a notch/slot for mounting of key phasor.

8. The quantity of instruments for the 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.

9. All the Primary Instruments as indicated in enclosed flow schemes/diagrams and relevant tender drawings/ BOQ, corresponding Mechanical sections and meeting redundancy and other requirements specified under technical specifications are to be provided as a minimum. Scope of supply of PG instrument, if applicable, shall be in bidder's scope.

10. All Instruments which are Integral to equipment like pumps, motors etc. which are not indicated in enclosed P&IDs but are required for control. monitoring and operation of the equipment/plant/system are to be provided.

11. All the instruments which are required to meet the control philosophy as specified in corresponding mechanical sections shall be provided by the bidder.

12. For corrosive applications, all instruments applications, they shall be provided with wetted parts made of Monel/ Hastelloy C or any other material (if proven ness experience of the proposed material for such applications is established by bidder).

13. Space required for bidder's equipment/panel shall be accommodated by bidder without any price implication.

14. STANDARDISATION AND UNIFORMITY OF HARDWARE:
Bidder shall ensure that various C&I instruments /equipment like 4-20mA electronic transmitters / transducers, Temperature elements and other instruments/ local devices etc. that are being furnished by the Bidder, are of the same make, series and family of hardware to the extent possible so as to ensure smooth and optimal maintenance, easy interchangeability and efficient spare parts management.

15. The contacts of equipment mounted instruments, sensors, switches etc. for external connection including spare contacts shall be wired out in flexible/rigid conduits, independently to suitably located common junction boxes.

16. Power supply derived for Transmitters, contact interrogation, interposing relay and solenoid shall generally be ungrounded 24V D.C only. In all cases redundancy in power modules shall be considered.

17. 230 V AC UPS Power supply shall be provided by BHEL at water system control room, further distribution to various instruments/equipment of the system shall be in bidder scope. Bidder to include necessary power distribution board in his scope. Any power supply other than the above, if required by any instrument/equipment has to be derived by the bidder from the above supply & all necessary hardware for the same shall be in bidder scope.

18. Bidder to furnish electrical load/UPS load data during bidding stage on not to exceed basis.

19. The solenoid operated valves shall have limit switches for open/close feedback.

20. All motorized valves shall be supplied with Non-Intrusive type Electric Actuator (with integral starter) along with necessary interface units for linking to corresponding Control System as applicable. Non-contact type electronic 2 wire position transmitter shall be provided for all inching type motorized valves. The details are attached elsewhere in the specification.

21. All regulating duty control valves shall be equipped with smart positioner, having integral I-P converter and valve position transmitter.

22. Interface of MCC, HT SWGR, Solenoid Valves, field instruments, Actuators etc. with DDCMIS based control system shall be as per Drive Control Philosophy enclosed in specification.

23. Diaphragm seal shall be provided with Instruments having contact with corrosive, viscous media.

24. The redundancy in sensor, cable, control system component, power supply system component shall be designed by the Contractor to ensure that malfunction of any single sensor/ cable / Control system component/ power supply system component etc. shall not lead to loss of any Major Auxiliary (all HT Drives and Critical LT drives) or loss of Generation or loss of control function or loss of protection function.

25. Current measurement (4-20mA) of all HT/MV and critical LT drives shall be connected hardwired in respective DDCMIS.

26. Redundancy of instruments to be provided by bidder shall be as follows: -

    (i) Triple redundancy for all analog and binary inputs required for protection of system/drives.
    (ii) For all other control functions dual redundancy of the sensors shall be provided by the bidder.

27. All instruments shall be terminated on JB/LIE/LIR/LCP in field. Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 12-15 mtrs) and trunk cable. In case grouping is not possible and these are to be installed individually, canopy with suitable mounting arrangement shall be provided.

28. Temperature transmitter shall be provided for all temperature measurement applications (as applicable). All temperature transmitters shall be suitably grouped together and mounted inside

    (i) Enclosures in case of open areas of the plant
    (ii) Racks in case of covered areas on as required basis.
    (iii) In case grouping is not possible and temperature transmitter is to be installed individually, canopy with suitable mounting arrangement shall be provided.

29. All transmitters and switches shall be suitably grouped together and mounted inside (i) Local Instruments Enclosures (LIE) in case of Open Areas of the Plant (ii) Local Instrument Racks (LIR) in case of covered areas (iii) Local Indicators/Gauges shall also be suitably grouped in Local Instrument Racks. In case grouping is not possible and these are to be installed individually, canopy with suitable mounting arrangement shall be provided.

30. In case of multiple measurements of temperature for any application, resulting in trip / protection, where logic implementation tolerates failure of one TE (e.g.2v3, 2v4 etc.), for only one of the TE, dual TT is to be provided.

31. All the outdoor field instruments such as analysers/transmitters/meters etc. shall be provided with suitable Free-standing cabinet(s)/panel/rack so that the equipment is protected against rain/ sunlight etc.

32. Instrument installation and accessories shall be in Bidder's scope and shall be submitted after award of contract. Same shall be as per attached "Hook up diagrams of Instruments". However, any instrument / analyser installation not covered in the same shall be subject to customer and BHEL approval during detailed engineering.

33. Any Intelligent controller unit shall communicate on the communication bus (Device-net /Modbus/Profibus).

34. All electric actuators, pneumatic control valves, Junction Boxes, Solenoid boxes and Local control panels which are not installed inside building, suitable canopy shall be provided and design of canopy shall be approved by Employer during detailed engineering. Bidder to provide erection hardware including junction boxes, canopies, structural steel as required.

35. Bidder to provide Junction Boxes & SOV box in field for termination of all the instruments & solenoids respectively. For termination of single transmitters 5 nos. of TB to be used & for termination of switch 9 TBs to be used in Junction box.

36. Provision for separate Terminal block/wiring diagram for power and control blocks of control panel to be ensured.

37. Bidder to provide temperature sensor along with temperature transmitter for HT drives i.e. Pump and Motor for bearing and winding temp measurement.

38. The necessary root valves, impulse piping, drain cocks, gauge-zeroing cocks, valve manifolds 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. Also, the proposal shall include the necessary cables, instrument racks, junction boxes and accessories for the above purpose. Double root valves shall be provided for all pressure tapping where the pressure exceeds 40 Kg./sq.cm. Single root valves for pressure below 40 Kg./sq.cm.

39. Bidder to furnish electrical load/UPS load data during bidding stage on not to exceed basis.

40. Vibration monitoring system is envisaged for HT Motors which is in BHEL scope. However, mounting of vibration sensors/probe, bidder to provide vibration pad for mounting of sensors and a notch/slot for mounting of key phasor.

41. Local control panel and VFD panel, if any required for operation shall be in bidder's scope.

42. Instrument air filters cum regulator set with mounting accessories shall be provided for pneumatic device requiring air supply.

43. Time synchronization of compressor microprocessor system with DCS has to be done. Bidder to provide necessary hardware / software at their end.

44. Bidder shall specifically mention any deviation they would like to take on C&I specification.

45. Bidder to meet provenness criteria for all the supplied C&I items mentioned elsewhere in the specification.

46. Bidder shall furnish Instrument Schedule, Control Schemes, I/O list, Drive list, Root valve schedule, JB grouping (including Solenoid valve grouping), Cable Schedule, Cable interconnection (for local cabling & from JB to DCS, DCS end TB detail shall be provided to the successful bidder during detail engineering to incorporate in cable interconnection), Instrument/SOV/Analyzers Installation diagram, Instrument/Analyzer datasheets, Annunciation list, List of Instruments/devices in BHEL approved format. Also, editable database format like MS Excel, MS Access etc. of these documents shall also be provided by Bidder. Soft copy of the formats shall be provided to the successful bidder.

47. Where ever in the specification, Bidder's offering as per his "standard and proven practice" are identified to be acceptable, the same shall be accepted (with project/plant specific customisation as necessary) based on the documentary evidence of the reference project/plant indicated in the bid document. Any other reference project, if proposed by the bidder during detailed engineering, shall be strictly as agreed by the employer during detailed engineering.

48. All field equipment including local instruments, transducers, valves, actuators, sensors, junction boxes and cabinets shall have nameplates with the instrument tag number and descriptor in English language. The nameplates shall be fixed to the mounting plate, the mounting brackets or junction box. Loosely attached nameplates by wires are not acceptable. Label material and writing shall be selected to withstand the environmental conditions where they are mounted. The label size and fixing place shall be selected to allow easy reading.

49. Bidder to provide mandatory spares as per mandatory spares list.

50. At least 20% spare unused terminals shall be provided everywhere including local junction boxes, instrument racks/enclosures, termination/marshalling cabinets, etc.

51. Number of pairs to be selected for Screen /Control cable (Size : 0.5 mm2)
    a) F-Type: 2P/4P/8P/12P
    b) G-Type: 2P/4P/8P/12P

52. Number of cores to be selected for Control cable:
    a) 3 Core (Size: 2.5 mm2):
    b) 5 Core (Size: 2.5 mm2):
    c) 12 Core (Size: 1.5 mm2):

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CONTROL VALVE

CHAPTER – 11

CONTROL VALVES WITH ACTUATORS

11.01.00 CONTROL VALVES, ACTUATORS & ACCESSORIES

11.01.00 General Requirements

11.01.01 The control valves and accessories equipment furnished by the Bidder shall be designed, constructed and tested in accordance with the latest applicable requirements of code for pressure piping ANSI B 31.1, the ASME Boiler & pressure vessel code, Indian Boiler Regulation (IBR), ISA, and other standards specified elsewhere as well as in accordance with all applicable requirements of the "Federal Occupational Safety and Health Standards, USA" or acceptable equal standards. All the Control Valves, their actuators and accessories to be furnished under this Sub-section will be fully suitable and compatible with the modulating loops covered under the Specification.

11.01.02 All the control valves and accessories offered by the Bidder shall be from reputed, experienced manufacturers of specified type and range of valves.

11.01.03 For special type of control valves such as combined pressure and temperature control valves for Aux PRDS application, separator drain control valves, also refer to the corresponding mechanical sections.

Control valve station shall be provided at the interconnection line between service air header and instrument air header before air dryer unit. When instrument air header pressure falls below set value, the control valve will start opening and maintain the instrument header pressure at specified level in line with plant requirement. Again when instrument air header pressure goes above specified level in line with plant requirement the control valve will fully close automatically. Complete system shall be in bidder scope.

11.02.00 CONTROL VALVE SIZING & CONSTRUCTION

11.02.01 The design of all valve bodies shall meet the specification requirements and shall conform to the requirements of ANSI (USA) for dimensions, material thickness and material specification for their respective pressure classes.

11.02.02 The valve sizing shall be suitable for obtaining maximum flow conditions with valve opening at approximately 80% of total valve stem travel and minimum flow conditions with valve stem travel not less than 10% of total valve stem travel. All the valves shall be capable of handling at least 120% of the required maximum flow. Further, the valve stem travel range from minimum flow condition to maximum flow condition shall not be less than 50% of the total valve stem travel. The sizing shall be in accordance with the latest edition of ISA handbook on control valves. While deciding the size of valves, Bidder shall ensure that valves trim exit outlet velocity as defined in ISA handbook does not exceed 8 m/sec for liquid services, 150 m/sec. for steam services and 50% of sonic velocity for flashing services. Bidder shall furnish the sizing calculations clearly indicating the outlet velocity achieved with the valve size selected by him as well as noise calculations, which will be subject to Owner's approval during detailed engineering.

11.02.03 Control valves for steam and water applications shall be designed to prevent cavitation, wire drawing, flashing on the downstream side of valve and downstream piping. Thus for cavitation/flashing service, only valve with anti cavitations trim shall be provided. Detailed calculations to establish whether cavitation will occur or not for any given application shall be furnished.

11.02.04 Control valves for application such as Feed water control valve, HP & LP by pass spray control valves, APRDS control valves, Soot blower control valve, separator drain control valve, SH Spray Control, RH spray Control, Heavy Oil Heating, pressurizing and Control system, HP/LP heater Emergency level control, Emergency Make-up to condenser hotwell, GSC minimum flow, Deaerator Drain to Condenser Hotwell, Condensate spill to condensate reserve tank, condenser normal make- up and valve gland sealing supplying pressure control, CEPs minimum flow control, BFP minimum circulation control valve shall have permissible leakage rate as per leakage Class V. All other control valves shall have leakage rate as per leakage Class-IV.
All SH/RH block valves, shut off valve of LDO & HFO and HP/LP bypass control valve shall have leakage class MSS-SP-61.

11.02.05 The control valve induced noise shall be limited to 85 dba at 1 meter from the valve surface under actual operating conditions. The noise abatement shall be achieved by valve body and trim design and not by use of silencers.

11.02.06 The Liquid pressure recovery factor (FL) shall be 0.995 or better for severe flashing/cavitation services. Feed Water Control Valve, Super heater & Reheater Spray Water Control valves, LP/HP heater emergency & normal level control valve, HP /LP BP control valves, HP /LP BP spray control valves, Deaerator Overflow control valve and Separator Drain level control valve shall be considered for Severe Flashing/ cavitations service by bidder.

11.02.07 The Liquid pressure recovery factor (FL) shall be 0.985 or better for low flashing/cavitation services.

11.02.08 The valve travel time shall be less than 10 second for non critical services valves.

11.02.09 Rangeability should be 50 to 1 (min.) for non critical services valves.

11.02.10 Modulating Type Control Valve's Linearity, Hysteresis, Accuracy shall be $\leq \pm 1\%$ and Sensitivity shall be $\leq \pm$ 0.5%.

11.03.00 **VALVE CONSTRUCTION**

11.03.01 All valves shall be of globe body design & straightaway pattern with single or double port, unless other wise specified or recommended by the manufacturer to be of angle body type. Rotary valve may alternatively be offered when pressure and pressure drops permit.

11.03.02 Valves with high lift cage guided plugs & quick-change trims shall be supplied.

11.03.03 Cast Iron valves are not acceptable.

11.03.04 Bonnet joints for all control valves shall be of the flanged and bolted type or other construction acceptable to the Owner. Bonnet joints of the internal threaded or union type will not be acceptable.

11.03.05 Plug shall be of one-piece construction cast, forged or machined from solid bar stock. Plug shall be screwed and pinned to valve stems or shall be integral with the valve stems.

11.03.06 All valves connected to vacuum on down stream side shall be provided with packing suitable for vacuum applications (e.g. double vee type chevron packing)

11.03.07 Valve characteristic shall match with the process characteristics.

11.03.08 Extension bonnets shall be provided when the maximum temperature of flowing fluid is greater than 280 deg. C.

11.03.09 Flanged valves shall be rated at no less then ANSI press class of 300 lbs.

11.03.10 Each valve shall have an arrow permanently fixed on the valve body to indicate the correct direction of flow.

11.03.11 Each valve shall have a stainless steel name plate permanently fastened to the yoke which shall be visible when the valve is in service. The name plate shall include

a. Tag No. and Valve Serial No.
b. Body material, size and pressure rating
c. Trim material, size characteristics
d. Action on air failure
e. Spring range
f. Stem travel
g. Valve action, etc.

11.04.00 **VALVE MATERIALS**

S. No.	Service	Body material	Trim Material
1	Non-corrosive, non-flashing, and non- cavitation service except DM water	Carbon steel ASTM-A216 Gr WCB for fluid temperature below 275 Deg. C Alloy steel ASTM-A217Gr. WC9 for fluid temperature above 275 Deg. C and up to 550 deg. C. and for Aux. steam flow to Deaerator, CRH flow to Deaerator.	316SS stellited with stellited faced guide posts and bushings.
2	Severe flashing/cavitation services	Alloy steel ASTM-A217 Gr. WC9	440 C
3	Low flashing/cavitation	Alloy steel ASTM-A217 Gr. WC6	17-4 PH SS

S. No.	Service	Body material	Trim Material
	services		
4	DM water services	SS 316	316 SS/17-4 PH SS
5.	Main steam to Aux steam header, HP Bypass control valve.	SA182F92	Refer below cl. No. 11.04.01.
6.	LP Bypass Control Valve & Soot blower pressure control valve.	SA182F91	Refer below cl. No. 11.04.01.

11.04.01 **i.** Material of the HC PRV valve & Soot blower pressure control valve internals should be as under or better:-

Guide : Inconel 718
Plug/stem : Inconel 718
Seat ring : SS 316 stellited

ii. Material of LP Bypass steam conditioning valve internals should be as under or better:

Guide : AISI616 or X20CrMoV111, whichever is better
Plug/stem : AISI616 or X20CrMoV111, whichever is better.
Seat ring : A-182 F91/C21 coating or X20CrMoV111, whichever is better.

iii. Material of HP Bypass steam conditioning valve internals should be as under or better:

Guide : X20CrMoV121.
Plug/stem : X20CrMoV121.
Seat ring : X20CrMoV121.

NOTE : Valve body rating shall meet the process pressure and temperature requirement as per ANSI B16.34.

Cage material may be different from Trim/Plug material subject to superiority of cage material than trim/plug material.

However, Bidder may offer valves with body and trim materials better than specified materials and in such cases Bidder shall furnish the comparison of properties including cavitation resistance, hardness, tensile strength, strain energy, corrosion resistance and erosion resistance etc. of the offered material vis-a-vis the specified material for Owner's consideration and approval.

11.05.00 **END PREPARATION**

Valve body ends shall be either butt welded/socket welded, flanged

(Rubber lined for condensate service) or screwed as finalized during detailed engineering and as per Owner's approval. The welded ends wherever required shall be butt welded type as per ANSI B 16.25 for control valves of sizes 65 mm and above. For valves size 50 mm and below welded ends shall be socket welded as per ANSI B 16.11. Flanged ends wherever required shall be of ANSI pressure-temperature class equal to or greater than that of the control valve body.

11.06.00 **VALVE ACTUATORS**

All control valves shall be furnished with pneumatic actuators except for pressure and temperature control valve for auxiliary PRDS application (Electro-hydraulic / pneumatically operated) and separator drain control valve (Electro-hydraulic type).The Bidder shall be responsible for proper selection and sizing of valve actuators in accordance with the pressure drop and maximum shut off pressure and leakage class requirements. The valve actuators shall be capable of operating at 60 deg.C continuously.

Valve actuators and stems shall be adequate to handle the unbalanced forces occurring under the specified flow conditions or the maximum differential pressure specified. An adequate allowance for stem force, at least 0.15 Kg/sq.cm. per linear millimeter of seating surface, shall be provided in the selection of the actuator to ensure tight seating unless otherwise specified.

The travel time of the pneumatic actuators shall not exceed 10 seconds.

11.07.00 **CONTROL VALVE ACCESSORY DEVICES**

11.07.01 All pneumatic actuated control valve accessories such as air locks, hand wheels/hand-jacks, limit switches, microprocessor based electronic Positioner, diffusers, external volume chambers, position transmitters (capacitance or resistance type only), reversible pilot for Positioner, tubing and air sets, solenoid valves and junction boxes etc. shall be provided as per the requirements.

11.07.02 Separate moisture separator unit for ensuring dryness of air entering I/P as well as the power cylinder is to be supplied with each control valve and control damper.

11.08.00 **SPECIFICATIONS FOR MICROPROCESSOR BASED ELECTRONIC POSITIONER**

1	Electrical	a) Input Demand Signal	4-20 mA
		b) Power Supply	Loop Powered from the output card of Control System.

		c) HART Protocol	Compatibility for Remote Calibration & Diagnostics (Super-imposed HART signal on input Signal (4-20 mA)
		d. Valve position sensing	Position sensing, 4-20 mA output signal to be provided for control system
2	Environment	a) Operating temp.	(-)30 To 80 Deg. C
		b) Humidity	0-95 %
		c) Protection class	IP-65 Minimum with Die cast Aluminum/SS316 enclosure.
3	Software for Configuration and Diagnostics	Software	Windows based software. Software shall meet the requirements for Configuration, Diagnostics, Calibration and Testing of the actuator.
		Diagnostic/Test features	Advanced diagnostic features like Stroke counter or Travel counter, Leakage in actuators, Valve Signature analysis, Step Response test, Valve friction /Jamming detection etc. to be provided
4	Test reports/ Certificates	Factory Valve Signature Tests Reports (Pressure versus Valve travel and Travel versus I/P signal) are to be provided.	
		Test certificates as per Manufacture Standard/Relevant Standard are to be submitted.	
5	Configuration/ Calibration	Remote & Local Calibration, Auto & Manual Calibration shall be possible.	
6	Operating Range	Full range/ Split range.	
7	Modes	Valve Action	Direct / Reverse Valve Action
		Flow Characterization	Possible to fit Valve Characteristic Curves- Linear , Equal percentage etc.

8	Fail Safe/Fail Freeze	Fail Safe/Fail Freeze feature is to be provided. (In case the fail freeze feature is not intrinsic to the positioner, Bidder shall achieve the same externally through solenoid valve connected in the pneumatic circuit).	
9	Pneumatic	Air capacity	Sufficient to handle the valves & actuators selected/ Boosters to be supplied, if required.
		Air pressure	To suit the air supply pressure/quality available.
		Process connection	¼" NPT
10	Performance	Characteristic deviation	<=0.5 % of span.
		Ambient temp effect	<=0.01 %/ deg C or better.
11	EMC & CE compliance	Required to International Standard like EN/IEC.	EN50081-2 & E N 5 0 0 8 2 or equivalent.
12	Accessories	In-built Operator Panel	Display with push buttons for configuration and display on the positioner itself (Password protected/Hardware lock).
		Hand Held Hart Calibrator	Universal Hart Calibrator to be provided (for quantity, refer Part-A Vol-V C&I : Contract quantities of the specification).
		Pressure Gauge Block & Position Indicators.	For supply & output pressures, Air Filter Regulator, integral type position transmitter, in built mechanical position indicator and other accessories shall be provided on as required basis for making system complete.
		Electrical Cable Entry	1/2" NPT, side or bottom entry to avoid water ingress.

		Valves Mounting Assembly	For Sliding Stem/Rotary/Single acting/Double acting actuators on as required basis.

*** Note**:

i. The HART signals shall be picked up from marshalling terminals of DDCMIS (SG/TG DDCMIS as well as BOP DDCMIS), as applicable. The details of the above mentioned HART management system specification are mentioned in HART system Vol-V, Part B, Chapter 3, DDCMIS, cl. no. 3.45.00. The positioners shall be monitored from this HART management system .To achieve this, Bidder shall provide the necessary software to achieve the functionalities described above under "Remote Configuration and Diagnostics", and this software shall be loaded in the HART management system.

ii. Actuators shall have provision to be on fail safe condition in case of Air/power/hydraulic system failure.

11.10.00 **TEST AND EXAMINATION**

All valves shall be tested in accordance with the quality assurance program agreed between the Owner and Contractor, which shall meet the requirements of IBR and other applicable codes mentioned elsewhere in the specifications. The tests shall include but not be limited to the following:

11.10.01 Non Destructive Test as per ANSI B-16.34.

11.10.02 Hydrostatic shell test in accordance with ANSI B 16.34 prior to seat leakage test.

11.10.03 Valve closure test and seat leakage test in accordance with ANSI-B 16.34 and as per the leakage class indicated above.

11.10.04 Functional Test: The fully assembled valves including actuators control devices and accessories shall be functionally tested to demonstrate times from open to close position.

11.10.05 CV Test: Please refer Cl No. 13.00.00, Vol. V Part-B, Chapter : 13 (Type test requirements), Control Valves.

Bidder shall furnish all the control valves under this main plant package as finalized during detailed engineering stage without any price repercussions whatsoever depending on the process requirements. All the control valves provided by the Bidder for this project shall meet the specifications requirements specified herein. Specification for control valves in this chapter has to be read in conjunction with other relevant chapter of this specification.

CHAPTER – 13

TYPE TEST REQUIREMENTS

13.00.00 General Requirements

13.00.01 The Bidder shall furnish the type test reports of all type tests as per relevant standards and codes as well as other specific tests indicated in this specification. If the bidder proposes a different standard/code from that indicated at table 13.02.00 below, same is acceptable provided the equivalence of the proposed standard is established by the bidder. A list of such tests are given for various equipment in table titled 'TYPE TEST REQUIREMENT FOR C&I SYSTEMS' at the end of this chapter and under the item Special Requirement for Solid State Equipments/Systems. For the balance equipment instrument, type tests may be conducted as per manufactures standard or if required by relevant standard.

(a) Out of the tests listed, the Bidder/ sub-vendor/ manufacturer is required to conduct certain type tests specifically for this contract (and witnessed by Owner or his authorized representative) even if the same had been conducted earlier, as clearly indicated subsequently against such tests.

(b) For the rest, submission of type test results and certificate shall be acceptable provided.

i. The same has been carried out by the Bidder/ sub-vendor on exactly the same model /rating of equipment.

ii. There has been no change in the components from the offered equipment & tested equipment.

iii. The test has been carried out as per the latest standards along with amendments as on the date of Bid opening.

(c) In case the approved equipment is different from the one on which the type test had been conducted earlier or any of the above grounds, then the tests have to be repeated and the cost of such tests shall be borne by the Bidder/ sub-vendor within the quoted price and no extra cost will be payable by the Owner on this account.

13.00.02 As mentioned against certain items, the test certificates for some of the items shall be reviewed and approved by the main Bidder or his authorized representative and the balance have to be approved by the Owner.

13.00.03 The schedule of conduction of type tests/ submission of reports shall be submitted and finalized during pre-award discussion.

13.00.04 For the type tests to be conducted, Bidder shall submit detailed test procedure for approval by Owner. This shall clearly specify test setup, instruments to be used, procedure, acceptance norms (wherever applicable), recording of different parameters, interval of recording precautions to be taken etc. for the tests to be carried out.

13.02.00 **TYPE TEST REQUIREMENT FOR C&I SYSTEMS**

S. No.	Item COL2	Test Requirement COL3	Standard COL4	Test to be specifically conducted COL5	Approval required on Test certificate COL6
			2. IK: IEC 62262:2002		
	Flue Gas Analysers	Degree of protection Test	IS-13947	No	Yes
	Mercury Analysers	Degree of protection Test	IS-13947	No	Yes
	AAQMS Analysers	Degree of protection Test	IS-13947	No	Yes
	Master clock	Functional test	As per Approved procedure	No	Yes
	CJC Box	Degree of protection Test and Impact resistance test.	1. IP: IS/IEC 60529 or IS 13947 2. IK: IEC 62262:2002	No	Yes
	Junction Box	Degree of protection Test and Impact resistance test.	1. IP: IS/IEC 60529 or IS 13947 2. IK: IEC 62262:2002	No	Yes
	OPC data access server Data exchange server and Historical data access server	OPC Compliance testing		No	Yes (Self certification is also acceptable)
	Conductivity type level switch	Degree of protection Test	IS-2147	No	No
	Local Gauges	Degree of protection Test	IS-2147	No	No
	Process actuated switches	Degree of protection Test	IS-2147	No	No
	Control Valves	CV Test	ISA 75.02	No	Yes

S. No.	Item COL2	Test Requirement COL3	Standard COL4	Test to be specifically conducted COL5	Approval required on Test certificate COL6
	PLCs	As per standard (col4) and cl. No. 13.03.00 below.	IEC 1131	No	No
	Flow Nozzle orifice plate	Calibration	ASME PTC BS 1042	No	Yes

The bidder shall submit for Owners approval the reports of all the type test as per latest IS-10918 carried out within last ten years from the date of Bid opening and the test(s) should have been either conducted at an independent laboratory or in presence / owners representative. The complete type test reports shall be for any rating of Battery in a particular group based on plate dimensions being manufactured by supplier.

Note: Type Tests are to be conducted only for the items, which are being supplied as a part of this Package.

CI.8. CONTROL VALVES AND ACTUATORS

CONTROL VALVE ACTUATORS AND ACCESSORIES.

TESTS / ITEMS	Make,model,tag (R)	Dimension®	Surface finish®	Heat Treatment®	Material Test Certificates®	IBR Certificates®	Hydraulic Test®	UT/Radiography for >900 lb rating®	MPI/DP®	Pressure Resistance®	Seat leakage®	Timeing Open/Close®	Linearity/Hysterisis®	Functional Test, review for make and TC of accessories®
CONTROL VALVE AND ACTUATOR														
Overall	Y	Y	Y			Y	Y				Y	Y	Y	Y
Body		Y	Y	Y	Y			Y	Y	Y				
Bonnet		Y	Y	Y	Y									
Trim		Y			Y			Y *						
Pneumatic actuator	Y	Y								Y				

R- Routine Test A - Acceptance Test Y - Test Applicable

Y* - UT on spindle dia >= 40 mm.

Note :

1) Detailed procedure of Burn-in and Elevated Temperature test shall be as per Quality Assurance Programme General Technical Conditions

2) This is an indicative list of tests/checks. The manufacture is to furnish a detailed Quality Plan indicating his practice & Procedure along with relevant supporting documents during QP finalisation for all item.

3) Acceptance tests shall be carried out in presence of owner's representative.

BHEL	TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM 2x660MW HTPS KORBA WEST & 2X660 MW RAGHUNATHPUR	PE-TS-530-YYY-HZZZ Issue No: 01 Rev. No. 00 Date :

GENERAL TECHNICAL REQUIREMENT(KORBA WEST & RAGHUNATHPUR)	
C&I TECHNICAL REQUIREMENT	
1	Complete C&I system for Compressed Air System is in bidder scope of supply. Items not specifically mentioned however required for the completeness of the system shall be supplied by bidder without any commercial and time implication. The requirement given are to be read in conjunction with detailed technical specification. Further in case of any discrepancy in the requirement, the more stringent requirement as per interpretation of the Customer shall prevail without any commercial and time implication.
2	Compressors operation and bearing temperature / vibration monitoring in main DCS shall be through redundant bus serial link interface between Compressor control system and DCS.
3	The scope of instrumentation cable(screend control cable), fibre optic cable & control cable shall be as per Electrical scope matrix in Electrical portion of the specification. Any cable in bidder's scope shall be as per specification. Cable from Combox to DCS for softlink shall be in BHEL scope.
4	Bidder to include all the instruments required for the package along with fittings, accessories and valve manifold. All fittings shall use metric threads. Use of process actuated switches shall be avoided unless unavoidable.
5	Vibration monitoring system is envisaged for compressed air system which is in BHEL scope. However, for mounting of vibration sensors/probe, bidder to provide vibration pad for mounting of sensors and a notch/slot for mounting of key phasor.
6	Bidder to provide temperature sensor along with temperature transmitter for HT drives i.e. Pump and Motor for bearing and winding temp measurement.
7	The redundancy in sensor, cable, control system component, power supply system component shall be designed by the Contractor to ensure that malfunction of any single sensor/ cable / Control system component/ power supply system component etc. shall not lead to loss of any Major Auxiliary (all HT Drives and Critical LT drives) or loss of Generation or loss of control function or loss of protection function.
8	Current measurement (4-20mA) of all HT/MV and critical LT drives shall be connected hardwired in respective microprocessor panel/DDCMIS.
9	Redundancy of instruments to be provided by bidder shall be as follows :- (i) Triple redundancy for all analog and binary inputs required for protection of system/drives. (ii) For all other control functions dual redundancy of the sensors shall be provided by the bidder. For measuring instruments type, specification, redundancy and quantities that are connected to Skid Mounted systems, integral to Equipment , bidder's standard and proven practice can be accepted.
10	Bidder to provide Junction Boxes in field for termination of all the instruments.
11	The contacts of equipment mounted instruments, sensors, switches etc. for external connection including spare contacts shall be wired out in flexible/rigid conduits, independently to suitably located comnon junction boxes.
12	The solenoid operated valves shall have limit switches for open/close feedback.
13	Bidder to note that Instrumentation Cable shall be as per Electrical Cable scope matrix attached elsewhere in the Specification.
14	Bidder to provide at least 20% spare terminals in Junction boxes, LIE/LIRs etc.
15	All the transmitters supplied by Bidder shall be LIE/LIR mounted. The LIE/LIRs shall be in Bidder's scope of supply.
16	All the instruments having contact with corrosive media shall be provided with chemical/diaphragm seal.
17	For level transmitters, electronics items etc. all weather canopy/rack enclosures shall be provided by Bidder for protection from direct sunlight and rain for open locations. For applications where transmitter location is not accessible, the transmitter shall have separate sensor unit and electronic unit for such applications. It should be mounted at accessible location.
18	All instruments shall be terminated on JBILIEILIRILCP in field. Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 12-15 mtrs) and trunk cable. In case grouping is not possible and these are to be installed individually, canopy with suitable mounting arrangement shall be provided.
19	Temperature transmitter shall be provided for all temperature measurement applications (as applicable). All temperature transmitters shall be suitably grouped together and mounted inside :- (i) Enclosures in case of open areas of the plant (ii) Racks in case of covered areas on as required basis. (iii) In case grouping is not possible and temperature transmitter is to be installed individually, canopy with suitable mounting arrangement shall be provided.
20	All transmitters and switches shall be suitably grouped together and mounted inside (i) Local Instruments Enclosures (LIE) in case of Open Areas of the Plant (ii) Local Instrument Racks (LIR) in case of covered areas (iii) Local Indicators/Gauges shall also be suitably grouped in Local Instrument Racks. In case grouping is not possible and these are to be installed individually, canopy with suitable mounting arrangement shall be provided.
21	In case of multiple measurements of temperature for any application, resulting in trip / protection, where logic implementation tolerates failure of one TE (e.g.2v3, 2v4 etc.), for only one of the TE, dual TT is to be provided.
22	All the outdoor field instruments such as analysers/transmitters/meters etc. shall be provided with suitable Free-standing cabinet(s)/panel/rack so that the equipment is protected against rain/sunlight etc.
23	All electric actuators, pneumatic control valves, Junction Boxes, Solenoid boxes and Local control panels which are not installed inside building, suitable canopy shall be provided and design of canopy shall be approved by Employer during detailed engineering.
24	Bidder to provide Junction Boxes & SOV box in field for termination of all the instruments & solenoids respectively. For termination of single transmitters 5 nos. of TB to be used & for termination of switch 9 TBs to be used in Junction box.
25	Provision for separate Terminal block/wiring diagram for power and control blocks of control panel to be ensured.
26	The necessary root valves, inlpulse piping, drain cocks, gauge-zeroing cocks, valve manifolds 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. Double root valves shall be provided for all pressure tapping where the pressure exceeds 40 Kg./sq.cm.
27	Bidder to provide erection hardware including junction boxes, canopies, structural steel as required.
28	Bidder to furnish electrical load/UPS load data during bidding stage on not to exceed basis.
29	All field instruments/analyzers/actuators/sov/control valves etc. shall be hooked with DDCMIS based control system as per requirement mentioned elsewhere in the specification.
30	The necessary root valves, impulse piping, drain cocks, gauge-zeroing cocks, valve manifolds 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. Double root valves shall be provided for all pressure tapping where the pressure exceeds 40 Kg./sq.cm.
31	All measuring instruments/equipment/analysers and subsystems offered by the Bidder shall be from reputed experienced manufacturers (from BHEL/customer approved vendor list) of specified type and range of equipment, whose guaranteed and trouble free operation has been proven. Further, all instruments shall be of proven reliability, accuracy, and repeatability requiring a minimum of maintenance and shall comply with the acceptable international standards.
32	STANDARDISATION AND UNIFORMITY OF HARDWARE: Bidder shall ensure that various C&I instruments /equipment like 4-20mA electronic transmitters/ PROFIBUS transmitters/transducers, Temperature elements and other instruments/ local devices etc. that are being furnished by the Bidder, are of the same make, series and family of hardware to the extent possible so as to ensure smooth and optimal maintenance, easy interchangeability and efficient spare parts management.
33	Space required for bidder's equipment/panel shall be acconlmodated by bidder without any price implication.
34	Further, Bidder to meet the provenness criteria for all the supplied C&I items mentioned elsewhere in the specification

35	230 V AC UPS/ 415 V AC power supply shall be provided by BHEL at single point. Further, distribution to various instruments/equipment of the system shall be in bidder's scope. Bidder to include necessary power distribution board in his scope. Any power supply other than the above, if required by any instrument/equipment has to be derived by the bidder from the above supply & all necessary hardware for the same shall be in bidder's scope. Further, bidder to furnish UPS load data during detailed engineering in BHEL format.
36	Power supply derived for Transmitters, contact interrogation, interposing relay and solenoid shall generally be ungrounded 24 V DC only. In all cases redundancy in power modules shall be considered.
37	Bidder to provide mandatory spares for C&I items as per mandatory spares list.
38	Bidder to perform tests of C&I items/instruments/systems as per Quality plans/type test attached in the specification.
39	The instruments,equipment offered by the bidder shall be as the approved sub-vendor list mentioned elsewhere in the specification.
40	Bidder's presence is required for 3 Man days (Excluding travel time) at EDN Bangalore during FAT of DDCMIS for certifying correctness & completeness of implementation of Control logic. Intimation regarding FAT shall be given 2 days in advance. All the expenses like boarding, lodging and travel, air fare etc. shall be in bidder's scope.
41	Bidder shall furnish Instrument Schedule, Control Scheme, I/O list, Drive list, Cable Schedule, Cable interconnection, Instrument/SOV/Analyzers Installation diagram, Instrument/Analyzer datasheets, JB grouping, SOV grouping, Annunciation list, List of Instruments/devices for Profibus/HART, configuration diagram for Profibus based actuators/instruments in BHEL approved format. Also, editable database format like MS Excel, MS Access etc. of these documents shall also be provided by Bidder.
42	The quantity of instruments for the system sahll 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.
43	All Instruments which are Integral to equipment like pumps, motors etc. which are not indicated in enclosed P&IDs but are required for control. monitoring and operation of the equipment/plant/system are to be provided. All the instruments which are required to meet the control philosophy as specified in corresponding mechanical sections shall be provided by the bidder.
44	Instrument air filters cum regulator set with mounting accessories shall be provided for pneumatic device requiring air supply.
45	Bidder shall furnish Instrument Schedule, Control Schemes, I/O list, Drive list, Root valve schedule, JB grouping (including Solenoid valve grouping), Cable Schedule, Cable interconnection (for local cabling & from JB to DCS, DCS end TB detail shall be provided to the successful bidder during detail engineering to incorporate in cable interconnection), Instrument/SOV / Analyzers Installation diagram, Instrument/Analyzer datasheets, Annunciation list, List of Instruments/devices in BHEL approved format. Also, editable database format like MS Excel, MS Access etc. of these documents shall also be provided by Bidder. Soft copy of the formats shall be provided to the successful bidder.
46	Where ever in the specification, Bidder's offering as per his "standard and proven practice" are identified to be acceptable, the same shall be accepted (with project/plant specific customisation as necessary) based on the documentary evidence of the reference project/plant indicated in the bid document. Any other reference project, if proposed by the bidder during detailed engineering, shall be strictly as agreed by the employer during detailed engineering.
47	All field equipment including local instruments, transducers, valves, actuators, sensors, junction boxes and cabinets shall have nameplates with the instrument tag number and descriptor in English language. The nameplates shall be fIXed to the mounting plate, the mounting brackets or junction box. Loosely attached nameplates by wires are not acceptable. Label material and writing shall be selected to withstand the environmental conditions where they are mounted. The label size and fixing place shall be selected to allow easy reading.
48	At least 20% spare unused terminals shall be provided everywhere including local junction boxes, instrument racks/enclosures, termination/marshalling cabinets, etc.
49	Number of pairs to be selected for Screen /Control cable (Size: 0.5 mm2) a) F-Type: 2P/4P/8PI12P b) G-Type: 4P/8P112P
50	Number of cores to be selected for Control cable: a) 3 Core (Size: 2.5 mm2): b) 5 Core (Size: 2.5 mm2): c) 12 Core (Size: 1.5 mm2):
51	**TYPE TEST GENERAL REQUIREMENT**
51.1	Submission of type test results and certificate shall be acceptable provided:
51.1.1	The same has been carried out by the Bidder/ sub-vendor on exactly the same model /rating of equipment.
51.1.2	There has been no change in the components from the offered equipment & tested equipment.
51.1.3	The test has been carried out as per the latest standards alongwith amendments as on the date of Bid opening.
51.2	In case the approved equipment is different from the one on which the type test had been conducted earlier or any of the above grounds, then the tests have to be repeated and the cost of such tests shall be borne by the Bidder/ sub-vendor within the quoted price and no extra cost will be payable by the Employer on this account.
51.3	The schedule of conduction of type tests/ submission of reports shall be submitted and finalized during pre-award discussion.
51.4	For the type tests to be conducted, Contractor shall submit detailed test procedure for approval by Employer. This shall clearly specify test setup, instruments to be used, procedure, acceptance norms (wherever applicable), recording of different parameters, interval of recording, precautions to be taken etc. for the tests to be carried out.

SPECIFIC TECHNICAL REQUIREMENT FOR KORBA WEST	
1.1	Integrated microprocessor based control system along with suitable operator interface shall be provided for each Instrument Air Compressor, Service Air Compressor & their Dryers. All profibus based instruments like PT, DPT, TT, and other instruments inside & outside the compressor skid shall also be hooked-up to this system. Further, critical signals shall be monitored through soft link between combox (used for integrating the soft communication among various compressors) and DCS (DCS in BHEL scope). MODBUS Protocol shall be used to establish connectivity with DCS. In addition to the soft link, provision for hardwired START, STOP and LOAD & UNLOAD commands from DCS to all the compressors & their status feedbacks to DCS shall also be provided. Bidder to furnish the configuration diagram of control system of compressor showing communication with DCS along with the bid. Bidder to furnish signal exchange list between DCS and compressed air system's control system in BHEL format attached elsewhere.
1.2	Bidder to provide Profibus PA protocol compatible PT (Pressure Transmitters), DPT (Differential Pressure Transmitters), TT (Temperature Transmitters) and Flow/Level Transmitters (DP type) for entire Compressed air system (CAS).
1.3	All motorized valves shall be supplied with Non-intrusive Profibus based Electric Actuator (with integral starter) for CAS package along with necessary interface units for linking to corresponding Control System as applicable.
1.4	Profibus based electronic positioner (as per standard and proven practice of valve OEM) is to be provided with all the pneumatically operated control valves(if applicable)
1.5	The Profibus protocol design shall be further validated by BHEL and approved by NTPC during detailed engineering and any variation/changes required based on DDCMIS system requirements and actual field installation, operational philosophy etc. shall be considered by bidder without any implications.
1.6	Profibus DP based IMC in LV SWGR/MCC (BHEL's scope) shall be provided.
2	**ANNUAL MAINTAINENCE SERVICE (AMS) FOR PROFIBUS INSTRUMENTS**
2.1	The requirements specified below are applicable for warranty (defect liability period) and 3 years AMS period.
2.2	The Contractor's scope shall also include providing Post Warranty Maintenance for 3 years after completion of warranty period of the offered wireless systems and all associated components as per specification. The AMS shall include tools and tackle as required; travel, boarding & lodging of service engineer. In the event of any malfunction of the system hardware/system software, experienced service engineer shall be made available at site within 48 hours on the receipt of such information from Employer.
2.3	Employer personnel will work on system day-to-day basis and wherever possible, Employer shall inform the type of failure of hardware/ software to Contractor based on diagnostic available with the system. However Contractor shall be fully responsible to attend and rectify the root cause and the failure within 48 hrs. Contractor may utilize the spares available with Employer, if necessary and available with Employer at site, which are part of mandatory spares supplied with system as per this specification. However, the consumed spares shall be replenished to Employer within 2 months' time.
3	The services under Post Warranty Maintenance Agreement, shall broadly comprise of the following:
3.1	Periodic Maintenance Site visits, minimum four (4) times in a year (total days expected 16 in a year), schedule of visits to be discussed and finalized jointly between Contractor and client after placement of order/ delivery. It shall include inspection of general healthiness of the system, study and advice on daily maintenance, inspection of Hardware & Software, if any problem is reported, running of test programs, on-line servicing and solving reported problems. System shall be checked online.
3.2	Software Maintenance/ Support Contractor shall maintain the existing operating & application software for any debugging requirements to have consistent performance of the system.
3.3	Emergency Service In the event of any malfunction of the wireless system hardware/system software during this period, Service Engineer must report at site within 48 hrs. of report of failure. The system must be brought back within 48 hours after reporting at site.
3.4	Contractor shall note that while carrying out the Annual Maintenance Contract activities, Employer's engineers shall associate with the Contractor. On-job training of these associated engineers shall be covered under this scope. This shall include all items being supplied by Contractor, including any bought out items but not limited to the following: Labour, at no additional cost, to repair any system devices , to provide tests, and adjustment to system devices.
SPECIFIC TECHNICAL REQUIREMENT FOR RAGHUNATHPUR	
1.1	Integrated microprocessor based control system along with suitable operator interface shall be provided for each Instrument Air Compressor, Service Air Compressor & their Dryers. All instruments inside & outside the compressor skid shall also be hooked-up to this system. Further, critical signals shall be monitored through soft link between combox (used for integrating the soft communication among various compressors) and DCS (DCS in BHEL scope). MODBUS Protocol shall be used to establish connectivity with DCS. In addition to the soft link, provision for hardwired START, STOP and LOAD & UNLOAD commands from DCS to all the compressors & their status feedbacks to DCS shall also be provided. Bidder to furnish the configuration diagram of control system of compressor showing communication with DCS along with the bid. Bidder to furnish signal exchange list between DCS and compressed air system in BHEL format attached elsewhere.
1.2	Conventional controls (hardwired 4-20mA/DI/DO) are envisaged for this package.

APPLICABLE FOR KORADI,KORBA WEST,UKAI,YAMUNANAGAR,RAGHUNATHPUR

Cheklist for Serial Communication between maxDNA Systems and Foreign Device :BHEL

A Device Specific :

SN	Parameters	Options available	Remarks if any
1	Modle No.& Make of Device		
2	Communications Link Options	☐ Multidrop ☐ Peer to Peer ☐ N/w topology attached	
3	Protocol Mode (Device is a)	☐ Master ☐ Slave ☐ Master/Slave	
4	Protocol	☐ RTU ☐ ASCII ☐ Other ----------	
5	Master	☐ System maxDNA ☐ Other ----------	
6	Redundancy Requirements	Yes / No	
7	Dist.bet.maxDNA System & Device*	☐ ---------- Feet ☐ ---------- Meters	

B Electrical Spcific :

1	Interface Type	☐ RS232 ☐ RS422 ☐ RS485	
2	Wiring at Device end	☐ 2 Wire ☐ 4 Wire	
3	Transmission Channel	☐ Half Duplex ☐ Full Duplex	
4	Baud Rates (bps)	☐ 1200 ☐ 2400 ☐ 4800 ☐ 9600 ☐ 19200	
5	Databits	☐ 8 ☐ 7	
6	Stopbits	☐ 1 ☐ 2	
7	Parity	☐ None ☐ Odd ☐ Even	
8	H/w & Software Handshake	☐ Yes ☐ No	
9	Response Timeout time (Sec)	☐ ---------- ☐ Configurable timeout	
10	Data Formats Supported	☐ Boolean ☐ Real ☐ Char ☐ Sn.Int ☐ UnSn.Int	
11	Transmission mode	☐ Asynchronous ☐ Synchronous	

C Application Specific : *

1	Primary Function*	☐ Data Acquisition ☐ Data Acquisition & Control	
		☐ Download parameter sets	
2	Analog Points to read	-------Nos. ☐ Details attached ☐ Details not attached	
3	Analog Points to write	-------Nos. ☐ Details attached ☐ Details not attached	
4	Digital Points to read	-------Nos. ☐ Details attached ☐ Details not attached	
5	Digital Points to write	-------Nos. ☐ Details attached ☐ Details not attached	
6	Memory / Flag Points to read	-------Nos. ☐ Details attached ☐ Details not attached	
7	Memory / Flag Points to write	-------Nos. ☐ Details attached ☐ Details not attached	

D Hardware Specific :

1	Cable type	☐ Boolean cable ☐ Twisted pair cable	
2	Cable Details Enclosed	☐ Yes ☐ No	
3	Any specific Converter required	☐ Yes ☐ No ☐ Details enclosed	

E Device Documents :

1	Manufacturer's Documents*	☐ Tech., Spec. ☐ Operating Manual	

***Notes:**

A6 To identify converter requirement and cable length.

C The sr.no.1 to 7 are reqd.to be furnished for interface impl. :such as Tagname,Description,point type, modbus(Register) address,EU,range & device (dlave) address

C1 What is the primary purpose of the communications link?

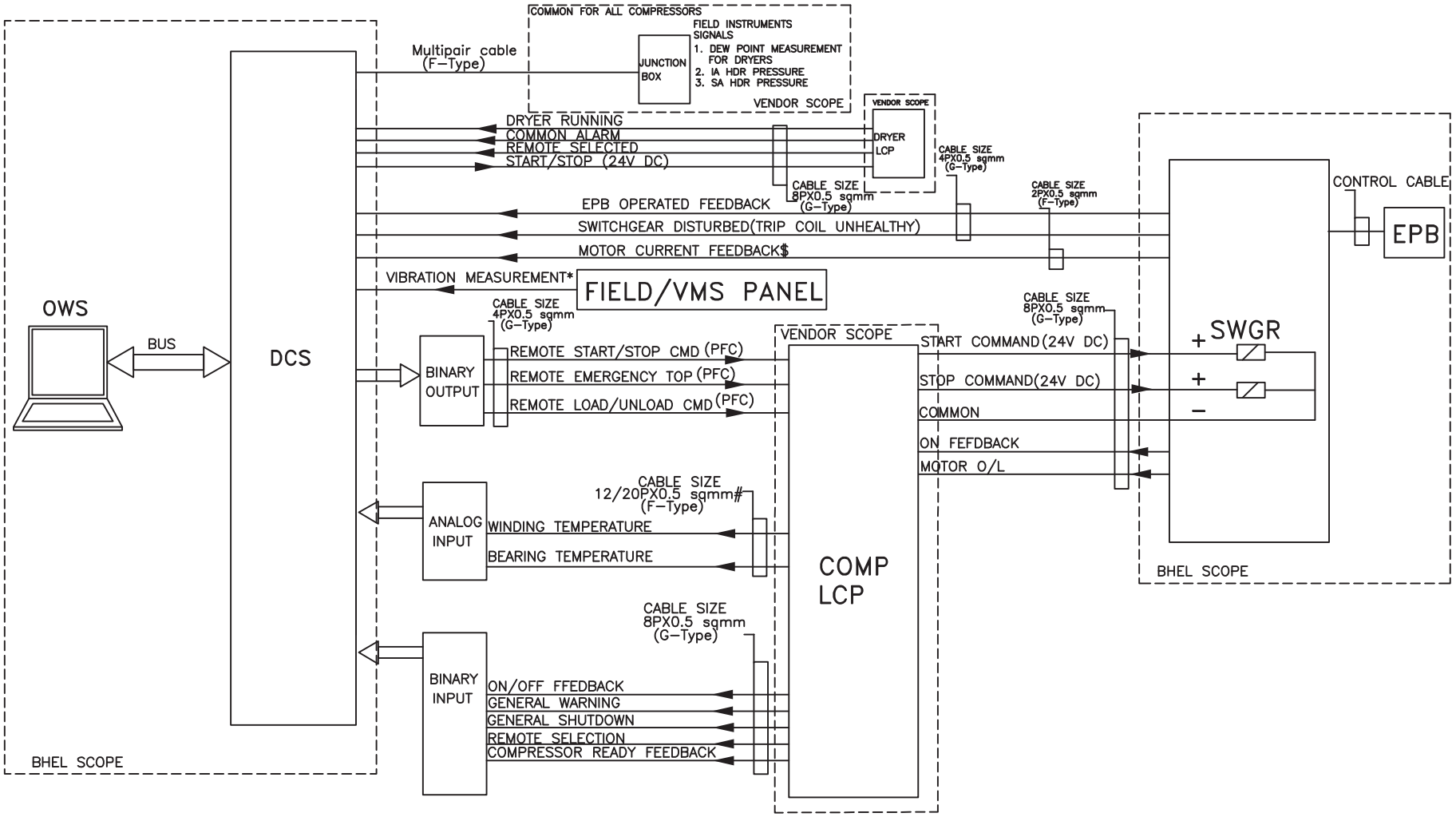
E1 Reqd. Contents : This document must provide an overview of the device including its intended use(a general technical,communication & electrical details)

Tag name (Maximum 15 Char.)	**Tag Description** (Maximum of 32 Char.)	**Point Type** (Note-1)	**DCS (Engg.) Range**		**Modbus Range**		**Engg. Unit**	**Alarm Requirement** (Y / N)	**Alarm Priority** (URGENT/HI/LO)	**Alarm SetPoint**	**State text for 0 condition**	**State text for 1 condition**	**Normal State (State 0 or State 1)**	**History Required** (Y/N)	**Data Format** (Note-3)	**Device ID (Address)**	**Modbus address**	**Function Code / Register Type** (Note-4)
			Min	Max	Min	Max												

Notes:

1. Data type (AI/AO/DI/DO) shall be specified with respect to DCS.
2. For Digital points (IOs) please indicate the alarm state.
3. Data Format : SIGN16, USIGN16, SIGN32, USIGN32, FLOAT32, LONG32, BOOL, LOGIC
4. Function code: 1-Coil Status, 2-Input Status, 3-Holding Register, 4- Input Register, 5-Force single Coil, 6-Preset Single Register **as per Modbus Standard**

STANDARD HARDWIRED INTERFACE BETWEEN COMPRESSOR CONTROL SYSTEM, DCS AND SWGR

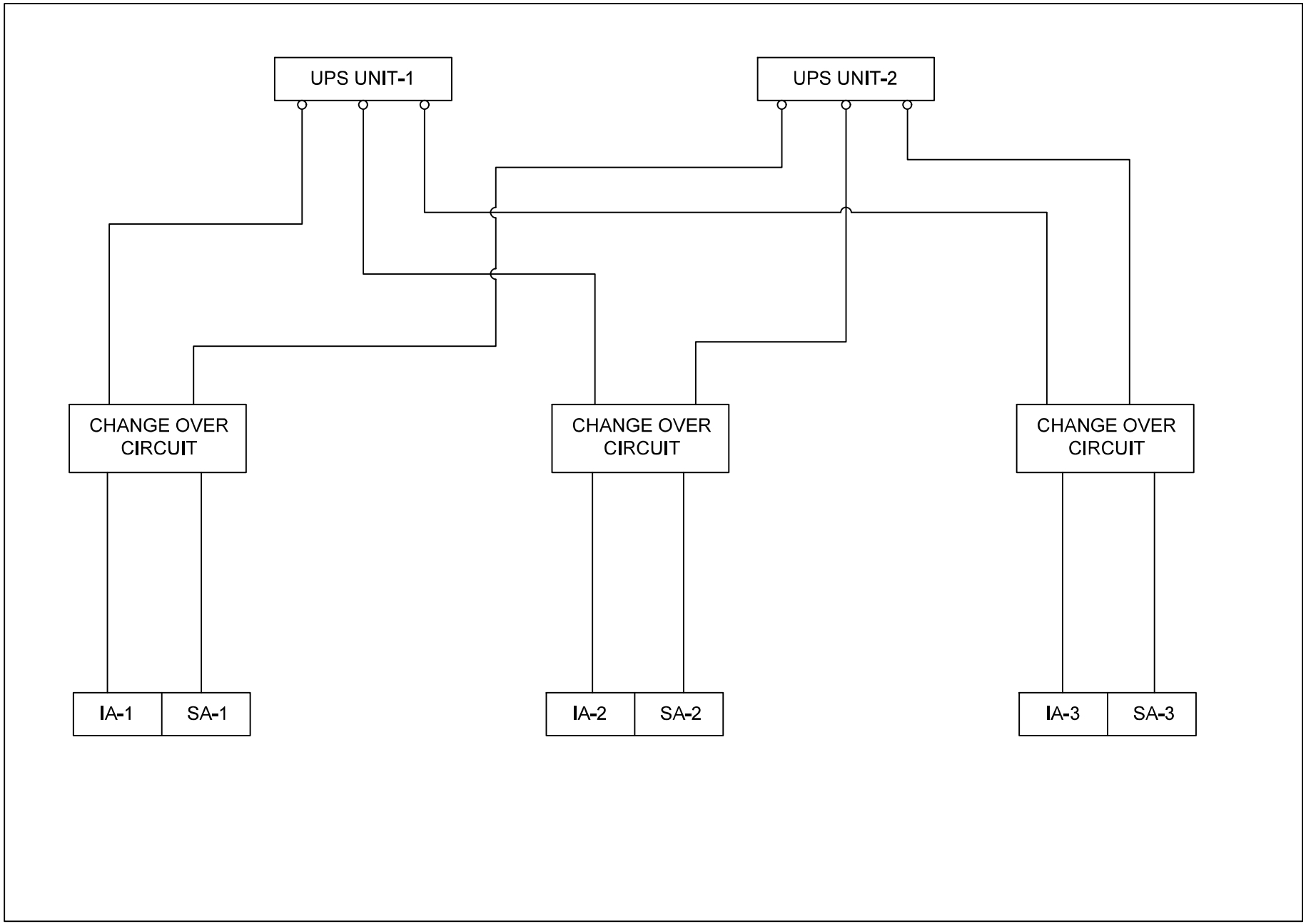


NOTE:
1. *APPLICABLE FOR HT MOTORS (PROJECT SPECIFIC)
2. #12P APPLICABLE IF 'TT' IS ENVISAGED. 20P APPLICABLE IF 'RTD' IS ENVISAGED.
3. $FOR NTPC PROJECTS MIN 4P(F-TYPE) TO BE USED.
4. CABLE SCOPE SHALL BE AS PER ELECTRICAL SCOPE MATRIX OF PARTICULAR PROJECT

BHEL

TITLE: DDCMIS/LCP/SWGR INTERFACE FOR INDIVIDUAL COMPRESSOR/DRYER

APPLICABLE FOR KORADI,UKAI,YAMUNANAGAR



SPECIFICATION FOR
MOTORISED VALVE ACTUATOR

APPLICABLE ONLY FOR KORADI,UKAI,YAMUNANAGAR

APPLICABLE FOR KORADI

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR	SPECIFICATION NO.: PE-ID-527-145-H902
		VOLUME II B
		SECTION D
		REV. NO. 00 DATE:30/07/2025
		SHEET 2 OF 6

Data Sheet A & B

	DATA SHEET-A (TO BE FILLED BY PURCHASER)		DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
GENERAL*	* PROJECT	2X660 MW KORADI TPP UNIT 11&12 - BTG		
	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 -20 to70 DEG C AND RELATIVE HUMIDITY OF 0-95% IN HOT, HUMID AND TROPICAL ATMOSPHERE AND HIGHLY POLLUTED AT PLACES OF COAL DUST AND FLY DUST		
	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, DUST TIGHT SUITABLE FOR OUTDOOR USE WITHOUT CANOPY, NEMA6/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 90% 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 as per standard EN 12570:2000	* 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) (REFER NOTE NO. 6 & 7)	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) ■ TO BE DECIDED DURING DETAILED ENGINEERING		
	PAINT TYPE	☐ ENAMEL ■ EPOXY CONFIRMING TO CORROSION CATEGORY C5-I		
	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		

Data Sheet A & B

		DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
	@ CONTROL VOLTAGE REQUIREMENT	TO BE DERIVED FROM THE POWER SUPPLY TO THE STARTER ☐ 230 V ☐ 110 V	
	@ ENCLOSURE CLASS OF MOTOR	☐ IP 67 ■ IP 68 ☐ 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 (THERMISTOR PTC)	
INTEGRAL STARTER	INTEGRAL STARTER	☐ REQUIRED ■ NOT REQUIRED	
	TYPE OF SWITCHING DEVICE	☐ CONTACTORS ☐ THYRISTORS	
	TYPE	☐ CONVENTIONAL ☐ SMART (NON-INTRUSIVE)	
	IF SMART (REFER BELOW POINT a – h)		
	a) SERIAL LINK INTERFACE	☐ INTEGRAL ☐ FIELD MOUNTED	
	b) SERIAL LINK PROTOCOL	☐ FOUNDATION FIELD-BUS ☐ PROFI-BUS ☐ DEVICE NET ☐……	
	c) SERIAL LINK MEDIA	☐ TWISTED PAIR Cu-CBL ☐ CO-AXIAL Cu-CBL ☐ OFC	
	d) HAND HELD PROGRAMMER	☐ REQUIRED ☐ NOT REQUIRED	
	e) TYPE OF HAND HELD PROGRAMMER	☐ BLUETOOTH ☐ INFRARED ☐.....	
	f) MASTER STATION	☐ REQUIRED ☐ NOT REQUIRED	
	g) MASTER STN INTRFACE WITH DCS	☐ MODBUS ☐ TCP/IP	
	h) DETAILS OF SPECIAL CABLE	☐ ENCLOSED ☐ NOT REQUIRED	
	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 ☐ NOT REQUIRED	
	ACTION ON LOSS OF EXTERNAL ELECTRIC POWER	☐STAYPUT ☐ FAIL SAFE	
INTERPOSING RELAY/OPTO COUPLER (Applicable for integral Starter) **DATASHEET & WIRING DIAGRAM OF ISOLATION DEVICE TO BE PROVIDED**	TYPE OF ISOLATING DEVICE	☐ INTERPOSING RELAY ☐ OPTO COUPLER ☐ TO BE DECIDED DURING DETAILED ENGINEERING	
	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	

Data Sheet A & B

DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)

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					
	ACCURACY	2% OF SET VALUE					
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	± 1% FS					
SPACE HEATER	@SPACE HEATER	REQUIRED					
	@ POWER SUPPLY (NON INTEGRAL)	240V 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	☐ REQUIRED ■ NOT REQUIRED					
	NO. OF PINS REQUIRED (TO BE CHECKED AS PER SIGNALS IN DRIVE CONTROL PHILOSOPHY)						
	NOS. OF PLUG & SOCKET	☐ 1 Nos. for ON/OFF ☐ 2 NOS.(for inching duty) ☐ OTHER (TO BE SPECIFIED INLINE WITH DRIVE CONTROL PHILOSOPHY)					
CABLE GLANDS	@ POWER CABLE GLAND	SIZE:----------					
	@ SPACE HEATER CABLE GLAND	SIZE:----------					
	CONTROL CABLE GLANDS-1	QUANTITY & SIZE :- 1 no. & 4P x 0.5 sqmm, G type					
	CONTROL CABLE GLANDS-2 (Additional for inching duty)	QUANTITY & SIZE : 1 no. & 2P x 0.5 sqmm, G type					
	CONTROL CABLE GLANDS-3	QUANTITY & SIZE : 1 no & 5 C X 2.5 sqmm Cable					
WEIGHT	TOTAL WEIGHT (ACTUATOR + ACCESSORIES)	BIDDER TO SPECIFY					_____ Kg.

Data Sheet A & B

DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)

NOTES:

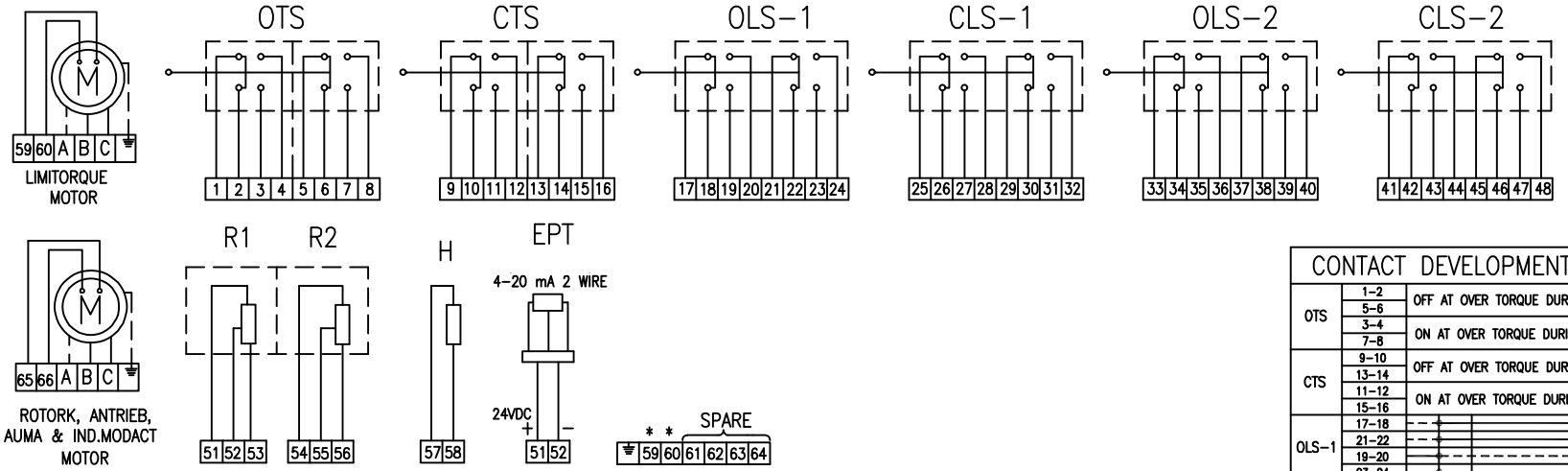
1. **SCOPE**: DESIGN, MANUFACTURE, INSPECTION, TESTING AND DELIVERY TO SITE OF ELECTRIC ACTUATOR FOR INCHING OR OPEN / CLOSE DUTY.
2. **CODES & STANDARDS**: DESIGN AND MATERIALS USED SHALL COMPLY WITH THE RELEVANT LATEST NATIONAL AND INTERNATION STANDARD. AS A MINIMUM, THE FOLLOWING STANDARDS SHALL BE COMPLIED WITH: IS-9334, IS-2147, IS-2148, IS-325, IS-2959, IS-4691, IS-4722, IEC 60947-5-1 AND EN 15714-3 :2010 OR LATEST VERSION.
3. TEMPERATURE RISE SHALL BE RESTRICTED TO 70 DEG. C FOR AMBIENT TEMPERATURE OF 50 DEG C.
4. CABLE GLANDS OF DOUBLE COMPRESSION TYPE, BRASS MATERIAL SHALL BE PROVIDED.
5. 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.
6. THE MOTOR SHALL BE SUITABLE FOR DIRECT ON LINE STARTING. IT SHALL BE RATED FOR S2-15 MINUTES DUTY FOR ON/OFF VALVE AND INTERMITTENT DUTY FOR INCHING DUTY. MAXIMUM CONTINUOUS MOTOR RATING SHALL BE ATLEAST 10% ABOVE THE MAXIMUM LOAD DERIVED OF THE DRIVEN EQUIPEMNT UNDER ENTIRE OPERATING RANGE INCLUDING VOLATGE AND FREQUENCY VARIATION.
7. MOTOR SHALL BE SUITABLE FOR OPERATION UNDER VOLTAGE VARIATION OF +/- 10%, FREQUENCY VARIATION OF +/- 5% AND COMBINED VOLTAGE & FREQUENCY VARIATION OF 10% ABSOLUTE.
8. THE MOTOR SHALL BE CAPABLE OF STARTING AT 85 PERCENT OF RATED VOLTAGE RUNNING AT 80 PERCENT OF RATED VOLTAGE AT RATED TORQUE AND 85 PERCENT RATED VOLTAGE AT 33 PERCENT EXCESS RATED TORQUE FOR A PERIOD OF 5 MINUTES EACH.
9. IN ADDITION TO ABOVE REQUIREMENTS FOR LIMIT/TORQUE SWITCH, **MECHANICAL END STOP** WITH ACCURACY OF 2% SHALL BE SUPPLIED.
10. IT SHOULD BE POSSIBLE TO OPERATE THE ACTUATOR LOCALLY. LOCKABLE LOCAL/REMOTE SELECTION SHALL BE PROVIDED ON THE MCC.
11. LOCAL POSITION INDICATOR SHALL BE PROVIDED FOR 0 TO 100 % TRAVEL.
12. CONTROL WIRING SHALL BE SUITABLE VOLTAGE GRADE COPPER WIRE 1.5 SQ. MM.
13. ENDURANCE: RATED TORQUE RANGE SHOULD BE BASED ON ISO 5211, ISO5210.
14. TAG PLATE SHALL BE CONFIRMING TO STANDARD BS-15714.
15. ACTUATOR SHALL ATTAIN FULL SPEED OPERATIONS BEFORE VALVE LOAD IS ENCOUNTERED AND IMPART AN UNSEATING BLOW TO START THE VALVE IN MOTION (HAMMER BLOW EFFECT).

** VALVES WITH 10 DEGREE/20DEGREE FEEDBACK REQUIREMENT FOR APPLICATIONS SUCH AS CW/ACW/PLANT WATER SYSTEM SHALL BE CONSIDERED AS INCHING DUTY VALVES. ACCORDINGLY, POSITION FEED BACK TRANSMITTER, PLUG & SOCKET REQUIREMENT SHALL BE CONSIDERED.

$$ TORQUE SWITCH & LIMIT SWITCH SHALL ACT INDEPENDENT OF EACH OTHER. TANDEM OPERATION IS NOT ACCEPTABLE.

	PREPARED BY	CHECKED BY	APPROVED BY	VENDOR COMPANY SEAL
NAME	ANJALI RAMAN	MAYANK KESHARWANI	MAYANK KESHARWANI	NAME
SIGNATURE				SIGNATURE
DATE	30.07.2025	30.07.2025	30.07.2025	DATE

NOTES* = TO BE FILLED BY MPL (LEAD AGENCY). @ BE FILLED BY ES



CONTACT DEVELOPMENT DIAGRAM						
OTS	1–2	OFF AT OVER TORQUE DURING OPENING TRAVEL				
	5–6					
	3–4	ON AT OVER TORQUE DURING OPENING TRAVEL				
	7–8					
CTS	9–10	OFF AT OVER TORQUE DURING CLOSING TRAVEL				
	13–14					
	11–12	ON AT OVER TORQUE DURING CLOSING TRAVEL				
	15–16					
OLS–1	17–18					
	21–22					
	19–20					
	23–24					
CLS–1	25–26					
	29–30					
	27–28					
	31–32					
OLS–2	33–34					
	37–38					
	35–36					
	39–40					
CLS–2	41–42					
	45–46					
	43–44					
	47–48					
SWITCH	TERMINAL NO.	FULL OPEN	a	INTERMEDIATE	b	FULL CLOSE
		VALVE POSITION				

——— INDICATES CONTACT CLOSED

– – – – – – INDICATES CONTACT OPEN

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

* – SPARE FOR ROTORK, AUMA, ANTRIEB & IND.MODACT

SWITCHES – ALL ARE POTENTIAL FREE AND TWO PAIR OF CONTACTS CAN BE USED FOR DIFFERENT SUPPLY

THERMOSTAT – 65–66 (ROTORK, AUMA, ANTRIEB & IND.MODACT), 59–60 (LIMITORQUE).

EPT – ELECTRONIC POSITION TRAMSMITTER (POTENTIOMETRIC TYPE, FOR INCHING DUTY)

THERMOSTAT TERMINALS – TERMINATED IN MOTOR TB IN ANTRIEB & IND.MODACT AND IN MAIN TB IN OTHER MAKES

CTS – TORQUE SWITCHES FOR CW ROTATION (CLOSE) – 2 NO+2 NC

OTS – TORQUE SWITCHES FOR CCW ROTATION (OPEN) – 2 NO+2 NC

OLS–1, OLS–2 – LIMITSWITCHES FOR POSITION OPEN – 2 NO+2 NC

CLS–1, CLS–2 – LIMITSWITCHES FOR POSITION CLOSE – 2 NO+2 NC

OTS, CTS – TWO INDEPENDENT SWITCHS IN ANTRIEB & LIMITORQUE

OLS–2 & CLS–2 – CAM DISC IN ROTORK & ANTRIEB

R1–R2– POTENTIOMETER 2 x 100 OHMS

H – SPACE HEATER 1ø 240V AC SUPPLY

M – MOTOR 3ø 415V 50 Hz AC SUPPLY

ILS-1, ILS-2 - INTERMEDIATE LIMIT SWITCH (ADJ.) - 2NO + 2NC

SETTING PROCEDURE OF POSITION LIMIT AND TORQUE SWITCH				
VALVES	OPEN		CLOSE	
	MAIN	BACK UP	MAIN	BACK UP
GATE VALVE OF 100 mm AND ABOVE IN 1500 CL AND ABOVE RATINGS	OLS	OTS	CLS	CTS
ALL OTHER GATE & GLOBE VALVES	OLS	OTS	CTS	@

@ – CLS NOT TO BE CONNECTED IN TRIP CIRCUIT

NOTE:

1. BYPASS OTS FOR INITIAL 5% OF TRAVEL (FOR GATE VALVES ONLY)
2. CONNECT THERMOSTAT WITHOUT FAIL IN THE STARTER CIRCUIT

BHARAT HEAVY ELECTRICALS LTD.
UNIT: HIGH PRESSURE BOILER PLANT.
TIRUCHIRAPALLI 620014.

365–139

REV	DATE	CHED	APPD	DESCRIPTION
11	09.09 2000			CONTACT DEV. FIG.ADDED.

DRAWN: N.P.ESWAR
CHECKED: K.ARUNACHALAM
APPROVED: P.LOGANATHAN
DATE: 09.09.2000

TITLE
INTERNAL WIRING DIAGRAM
FOR
ELECTRICAL VALVE ACTUATORS (AC)
(DRAWN FOR INTERMEDIATE POSITION OF VALVES)

DRAWING No. 4–V–MISC–90271 REV 11

RETRACED WITH REVISION 11

15.00.00 ELECTRICAL ACTUATORS – NON-INTEGRAL STARTER

15.01.00 SCOPE

15.01.01 This Specification covers the general requirements of Electric Motor Actuators for valves, dampers and gates.

15.01.02 All electric motor actuators shall be furnished in accordance with this general specification and the accompanying driven equipment specification.

15.02.00 CODES & STANDARDS

All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) / IEC as given below except where modified and/or supplemented by this specification.

Code	Name of Standard
IS: 325	Specification for three phase induction motor
IS: 900	Code of Practice for installation and maintenance of induction motors.
IS: 996	Single Phase AC Motor
IS: 1271	Thermal evaluation and classification of electrical insulation.
IS: 2223	Dimensions of flange mounted AC induction motors.
IS: 3043	Code of practice for earthing
IS: 4029	Guide for testing three phase induction motors.
IS: 4691	Degree of protection for enclosures of rotating electrical machinery.
IS: 4722	Specification for rotating electrical machinery.
IS: 4728	Terminal marking and direction of rotation for rotating electrical machinery.
IS: 4889	Methods of determination of efficiency of rotating electrical machines.
IS: 5571	Guide for selection of electrical equipment for hazardous areas.
IS: 6362	Designation of Method of Cooling of Rotating electrical machines.
IS: 8789	Values of performance characteristics for three phase induction motors.
IS: 9334	Electrical Motor Operated Actuators
IS: 12065	Noise level of motors.
IS: 12075	Measurement and evaluation of vibration of rotating electrical machines.
IS: 12615	Induction motors – Energy efficient, three-phase, squirrel cage – Specification
IS: 12802	Temperature rise measurement of rotating electrical machines.
IS: 12824	Type of duty and classes of rating assigned.
IEC: 60034-1	Rotating electrical machines
NEMA, MG-1	Motors and Generators

Equipment and material conforming to any other standard, which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be furnished during detail engineering. The electrical installation shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.

15.03.00 SERVICE CONDITIONS

15.03.01 The actuator shall be Non-integral type and suitable for operation in a hot, humid and tropical atmosphere, highly polluted at places with coal dust & fly ash and shall be suitable for an ambient temperature ranging from (–) 20 deg C to (+) 70 deg C.

15.03.02 Actuators for explosion-hazardous applications shall in addition be certified Flameproof for Zones 1 and 2 (Divisions 1 and 2 Group gases).

15.04.00 RATING

15.04.01 Supply Voltage & frequency: 415V ±10%, 3 Phase, 3 Wire 50Hz ±5%. It shall be equipped with 3 phase induction motor, rated for S2–15 minutes duty for ON/OFF valve and intermittent duty for inching duty.

15.04.02 Sizing:

i. For Open/Close at rated speed against designed differential pressure at 90% of rated voltage.
ii. For isolating service: three successive open-close operations or 15 minutes, whichever is higher. For regulating service 150 starts per hour or required cycles, whichever is higher.
iii. Maximum continuous motor rating shall be at least 10% above the maximum load derived of the driven equipment under entire operating range including voltage & frequency variation.

15.04.03 Control voltage of the motor starter shall be 110V AC.

15.05.00 PERFORMANCES

15.05.01 The actuator shall meet the following performance requirements:

15.05.02 Open and close the valve completely and make leak-tight valve closure, without jamming.

15.05.03 Attain full speed operation before valve load is encountered and impart an unseating blow to start the valve in motion (hammer blow effect).

15.05.04 Operate the valve stem at standard stem speed and shall function against design differential pressure across the valve seat.

15.05.05 The motor reduction gearing shall be sufficient to lock the shaft when the motor is de energised and prevent drift from torque switch spring pressure.

15.05.06 The entire mechanism shall withstand any shock resulting from closing with improper setting of limit switches or from lodging of foreign matter under the valve seat.

15.06.00 SPECIFIC REQUIREMENT OF MOTOR OPERATED NON-INTEGRAL VALVE ACTUATORS

15.06.01 Construction

i) The actuator shall essentially comprise the drive motor, torque/ Position limit switches, gear train, clutch, hand wheel, position indicator and transmitter, inbuilt thermostat for overload protection, space heater and internal wiring.

ii) The actuator enclosure shall be totally enclosed, dust tight, weather proof (NEMA-6/IP-68) suitable for outdoor use without necessity of any canopy.

iii) All electrical equipment, accessories and wiring shall be provided with tropical finish to prevent fungus growth.

iv) The actuator shall be designed for mounting in any position without any lubricant leakage or operating difficulty.

v) A lockable local/remote selector switch shall also be provided for selecting mode of operation.

vi) Gear Train:-Metal (Fibre gears are not acceptable) self-locking to prevent drift under torque switch (where ever applicable) spring pressure when motor is de-energised.

vii) Manual Wheel:- Shall disengage automatically during motor operation.

viii) The actuators shall have MCC based starters along with over load relays. The actuator shall be designed for short time duty (S2) in accordance with IEC 34-1.

ix) Actuators shall be non-integral type with starters located in separate MCCs/ separate Gate Valve damper control room in switchgear room/ control room.

x) The control wiring runs from the control room to the MCC with feedback wires from the valve actuator position-indicating and torque-sensing switches. The power cables run from the MCC to the individual actuators.

xi) The actuator with non integral starter shall be time rated for at least 15 minutes or twice the valve stroking time, whichever is higher at an average load of at least 33% of the maximum valve torque. For regulating service, the actuator with integral starter shall be suitably time rated for the duty cycle involved with necessary number of starts per hour, but in no case less than 150 starts per hour. It shall be capable of starting at 85% of rated voltage. Torque switch must trip at maximum driven equipment torque at 90% rated voltage.

xii) Motor shall have minimum class 'F' (150 deg C) insulation with temperature rise restricted to 70 degC.

xiii) Motor shall be suitable for operation under voltage variation of +/- 10%, frequency variation of +/- 5% and combined voltage & frequency variation of 10% absolute.

xiv) The actuator with direct online start from module shall be complete with all accessories viz torque limit switch, end of-travel switch, adjustable position limit switch, hand-wheel etc shall be supplied.

xv) Complete actuator shall be tested as per QA before dispatch.

xvi) Actuator enclosures & internal wiring should be resistant to steam ingress and give maximum protection against steam leakages in surrounding area. Control & Power

Cables of actuators in the high heat zone area should be heat proof and shall be covered with Heat resistant tape for high heat zone to provide maximum protection against Steam leakages.

xvii) Local controls with 'OPEN - STOP - CLOSE' pushbutton station. A lockable selector switch with 'LOCAL - OFF - REMOTE' function at MCC or Local. Local controls shall be supplied with indicating lights red for 'OPEN', yellow for 'FAULT' and green for 'CLOSED'.

15.06.02 Motor

i) The squirrel cage induction motor shall be designed for full voltage direct-on-line start, with starting current limited to 6 times full-load current. The motor shall be capable of starting at 85% of rated voltage and running at 80% of rated voltage at rated torque and also at 85% of rated voltage at 33% excess rated torque for a period of 5 minutes each. The motors shall otherwise generally confirm with technical specification for motors mentioned elsewhere in this specification.

ii) The actuators shall be sized so as to open or close valves/ dampers at rated speed. Enclosure shall not be more than 70 degree 'C' over ambient temperature of 70°C as these are subjected to higher ambient conditions due to their vicinity to operate fluid on continuous load operation. The actuators shall be suitable for a relative humidity of 95%. Class of insulation shall be Class-F and type of enclosure shall be IP-65.

iii) Motor shall be surface-cooled, designed for enclosure protection class of IP-67. Motor shall be suitable for starting direct-on-line.

a) Insulation: The motor winding shall be insulated with Class-F insulation having temperature rise limited to Class-B. Motor shall be of Class-H insulation with temperature limited to Class-B, used for high pressure and high temperature valves.

b) Performance: The motor shall be capable of –
- Starting at 85% of rated voltage
- Running at 80% of rated voltage at rated torque for 5 minutes
- Running at 85% rated voltage at 33% excess rated torque for 5 minutes

iv) Bearing: The motor bearing shall be double shielded, grease lubricated and antifriction type.

v) Earthing
At least two earthing terminals shall be provided for the motor body. Separate earthing terminal should be provided for terminal box.

vi) Protection: The following electrical protections should be provided for the motor:
a) Single Phasing Protection
b) Overload Protection
c) Overheating protection through thermostat

vii) The actuators shall be designed to be self-locking upon loss of power. Motor shall be designed to close in 30 seconds (depending on valve size and process requirement) from full open position and shall have adequate capacity to open and close under full unbalanced design pressure.

viii) The actuators shall be flange mounted to valve bonnets or with gearing and disengaging hand wheel for dampers.

15.06.03 Limit Switches

i) Each motor actuator shall have six (6) rotary drum position limit switches with two for open each with 2 NO + 2 NC contacts and two for close each with 2 NO + 2 NC contacts positions, with adjustable setting between fully open and fully closed positions. Each rotary drum limit switch shall have two (2) limit switches for intermediate open position each with 2 NO + 2 NC contacts. The limit switches shall have a capacity of 5A at 240V AC or 0.5A at 220V DC.

ii) Each motor actuator shall also have two (2) torque limit switches with two (2) normally opened and two (2) normally closed contacts each.

iii) The torque switches shall have a minimum accuracy of 3% of set value. The torque switches shall be provided with calibrated knobs for setting desired torque and separate knobs shall be provided for open and close torque switches. The torque and position limit switches shall be housed in a separate enclosure with protection class as that of actuator. The torque switches with provision for adjusting the desired torque are must to avoid overrun and mechanical jamming of valves.

iv) The motor operators/actuators shall be capable of meeting 150 percent of unseating torque at specified voltage.

v) Deleted

vi) Torque switches shall function to stop the motor on closing/opening. Upon actuation by the torque clutch it is restricted its attempt to open or close, thereby causing an overloading torque. Torque switches shall be self-resetting type only (i.e.) once a particular direction torque switch operates, it shall get resetted only when the equipment is operated in other direction.

vii) All six (6) limit switches shall be changeover type and adjustable besides having the snap facility. All limit switches, contacts shall be wired up independently upto the terminal block.

15.06.04 Position Indicator/Transmitter

i) Motor actuators shall be provided with clearly visible local position indicators mounted on the operator assembly itself. Suitable transducers shall be provided for remote indication of the position.

ii) To be provided for 0 to 100% travel.

iii) As required. Suitable for stabilized 4–20 mA signal, 2-wire inductive type, 24 volts DC operated.

15.06.05 Hand Wheel

Each actuator shall have a hand wheel fitted on it for emergency operation. The hand wheel shall be designed such that it is declutched automatically when the power supply to the motor is restored. The material of the hand wheel shall be either malleable iron or steel. The hand wheel shall have adequate clearance from housing for each gripping and operation. Actuators offered shall be with self-locking worm.

15.06.06 Space Heater

Provision of space heater, if necessary, shall also be made with servomotor limit switch compartments. The space heaters shall be suitable for operation at 240V AC and its rating shall be indicated by the tenderer. Space heater circuit shall be complete with thermostat.

15.06.07 Terminal Box

i) The terminals, terminal boards, terminal boxes, winding coils, and associated equipments shall be suitable for connection to supply system having short-circuit capacity specified in the data sheet and clearance time determined by associated fuses. The terminal boxes shall be totally enclosed.

ii) 1100V grade for power cables.

15.06.08 Wiring

i) All wiring connections for various limit and torque switches, space heaters, position transmitters shall be brought out on separate terminal boards, having liberal space for wiring and making connections to Purchaser's external circuits. Plug-in type terminals shall be used suitable for analog/digital application. There shall be at least 5 terminal spare to terminate spare cores of cable. Size of each control terminal shall be such that two (2) nos. lugged 2.5 sq.mm cable can be terminated on each side. Power terminals shall be suitable for termination of 6 sq.mm lugged wire or as required depending on the motor capacity.

ii) Motor terminal box and actuator terminal box shall be provided with double compression cable glands to suit cable type and size and copper lugs for cables.

iii) Adequate earthing terminals preferably not less than 8 SWG GI wire shall be provided for suitable earthing system. Two earthing terminals shall be provided per motor, one No. on either side of the motor.

15.06.09 Interfaces:

i) Open/Close command termination logic with position & torque Limit Switches, positioner circuit shall be suitably built in the PCB inside the power supply feeder or separate GVDC (Gate valve damper control room) panel shall be considered for all motor operated valves.

ii) For Binary Drive (both ON-OFF and INCHING type):- Open/Close command & status thereof and disturbance monitoring signal (common contact for Overload, Thermostat, control supply failure, L/R selector switch at local & other protections operated) shall be provided.

iii) Interface with the control system shall be through hardware signal only. Inter posing relays provided (with coil burden 2.5 VA) in the power supply feeder or separate GVDC (Gate valve damper control room) panel shall be energized to initiate opening and closing, by 24V DC signal from the external control system

iv) For Modulating Drive:- the command to actuator shall be in form of 4- 20mA signal. The necessary positioning circuit and motor protection shall be provided.

v) Open/close command termination logic shall be suitably built inside power supply feeder or separate GVDC (Gate valve damper control room) panel.

vi) The following individual fault annunciation LED's (Colour-Red) shall be provided in power supply feeder or separate GVDC (Gate valve damper control room) panel locally.
   a) Torque switch OPEN
   b) Torque switch CLOSE
   c) Thermo switch trip
   d) Electronic overload relay trip
   e) Motor single phasing
   f) Common fault (Inclusive of any one or combination of above fault)

vii) View port shall be provided on starter to monitor the above status annunciation and fault annunciation.

viii) Electronic Overload relay shall be provided to trip actuator in case of overload.

ix) OPEN-CLOSE indication /LED shall be provided for indication of full open/close position.

x) Automatic phase correction facility and potential free contact for annunciation of power failure shall be provided.

xi) The following individual potential free relay contacts shall be provided in the power supply feeder or separate GVDC (Gate valve damper control room) panel for remote annunciation to facilitate continuous monitoring of the actuator.
   a) Actuator (valve) running in OPEN direction.
   b) Actuator (valve) running in CLOSE direction.
   c) Actuator in remote mode.
   d) Actuator in local mode.
   e) Actuator power switched off /single phasing.
   f) Torque switch trip, thermo switch trip and overload relay trip

15.06.10 Name Plate

Name plate shall be provided on the actuators with at least following data (a) Tag no. (b) Torque Rating (c) Full travel time.

15.06.11 Painting

The actuator shall be painted with epoxy-based paint (the colour shall be indicated by the supplier). Paint shade shall be as mentioned in General technical requirement.

15.06.12 Packing

The actuators shall be properly packed for transport by rail/ road/sea as applicable.

15.06.13 Overload Protection

The actuator motor shall be provided with thermostat for overload protection.

15.06.14 Tests

i) The actuator and all components thereof shall be subject to routine factory tests as per relevant IS Standards. In addition, if any special test is called for in equipment specification, the same shall be performed.

ii) Following routine test shall be conducted as per IEC/IC standard. (a) Meggar Test, (b) Continuity test, (c) Operational test. Test certificates duly signed by inspecting agency shall be furnished.

iii) The actuator shall be type tested as per IEC/National Standard, by international/national recognized test house. The test certificates issued by this house shall be furnished.

iv) Test Witness

Tests shall be performed in the presence of Purchaser/Purchaser's representative so desired by the Purchaser/ Purchaser. The Bidder shall give at least fifteen (15) days advance notice of the date when the tests are to be carried out.

15.06.15 Drawing and Manuals

Following drawings/ data and Manuals to be submitted for approval: -

i) Instruction manuals on Installation, tests
ii) Actuator Data sheet.
iii) Internal wiring diagram and control schematic.
iv) Torque switch and Limit switch contact development.
v) QAP for Test reports.
vi) Manufacturers Catalogue
vii) Instruction manuals on installation methods, tests etc.

CHAPTER – 17

ELECTRICAL ACTUATORS WITH INTEGRAL STARTERS

17.01.00 **SCOPE**

17.01.01 This Specification covers the general requirements of Electric Motor Actuators for valves, dampers and gates.

17.01.02 All electric motor actuators shall be furnished in accordance with this general specification and the accompanying driven equipment specification.

17.01.03 Actuators shall be designed to ensure proper function in accordance with specifications given below and complying to EN15714-2 or equivalent.

17.02.00 **CODES & STANDARDS**

All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) / IEC mentioned in Chapter 37 except where modified and / or supplemented by this specification.

Equipment and material conforming to any other standard, which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be furnished during detail engineering.

The electrical installation shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.

17.03.00 **SERVICE CONDITIONS**

17.03.01 The actuator shall be integral type and suitable for operation in a hot, humid and tropical atmosphere, highly polluted at places with coal dust & fly ash and shall be suitable for an ambient temperature ranging from (-) 20 deg C to (+) 70 deg C.

17.03.02 Actuators for explosion-hazardous applications shall in addition be certified Flameproof for Zones 1 and 2 (Divisions 1 and 2 Group gases).

17.04.00 **RATING**

17.04.01 Supply Voltage & frequency: 415V +/- 10%, 3 Phase, 3 Wire, 50HZ +/-5%.

17.04.02 Sizing:-

i) For Open/Close at rated speed against designed differential pressure at 90% of rated voltage.

ii) For isolating service:- three successive open-close operations or 15 minutes, whichever is higher. For regulating service 150 starts per hour or required cycles, whichever is higher.

17.04.03 Control voltage of the motor starter shall be 110V AC. Power supply to electrical actuators shall be backed up with reliable battery supply.

17.05.00 **PERFORMANCES**

The actuator shall meet the following performance requirements:

17.05.01 Open and close the valve completely and make leak-tight valve closure, without jamming.

17.05.02 Attain full speed operation before valve load is encountered and impart an unseating blow to start the valve in motion (hammer blow effect).

17.05.03 Operate the valve stem at standard stem speed and shall function against design differential pressure across the valve seat.

17.05.04 The motor reduction gearing shall be sufficient to lock the shaft when the motor is de-energised and prevent drift from torque switch spring pressure.

17.05.05 The entire mechanism shall withstand any shock resulting from closing with improper setting of limit switches or from lodging of foreign matter under the valve seat.

17.06.00 **SPECIFIC REQUIREMENT**

17.06.01 Construction

i) The actuator shall essentially comprise the drive motor, torque/ Position limit switches, gear train, clutch, hand wheel, position indicator and transmitter, inbuilt thermostat for overload protection, single phase preventer protection, space heater and internal wiring. Actuator shall be integral type. Integral starters shall have two sets of torque and limit switches for independent hook-up with plant DCS logic and electrical logic/interlock. All actuators shall be certified for SIL 2 or better.

ii) The actuators shall be Non-intrusive electric actuators with accessories. All actuator settings including torque, limit shall be possible without opening the actuator cover and LCD indication shall be available integral to actuator body.

iii) The actuator enclosure shall be totally enclosed, dust tight, weatherproof (NEMA-6/IP-68) suitable for outdoor use without necessity of any canopy.

iv) All electrical equipment, accessories and wiring shall be provided with tropical finish to prevent fungus growth.

v) The actuator shall be designed for mounting in any position without any lubricant leakage or operating difficulty.

vi) A lockable local/remote selector switch shall also be provided for selecting mode of operation.

vii) Gear Train:-Metal (Fibre gears are not acceptable) self-locking to prevent drift under torque switch (where ever applicable) spring pressure when motor is de-energised.

viii) Manual Wheel:- Shall disengage automatically during motor operation.

ix) Duty cycle of actuators shall suit the system requirement. The actuators shall be capable of giving the required torque at the output shaft. The actuators shall be designed to take the full thrust

x) The integral starter which shall have sophisticated electronic controls with field programming feature. It shall be designed for remote control from DCS/Respective control system. Required interposing relays for receiving open/close/stop command from DCS/Respective control system shall be provided. Potential free contacts and transducers shall be provided to provide status indication at remote DCS/Respective control system.

xi) A three-position selector switch (marked as LOCAL-OFF-REMOTE) and push buttons OPEN-STOP-CLOSE (for local operation) with indication lamps for running OPEN and running CLOSE shall be provided.

xii) The Remote command signal (OPEN-STOP-CLOSE) from DCS/Respective control system/Control panel shall be isolated from control electronics through opto-isolator.

xiii) The following individual status annunciation LED's (Colour-Green) shall be provided locally (Integral to actuator) to annunciate the following for easy local monitoring. The local status display of actuator shall be clearly understandable by operator (Display of instruction should be clearly mentioned in the name plate i.e., operation alarm and fault indication).

- Actuator in local mode
- Actuator in remote mode
- Actuator running in OPEN direction
- Actuator running in CLOSE direction
- Actuator in inching mode.
- Actuator in self-retaining mode
- Limit switch OPEN trip
- Limit switch CLOSE trip
- Control voltage availability

xiv) The following individual fault annunciation LED's (Colour-Red) shall be provided locally. (Integral to Actuator)

- Torque switch OPEN
- Torque switch CLOSE
- Thermo switch trip
- Electronic overload relay trip
- Motor single phasing
- Common fault (Inclusive of any one or combination of above fault)

xv) View port shall be provided on integral starter unit to monitor the above status annunciation and fault annunciation.

xvi) Electronic overload relay shall be provided to trip actuator in case of overload. Plug in connections/design shall be provided between:

- Integral starter unit and basic actuator
- Between external customer connections and actuator

xvii) OPEN-CLOSE indication /LED shall be provided for indication of full open/close position.

xviii) Automatic phase correction facility and potential free contact for annunciation of power failure shall be provided.

xix) All required accessories (if applicable) for calibration/ settings/ configuration of various parameters of actuator shall be provided.

17.06.02 Motor

i) The squirrel cage induction motor shall be designed for full voltage direct-on-line start, with starting current limited to 6 times full-load current. The motors shall otherwise generally confirm with technical specification for motors mentioned elsewhere in this specification.

ii) The actuators shall be sized so as to open or close valves/ dampers at rated speed.

iii) Motor insulation shall be class B or better. With Temperature rise not more than 70 degree 'C' over ambient temp. of 50 deg.C. The actuators shall be suitable for a relative humidity of 95%.

iv) Performance:-The motor shall be capable of:

a) Starting at 85% of rated voltage
b) Running at 80% of rated voltage at rated torque for 5 minutes
c) Running at 85% rated voltage at 33% excess rated torque for 5 minutes.

v) Maximum continuous motor rating shall be atleast 10% above the maximum load derived of the driven equipment under entire operating range including voltage & frequency variation.

vi) Bearing

The motor bearing shall be double shielded, grease lubricated and antifriction type.

vii) Earthing

At least two earthing terminals shall be provided for the motor body. Separate earting terminal should be provided for terminal box.

viii) Protection:-The following electrical protections should be provided for the motor:-

a) Single Phasing Protection
b) Overload Protection
c) Overheating protection through thermostat
d) Wrong Phase Sequence Protection

ix) The actuators shall be designed to be self locking upon loss of power. Motor shall be designed to close in 30 secs from full open position and shall have adequate capacity to open and close under full unbalanced design pressure.

x) The actuators shall be flange mounted to valve bonnets or with gearing and disengaging hand wheel for dampers.

17.06.03 Limit Switches

i) Each motor actuator shall have Six (6) rotary drum position limit switches with two for open each with 2 NO + 2NC contacts and two for close each with 2 NO + 2 NC contacts positions, each with adjustable setting between fully open and fully closed positions. Each rotary drum limit switch shall have two (2) limit switches for intermediate open position each with 2 NO + 2 NC contacts. The limit switches shall have capacity of 5A at 240V AC or 0.5A at 220V DC.

ii) Each motor actuator shall also have two (2) torque limit switches with two (2) normally opened and two (2) normally closed contacts each.

iii) The torque switches shall have a minimum accuracy of 3% of set value. The torque switches shall be provided with calibrated knobs for setting desired torque and separate knobs shall be provided for open and close torque switches. The torque and position limit switches shall be housed in a separate enclosure with protection class as that of actuator.

iv) The motor operators/actuators shall be capable of meeting 150 percent of unseating torque at specified voltage.

v) The motor actuators shall have 2 nos. potentiometric type transmitters of 100-ohm rating.

vi) Torque switches shall function to stop the motor on closing/opening. Upon actuation by the torque clutch it is restricted its attempt to open or close, thereby causing an overloading torque. Torque switches shall be self-resetting type only (i.e.) once a particular direction torque switch operates, it shall get resetted only when the equipment is operated in other direction.

vii) All six (6) limit switches shall be changeover type and adjustable besides having the snap facility. All limit switches, contacts shall be wired up independently upto the terminal block.

17.06.04 Position Indicator/Transmitter

i) Motor actuators shall be provided with clearly visible local position indicators mounted on the operator assembly itself. Suitable transducers shall be provided for remote indication of the position.

ii) To be provided for 0 to 100% travel.

iii) As required. Suitable for stabilized 4-20 mA signal, 2 wire inductive type, 24 volts DC operated.

17.06.05 Hand Wheel

Hand wheel shall enable manual operation in case of power failure but it shall get automatically disengaged when once the motor starts functioning. The effort required to operate manually shall not exceed 18 Kg.

17.06.06 Space Heater

Provision of space heater, if necessary, shall also be made with servomotor limit switch compartments. The space heaters shall be suitable for operation at 240V AC and its rating shall be indicated by the tenderer. Space heater circuit shall be complete with thermostat.

17.06.07 Terminal Box

i) The terminals, terminal boards, terminal boxes, winding coils and associated equipments shall be suitable for connection to supply system having short circuit capacity specified in data sheet and clearance time determined by associated fuses. The terminal boxes shall be totally enclosed.

ii) 1100V grade for power cables.

17.06.08 Wiring

i) All wiring connections for various limit and torque switches, space heaters, position transmitters shall be brought out on separate terminal boards mounted on the valve, having liberal space for wiring and making connections to Owner's external circuits. Plug in type/ screw terminals shall be used suitable for analog/digital application. There shall be at least 5 terminal spare to terminate spare cores of cable. Size of each control terminal shall be such that two (2) nos. lugged 2.5 sq.mm cable can be terminated on each side. Power terminals shall be suitable for termination of 6 sq.mm lugged wire or as required depending on the motor capacity.

ii) Motor terminal box and actuator terminal box shall be provided with double compression cable glands to suit cable type and size and copper lugs for cables.

iii) Adequate earthing terminals preferably not less than 8 SWG GI wire shall be provided for suitable earthing system. Two earthing terminals shall be provided per motor, one No. on either side of the motor.

17.06.09 Interfaces:

i) Open/Close command termination logic with position & torque Limit Switches, positioner circuit shall be suitably built in the PCB inside the actuator.

ii) The following individual potential free relay contacts shall be provided in the actuator for remote annunciation to facilitate continuous monitoring of the actuator.

- Actuator (valve) running in OPEN direction.
- Actuator (valve) running in CLOSE direction.

- Actuator in remote mode.
- Actuator in local mode.
- Actuator power switched off /single phasing.
- Torque switch trip, thermo switch trip and overload relay trip
- And as also as per drive control philosophy

iii) Interface with the control system shall be through hardwired signal only. Inter posing relays provided (with coil burden 2.5 VA) in the actuator shall be energized to initiate opening and closing, by 24V DC signal from the external control system.

iv) For Modulating Drive:- the command to actuator shall be in form of 4-20mA signal. The necessary positioning circuit and motor protection shall be provided.

iv) Open/close command termination logic shall be suitably built inside actuator.

17.06.10 Name Plate

Name plate shall be provided on the actuators with at least following data (a) Tag no. (b) Torque Rating (c) Full travel time.

17.06.11 Painting

The actuator shall be painted with epoxy based paint (the colour shall be indicated by the supplier). Paint shade shall be as mentioned in Chapter 1.

17.06.12 Packing

The actuators shall be properly packed for transport by rail/ road/sea as applicable.

17.06.13 Overload Protection

The actuator motor shall be provided with integral starter along with thermostat for overload protection.

17.06.14 Tests

i) The actuator and all components thereof shall be subject to routine factory tests as per relevant IS Standards. In addition, if any special test is called for in equipment specification, the same shall be performed.

ii) Following routine test shall be conducted as per IEC/IC standard. (a) Meggar Test, (b) Continuity test, (c) Operational test. Test certificates duly signed by inspecting agency shall be furnished.

iii) The actuator shall be type tested as per IEC/National Standard, by international/national recognized test house. The test certificates issued by this house shall be furnished.

iv) Test Witness

Tests shall be performed in the presence of Owner's representative so desired by the Owner. The Bidder shall give at least fifteen (15) days advance notice of the date when the tests are to be carried out.

17.06.15 Drawing and Manuals

Bidder shall submit the following minimum drawings/ data and Manuals for approval:

i) Instruction manuals on Installation, tests
ii) Actuator Data sheet.
iii) Internal wiring diagram and control schematic.
iv) Torque switch and Limit switch contact development.
v) QAP for Test reports.
vi) Manufacturers Catalogue
vii) Instruction manuals on installation methods. tests etc.
viii) Motor sizing calculation
ix) Integral starter details
x) General arrangement drawings
xi) Test reports-The type test reports from Govt. Recognized lab shall be treated as reference.
xii) Manufacturing quality plan
xiii) Field quality plan

17.06.16 Training

Bidder shall provide training on Non-intrusive hardwired Electric Actuator for Owner's personnel.

17.06.17 Mandatory spares

Mandatory spares for actuator shall include 10 % or 1 No. of each type, class, size and make, whichever is more.

DATASHEET

1.0	**Auxiliary power supply**	
1.1	415V, 3Φ, 3W, 50 Hz. Fault level 50 kA symm for 1 sec.	Motors above 200 W and including 160kW
1.2	240V, 1Φ, 2W, 50 Hz effectively earthed	Motors including 200 W and below. Lighting, space heating, AC control and protective devices
1.3	**DC supply**	
	220V,2W, unearthed. Fault level 25 kA for 1 sec.	DC alarm, control and protective devices.
	Fault level	25 kA for 1 second
2.0	**Range of variation**	
2.1	AC supply	
	voltage	± 10%
	Frequency	± 5%
	Combined voltage & frequency	10% (Absolute sum)
2.2	DC supply	187 to 242 V

15.00.00 ELECTRICAL ACTUATORS - NON INTEGRAL STARTER

15.01.00 SCOPE

15.01.01 This Specification covers the general requirements of Electric Motor Actuators for valves, dampers and gates.

15.01.02 All electric motor actuators shall be furnished in accordance with this general specification and the accompanying driven equipment specification.

15.02.00 CODES & STANDARDS

All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) / IEC as given below except where modified and / or supplemented by this specification.

Code	Name of Standard
IS: 325	Specification for three phase induction motor
IS: 900	Code of Practice for installation and maintenance of induction motors.
IS: 996	Single Phase AC Motor
IS: 1271	Thermal evaluation and classification of electrical insulation.
IS:2223	Dimensions of flange mounted AC induction motors.
IS: 3043	Code of practice for earthing
IS: 4029	Guide for testing three phase induction motors.
IS: 4691	Degree of protection for enclosures of rotating electrical machinery.
IS: 4722	Specification for rotating electrical machinery.
IS: 4728	Terminal marking and direction of rotation for rotating electrical machinery.
IS: 4889	Methods of determination of efficiency of rotating electrical machines.
IS: 5571	Guide for selection of electrical equipment for hazardous areas.
IS:6362	Designation of Method of Cooling of Rotating electrical machines.
IS: 8789	Values of performance characteristics for three phase induction motors.
IS: 9334	Electrical Motor Operated Actuators
IS: 12065	Noise level of motors.
IS: 12075	Measurement and evaluation of vibration of rotating electrical machines.
IS: 12615	Induction motors-Energy efficient, three-phase, squirrel cage – Specification
IS: 12802	Temperature rise measurement of rotating electrical machines.
IS: 12824	Type of duty and classes of rating assigned.

Code	Name of Standard
IEC: 60034-1	Rotating electrical machines
NEMA, MG-1	Motors and Generators

Equipment and material conforming to any other standard, which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be furnished during detail engineering.

The electrical installation shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.

15.03.00 SERVICE CONDITIONS

15.03.01 The actuator shall be Non integral type and suitable for operation in a hot, humid and tropical atmosphere, highly polluted at places with coal dust & fly ash and shall be suitable for an ambient temperature ranging from (-) 20 deg C to (+) 70 deg C.

15.03.02 Actuators for explosion-hazardous applications shall in addition be certified Flameproof for Zones 1 and 2 (Divisions 1 and 2 Group gases).

15.03.03 For actuator motor installed outdoor and exposed to direct sun rays , the effect of solar heat [manufacturer to decide] shall be considered or overhead shed shall be provided locally to avoid direct sun rays.

15.04.00 RATING

15.04.01 Supply Voltage & frequency: 415V +/- 10%, 3 Phase, 3 Wire 50HZ +/-5%. It shall be equipped with 3 phase induction motor, rated for S2-15 minutes duty for ON/OFF valve and intermittent duty for inching duty.

15.04.02 Sizing:

i) For Open/Close at rated speed against designed differential pressure at 90% of rated voltage.
ii) For isolating service:- three successive open-close operations or 15 minutes, whichever is higher. For regulating service 150 starts per hour or required cycles, whichever is higher.
iii) Maximum continuous motor rating shall be atleast 10% above the maximum load derived of the driven equipment under entire operating range including voltage & frequency variation.

15.04.03 Control voltage of the motor starter shall be 230V AC

15.05.00 PERFORMANCES

15.05.01 The actuator shall meet the following performance requirements:

15.05.02 Open and close the valve completely and make leak-tight valve closure, without jamming.

15.05.03 Attain full speed operation before valve load is encountered and impart an unseating blow to start the valve in motion (hammer blow effect).

15.05.04 Operate the valve stem at standard stem speed and shall function against design differential pressure across the valve seat.

15.05.05 The motor reduction gearing shall be sufficient to lock the shaft when the motor is de-energised and prevent drift from torque switch spring pressure.

15.05.06 The entire mechanism shall withstand any shock resulting from closing with improper setting of limit switches or from lodging of foreign matter under the valve seat.

15.06.00 SPECIFIC REQUIREMENT OF MOTOR OPERATED NON INTEGRAL VALVE ACTUATORS

15.06.01 Construction

i) The actuator shall essentially comprise the drive motor, torque/ Position limit switches, gear train, clutch, hand wheel, position indicator and transmitter, inbuilt thermostat for overload protection, space heater and internal wiring.
ii) The actuator enclosure shall be totally enclosed, dust tight, weather proof (NEMA-6/IP-68) suitable for outdoor use without necessity of any canopy.
iii) All electrical equipment, accessories and wiring shall be provided with tropical finish to prevent fungus growth.
iv) The actuator shall be designed for mounting in any position without any lubricant leakage or operating difficulty.
v) A lockable local/remote selector switch shall also be provided for selecting mode of operation.
vi) Gear Train:-Metal (Fibre gears are not acceptable) self-locking to prevent drift under torque switch (where ever applicable) spring pressure when motor is de-energised.
vii) Manual Wheel:- Shall disengage automatically during motor operation.
viii) The actuators shall have MCC based starters along with over load relays.The actuator shall be designed for short time duty (S2) in accordance with IEC 34-1.
ix) Actuators shall be non-integral type with starters located in separate MCCs/ separate Gate Valve damper control room in switchgear room/ control room.
x) The control wiring runs from the control room to the MCC with feedback wires from the valve actuator position-indicating and torque-sensing switches. The power cables run from the MCC to the individual actuators.
xi) The actuator with non integral starter shall be time rated for at least 15 minutes or twice the valve stroking time, whichever is higher at an average load of at least 33% of the maximum valve torque. For regulating service, the actuator with integral starter shall be suitably

timerated for the duty cycle involved with necessary number of starts per hour, but in no case less than 150 starts per hour. It shall be capable of starting at 85% of rated voltage. Torque switch must trip at maximum driven equipment torque at 90% rated voltage.

xii) Motor shall have minimum class 'F' (150 deg C) insulation with temperature rise restricted to 70 degC.

xiii) Motor shall be suitable for operation under voltage variation of +/- 10%, frequency variation of +/- 5% and combined voltage & frequency variation of 10% absolute.

xiv) The actuator with direct online start from module shall be complete with all accessories viz torque limit switch, end of-travel switch, adjustable position limit switch, hand-wheel etc shall be supplied.

xv) Complete actuator shall be tested as per QA before dispatch.

xvi) Actuator enclosures & internal wiring should be resistant to steam ingress and give maximum protection against steam leakages in surrounding area. Control & Power Cables of actuators in the high heat zone area should be heat proof and shall be covered with Heat resistant tape for high heat zone to provide maximum protection against Steam leakages.

xvii) Local controls with 'OPEN - STOP - CLOSE' pushbutton station. A lockable selector switch with 'LOCAL - OFF - REMOTE' function at MCC or Local. Local controls shall be supplied with indicating lights red for ‘OPEN’, yellow for ‘FAULT’ and green for ‘CLOSED’.

15.06.02 Motor

i) The squirrel cage induction motor shall be designed for full voltage direct-on-line start, with starting current limited to 6 times full-load current. The motor shall be capable of starting at 85% of rated voltage and running at 80% of rated voltage at rated torque and also at 85% of rated voltage at 33% excess rated torque for a period of 5 minutes each. The motors shall otherwise generally confirm with technical specification for motors mentioned elsewhere in this specification.

ii) The actuators shall be sized so as to open or close valves/ dampers at rated speed enclosure shall not be more than 70 degree 'C' over ambient temp. of 70 deg.C as these are subjected to higher ambient conditions due to their vicinity to operate fluid on continuous load operation. The actuators shall be suitable for a relative humidity of 95%. Class of insulation shall be class-F and type of enclosure shall be IP-65.

iii) Motor shall be surface cooled designed for enclosure protection class of IP 67. Motor shall be suitable for starting direct on-line.

a) Insulation:- The motor winding shall be insulated with class-F insulation having temperature rise limited to Class-B. Motor shall be of class H insulation with temperature limited to class B used for high pressure and high temperature valves.

b) Performance:-The motor shall be capable of:

- Starting at 85% of rated voltage
- Running at 80% of rated voltage at rated torque for 5 minutes

- Running at 85% rated voltage at 33% excess rated torque for 5 minutes.

iv) Bearing
The motor bearing shall be double shielded, grease lubricated and antifriction type.

v) Earthing
At least two earthing terminals shall be provided for the motor body. Separate earting terminal should be provided for terminal box.

vi) Protection:- The following electrical protections should be provided for the motor:

a) Single Phasing Protection
b) Overload Protection
c) Overheating protection through thermostat

vii) The actuators shall be designed to be self locking upon loss of power. Motor shall be designed to close in 30 secs from full open position and shall have adequate capacity to open and close under full unbalanced design pressure.

viii) The actuators shall be flange mounted to valve bonnets or with gearing and disengaging hand wheel for dampers.

15.06.03 Limit Switches

i) Each motor actuator shall have Six (6) rotary drum position limit switches with two for open each with 2 NO + 2NC contacts and two for close each with 2 NO + 2 NC contacts positions, each with adjustable setting between fully open and fully closed positions. Each rotary drum limit switch shall have two (2) limit switches for intermediate open position each with 2 NO + 2 NC contacts. The limit switches shall have capacity of 5A at 240V AC or 0.5A at 220V DC.

ii) Each motor actuator shall also have two (2) torque limit switches with four (4) normally opened and four (4) normally closed contacts each.

iii) The torque switches shall have a minimum accuracy of 3% of set value. The torque switches shall be provided with calibrated knobs for setting desired torque and separate knobs shall be provided for open and close torque switches. The torque and position limit switches shall be housed in a separate enclosure with protection class as that of actuator.

iv) The motor operators/actuators shall be capable of meeting 150 percent of unseating torque at specified voltage.

v) The motor actuators shall have 2 nos. potentiometric type transmitters of 100 ohm rating.

vi) Torque switches shall function to stop the motor on closing/opening. Upon actuation by the torque clutch it is restricted its attempt to open or close, thereby causing an overloading torque. Torque switches shall be self-resetting type only (i.e.) once a particular direction torque switch operates, it shall get resetted only when the equipment is operated in other direction.

vii) All six (6) limit switches shall be changeover type and adjustable besides having the snap facility. All limit switches, contacts shall be wired up independently upto the terminal block.

15.06.04 Position Indicator/Transmitter

i) Motor actuators shall be provided with clearly visible local position indicators mounted on the operator assembly itself. Suitable transducers shall be provided for remote indication of the position.
ii) To be provided for 0 to 100% travel.
iii) As required. Suitable for stabilized 4-20 mA signal, 2 wire inductive type, 24 volts DC operated.

15.06.05 Hand Wheel

Each actuator shall have a hand wheel fitted on it for emergency operation. The hand wheel shall be designed such that it is declutched automatically when the power supply to the motor is restored. The material of the hand wheel shall be either malleable iron or steel. The hand wheel shall have adequate clearance from housing for each gripping and operation. Actuators offered shall be with self-locking worm.

15.06.06 Space Heater

Provision of space heater, if necessary, shall also be made with servomotor limit switch compartments. The space heaters shall be suitable for operation at 240V AC and its rating shall be indicated by the tenderer. Space heater circuit shall be complete with thermostat.

15.06.07 Terminal Box

i) The terminals, terminal boards, terminal boxes, winding coils and associated equipments shall be suitable for connection to supply system having short circuit capacity specified in data sheet and clearance time determined by associated fuses. The terminal boxes shall be totally enclosed.
ii) Shall be suitable for 1100V grade for power cables.
iii) Fuse TBs shall be provided instead of ordinary TBs at field in DC solenoid operated valves like IOTV, HOTV etc.

15.06.08 Wiring

i) All wiring connections for various limit and torque switches, space heaters, position transmitters shall be brought out on separate terminal boards , having liberal space for wiring and making connections to Purchaser's external circuits. Plug in type terminals shall be used suitable for analog/digital application. There shall be atleast 5 terminal spare to terminate spare cores of cable. Size of each control terminal shall be such that two (2) nos. lugged 2.5 sq.mm cable can be terminated on each side. Power terminals shall be suitable for termination of 6 sq.mm lugged wire or as required depending on the motor capacity.

ii) Motor terminal box and actuator terminal box shall be provided with double compression cable glands to suit cable type and size and copper lugs for cables.

iii) Adequate earthing terminals preferably not less than 8 SWG GI wire shall be provided for suitable earthing system. Two earthing terminals shall be provided per motor, one No. on either side of the motor.

15.06.09 Interfaces:

i) Open/Close command termination logic with position & torque Limit Switches, positioner circuit shall be suitably built in the PCB inside the power supply feeder or separate GVDC (Gate valve damper control room) panel shall be considered for all motor operated valves.

ii) For Binary Drive (both ON-OFF and INCHING type):- Open/Close command & status thereof and disturbance monitoring signal (common contact for Overload, Thermostat, control supply failure, L/R selector switch at local & other protections operated) shall be provided.

iii) Interface with the control system shall be through hardware signal only. Inter posing relays provided (with coil burden 2.5 VA) in the power supply feeder or separate GVDC (Gate valve damper control room) panel shall be energized to initiate opening and closing, by 24V DC signal from the external control system.

iv) For Modulating Drive:- the command to actuator shall be in form of 4-20mA signal. The necessary positioning circuit and motor protection shall be provided.

v) Open/close command termination logic shall be suitably built inside power supply feeder or separate GVDC (Gate valve damper control room) panel.

vi) The following individual fault annunciation LED's (Colour-Red) shall be provided in power supply feeder or separate GVDC (Gate valve damper control room) panel locally.

a) Torque switch OPEN
b) Torque switch CLOSE
c) Thermo switch trip
d) Electronic overload relay trip
e) Motor single phasing
f) Common fault (Inclusive of any one or combination of above fault)

vii) View port shall be provided on starter to monitor the above status annunciation and fault annunciation.

viii) Electronic Overload relay shall be provided to trip actuator in case of overload.

ix) OPEN-CLOSE indication /LED shall be provided for indication of full open/close position.

x) Automatic phase correction facility and potential free contact for annunciation of power failure shall be provided.

xi) The following individual potential free relay contacts shall be provided in the power supply feeder or separate GVDC (Gate valve damper control

room) panel for remote annunciation to facilitate continuous monitoring of the actuator.

a) Actuator (valve) running in OPEN direction.
b) Actuator (valve) running in CLOSE direction.
c) Actuator in remote mode.
d) Actuator in local mode.
e) Actuator power switched off /single phasing.
f) Torque switch trip, thermo switch trip and overload relay trip

15.06.10 Name Plate

Name plate shall be provided on the actuators with at least following data (a) Tag no. (b) Torque Rating (c) Full travel time.

15.06.11 Painting

The actuator shall be painted with epoxy based paint (the colour shall be indicated by the supplier). Paint shade shall be as mentioned in General technical requirement.

15.06.12 Packing

The actuators shall be properly packed for transport by rail/ road/sea as applicable.

15.06.13 Overload Protection

The actuator motor shall be provided with thermostat for overload protection.

15.06.14 Tests

i) The actuator and all components thereof shall be subject to routine factory tests as per relevant IS Standards. In addition, if any special test is called for in equipment specification, the same shall be performed.
ii) Following routine test shall be conducted as per IEC/IC standard. (a) Meggar Test, (b) Continuity test, (c) Operational test. Test certificates duly signed by inspecting agency shall be furnished.
iii) The actuator shall be type tested as per IEC/National Standard, by international/national recognized test house. The test certificates issued by this house shall be furnished.
iv) Test Witness
Tests shall be performed in the presence of Purchaser/Purchaser's representative so desired by the Purchaser/ Purchaser. The Bidder shall give at least fifteen (15) days advance notice of the date when the tests are to be carried out.

15.06.15 Drawing and Manuals

Following drawings/ data and Manuals to be submitted for approval:-

i) Instruction manuals on Installation, tests
ii) Actuator Data sheet.
iii) Internal wiring diagram and control schematic.

iv) Torque switch and Limit switch contact development.
v) QAP for Test reports.
vi) Manufacturers Catalogue
vii) Instruction manuals on installation methods, tests etc.

SPECIFICATION FOR FIELD INSTRUMENTS

APPLICABLE FOR KORADI,KORBA WEST,YAMUNANAGAR,UKAI,RAGHUNATHPUR

7.03.00 ELECTRONIC TRANSMITTER

7.03.01 **For Pressure, Diff Press And DP Based Flow / Level Measurements**

1.	Working Principle	:	Smart
2.	Type	:	Microprocessor based 2 wire type (loop powered), Hart protocol compatible.
3.	Output Signal	:	Simultaneous transmission of digital and 4-20 mA DC signal. HART protocol
4.	Signal Processing		Silicon solid state electronic circuitry
5.	Measuring Element		Capsule / Diaphragm
6.	Element material		AISI-316 (Stainless Steel) or better
7.	Accuracy		± 0.075% of span or better
8.	Repeatability		±0.05% of Span or better
9.	Over Pressure		150% of max. Operating pressure
10.	Turn-down ratio (minimum)		100:1
11.	Zero and span drift		+/- 0.015% per deg.C at max span
12.	stability		± 0.1% of calibrated span for six months for Ranges up to and including70 Kg/cm² ± 0.25% of calibrated span for six months for Ranges more than 70 Kg/cm²
13.	Span and Zero		Continuous, tamper proof, Remote as well as manual adjustability from instrument with zero suppression and elevation facility.
14.	Housing		Weather proof as per IP-65, metallic housing with durable corrosion resistant coating
15.	Connection (Electrical)		Plug and socket type
16.	Process connection		1/2 inch NPT (F)
17.	Accessories		-Diaphragm seal, pulsation dampeners, syphon etc. as required by service and operating condition. -2 valve manifold for absolute & Gauge pressure

			transmitters, 3-valve and 5 valve manifold for DP/Level/Flow applications. The valve manifold shall be non integral type (except Fuel Oil area). For hazardous area, explosions proof enclosure as described in NEC article 500 Mounting: 2 inch pipe mounting.
18.	Diagnostics & display		Self-Indicating feature and digital display on transmitter
19.	Power supply		24V DC ± 10%.
20.	Adjustment/calibration/maintenance		From hand held HART calibrator/ centralized PC based system (as applicable).

Notes

- For primary air/ secondary air/flue gas applications, DP type transmitters shall be provided for pressure measurement.
- LVDT type is not acceptable.
- 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.

7.05.02 **Resistance Temperature Detector (RTD)**

Sl. No.	Features	Essential / Minimum Requirements
1	Type	Platinum (Duplex), Ungrounded.
2	Resistance	100 ohm at 0 ^{O}C.
3	Base	Wound on ceramic (anti-inductive).
4	Wiring	3 / 4 Wire.
5	Protecting Tube	
	a. O.D.	8 mm.
	b. Material	SS-316, Seamless.
	c. Filling	Magnesium oxide (Purity above 99.4%).
8	Response time	< 20 seconds for measurement.
		< 10 seconds for control.
9	Calibration	DIN 43760.
10	Accuracy	± 0.5%.
11	Head:	
	Type	IP-65 universal screwed type.

Sl. No.	Features	Essential / Minimum Requirements
	Material	Die cast aluminium or better.
	Terminal blocks	
	Cable connection	½" NPT gland and grommet.
	Others	Terminal head cover with SS chain and suitable gasket. All thermowells in the high velocity steam service shall be checked for Strouhal's frequency limit to arrive at a safe size and design of thermowells.
	Accessories	(a) Adjustable nipple-union-nipple (½" Sch 80 x ½" NPT M) with Thermowe (b) Compression fittings / unions. (c) Flanges etc. (for flanged connections only) (d) Forged / barstock Thermowell as per ASME PTC code. Process connec Material of construction of Thermowell: SS 316: In general. Inconel: For flue gas application. Tungsten carbide: For coal mill application.
	Name plate	Compression fittings / unions.

7.05.04 **Thermowells**

a) Shall be one-piece solid bored type of 316 SS of step-less tapered design. (As per ASME PTC 19.3, 1974)
(b) For Mill classifier outlet long life solid sintered tungsten carbide material of high abrasion resistance shall be provided.
(c) For Air & Flue gas 316 SS protecting tube with welded cap. (However contractor shall provide better material for Flue gas service if required based on the specified boiler design parameters).
(d) For furnace zone, impervious ceramic protecting tube of suitable material along with Incoloy supporting tubes and adjustable flanges.

7.06.00 PR. GAUGE, D.P. GAUGE, TEMP. GAUGE AND LEVEL GAUGE

7.06.01 Pressure Gauge and Differential Pressure Gauge

1	Type	:	Bourdon/Bellows/Diaphragm
2	MOC Sensing &Socket	:	AISI-316 SS
3	Movement Material	:	AISI-304 SS
4	Case Material	:	Stainless steel. Enclosure IP-65.
5	Dial Size	:	Generally 150 mm (100 mm for SWAS gauges)
6	Scale	:	Black lettering on white background in 270 Deg. arc.
7	Window	:	Shatterproof glass
8	Range Selection	:	Normal process pressure – 50 ~ 70% of range (approximately).
9	Over-range Protection	:	125% of maximum range by internal stop. External stop at zero.
10	Adjustment	:	Micrometer screw for zero adjustment.
11	Element Connection	:	Argon welding
12	Process Connection	:	1/2" NPT (M) Bottom connection for local mounting, backconnection for panel mounting.
13	Performance	:	Accuracy of +/- 1.0% of span or better.
14	Safety Feature	:	Blow out disc /diaphragm at the back
15	Accessories	:	a) Snubbers and Glycerin filled for pulsating
			b) siphons for steam and hot water services
			c) Stainless steel Diaphragm seals for corrosive, viscous andsolid-bearing or slurry type process fluids.
			d) Gauge saver wherever required
			e) 3-Way stainless steel Gauge valve for pressure gauges.Process connection ½" NPT.
			f) 5-valve SS316 manifold constructed from bar stock fordifferential pressure gauge. Process

			connection ½" NPT.
			g) Union, nut & tail piece and other Installation accessoriesas required.
16	Applicable standard	:	IS-3624 / 1996
17	Electrical Contactrating	:	Not applicable
18	Nameplate	:	Tag number, service engraved in stainless steel tag plate

7.06.02 Temperature Gauge

1	Type	:	Inert gas filled capillary type / Bimetallic rigidstem type
2	Sensi Element ng Mater ial	:	Bourdon-AISI 316 SS / Bimetal strip helix
3	Capillary	:	AISI 316
4	Bulb / Stem Mater ial	:	AISI 316
5	Thermometer connection to well	:	½" NPT / SS 304
6	Case Material	:	Stainless Steel
7	Dial Size	:	150 mm in general
8	Scale	:	Black lettering on white background.
9	Capillary	:	Armoured Stainless steel. Length of capillary shall be on 'As required' basis.
10	Mounting	:	Surface with adjustable angle / Panel.
11	Overrange Protection	:	125% of range or more.
12	Range	:	Normal temperature – 50 ~ 70% of range approximately.
13	Zero adjuster	:	Micrometer screw adjustable from front.
14	Window	:	Shatterproof glass.
15	Accuracy	:	1 %
16	Enclosure Class	:	IP-65
17	Accessories	:	a). Forged/bar stock thermowell screwed as per ASME PTC code. Process connection M 33X2 (M).
			Material of construction of Thermowell:

			- SS 316: In general
			- Inconel: For flue gas application
			b) Installation accessories as required.
			c)Tungsten carbide for coal mill operation
18	Nameplate	:	Tag number, service engraved in stainless steel tagplate

7.06.03 Gauge Glass

1	Type	:	Reflex or transparent. Resistant to mechanical shocks bysteel armour.
2	Glass	:	Toughened borosilicate
3	Body material	:	forged Carbon steel / stainless steel as per processrequirements/ flanged connection
4	End connection	:	As per ASME PTC and drain /vent valve 15NB
5	Accuracy	:	± 2%
6	Pressure rating	:	Twice the maximum working pressure
7	Scale	:	Linear vertical
8	Range selection	:	Covers 125% of max. of scale
9	Test Pressure	:	1.5 times to the max. design pressure at 38°C
10	Housing	:	CS /304SS
11	Accessories	:	SS Ball check valves, gaskets, companion flange, SS drainand vent valve, nuts & bolts etc.

7.06.04 Sight Glass

1	Type	:	Flap-type
2	End connection	:	Screwed / Flanged
3	Material :		
a)	Body	:	SS-304
b)	Cover Plate	:	SS-304
c)	Indicator	:	SS-316
4	Sight Glass	:	Toughened Borosilicate
5	Gasket	:	Neoprene
6	Bolts & Nuts	:	High tensile steel
7	Hydraulic Test Pressure	:	1.5 times maximum working pressure
8	Accessories	:	As required

7.13.08 Dew point meter

Sl. No.	Items	Description
1.	Sensor Type	Capacitance type with change in output proportional to moisture present.
2.	Service	Dry Air
3.	Range	50 to 0 Degree Centigrade Dew-Point
4.	Sensor Accuracy	Better than+/-0.5
5.	Operating Temperature	0 to 50degree C
6.	Operating Pressure	0-10Kg./Cm2,suitable for process application
7.	Analyser Input	Change in capacitance from dew point sensor.
8.	Display	Combined enclosure with two three-digit seven segments LED display with decimal point after two digits. LED height shall be 4 inches, clearly eligible from a distance of atleast10meters.
9.	Display Accuracy	Better than=/-2DegreeC.
10.	Mounting	Table top/Flush mounting, to be finalized during detailed engineering.
11.	Power supply	240VAC,50Hz to be arranged by the Bidder
12.	Output	5-20m ADC capable of driving a load impedance of 500 ohms minimum

9.19.00 SOLENOID VALVE

i)	Operating Principle	:	Electromagnetic (noiseless)
ii)	Coil voltage rating	:	24V DC /48V DC (in general) other 220V DC/ 240V AC /110V AC as required
iii)	Ways	:	3 ways in general other depending on requirement
iv)	Port size	:	1/4" NPT all ports
v)	Body	:	SS Bar Stock
vi)	Trim	:	AISI SS-316
vii)	Manual Operator	:	In built
viii)	Duty	:	Suitable for continuous energization
ix)	Sealing	:	Airtight and leak proof
x)	Ambient Temperature	:	0 - 50OC
xi)	Fluid Temperature	:	0-150OC (approx.)
xii)	Coil Enclosure	:	Stainless Steel
xiii)	Insulation	:	Class-H
xiv)	Coil Casing	:	IP-65 (Explosion proof for NEC Class-1, Division-1 area)
xv)	Mounting	:	On pipe or on panel
xvi)	Cable Connection	:	½" NPT cable gland
xvii)	Accessories	:	Mounting brackets, nuts and bolts
xviii)	Special feature	:	(i) LED indication (ii) Double coil type for open & close operation of valve / damper.

14.09.00 **JUNCTION BOX (JB)**

14.09.01 Junction boxes to be supplied by bidder's as on required basis.

14.09.02 Junction Boxes shall have following features:

i) Single door type, explosion proof type and front open with cable entry from bottom.

ii) 12/24/36/48/64 way with 20% spares terminals.

iii) Spring-loaded terminals shall be used.

iv) 4mm thick fibreglass reinforced polyester.

v) JB shall have Hinged Door with steel handle and IP lock. Door gasket shall be of synthetic rubber.

vi) Suitable for mounting on walls, columns, structures etc. The brackets, bolts, nuts, screws, glands and lugs required for erection shall be of brass, included in Bidders scope of supply.

vii) Terminals shall be rail mounted cage-clamp type suitable for conductor size upto 2.5 mm2. Terminals shall have screwed connection for conductor cross section above 2.5Sq.mm.

viii) An M6 earthing stud shall be provided.

ix) Enclosure shall be IP: 65 or better.

x) 3mm (min) Gland plate shall be provided for cable entry.

CHAPTER – 2

FIELD AND MEASURING INSTRUMENTS

2.00.00 MEASURING INSTRUMENTS (PRIMARY AND SECONDARY)

2.00.01 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. Refer Sub-section/chapter 1, Vol. V, Basic Design Criteria. Further, all instruments shall be of proven reliability, accuracy, and repeatability requiring a minimum of maintenance and shall comply with the acceptable international standards and shall be subject to Owner's approval.

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

2.00.03 All transmitters, sensors, and switches, Gauges for parameters like pressure, temperature, level, flow etc. as required for the safe and efficient operation and maintenance as well as for operator and management information (including all computation) of equipment in the system under the scope of specification shall be provided on as required basis with in quoted lump sum price. The Bidder shall furnish all Instrumentation / Control equipment & accessories under this specification as per technical specification, ranges, makes & model as approved by the Owner during detailed engineering.

2.00.04 The necessary root valves, impulse piping, drain cocks, gauge-zeroing cocks, valve manifolds 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 in flexible/rigid conduits, independently to suitably located common junction boxes. The proposal shall include the necessary cables, flexible conduits, junction boxes and accessories for the above purpose. Double root valves shall be provided for all pressure tapping where the pressure exceeds 40 Kg./sq.cm.

2.00.05 For corrosive applications, all instruments applications, they shall be provided with wetted parts made of Monel/ Hastelloy C or any other material (if proven ness experience of the proposed material for such applications is established by bidder).

All instruments shall be provided with durable epoxy coating for housings and all exposed surfaces of the instruments.

2.00.06 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 1/2, Division 1 area & Flame proof area) and an anti corrosive paint shall be applied to the

field mounted enclosures / instruments. In general, double cable entry shall be provided, wherever available, unused cable entry shall be provided with blind metal plug. All the field instruments shall also be provided with SS tag nameplate. Counter and mating flange (SS316 material), fastener, gaskets, Nuts, bolts etc. shall also be included wherever required with the field instruments.

2.00.07 In general, front draw out type instruments with plug-in facility at the rear for connecting cables for power supply and signal shall be provided unless otherwise specified like for Explosion proof area, Flame proof area and high vibration prone area. Separate plugs & socket connection shall be provided for connecting power supply cables and signal cables.

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 and Electrical connection shall be screwed connection with double compression type Nickel-plated brass/SS316 cable glands (Material as decided by owner) for Explosion proof area, Flame proof area and high vibration prone area.

2.00.08 The minimum quantity of secondary instruments etc. to be provided by Bidder is listed in Appendix- I to Vol. V, Part A of Technical Specifications. Any other additional quantity of secondary instruments shall be envisaged by bidder as per system and process requirements without any cost implication.

2.01.00 SPECIFICATION FOR ELECTRONIC TRANSMITTERS

2.01.01 SPECIFICATION FOR ELECTRONIC TRANSMITTER FOR PRESSURE, DIFF. PRESSURE AND DP BASED FLOW, LEVEL MEASUREMENTS

S. No.	Features	Essential/Minimum Requirements
1	Type of Transmitter	Sealed capacitance/Inductance/Silicon resonance type microprocessor based 2 wire type, Hart protocol (latest) compatible
2	Accuracy	± 0.1% of calibrated span (minimum) (upto turn down ratio of 10:1).
3	Output signal range	4-20 mA DC (Analog) along with superimposed digital signal (based on HART protocol)
4	Turn down ratio	10:1 for vacuum/very low pressure applications. 5:1 for very high pressure application. 100:1 for other applications.
5	Stability	± 0.15% of URL for 10 years.
6	Zero and span drift	+/- 0.015% per deg.C at max span. +/- 0.011% per deg.C at min. span.
7	Load impedance	500 ohm (min.)
8	Housing	Weather proof as per IP-65 with durable corrosion resistant coating.
9	Over Pressure	150% of max. Operating pressure.

S. No.	Features	Essential/Minimum Requirements
10	Connection (Electrical)	Plug and socket type
11	Process connection	1/2 inch NPT (F)
12	Span and Zero	Continuous, tamper proof, Remote as well as adjustability manual from instrument with zero suppression and elevation facility
13	Material	Die cast Aluminum with epoxy coating/SS316 for body. SS316 for Diaphragm.
14	Accessories	• Diaphragm seal, pulsation dampeners, syphon etc. as required by service and operating condition. • LCD/TFT digital integral Indicators with scale of Engg. Units. • 2 valve SS316 manifold for absolute & Gauge pressure transmitters, 3-valve SS316 manifold for vacuum pressure transmitters & where DP transmitters are being used for pressure measurement and 5 valve SS316 manifold for DP/Level/Flow applicable. Transmitters should not be mounted directly on the manifold; Manifold shall be non integral type only. • Snubbers/Pulsation dampners shall be used where the process media is unstable for measurement such as the discharge of a pump. • For hazardous area, explosions proof enclosure as described in NEC article 500.
15	Diagnostics	Self Indicating feature
16	Power supply	24V DC ± 10%.
17	Adjustment/calibration From hand held calibrator/centralized OWS based system/ maintenance (as applicable).	From hand held calibrator/centralized OWS based system

Notes:

For primary air/ secondary air/flue gas applications, DP type transmitters shall be provided for pressure measurement.

LVDT type is not acceptable.

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 Hydrogen gas pressure/differential pressure transmitters, the suitable material and coating shall be chosen as per the suggestion of transmitter manufacturer.

2.02.00 Specification for Pressure Gauge, D.P Gauge, Temperature Gauge and Level Gauge

S. No.	Features	Essential minimum requirements		
		Pr. Gauge/DP Gauge/Draught gauges	**Temperature gauge**	**Level Gauge**
1	Sensing Element and Material	Bourdon for high pressure, Diaphragm/ Bellow for Low pr. Of SS 316	Mercury in Steel for below 450°C and inert gas actuated for above 450°C of SS bulb and capillary	Tempered * toughened Borosilicate gauge glass steel armoured reflex or transparent type.
2	Body Material	Die Cast Aluminum with stoved enamel black finish /SS316	Die Cast Aluminum with stoved enamel black finish /SS316	Forged carbon steel/SS 304
3	Dial Size	150 mm with toughened shatter proof glass	150 mm with toughened shatter proof glass	Tubular covering entire range
4	End Connection	½ inch NPT (M)	¾" NPT (M)	Process connection as per ASME PTC and drain/vent 15 NB
5	Accuracy	+/- 1% span	+/- 1% span	+/- 2%
6	Scale	Linear, 270° arc graduated in metric units	Linear, 270° arc graduated in °C	Linear vertical
7	Range Selection	Cover 125% of max. of scale	Cover 125% of max. of scale	Cover 125% of max. of scale
8	Over range test	Test pr. For the assembly shall be 1.5 to the max. Design pr. At 38°C		
9	Housing	Weather and dust proof as per IP-65	Weather and dust proof as per IP-65	CS/304 SS leak proof.

S. No.	Features	Essential minimum requirements		
		Pr. Gauge/DP Gauge/Draught gauges	**Temperature gauge**	**Level Gauge**
10	Zero/span Adjustment	Provided	Provided	-
11	Identification	Engraved with service legend or laminated phenolic name plate		
12	Accessories	Blow out Disc, siphon, snubber, pulsation dampener, chemical seal (if required by process) gauge isolation valve	SS316 Thermowell	Gasket for all KEL-F shield for transparent type vent and drain valves of CS/ alloy steel/SS as per process requirement.
13	Material of Bourdon/ movement	SS 316	SS 316	

Notes – *Bicolour type level gauges will be provided for applications involving steam and water except for condensate and feed water services.

Length of gauge glass shall not be more than 1400 mm. If the vessel is higher, multiple gauge glasses with 50 mm overlapping shall be provided.

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 inert liquid suitable for the application.

For condensate storage tank and DM water storage tanks, the pressure gauge in terms of 0-10000 mm wc or suitable range having **dial size of 300mm or bigger size** shall be provided.

2.06.00 Temperature Elements and accessories

2.06.01 Thermocouples

S. No.	Features	Essential/Minimum Requirements
1.	Type of Thermocouple	16 AWG wire of Chromel-Alumel (Type K) or 24 AWG wire Pt-Rhodium Pt (Type S/R) depending on operating temperature Range (ungrounded type).
2.	No. of element	Duplex
3.	Housing/Head	IP-65/Die cast Aluminum. Head of TE to be provided with sufficient space and arrangement to head mounted temperature transmitter (as applicable). Plug in connectors are to be provided for external signal cable connection.
4.	Sheathing of Thermocouple	Swaged type magnesium oxide insulation. Magnesium Oxide shall be provided with high purity of 99.4% minimum.
5.	Calibration and accuracy	As per IEC-751/ANSI-C-96.1(special class) for T/C
6.	Characteristic	Linear with respect to temp, within ±1/2 percent of top range value
7.	Accessories	Thermo well (as specified below) and shall be spring loaded for positive contacts with the well.
8.	Standard	ANSI C 96.1 for Thermocouple and ASME PTC-19.3 (latest edition) for Thermo-well.
9.	Sheath Material/ Insulation	316SS/Compacted Magnesium Oxide.
	Sheath O D	8 mm.
10.	Insulation Resistance	More than 1000 M Ohms at Ambient temperature
11.	Response Time	6-10 Sec bare & 30 Sec. With protective sheath/thermowell
12.	Instrument Connection	1/2 " NPT (F).

S. No.	Features	Essential/Minimum Requirements
13.	Electrical connection	Gold plated Plug in type. Double entry, one unused entry with blind plug.
14.	Enclosure Class	IP-65 or better.
15.	Process Connection	i) M33 x 2 ii) Flanged for Air & Gas systems with mating flanges, fastner, gasket etc.
16.	Extension	Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends
17.	Extension neck length	Minimum 100 mm above Insulation of pipe and Minimum 160 mm when there is no insulation on pipe.

Notes

1. Extension 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.

2. Thermocouples provided for steam services like super heater / de super heater area, where the process pipe is inside the insulation of boiler penthouse, Thermowells are inaccessible and terminal head and connecting cable cannot withstand high temperature, for such services thermocouples shall be provided with flexible extension SS316 Sheath of 10-15 meters.

3. Bidder may also provide Triplex Thermocouples as per process requirements.

4. Metal plug with chain is to be provided with thermowell to avoid ingress of foreign material inside thermowell when TE is not fitted or during maintenance.

2.06.02 Resistance Temperature Detector (RTD)

S. No.	Features	Essential/Minimum Requirements
1.	Type of RTD	Three wire/Four wire, Pt-100 (100 Ohms resistance at zero degree Centigrade).
2.	No. of element	Duplex
3.	Housing/Head	IP-65/Diecast Aluminum. Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter (as applicable). Plug in connectors are to be provided for external signal cable connection.

S. No.	Features	Essential/Minimum Requirements
4.	Sheathing of RTD	Metal sheathed, ceramic packed
5.	Calibration and accuracy	As per DIN-43760/IEC 60751 Class-A for RTD
6.	Characteristic	Linear with respect to temp, within ±1/2 percent of top range value.
7.	Accessories	Thermo well (as specified below) and shall be spring loaded for positive contacts with the well
8.	Standard	DIN-43760/IEC 60751 for RTD and ASME PTC-19.3 (latest edition) for Thermo-well.
9.	Sheath Material/ Insulation	316SS/Compacted Magnesium Oxide.
	Sheath O D	8 mm.
	Gauge	18 SWG
10.	Insulation Resistance	More than 1000 M Ohms at Ambient temperature
11.	Response Time	6-10 Sec bare & 30 Sec. With protective sheath/thermowell
12.	Instrument Connection	1/2 " NPT (F).
13.	Electrical connection	Gold plated Plug in type. Double entry, one unused entry with blind plug.
14.	Enclosure Class	IP-65 or better.
15.	Process Connection	i) M33 x 2 ii) Flanged for Air & Gas systems with mating flanges, fastner, gasket etc.
16.	Extension	Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends
17.	Extension neck length	Minimum 100 mm above Insulation of pipe and Minimum 160 mm when there is no insulation on pipe.

NOTES:

1) The specifications for RTDs of winding/ bearings of motor/ pump can be as per their manufacturer standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice. However the type of RTD shall be PT100.

2) Metal plug with chain is to be provided with thermowell to avoid ingress of foreign material inside thermowell when TE is not fitted or during maintenance.

2.06.05 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 SS 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.

2.07.00 TEMPERATURE TRANSMITTER

Following types of 2-wire temperature transmitter (directly powered from 4-20mA input cards of DDCMIS/PLC) shall be provided. The temperature transmitter shall be fully compatible with thermocouples and RTDs being provided by the bidder as well as Owner. Temperature compensation of the thermocouples shall be performed in the temperature transmitter itself.

a. **Single Input Head mounted Temperature Transmitter**

These shall be suitable for mounting in the head of temperature element itself. The protection class of head of thermo well along with its plug-in connector shall be min. IP65.

b. **Single Input DIN-rail mounted Temperature Transmitter**

These shall be suitable for mounting on DIN-rails in JBs. The specifications of the JBs shall be same as indicated in Subsection INST CABLE with additional DIN-rails and IP 65 Protection class. This temperature transmitter shall be the ones which are especially designed for DIN-rail mounting with IP 20 protection class. These shall have terminals for input/output provided on front side when mounted on DIN-rail.
Head mounted temperature transmitter with clamps to make it suitable for DIN-rail mounting shall not be acceptable under this category.

c. **Dual-input Temperature Transmitter with Indicator:**

These shall be suitable for mounting on pipes/ support. Indicator shall be provided with these transmitters. These transmitters shall have bump less change over facility to second sensor in case first sensor fails .This change-over is to be alarmed. Protection class shall be IP65 minimum.

The exact applications for which this type of transmitter is to be provided shall be finalized by owner during detailed engineering.

d. Common requirements for each of the above type of temperature transmitters.

Output	:	2-wire (power supply from input card of Control System) with 4-20mA output with superimposed HART protocol signal.
Input	:	Same transmitter shall be capable to handle Pt-100 RTD, Thermocouples –K&R types (input type to be selectable at site through HART terminal)
Isolation	:	Min. 500 V AC
EMC compatibility	:	as per EN 61326
Operating ambient temperature	:	0 to 85 deg C (without indicator) 0 to 70 deg C (with indicator)
Power supply	:	Compatible with input module of Control System
Accessories	:	Mounting arrangements including Clamps etc.
Composite Accuracy	:	a) For head mounted and DIN-rail mounted type Refer note-2 RTD =<0.4% of 0-250 degC span

T/C-K type =<0.4% of 0-600 deg C span

T/C-R type =<0.4% of 0-1000 deg C span

CJC accuracy (for thermocouples) shall be =< 1 Deg C

b) For dual-input type:

RTD =<0.25% of 0-250 deg C span

T/C-K type =<0.2% of 0-600 deg C span

CJC accuracy (for thermocouples) shall be =<1 deg C

e. Field bus compatible temperature transmitters:-

Temperature transmitters of this category shall be field mounting type & shall be capable of withstanding operating ambient temperature upto 85 deg C. These modules shall be connected to DDCMIS through field bus such as Profibus, Foundation Field bus etc directly from the transmitter. Maximum Number of inputs per such temperature transmitter shall be eight. These shall be mounted in cabinets in non-AC areas.

As an alternate, these signals from temperature transmitters can be connected to DDCMIS through standard remote I/O modules of the DCS, in which case, the temperature transmitter signals will be acquired through 4-20mA input modules in the remote I/O cabinet for connecting to DDCMIS through remote I/O bus.

Notes (Common for a to e above):-

1. In case of failure (open or burn-out) of RTD/thermocouple, temp. Transmitter shall provide low temperature output.

2. Composite Accuracy is to be calculated as summation of all applicable accuracies of temp transmitter, for converting sensor input to output in 4-20 mA (e.g., basic accuracy, digital accuracy, D/A accuracy, etc.) and temperature effect on these accuracies at ambient temperature of 50 deg C, based on the figure/ formula given in the standard product catalogue for span as specified above for various types of Temperature Elements specified. All such accuracy/ temp effect figures in catalogue shall be first converted to deg C, and then percentage of this converted accuracy in specified span shall be calculated to compare with the specified composite accuracy figures.

3. For BFPs' differential temperature protection by 2 out of 3 logic, DTT shall be employed to deliver 4-20 mA output to DDCMIS using suction & discharge temperature measurements.

2.12.09 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
Accessories	:	Scale, Bolts, Nuts, Cover plates and Gaskets as required
Tests	:	Tested at two hundred (200) percent of the maximum process Pressure

2.14.00 SOLENOID VALVES

Solenoid valves shall be provided as per NAMUR standard 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. Type 2/3/4 way with body material of SS 316/Forged Brass and epoxy painting (depending on the application subject to Owner's approval during detailed Engg.). Material of Wetted parts shall be SS316.

b. Power supply 24 V DC + 10%.

c. Plug and socket electrical connection.

d. Insulation: Class 'H'.

e. All solenoid shall be with, LED indication, surge suppression diode circuits.

f. 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.

g. Two (2) way solenoid valves shall be provided, where process line of less than 50 mm with low pressure and temperature application.

h. 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.

i. Four (4) way solenoid valve shall be provided for operating double acting cylinders, e.g, Pneumatically operated on-off type dampers.

j. Solenoid valve shall operate on 24 V DC, UPS 230 V AC or 220 V DC as per system requirements.

2.17.00 AC PLANT AND COMPRESSOR RELATED SPECIAL INSTRUMENTS

2.17.01 (HUMIDITY SENSOR)

Sensor	:	Capacitance type
Accuracy	:	+/-3% R.H
Range	:	0-100%
R.H Output	:	4-20 ma
Time constant	:	2 mins.

Output from the sensor is to be connected to respective control system. Bidder can also provide combined instrument for measurement of humidity and temperature subject to Owner's approval during detailed engineering. In all such cases, 4-20 ma outputs, each for temperature and humidity measurements are to be provided.

2.17.02 TEMPERATURE/ HUMIDITY INDICATOR

Sensor	:	RTD for (Pt 100) for temperature
	:	Capacitance Type for Humidity (specs for humidity and temperature shall be as mentioned above)
Display	:	Combined enclosure with two three digit seven segments LED display with decimal point after two digits. LED height shall be 4 inches, clearly legible from a distance of at least 10 meters.
Range	:	0-60 Deg C for temperature.
	:	0-95.0 % for Relative Humidity.
Accuracy	:	Better than +/_0.5 % for Temperature
	:	Better than +/_2.5 % for Relative Humidity
Mounting	:	Table Top/ wall mounting.
Power supply	:	240 V AC, 50 Hz.
Output	:	4-20 mA signal each for temperature.
Qty.	:	15 nos. each of temperature & Humidity indicators (combined indicators for Humidity and temperature is also applicable).

One Set of output signal is to be connected to respective control system. Apart from displaying the temperature/humidity values on indicator.

2.17.03 DEW POINT METER

Type	:	2 Wire Loop Powered Dew point Transmitter
Overall Range	:	-60°C to +20°C Dew point
Accuracy	:	± 2°C Dew point
Material	:	SS316 (wetted parts)
Features	:	a) AUTOMATIC CALIBRATION

(b) Can be Configured for Linear 4-20mA signal in °C & °F Dewpoint, ppm(v), ppb(v), g/m3
(c) Temperature Compensation
(d) Failure Diagnostics
(e) Long Term Stability
(f) Fast Response
(g) IP 66 / NEMA4X Protection
(h) Supplied with Calibration Certificate Traceable to National & International Humidity Standards
(i) Sensor protection with sintered filter
(j) Local LCD Display for Dew Point

2.18.00 Limit switches

For offsite plant application Limit switches shall be gold plated with high conductivity and non corrosive type. Contact rating shall be sufficient to meet the requirement of DDCMIS subject to a minimum of 60 V, 6 VA rating. Protection class shall be IP 65. Contact shall be either 1 no, DPDT or 2 nos. SPDT minimum.

For main plant application, limit switches are to be provided as per bidder standard and proven practice.

All limit switch shall be conform to IEC-60947-5-1.

7.03.00 ELECTRONIC TRANSMITTER

7.03.01 **For Pressure, Diff Press And DP Based Flow / Level Measurements**

1.	Working Principle	:	Smart
2.	Type	:	Microprocessor based 2 wire type (loop powered), Hart protocol compatible.
3.	Output Signal	:	Simultaneous transmission of digital and 4-20 mA DC signal. HART protocol
4.	Signal Processing		Silicon solid state electronic circuitry

5.	Measuring Element		Capsule / Diaphragm
6.	Element material		AISI-316 (Stainless Steel) or better
7.	Accuracy		± 0.075% of span or better
8.	Repeatability		±0.05% of Span or better
9.	Over Pressure		150% of max. Operating pressure
10.	Turn-down ratio (minimum)		100:1
11.	Zero and span drift		+/- 0.015% per deg.C at max span
12.	stability		± 0.1% of calibrated span for six months for Ranges up to and including70 Kg/cm² ± 0.25% of calibrated span for six months for Ranges more than 70 Kg/cm²
13.	Span and Zero		Continuous, tamper proof, Remote as well as manual adjustability from instrument with zero suppression and elevation facility.
14.	Housing		Weather proof as per IP-65, metallic housing with durable corrosion resistant coating
15.	Connection (Electrical)		Plug and socket type
16.	Process connection		1/2 inch NPT (F)
17.	Accessories		-Diaphragm seal, pulsation dampeners, syphon etc. as required by service and operating condition. -2 valve manifold for absolute & Gauge pressure transmitters, 3-valve and 5 valve manifold for DP/Level/Flow applications. The valve manifold shall be non integral type (except Fuel Oil area).

			For hazardous area, explosions proof enclosure as described in NEC article 500 Mounting: 2 inch pipe mounting.
18.	Diagnostics & display		Self-Indicating feature and digital display on transmitter
19.	Power supply		24V DC ± 10%.
20.	Adjustment/calibration/maintenance		From hand held HART calibrator/ centralized PC based system (as applicable).

Notes
- For primary air/ secondary air/flue gas applications, DP type transmitters shall be provided for pressure measurement.
- LVDT type is not acceptable.
- 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.

7.05.00 TEMPERATURE ELEMENTS AND ACCESSORIES

7.05.01 Thermocouple

Sl. No.	Features	Essential / Minimum Requirements
1	Type	(a) Type-J (Iron Constantan) / Type-K (Chromel Alumel) / Type-R (Pt.- Rhodium Pt.). [As per application]
		(b) Duplex.
		(c) Ungrounded.
2	Wire gauge	16 AWG for Type-K, 24 AWG for Type-R.
3	Standard	ANSI-MC 96.1.
4	Protecting Tube	
a.	O.D	8 mm.

Sl. No.	Features	Essential / Minimum Requirements
b.	Material	316-SS Seamless.
c.	Filling	Magnesium Oxide (Purity above 99.4%).
5	Response time	a) < 20 seconds for measurement.
		b) < 10 seconds for control.
6	Accuracy	± 1.1^0 C up to 300 ^{0}C & 0.4% of measured temperature range above 300 ^{0}C.
7	Head	
	Type	IP-65 universal screwed type.
	Material	Die cast aluminium or better.
	Terminal blocks	Nickel plated Brass - screw type/ silver plated.
	Instrument connection to well	½" NPT F.
	Cable connection	½" NPT gland and grommet.
	Others	Terminal head cover with SS chain and suitable gasket. All thermowells in the high velocity steam service shall be checked for Strouhal's frequency limit to arrive at a safe size and design of thermowells.
8	Accessories	(a) Adjustable nipple-union-nipple (½", Sch 80 x ½" NPT M) with thermowell connection.
		Compression fittings/unions.
		(b) Flanges etc. (for flanged connections only).
		(c) Forged barstock thermowell as per ASME PTC code. Process connection M 33 x 2 (M) in general or 1½" Flanged for Flue gas / Furnace / Air etc. application. Material of construction of Thermowell: SS 316 : In general Inconel: For flue gas application Tungsten carbide : For coal mill application.
9.	Name plate	Tag number, service engraved in stainless steel tag plate.

7.05.02 **Resistance Temperature Detector (RTD)**

Sl. No.	Features	Essential / Minimum Requirements
1	Type	Platinum (Duplex), Ungrounded.
2	Resistance	100 ohm at 0 ^{O}C.
3	Base	Wound on ceramic (anti-inductive).
4	Wiring	3 / 4 Wire.
5	Protecting Tube	
	a. O.D.	8 mm.
	b. Material	SS-316, Seamless.
	c. Filling	Magnesium oxide (Purity above 99.4%).
8	Response time	< 20 seconds for measurement.
		< 10 seconds for control.
9	Calibration	DIN 43760.
10	Accuracy	± 0.5%.
11	Head:	
	Type	IP-65 universal screwed type.
	Material	Die cast aluminium or better.
	Terminal blocks	
	Cable connection	½" NPT gland and grommet.
	Others	Terminal head cover with SS chain and suitable gasket. All thermowells in the high velocity steam service shall be checked for Strouhal's frequency limit to arrive at a safe size and design of thermowells.
	Accessories	(a) Adjustable nipple-union-nipple (½" Sch 80 x ½" NPT M) with Thermowell connection. (b) Compression fittings / unions. (c) Flanges etc. (for flanged connections only) (d) Forged / barstock Thermowell as per ASME PTC code. Process connection M33 x 2 (M). Material of construction of Thermowell: SS 316: In general. Inconel: For flue gas application. Tungsten carbide: For coal mill application.
	Name plate	Compression fittings / unions.

7.05.04 **Thermowells**

i) Shall be one-piece solid bored type of 316 SS of step-less tapered design. (As per ASME PTC 19.3, 1974)

ii) For Mill classifier outlet long life solid sintered tungsten carbide material of high abrasion resistance shall be provided.

iii) For Air & Flue gas 316 SS protecting tube with welded cap. (However contractor shall provide better material for Flue gas service if required based on the specified boiler design parameters).

iv) For furnace zone, impervious ceramic protecting tube of suitable material along with Incoloy supporting tubes and adjustable flanges.

7.05.05 **TEMPERATURE TRANSMITTER**

Following types of 2-wire temperature transmitter (directly powered from 4-20mA input cards of DCS) shall be provided. The temperature transmitter shall be fully compatible with thermocouples and RTDs being provided by the contractor. Temperature compensation of the thermocouples shall be performed in the temperature transmitter itself.

a. Single Input Head mounted Temperature Transmitter
These shall be suitable for mounting in the head of temperature element itself. The protection class of head of thermo well along with its plug-in connector shall be min. IP65.

b. Single Input DIN-rail mounted Temperature Transmitter
These shall be especially designed for DIN-rail mounting in JBs. JB shall be as per tender specification and IP 65 Protection class. This temperature transmitter shall be the ones which are specially designed for DIN-rail mounting with IP 20 protection class. These shall have terminals for input/output provided on front side when mounted on DIN-rail. Head mounted temperature transmitter with clamps to make it suitable for DIN-rail mounting shall not be acceptable under this category.

c. Dual-input Temperature Transmitter with Indicator:
The dual-input TTs shall be suitable for mounting in enclosures/racks and shall be provided with clamps. Indicator shall be provided with these transmitters. These transmitters shall have bump less change over facility to second sensor in case first sensor fails. This change-over is to be alarmed. Protection class shall be IP65 minimum.

d. Common requirements for each of the above type of temperature transmitters

i. Output : 2-wire (power supply from input card of Control System) with 4- 20mA output withSuper-imposed HART protocol signal

ii. Input : Same transmitter shall be capable to handle Pt-100 RTD, Thermocouples K&R types (input type

to be selectable at site through HART terminal)

iii. Isolation : min. 500 V AC
iv. EMC compatibility : as per EN 61326
v. Operating ambient : 0 to 85 deg C (without indicator)temperature0 to 70 deg C (with indicator)
vi. Power supply : compatible with input module of ControlSystem
vii. Accessories : Mounting arrangements including clampsetc.
viii. Composite Accuracy: a. For head mounted and DIN-rail mounted types
RTD =<0.4% of 0-250 deg C span T/C-K type
=<0.4% of 0-600 deg C Span T/C-R type
=<0.4% of 0-1000 deg C span CJC accuracy (for thermocouples) shall be =< 1 deg C
ix. For dual-input type:
RTD =<0.25% of 0-250 deg C Span T/C-K type
=<0.2% of 0-600 deg C span
CJC accuracy (for thermocouples) shall be =< 1 deg C

7.06.00 PR. GAUGE, D.P. GAUGE, TEMP. GAUGE AND LEVEL GAUGE

7.06.01 Pressure Gauge and Differential Pressure Gauge

1	Type	:	Bourdon/Bellows/Diaphragm
2	MOC Sensing &Socket	:	AISI-316 SS
3	Movement Material	:	AISI-304 SS
4	Case Material	:	Stainless steel. Enclosure IP-65.
5	Dial Size	:	Generally 150 mm (100 mm for SWAS gauges)
6	Scale	:	Black lettering on white background in 270 Deg. arc.
7	Window	:	Shatterproof glass
8	Range Selection	:	Normal process pressure – 50 ~ 70% of range (approximately).
9	Over-range Protection	:	125% of maximum range by internal stop. External stop at zero.
10	Adjustment	:	Micrometer screw for zero adjustment.
11	Element Connection	:	Argon welding
12	Process Connection	:	1/2" NPT (M) Bottom connection for local mounting, backconnection for panel mounting.
13	Performance	:	Accuracy of +/- 1.0% of span or better.
14	Safety Feature	:	Blow out disc /diaphragm at the back

15	Accessories	:	a) Sl. NO.ubbers and Glycerin filled for pulsating fluid applications.
			b) siphons for steam and hot water services
			c) Stainless steel Diaphragm seals for corrosive, viscous andsolid-bearing or slurry type process fluids.
			d) Gauge saver wherever required
			e) 3-Way stainless steel Gauge valve for pressure gauges.Process connection ½" NPT.
			f) 5-valve SS316 manifold constructed from bar stock fordifferential pressure gauge. Process connection ½" NPT.
			g) Union, nut & tail piece and other Installation accessoriesas required.
16	Applicable standard	:	IS-3624 / 1996
17	Electrical Contactrating	:	Not applicable
18	Nameplate	:	Tag number, service engraved in stainless steel tag plate

7.06.02 Temperature Gauge

1	Type	:	Inert gas filled capillary type / Bimetallic rigidstem type
2	Sensi Elementng Material	:	Bourdon-AISI 316 SS / Bimetal strip helix
3	Capillary	:	AISI 316
4	Bulb / Stem Material	:	AISI 316
5	Thermometer connection to well	:	½" NPT / SS 304
6	Case Material	:	Stainless Steel
7	Dial Size	:	150 mm in general
8	Scale	:	Black lettering on white background.
9	Capillary	:	Armoured Stainless steel. Length of capillary shallbe on 'As required' basis.
10	Mounting	:	Surface with adjustable angle / Panel.

11	Overrange Protection	:	125% of range or more.
12	Range	:	Normal temperature – 50 ~ 70% of range approximately.
13	Zero adjuster	:	Micrometer screw adjustable from front.
14	Window	:	Shatterproof glass.
15	Accuracy	:	1 %
16	Enclosure Class	:	IP-65
17	Accessories	:	a). Forged/bar stock thermowell screwed as per ASME PTC code. Process connection M 33X2 (M).
			Material of construction of Thermowell:
			- SS 316: In general
			- Inconel: For flue gas application
			b) Installation accessories as required.
			c)Tungsten carbide for coal mill operation
18	Nameplate	:	Tag number, service engraved in stainless steel tag plate

7.06.03 Gauge Glass

1	Type	:	Reflex or transparent. Resistant to mechanical shocks bysteel armour.
2	Glass	:	Toughened borosilicate
3	Body material	:	forged Carbon steel / stainless steel as per process requirements/ flanged connection
4	End connection	:	As per ASME PTC and drain /vent valve 15NB
5	Accuracy	:	± 2%
6	Pressure rating	:	Twice the maximum working pressure
7	Scale	:	Linear vertical
8	Range selection	:	Covers 125% of max. of scale
9	Test Pressure	:	1.5 times to the max. design pressure at 38°C
10	Housing	:	CS /304SS
11	Accessories	:	SS Ball check valves, gaskets, companion flange, SS drainand vent valve, nuts & bolts etc.

7.06.04 Sight Glass

1	Type	:	Flap-type
2	End connection	:	Screwed / Flanged
3	Material :		
a)	Body	:	SS-304
b)	Cover Plate	:	SS-304
c)	Indicator	:	SS-316
4	Sight Glass	:	Toughened Borosilicate
5	Gasket	:	Neoprene
6	Bolts & Nuts	:	High tensile steel
7	Hydraulic Test Pressure	:	1.5 times maximum working pressure
8	Accessories	:	As required

7.13.08 Dew point meter

Sl. No.	Items	Description
1.	Sensor Type	Capacitance type with change in output proportional to moisture present.
2.	Service	Dry Air
3.	Range	50 to 0 Degree Centigrade Dew-Point
4.	Sensor Accuracy	Better than+/-0.5
5.	Operating Temperature	0 to 50degree C
6.	Operating Pressure	0-10Kg./Cm2,suitable for process application
7.	Analyser Input	Change in capacitance from dew point sensor.

Sl. No.	Items	Description
8.	Display	Combined enclosure with two three-digit seven segments LED display with decimal point after two digits. LED height shall be 4 inches, clearly eligible from a distance of atleast10meters.
9.	Display Accuracy	Better than=/-2DegreeC.
10.	Mounting	Table top/Flush mounting, to be finalized during detailed engineering.
11.	Power supply	240VAC,50Hz to be arranged by the Bidder
12.	Output	5-20m ADC capable of driving a load impedance of 500 ohms minimum

7.15.03 Limit switches

7.15.04 For offsite plant (except PT, DM, Chlorination, chemical treatment, Liquid effluent treatment) application Limit switches shall be silver plated with high

conductivity and non-corrosive type. Contact rating shall be sufficient to meet the requirement of DCS subject to a minimum of 60 V, 6 VA rating. Protection class shall be IP 55.

7.15.05 For PT, DM, Chlorination system, chemical treatment, Liquid effluent treatment plant, limit switches of manual valves and solenoid operated on-off valves shall be of inductive proximity type and shall be mounted inside the enclosure: pl. refer the minimum specification requirement below.

Sl No	Feature	Description
1.	Operating voltage Range	Inductive Proximity type , 2 Wire
2.	Sensing system	NO
3.	Reverse polarity and short circuit protection	Yes
4.	IP Class-Sensor	IP67
5.	IP Class-Enclosure(Switch box)	IP67
6.	Cable entry-Enclosure(Switch box)	2no-1/2" NPT
7.	Casing material-Sensor	Brass /SS
8.	Enclosure(Switch box) Housing material	FRP or SS
9.	Operating Ambient temp(sensors)	-5 to 70 deg C
10.	Max allowed Voltage Drop across sensor	5 V
11.	Standard applicable	EN 60947-5-2 or equivalent.

9.19.00 SOLENOID VALVE

i)	Operating Principle	:	Electromagnetic (noiseless)
ii)	Coil voltage rating	:	24V DC /48V DC (in general) other 220V DC/ 240V AC /110V AC as required
iii)	Ways	:	3 ways in general other depending on requirement
iv)	Port size	:	1/4" NPT all ports
v)	Body	:	SS Bar Stock
vi)	Trim	:	AISI SS-316
vii)	Manual Operator	:	In built
viii)	Duty	:	Suitable for continuous energization
ix)	Sealing	:	Airtight and leak proof
x)	Ambient Temperature	:	0 - 50OC
xi)	Fluid Temperature	:	0-150OC (approx.)
xii)	Coil Enclosure	:	Stainless Steel
xiii)	Insulation	:	Class-H
xiv)	Coil Casing	:	IP-65 (Explosion proof for NEC Class-1, Division-1 area)
xv)	Mounting	:	On pipe or on panel
xvi)	Cable Connection	:	½" NPT cable gland
xvii)	Accessories	:	Mounting brackets, nuts and bolts

xviii) Special feature : (a) LED indication
(b) Double coil type for open & close operation of valve / damper.

13.09.00 **JUNCTION BOX (JB)**

13.09.01 Junction boxes to be supplied by bidder's as on required basis.

13.09.02 Junction Boxes shall have following features:

i) Junction Boxes material shall be stainless-steel SS-304 (1.4301 (V2A)) with 1.5mm thickness folded and welded from a single piece with protection channel around the door opening ,IP66 rating, RoHS compliant,

UL certified and manufactured in accordance with IEC 62208, ensuring the highest quality, painted with weatherproof super durable painting .

ii) Enclosure and door - Brushed grain 400, peak-to-valley height < 0.8 µm .

iii) Type of Enclosure shall be IP-66 rated Flame proof/Weatherproof /Explosion Proof as per area classification. Design shall be as per NEC-370 Article 18, 19 & 20 with IK-08 Enclosure Protection class against external mechanical stresses as per EN 50102/IEC 62262.

iv) No. of Ways shall be 12/24/36/48/64/72/96/128 with 20% spare terminals.

v) Each junction box shall be provided with sufficient terminals for the individual termination of all spare cores within the interconnecting cabling. As minimum, additional 20% wired terminals shall be provided for future use.

vi) Cable entry shall be Bottom or Side.

vii) Cable glands shall be Double compression type – Nickel plated Brass/SS316 with PVC hoods.

viii) Mounting shall be Indoor/ Outdoor and IP55 rating for Junction Boxes shall apply for Double Door only and IP-66 for Single door only.

ix) Terminals shall be from Phoenix/Wago (screw less rail mounted cage clamp type spring loaded suitable for conductor size up to 2.5 sq. mm)

x) Salt spray tests shall be conducted in accordance with ISO 9227:2012(en) i.e., Corrosion tests in artificial atmospheres in compliance with EN IS 12944-6 (with weatherproof super durable painting)) with minimum 720 hours as per C4H environment . Paint test standards as per DIN EN ISO 2409/1520/1519/2815

xi) Doors shall be hinged /lockable type. The door hinges shall be easily swappable to opposite side for single-door enclosure at 130° opening angle as per relevant applicable VDI standards. Doors shall be provided with double bit cam locks to ensure rigid and in position locking. Lock insert shall be of Die-cast zinc type, nickel-plated with 3 mm cam lock and double-bit insert in accordance with DIN 43668 .

xii) Terminals shall be from Phoenix/Wago (screw less rail mounted cage clamp type spring loaded suitable conductor size up to 2.5 sq. mm) Grounding should be two terminals for body shield ground.

xiii) Suitable mounting clamps and other accessories shall be in scope of Bidder.

xiv) The brackets, bolts, nuts, screws, glands, lugs required for erection shall be of SS304, included in Bidder scope of supply. xiv.

xv) High voltage & insulation resistance test shall also be conducted.

xvi) M6 Ni plated Brass earthing stud shall be provided (external 2 nos. internal 1 no.)

xvii) Color shall be decided during detailed engineering & shall subject to owner's approval.

xviii) Gasket (Normal)- Polyurethane (durometer hardness as per ASTM D2240- 97/e1) with sustainable IP throughout product life .Silicon for high Temp. area. shall be provided.

APPLICABLE FOR KORBA WEST

TECHNICAL DATA SHEETS

2.1	**DATASHEET - PRESSURE TRANSMITTER, DIFFERENTIAL PRESSURE TRANSMITTER, DP BASED FLOW AND LEVEL TRANSMITTER**		
	Output		Profibus PA complying to IEC 61158, digital output
	Turndown ratio		50:1
	Accuracy	%	0.06%
	Stability (% of calibrated range)	%	+/-0.25% for 10 year
	Diaphragm seal material		Suitable for process fluid
	Diagram fill fluid		Inert liquid
	Wetted parts		All wetted parts upto diaphragm seal shall be suitable for process application.
	Housing		Metallic housing with durable corrosion resistant coating
	Protection		Weather proof IP-67
	Display		Integral digital display
	Diagonstic feature		Required
	Electrical connection		1/2" NPT (f)
	Manifold		2/3 valve non integral manifold for PT and 5 valve non integral manifold for DPT
2.2	**DATASHEET - PRESSURE GAUGE, DIFFERENTIAL PRESSURE GAUGE**		
	Sensing element		Bourdon for high pressure, diaphragm/bellow for low pressure
	Sensing element material		SS316
	Movement material		SS316
	Body material		SS316
	Dial size	mm	150mm
	End connection	inch	1/2 inch NPT (m)
	Accuracy		±1% of span
	Scale		Linear, 270° arc graduated in metric units
	Range selection	%	Cover 125% of max. of scale
	Over range test		Test pr. for the assembly shall be 1.5 to the max. Design pr. At 38°C.
	Diaphragm seal material		Suitable for process fluid
	Diaphragm fill fluid		Inert liquid
	Wetted parts		All wetted parts upto diaphragm seal shall be suitable for process application
	Housing		IP-55
	Zero/span adjustment		External
	Accessories		Blow out disc, siphon, snubber, pulsation, dampener, chemical seal, gauge isolation valve
2.3	**DATASHEET- LEVEL SWITCH**		
	Repeatability	%	+/-0.5% of full range
	No. of contacts		2 No.+2NC. SPDT snap action dry contact
	Rating of contacts	V, VA	60 V DC, 6 VA
	Elect. Connection		Plug in socket.
	Set point adjustment		Provided over full range.
	Dead band adjustment		Adjustable/ fixed as per requirement of application.
	Enclosure		IP-55
	Power Supply	V	24V DC
	Sensing Element		Float type, conductivity type, Ultrasonic type as per suitability to the application
	Material		316 SS
	End connection		Manufacturer standard
	Over range/ proof pressure	%	150% of maximum operating pr.
	Accessories		All mounting accessories

2.4	**DATASHEET - LEVEL GAUGE**		
	Sensing element and material		Tempered toughened borosilicate gauge glass steel armoured reflex or transparent type, bicolour type
	Body material		304 SS
	End connection		Process connection as per ASME ptc , 3/4" and drain/vent 15 NB
	Accuracy	%	± 2%
	Scale		Liner vertical
	Housing		304 SS leak proof
	Over range test		Test pr. for the assembly shall be 1.5 to the max. Design pr. At 38°C.
	Wetted parts		All wetted parts upto diaphragm seal shall be suitable for chemical application
	Accessories		Gasket for all KEL-F shield for transparent type vent and drain valves of steel/SS as per CS /Alloy process requirement.
	Length of Gauge glass		Length of gauge glass shall not be more than 1400 mm. If the vessel is higher, multiple gauge glasses with 50 mm overlapping shall be provided.
2.5	**DATASHEET - TEMPERATURE TRANSMITTER**		
	Transmitter Type		Profibus PA complying to IEC 61158 with EMC compatibility as per EN 61326, Dual input (Trip/Protection), Single Input (other application), 2- wire loop powered from 4-20mA DDCMIS input cards.
	Compatibility		fully compatible with RTDs
	Protection Class		IP-67
	Display		Integral digital display
	Diagonstic feature		self-indicating diagnostics
	Operating ambient temperature (with display)	DegC	70 deg C
	Operating ambient temperature (without display)	DegC	85 deg C
	Electrical Connection	inch	1/2" NPT(F)
	Composite Accuracy	%	RTD =<0.25% of 0-250 deg C span
	Changeover facility		Bump less changeover to second sensor in case first sensor fails with alarm facility.
	Composite accuracy Calculation		Accuracies of temperature transmitter for converting sensor input to output + temperature effect on these accuracies at ambient temperature of 50 deg C (based on the figure/ formula given in the standard product catalogue for span as specified for RTD).
	Emergency/failure Measures		In case of failure (open or burn-out) of RTD, transmitter shall provide low temperature output.
2.6	**DATASHEET - RESISTANCE TEMPERATURE DETECTOR (RTD)**		
	Type		Four wire, Pt-100 (100 Ohms resistance at zero degree Centigrade).
	No. of element		Duplex
	Housing		Diecast Aluminium
	Protection Class		IP-65
	Head		Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter
	Plug in connectors		Required
	Terminal head		Spring loaded for positive contacts with the thermo well
	Insulation and sheathing		Mineral (magnesium oxide) insulation and SS316 sheath
	Calibration and accuracy		As per IEC-751/ DIN-43760 Class-A for RTD
	Accessories		Thermo well and associated fittings
2.7	**DATASHEET - THERMOWELL**		
	Design		One piece solid bored type of step-less tapered design
	Material		SS316

2.8	**SPECIFICATIONS - TEMPERATURE GAUGE**		
	Body Material		Die-cast aluminium
	Material of bourdon/movement		316SS / 304SS
	End connection		3/4" NPT (M)
	Accuracy	%	± 1% of span
	Dial Size	mm	150 mm
	Scale		Linear, 270° arc graduated in °C
	Range selection	%	Cover 125% of max. of scale
	Over range test		Test pr. for the assembly shall be 1.5 to the max. Design pr. At 38°C.
	Housing		IP-55
	Zero/span adjustment		Required
	Accessories		SS Thermowell
2.9	**DATASHEET - TEMPERATURE/ HUMIDITY INDICATOR**		
	Sensor		RTD for(Pt 100) for temperature
			Capacitance Type for Humidity (specs for humidity and temperature shall be as mentioned above)
	Display		Combined enclosure with two three digit seven segments LED display with decimal point after two digits. LED height shall be 4 inches, clearly legible from a distance of at least 10 meters.
	Range		0-60 Deg C for temperature.
			0-95.0 % for Relative Humidity.
	Accuracy		Better than +/_0.5 % for Temperature
			Better than +/_2.5 % for Relative Humidity
	Mounting		Table Top/ wall mounting.
	Power supply		240 V AC, 50 Hz.
	Output		4-20 mA signal each for temperature.
	Qty.		15 nos. each of temperature & Humidity indicators (combined indicators for Humidity and temperature is also applicable).
2.10	**DATASHEET - HUMIDITY SENSOR**		
	Sensor		Capacitance type
	Accuracy		+/-3% R.H
	Range		0-100% R.H
	Output		4-20 mA
	Time constant		2 mins.
2.11	**DATASHEET - SOLENOID VALVE**		
	Type		2/3/4 way SS 316/Forged Brass (depending on the application subject to Employer's approval during detailed Engg.)
	Power supply		24 V DC + 10%.
	Electrical connection		Plug and socket
	Insulation		Class 'H'
	IP Class		IP65
	Limit switches (for open/close feedback)		Required
2.12	**DATASHEET - LIMIT SWITCH**		
	Type		Inductive proximity type
	Mounting arrangement		Inside the enclosure
	Operating voltage Range	V	10-40 V DC
	Sensing system		Inductive Proximity type , 2 Wire
	Sensor Contact Type		NO
	Reverse polarity and short circuit protection		Yes
	IP Class-Sensor		IP67
	IP Class-Enclosure(Switch box)		IP67
	Cable entry-Enclosure(Switch box)		2 no-1/2" NPT
	Casing material-Sensor		Brass /SS
	Enclosure(Switch box) Housing material		FRP or SS
	Operating Ambient temp(sensors)	DegC	-5 to 70 deg C
	Max allowed Voltage Drop across sensor	V	5 V
	Standard applicable		EN 60947-5-2 or equivalent.
	Applicable for		Manual valves and solenoid operated on-off valves

2.24	**LOCAL INSTRUMENT ENCLOSURE AND LOCAL INSTRUMENT RACK**		
	Scope		LIE and LIR complete with all fittings, mountings & accessories, drains and utility lighting, cable & grounding cable etc.
	Construction		
	Rack	mm	1.6mm sheet plate
	Frame	mm	3mm thick channel frame of steel
	Free standing type		Yes
	Rack		Yes, >=3mm thick steel, extended beyond the ends of the rack.
	Degree of Protection		IP-55 for LIE & JB of LIE/LIR
	Junction Box		Applicable
2.25	**JUNCTION BOX**		
	No. of ways		12/24/36/48/64/72/96/128
	Material and Thickness		4mm thick Fiberglass Reinforced Polyester(FRP)
	Type of terminal blocks		Rail mounted cage-clamp type suitable for conductor size upto 2.5 mm2. A M6 earthing stud shall be provided.
	Protection Class		IP- 55 min. for indoor & IP-65 min for outdoor applications.
	Grounding		To be provided
	Color		RAL 7035
	Spare Terminals		At least 20% unused terminals
2.26	**SPECIFICATIONS - FLOW SWITCH**		
	Type		Paddle/Piston/Disk
	Wetted part material		Stainless steel or Hastelloy for acidic application
	End connection		a) Threaded upto 1" line size with integral Tee b) Flanged for line size > 1 ½"
	Enclosure Material		Stainless Steel
	Enclosure		IP-55
	Switch Congfiguration		2 SPDT (5A, 240 V AC, 0.5A, 220 V DC)
	Repeatability	%	2%
	Cable connection		½"NPTF
	Accessories		a) Tee, Counter flange, nuts & bolts, suitable gasket etc b) 1 ½" NPT cable gland. c) Stainless steel nameplate with alpha-numeric engraved for
2.28	**Impulse piping for water area/equipment**		
	Painting color scheme		Grey RAL 9002
	Identification Tag/band color scheme		Sea green, ISC no. 217
2.29.2	**ROTAMETERS**		
	TYPE		VARIABLE AREA METAL TUBE
	FLUID MEDIA		WATER/OIL
	TUBE BODY		SS316
	MATERIAL OF FLOAT		SS316
	INDICATOR		LINEAR SCALE
	ACCESSORIES		FLANGE, ORIFICE IN CASE OF BYPASS ROTA METER (FOR LINE SIZE ABOVE 100 MM)
	HOUSING PROTECTION CLASS		IP-55
	ACCURACY		+/- 2% OF MEASURED VALUE

2.29.4	**DEW POINT METER**	
	Sensor	
	Type	Capacitance type with change in output proportional to moisture present.
	Service	Dry Air
	Range	SS316
	Sensor Accuracy	Better than +/- 0.5%
	Operating Temperature	0 to 50 degree C.
	Operating Pressure	0-10 Kg./Cm2, suitable for process application.
	HOUSING PROTECTION CLASS	IP-55
	ACCURACY	+/- 2% OF MEASURED VALUE
	Analyser	
	Input	Change in capacitance from dew point sensor.
	Display	Combined enclosure with two three-digit seven segments LED display with decimal point after two digits. LED height shall be 4 inches, clearly legible from a distance of atleast 10 meters.
	Range	SS316
	Display Accuracy	Better than +/- 2 Dehree C
	Mounting	Table top/Flush mounting, to be finalised during detailed engineering.
	Power Supply	240V AC, 50 Hz to be arranged by the contractor.
	Output	IP-55
	ACCURACY	5-20 mA DC capable of driving a load impedance of 500 ohms minimum
2.29.5	**SIGHT FLOW GLASS**	
	Type	Flapper nozzle type
	Body Material	SS304
	Flapper Material	SS316
	Cover plate Material	SS304
	Sight Glass/Window	Toughened Borosilicate
	Gasket	Neoprene
	End Connection	Flanged type(with nut and bolt)
	Flange Material	SS304
	Mating Flange	To be provided by bidder
	Material of Mating Flange	SS304

Notes: -

1) 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.

CLAUSE NO.	TECHNICAL REQUIREMENTS

2.00.00 **SPECIFICATION FOR ELECTRONIC TRANSMITTERS**

2.01.00 **SPECIFICATION FOR ELECTRONIC TRANSMITTER FOR PRESSURE, DIFF PRESS AND DP BASED FLOW / LEVEL MEASUREMENTS**

Microprocessor based 2 wire loop powered electronic transmitter with 4-20 mA DC HART output signal shall be provided.

Range	Accuracy (For calibrated Range)	Turndown (For span)	Stability (% of Calibrated range)
<=400mmwc	0.1%	20:1	+/-0.2% for 1 year
>400mmwc	0.060%	50:1	+/-0.25 % for 10 year
>250 kg/cm2	0.065%	10:1	+/- 0.15 % for 5 years
static pressure >420 kg/cm2	0.1%	10:1	+/- 0.2 % for 5 years

Above parameters/features of offered models shall be strictly as defined in standard published catalogue of the manufacturer only.

Transmitter shall have weatherproof IP-67 metallic housing with durable corrosion resistant coating, integral digital display with self-indicating diagnostics, Plug and socket type electrical connection for HART, calibration using HART, 2/3/5 Valve non integral manifold and rack with canopy. For HART transmitter SIL 2 certification is required. Overpressure shall be 150% of max. operating pressure.
For primary air and flue gas applications, DPT shall be provided for pressure measurement below range of 2000 mmWC.
For corrosive, viscous, solid bearing, slurry type process fluids, suitable diaphragm seal shall be provided. Parts below seal shall be removable for cleaning. Entire volume shall be completely filled with inert liquid suitable for instruments. LVDT type transmitter is not acceptable.

3.00.00 **Temperature Elements and accessories**

3.01.00 **Thermocouple**

Sr. No.	Features		Essential/Minimum Requirements
1	Type of Thermocouple.	:	16 AWG wire of Chromel-Alumel (Type K) or 24 AWG wire Pt-Rhodium Pt (Type R) depending on operating temperature Range (ungrounded separate junction type).
2	No. of element	:	Duplex
3	Housing/Head	:	IP-65/Diecast Aluminium. Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter (as applicable). Plug in connectors are to be provided for external signal cable connection. TE terminal head shall be spring loaded for positive contacts with the thermo well.
4	Insulation and Sheathing of Thermocouple	:	Swaged type mineral (magnesium oxide) insulation and SS316 sheath.
5	Calibration and accuracy	:	As per IEC-584/ ANSI-MC-96.1 (special limits of errors/ class1) for T/C.
6	Accessories	:	Thermo well and associated fittings
7	Standard	:	IEC-584/ ANSI MC 96.1 for Thermocouple and ASME PTC-19.3-2016 for Thermo-well

3.02.00 **Resistance Temperature Detector (RTD)**

Sr. No.	Features		Essential/Minimum Requirements
1	Type of RTD.	:	Four wire, Pt-100 (100 Ohms resistance at zero degree Centigrade).
2	No. of element	:	Duplex
3	Housing/Head	:	IP-65/Diecast Aluminum. Head of TE to be

				provided with sufficient space and arrangement to mount head mounted temperature transmitter (as applicable). Plug in connectors are to be provided for external signal cable connection. TE terminal head shall be spring loaded for positive contacts with the thermo well
	4	Insulation and sheathing of RTD	:	Mineral (magnesium oxide) insulation and SS316 sheath,
	5	Calibration and accuracy	:	As per As per IEC-751/ DIN-43760 Class-A for RTD
	6	Accessories	:	Thermo well and associated fittings
	7	Standard	:	IEC-751/ DIN-43760 for RTD and ASME PTC-19.3-2016 for Thermo-well.

NOTES :

1) The specifications for RTDs of winding/ bearings of motor/pump, can be as per their manufacturer standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice. However, the type of RTD shall be Pt100.

2) The specifications of temp elements for air conditioning & ventilation system / process can be as per system manufacturer's standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice.

3.03.00 Metal Temperature Thermocouples

Measuring Medium	Metal Temperature
Material of Thermocouple.	Chromel Alumel Type K
Type of Thermocouple	Duplex with ungrounded separate hot junctions
Insulation	Mineral Insulation (Magnesium Oxide).
Thermocouple wire gauge	18 AWG
Protective sheath	SS 321
Protective sheath dia.	6 mm OD (minimum)
Calibration & accuracy	As per IEC-584/ ANSI-MC-96.1 (special limits of error) for T/C
Mounting accessories	1/2" BSP SS sliding end connector, weld pad, clamps of heat resistant steel SS310. Adjustable gland fitting for connection at the junction box end as per manufacturer's standard.

	Cold end sealing	SS pot seal with colour coded PTFE Insulated flexible tails. Sealing compound- Epoxy resin. Length of PTFE insulated flying leads shall be minimum 750 mm.
	Minimum bending radius	30 mm
	Length of T/C	On as required basis considering location of measurement point and the JB/TTJB location.

Notes :

1) The specification for thermocouples of bearings metal temp measurements can be as per their manufacturer standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice. However, type of thermocouples shall be K-type.

2) For boiler metal temperature applications, considering the location of installations and response time, manufacturer's standard and proven specification for metal temperature measurement can also be accepted subject to employer's approval. The manufacturer shall submit adequate supporting documents for establishing their standard and proven practice.

3.04.00 **Thermo well** (for all process temp. elements)

(a) Shall be one-piece solid bored type of 316 SS of step-less tapered design. (As per ASME PTC 19.3, 2016)

(b) For Mill classifier outlet long life solid sintered tungsten carbide material of high abrasion resistance shall be provided.

(c) For Air & Flue gas 316 SS protecting tube with welded cap. (However, contractor shall provide better material for Flue gas service if required based on the specified boiler design parameters).

(d) For furnace zone, impervious ceramic protecting tube of suitable material along with Incoloy supporting tubes and adjustable flanges.

3.05.00 **Not Used**

3.06.00 **TEMPERATURE TRANSMITTER**

Minimum technical requirements shall be as follows:

Single input/Dual input temperature transmitter shall be 2-wire loop powered directly from 4-20mA input cards of DDCMIS. Transmitter shall be fully compatible with thermocouples and RTDs being provided. It shall be capable to handle Pt-100 RTD, Thermocouple –K, R & S types (selectable through HARTcalibrator). Temperature compensation for T/C shall be performed in the transmitter itself.

In case of failure (open or burn-out) of RTD/thermocouple, transmitter shall provide low temperature output. Transmitter shall be HART compatible, have EMC compatibility as per EN 61326, weather proof IP-67 metallic housing with durable corrosion resistant coating,

plug and socket type electrical connection for HART and 1/2" NPT(F) connection for , integral digital display with self-indicating diagnostics, operating ambient temperature of 85 deg C without display & 70 deg C with display, suitable for 2 inch pipe mounting in enclosure/rack . Composite Accuracy shall be as follows:. RTD =<0.25% of 0-250 deg C span, T/C -K type =<0.2 % of 0-600 deg C span, CJC accuracy (for T/C) shall be < 1 deg C.

Notes :

1. Dual input temperature transmitter shall have bump less changeover facility to second sensor in case first sensor fails. This changeover is to be alarmed in control system.
2. Composite accuracy is to be calculated as summation of all applicable accuracies of temperature transmitter for converting sensor input to output (e.g., A/D accuracy, basic accuracy, digital accuracy, etc.) and temperature effect on these accuracies at ambient temperature of 50 deg C, based on the figure/ formula given in the standard product catalogue for span as specified above for various types of temperature elements specified.

rd product catalogue for span as specified above for various types of temperature elements specified.

3. Above mentioned parameters/features of offered models shall be strictly as defined in standard published catalogue of the manufacturer only.
4. Dual input temperature transmitters can also be accepted in place of single input TT.

3.07.00 **Din rail temperature transmitter** 4-20mA HART based suitable for mounting on DIN-rails in JBs. The specifications of the JBs shall be same as indicated in Subsection INST CABLE with additional DIN-rails and IP 65 Protection class. This temperature transmitter shall be the ones which are especially designed for DIN-rail mounting with IP 20 protection class. These shall have terminals for input/output provided on front side when mounted on DIN-rail. Head mounted temperature transmitter with clamps to make it suitable for DIN-rail mounting shall not be acceptable under this category. Accuracy of Din rail should be:. RTD =<0.4% of 0-250 deg C span, T/C -K type =<0.4 % of 0-600 deg C span, CJC accuracy (for T/C) shall be < 1 deg C. Oher specifications shall be as mentioned in clause 3.06.00. Exact applications shall be as defined in PART-A of specifications.

3.08.00 **Multi Input Temperature transmitter (Temperature Multiplexer)**

For only information related temperature inputs fieldbus based Multi input temperature transmitters can be provided. Transmitters shall be capable of withstanding ambient temperature up to 85 deg C. Maximum number of inputs per such temperature transmitter shall be eight. One (1) no. input shall be kept as spare wired up to TBs of field mounted panel in each multi-input TT. These shall be installed in field mounted panels with minimum IP 55 protection class. Exact applications shall be as defined in PART-A of specifications.

17.00.00 **SOLENOID VALVES**

Solenoid valves shall fulfil the following requirements:

a. Type 2/3/4-way SS 316/Forged Brass (depending on the application subject to Employer's approval during detailed Engg.)

b. Power supply: 24 V DC ± 10%.

c. Plug and socket electrical connection.

d. Insulation: Class 'H'

e. IP Class: IP65

18.00.00

Limit Switch

For offsite plant (except PT, DM, Chlorination, chemical treatment, Liquid effluent treatment) application Limit switches shall be silver plated with high conductivity and non-corrosive type. Contact rating shall be sufficient to meet the requirement of DDCMIS subject to a minimum of 60 V, 6 VA rating. Protection class shall be IP 55.

For main plant application limit switches are to be provided as per contractor standard and proven practice.

For PT, DM, Chlorination system, chemical treatment, Liquid effluent treatment plant , limit switches of manual valves and solenoid operated on-off valves shall be of inductive proximity type and shall be mounted inside the enclosure: pl. refer the minimum specification requirement below .

Operating voltage Range	10-40 V DC
Sensing system	Inductive Proximity type, 2 Wire
Sensor Contact Type	NO
Reverse polarity and short circuit protection	Yes
IP Class-Sensor	IP67
IP Class-Enclosure(Switch box)	IP67
Cable entry-Enclosure(Switch box)	2no-1/2" NPT
Casing material-Sensor	Brass /SS
Enclosure(Switch box) Housing material	FRP or SS
Operating Ambient temp(sensors)	-5 to 70 deg C
Max allowed Voltage Drop across sensor	5 V
Standard applicable	EN 60947-5-2 or equivalent.

20.00.00 **AC PLANT RELATED SPECIAL INSTRUNMENTS**

20.01.00 **HUMIDITY SENSOR**

Sensor	:	Capacitance type
Accuracy	:	+/-3% R.H
Range	:	0-100% R.H
Output	:	4-20 ma
Time constant	:	2 mins.

Output from the sensor is to be connected to respective control system. Contractor can also provide combined instrument for measurement of humidity and temperature subject to Employer's approval during detailed engineering. In all such cases, 4-20 ma outputs, each for temperature and humidity measurements are to be provided.

20.02.00 **TEMPERATURE/ HUMIDITY INDICATOR**

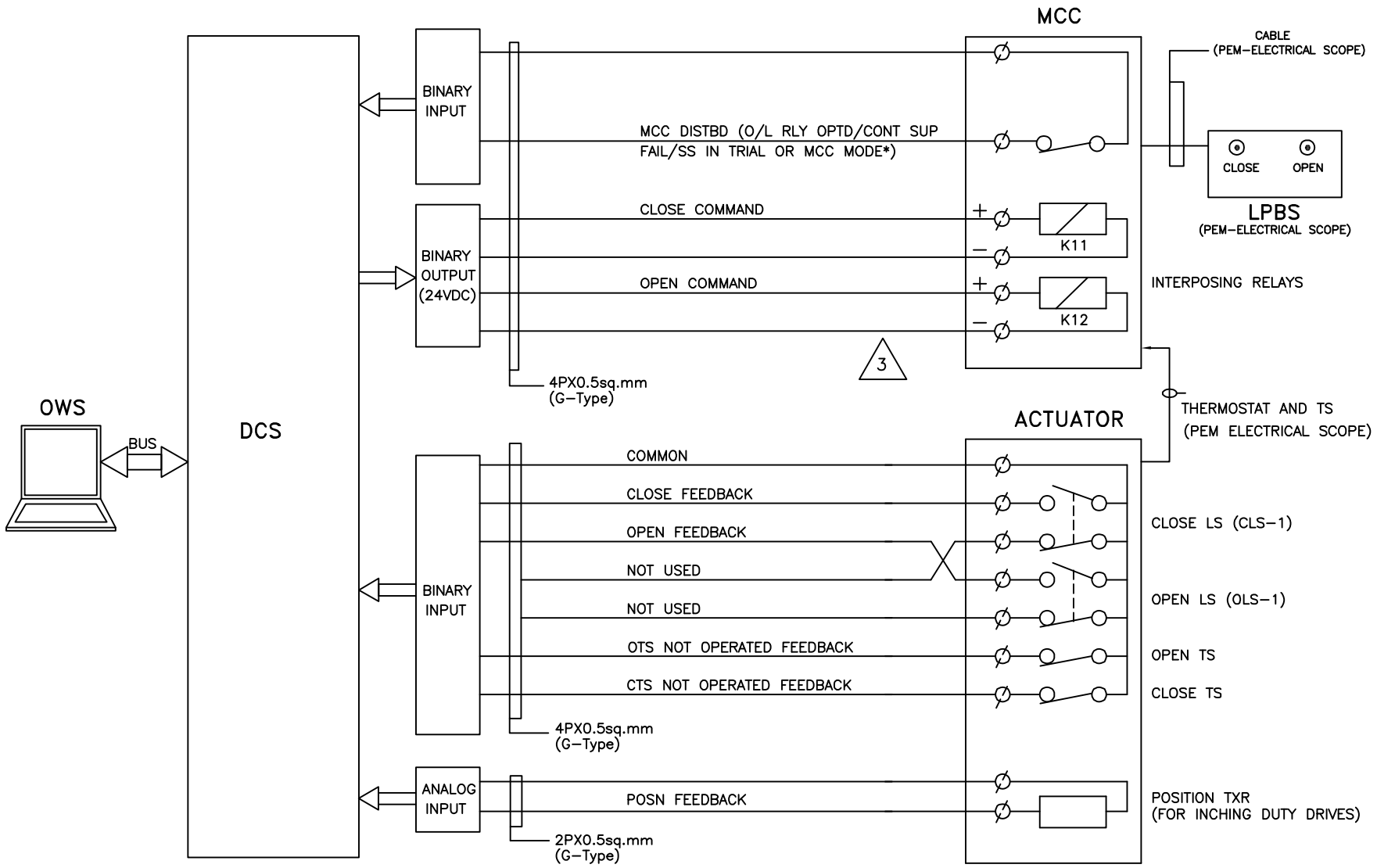
Sensor	:	RTD for(Pt 100) for temperature
	:	Capacitance Type for Humidity (specs for humidity and temperature shall be as mentioned above)
Display	:	Combined enclosure with two three-digit seven segments LED display with decimal point after two digits. LED height shall be 4 inches, clearly legible from a distance of at least 10 meters.
Range	:	0-60 Deg C for temperature.
	:	0-95.0 % for Relative Humidity.
Accuracy	:	Better than +/_0.5 % for Temperature
	:	Better than +/_2.5 % for Relative Humidity
Mounting	:	Tabletop/ wall mounting.
Power supply	:	240 V AC, 50 Hz.
Output	:	4-20 mA signal each for temperature.
Qty.	:	15 nos. each of temperature & Humidity indicators (combined indicators for Humidity and temperature is also applicable).

One Set of output signal is to be connected to respective control system. Apart from displaying the temperature/humidity values on indicator.

SIGNL EXCHANGE BETWEEN DRIVES & DCS

APPLICABLE FOR KORADI,KORBA WEST,UKAI,YAMUNANAGAR,RAGHUNATHPUR

DCS INTERFACE FOR BIDIRECTIONAL DRIVE (WITH MCC)

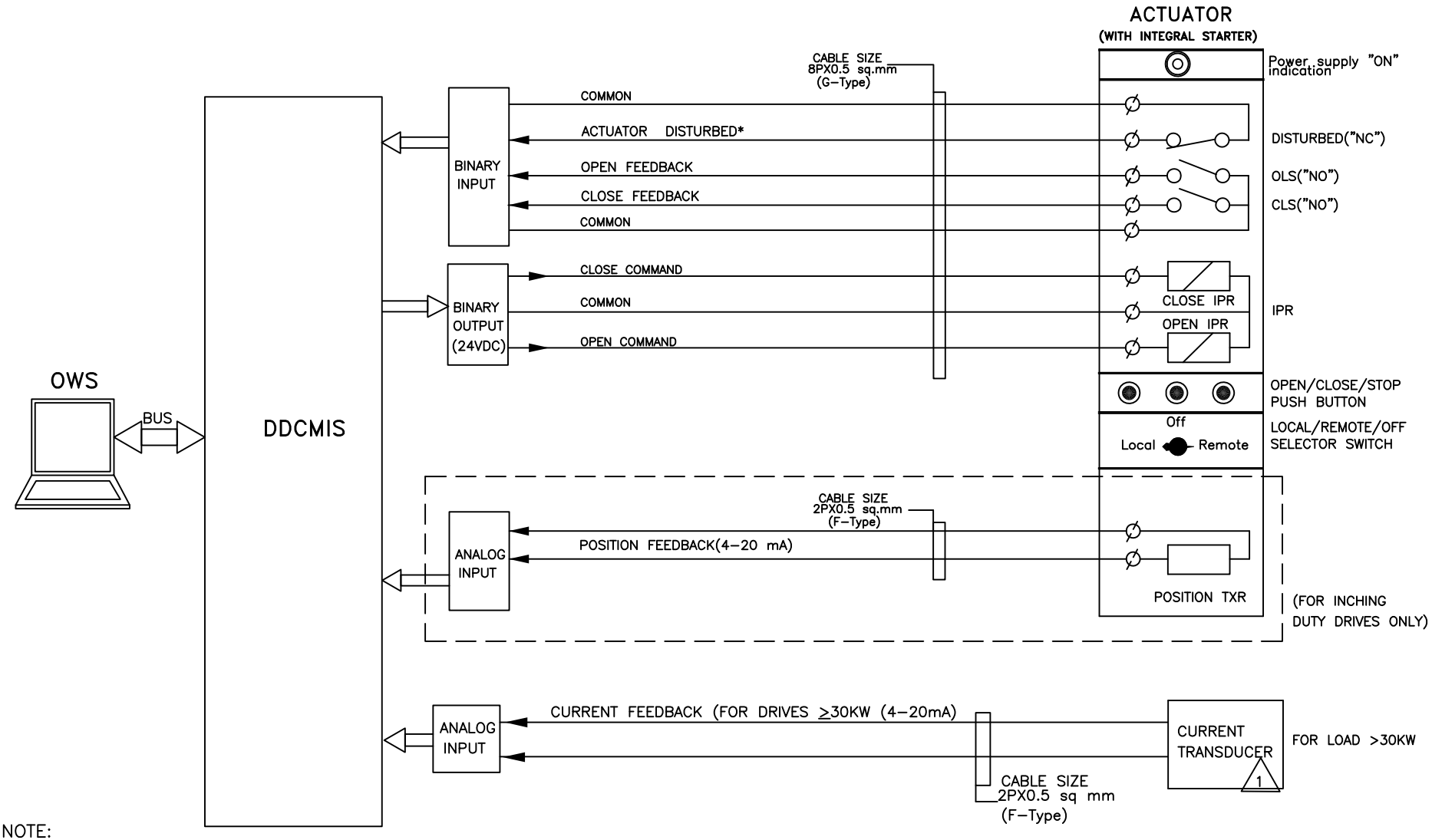


* SELECTOR SWITCH IN TRIAL(LOCAL) OR MCC(TEST) POSITION 2

BHEL Maharatna Company	PROJECT: 2X660 MW KORADI TPP UNIT 11&12 – BTG	DRG.NO.	PE–DM–527–145–H002
		DATE	20.08.2025
	TITLE: DDCMIS INTERFACE FOR BIDIRECTIONAL DRIVE	REV.NO.	05
		SHT	9 OF 13

APPLICABLE FOR YAMUNANAGAR

DDCMIS INTERFACE FOR BIDIRECTIONAL DRIVE(WITH INTEGRAL STARTER)



NOTE:

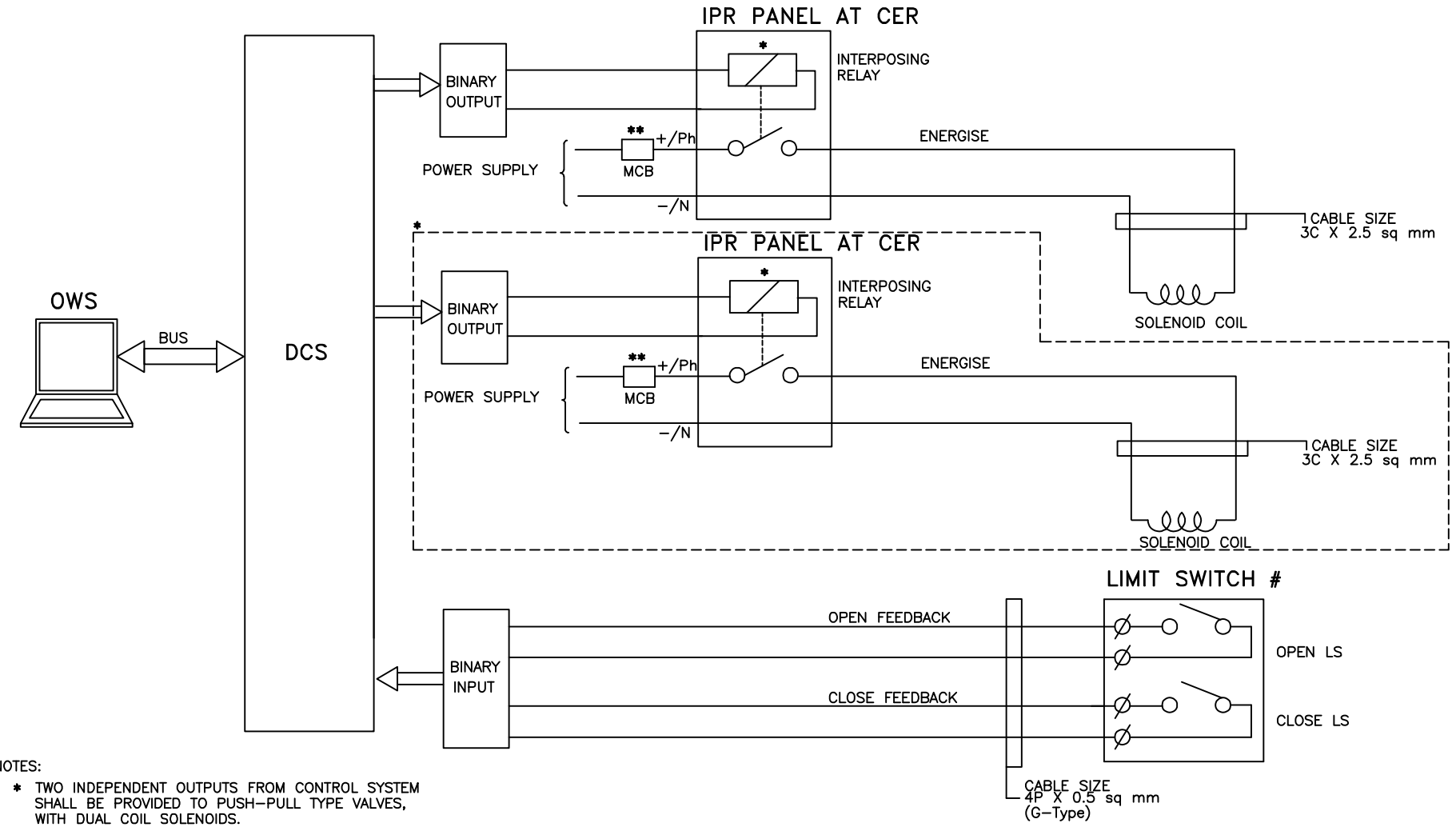
1. * DISTURBED= LOSS OF POWER SUPPLY (1 PHASE/3 PHASE)/ LOSS OF CONTROL SUPPLY/ THERMAL OVER LOAD / LOCAL/REMOTE SEL. SWITCH IN LOCAL

2. POSITION FEEDBACK OF BIDIRECTIONAL INCHING DUTY DRIVES IN VICINITY MAY BE GROUPED TOGETHER IN THE FIELD DURING CABLE ENGG. USING JUNCTION BOXES & SINGLE TRUNK CABLE OF HIGHER SIZE MAY BE USED TO CONNECT.

3. REDUNDANCY OF IOs SHALL BE AS PER CONTRACT SPECIFICATION REQUIREMENT

PROJECT: 1x800MW YAMUNANAGAR STPP		DRG.NO. PE-DM-510-145-H002
1	DDCMIS INTERFACE FOR BIDIRECTIONAL DRIVE	DATE 20.12.2024
		SHT 6 OF 10

DCS INTERFACE FOR SOLENOID DRIVE
(24V DC / 240V AC UPS)



NOTES:

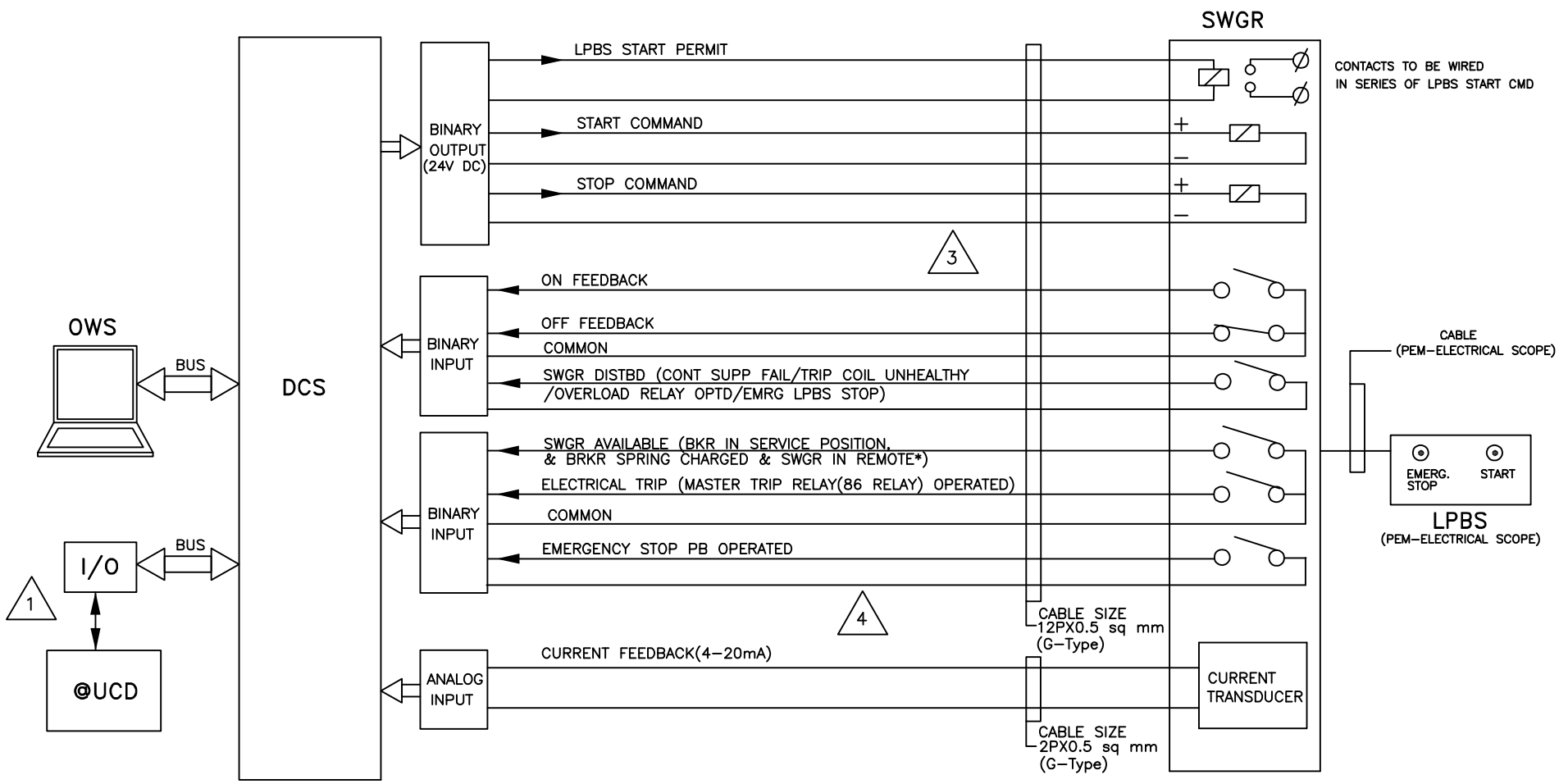
* TWO INDEPENDENT OUTPUTS FROM CONTROL SYSTEM SHALL BE PROVIDED TO PUSH-PULL TYPE VALVES, WITH DUAL COIL SOLENOIDS.

** MCB SHALL BE PROVIDED FOR EACH SOLENOID

\# FOR ON/OFF TYPE, SOLENOID ACTUATED CONTROL VALVE.

BHEL Maharatna Company	PROJECT: 2X660 MW KORADI TPP UNIT 11&12 – BTG	DRG.NO.	PE-DM-527-145-H002
		DATE	20.08.2025
	TITLE: DDCMIS INTERFACE FOR SOLENOID DRIVE	REV.NO.	05
		SHT	11 OF 13

DCS INTERFACE FOR HT/LT UNIDIRECTIONAL DRIVES(BREAKER OPERATED)



@ WHEREVER APPLICABLE

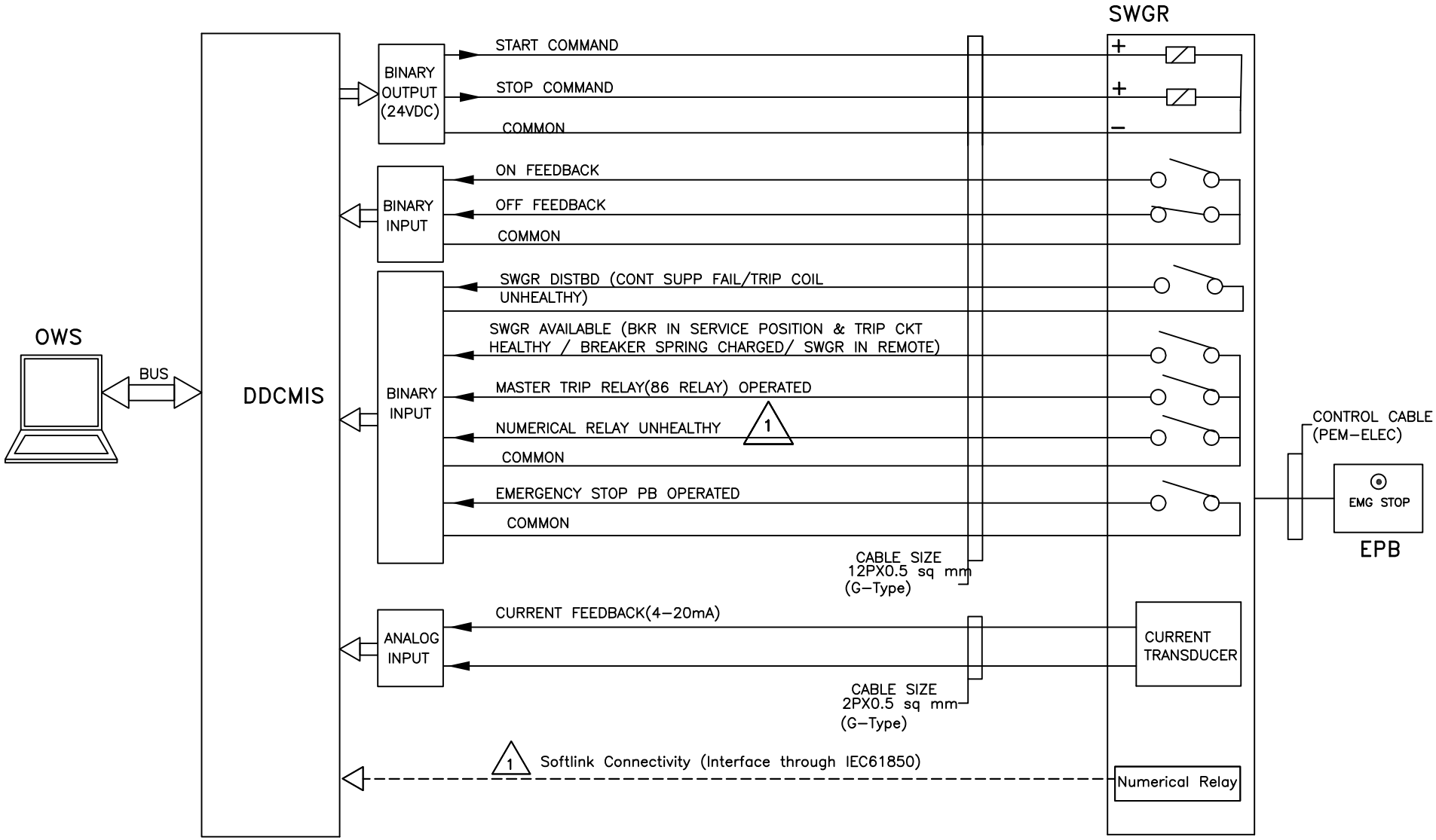
* SELECTOR SWITCH IN NORMAL(REMOTE) POSITION 2

NOTE:- INTERPOSING RELAYS(IPRs) TO BE SUPPLIED ALONG WITH SWITCHGEAR.

BHEL Maharatna Company	PROJECT: 2X660 MW KORADI TPP UNIT 11&12 – BTG	DRG.NO.	PE-DM-527-145-H002
		DATE	20.08.2025
	TITLE: DDCMIS INTERFACE FOR UNIDIRECTIONAL HT DRIVE	REV.NO.	05
		SHT	12 OF 13

APPLICABLE FOR YAMUNANAGAR

DDCMIS INTERFACE FOR HT/LT UNIDIRECTIONAL DRIVES(BREAKER OPERATED)



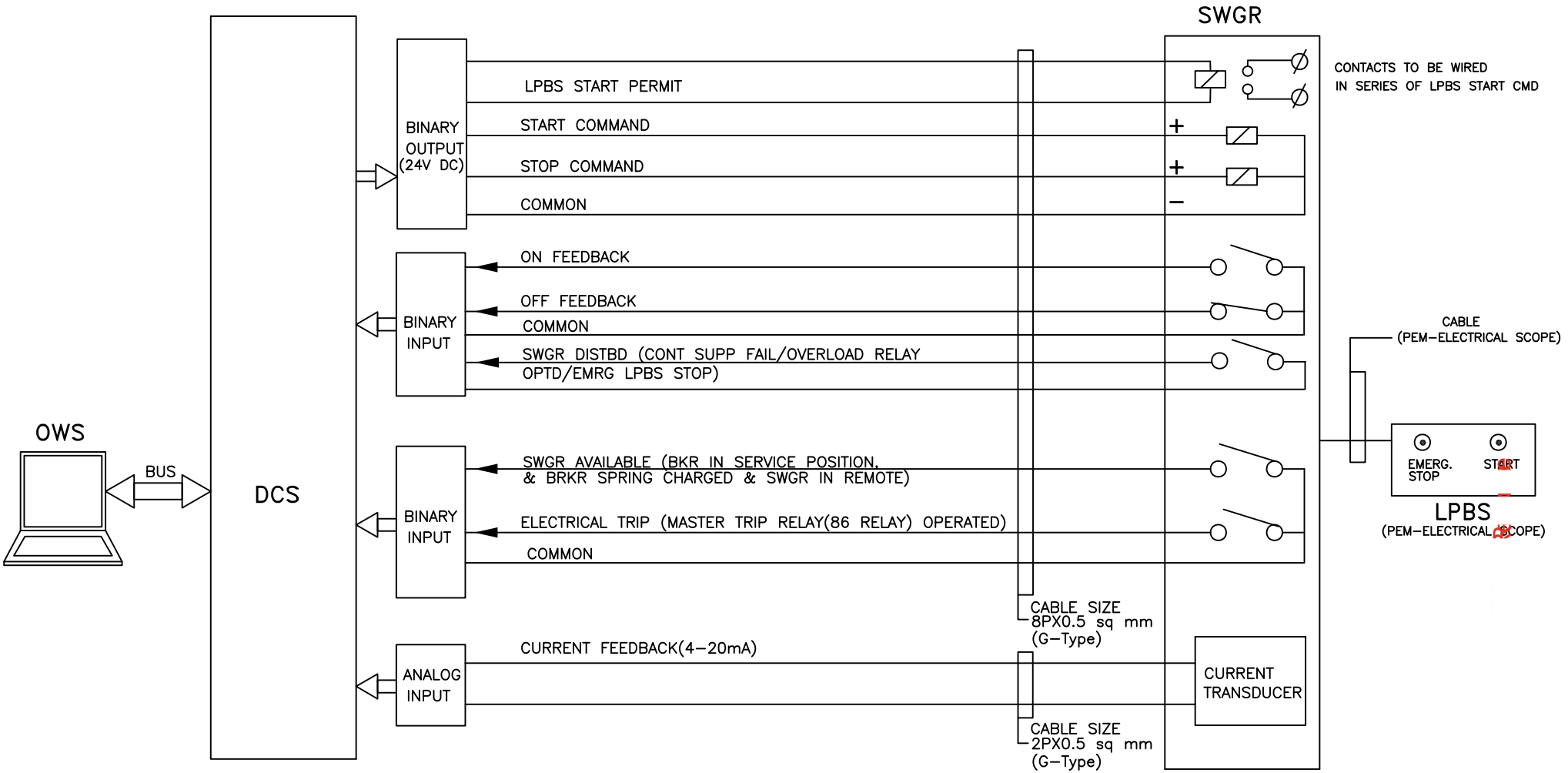
NOTE: 1

1. VIBRATION, WINDING & BEARING SIGNALS SHALL BE INTERFACED WITH DDCMIS & INCLUDED IN EDN DOCUMENT
2. REDUNDANCY OF IOs SHALL BE AS PER CONTRACT SPECIFICATION REQUIREMENT

PROJECT: 1x800MW YAMUNANAGAR STPP	DRG.NO. PE-DM-510-145-H002
DDCMIS INTERFACE FOR UNIDIRECTIONAL HT/LT DRIVE (BRKR OPERATED)	DATE 20.12.2024
	SHT 9 OF 10

APPLICABLE FOR UKAI

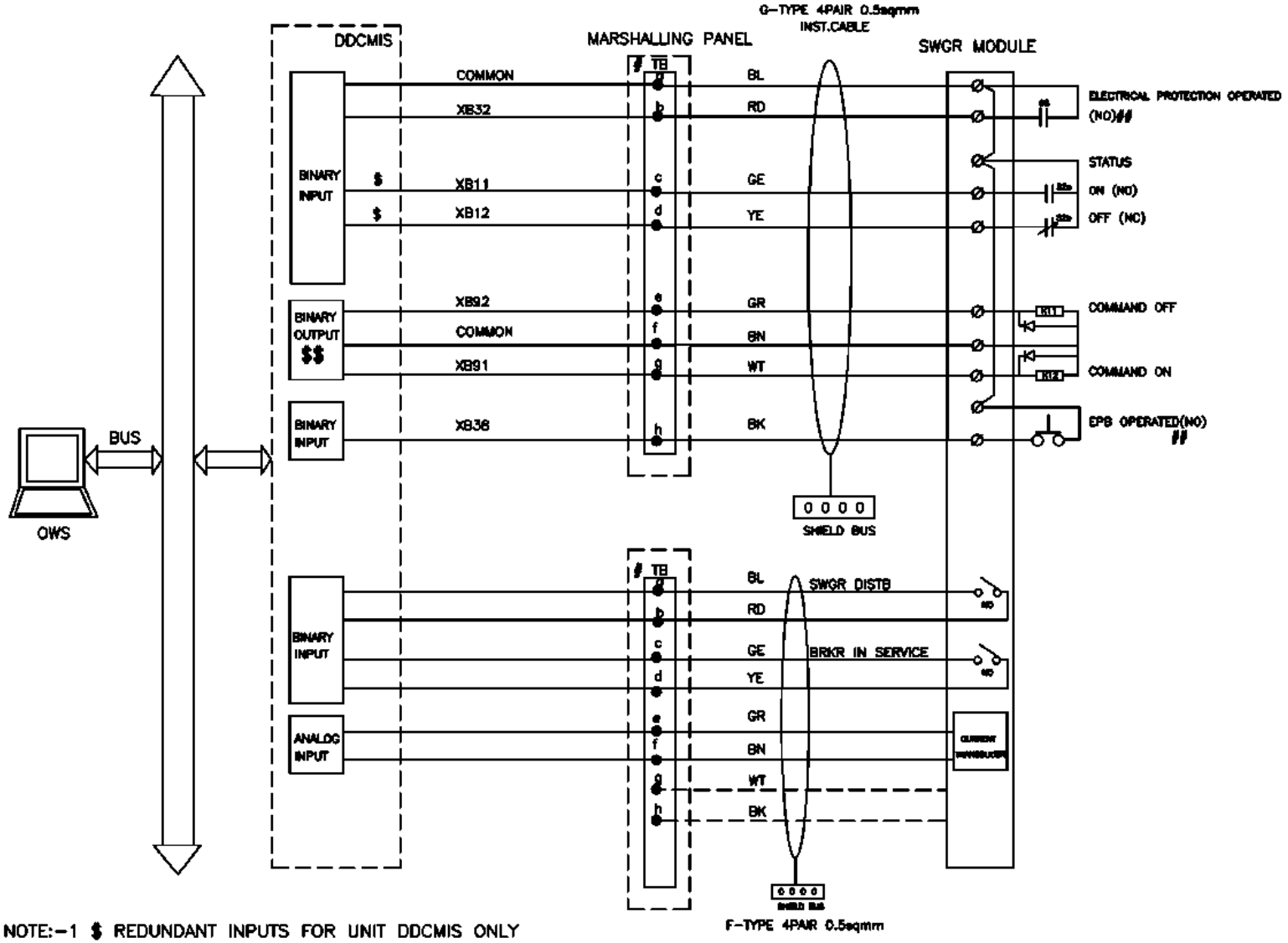
DCS INTERFACE FOR HT/LT UNIDIRECTIONAL DRIVES(BREAKER OPERATED)



NOTE:- INTERPOSING RELAYS(IPRs) TO BE SUPPLIED ALONG WITH SWITCHGEAR.

BHEL Maharatna Company	PROJECT: 1X800MW SUPER CRITICAL TPP UNIT NO.7 ON ASH DYKE AREA AT UKAI	DRG.NO.	PE-DM-529-145-H002
		DATE	01.09.2025
	TITLE: DDCMIS INTERFACE FOR UNIDIRECTIONAL HT DRIVE	REV.NO.	00
		SHT	11 OF 12

DDCMIS INTERFACE WITH HT SWITCH GEAR (HT)



NOTE:-1 $ REDUNDANT INPUTS FOR UNIT DDCMIS ONLY

NOTE:-2 $$ REDUNDANT OUTPUTS WHEREVER APPLICABLE

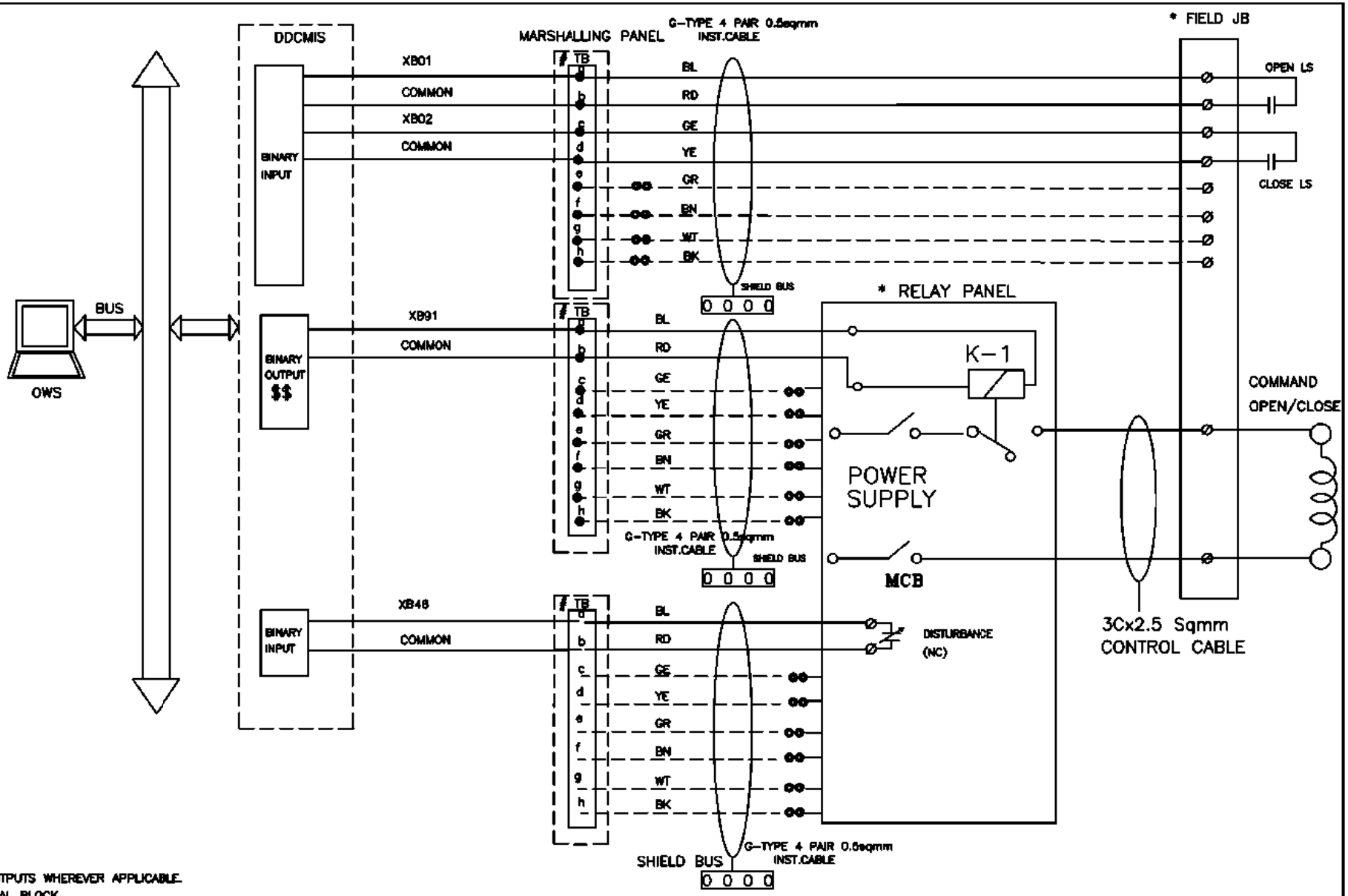
NOTE:-3 # 8 LEVEL TERMINAL BLOCK

NOTE:-4 ## DI-SOE SIGNALS FOR UNIT DDCMIS ONLY

NOTE:-5 CURRENT SIGNAL IS TO BE CONSIDERED IN DDCMIS FROM HT BREAKER FOR FD,ID,PA,MILL MOTORS, CHP HT CONVEYORS,BFP,CEP, HT DRIVES FOR FGD

BHEL		DRG.NO.	
	DDCMIS INTERFACE WITH HT SWITCH GEAR(HT)	SH	04 OF 34

DDCMIS INTERFACE WITH SOV/O/L(WITH FEED BACKS)

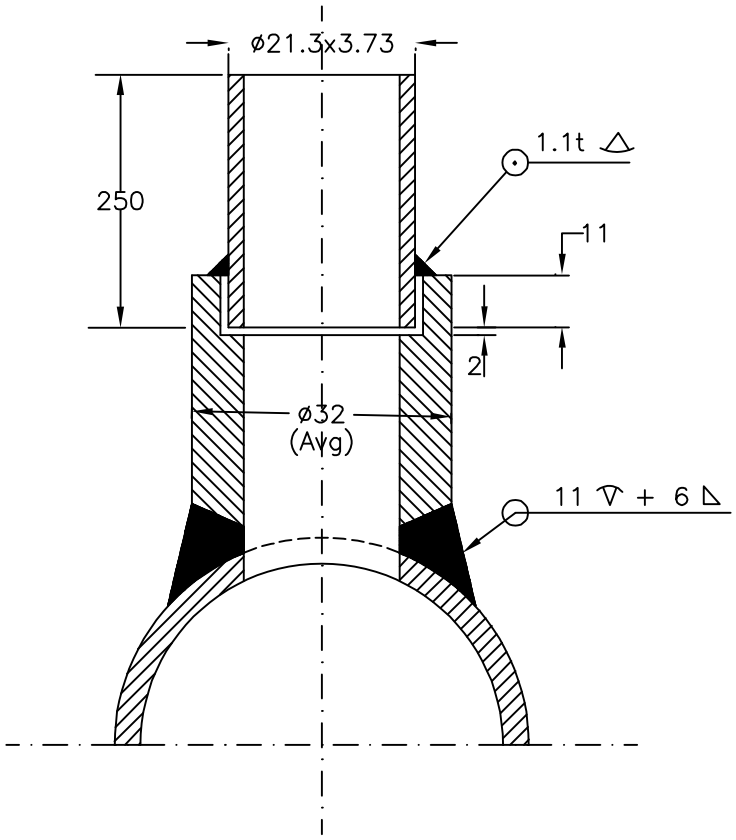


NOTE:-1 $$ REDUNDANT OUTPUTS WHEREVER APPLICABLE.
NOTE:-2 # 8 LEVEL TERMINAL BLOCK.
NOTE:-3 ●● INEACH DDCMIS POST,UNUSED TB'S ARE USED FOR SPARE CORE TERMINATION.
NOTE:-4 * FEEDBACKS/COMMANDS OF DSOV/SOV CAN BE GROUPED IN FIELD JB/RELAY PANEL AND MULTIPAIR/ MULTICORE CABLE IS TO BE USED FOR GROUPED SIGNALS FROM FIELD JB/RELAYPANEL TO MARSHALING PANEL.
NOTE:-5 FOR ON/OFF TYPE,SOLENOID ACTUATED CONTROL VALVE.

BHEL		DRG.NO.	9585-001-405-PVI-B-152B
	DDCMIS INTERFACE WITH SOV/O/L(WITH FEEDBACKS)	SHT	12 OF 34

INSTRUMENT INSTALLATION & HOOKUP DIAGRAM

APPLICABLE FOR KORADI,KORBA WEST,UKAI,YAMUNANAGAR,RAGHUNATHPUR

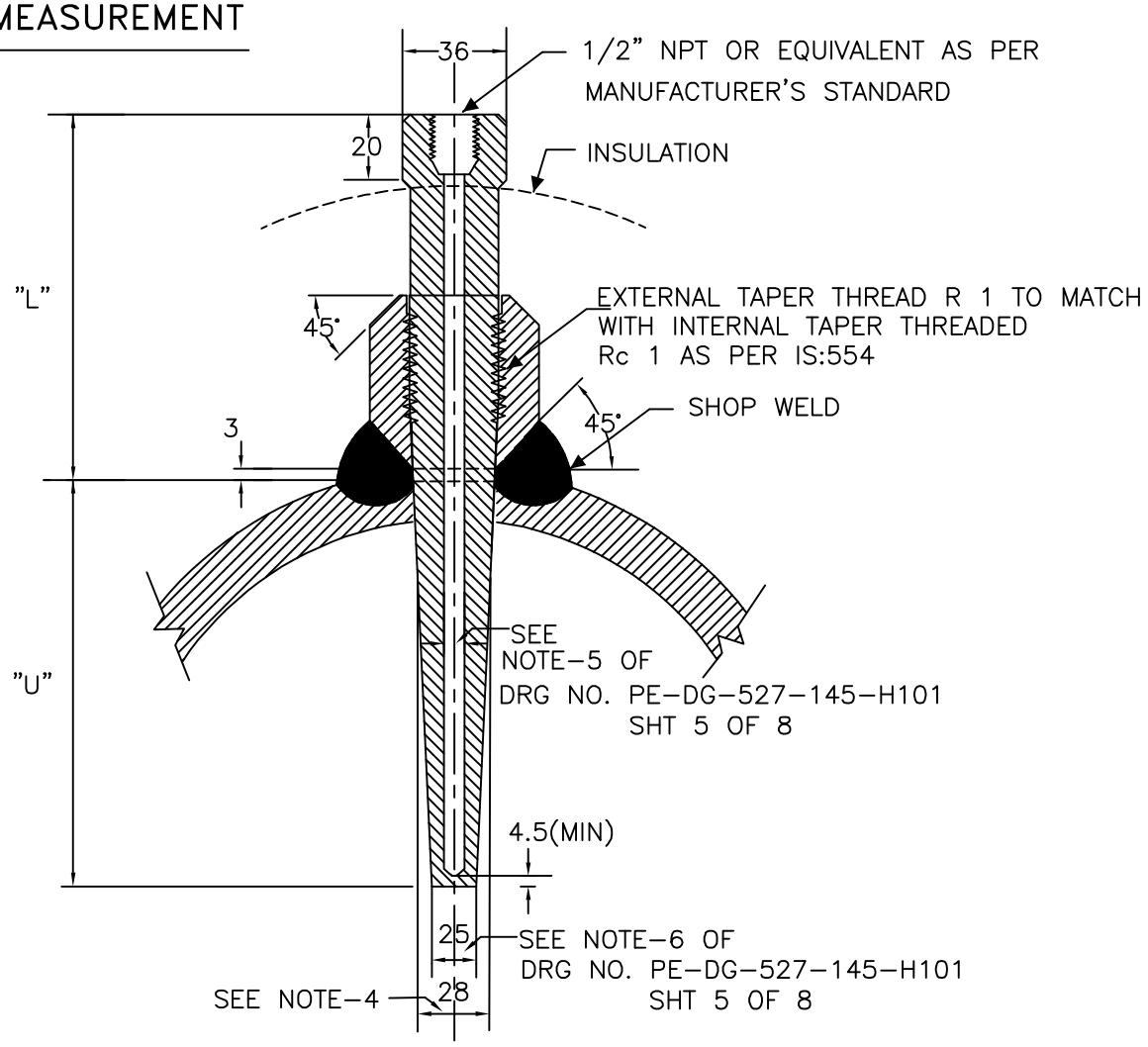


NOTE :

1. MATERIAL OF THE BOSS AND NIPPLE SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED AND CONFORM TO ANSI B16.11.
2. THE LENGTH OF NIPPLE SHALL BE 250 MM.
3. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE INDICATED
4. EDGE HOLE MUST BE CLEAN AND SQUARE OR ROUNDED SLIGHTLY (1/64" RADIUS) FREE FROM BURRS, WIRE EDGES OR OTHER IRREGULARITIES

BHEL	TITLE : INSTRUMENT STUB DETAILS FOR PRESSURE MEASUREMENT (PRESS < 60Kg/Cm2, TEMP < 425DegC & Nb15, CLASS 3000#)	DRG. NO. PE-DG-527-145-H101 REV. 00 SH. 4 OF 8 SHS.

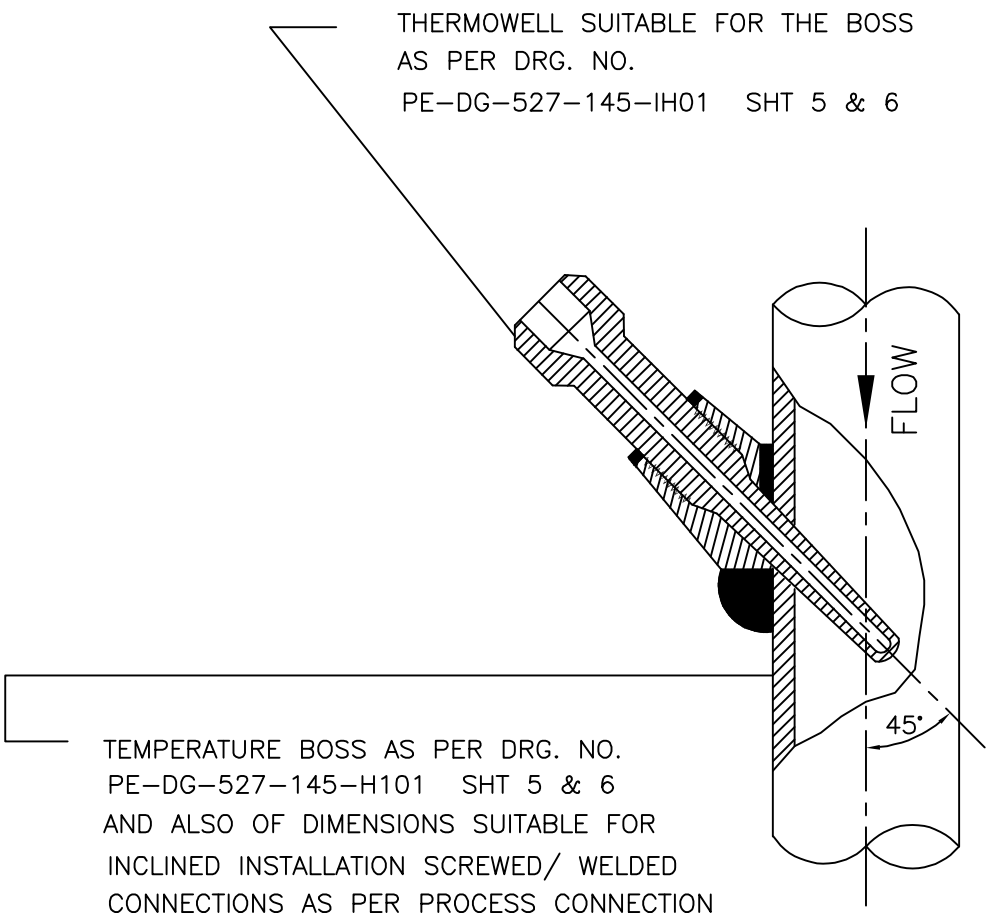
TEMP. MEASUREMENT



NOTES :-

1. THIS TYPE OF TEMPERATURE BOSS IS APPLICABLE FOR THE DESIGN PRESS/ TEMP BELOW 40 KG/CM2(g)/400°C.
2. FOR PRESS. TIGHT JOINTS THE BOSS SHOULD HAVE INTERNAL TAPERED PIPE THREAD Rc 1 AS PER IS:554. THE LENGTH OF THREAD ENGAGEMENT SHOULD BE AS PER ABOVE STANDARD.
3. SEE NOTES-2 TO 8 IN SHT. 5 OF 8 OF THIS DRG.
4. THERMOWELL SHALL BE SUITABLE TO MATCH THE STUB DIMENSIONS AS PER Rc 1.
5. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE INDICATED

भेल BHEL	TITLE : INSTRUMENT STUB DETAILS FOR TEMPERATURE MEASUREMENT (APPLICABLE FOR PIPE SIZE ABOVE 4") [DESIGN PRESS < 40 Kg/Cm2 (g) & DESIGN TEMP < 400 C]	DRG. NO. PE-DG-527-145-H101 REV. 00 SH. 6 OF 8 SHS.



NOTES :–

1. INCLINED INSTALLATION OF THERMOWELL SHALL BE APPLICABLE FOR 4" AND SMALLER LINE SIZE BUT LIMITED TO MIN. 3" LINE SIZE.
2. FOR 2" AND SMALLER LINE SIZE NECESSARY EXPANDER OF MIN. 3" SIZE OF MAIN PIPING SPECIFICATION SHALL BE USED.
3. THIS TYPE OF INSTALLATION IS APPLICABLE FOR HORIZONTAL AND VERTICAL PIPE SECTION.
4. FOR STEAM SERVICES EXPANDER SECTION TO BE USED ONLY IN VERTICAL RUN.
5. THE EXPANDER SECTION SHALL BE OF ADEQUATE LENGTH (AT LEAST 3–4 TIMES DIA OF THE MAIN PROCESS PIPE AT BOTH SIDES OF THE INSTALLED THERMOWELL).

भेल BHEL	TITLE : INSTRUMENT STUB DETAILS FOR TEMPERATURE MEASUREMENT THERMOWELL INSTALLATION	DRG. NO. PE–DG–527–145–H101 REV. 00 SH. 7 OF 8 SHS.

PERFORMANCE GUARANTEES

The contractor shall meet the performance/ functional guarantees for the compressed Air System as mentioned herein. Format for recording performance/ functional guarantees is also attached with this section.

CATEGORY-I GUARANTEES

Auxiliary Power Consumption for Compressed Air System

CATEGORY-II GUARANTEES

Noise level for Compressors

CATEGORY-III GUARANTEES

PERFORMANCE GUARANTEES TO BE DEMOSTRATED AT SITE	
S.N.	**DESCRIPTION OF TESTS TO BE PERFORMED**
i)	Parallel operation of air compressors
ii)	Dew point of air at the outlet of air drying plants of instrument air compressor.
iii)	Pressure drop across the air drying plants of air compressors.
iv)	Vibration level of air compressors, blowers of air drying plant
PERFORMANCE GUARANTEES TO BE DEMOSTRATED AT SHOP	
S.N.	**DESCRIPTION OF TESTS TO BE PERFORMED**
i)	Capacity and discharge pressure of each air compressor.

Penalties for poor performance

Category-I Guarantees

Accept the equipment/system/plant after levying Liquidated Damages as specified hereunder. The liquidated damages, for shortfall in performance, that is auxiliary power consumption for the system, has been indicated separately for each project in price schedule.

The liquidated damages shall be prorated for the fractional parts of the deficiencies. The performance guarantees coming under this category shall be called ‘Category - I’ Guarantees.

Category-II Guarantees

In case the performance guarantee(s) are not met by the Contractor during demonstration test, the Contractor shall carry out all necessary modifications and/or replacements to comply with the guaranteed requirements at no extra cost to the Employer and re-conduct the performance guarantee test(s) with Employer’s consent. If, however, the demonstrated guarantee(s) are not met even after the above modifications / replacements within ninety (90) days, it will be concluded that, the equipment has failed to meet the guarantee(s). In such a case, Employer shall Reject the equipment/plant/system and recover from the Contractor the payments already made. The performance guarantees under this category shall be called 'Category - II ' Guarantees.

Conformance to the performance requirements under Category -II is mandatory.

Category-III Guarantees

Accept the equipment/system after assessing the deficiency in respect of the various ratings, performance parameters and capabilities and recover from the contract price an amount equivalent to the damages as determined by the EMPLOYER. Such damages shall, however be limited to the cost of replacement of the equipment(s) / system(s) replacement of which shall remove the deficiency so as to achieve the guarantee performance. These parameters/capacities shall be termed as category - III, guarantees.

Standard TG PG Test Procedure of Compressed air System

	Station Name--- Capacity	
1	**OWNER**	**Name----------**
2	**CONTRACTOR**	**Name----------**
3	**CONTRACT No.**	
4	**SUB-CONTRACTOR**	
5	**OWNER's Doc. No./Rev No**	
6	**CONTRACTOR's Doc. No. / Rev No.**	/
7	**SUB-CONTRACTOR's Doc No. / Rev. No.**	/
8	**DRG./DOC. Title**	**PG TEST PROCEDURE FOR Compressed air System**
9	**PURPOSE**	**FOR APPROVAL**

REVISION STATUS FOR OWNER'S DOCUMENT

Revision No.	Date	Name (On behalf of Owner)	Comment	Date	Name On behalf of Contractor)	Comment	Remarks

OWNER's APPROVAL			CONTRACTOR's APPROVAL		
Authorized Representative	signature	Name	Authorized Representative	Signature	Name
Approved by			Approved by		
Checked by			Checked by		
Prepared by			Prepared by		

CLAUSE NO.	TECHNICAL REQUIREMENTS

CONTENTS

Test Parties: -

a. Witness :- END CUSTOMER

b. Contractor: - BHEL

c. Sub- Contractor: - ----------Name of organization

This document provides the Performance Guarantee Test Procedure for ***Compressed Air System*** *Station Name----------, capacity------- to confirm that the following item meet the guarantee value as per BHEL* ***technical specification Functional Guarantee & Liquidated Damage (FGLD)*** *&* ***Attachment 10*** *(whichever is applicable).*

Scope: - PG test shall be Conducted as per Contract. The test procedure shall cover the performance test to be conducted at site for the Compressed air system and accordingly listed in this procedure. The test procedure shall cover the testing method for technical para meters, checking of ratings and performance requirements stipulated for various equipment covered in this procedure.

2. OBJECTIVE OF THE TEST: -

The objective of test is to be checking following parameters of air compressed system:

1. To check healthy condition of all equipment forming total compressed air system.
2. Operating parameters of the system to be logged for the complete cycle with online (calibrated) instruments at the time of test.
3. To check satisfactory operation of all safety switches and electrical interlocks for each individual equipment and for the complete system.
4. To check healthy condition of all electrical as well as instruments installed on air compressed system.
5. Operability test of balance system which cannot be operated/checked at the vendor's work/plant
6. Check parallel operation of working compressors
7. To check pressure, drop across ADP, capacity & outlet dew point of each ADP (Air Dryer Plant).
8. Noise level measurement, vibration/shock pulse measurement shall be conducted.
9. The capacity measurement & power consumption of the compressors shall be conducted either at the shop floor or test bed of vendor workshop. Signed Copies of the test reports by VENDOR & END CUSTOMER shall be furnished during the site PG test & it will be acceptable to both parties

VENDOR TO QUOTE/INCLUDE THE SUITABLE VALUE OF GUARANTEED PARAMETERS VALUE FOR SL NO, 6,7,8, 9 AS PER BHEL TECH SPECS (FGLD SHEET) ATTACHMENT 10 & APPROVED TECH DATA SHEET (WHICHEVER IS APPLICABLE)

3. Test conditions responsibility & prerequisites before the test

i. Conductance of PG test by representatives of Vendor and End Customer as per the approved PG test Procedure.

ii. Contractor shall be given permission to inspect the system in advance and make it ready for the test.

iii. To ensure Continuous run of plant for at least two hours for stabilization of the system before commencement of PG test.

iv. Availability of approved data sheets for the plant/system during the test.

v. To ensure Cleanliness of Plant/System, filters etc & uninterrupted power supply within specified parameters during the test.

vi. Availability of suitable fire protection system/firefighting equipment's to be ensured.

vii. Successful completion of trial operation of Compressors.

CONTRACTOR

I. Deputation of team to site to associate with the test to be ensured by the Contractor

II. Readiness of Formats as well instrument availability for Recordings of Parameters for PG test requirements.

III. Responsibility for conducting the test rests with Contractor.

IV. Calibration of all instruments used during the test in an approved NABL labs/ labs certified by End Customer & Hand over of all calibration certificates (in original) to End Customer at least 15 days before start of PG test.

V. All the installation / commissioning protocols in respect of alarm/ annunciation/ control system, pipeline flushing, vibration & noise level measurement data of motors, fans & pumps during commissioning shall be made available during Guarantee Test.

VI. Readiness of all protections, interlocks and safety switches to be ensured. Joint protocol in this respect shall be signed before the Test.

VII. Sufficient skilled/ required Manpower availability & removal of Instruments as required/Instructed by End Customer.

The plant/ system shall be jointly inspected by End Customer and the contractor and a joint protocol shall be signed that the plant is fit for conducting guarantee Test

TEST INSTRUMENTS

All instruments required for the site performance test shall be provided/arranged by the Contractor. The instruments furnished below shall be used for the purpose of the PG. If additional instruments are required for the test, the same shall be arranged by supplier at the time of testing. **Calibration of all instruments used during the test in an approved NABL labs/ labs certified by End Customer & Hand over of all calibration certificates (in original) to End Customer at least 15 days before start of the PG test.**

- *Bearing Temperature* is to be measured using RTD by 0.5 % accuracy or better.
- *Pressure gauges* shall be used for recording the parameters of pumps. Accuracy 0.5 % or better.
- *Wattmeter* of + 0.5 % accuracy class or better shall be used for power consumption measurement.
- **Vibration & Noise level** of motors, fans & pumps shall be measured by calibrated instruments.
- **Manometer** to be used for measurement of pressure drop across filters.

- Voltage and current shall be measured using *tong tester/Clamp meter* of +/- 0.5 % accuracy class or better.

TEST METHODOLOGY

- **AIR DRYER**

DEW POINT

The demonstration of the Dew point temperature at atmospheric pressure at the rated full load to be carried out at site. The atmospheric Dew point temperature at the air dryer outlet shall be --------- deg C as per approved Dryer datasheet drawing no ----------specification. The graph showing the relation between Atmospheric dew point (ADP)

& Pressure dew point(PDP) shall be provided by Contractor.

- PRESSURE DROP ACROSS AIR DRYER

The pressure drops across the air dryer, while the dedicated Instrument air compressor and dryer combination is working together at the rated load shall be recorded.

- AIR COMPRESSOR

PROTECTION AND ALARM CHECK

Operation of protection interlocks, alarms shall be checked and recorded. However, the joint inspection reports / protocols, made before / during commissioning of the units duly signed by the site officials shall be verified and considered as official documents for this purpose.

- DISCHARGE AIR PRESSURE: -

The compressor air discharge pressure and current shall be recorded in the format for the site performance test. Performance of receiver drain traps shall be checked and recorded in the format for the site performance test.

NOISE LEVEL MEASUREMENT

The specified noise level is ------- dB (A) as per standard reference code preferably ISO 2151 code.

Noise level shall be measured by a calibrated portable instrument. It shall be measured at 1 metre distance from the equipment and at 1.5 metre above the floor level. The readings shall be taken at all four sides of the compressor unit.

For eventual noise, from the discharge line, accessories and /or ancillary equipment which are not included, a correction factor shall be allowed for background & ambient noise, calculation for same shall be submitted for approval.

This correction factor is based on the background noise in the air compressor room having multiple compressor units along with the canopy with sound absorbing foam.

The noise levels shall be recorded in the format for the site test.

- VIBRATION MEASUREMENT

The vibration measurements shall be as per international standard (VOi 3836, Group 2) or ISO 10816-3.

Based on the above reference, the limits of vibration in terms of velocity shall be :-

Acceptable velocity value = 10 mm / sec [RMS] or less

The readings shall be taken with the calibrated portable instrument and recorded in the format for the site test.

CAPACITY & POWER MESUREMENT OF COMPRESSOR

Capacity & power consumption test copy witnessed at shop floor /Test bed of Contractor shall be acceptable for this test.

CLAUSE NO.	TECHNICAL REQUIREMENTS

Formats (Complete system) **PROJECT: Station Name ----------, Capacity (-----**
----) PACKAGE : ***Compressed Air System*** ***Date :----------***

Compressor Model		Customer	
Compressor Make		O/A Number	
Compressor Sr. No		Consultant	
Main motor Sr. No		Main Motor Make	

- PERFORMACE TEST DATA OF COMPRESSOR & AIR DRYER

SL.NO	PARAMETER	UNIT	Reading 1	Reading 2
1.	Time	HR: MIN		
2.	Ambient Temperature	Deg C		
3.	Ambient Pressure	Bar A		
4.	Relative humidity	%		
5.	Compressor Discharge Pressure	Bar G		
6.	Cooling water inlet pressure	Bar G		
7.	Cooling water outlet pressure	Bar G		
8.	Cooling water inlet Temperature	Deg C		
9.	Cooling water outlet Temperature	Deg C		
10.	Main Drive motor Current	Amp		
11.	Auxiliary air compressor power	kW		
12.	Noise level	dBA		
13.	Vibration velocity	mm/sec		
	Air dryer			
14.	Atmospheric dew point	Deg C		
15.	Air Pressure drop	Bar G		
16.	Cooling water inlet	Bar G		
17.	Cooling water outlet	Bar G		
18.	Cooling water inlet	Deg C		
19.	Cooling water outlet	Deg C		
20.	Air outlet pressure	Bar G		
21.	Air outlet temperature	Deg C		
22.	Air dryer power	kW		

CLAUSE NO.	TECHNICAL REQUIREMENTS

- **PERFORMANCE GUARANTEES**

SL.NO	PARAMETER	Unit	Test value /Observation	Remarks
1.	Parallel operation of air compressors	-		Yes / No
2.	Air dryer plant power consumption	kW		OK / Not OK
3.	Atmospheric Dew point at outlet of Air Dryer Plant	Deg C		OK / Not OK
4.	Pressure drops across air dryer plant	Bar G		OK / Not OK
5.	Compressor Noise level	dBA		OK / Not OK
6.	Vibration velocity (RMS)	mm/se c		OK / Not OK

- ***GENERAL PARAMETERS***

SL.NO	PARAMETER	Value/Observatio n	Remarks
1.	General observation on equipment installation		OK / Not OK
2.	General observation on Compressor system layout and Piping		As per approve d drawing /
3.	Approved engineering doc + Shop test reports		Yes / No
4.	Availability of instruments for performance test as per		Yes / No
5.	Availability of safety equipment's at		Yes / No
6.	Start equipment as per start up procedure in instruction manual		Yes / No
7.	Leakages in Pipe Joints (Soap solution method)		OK / Not OK

8.	Smooth operation of valves (Hand operation)		OK / Not OK
9.	Field instruments working		OK / Not OK
10.	Protection and Alarms		OK / Not OK

Attachment (to be provided by Contractor)

1) BHEL Tech specifications sheet (FGLD) of Compressed Air system .

2) Attachment 10 or relevant document.

3) Approved data sheet if any.

4) Any transmittal received for this System.

5) ADP vs PDP graph to be provided by Contractor

6) Shop test reports of individual compressors showing FAD, DAP and specific power consumption

QUALITY ASSURANCE
AND
QUALITY PLAN

QP OF SCREW AIR COMPRESSOR

SR. NO.	COMPONENTS AND OPERATORS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE	FORMAT OF RECORD	D*	AGENCY**			REMARKS
										P	W	V	
1	2	3	4	5	6	7	8	9	D*	10			11
A	MATERIAL INSPECTION												
1.1	ROTOR	MATERIAL CHECK	MAJOR	MECH. TEST CHEM.ANALYSIS HARDNESS ULTRASONIC TEST	One per Heat/Batch	APPROVED DATA SHEET / GA DRAWING / P&ID (As applicable)	APPROVED DATA SHEET / GA DRAWING / P&ID (As applicable)	CONF. CERTF.	V	3		1,2	
1.2	COMPRESSOR CASING / ROTOR HOUSING	MATERIAL CHECK	MAJOR	MECH. TEST CHEM.ANALYSIS	One per Heat/Batch	APPROVED DATA SHEET / GA DRAWING / P&ID (As applicable)	APPROVED DATA SHEET / GA DRAWING / P&ID (As applicable)	CONF. CERTF.	V	3		1,2	
1.3	BULL GEAR	MATERIAL CHECK	MAJOR	MECH. TEST CHEM.ANALYSIS HARDNESS	One per Heat/Batch	APPROVED DATA SHEET / GA DRAWING / P&ID (As applicable)	APPROVED DATA SHEET / GA DRAWING / P&ID (As applicable)	CONF. CERTF.	V	3		1,2	
1.4	PINION	MATERIAL CHECK	MAJOR	MECH. TEST CHEM.ANALYSIS HARDNESS	One per Heat/Batch	APPROVED DATA SHEET / GA DRAWING / P&ID (As applicable)	APPROVED DATA SHEET / GA DRAWING / P&ID (As applicable)	CONF. CERTF.	V	3		1,2	

SR. NO.	COMPONENTS AND OPERATORS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE	FORMAT OF RECORD		AGENCY**			REMARKS
										P	W	V	
1	2	3	4	5	6	7	8	9	D*	10			11
1.5	DRIVE SHAFT	MATERIAL CHECK	MAJOR	MECH. TEST	One per Heat/Batch	APPROVED DATA SHEET / GA DRAWING / P&ID (As applicable)	APPROVED DATA SHEET / GA DRAWING / P&ID (As applicable)	CONF. CERT.	√	3		1,2	
				CHEM.ANALYSIS HARDNESS ULTRASONIC TEST									
1.6	INTERCOOLER TUBES & TUBE SHEET	MATERIAL CHECK	MAJOR	CHEM.ANALYSIS		APPROVED DATA SHEET / GA DRAWING / P&ID (As applicable)	APPROVED DATA SHEET / GA DRAWING / P&ID (As applicable)						
				TENSILE STRENGTH	One per Heat/Batch			CONF. CERT.	√	3		1,2	
1.7	INTERCOOLER SHELL	MATERIAL CHECK	MAJOR	CHEM.ANALYSIS		APPROVED DATA SHEET / GA DRAWING / P&ID (As applicable)	APPROVED DATA SHEET / GA DRAWING / P&ID (As applicable)						
				TENSILE STRENGTH	One per Heat/Batch			CONF. CERT.	√	3		1,2	
1.8	AFTER COOLER TUBE & TUBE SHEET	MATERIAL CHECK	MAJOR	CHEM.ANALYSIS		APPROVED DATA SHEET / GA DRAWING / P&ID (As applicable)	APPROVED DATA SHEET / GA DRAWING / P&ID (As applicable)						
				TENSILE STRENGTH	One per Heat/Batch			CONF. CERT.	√	3		1,2	
1.9	AFTER COOLER SHELL	MATERIAL CHECK	MAJOR	CHEM.ANALYSIS		APPROVED DATA SHEET / GA DRAWING / P&ID (As applicable)	APPROVED DATA SHEET / GA DRAWING / P&ID (As applicable)						
				TENSILE STRENGTH	One per Heat/Batch			CONF. CERT.	√	3		1,2	
2.0	OIL COOLER	MATERIAL CHECK	MAJOR	CHEM.ANALYSIS	One per Heat/Batch								
	PLATE TYPE			TENSILE STRENGTH		APPROVED DATA SHEET / GA DRAWING / P&ID (As applicable)	APPROVED DATA SHEET / GA DRAWING / P&ID (As applicable)		√				
		DIMMENSION CHECK	MAJOR	MEASUREMENT	100%	ACIL STD DRG.	ACIL STD DRG.	CONF. CERT.		3		1,2	

SR. NO.	COMPONENTS AND OPERATORS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE	FORMAT OF RECORD	D*	AGENCY** P	W	V	REMARKS
1	2	3	4	5	6	7	8	9		10			11
8	INPROCESS INSPECTION												
2.1	OIL COOLERS PLATE TYPE	TIGHTNESS	MAJOR	HYDROSTATIC	100%	ACIL MFG STD		CONF. CERT.	V	3		1,2	
2.2	INTERCOOLER [SHELL & TUBE]	TIGHTNESS	MAJOR	HYDROSTATIC	100%	ACIL MFG STD	NO LEAKAGE	CONF. CERT.	V	3		1,2	
2.3	AFTERCOOLER [SHELL & TUBE]	TIGHTNESS	MAJOR	HYDROSTATIC	100%	ACIL STD MFG DRG	NO LEAKAGE	CONF. CERT.	V	3		1,2	
2.4	SAFETY VALVE Water Shut Off Valve	SET PRESSURE	MAJOR	MEASUREMENT	100%	ACIL STD	SET.PRESSURE	CONF. CERT.	V	3		1,2	
2.5	ROTOR ELEMENT	SURFACE FINISH	MAJOR	VISUAL	100%	ACIL MFG STD	ACIL MFG STD	CONF. CERT.	V	3		1,2	
		COATING QUALITY	MAJOR	MEASUREMENT	100%	ACIL MFG STD	ACIL MFG STD		V	3		1,2	
		DYNAMIC BALANCING	MAJOR	BALANCING	100%	ACIL MFG STD	ACIL MFG STD		V	3		1,2	
2.6	COMPRESSOR CASING / ROTOR HOUSING LP & HP.	DIMENSION CHECK	MAJOR	MEASUREMENT	100%	Apprd.GA Drg	Apprd.GA Drg	CONF. CERT.	V	3		1,2	
		TIGHTNESS	MAJOR	HYDROTEST	100%	ACIL MFG STD	NO LEAKAGE	CONF. CERT.	V	3		1,2	
2.7	AIR ENDS [HP & LP SCREW ELEMENTS]	RUN TEST	MAJOR	FAD LEAKAGE ABNORMAL NOISE	100%	ACIL MFG STDS / ISO 1217 Ed 1996 std.	ACIL MFG STDS / ISO 1217 Ed 1996 std.	CONF.CERT	V	3		1,2	
2.8 a	OIL FILTER AIR FILTER THROTTLE VALVES	APPEARANCE	MAJOR	VISUAL	One per Heat/Batch	ACIL Mfg stdb	ACIL Mfg stdb	CONF.CERT	V	3		1,2	
2.8 b	CANOPY BASE FRAME Control Panel	APPEARANCE	MAJOR	VISUAL	100%	APPROVED DATA SHEET / GA DRAWING / P&ID (As applicable)	APPROVED DATA SHEET / GA DRAWING / P&ID (As applicable)	CONF.CERT	V	3		1,2	

SR. NO.	COMPONENTS AND OPERATORS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE	FORMAT OF RECORD		AGENCY**			REMARKS
										P	W	V	
1	2	3	4	5	6	7	8	9	D*	10			11
C	FINAL INSPECTION												
3.0	OVERALL ASSLY. ALONG WITH MOTOR AND OTHER ACC.	DIMENSION & APPEARANCE	MAJOR	MEASUREMENT VISUAL	100%	APPROVED DATA SHEET / GA DRAWING / P&ID (As applicable)	APPROVED DATA SHEET / GA DRAWING / P&ID (As applicable)	INSP REPORT	V	3	1,2		
3.1	RUN TEST AND PERFORMANCE TEST	Discharge pressure - 8 Bar Discharge Temperarture - 46 Deg Shaft Power at load - 425 BKW Shaft Power at load - 75 KW	CRITICAL	OPERATION & CONFORMANCE	100%	APPROVED DATA SHEET / GA DRAWING / P&ID (As applicable) PERFORMANCE TEST AS PER ISO 1217	APPROVED DATA SHEET / GA DRAWING / P&ID (As applicable) / DRGS & PERFORMANCE TEST AS PER ISO 1217		V	3	1,2		Testing with BHEL supplied BHEL make motor.
		NOISE/ VIBRATIONS	MAJOR	MEASURMENT	100%	ACIL Mfg std							Only for reference.
3.2	CONTROLLER, INSTRUMENTS & COMPRESSOR INTERLOCK CHECK	INSTRUMENT INTERLOCK CHECK	-	VERIFICATION	100%	AS PER APPROVED COMPRESSOR WIRING DIAGRAM & P & ID	AS PER APPROVED COMPRESSOR WIRING DIAGRAM & P & ID	CONF. CERTF.	V	3	1,2		ANY TWO INTERLOCKS (Oil PRESSIRE & TEMPERATURE) SHALL BE SHOWN. ##REFER NOTES.
D	PACKING AND DESPATCH												
4.1	PACKING SHIPPING	PACKING AND TRANSPORTATION	MAJOR	VERIFICATION	100%	AS PER ACIL PACKING PROCEDURE	AS PER PACKING PROCEDURE	ALL SHIPPING DOCUMENTS	V	3		1,2	
4.2	PAINTING	PAITING	MAJOR	VERIFICATION	100%	AS PER ACIL STD PAINTING PROCEDURE	AS PER ACIL STD PAINTING PROCEDURE	CONF.CERT	V	3		1,2	
4.3	REVIEW OF Q.A DOCUMENT	-	MINOR	VERIFICATION	100%	AS PER APPROVED Q.A.P	AS PER APPROVED Q.A.P		V	3		1,2	

LEGEND : Records identified with 'V ' shall essentially be included by contractor QAP document.	
1- CUSTOMER/ CONSULTANT	P - Performing the Test
2 - BHEL / BHEL's TPI	W - Witnessing the Test
3. MANUFACTURER	V - Verifying the Test
	D - Documents

** This is Category-I equipment. CUSTOMER /Consultant/CUSTOMER appointed TPIA (Final inspection including document review as per approved QAP).

NOTE: ## Factory check for loose controllers for Air Compressors (To be supplied with compressed System Package) shall be witnessed by BHEL/CUSTOMER for Logic & software.
Oil Pressure and Temperature interlocks will be shown by removing the transducers connections during the running of Compresser and after removal, will show reading on control panel
1. Statutory requirements will be complied.
2. Calibrated instruments shall be used for testing.
3. All the test certificates as per the approved quality plan shall be submitted to TANGEDCO/TPIA for review and further clearance.
4. Reference Drawing / Documents are

QP OF CENTRIFUGAL AIR COMPRESSOR

SR. NO.	COMPONENTS AND OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE	FORMAT OF RECORD		AGENCY			REMARKS
										M	C	N	
1	2	3	4	5	6	7	8	9	D		10		11
1	MATERIAL INSPECTION												
1.1	GEAR BOX CASING	MATERIAL CHECK	MAJOR	CHEMICAL & MECHANICAL	ONE / HEAT	DRG / TECH SPEC./ APPRD DRG / DATA SHEET	DRG / TECH SPEC./ APPRD DRG / DATA SHEET	MFG'S TC	√	P	R	R	
1.2	VOLUTES	MATERIAL CHECK	MAJOR	CHEMICAL & MECHANICAL	ONE / HEAT	DRG / TECH SPEC./ APPRD DRG / DATA SHEET	DRG / TECH SPEC./ APPRD DRG / DATA SHEET	MFG'S TC	√	P	R	R	
1.3	INTERCOOLER HOUSING	MATERIAL CHECK	MAJOR	CHEMICAL & MECHANICAL	ONE / HEAT	DRG / TECH SPEC./ APPRD DRG / DATA SHEET	DRG / TECH SPEC./ APPRD DRG / DATA SHEET	MFG'S TC	√	P	R	R	
1.4	AFTERCOOLER HOUSING (IF APPLICABLE)	MATERIAL CHECK	MAJOR	CHEMICAL & MECHANICAL	ONE / HEAT	DRG / TECH SPEC./ APPRD DRG / DATA SHEET	DRG / TECH SPEC./ APPRD DRG / DATA SHEET	MFG'S TC	√	P	R	R	
1.5	IMPELLERS	MATERIAL CHECK	MAJOR	CHEMICAL & MECHANICAL	ONE / HEAT	DRG / TECH SPEC./ APPRD DRG / DATA SHEET	DRG / TECH SPEC./ APPRD DRG / DATA SHEET	MFG'S TC	√	P	R	R	

SR. NO.	COMPONENTS AND OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUN OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE	FORMAT OF RECORD		AGENCY			REMARKS
										M	C	R	
1	2	3	4	5	6	7	8	9	D		10		11
1.6	BULL GEAR	MATERIAL CHECK	MAJOR CRITICAL	CHEMICAL & MECHANICAL HARDNESS	ONE / HEAT	DRG / TECH SPEC./ APPRD DRG / DATA SHEET	DRG / TECH SPEC./ APPRD DRG / DATA SHEET	MFG'S TC	√	P	R	R	
1.7	MAIN SHAFT	MATERIAL CHECK	MAJOR CRITICAL	CHEMICAL & MECHANICAL, UT HARDNESS	ONE / HEAT	DRG / TECH SPEC./ APPRD DRG / DATA SHEET,	DRG / TECH SPEC./ APPRD DRG / DATA SHEET	MFG'S TC	√	P	R	R	UT FOR DIA ≥ 40 MM
1.8	PINIONS	MATERIAL CHECK	MAJOR CRITICAL	CHEMICAL & MECHANICAL HARDNESS	ONE / HEAT	DRG / TECH SPEC./ APPRD DRG / DATA SHEET	DRG / TECH SPEC./ APPRD DRG / DATA SHEET	MFG'S TC	√	P	R	R	
1.9	INTERCOOLER TUBES	MATERIAL CHECK	MAJOR	CHEMICAL & MECHANICAL	ONE / HEAT	DRG / TECH SPEC./ APPRD DRG / DATA SHEET	DRG / TECH SPEC./ APPRD DRG / DATA SHEET	MFG'S TC	√	P	R	R	
1.10	AFTERCOOLER TUBES (IF APPLICABLE)	MATERIAL CHECK	MAJOR	CHEMICAL & MECHANICAL	ONE / HEAT	DRG / TECH SPEC./ APPRD DRG / DATA SHEET	DRG / TECH SPEC./ APPRD DRG / DATA SHEET	MFG'S TC	√	P	R	R	
1.11	OIL COOLER PLATE TYPE	MATERIAL CHECK	MAJOR	CHEMICAL & MECHANICAL	ONE / BATCH	DRG / TECH SPEC./ APPRD DRG / DATA SHEET	DRG / TECH SPEC./ APPRD DRG / DATA SHEET	COC	√	P	R	R	

SR. NO.	COMPONENTS AND OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE	FORMAT OF RECORD		AGENCY			REMARKS
										M	C	N	
1	2	3	4	5	6	7	8	9	D		10		11
2	IN PROCESS INSPECTION												
2.1	INTERCOOLER HOUSING & TUBE BUNDLE	TIGHTNESS	MAJOR	HYDRO TEST	100%	1.5 X DESIGN PRESSURE DRG / TECH SPEC / DATA SHEET	NO LEAKAGE IN 30 MINUTES	TEST REPORT / COC	√	P	R	R	
2.2	AFTERCOOLER HOUSING & TUBE BUNDLE (IF APPLICABLE)	TIGHTNESS	MAJOR	HYDRO TEST	100%	MINIMUM 1.5 X DESIGN PRESSURE DRG / TECH SPEC / DATA SHEET	NO LEAKAGE IN 30 MINUTES	TEST REPORT / COC	√	P	R	R	
2.3	OIL COOLER PLATE TYPE	TIGHTNESS	MAJOR	HYDRO TEST	100%	MINIMUM 1.5 X DESIGN PRESSURE DRG / TECH SPEC / DATA SHEET	DRG / TECH SPEC / DATA SHEET	TEST REPORT / COC	√	P	R	R	
2.4	VOLUTES	TIGHTNESS	MAJOR	HYDRO TEST	100%	MINIMUM 1.5 X DESIGN PRESSURE DRG / TECH SPEC / DATA SHEET	NO LEAKAGE IN 30 MINUTES	TEST REPORT / COC	√	P	R	R	
2.5	ROTOR ASSEMBLY FOR LS PINION HS PINION	STATIC BALANCING DYNAMIC BALANCING	MAJOR	BALANCING	100%	DRG	DRG /	BALANCING CERTIFICATE	√	P	R	R	

SR. NO.	COMPONENTS AND OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE	FORMAT OF RECORD		AGENCY			REMARKS
										M	C	N	
1	2	3	4	5	6	7	8	9	D		10		11
2.6	GEAR BOX CASING	DIMENSION CHECK	MAJOR	MEASUREMENT	100%	DRG	DRG	COC	√	P	R	R	
2.7	VOLUTES	DIMENSION CHECK	MAJOR	MEASUREMENT	100%	DRG	DRG	COC	√	P	R	R	
2.8	BULL GEAR	DIMENSION CHECK	MAJOR	MEASUREMENT	100%	DRG	DRG	COC	√	P	R	R	
2.9	MAIN SHAFT	DIMENSION CHECK	MAJOR	MEASUREMENT	100%	DRG	DRG	COC	√	P	R	R	
2.10	PINION	DIMENSION CHECK	MAJOR	MEASUREMENT	100%	DRG	DRG	COC	√	P	R	R	
2.11	IMPELLER	DIMENSION CHECK	MAJOR	MEASUREMENT	100%	DRG	DRG	COC	√	P	R	R	

SR. NO.	COMPONENTS AND OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE	FORMAT OF RECORD		AGENCY			REMARKS
										M	C	N	
1	2	3	4	5	6	7	8	9	D		10		11
2.12	BASE FRAME	DIMENSION CHECK	MAJOR	MEASUREMENT	100%	DRG	DRG	COC	√	P	R	R	
2.13	COMPRESSOR CONTROL PANEL / SEQUENTIAL CONTROL PANEL	FUNCTIONAL TEST / LOGIC VERIFICATION DISPLAY, INTERLOCKS RV / IR	MAJOR	SIMULATION	100%	DRG/TECH SPECS /APPRD DRG	DRG/TECH SPECS /APPRD DRG	QOC	√	P	R	R	
3 3.1	FINAL INSPECTION PERFORMANCE TEST OF COMPRESSOR WITH JOB MOTOR, CONTROL PANEL & OTHER ACCESSORIES (AS APPLICABLE)	GA DIMENSIONS, ASSLY COMPLETENESS, TIGHTNESS OF AIR, OIL & WATER LINE, CAPACITY, LOAD-UNLOAD MECHANISM, MOTOR SHAFT POWER, DISCHARGE PRESSURE, NOISE & VIBRATION.	CRITICAL	OPERATION & CONFORMANCE	100%	APPROVED DATA SHEET / TEST PROCEDURE / ISO 18740	APPROVED DATA SHEET / TEST PROCEDURE / ISO 18740	TEST REPORT	√	P	W	W	1. MOTOR INPUT TERMINAL POWER AT UNLOADED CONDITION WILL BE MEASURED WITH IGV FULLY CLOSED & BOV WITH FULLY OPENED CONDITION 2. SAFETY VALVE NOT APPLICABLE
3.2	REVIEW OF QA DOCUMENTS	AS PER APPROVED QAP											CHP

Legends :

Legends :
P.O.: Purchase Order, QAP: Quality Assurance Plan, COC : Certificate of Conformance
M: Manufacturer/Sub-Supplier, C: Customer, N: NTPC
P: Perform, R: Review, W: Witness, IR: Ingersoll Rand India Limited
Drg.: Drawing, Mfg: Manufacturing, STD: Standard, Spec.: Specification

QP OF ROTARY AIR DRYER

SR. NO.	COMPONENTS AND OPERATORS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE	FORMAT OF RECORD	AGENCY**			REMARKS
									M	C	N	
1	2	3	4	5	6	7	8	9	10			11
A	**MATERIAL INSPECTION**											
1.1	ROTOR DRUM	CHEMICAL	MAJOR	CHEMICAL ANALYSIS Mechanical, NDT (UT) * Completeness verification *	100%	APPROVED DATASHEET / GA DRAWING / P&ID (as applicable)	APPROVED DATASHEET / GA DRAWING / P&ID (as applicable)	CONFIRMITY CERTIFICATE	P	V	V	
1.2	DRYER VESSEL COMPLETE Dished End Checks*	DIMENSIONS MECHANICAL	MAJOR	DIMENSIONS MECH. PROPERTIES Chemical * NDT* completeness verification*	100% 100%	APPROVED DATASHEET / GA DRAWING / P&ID (as applicable)	APPROVED DATASHEET / GA DRAWING / P&ID (as applicable)	CONFIRMITY CERTIFICATE	P	V	V	
1.3	REGENERATION COOLERS	MECHANICAL CHEMICAL	MAJOR	CHEMICAL & MECHANICAL	100%	APPROVED DATASHEET / GA DRAWING / P&ID (as applicable)	APPROVED DATASHEET / GA DRAWING / P&ID (as applicable)	CONFIRMITY CERTIFICATE	P	V	V	
1.4	Valves, Instruments, Pipes & fittings	MECHANICAL	MAJOR	MECHANICAL / MAKE	100%	APPROVED DATASHEET / GA DRAWING / P&ID /ACIL Std (as applicable)	APPROVED DATASHEET / GA DRAWING / P&ID /ACIL Std (as applicable)	CONFIRMITY	P	V	V	
B	**INPROCESS INSPECTION**											
2.1	REGENERATION COOLERS	TIGHTNESS	MAJOR	HYDROSTATIC	100%	1.5 TIMES OF DESIGN PRESSURE FOR 30 MINS.	1.5 TIMES OF DESIGN PRESSURE FOR 30 MINS.	CONFIRMITY CERTIFICATE	P	V	V	
2.2	DRYER VESSEL WATER SEPERATOR	TIGHTNESS	MAJOR	HYDROSTATIC	100%	1.5 TIMES OF DESIGN PRESSURE FOR 30 MINS.	1.5 TIMES OF DESIGN PRESSURE FOR 30 MINS.	CONFIRMITY CERTIFICATE	P	V	V	
2.3	WATER SEPERATOR GEAR BOX DRAIN VALVES MOTOR Control Panel	FUNCTIONAL	MAJOR	FUNCTIONAL	100%	ACIL MFG. PROCEDURE	ACIL MFG. PROCEDURE	CONFIRMITY CERTIFICATE	P	V	V	
C	**ASSEMBLY & TESTING**											
3.1	ASSEMBLY & TESTING	DIMENSIONAL APPERANCE & COMPLETENESS	MAJOR	MEASUREMENT VISUAL	100%	APPROVED DATASHEET / GA DRAWING / P&ID (as applicable) ACIL MFG. STD	APPROVED DATASHEET / GA DRAWING / P&ID (as applicable) ACIL MFG. STD	INSP. REPORT CONFIRMITY CERTIFICATE	P	W	W	Dryer Dew Point shall be measured at Site under performance Guarantee Test
		MECH. RUN TEST	MAJOR	FUNCTIONAL TEST	100%	ACIL MFG. STD	ACIL MFG. STD	CONFIRMITY CERTIFICATE	P	W	W	
		TIGHTNESS		PNEUMATIC TEST	100%	1.1 X WORKING PRESSURE FOR 10 MINS (Holding time)	1.1 X WORKING PRESSURE FOR 10 MINS	CONFIRMITY CERTIFICATE	P	W	W	
3.2	DRYER HEATER	FUNCTIONAL	MAJOR	FUNCTIONAL TEST	100%	ACIL MFG. STD.	ACIL MFG. STD.	CONFIRMITY CERTIFICATE	P	W	W	Heater start/stop & its setpoint shall be demonstrated on Microprocessor panel
C	**PACKING & DISPATCH**											
5.1	Surface preparation and Painting	PAITING	MAJOR	VERIFICATION	1	AS PER ACIL STD PAINTING PROCEDURE	AS PER ACIL STD PAINTING PROCEDURE	CONF.CERT	√	V	V	
5.2	Final document closing PACKING SHIPPING	CHECK DOC. PACKING	MAJOR	VERIFICATION	100%	ACIL PACKING PROCEDURE	AS PER PACKING PROCEDURE	CERTIFICATE ALL SHIPPING DOCUMENTS	P	V	V	

QP OF HOC TWIN TOWER AIR DRYER

Sr. No. 1.	COMPONENT / OPERATION 2.	CHARACTERISTICS 3.	CLASS 4.	TYPE OF CHECK 5.	QNTM. OF CHECK 6.		REFERENCE DOCUMENT 7.	ACCEPTANCE NORMS 8.	FORMAT OF RECORD 9.		AGENCY 10.			REMARKS 11.
					M/C	N				D	M	C	N	
I	RAW MATERIAL													
1.1	TOWER (Plates for Shell)	Visual Dimensional Chemical Mechanical	MA MA MA MA	Visual Measurement Chemical Mechanical	100% 100% 1/ Lot 1/ Lot	– – — —	Approved/ Manufacturing Drawing / IS 2062	Approved/ Manufacturing Drawing/IS 2062	IR IR Lab TC/ * Lab TC/ *	√ √ √ √	P P P P	V V V V	V V V V	* MILL TC
1.2	Dished End	Visual Dimensional Chemical Mechanical DP Test on Knuckle Radius Thinning Measurement	MA MA MA MA MA MA	Visual Measurement Chemical Mechanical DP Test Measurement	100% 100% 1/ Lot 1/ Lot 100% 100%	– – — — — —	Approved/ Manufacturing Drawing / IS 2062	Approved/ Manufacturing Drawing / IS 2062	IR IR Lab TC/ * Lab TC/ * IR IR	√ √ √ √ √	P P P P P P	V V V V V V	V V V V V V	* MILL TC In case of Cross Joint in Dish end 100% RT on joint to be done and RT films & reports submitted for review during inspection
1.3	Pipe Line	Visual Dimensional Chemical Mechanical	MA MA MA MA	Visual Measurement Chemical Mechanical	100% 100% 1/ Lot 1/ Lot	– – — —	Approved/ Manufacturing Drawing/ IS1239	Approved/ Manufacturing Drawing /IS 1239	IR IR Lab TC/ * Lab TC/ *	√ √ √ √	P P P P	V V V V	V V V V	* MILL TC
1.4	Plates / Pipes, Tubes for After filter, Inter cooler Regeneration cooler	Material check	MA	Chemical Mechanical	Verify	Verify	Approved Drawings/ Datasheet	Approved Drawings/ Datasheet	Mfg.TC	√	P	V	V	
1.5	Bought Out Items	Visual Dimensional	MA	Item, Make, Range, Dimensional	Verify	Verify	Approved Drawings/ Datasheet	Approved Drawings/ Datasheet	Mfg.TC / Calibration Report	√	P	V	V	
II	IN PROCESS INSPECTION													
2.1	Welder Qualification	WPS,PQR & WPQ	CR	Qualification	100%	Verify	Approved WPS & ASME SEC IX	ASME SEC IX	WPS, PQR, WPQ	√	P	V	V	Refer Note 2

Sr. No. 1.	COMPONENT / OPERATION 2.	CHARACTERISTICS 3.	CLASS 4.	TYPE OF CHECK 5.	QNTM. OF CHECK 6.		REFERENCE DOCUMENT 7.	ACCEPTANCE NORMS 8.	FORMAT OF RECORD 9.		AGENCY 10.			REMARKS 11.
					M/C	N				D	M	C	N	
2.2	Edge preparation, Weld fit up, Shell dish end joint setup.	Physical alignment. Ovality/ Offset	MA MA	Visual Measurement	100% 100%	– –	Approved Manufacturing Drawing	Approved Manufacturing Drawing	–	- - -	P P P	- - -	- - -	
2.3	Weld quality of butt welds. Weld quality of fillet welds. Weld quality Final weld of butt welds.	DPT on Root Run. DPT on final weld of Butt & fillet weld Radiography	MA MA CR	DP test DP test Radiography	100% 10%R &&	– – –	Manufacturing Drawing/ ASME V	Mfg. Drawing/ No significant defects / ASME sec VIII DIV 1	IR IR RT film & reports.	√ √ √	P P P	V V V	V V V	&& 10% on Butt Joint including 100% "T" joints
2.4	Weld quality of Pipe Weld	DPT on Root Run of Butt Weld & Final Weld	MA	DPT on Final weld	100%	–	Manufacturing Drawing/ ASME SEC V	Mfg. Drawing/ No significant defects /ASME sec VIII DIV 1	IR	√	P	V	V	All Nozzle and attachment welds- 100% MT / PT shall be done and certificates shall be reviewed
2.5	Heat Exchanger	Tube To Tube Sheet	MA	DP test	100%	——	ASME Sec V	No Signification defects/ASME sec VIII DIV 1	IR	√	P	V	V	
2.6	Vessel (Tower) Moisture Separator & heat exchangers.	Hydrotest	MA	Hydrotest	100%	100%	App. Drawing / Datasheet	App. Drawing / Datasheet	IR	√	P	V	V	Hydro Test pressure @ 1.5 Times of Design Pressure
2.7	Pneumatic Test	Pneumatic Test	MA	Pneumatic	100%	100%	App. Drawing / Datasheet	App. Drawing / Datasheet	IR	√	P	W	W	Test pressure @ 1.1 Times of Design Pressure
III	FINAL INSPECTION													
3.1	Final Assembly	Final Assembly	MA MA	Visual Measurement	100% 100%	100% 100%	Approved Drawing / Datasheet	Approved Drawing /	IR IR	√ √	P P	W W	W W	
3.2	Functional test	No load test	MA	Functional / operation of Change Over valve & ADT	100%	100%	App. Drawing / Datasheet / app. Procedure	App. Drawing / Datasheet / app. Procedure	IR	√	P	W	W	Ref Note 3
3.3	Insulation / cladding (as applicable)	Completeness	MA	Verification	100%	100%			IR	√	P	V	V	

LEGEND: *RECORDS IDENTIFIED WITH " √ " SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION.
** M: MANUFACTURER C: MAIN SUPPLIER / CONTRACTOR (BHEL) N:CUSTOMER "P" PERFORMS "W" WITNESS AND "V" VERIFICATION AS APPROPRIATE. "CHP" TPI SHALL IDENTIFY IN COLUMN"N" AS "W",

QP OF AIR RECEVIER

SI NO	COMPONENT & OPERATION	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT *	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
					M	C/N					M	C	N	
1	2	3	4	5	6		7	8	9	D*	** 10			11
I.0	**RAW MATERIAL INSPECTION**													
1.1	Plates for Shell and Dished Ends	Surface quality	MR	Visual	100%	100%	Manufacturing Drawing	Free From Pitting and rust	IR	-	P	V	-	
		Chem. Properties & Physical Properties	CR	Chemical Analysis& Mechanical Tests	1/ Heat	1/ Heat	Approved Drawing / Data sheet		MTC	√	P	V	V	See Note 1
	Flanges, Nozzles, Pipes, Fittings	Surface quality	MR	Visual	100%	100%	Manufacturing Drawing	Free From Pitting and rust	IR	-	P	V		
		Chem. Properties & Physical Properties	CR	Chemical Analysis& Mechanical Tests	1 / Lot	1 / Lot	Approved Drawing / Data sheet / Manufacturing Drawing		MTC	√	P	V	V	
2.0	**IN PROCESS INSPECTION**													
2.1	WPS, PQR & WPQ	Conformance to Code Requirements	MR	Verification/ Mechanical Test / NDT	100%	100%	ASME Sec IX		QW-482 /483/ 484	√	P	V	V	See Note 2
2.2a	Dished Ends (See Note 3)	Dimensions, Circularity, Thickness, Profile	MR	Measurement / Template	100%	100%	IS 2825 -1969/ IS 4049 part 1 / 2 - 1998		IR	√	P	V	V	
		Stress Relieving on Dished ends and on Butt Welds of dish ends (Incase of Joint in dish end due to size limitation)	MR	Heat Treatment Cycle	100%	100%	IS 2825-1969 / ASME Sec VIII		HT Chart	√	P	V	V	See Note 4
		Surface Defects on Straight Face and Knuckle Radius	MR	DPT	100%	100%	ASME Sec V	ASME Sec VIII Div 1, Appendix 8	DP Report	√	P	V	V	
2.2b		Internal defects on Butt welds of Dished End	CR	RT	100%	100%	ASME Sec V	ASME Sec VIII Div 1, UW-51	RT Film & Report	√	P	V	V	
2.3	Shell Fabrication - Marking, Cutting, Rolling, Joint Set-up, Nozzle Set-up	Dimensions, Edge Preparation	MR	Visual/ Measurement	100%	100%	IS 2825-1969/ ASME Sec VIII / Manufacturing Drawing		IR	-	P	V	-	
		Out of Roundness, Orientation of Nozzles			100%	100%			IR	√	P	V	V	
2.4	Surface defects on Butt Weld Joints	On Root Run after Back chipping	MR	DPT	100%	100%	ASME Sec V	ASME Sec VIII Div 1, Appendix 8	DP Report	√	P	V	V	
		On Final Run			100%	100%								
	Surface defects on fillet Joints	On Final Welds			10%	10%								
	Surface defects of Nozzle/Flange/ Pipe/ Socket joints	On Final Welds			100%	100%								

SI NO	COMPONENT & OPERATION	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT #	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
					M	C/N					M	C	N	
1	2	3	4	5	6		7	8	9	D*	** 10			11
2.5	Internal Defects on Butt Welds *	On 10% Butt Welds	CR	RT	10%	10%	ASME Sec V	ASME sec VIII Div 1 UW 51/ 52	RT Report & Film	√	P	V	V	* Applicable for Class II vessels. Also See Note 5
		On 100% on 'T' & 'X' Joints			100%	100%								
2.6	Production test Coupon	Coupon Testing		Mechanical Tests	IS 2825-1969	IS 2825-1969	IS 2825 - 1969		TC	√	P	V	V	If design code is IS 2825-1969
3.0	FINAL INSPECTION													
3.1	Complete Air Receiver	Dimensions	CR	Measurement	100%	10%	Approved drawing /Data Sheet/ASME sec VIII/ IS 2825-1969		IR	√	P	W	W	
		Nozzle Orientation	CR	Measurement	100%	10%	Approved drawing /Data Sheet/ASME sec VIII/ IS 2825 - 1969		IR	√	P	W	W	
		Pneumatic Test of RF pads	CR	Pneumatic test with soap solution	100%	10%	At 1.5 Bar pressure	No leakage	IR	√	P	W	W	Duration 30 Seconds.
		Hydrotest of Air Receiver	CR	Hydrotest	100%	10%	See Note 6	No Leakage	IR	√	P	W	W	Duration 30 minutes.
3.2	Painting & Stamping	Internal & External cleaning	MR	Verification	100%	100%	Approved Drawing / Manufacturer's Std		IR	-	P	V	-	
		Painting	MR	Paint Shade, DFT	Random	Random	Approved drawing		IR	-	P	V	V	
		Stamping	MR	Verification	100%	100%	Approved Drawing / Manufacturer's Std		IR	-	P	V	-	

Notes:

1.) Steel Plates shall be of SAIL/TISCO/RINL/ Jindal Steel & Power Ltd/ Essar Steel Ltd/ Ispat Industries Ltd /Lloyd's Steel Industries Ltd/ JSW Steel Ltd make. Correlation of material with MTC shall be maintained by the manufacturer. In the absence of correlated MTC, one sample per plate will be taken in the presence of Main Contractor and tested for Mechanical and Chemical Properties at reputed Third party lab and lab reports shall be used to maintain correlation. Lab reports shall be submitted for Review during inspection.

2.) NTPC/BHEL/Lloyds/BVQI/TUV/DNV/SGS/Quest approved WPS. Procedure & Welders Qualified by NTPC/BHEL/Lloyds/BVQI/TUV/DNV/SGS/Quest. If welders are already qualified by NTPC/BHEL/Lloyds/BVQI/TUV/DNV/SGS/Quest and doing similar jobs then Welder Qualification records shall be verified inplace of Witness.

3.) Dished End shall be from M/s Abacus Heat Transfer Ltd. regular sources

4.) Stress Relieving shall be done incase of deformation / extreme fibre elongation exceeds 5% as per Clause No 6.4.10 of IS 2825 / UCS-79 of ASME sec VIII Div 1 respectively.

5.) In case of discrepancies, BHEL may ask for check shots on welds.

6.) Hydrotest at 1.5 x Design Pressure for 30 Minutes duration.

LEGEND
D* RECORDS INDENTIFIED WITH "TICK" SHALL BE ESSENTIALLY PROVIDED BY CONTRACTOR IN QA DOCUMENTATION **M – MANUFACTURER C :- BHEL/ BHEL-TPIA, N :- CUSTOMER
INDICATE "P" PERFORM, "W" WITNESS, "R" REVIEW OF DOCUMENTS MTC: MATERIAL TEST CERTIFICATE, IR: INTERNAL INSPECTION REPORT, QR: QUALITY CONTROL REPORT, CHP: CHECK HOLD POINT

QP OF NON RETURN VALVES

SWING CHECK VALVE / NON-RETURN VALVE (WATER SYSTEMS) SECTION: PAGE 1 OF 4

SL NO.	COMPONENT & OPERATIONS	CHARACTERIST-ICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	*	AGENCY			REMARKS *
					M	C/N				D	M	C	N	
1	2	3	4	5	6		7	8	9		**			10
1.0 MATERIAL:														
1.1	BODY, COVER, BODY/DISC SEAT RINGS, DISC, HINGE, HINGE PIN	1. PHYSICAL, CHEMICAL PROPERTIES a) TENSILE STRENGTH b) HARDNESS TEST	MA	PHYSICAL & CHEMICAL TESTS	1/HEAT	—	APPD. DRG.	APPD. DRG.	MTC	✓	P/W	V	V	1.CORRELATION OF BODY & BONNET REQD. WITH MTC HEAT NO. 2.FOR CI, ONLY PHYS. TEST. 3. REFER NOTE-4.
		2. DIMENSIONS	MA	MEASUREMENT	100%	—	APPD. DRG.	APPD. DRG.	LOG BOOK	✓	P/W	V	V	
		3. SURFACE DEFECTS	MA	VISUAL	100%	—	MSS-SP-55	MSS-SP-55	INSPN. REPORT	✓	P/W	V	V	
		4. HEAT TREATMENT	MA	HT CHART	100%	—	MSS-SP-55	MSS-SP-55	HT CHART /TC	✓	P/W	V	V	
1.2	BODY, COVER, HINGE & DISC	1. SURFACE DEFECTS	CR	MPI	100%	—	ASTM E709/ ASTM A275	ASME B16.34 APPENDIX-II	NDT REPORT	✓	P/W	V	V	MPI FOR BODY & BONNET SIZE 350NB AND ABOVE CI VALVES
		2. SUB SURFACE DEFECTS	CR	RT	100%	—	ASME B16.34	ASME B16.34 APPENDIX-II	NDT REPORT	✓	P/W	V	V	1.RT ON CHANGE OF SECTION FOR D2-NI VALVE ONLY. 2.RT FILM REVIEW BY BHEL.
1.3	FASTENERS	PHY. & CHEM. PROP	MA	PHY & CHEM TESTS	1/HEAT	—	APPD. DRG.	APPD. DRG.	MTC	✓	P/W	V	V	1
2.0 INPROCESS:														
2.1	MACHINING OF ALL COMPONENTS	1. DIMENSIONS	MA	MEASUREMENT	100%	—	MFG DRG.	MFG DRG.	LOG BOOK	✓	P/W	V	V	
		2. SURFACE DEFECT (MACHINED AREAS)	CR	PT	100%	—	ASTM E-165	NO DEFECTS	NDT REPORT	✓	P/W	V	V	

SL NO.	COMPONENT & OPERATIONS	CHARACTERIST-ICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**			10
					M	C/N				D	M	C	N	
		3 SUB SURFACE DEFECTS (HINGE PIN, BODY & DISC SEAT RINGS)	CR	UT	100%	—	ASME B16.34	ASME B16.34 APPENDIX-IV	NDT REPORT	✓	P/W	V	V	1. IF HINGE PIN DIA IS EQUAL OR GREATER THAN 40 MM. 2. IF SEAT THKN. IS EQUAL TO OR GREATER THAN 25 MM.
2.2	DISC & BODY SEATS	1. SURFACE DEFECTS	CR	PT	100%	—	ASTM E 165	ANSI B16.34 APPENDIX-IV	NDT REPORT	✓	P/W	V	V	
		2. HARDNESS	MA	TESTING	100%	—	APP.DRG.	APP. DRG.	INSPN. REPORT	✓	P/W	V	V	
2.3	DISC. AND BODY SEAT RING	LAPPING	CR	BLUE MATCHING	100%	—	UNIFORM METAL TO METAL CONTACT		INSPN. REPORT	✓	P/W	V	V	
3.0	ASSEMBLY	DIMENSIONS	MA	MEASUREME-NT	100%	—	APPD. DRG.	APPD. DRG.	INSPN. REPORT	✓	P/W	V	V	
4.0 EBONITE LINING (AS APPLICABLE IN DATA SHEET-A)														
4.1	EBONITE FORMULATION	TENSILE, ELONGATION, HARDNESS	MA	PHYSICAL	1 / BATCH	—	IS 4682 PT.1	IS 4682 PT.1	TEST CERT.	✓	P/W	V	V	
4.2	SURFACE PREPARATION OF ITEM TO BE LINED	FREE FROM RUST, SCALE, DUST, GREASE	MA	VISUAL EXAMINATIO N	100%	—	IS 4682 PT.1	IS 4682 PT.1	INSPN. REPORT	✓	P/W	V	V	
4.3	APPLICATION	VISUAL DEFECTS, THICKNESS MEASUREMENT	MA	VISUAL TEST, MEASUREME NT	100%	—	IS 4682 PT.1	IS 4682 PT.1	INSPN. REPORT	✓	P/W	V	V	
4.4	VULCANIZING	TEMP, PRESSURE & TIME	MA	MEASUREME NT	Regular Intervals	—	MFG. PROCEDURE	MFG. PROCEDURE	PROCESS RECORDS	✓	P/W	V	V	AS APPLICABLE
4.5	VULCANIZED AND EBONITE LINED ITEMS	ADHESION, DEFECTS, THICKNESS	MA	VISUAL TEST, MEASUREME NT	1 / BATCH	—	IS 4682 PT.1 AND APPROVED GA	IS 4682 PT.1 AND APPROVED GA	INSPN. REPORT	✓	P/W	V	V	1. AS APPLICABLE 2.TO BE DONE ON A MOCKUP PIECE ON SAME MATERIAL TOGETHER WITH VULCANIZED JOB

SL NO.	COMPONENT & OPERATIONS	CHARACTERIST-ICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**		10
					M	C/N				D	M	C	N
5.0 TESTING:													
5.1	BODY	LEAK TIGHTNESS	CR	HYDRAULIC TEST	100%	REFER NOTE-1	APPD. DRG.	NO LEAKAGE	INSPN. REPORT	✓	P	W	V	
5.2	SEAT	LEAK TIGHTNESS	CR	HYDROLIC TEST 1.AT SPECIFIED PRESSURE 2. AT 25% OF SEAT TIGHTNESS TEST	100%	REFER NOTE-1	APPD. DRG.	LEAKAGE ACCEPTANCE AS PER BSEN 16767	INSPN. REPORT	✓	P	W	V	
5.3	COMPLETE VALVE	1.PERFORMANCE	CR	OPERATION OF FLAP	100%	REFER NOTE-1	APPD. DRG.	APPD. DRG.	INSPN. REPORT	✓	P	W	V	
		2.WORKMANSHIP, MARKING & TAG NO.	MA	VISUAL	100%	REFER NOTE-1	APPD. DRG.	APPD. DRG.	INSPN. REPORT	✓	P	W	V	
6.0	END CONNECTION DETAILS	DIMENSIONS & VISUAL IN COMPLETE ASSEMBLED CONDITION	MA	MEASUREMENT/ VISUAL	100%	REFER NOTE-1	APPD. DRG.	APPD. DRG.	INSPN. REPORT	✓	P	W	V	
7.0	SURFACE PREPARATION AND PAINTING	QUALITY AND THICKNESS OF PAINT	MA	VISUAL AND MEASUREMENT	100%	—	APPD. DRG.	APPD. DRG.	INSPN. REPORT	✓	P/W	V	V	
8.0	TAGGING/MARKING AFTER PAINTING OF THE VALVE	VERIFICATION	MA	VISUAL	100%	—	APPD. DRG.	APPD. DRG.	INSPN. REPORT	✓	P/W	V	V	
9.0	PACKING	APPD. DWG.	MA	VISUAL	100%	100%	APPD. DRG. / PACKING PROCEDURE (IF APPLICABLE)	APPD. DRG. / PACKING PROCEDURE (IF APPLICABLE)	INSPN. REPORT	✓	P/W	W	V	REFER NOTE-2.
10.0	ISSUANCE OF IRN WITH REVIEW OF COMPLETE QUALITY DOSSIER WITH INDEX									✓	P/W	W	V	

NOTES:

1. 10% or min. 02nos. at random shall be witness by BHEL per size/class/rating & 100% by supplier for each type, size & rating.
2. Following to be noted for packing:
   a). Material shall be packed suitably in order to avoid damage of paint and valve during transit and also during storage at site in tropical climate conditions for a period of 15-18 months.
   b). Photographs of the packing (with LR No.) just before dispatch for information of PEM.
3. BHEL reserves the right for conducting repeat tests, if required.
4. Welding and Impregnation of casting are not permitted.
5. The latest revision/year of issue of all the standard indicated in the QP shall be referred.
6. Reference Drawing/ Approved Drawing: GA drawing for Cast Iron/D2 Gate/Globe/NR Valves (Water System), Dwg. No. PE-V0-435-100-M081(Sh.,05,06,07 of 07). 1
7. Instruments used for test shall have valid calibration certificate with traceability to national level. 1
8. All the test certificates as per the approved quality plan shall be submitted to TANGEDCO for review and further clearance. 1
9. Testing by suitable method shall be done at 'AV' own 'IBR' certified foundry in-house LAB. The NDT Reports shall be certified and approved by minimum ASNT/ISNT Level-II qualified personnel. 1
10. WPS/PQR/WPQ Certificate (as applicable) shall be reviewed by BHEL/ Third Party Inspection Agency/ Customer. 1
11. PMI report to be submitted for SS material for review. 1

LEGENDS:

*: Records, identified with "Tick" (✓) shall be essentially included by supplier in QA Documentation.

** **M**: Supplier/ Manufacturer/ Sub-Supplier
P: Perform
MA: Major Characteristic
MTC: Mill Test Certificate
RT: Radiography Test
PMI: Positive Material Identification 1
PQR: Procedure Qualification Record.

C: Main Supplier/BHEL/ Third Party Inspection Agency
W: Witness
MI: Minor Characteristic
PT: Penetrant Test
D: Documentation
IRN: Inspection Release Note 1
WPQ: Welder Performance Qualification

N: Customer
V: Verification
CR: Critical Characteristic
UT: Ultrasonic Test
NDT: Non-Destructive Testing
WPS: Welding Procedure Specification 1

QP OF BALL VALVES

SL. NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
1.0	**MATERIALS**													
1.1	BODY, END PIECES BALL, SPINDLE, GLAND, LEVER, FASTENERS	1. PHYSICAL, CHEMICAL PROPS.	MA	PHYSICAL, CHEM.TESTING	ONE PER BATCH/ LOT/ HEAT		APPD. DRG. / REL. STD.	APPD. DRG./ REL. STD.	MILL T.C.	√	P/W	V	V	CORELATION REQD. FOR BODY & END PIECES W.R.T. HEAT Nos.
		2. HEAT TREATMENT	CR	REVIEW OF H.T. RECORDS	100%		-DO-	-DO-	H.T. INTERNAL INSPN. RECORDS	√	P/W	V	V	
		3. SURFACE DEFECTS	MA	VISUAL	100%		MSS-SP-55	FREE FROM DEFECTS	INSPN. REPORT	√	P/W	V	V	
1.2	BODY, END PIECES	1. SURFACE DEFECTS	CR	PENETRANT TEST	100%		ASTM E 165	ANSI B 16.34	TEST REPORT	√	P/W	V	V	APPLICABLE ONLY FOR SS CASTINGS.
2.0	**IN PROCESS INSPECTION**													
2.1	MACHINING OF ALL COMPOMENTS	1. DIMENSIONS	MA	MEASUREMENT	100%		MFG. DRG.	MFG. DRG.	LOG BOOK	-	P/W	-	-	
		2. SURFACE FINISH	MA	VISUAL	100%		MFG. DRG.	MFG. DRG.	LOG BOOK	-	P/W	-	-	
		3. HARDNESS (FOR BALL AND SPINDLE)	MA	HARDNESS TESTING	100%		APPD. DRG. / REL. STD.	APPD. DRG. / REL. STD.	T.C.	√	P/W	V	V	
		4. SURFACE DEFECTS	CR	PENETRANT TEST	100%		ASTM E 165	ANSI B16.34	T.C.	√	P/W	V	V	FOR BALL, SPINDLE SEATS & MACHINED SURFACES.
3.0	**BEFORE GALVANISING - SHELL TEST FOR PRESSURE PARTS (FOR CS VALVES ONLY)** -NOT APPLICABLE FOR THIS PROJECT 02													
3.1	BODY, END PIECES (PRESSURE PARTS)	LEAK TIGHTNESS	CR	HYDRAULIC TEST	100%		APPD. DRG.	NO LEAKAGE	T.C.	√	P/W	V	V	
4.0	HOT DIP GALVANIZING OF CARBON STEEL BODY, END PIECES AND ALL OTHER CARBON STEEL VALVE PARTS	1. FREEDOM FROM SURFACE DEFECTS	MA	VISUAL	100%		IS:2629	IS:2629	INSPN REPORT	√	P/W	V	V	
		2. UNIFORMITY IN THICKNESS	MA	THICKNESS	VALVE BODY AT RANDOM		IS:2629	IS:2629	INSPN REPORT	√	P/W	V	V	THICKNESS 50 MICRONS (MIN.) TO BE CHECKED WITH ELCOMETER.
		3. ADHESION	MA	KNIFE TEST	-DO-		IS:2629	IS:2629	INSPN REPORT	√	P/W	V	V	

SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
5.0	**ASSEMBLY OF ALL VALVE**													
5.1	BALL AND SEAT	MIRROR FINISH (BALL)	CR	BUFFING/ GRINDING/ MACHINING	100%		THE SURFACE SHALL BE SMOOTH AND SHALL HAVE UNIFORM CONTACT WITH SOFT SEAT		LOG BOOK	√	P/W	V	V	
6.0	**FINAL TESTING**													
6.1	ASSEMBLY	1. DIMENSIONS	MA	MEASUREMENT	100%	REFER NOTE-2	APPD. DRG.	APPD. DRG.	INSPN. REPORT	√	P/W	W	W	
		2. OPENING/ CLOSING	MA	OPERATION	100%		SMOOTH OPERATION OF VALVE	SMOOTH OPERATION OF VALVE	-DO-	√	P/W	W	W	
		3. **APPEARANCE:** WORKMANSHIP, ORIENTATION, MARKING, TAG No.	MA	VISUAL	100%		APPD. DRG.	APPD. DRG.	INSPN. REPORT	√	P/W	W	W	02
6.2	BODY	1. LEAK TIGHTNESS	CR	HYDRAULIC TEST	100%		APPD. DRG.	BS EN ISO 17292	TEST CERT.	√	P/W	W	W	
6.3	SEAT	1. LEAK TIGHTNESS	CR	-DO-	100%		-DO-	-DO-	-DO-	√	P/W	W	W	
		2. LEAK TIGHTNESS	CR	PNEUMATIC TEST	100%		-DO-	-DO-	-DO-	√	P/W	W	W	
6.4	COMMISSIONING SPARES	WORKMANSHIP & SUITABILITY	MA	VISUAL	100%	100%	-DO-	APPD. DRG.	INSPN. REPORT	√	P/W	W	V	
7.0	PACKING	SOUNDNESS OF PACKING	MA	VISUAL	100%	100%	APPD. DRG. / PACKING PROCEDURE (IF APPLICABLE)	APPD. DRG. / PACKING PROCEDURE (IF APPLICABLE)	INSPN. REPORT	√	P/W	W	-	REFER NOTE-3.

NOTES:

1. In case of foreign supplier, all test certificates shall be furnished by the supplier, duly witnessed/verified by supplier's TPIA.
2. 10% or min. 2 nos. at random by BHEL/Customer & 100% by supplier for each type, size & rating.
3. Following to be noted for packing:
   a) Material shall be packed suitably in order to avoid damage of paint and valve during transit and also during storage at site in tropical climate conditions.
   b) Photographs of the packing (with LR No.) just before dispatch for information of PEM.
4. BHEL reserves the right for conducting repeat tests, if required.
5. Welding and Impregnation of casting are not permitted.
6. The latest revision/year of issue of all the standard indicated in the QP shall be referred.
7. All materials shall be as per Approved drgs/ Data sheet for valves.
8. All instruments to be used for testing/ inspection shall have valid 'calibration certificates' to be verified by agencies, manufacturer and the contractor.
9. Each of the raw materials (as per approved Drg/technical data sheet) TCs should be marked-up at the particular cast/ batch/ heat no. Of the material used for equipment, mentioning the part/ component that raw material is used for.
10. A 'heat number correlation chart' shall be submitted (wherever applicable) for reviewing the material test certificates.
11. Any Lab-TC (duly endorsed by manufacturer & supplier shall be submitted from NABL accredited lab only if in-house calibrated measuring instruments are not available.
12. For any 'heat treated' component (as applicable), the corresponding 'graph' to be submitted for review.
13. Painting can be done only after inspection clearance, as per customer's approved paint specification / schedule. If mentioned. Otherwise manufacturer's standard shall be followed.
14. For any spares item, apart from 'visual inspection' the 'interchangeability, fitment certificate' & 'material TC' are to be submitted, with specific mentioning of the 'pert no/ item no of the 'approved GA/ X-Sec drg'
15. All TCs / IRs shall be endorsed by agencies manufacturer & supplier, before submitting to agency 'contractor/client/consultant' for review

LEGENDS:

*: Records, identified with "Tick"(√) shall be essentially included by supplier in QA Documentation.

** **M**: Supplier/ Manufacturer/ Sub-Supplier
P: Perform
MA: Major Characteristic
MTC: Mill Test Certificate
D: Documentation

C: Main Supplier/BHEL/ Third Party Inspection agency
W: Witness
MI: Minor Characteristic
PT: Penetrant Test
NDT: Non Destructive Testing

N: Customer/Third Party
V: Verification
CR: Critical Characteristic
UT: Ultrasonic Test

QP OF VALVE ACUTATOR

SR. NO.	Component of Operation	Characteristic	Class	Type of Check	Quantum of Check	Reference Documents	Acceptance Norms	Format of Record	Agency			Remarks
									M	C	N	
1	2	3	4	5	6	7	8	9	10			11
1.0	RAW MATERIAL INSPECTION											
1.1	Body /Ball	Chemical & Mechanical	Major	Chemical& mechanical	One Sample/ Heat	Material specification	Relevant Material Std.	Lab report	P	R	R	Lab report shall be NABL Certified Laboratory
1.2	Stem	Chemical	Major	Chemical	One Sample/ Lot	Material specification	Relevant Material Std.	Lab report	P	R	R	
2.0	IN PROCESS INSPECTION											
2.1	Body/ Ball	Dimensional	Major	Visual& Dimension	Random & 100%	Approved Drawing	Approved Drawing	Record	P	---	---	
3.0	FINAL INSPECTION											
3.1	Valve Assembly	---------	Major	Visual& Dimension	100%	Approved Drawing	Approved Drawing	Record	P	R	---	
3.2	Hydro-Static Test	Body Test	Major	Hydro	100%	Approved Drawing	Approved Drawing	Test Report	P	W	W	Refer Note [1&2]
		Seat Test	Major	Hydro	100%	Approved Drawing	Approved Drawing	Test Report	P	W	W	Refer Note [1&2]
3.3	Operation with Electrical Actuator	------	Major	Visual	100%	Approved Drawing	Approved Drawing	Report	P	W	W	Refer Note [1&2]
3.4	Performance of Electrical Actuator	Operation of: -Limit Switches -Hand wheel -Local Position Indicator	Major	Visual	100%	Approved Drawing / Wiring Diagram	Approved Drawing / Wiring Diagram	Report	P	W	W	
4.0	CONSERVATION & PACKING BEFORE DISPATCH											
4.1	Painting & Packing	------	Major	Visual	100%	Manufacturers Standards	Manufacturers Standards	Report	P	R	R	

Note: This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted alongwith relevant supporting documents.

MEASURING INSTRUMENTS

Item Components / Sub System Assembly	Dimensions (R)	Make, Model, Type, Rating (R)	Process / Electrical connection (R)	Calibration (R)	Test as per standard(R)	Insulation Resistance (R)	IBR Certification (As applicable)(R)	Hydro Test(R)	Material Test certificate (R)
Pressure Gauge (IS-3624)	Y	Y	Y	Y	Y				
Pressure /Differential Pressure Switch(BS-6134)	Y	Y	Y	Y	Y	Y			
Electronic Transmitter(IEC-60770)	Y	Y	Y	Y	Y	Y			
Transducer (IS-14570)	Y	Y	Y	Y	Y	Y			
R-Routine Test A- Acceptance Test Y – Test applicable									

PROCESS CONNECTION AND PIPING

Tests / Items	Visual & Dimensions ®	GA, BOM, Layout of component & construction feature, Paint Shade/thickness ®	Flattening,flaring,hydrotest,hardness check as per ASTM standard (A)	Component Ratings ®	Wiring ®	Make, Model, Type, Rating®	IR & HV ®	Review of TC for instrument/devices (R)	Accessability of TBs/Devices Illumination,aroundi	Tubing ®		Chemical/physical	Proof pressure	Tests as per
Local Instrument enclosure	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y			
Local instruments racks	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y			
Junction Box	Y	Y*		Y		Y	Y							
Impulse pipes and tubes	Y		Y			Y						Y		
Socket weld fittings ANSI B-16.11	Y					Y						Y		Y
Compression fittings	Y					Y					Y	Y	Y	
Instrument valves & Valve manifolds	Y					Y					Y	Y		
*-applicable for painted junction boxes														
®-Routine Test A-Acceptance Test Y – Test applicable														

LOCAL CONTROL PANEL

Tests / Items	Pre Power on Check (#) (R)	Post Power on Check (%) (R)	Internal cabling / Wiring checking(R)	Door Alignment, waviness, and	Louvers, Fans, wire mesh, Lifting	HV / IR on wired panels (R)	Paint Shade, Thickness and	Hardware/Make as per BOM (R)	Dimensions, GA, layout (R)
Local Control Panel	Y	Y	Y	Y	Y	Y	Y	Y	Y
R-Routine Test A- Acceptance Test Y – Test applicable									

Note:

2) Pre power on check: - Wire dressing, looseness, Availability of Fuses and MCB, Modules are inserted properly, Earthing connection, Input Voltage checking.

3) Manufacturer also needs to include their practices and procedure in MQP along with relevant supporting documents.

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
	CUSTOMER :		QP NO.: PE-QP-999-Q-006, REV-02	DATE: 17.04.2020
	PROJECT:		PO NO.:	DATE:
	ITEM: AC ELECT. MOTORS UPTO 50 KW 415V	SYSTEM:	SECTION: II	SHEET 1 of 2

S. NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	*	AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	D	**			
					M	C/ N					M	C	N	
1.0	ASSEMBLY	1.WORKMANSHIP	MA	VISUAL	100%	-	MFG. SPEC.	MFG. SPEC.	LOG BOOK		P	-	-	
		2.DIMENSIONS	MA	VISUAL	100%	-	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	LOG BOOK		P	-	-	
		3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE	MA	VISUAL	100%	-	MFG.SPEC./	MFG.SPEC.	LOG BOOK		P	-	-	
2.0	PAINTING	1.SHADE	MA	VISUAL	SAMPLE	-	MFG. SPEC/ APPROVED DATASHEET	MFG. SPEC/ APPROVED DATASHEET	LOG BOOK	✓	P	V	-	
3.0	TESTS	1.ROUTINE TEST INCLUDING SPECIAL TEST	MA	VISUAL	100%	-	IS-325 / IS-12615/ APPROVED DATA SHEET	IS-325 / IS-12615/ APPROVED DATA SHEET	TEST/ INSPN. REPORT	✓	P	V *	-	* NOTE -1
		2.OVERALL DIMENSIONS & ORIENTATION	MA	MEASUREMENT & VISUAL	100%	-	APPROVED DRG/ DATA SHEET	APPROVED DRG/ DATA SHEET	TEST/ INSPN. REPORT	✓	P	V *	-	* NOTE -1 & NOTE-2

BHEL						BIDDER/ SUPPLIER	
ENGINEERING			QUALITY			Sign & Date	
	Sign & Date	Name		Sign & Date	Name	Seal	
Prepared by:	HEMA KUSHWAHA	HEMA KUSHWAHA	Checked by:		KUNAL GANDHI		
Reviewed by:	PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:	RITESH KUMAR JAISWAL	RITESH KUMAR JAISWAL		

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
		CUSTOMER :		QP NO.: PE-QP-999-Q-006, REV-02	DATE: 17.04.2020
		PROJECT:		PO NO.:	DATE:
		ITEM: AC ELECT. MOTORS UPTO 50 KW 415V	SYSTEM:	SECTION: II	SHEET 2 of 2

		3.NAMEPLATE DETAILS	MA	VISUAL	100%	-	IS-325 / IS-12615 / APPROVED DATA SHEET	SAME AS COL. 7	TEST/ INSPN. REPORT	✓	P	V	-	
4.0	PACKING	SURFACE FINISH & COMPLETENESS	MA	VISUAL	100%	100%	AS PER MFG. STANDARD / (#)	AS PER MFG. STANDARD / (#).	INSPC. REPORT	✓	P	W	-	(#) REFER NOTE-8

NOTES:
1. Routine tests on 100% motors shall be done by the vendor. However, BHEL/ Customer shall witness routine tests on random samples. The sampling plan shall be mutually agreed upon.
2. For exhaust/ventilation fan motors of rating up to 1.5 KW, only routine test certificates shall be furnished for scrutiny.
3. In case test certificates for these tests on similar type, size and design of motor from independent laboratory are available, the same is valid for 5 years.
4. BHEL reserves the right to perform repeat test, if required.
5. After packing and prior to issue MDCC, photographs of items to be despatched shall be sent to BHEL for review.
6. In case of any changes in QP commented by customer at contract stage, same shall be carried out by bidder without any implication to BHEL/ Customer.
7. Project specific QP to be developed based on customer requirement.
8. For export job, BHEL technical specification for seaworthy packing to be followed.
9. Packing shall be suitable for storage at site in tropical climate conditions.
10. Latest revision/ year of issue of all the standards (IS/ ASME/ IEC etc.) indicated in QP shall be referred.

LEGENDS:
*RECORDS, INDENTIFIED WITH "TICK"(√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION,
** **M**: SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, B: MAIN SUPPLIER/ BHEL/ THIRD PARTY INSPECTION AGENCY, **C**: CUSTOMER,
P: PERFORM, **W**: WITNESS, **V:** VERIFICATION, AS APPROPRIATE
MA: MAJOR, **MI**: MINOR**, CR:** CRITICAL
D: DOCUMENTATION

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:	HEMA KUSHWAHA	HEMA KUSHWAHA	Checked by:		KUNAL GANDHI
Reviewed by:	PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:	RITESH KUMAR JAISWAL	RITESH KUMAR JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

SUB VENDOR LIST

		TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM			
		SUB VENDOR LIST & INSPECTION CATEGORISATION			
S. No.	**Item**	**QP/ Insp.**	**Proposed Subvendor**	**Place of Manufacturer**	**Remarks**
1	**AIR DRYING PLANT (HOC TYPE)**	I	ACIL	BELGIUM	
			MELLCON ENGRS PVT LTD	GR NOIDA	
			DELAIR INDIA LTD	GURGAON	
			SUMMITS HYGRONICS	COIMBATORE	
			INDCON	DELHI	
			TRIDENT PNEUMATIC PVT LTD	COIMBATORE	
2	**MS/GI Pipes –ERW IS 1239 / IS 3589**	III	SAIL	Rourkela	
			JINDAL SAW LTD	BELLARY	SAW UP TO 3632 OD THICKNESS 16 MM
			Surya Roshni	ANJAR	SAW UP TO 2032 OD
			PSL	Chennai/Vizag/Kutch/Daman	
			LALIT PIPES AND PIPES LTD	THANE	SAW 350 TO 1400 NB
			Samshi Pipes Industries	Vadodara	SAW 450 TO 2540 NB
			Mukut Pipes	Rajpura	SAW UPTO 1800 NB
			Mann Ind	Indore	SAW UPTO 1400 NB
			JCO PIPES	Chindwara	SAW UPTO 1600 NB
			Mukat Tanks and Vessels	Tarapur	SAW 200 TO 1200 NB
			Ratnamani	Kutch/Chhatral	SAW 600 TO 2600 NB SAW 400 TO 3600 NB
			Welspun	Anjar/Bharuch	SAW UPTO 2600 NB
			CAPACITE STRUCURES PVT LTD	THANE	406.4 MM TO 3874 MM OD
3	**Forged/Formed fittings**	III	EBY	Taloja	
			Siddarth & Gautam	Faridabad	
			Pipefit	Baroda	
			MS Fittings	Kolkata	
			Tube Products	Baroda	
			Bharat Forge	Pune	
			NL Hazra	Kolkata	
			Phoenix Tubes & Fittings	Pune	
4	**Ball Valve**	II	Precision Engg	Nasik	upto 400NB 150 class
			SWIMS TECHNOLOGIES	HUBLI	
			Microfinish Valves Ltd	Hubli	
			Flow chem. Industries	Ahemdabad	upto 50 NB 800 Class: 350NB 150 class
			A V Valves	Agra	
			GM ENGINEERING PVT. LTD	Rajkot	
			L&T VALVES LIMITED	COIMBATORE	
			WELLCAST INDUSTRIES	AHMEDABAD	
			Belgaum Aqua Valve	Belgaum	
5	**CS/FS Gate/Globe/Check valves**	II	Foures Engg	Thane	
			L & T Valves	Coimbatore	
			LEADER VALVES LTD.	Jalandhar	
			KSB Pump Ltd	Coimbatore	
			Niton Valves India Pvt Ltd	Navi Mumbai/Aurangabad	
			BHEL	IVP GOINDWAL	
			HAWA ENGINEERS	AHMEDABAD	

S. No.	Item	QP/ Insp.	Proposed Subvendor	Place of Manufacturer	Remarks
			SWIMS TECHNOLOGIES	HUBLI	
			HITECH ENGG PVT LTD	AHMEDABAD	
6	**Air Receiver**	II	Integrated Engineers	Mumbai	
			Diamond Fabricators	Pune	
			Parkaire	Delhi	
			Temasme Vesselex	Noida	
			United Engineering Works	Nasik	
			PEERFINTUBES & ENGINEERING	Ambernath, Thane, MH	
7	**After Cooler (Shell & Tube Type)**	II	PEERFINTUBES & ENGINEERING	Ambernath, Thane, MH	
8	**Safety Relief Valve**	III	LEADER	JALANDHAR	
			SPIRAX MARSHALL	PUNE	
			FISCHER SANMAR	CHENNAI	
9	**Pr./Vacuum/Dp Gauges**	III	Auxitrol	U.K	
			Switzer (for DP gauge)	Chennai	
			Budenburg	U.K	
			A.N.Instruments	Kolkata	
			Bells Control	Kolkata	
			Manometer India	Mumbai	
			H Guru Industries	Kolkata	
			Ashcroft India	Kalol	
			General Inst.	Mumbai/Goa	
			Gluck India	Mumbai	
			BOSE PANDA INSTRUMENTS PVT.LTD.	Kolkata	
			Forbs Marshall	Hyderabad	
			Gauge Bourdon	Mumbai	
			H Guru Instruments	Bangalore	
			Baumer Technologies	Mumbai	
10	**Pr./Vacuum/DP.switch**	III	Barton Inst.system	USA	
			Indfoss	Ghaziabad	
			SOR	USA	
			Dressor	USA	
			Delta control	UK	
			Trafag	Ranipet	
			GIC(Gauges Bourdon)	Panvel	
			ASHCROFT INDIA PVT LTD.	USA/GERMANY	
			Switzer	Chennai	
11	**Temperature Gauge**	III	Budenburg	U.K	
			A.N.Instruments	Kolkata	
			Bells Control	Kolkata	
			H Guru Industries	Kolkata	
			General Inst.	Mumbai/Goa	
			H Guru Instruments	Bangalore	
			Forbs Marshall	Hyderabad	
			Goa Instruments	Goa	
			Goa Thermostatics Instruments Pvt. Ltd.	Goa	
			Gauge Bourdon	Mumbai	
			Baumer Technologies	Mumbai	
			Ashcroft India	Kalol	

S. No.	Item	QP/ Insp.	Proposed Subvendor	Place of Manufacturer	Remarks
12	**Transmitters (PT, TT, DPT, LT)**	III	ABB	Faridabad	PRESSURE TRANSMITTER, DP TRANSMITTER and TEMP TRANSMITTER
			Yokogawa	Bangalore	
			Emerson	Mumbai	
			(ABB) -2600T series	Faridabad/Italy	
			Pune Techtrol Pvt. Ltd.	Pune	Only for capacitance Type Level Transmitter
			SIEMENS LIMITED	Mumbai	
			SMART INSTRUMENTS LTD, BRAZIL	Mumbai	LD-301 & T-301 TRANSMITTER FROM M/S SMART EQUIPMENTS BRAZIL.
			SBEM PVT. LTD.	Pune	Only for capacitance Type Level Transmitter
			TOSHNIWAL INDUSTRIES PVT. LTD.,	Ajmer	
			V. AUTOMAT & INTRUMENTS (P) LTD.	NEW DELHI	a)DISPLACEMENT TYPE TRANSMITTERS. b)PRESSURE AND DP TRANSMITTERS
			Honeywell Automation	NEW DELHI	
			Fuji	Japan	
			NIVO CONTROLS PVT. LTD.	Indore	For Capacitance type only
			Moore Industries International Inc.	CALIFORNIA, USA	Indian Associate - Chemtrol
			Endress + Hauser (India) Pvt. Ltd.,	NEW DELHI	TEMP. TRANSMITTER ONLY
13	**Transmitters Profibus type**	I	ABB	Bangalore	
14	**Flow Switch**	III	Switzer	Chennai	
			Levecon	Kolkata	
			DK Instruments	Kolkata	
			Delta	UK	
			ITT Barton	USA	
15	**Temp Sensor**	III	Pyro Electric	Mumbai	
			Detriv	Mumbai	
16	**Flow Indicator**	III	Sigma	Mumbai	
			Eureca	Pune	
17	**Auto Drain Trap**	III	Pennant	Pune	
			Forbes Marshall	Pune	
18	**Dew point meter**	III	GE Sensing	Ireland	
			Michell Instruments	UK	
			XENTAUR	USA	
			Shaw	UK	
19	**Flow Meter / Rota Meter**	III	Trac	Hyderabad	
			Eureca	Pune	Rota Meter only
			Flow Star Engg.	Faridabad	Rota Meter only
			Flow Tech instruments	Vadodara	Rota Meter only
			Instruments Engineers Pvt. Ltd.	Hyderabad	Rota Meter only
			Scientific Devices (Bombay) Pvt. Ltd.	Mumbai	Rota Meter only
			Emerson Process Management	singapore	Vortex Type
			ABB Ltd.	India	Vortex Type
			Krohne Marshall Pvt. Ltd.	India	Vortex Type
			Endress + Hauser (I) Pvt. Ltd	India	Vortex Type
			Yokogawa Electric Corporation(other than high temp & h2 services)	japan	Vortex Type
			Krohne Messtechnik Gmbh & Co. Kg	Germany	Vortex Type

S. No.	Item	QP/ Insp.	Proposed Subvendor	Place of Manufacturer	Remarks
20	**Solenoid Valve**	III	HERION	GERMANY/ ITALY	
			ROTEX AUTOMATION LTD.	V V NAGAR/ BARODA	
			ASCO	CHENNAI	
			JEFFERSON	ARGENTINA	
			AVCON	MUMBAI	
21	**Cable trays (max 300 meters)**	III	INAR PROFILE	ANNAKAPALLI	
			ANAND UDYOG	THANE	
			MJ ENGG.	DELHI	
			INDIANA	MUMBAI	
			TECHNO ENGG	CHANDIGARH	
			JAMUNA METAL	DELHI	
			INDUSTRIAL PERFORATION	KOLKATA	
			VATCO	MUMBAI	
22	**Cable Glands**	III	SUNIL& COMPANY	KOLKATA	
			ARUP ENGG	KOLKATA	
			COMMET	MUMBAI	
			QUALITY PRECISION	KOLKATA	
23	**Cable Lugs**	III	DOWELLS	MUMBAI	
			CHETNA ENGG	NASIK	
			3D	VALSAD	
24	**INSTRUMENT FITTINGS**	III	AURA INCORPORATED	NEW DELHI	
			Astec Valves & Fittings Pvt. Ltd.,	Mumbai	
			Arya Crafts & Engineering Pvt. Ltd.	Mumbai	
			Comfit & Valve Pvt. Ltd.	Nandasan-Gujarat	
			FLUIDFIT ENGINEERS PVT. LTD.	Mumbai	
			Fluid Controls Pvt. Ltd.	Mumbai	
			HP VALVES & FITTINGS INDIA PVT. LTD.	Chennai	
			PRECISION ENGINEERING INDUSTRIES	Mumbai	
			Panam Engineers,	Mumbai	
			Perfect Instrumentation Control (India) Pvt. Ltd.	Mumbai	
			VIKAS INDUSTRIAL PRODUCTS	Noida	
25	**Fibre Optic Cable**	III	Birla Ericsson	Rewa	
			Finolex	Pune/Goa	
			Aksh Fibre	Bhiwadi	
			U M Cables Ltd	Silvassa (Daman)	
			KEC International Ltd	Mysore	
			Apar Industries Limited	Valsad (Gujrat)	
			HFCL	Goa	
			R&M	Switzerland	
			Molex	UK	
			Corning	USA	
26	**Junction Box**	III	AJMERA INDUSTRIAL & ENGINEERING WORKS	Mumbai	For galvanised & FRP Junction boxes
			FLEXPRO ELECTRICALS PVT. LTD.	Navsari, Gujarat	Metal type Junction boxes only
			K.S.INSTRUMENTS PVT.LTD.	Bangalore	
			SUCHITRA INDUSTRIES	Bangalore	`
			Shrenik & Company,	Ahemdabad	

S. No.	Item	QP/ Insp.	Proposed Subvendor	Place of Manufacturer	Remarks
27	**PAINTS**	III	Asian Paints (I) Ltd.	Mumbai	
			Berger Paints India Ltd	Delhi	
			Goodlass Nerolac	Mumbai	
			Jenson & Nicholson (I) Ltd	Gurgaon	
			CDC carboline (I) Ltd.	Delhi	
			Shalimar Paints Ltd.	Gurgaon	
			Addison Paints Ltd	Chennai	
			Grand Polycoat	Mumbai	
			Bombay Paints	Mumbai	
			Jotun Paints	Pune	
			Hemple Paints	Singapore	

NOTES:

1) INSP. CAT I : FOR THOSE ITEMS THE QUALITY PLANS ARE APPROVED BY CUSTOMER AND FINAL ACCEPTANCE WILL BE ON PHYSICAL INSPECTION WITNESS BY BHEL & CUSTOMER.

2) INSP. CAT II : FOR THOSE ITEMS THE QUALITY PLANS ARE APPROVED BY CUSTOMER. HOWEVER NO PHYSICAL INSPECTION WILL BE DONE BY BHEL / CUSTOMER. THE FINAL ACCEPTANCE BY BHEL / CUSTOMER SHALL BE ON THE BASIS OF REVIEW OF DOCUMENTS AS PER QP.

3) INSP. CAT III : FOR THOSE ITEMS FINAL ACCEPTANCE BY BHEL / CUSTOMER BASED ON BIDDER'S COC.

4) THE SUB VENDOR LIST ENCLOSED IS INDICATIVE ONLY AND IS SUBJECT TO APPROVAL / ACCEPTANCE BY CUSTOMER. BIDDER TO PROPOSE HIS SUB VENDOR LIST WITH BACK UP DOCUMENTS (EXPERIENCE LIST, END USER CERTIFICATE AS APPLICABLE) ETC. THE SAME SHALL SUBJECT TO BHEL AND CUSTOMER APPROVAL DURING DETAILED ENGINEERING STAGE WITHOUT ANY TECHNICAL, COMMERCIAL & DELIVERY IMPLICATIONS TO BHEL/ CUSTOMER.

5) MAKE FOR INSTRUMENTS MOUNTED WITHIN COMPRESSOR AND DRYER SKID ARE ACCEPTABLE AS PER PROVEN EXPERIENCE OF OEM. HOWEVER, BIDDER TO
NOTE THAT MAKE SHALL BE SUBJECTED TO CUSTOMER APPROVAL DURING DETAIL ENGG.

PAINTING REQUIREMENT

PAINTING REQUIREMENT

ITEM		PAINTING REQUIREMENT
AIR COMPRESSOR		AS PER OEM STANDARD COMPLIANT TO INDUSTRIAL GR. PAINT
AIR DRYER		AS PER OEM STANDARD COMPLIANT TO INDUSTRIAL GR. PAINT
AIR RECEIVER		a) Surface Preperation: SA 2-1/2 b) Primer coat: Epoxy resin based Zinc Phosphate; 100 microns. C) Intermediate coat: Epoxy resin based paint pigmented with Titanium dioxide; 100 microns. D) Top coat: Epoxy Paint ,Glossy finish ,Sky Blue RAL 5015; 75 microns. e) Additional Finishing: Polyurethane paint Sky blue RAL 5015; 25 microns.
PIPING & VALVES (COMPRESSED AIR SYSTEM AND COOLING WATER)		AS ATTACHED

2 X 660 MW KORBA WEST AND 2x660MW RAGUNATHPUR TPS

Sl.No	Description	Surface Preparation	Primer Coat			Intermediate Coat			Finish Coats			Total Min. Painting DFT (Microns)	Colour Shade
			Type of Primer	No. of Coats	Min. DFT / coat (Microns)	Type of coating	No.Coats	Min.DFT/Coat (Microns)	Type of coating	No.Coats	Min. DFT/ Coat (Microns)		
PIPING													
1	All Piping, fittings / components, valves, Equipments etc.	Shot blasting/ abrasive blasting./Power tool cleaning(SP3/SP 5)	Zinc Chrome Primer (Alkyd base) by brush/Spray to IS104/Red Oxide Zinc Phosphate primer (Alkyd base) to IS 12744	2	25	Synthetic Enamel (long oil alkyd) to IS2932.	1	30	Synthetic Enamel (long oil alkyd) to IS2932.	2	35	150	Refer Color shade/coding scheme
2	Stainless steel surface, Galvanized steel surface and gun	No Painting											

1X800 MW YAMUNA NAGAR

1	**Piping**
1.1	**Internal surfaces**
(i)	Surface cleaning by sand blasting.
(ii)	Two (2) coats of epoxy primer coats. The minimum DFT of each coat shall be 35 microns.
(iii)	Finish coat-Two (2) coats of high build epoxy paint. The minimum DFT of each coat shall be 35 microns.
(iv)	The total dry film thickness of 140 microns (min).
1.2	**External surfaces**
(i)	Surface cleaning by sand blasting.
(ii)	Two (2) coats of epoxy primer coats. The minimum DFT of each coat shall be 35 microns.
(iii)	Finish coat - Two (2) coats of high build epoxy paint. The minimum DFT of each coat shall be 35 microns.
(iv)	The total dry film thickness of 140 microns (min).
1.3	**Other requirements**
(i)	The pipes shall be color painted/banded for identification as per the color-coding scheme and shall be generally as per IS-9404.
(ii)	If finish paint is applied in shop, one coat of finish paint shall be applied at site.
(iii)	The dry film thickness of paint shall not be less than 0.15 mm.

2 X 660 MW MAHAGENCO KORADI TPP Unit 11 & 12 - BTG

Sl.No	Description	Surface Preparation	Primer Coat			Intermediate Coat			Finish Coats			Total Min. Painting DFT (Microns)	Colour Shade
			Primer	No. of Coats	Min. DFT (Microns)	Type of coating	No.of Coats	DFT (Microns)	Primer	No. of Coats	Min. DFT/ Coat (Microns)		
1	All LP piping , fittings,components,valves ,associated equipments	SP3/SP5 Sa2	HB Zn Phosphate (Alkyd base/Zinc Chrome (Alkyd base)	2	50	Zinc Chrome (Alkyd base)	1	30	Zinc Chrome (epoxy base)	2	70	150	Refer Color shade/coding scheme
2	Storage tanks(external)	SA 2 1/2	In organic Zn silicate	2	80	HB MIO EPOXY	1	120	Polyurethene	2	60	260	

GSECL UKAI THERMAL POWER STATION

Sl.No	Description	Surface Preparation	Primer Coat			Intermediate Coat			Finish Coats			Total Min. Painting DFT (Microns)	Colour Shade
			Paint	No. of Coats	Min. DFT (Microns)	Paint	No.of Coats	DFT (Microns)	Paint	No. of Coats	Min. DFT/ Coat (Microns)		
1	Above Ground Piping	Sa2½	Inorganic Zn silicate	2	80	HB MIO epoxy	1	120	Polyeurethene	2	60	260	Refer Color shade/coding scheme
2	Valves, pumps & motors (indoor)*	Sa2½	Zn phosphate epoxy	2	80				Chlorinated rubber	2	80	160	
3	Storage tanks(external)	Sa2½	Inorganic Zn silicate	2	80	HB MIO epoxy	2	200	Polyeurethene	2	60	340	
4	Storage tanks(Internal)	SA 2 1/2	3 coats of amine adducts									400	

* Note: Manufacturer to specify details of painting system capable of withstanding environmental conditions for a period of 10 years before first maintenance.

Color Shade/Coding Scheme(Tentative): Common for all projects.

Sl.No.	Equipment	Ground Colour		Identification Tag/Band		
		Colour	RAL	Colour	RAL	Remarks
1	Compressors with inter and after coolers	Blue	5012	White	9010	Identifying legends to be used
2	Heater/Drivers	Grey	9002	White	9010	
3	Air Receivers	Blue	5012	White	9010	Identifying legends to be used
4	IA/SA PIPINGS	Grey	9002	Sky Blue	101	

PACKING REQUIREMENT

PACKING REQUIREMENT

	COMMON GUIDELINES FOR PACKING
1	**GENERAL:**
1.1	The Components/Assemblies need to be packed suitably to avoid physical damage & corrosion during transit & storage. This packing shall be suitable for different handling operations and for the adverse conditions during transportation and during indoor / outdoor storage of materials.
1.2	All the equipment shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at site till the time of erection. The Contractor shall be responsible for all loss or damage during transportation, handling and storage due to improper packing.
1.3	The identification marking indicating the name and address of the consignee shall be clearly marked in indelible ink on two opposite sides and top of each of the packages. In addition the Contractor shall include in the marking gross and net weight, outer dimension and cubic measurement.
1.4	All the equipments shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. While packing all the materials, the limitation from the point of view of the sizes of railway wagons available in India should be taken account of. The CAS supplier shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. The CAS supplier shall ascertain the availability of Railway wagon sizes from the Indian Railways or any other agency concerned in India well before effecting despatch of equipment. Before despatch it shall be ensured that complete processing and manufacturing of the components is carried out at shop, only restricted by transport limitation, in order to ensure that site works like grinding, welding, cutting & preassembly to bare minimum. The BHEL's Inspector shall have right to insist for completion of works in shops before despatch of materials for transportation.
1.5	Each package shall be accompanied by a packing note quoting specifically the name of the Contractor, the number and date of contract and names of the office placing the contract, nomenclature of contents and Bill of Material.
2.	**TYPES OF PACKING:**
	The following 5 types of packing have been standardized for packing of General Components/ Assemblies.
a	**OP**' - Open Type.
b	**PP**' - Partially Packed.
c	**CP**' – Crate/Box Packing - Components/Equipment requiring physical protection.
d	'**CQ**' - Case Packing – Machined components - Small & Medium Components/ Assemblies/ Equipment which require corrosion & physical protection.
e	**'CR'** - Case Packing – Electrical/Electronic Components/ Assemblies, which require special packing viz. Water Proof, Shock Proof etc.
3.	**DESCRIPTION OF TYPES OF PACKING:**
	The various types of packing, as standardized above, are described below.
3.1	**'OP' - Open Type**
	In case, of components which are not affected by water & dust and do not require special protection, are generally not machined, shall be sent as open packages. However, these components may be sent in crates, wherever necessary.
3.2	**PP' - Partially Packed**
3.2.1	Components which need special protection at selected portions only shall be despatched partially packed. Machined surfaces should not be allowed to come directly in contact with the wood. Such surfaces should be protected with 100GSM(Colourless) Multi Layered Cross Laminated Polyethylene.
3.2.2	Film. All sharp corners and edges shall be protected by rubber mats to prevent damage to the polyethylene film.
3.3	**'CP' - Crate Packing**
	Assemblies/Components which need only physical protection from the point of view of handling shall be despatched duly packed in crates.

3.4	**'CQ' - Case Packing -** Machined Components/Assemblies/Equipment
3.4.1	Small and medium sized components/assemblies/equipment due to size/weight and to avoid handling and pilferage problems shall be packed in Case/Containers. Wherever required adequate quantity of silica gel or VCI Powder/Tablets, packed in thin muslin cloth cotton bags shall be suitably placed. Small machines/components of less weight shall be provided with suitable cushioning by Rubberised coir. The components inside the case shall be entirely covered with100GSM(Colourless) Multi Layered Cross Laminated Polyethylene Film, wherever required. This may be prescribed for electronic parts/critical machined components/surfaces.
3.4.2	For mechanical product like valves where motors are separately securely wrapped in polyethylene, the requirement of individual component wrapping shall be exempted.
3.5	**CR' - Case Packing** - Electrical & Electronic Components/Assemblies
	Delicate components likely to be damaged e.g. Gauges, Instruments etc. are to be wrapped in waxed paper or polyethylene air bubble film and packed in cartons. Adequate quantity of Silica gel packed in cotton bags of 100grams each are to be suitably placed in the cartons. The cartons shall be entirely covered with 100GSM(Colourless) Multi Layered Cross Laminated Polyethylene Film before being packed in the cases. VCI Powder/Tablets can be used as an alternative to Silica Gel.
4	**PREPARATION OF PACKING CASES**
4.1	**DIMENSIONS:**
a)	Thickness of planks for Front, rear, top and bottom sides and binding, jointing battens shall be 25/20mm +2/-3 mm as per applicable drawings of the respective units/manufacturers.
b)	Width of all planks including the tongue shall be more than 125mm and after plaining it shall be minimum 100mm.
c)	Minimum number of planks shall be used for a shook.
d)	Horizontal, vertical, diagonal planks shall be given for binding (number of such planks depend on the dimension of panel.
e)	Width of binding planks shall be minimum 100mm.
f)	Distance between any 2 binding planks shall be less than 750mm.
g)	diagonal planks shall be used in between vertical binding planks when distance between inner to inner of vertical planks is more than 750mm.
h)	Distance of the outer edges of these planks from the edge of case shall be less than 250mm.
i)	Diagonal planks are not required for top planks and width side, if the width of pallet is less than 750mm.
4.2	**HOOP IRON STRIPS**
	These are used for strapping the boxes. The width of the strips shall be 19+1mm and thickness 0.6+0.01mm. The material shall be free from rust. If sufficient nailing is done for bigger boxes, strapping need not be done.
4.3	**BRACKETS**
	These brackets are used for nailing to the corners of cubicle boxes. The brackets shall be of mild steel of thickness min 2mm and width 25+1mm. The brackets shall be of "L" shape, the length of each side being 100+2mm. Two holes shall be provided towards the end of each side for screwing /nailing.
4.4	**MULTI LAYERED CROSS LAMINATED POLYTHELENE FILM**
	100GSM (Colourless) Multi Layered Cross Laminated Polythelene Film are used to make covers to the jobs individually. The cross lamination gives qualities of extra toughness, together with flexibility and lightness coupled with good weather resistance to ultra violet rays.
4.5	**RUBBERISED COIR:**
	The rubberized coir is used as cushioning material. For the packing of loose items, items are to be arrested by using rubberized coir. For the packing of cubicles rubberized coir of thickness 25mm and width 75mm shall be used.

5	**MULTI LAYER CROSS LAMINATED POLY FILM WHILE PACKING OF CUBICLES/CASING**
5.1	The inner surface of 4 sides of shook's shall be nailed with Multi-layer cross laminated poly film (as per 4.4) using blue nails wherever 2 pieces of Cross laminated poly film are used, the joint shall have an overlap of minimum 20mm.
5.2	The inner surface of top cover shall be nailed with Multi-layer cross laminated poly film. This sheet shall project outside on 4 sides by at least 100mm and shall be nailed properly on sides. Joining of sheets should have overlap of minimum 20mm.
5.3	The cubicles shall be covered with Multi-layer cross laminated poly film.
6	**PACKING OF LOOSE ITEMS/SPARES**
6.1	Inner surfaces of all 6 sides shall be lined with Multi Layered Cross Laminated Polythelene Film (as per clause 5.4) using blue nails.
6.2	Rubberized coir of minimum 25mm thickness and 100 mm width shall be nailed to inner surfaces of bottom and 4 sides of box.
6.3	Internal packing: Items that go into the box shall be packed using 100GSM, (Colourless) Multi Layered Cross Laminated Polyethylene Film. Any space left between the job and the sides and the top of the box shall be filled with rubberized coir to get proper cushioning effect.
6.4	Certain items like transformers, reactors, breakers, etc., shall be bolted to the bottom of the box using bolts, nuts and washers.
6.5	Silica gel held in cotton bags shall be kept at proper places in the box.
6.6	Packing slip kept in polyethylene bag shall be placed in the box.
6.7	Two numbers of hoop iron strips shall be strapped tightly on the case using clips.
6.8	Stencil marking of various details and marking of various symbols shall be done as per BHEL instructions using indelible/non-washable marking ink.
6.9	Loose items to be kept inside the cubicle/casing.
	- Other items which are given loose in addition to cubicle shall be packed in separate boxes.
7	**TYPICAL PATTERN OF WOODEN BOX**

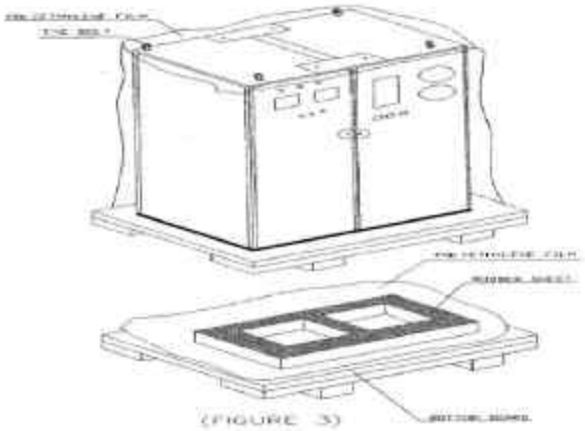


Figure 2

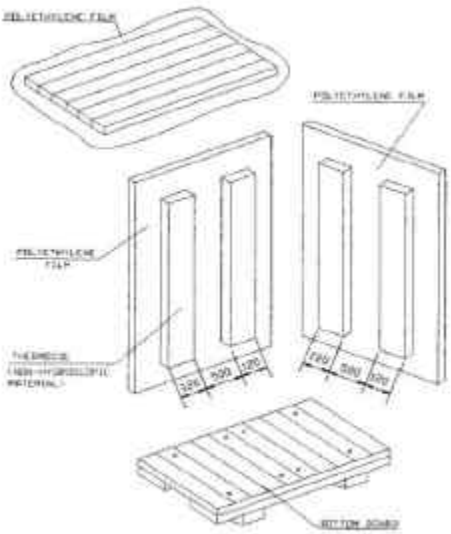
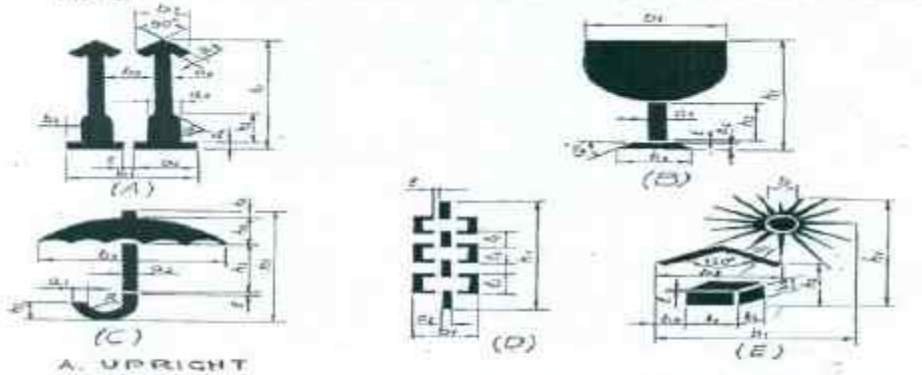


Figure 1

8	**SEALED PACKING:**
	Components sub-assemblies and assemblies sensitive to climatic conditions shall be packed seal tight. All the openings of the sensitive components, sub-assemblies and assemblies shall be blanketed to prevent the ingress of dust and moisture. The components sub-assemblies and assemblies are completely covered with 2 layers of polyethylene sheet. All sharp corners and edges are to be protected by rubber mats to prevent the polyethylene sheet from damage. Top surface of the case shall be free from dents to prevent rain water pockets.
9	**MARKINGS/STENCILINGS**
9.1	**"HANDLE WITH CARE", "FRAGILE DO NOT TURN OVER".**
9.2	Besides the caution signs the product information's shall be stencilled of letters with 13mm to 50mm height.
9.3	In case of consignment consists of more than one package, each package shall carry its package no. as given in shipping list. All caution signs shall be stencilled in high quality full glossy out door finishing paint red in colour (AA56126). All other markings shall be carried out in black enamel.
9.4	Caution signs & other markings shall be stencilled on both the end shooks & the side shooks.
9.5	Caution sign (for slinging) shall be stencilled only on side shooks at the appropriate place.
9.6	In case the size of package is small for using the stencils, then hand written letters/figures shall be allowed.

MARKINGS ON PACKING CASES

1. THIS PLANT STANDARD PRESCRIBES THE VARIOUS CAUTION SIGNS AND OTHER MARKINGS ON PACKING CASES.
2. DIMENSIONS IN THE TABLE I SHALL BE USED FOR MAKING STENCILS ONLY.



A. UPRIGHT
B. FRAGILE
C. PROTECTION FROM FALLING OR CONDENSING MOISTURE.
D. SLINGING POSITION
E. PROTECTION FROM DIRECT RADIATIONS.

Figure 3

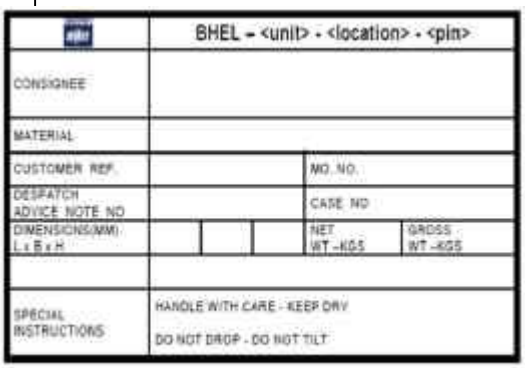


Figure 4 – TYPICAL MARKING PLATE (220 X 170)

Figure 5

Easy spares [Initial and O&M] Traceability and Identification at units and as well as at sites

10	**STANDARD METHOD OF PACKING**

Table 1 - Standard Method of Packing

S. No.	DESCRIPTION	CASE	CRATE	BUNDLE	BARE	DRUM
1	AIR COMPRESSORS	O				
2	AIR DRYERS	O				
3	AIR RECEIVERS				O	
4	PIPING				O	
5	FITTINGS, VALVES	O				
6	INSTRUMENTS	O				
7	PANELS	O				
8	UPS	O				
9	HOSES & AIR GUNS		O			
10	CABLE TRAYS, CABLE RACKS, EARTHING MATERIAL		O			
11	OPERATIONAL SPARES , MAINTENANCE TOOLS AND TACKLES	O				
12	ALL OTHER LOOSE ITEMS	O				

Note:	
	Protective coating applied on machined surfaces should not be disturbed. The plastic covering should be put back carefully so that it prevents ingress of dust and moisture. Some packing may have vapour phase inhibitor (VPI) paper enclosed inside the packing cases. This should be restored to its original place as far as possible.

BILL OF QUANTITY (BOQ)

BILL OF QUANTITY : 2x660 MW DVC RAGHUNATHPUR

S. No.	Description	Quantity & Unit
A	Total lump sum firm price inclusive of all prevailing taxes, duties and other levies for **Supply part, Services part, Mandatory Spares,Engineering Charges and AMC** comprising of design (i.e. preparation and submission of drawing /documents including "As Built" drawings and O&M manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, maintenance tools & tackles (as applicable), fill of lubricants & consumables, mandatory spares along with spares for erection (as required), start-up spares and commissioning spares (as required), operational spares (as specified), forwarding, proper packing, shipment and delivery at site, unloading, handling, transportation & storage at site, in-site transportation, assembly, erection & commissioning, final painting at site, minor civil work, trial run at site, carrying out Performance guarantee tests at site, training of BHEL & Customer O&M staff at project site and handover in flawless condition of the package to the end customer complete with all accessories for the total scope defined as per BHEL NIT & tender technical specification as specified above, amendments & agreements till placement of order.	**1 Lot**
	Break-up of A:	
1.0	Total lump sum firm price inclusive of all prevailing taxes, duties and other levies for **Supply part** comprising of manufacturing, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, maintenance tools & tackles (as applicable), fill of lubricants & consumables alongwith spares for erection as required, start-up and commissioning spares as required, operational spares (as specified), forwarding, proper packing, parts / spares required during warranty period (against defects in design, materials, construction and workmanship) shipment and delivery at site, for the total scope defined as per BHEL NIT & tender technical specification as specified above, amendment & agreements till placement of order.	**1 Lot**
2.0	Total lump sum firm price inclusive of all prevailing taxes, duties and other levies for **Services part** comprising of unloading, handling, transportation & storage at site, in-site transportation, assembly, erection & commissioning, connectivity of CAS with DCS, final painting at site, minor civil work, trial run at site and carrying out Performance guarantee tests at site as specified, travelling, lodging, boarding & other charges of E&C personnel's, training of BHEL & Customer O&M staff at project site and handover in flawless condition of the package to the end customer complete with all accessories for the total scope defined as per BHEL NIT & tender technical specification as specified above, amendments & agreements till placement of order.	**1 Lot**
3.0	Total lumpsum firm price inclusive of all prevailing taxes, duties and other levies for **Mandatory spares** comprising of manufacture, fabrication, assembly, inspection / testing (as applicable) at vendor's & sub-vendor's works, painting, forwarding, proper packing, shipment, delivery at site & handover of MS to BHEL/End Customer, for the total scope defined as per BHEL NIT & tender technical specification as specified above, amendments & agreements till placement of order.	**1 Lot**
4.0	Total lumpsum firm price for **Engineering Charges** comprising of design (i.e Preparation & submission of drawings/documents including "AS-BUILT" drawings and O&M Manuals and engineering as per tender technical specification above, amendments & agreements till placement of order.	**1 Lot**
5.0	Total lumpsum firm price inclusive of all prevailing taxes, duties and other levies for **AMC (Annual Maintenance Contract)**, for the total scope defined as per BHEL NIT & tender technical specification as specified above, amendments & agreements till placement of order.	**1 Lot**
	Break-up of Supply part (S.No 1.0) is as below:	
(i)	Instrument air Compressors **(Oil Free Screw / Centrifugal type)** each of minimum 50 NM3/Min capacity @ 8.0 kg/cm2 (min.) discharge pressure with suction filter with silencer, inter cooler and after cooler with moisture separators, automatic drain traps, instruments, control system, cable lugs, glands and other accessories (as required / as specified) **but excluding electric motor drive**.	4 Nos.
(ii)	Air Drying Plants HOC **type (Twin Tower / Rotary Drum)** of minimum 50 NM3/min. capacity for Air Compressor with all instruments, control panels, including Electronic due point meter and other accessories as specified.	4 Nos.
(iii)	Service air Compressors **(Oil Free Screw / Centrifugal type)** each of minimum 50 NM3/Min capacity @ 8.0 kg/cm2 (min.) discharge pressure with suction filter with silencer, inter cooler and after cooler with moisture separators, automatic drain traps, instruments, control system, cable lugs, glands and other accessories (as required / as specified) **but excluding electric motor drive**.	3 Nos.
(iv)	Air Receivers required for Compressed Air System of **minimum 10 Cu.M** capacity each with instruments, relief valve, isolation valve, drain connection with automatic trap stations (zero purge air loss type) and other accessories as specified.	10 Nos.
(v)	Inter connecting cooling water, drain piping and compressed air piping as specified including fittings and valves etc. for complete Compressed air system.	1 Lot
(vi)	Instruments as specified.	1 Lot

BILL OF QUANTITY : 2x660 MW DVC RAGHUNATHPUR

S. No.	Description	Quantity & Unit
(vii)	Interface module(s), JB's for the overall control & monitoring of compressed air system through DDCMIS including common Sequencing Panel.	1 Lot
(viii)	Operational spares for Compressed air system as given below:	
a	Lube oil (Qty. for 1 Lot in Ltr. shall be as per oil tank capacity for One Compressor)	7 Lot
b	Lube oil filters with seals	14 nos.
c	Air filters with gaskets	14 nos.
d	Service kit including seals, washers and rings for inter cooler & after cooler	7 nos.
	Break-up of Mandatory Spares (S.No. 3) is as below:	
1.00.00	**COMPRESSED AIR SYSTEM**	
1.01.00	Oil free Screw Air Compressor (as applicable)	
(i)	Complete HP Stage with HP element.	1 No.
(ii)	Complete LP stage with LP element	1 No.
(iii)	Void	NA
(iv)	LP stage Pinion	1 No.
(v)	HP stage Pinion	1 No.
(vi)	Air Oil Filter Kit	4 Nos.
(vii)	After cooler Safety Valve (if applicable)	1 No.
(viii)	Inter Cooler Safety Valve (if applicable)	1 No.
(ix)	Oil Pump kit	2 Nos.
(x)	After cooler drain valve kit (if applicable)	1 No.
(xi)	Inter cooler drain valve kit (if applicable)	1 No.
(xii)	Air receiver drain/moisture trap	1 No.
(xiii)	'O' Rings for oil cooler	8 Nos.
(xiv)	Moisture separators for Aftercooler (if applicable)	2 Nos.
(xv)	Moisture separators for Intercooler (if applicable)	2 Nos.
1.02.00	Centrifugal Compressor (as applicable)	
1.02.01	Pinion Shaft Journal Bearing Assembly	2 Sets
1.02.02	Thrust Bearing Assembly	2 Sets
1.02.03	Shaft Seals for Air-Oil (All stages)	2 Sets
1.02.04	Gasket / O rings	3 Sets each type/size
1.02.05	Air Filter Elements	4 Sets each type/size
1.02.06	Lub Oil System	
1.02.06.1	Main oil pump complete	1 No.
1.02.06.2	Aux. oil pump complete	1 No.
1.02.06.3	Complete coupling for Main & Aux. oil pump, spacer	1 No.
1.02.06.4	Cartridge filter elements with gaskets and seals	4 Sets
1.02.06.5	Motor Bearings	2 Sets
1.02.07	Drain / Moisture Trap	2 Set of each type/size
1.02.08	Oil Cooler Gaskets & Seals	2 sets
1.03.00	**AIR DRYING PLANT FOR IA SYSTEM (Twin tower Type) (As applicable)**	
1	Pre filter element (Ceramic candle or as applicable)	2 sets
2	After filter element (Ceramic candle or as applicable)	2 sets
3	Heater element (if applicable)	1 sets
4	Blower bearing (if applicable)	1 sets
5	Blower motor bearing (if applicable)	2 sets
6	Valves & Valve Actuators (pneumatic/hydraulic)	2 sets
7	Heater coil for temperature stabilization (for HOC type) (as applicable)	2 sets
8	Desiccant for Air Dryer: one complete fill for both towers of one dryer	1 Lot
1.04.00	Valves (within the compressor house having actuators) along with actuator	2 Nos. of each type / rating / size
1.05.00	Void	NA
1.06.00	**MEASURING INSTRUMENTS**	
1	Electronic Transmitters	
(i)	Transmitters of all types, ranges and model no. (for the measurement of Pressure, differential pressure flow, level, etc.)	2 Nos. of each type and model
2	Temperature elements	

BILL OF QUANTITY : 2x660 MW DVC RAGHUNATHPUR

S. No.	Description	Quantity & Unit
(i)	RTD's of each type and length	2 Nos. of each type and length
(ii)	Thermocouples of each type like K-type, R-type, metal etc. and length	2 Nos. of each type and length
(iii)	Thermowell	2 Nos. of each type and length
(iv)	Temperature transmitters	2 Nos. of each type
3	Process Actuated Switch Devices Includes all types of Pressure, differential pressure, flow, temperature, differential temperature, level switch Devices	2 Nos. of each type and model
4	Dew Point meters	1 No.
5	Solenoids	Nos. of each type
6	Actuators (if applicable)	No.
1.07.00	**MICROPROCESSOR BASED/PLC BASED CONTROL/ELECTRONIC BASED CONTRAL PANEL (AS APPLICABLE)**	
1	Fully programmed controller of electronic modules of each type (as applicable)	1 No.
2	Power supply module (if applicable)	1 No.
1.08.00	Rotary drum type Air drying plant for Instrument Air system (as applicable)	
1	Drive assembly consisting of motor, gear boxes, drive shaft & coupling	1 set
2	Desiccant for Air Dryer: one complete fill of one dryer	1 Lot

NOTE:

1	Wherever set is mentioned, one set of the spares of that item shall be for complete replacement of that particular item for one equipment.
2	Any fraction of a item shall mean the next higher integer.
3	Wherever quantity has been specified as percentage (%), the quantity of mandatory spares to be provided by contractor shall be the specified percentage (%) of the total population of the plant. In case the quantity so calculated happens to be fraction, the same shall be rounded off to next higher whole number.
4	Wherever the quantities have been indicated for each type, size, thickness, material, radius, range etc., these shall cover all the items supplied and installed and the breakup for these shall be furnished in the bid.
5	In case spares indicated in the list are not applicable to the particular design offered by the bidder, the bidder should offer spares applicable to offered design with quantities generally in line with the approach followed in the above list.

BILL OF QUANTITY: 2x660 MW CSPGCL KORBA WEST

S. No.	Description	Quantity & Unit
A	Total lump sum firm price inclusive of all prevailing taxes, duties and other levies for **Supply part, Services part, Mandatory Spares,Engineering Charges and AMC** comprising of design (i.e. preparation and submission of drawing /documents including "As Built" drawings and O&M manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, maintenance tools & tackles (as applicable), fill of lubricants & consumables, mandatory spares along with spares for erection (as required), start-up spares and commissioning spares (as required), operational spares (as specified), forwarding, proper packing, shipment and delivery at site, unloading, handling, transportation & storage at site, in-site transportation, assembly, erection & commissioning, final painting at site, minor civil work, trial run at site, carrying out Performance guarantee tests at site, training of BHEL & Customer O&M staff at project site and handover in flawless condition of the package to the end customer complete with all accessories for the total scope defined as per BHEL NIT & tender technical specification as specified above, amendments & agreements till placement of order.	**1 Lot**
	BREAK-UP OF A	
1.0	Total lump sum firm price inclusive of all prevailing taxes, duties and other levies for **Supply part** comprising of manufacturing, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, maintenance tools & tackles (as applicable), fill of lubricants & consumables alongwith spares for erection as required, start-up and commissioning spares as required, operational spares (as specified), forwarding, proper packing, **parts / spares required during warranty period** (against defects in design, materials, construction and workmanship) shipment and delivery at site, for the total scope defined as per BHEL NIT & tender technical specification as specified above, amendment & agreements till placement of order.	**1 Lot**
2.0	Total lumpsum firm prices inclusive of all prevailing taxes, duties and other levies for **Services part** comprising of unloading, handling, transportation & storage at site, in-site transportation, assembly, erection & commissioning, connectivity of CAS with DCS, final painting at site, minor civil work, trial run at site and carrying out Performance guarantee tests at site as specified, travelling, lodging, boarding & other charges of E&C personnel's, training of BHEL & Customer O&M staff at project site and handover in flawless condition of the package to the end customer complete with all accessories for the total scope defined as per BHEL NIT & tender technical specification as specified above, amendments & agreements till placement of order.	**1 Lot**
3.0	Total lumpsum firm price inclusive of all prevailing taxes, duties and other levies for **Mandatory spares** comprising of manufacture, fabrication, assembly, inspection / testing (as applicable) at vendor's & sub-vendor's works, painting, forwarding, proper packing, shipment, delivery at site & handover of MS to BHEL/End Customer, for the total scope defined as per BHEL NIT & tender technical specification as specified above, amendments & agreements till placement of order.	**1 Lot**
4.0	Total lumpsum firm price for **Engineering Charges** comprising of design (i.e Preparation & submission of drawings/documents including " AS-BUILT" drawings and O&M Manuals and engineering as per tender technical specification above, amendments & agreements till placement of order.	**1 Lot**
5.0	Total lumpsum firm price inclusive of all prevailing taxes, duties and other levies for **AMC (Annual Maintenance Contract)**, for the total scope defined as per BHEL NIT & tender technical specification as specified above, amendments & agreements till placement of order.	**1 Lot**
B	**Break-up of Supply part (S.No 1.0) is as below:**	
(i)	Instrument air Compressors (Oil Free Screw / Centrifugal type) each of minimum 50 NM3/Min capacity @ 8.0 kg/cm2 (min.) discharge pressure with suction filter with silencer, inter cooler and after cooler with moisture separators, automatic drain traps, instruments, control system, cable lugs, glands and other accessories (as required / as specified) **but excluding electric motor drive**.	3 Nos.
(ii)	Air Drying Plants HOC **type (Twin Tower / Rotary Drum)** of minimum 50 NM3/min. capacity for Air Compressor with all instruments, control panels, including Electronic due point meter and other accessories as specified.	3 Nos.
(iii)	Service air Compressors (Oil Free Screw / **Centrifugal** type) each of minimum 50 NM3/Min capacity @ 8.0 kg/cm2 (min.) discharge pressure with suction filter with silencer, inter cooler and after cooler with moisture separators, automatic drain traps, instruments, control system, cable lugs, glands and other accessories (as required / as specified) **but excluding electric motor drive**.	4 Nos.

BILL OF QUANTITY: 2x660 MW CSPGCL KORBA WEST

S. No.	Description	Quantity & Unit
(iv)	Air Receivers required for Compressed Air System of minimum 10 Cu.M capacity each with instruments, relief valve, isolation valve, drain connection with automatic trap stations (zero purge air loss type) and other accessories as specified.	9 Nos.
(v)	Air Receivers required for Compressed Air System of minimum 02 Cu.M capacity each with instruments, relief valve, isolation valve, drain connection with automatic trap stations (zero purge air loss type) and other accessories as specified.	1 No.
(vi)	Inter connecting cooling water, drain piping and compressed air piping as specified including fittings and valves etc. for complete Compressed air system.	1 Lot
(vii)	Instruments as specified.	1 Lot
(viii)	Interface module(s), JB's for the overall control & monitoring of compressed air system through DDCMIS including common Sequencing Panel.	1 Lot
(ix)	**Operational spares for Compressed air system as given below.**	
a	Lube oil (Qty. for 1 Lot in Ltr. shall be as per oil tank capacity for One Compressor)	7 lot
b	Lube oil filters with seals - 14 Nos.	14 nos
c	Air filters with gaskets - 14 Nos.	14 nos
d	Service kit including seals, washers and rings for inter cooler & after cooler	7nos
	Break-up of Mandatory Spares(S.No. 3) is as below:	
1.01	Oil free Screw Air Compressor (as applicable)	
(i)	Complete HP Stage with HP element	1 No.
(ii)	Complete LP stage with LP element	1 No.
(iii)	Motor Bearings	2 Set
(iv)	LP stage Pinion	1 No.
(v)	HP stage Pinion	1 No.
(vi)	Air Oil Filter Kit	4 Nos.
(vii)	After cooler Safety Valve (if applicable)	1 No.
(viii)	Inter Cooler Safety Valve (if applicable)	1 No.
(ix)	Oil Pump kit	2 Nos.
(x)	After cooler drain valve kit (if applicable)	1 No.
(xi)	Inter cooler drain valve kit (if applicable)	1 No.
(xii)	Air receiver drain/moisture trap	1 No.
(xiii)	'O' Rings for oil cooler	8 No.
(xiv)	Moisture separators for Aftercooler (if applicable)	2 No.
(xv)	Moisture separators for Intercooler (if applicable)	2 No.
1.02	Centrifugal Compressor (as applicable)	
(i)	Pinion Shaft Journal Bearing Assembly	2 Sets
(ii)	Thrust Bearing Assembly	2 Sets
(iii)	Shaft Seals for Air-Oil (All stages)	2 Sets
(iv)	Gasket / O rings	3 Sets each type/size
(v)	Air Filter Elements	4 Sets each type/size
(vi)	Lub Oil System	
(a)	Main oil pump complete	1 No.
(b)	Aux. oil pump complete	1 No.
(c)	Complete coupling for Main & Aux. oil pump, spacer	1 No.
(d)	Cartridge filter elements with gaskets and seals	4 Sets
(e)	Motor Bearings	2 Sets
(vii)	Drain / Moisture Trap	2 Set of each type/size.
(viii)	Oil Cooler Gaskets & Seals	2 sets
1.03	**AIR DRYING PLANT FOR IA SYSTEM (Twin tower Type) (As applicable)**	
(i)	Pre filter element (Ceramic candle or as applicable)	2 sets
(ii)	After filter element (Ceramic candle or as applicable)	2 sets
(iii)	Heater element (if applicable)	1 sets
(iv)	Blower bearing (if applicable)	1 sets
(v)	Blower motor bearing (if applicable)	2 sets
(vi)	Valves & Valve Actuators (pneumatic/hydraulic)	2 sets
(vii)	Heater coil for temperature stabilization (for HOC type) (as applicable)	2 sets
(viii)	Desiccant for Air Dryer: One complete fill for both towers of one dryer	1 Lot

BILL OF QUANTITY: 2x660 MW CSPGCL KORBA WEST

S. No.	Description	Quantity & Unit
1.04	Valves (within the compressor house having actuators) along with actuator	2 Nos. of each type / rating / size
1.05	Void	-
1.06	**MEASURING INSTRUMENTS**	
(i)	Electronic Transmitters	
(a)	Transmitters of all types, ranges and model no. (for the measurement of Pressure, differential pressure flow, level, etc.)	2 Nos. of each type and model
(ii)	Temperature elements	
(a)	RTD's* of each type and length	2 Nos. of each type and length
(b)	Thermocouples of each type like K-type, R-type, metal etc. and length *	2 Nos. of each type and length
(c)	Thermowell	2 Nos. of each type and length
(d)	Temperature transmitters (if applicable)	2 Nos of each type
(iii)	Process Actuated Switch Devices Includes all types of Pressure, differential pressure, flow, temperature, differential temperature, level switch Devices	2 Nos. of each type and model
(iv)	Dew Point meters	1 No.
1.07	**MICROPROCESSOR BASED/PLC BASED CONTROL/ELECTRONIC BASED CONTRAL PANEL (IF APPLICABLE)**	
(i)	Fully programmed controller of electronic modules of each type (as applicable)	1 No.
(ii)	Power supply module (if applicable)	1 No.
1.08	**Rotary drum type Air drying plant for Instrument Air system (As applicable)**	
(i)	Drive assembly consisting of motor, gear boxes, drive shaft & coupling	1 set
(ii)	Desiccant for Air Dryer: one complete fill of one dryer	1 Lot

NOTE:

1	Wherever set is mentioned, one set of the spares of that item shall be for complete replacement of that particular item for one equipment.
2	Any fraction of a item shall mean the next higher integer.
3	Wherever quantity has been specified as percentage (%), the quantity of mandatory spares to be provided by contractor shall be the specified percentage (%) of the total population of the plant. In case the quantity so calculated happens to be fraction, the same shall be rounded off to next higher whole number.
4	Wherever the quantities have been indicated for each type, size, thickness, material, radius, range etc., these shall cover all the items supplied and installed and the breakup for these shall be furnished in the bid.
5	In case spares indicated in the list are not applicable to the particular design offered by the bidder, the bidder should offer spares applicable to offered design with quantities generally in line with the approach followed in the above list.

BILL OF QUANTITY: 1x800 MW UKAI TPS

S. No.	Description	Quantity & Unit
A	Total lump sum firm price inclusive of all prevailing taxes, duties and other levies for **Supply part, Services part, Mandatory Spares,Engineering Charges and AMC** comprising of design (i.e. preparation and submission of drawing /documents including "As Built" drawings and O&M manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, maintenance tools & tackles (as applicable), fill of lubricants & consumables, mandatory spares along with spares for erection (as required), start-up spares and commissioning spares (as required), operational spares (as specified), forwarding, proper packing, shipment and delivery at site, unloading, handling, transportation & storage at site, in-site transportation, assembly, erection & commissioning, final painting at site, minor civil work, trial run at site, carrying out Performance guarantee tests at site, training of BHEL & Customer O&M staff at project site and handover in flawless condition of the package to the end customer complete with all accessories for the total scope defined as per BHEL NIT & tender technical specification as specified above, amendments & agreements till placement of order.	**1 Lot**
	BREAK-UP OF A	
1.0	Total lump sum firm price inclusive of all prevailing taxes, duties and other levies for **Supply part** comprising of manufacturing, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, maintenance tools & tackles (as applicable), fill of lubricants & consumables alongwith spares for erection as required, start-up and commissioning spares as required, operational spares (as specified), forwarding, proper packing, **parts / spares required during warranty period** (against defects in design, materials, construction and workmanship) shipment and delivery at site, for the total scope defined as per BHEL NIT & tender technical specification as specified above, amendment & agreements till placement of order.	1 Lot
2.0	Total lumpsum firm prices inclusive of all prevailing taxes, duties and other levies for **Services part** comprising of unloading, handling, transportation & storage at site, in-site transportation, assembly, erection & commissioning, connectivity of CAS with DCS, final painting at site, minor civil work, trial run at site and carrying out Performance guarantee tests at site as specified, travelling, lodging, boarding & other charges of E&C personnel's, training of BHEL & Customer O&M staff at project site and handover in flawless condition of the package to the end customer complete with all accessories for the total scope defined as per BHEL NIT & tender technical specification as specified above, amendments & agreements till placement of order.	1 Lot
3.0	Total lumpsum firm price inclusive of all prevailing taxes, duties and other levies for **Mandatory spares** comprising of manufacture, fabrication, assembly, inspection / testing (as applicable) at vendor's & sub-vendor's works, painting, forwarding, proper packing, shipment, delivery at site & handover of MS to BHEL/End Customer, for the total scope defined as per BHEL NIT & tender technical specification as specified above, amendments & agreements till placement of order.	1 Lot
4.0	Total lumpsum firm price for **Engineering Charges** comprising of design (i.e Preparation & submission of drawings/documents including " AS-BUILT" drawings and O&M Manuals and engineering as per tender technical specification above, amendments & agreements till placement of order.	1 Lot
5.0	Total lumpsum firm price inclusive of all prevailing taxes, duties and other levies for **AMC (Annual Maintenance Contract)**, for the total scope defined as per BHEL NIT & tender technical specification as specified above, amendments & agreements till placement of order.	1 Lot
B	**Break up of Supply part (S.No 1.0) are as below**	
(i)	Instrument air Compressors (Oil Free Screw / Centrifugal type) each of minimum 50 NM3/Min capacity @ 8.5 kg/cm2 (min.) discharge pressure with suction filter with silencer, inter cooler and after cooler with moisture separators, automatic drain traps, instruments, control system, cable lugs, glands and other accessories (as required / as specified) **but excluding electric motor drive**.	3 Nos.
(ii)	Air Drying Plants HOC **type (Twin Tower / Rotary Drum)** of minimum 60 NM3/min. capacity for Air Compressor with all instruments, control panels, including Electronic due point meter and other accessories as specified.	3 Nos.
(iii)	Service air Compressors (Oil Free Screw / **Centrifugal** type) each of minimum 50 NM3/Min capacity @ 8.5 kg/cm2 (min.) discharge pressure with suction filter with silencer, inter cooler and after cooler with moisture separators, automatic drain traps, instruments, control system, cable lugs, glands and other accessories (as required / as specified) **but excluding electric motor drive**.	2 Nos.
(iv)	Air Receivers required for Compressed Air System of minimum 12.5 Cu.M capacity each with instruments, relief valve, isolation valve, drain connection with automatic trap stations (zero purge air loss type) and other accessories as specified.	5 Nos.
(v)	Air Receivers required for Compressed Air System of minimum 10 Cu.M capacity each with instruments, relief valve, isolation valve, drain connection with automatic trap stations (zero purge air loss type) and other accessories as specified.	1 Nos.
(vi)	Air Receivers required for Compressed Air System of minimum 02 Cu.M capacity each with instruments, relief valve, isolation valve, drain connection with automatic trap stations (zero purge air loss type) and other accessories as specified.	1 No.
(vii)	Inter connecting cooling water, drain piping and compressed air piping as specified including fittings and valves etc. for complete Compressed air system.	1 Lot
(viii)	Instruments as specified.	1 Lot
(ix)	Interface module(s), JB's for the overall control & monitoring of compressed air system through DDCMIS including common Sequencing Panel.	1 Lot
(x)	Operational spares for Compressed air system as given below.	
a	Lube oil (Qty. for 1 Lot in Ltr. shall be as per oil tank capacity for One Compressor)	5 lot
b	Lube oil filters with seals - 10 Nos.	10 nos
c	Air filters with gaskets - 10 Nos.	10 nos
d	Service kit including seals, washers and rings for inter cooler & after cooler	5 nos
	Break-up of Mandatory Spares (S. No. 3) is as below:	
1	**Oil free Screw Air Compressor (as applicable)**	
1.1	Complete HP Stage with HP element.	1 No.
1.2	Complete LP stage with LP element	1 No.
1.3	All Bearings	100% of installed qty
1.4	Packing set	150% of installed qty

BILL OF QUANTITY: 1x800 MW UKAI TPS

S. No.	Description	Quantity & Unit
1.5	Axial thrust bearing	100% of installed qty
1.6	Timer gears	1 set
1.7	Suction and discharge valves	2 sets
1.8	LP stage Pinion	1 No.
1.9	HP stage Pinion	1 No.
1.1	Air and Oil Filter Kit	200% of installed qty
1.11	After cooler Safety Valve (if applicable)	1 No.
1.12	Inter Cooler Safety Valve (if applicable)	1 No.
1.13	Safety valve springs & gaskets	4 sets
1.14	Gear case breather filter element	200% of installed qty
1.15	Drain valve kit	1 set
1.16	Oil pump complete assembly	1 set
1.17	Oil Pump kit	2 Nos.
1.18	Oil pump & motor bearing	100% of installed qty
1.19	After cooler drain valve kit (if applicable)	1 No.
1.20	Inter cooler drain valve kit (if applicable)	1 No.
1.21	Air receiver drain/moisture trap	100% of installed qty
1.22	'O' Rings for oil cooler	8 Nos.
1.23	Moisture separators for Aftercooler (if applicable)	2 Nos.
1.24	Moisture separators for Intercooler (if applicable)	2 Nos.
1.25	Set of gasket and O-rings for all parts and joints	4 sets of each
1.26	HP Element Exchange kit	4 set
1.27	LP Element Exchange kit	4 set
1.28	Suction Filter with complete kit	200 % of installed qty
2	**Centrifugal Compressor (as applicable)**	
2.1	Pinion Shaft Journal Bearing Assembly	2 Sets
2.2	Thrust Bearing Assembly	100% of installed qty
2.3	Shaft Seals for Air-Oil (All stages)	2 Sets
2.4	Set of Gasket & O rings	2 Sets for each compressor
2.5	Air Filter Elements	4 Sets for each compressor
2.6	Lub Oil System	
2.6.1	Main oil pump complete	1 No
2.6.2	Aux. oil pump complete	1 No
2.6.3	Complete coupling for Main & Aux. oil pump, spacer	1 No
2.7	Cartridge filter elements with gaskets and seals	4 Sets
2.8	Motor Bearings	2 sets
2.9	Drain / Moisture Trap	2 Set for each compressor
2.10	Oil Cooler Gaskets & Seals	150% of installed qty
3	**AIR DRYING PLANT FOR IA SYSTEM (Twin tower Type) (As applicable)**	
3.1	Pre filter element (Ceramic candle or as applicable)	200% of installed qty
3.2	After filter element (Ceramic candle or as applicable)	200% of installed qty
3.3	Heater element (if applicable)	1 sets
3.4	Blower bearing (if applicable)	1 sets
3.5	Blower motor bearing (if applicable)	2 sets
3.6	Valves & Valve Actuators (pneumatic/hydraulic)	2 sets
3.7	Heater coil for temperature stabilization (for HOC type) (as applicable)	2 sets
3.8	Valves (within the compressor house having actuators) along with actuator	2 Nos. of each type / rating / size
4	**Rotary drum type Air drying plant for Instrument Air system (As applicable)**	
4.1	Drive assembly consisting of motor, gear boxes, drive shaft & coupling	1 set
5	**415 V Motors (for IA & SA Compressors, as applicable)**	
5.1	Complete Spare Motor:	10% of each type and rating or 1 no. whichever is higher.
5.2	Terminal plates	10 Nos. each for small motors up to 30 kW & 4 Nos. each for more than 30 kW
5.3	Heaters	2 sets
5.4	Greasing arrangements	4 sets each type of motor
5.5	Bearings (DE and NDE) for each type and rating of motor	4 sets
6	**415 V Motors (for Air drying plants, as applicable)**	
6.1	Complete Spare Motor:	10% of each type and rating or 1 no. whichever is higher.
6.2	Terminal plates	10 Nos. each for small motors up to 30 kW & 4 Nos. each for more than 30 kW
6.3	Heaters	2 sets
6.4	Greasing arrangements	4 sets each type of motor
6.5	Bearings (DE and NDE) for each type and rating of motor	4 sets
7	**ELCTRICAL ACTUATORS WITH NON-INTEGRAL STARTERS**	
7.1	Complete Actuator (with bush)	20% or 1 no. of each type, class, size and model whichever is more.

BILL OF QUANTITY: 1x800 MW UKAI TPS

S. No.	Description	Quantity & Unit
7.2	Power unit for modulating actuator	10% or 2 nos. of each type, whichever is more.
7.3	DC-DC unit/power pack units	10% or 2 nos. of each type, whichever is more.
7.4	Electronic cards	10% or 5 nos. of each type, whichever is more
7.5	Brake assembly	10% or 2 nos. of each type, whichever is more
7.6	Brake coils	10% or 2 nos. of each type, whichever is more
7.7	Position feedback transmitters	10% or 2 nos. of each type, whichever is more.
7.8	Electromechanical control unit with switches including torque switching heads	10% or 2 nos. of each type, whichever is more
7.9	Torque and limit switch assembly of each unit	20% or 4 nos. of each type, whichever is more.
7.10	Auxiliary Contact	1 no each type and rating
7.11	Motor	1 no each type and rating
7.12	Complete Seal kit	1 Set for each type and rating
7.13	Complete O-Ring Set	1 Set for each type and rating
7.14	Hand wheel	20% or 1 no. of each type, class, size and model
7.15	Hand wheel retainer flange	20% or 1 no. of each type, class, size and model
7.16	Clutch fork assembly	20% or 1 no. of each type, class, size and model
7.17	Worm wheel	20% or 1 no. of each type, class, size and model
7.18	Actuator bearings	20% or 1 no. of each type, class, size and model
7.19	Absolute Encoder (replaceable part)	5% of each type & model
7.20	Electronic Torque sensor	5% of each type & model
8	**PROCESS CONNECTION PIPING (FOR IMPULSE PIPING/TUBING, SAMPLING PIPING / TUBING AND AIR SUPPLY PIPING AS APPLICABLE)**	
8.1	Erection hardware mounted in field, LI E & LIR	
8.2	Instrument valves, manifold, fittings,	Ten (10) percent of each type,
8.3	impulse pipe, impulse tubes, drains pipes etc.	rat ing, model number and size of devices.
8.4	Manifold 2 way, 3 way, 5 way valve manifolds	Ten (10) percent of each type & Size installed
8.5	Fittings	Twenty (20) percent of each type & Size installed
8.6	Air Filter cum Regulator	Ten (10) percent of e ach type, make and model installed
8.7	MCB, and Power sockets used in LIE/LIR.	Ten (10) percent of each type
8.8	Fuses used in LIE/LIR.	Fifty (50) percent of each type and rating
9	**INSTRUMENTATION CABLE, INTERNAL WIRING & ELECTRICAL FIELD**	
9.1	Pre-fabricated cable with connector of each type (other than DCS application) (if applicable)	2 nos. of each type
9.2	Other cables (Instrumentation and Control cable)	10% or 500 mtrs whichever is more for each type, pair and size of actual supplied quantity
10	**Solenoid Valve**	
10.1	Solenoid valve	1 no. of each type and rating
10.2	Solenoid Valve Coil	10% of each type and rating but minimum 1 no
11	**Panels, local panels, System /Marshalling cabinets**	
11.1	Fully programmed controller of electronic modules of each type (as applicable)	1 No.
11.2	Power supply module (if applicable)	1 No.
11.3	Devices mounted on Control desk	Ten (10) percent or 2 nos' (whichever is more) of each type
11.4	LEDs for indicating lights shall be furnished.	100%
11.5	control circuit fuses	One hundred percent spare replacement of each current rating required
11.6	MCB/MCCB	Ten percent spare replacement of each current rating required
11.7	Push buttons, ILPBs.(complete with contact elements)	Ten (10) percent or 2 nos (whichever is more) of each type and color.

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S. No.	Description	Quantity & Unit
11.8	Cooling Fans	20% or 4 nos. (whichever is more) of each type, model and rating.
11.9	Electric meter.	Ten (10) percent or 2 nos (whichever is more) of each type
11.10	Power supply modules.	Ten (10) percent or 2 nos (whichever is more) of each type
11.11	Male/female parts of pre-fabricated cables	10 nos. of each type
11.12	Space Heater	10% of total quantity but minimum 1 no
11.13	Smoke Detector	10% of total quantity but minimum 1 no
11.14	Terminal Blocks	20% of total quantity
11.15	Terminals in Terminal blocks	10 nos of each type
11.16	Cable clamps	5 nos of each type.
11.17	Blowers	1no
11.18	Electronics modules of each type and	20% or 2 nos of each type and
11.19	Indication Lamps of all types	2 nos
12	**MEASURING INSTRUMENTS**	
12.1	Indicators, Recorders, Electrical Metering and Skid Mounted Instruments	
A	Indicators, recorders and meters offered from each model for the project. These instruments shall be supplied with three sets of blank scales.	10 % of Installed of each type/Model or a minimum of one number for each model and type, whichever is more
B	Instruments (including Skid Mounting)	10% of total number of instruments for each Type and model or a minimum of 2 number for each model and type, whichever is more
C	Panel and Wall mounted Indicators	10% of total number of instruments or a minimum of one number for each type, model, range etc. whichever is more
12.2	Transmitters	
A	Temperature Transmitters and Electronic Transmitters of all type, range and model no. (For Pressure, DP, Temp, Flow, Level), Process Transmitters, Radar type level transmitter, 3D type level Transmitter with local display, Magnetic/Electromagnetic flow meter with local display, mass flow meter with local display., Process meters, Junction Box, Position Transmitter, Transducer or any other instrument etc.	10% of total number of instruments/transducers offered or each model and type, rating or a minimum of two number for each model, rating and type , whichever is more.
12.3	Temperature elements	2 Nos. of each type and model
A	RTD elements	5% for RTD assemblies (with head assembly, terminal block and nipple) of each type and length or 2 nos. of each type and model whichever is more. The element assembly shall be suitable for direct replacement in the corresponding thermowell.
B	Thermowells	10% for each type of temperature sensors or a minimum of two for each type & size, whichever is more.
C	Thermo well for all applications	10% of each type and length
12.4	Process actuated switch Devices - As applicable for each package as per following: 1. Temperature Switches 2. Differential pressure Switches 3. Pressure switches 4. Flow switches 5. Level Switches 6. Safety Protection Switches	10% of total nos. or 2 nos. of each make, model, range and type whichever is more
12.5	Pressure, Differential Pressure, Flow, and temperature gauges	20% of the total or minimum 2 nos of each type/rating/model
12.6	Level Gauges	20% or 5 nos. whichever is more of each type.

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S. No.	Description	Quantity & Unit
12.7	All type of Rotameters & Sight Flow Indicator.	10% for each type, size and range but minimum 2 no
12.8	PD type flow transmitters with local display	1 no. of each range type and model
12.9	Any other instruments not indicated in the tender P&ID but required for control, monitoring and operation of the equipment / plant / systems	10% or 2 nos. of each type whichever is more
12.10	Dew Point meters	1 No.
13	**Low Pressure Piping**	
13.1	Valves all sizes (including Solenoid Valves & Drain traps) NOTE: 1. If there is one no valve only of particular type, class, and size then only one no is required 2. Wherever valves are specified as mandatory spare, complete valve along with actuator and all other accessories which are the part of original supply shall also be supplied.	10% of the total population of each type, size, and class OR minimum 2 nos. of each type size & class whichever is more

NOTE:

1	Wherever set is mentioned, one set of the spares of that item shall be for complete replacement of that particular item for one equipment.
2	Any fraction of a item shall mean the next higher integer.
3	Wherever quantity has been specified as percentage (%), the quantity of mandatory spares to be provided by contractor shall be the specified percentage (%) of the total population of the plant. In case the quantity so calculated happens to be fraction, the same shall be rounded off to next higher whole number.
4	Wherever the quantities have been indicated for each type, size, thickness, material, radius, range etc., these shall cover all the items supplied and installed and the breakup for these shall be furnished in the bid.
5	In case spares indicated in the list are not applicable to the particular design offered by the bidder, the bidder should offer spares applicable to offered design with quantities generally in line with the approach followed in the above list.
6	IDENTIFICATION-Each spare shall be clearly marked and labeled on the outside of the packing with its description. When more than one spare part is packed in a single case, a general description of the contents shall be shown on the outside of such case and a detailed list enclosed. All cases, containers, and other packages must be suitably marked and numbered for the purpose of identification.
7	CONTRACT-QUANTITIES-The quantities & mandatory spares shall be as specified herein. Any other mandatory spares not listed above however required for any instrumentation item shall also be supplied by bidder. The final quantities may require addition/deletion during the contract stage. The Bidder shall furnish unit price for each mandatory spare under appropriate schedules which shall be used for adjusting the contract price in the event of addition/deletion from contract quantities specified herein.
8	DOCUMENTATION Bidder shall furnish detailed catalogue, part number and subassembly /assembly drawings with manufacturer's cross reference for each spare part. The data and information furnished shall be of nature and content as per owner's approval to enable owner procurement of these spare parts directly from the respective manufacturer.
9	Interchangeability and Packing: All spares supplied under this contract shall be strictly interchangeable with parts for which they are intended for replacements. These spares shall include all mounted accessories like components, boards, add or items, fittings, connectors etc.

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S. No.	Description	Quantity & Unit
A	Total lump sum firm price inclusive of all prevailing taxes, duties and other levies for **Supply part, Services part, Mandatory spares, Engineering Charges and AMC** comprising of design (i.e. preparation and submission of drawing /documents including "As Built" drawings and O&M manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, maintenance tools & tackles (as applicable), fill of lubricants & consumables, mandatory spares along with spares for erection (as required), start-up spares and commissioning spares (as required), operational spares (as specified), forwarding, proper packing, shipment and delivery at site, unloading, handling, transportation & storage at site, in-site transportation, assembly, erection & commissioning, final painting at site, minor civil work, trial run at site, carrying out Performance guarantee tests at site, training of BHEL & Customer O&M staff at project site and handover in flawless condition of the package to the end customer complete with all accessories for the total scope defined as per BHEL NIT & tender technical specification as specified above, amendments & agreements till placement of order.	**1 Lot**
BREAK-UP OF A		
1.0	Total lump sum firm price inclusive of all prevailing taxes, duties and other levies for **Supply part** comprising of manufacturing, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, maintenance tools & tackles (as applicable), fill of lubricants & consumables alongwith spares for erection as required, start-up and commissioning spares as required, operational spares (as specified), forwarding, proper packing, **parts / spares required during warranty period** (against defects in design, materials, construction and workmanship) shipment and delivery at site, for the total scope defined as per BHEL NIT & tender technical specification as specified above, amendment & agreements till placement of order.	**1 Lot**
2.0	Total lumpsum firm prices inclusive of all prevailing taxes, duties and other levies for **Services part** comprising of unloading, handling, transportation & storage at site, in-site transportation, assembly, erection & commissioning, connectivity of CAS with DCS, final painting at site, minor civil work, trial run at site and carrying out Performance guarantee tests at site as specified, travelling, lodging, boarding & other charges of E&C personnel's, training of BHEL & Customer O&M staff at project site and handover in flawless condition of the package to the end customer complete with all accessories for the total scope defined as per BHEL NIT & tender technical specification as specified above, amendments & agreements till placement of order.	**1 Lot**
3.0	Total lumpsum firm price inclusive of all prevailing taxes, duties and other levies for **Mandatory spares** comprising of manufacture, fabrication, assembly, inspection / testing (as applicable) at vendor's & subvendor's works, painting, forwarding, proper packing, shipment, delivery at site & handover of MS to BHEL/End Customer, for the total scope defined as per BHEL NIT & tender technical specification as specified above, amendments & agreements till placement of order.	**1 Lot**
4.0	Total lumpsum firm price for **Engineering Charges** comprising of design (i.e Preparation & submission of drawings/documents including " AS-BUILT" drawings and O&M Manuals and engineering as per tender technical specification above, amendments & agreements till placement of order.	**1 Lot**
5.0	Total lumpsum firm price inclusive of all prevailing taxes, duties and other levies for **AMC (Annual Maintenance Contract)**, for the total scope defined as per BHEL NIT & tender technical specification as specified above, amendments & agreements till placement of order.	**1 Lot**
B	**Break up of Supply part (S.No 1.0) are as below**	
(i)	Instrument air Compressors (Oil Free Screw / Centrifugal type) each of minimum 53 NM3/Min capacity @ 8.5 kg/cm2 (min.) discharge pressure with suction filter with silencer, inter cooler and after cooler with moisture separators, automatic drain traps, instruments, control system, cable lugs, glands and other accessories (as required / as specified) **but excluding electric motor drive**.	3 Nos.
(ii)	Air Drying Plants HOC **type (Twin Tower / Rotary Drum)** of minimum 63.6 NM3/min. capacity for Air Compressor with all instruments, control panels, including Electronic due point meter and other accessories as specified.	3 Nos.
(iii)	Service air Compressors (Oil Free Screw / Centrifugal type) each of minimum 53 NM3/Min capacity @ 8.5 kg/cm2 (min.) discharge pressure with suction filter with silencer, inter cooler and after cooler with moisture separators, automatic drain traps, instruments, control system, cable lugs, glands and other accessories (as required / as specified) **but excluding electric motor drive**.	3 Nos.
(iv)	Air Receivers required for Compressed Air System of minimum 15 Cu.M capacity each with instruments, relief valve, isolation valve, drain connection with automatic trap stations (zero purge air loss type) and other accessories as specified.	6 Nos.
(v)	Air Receivers required for Compressed Air System of minimum 10 Cu.M capacity each with instruments, relief valve, isolation valve, drain connection with automatic trap stations (zero purge air loss type) and accessories as specified.	2 Nos.
(vi)	Air Receivers required for Compressed Air System of minimum 05 Cu.M capacity each with instruments, relief valve, isolation valve, drain connection with automatic trap stations (zero purge air loss type) and accessories as specified.	1 No.
(vii)	Inter connecting cooling water, drain piping and compressed air piping as specified including fittings and valves etc. for complete Compressed air system.	1 Lot
(viii)	Instruments as specified including fittings, root valves etc. for complete Compressed air system.	1 Lot
(ix)	Interface module(s), JB's for the overall control & monitoring of compressed air system through DDCMIS including common Sequencing Panel.	1 Lot
(x)	Operational spares for Compressed air system as given below (to be supplied post commissioning at intervening period and PG test period as per requirement).	
a	Lube oil (Qty. for 1 Lot in Ltr. shall be as per oil tank capacity for One Compressor)	6 lot
b	Lube oil filters with seals	12 nos
c	Air filters with gaskets	12 nos
d	Service kit including seals, washers and rings for inter cooler & after cooler	6 nos

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Break-up of Mandatory Spares(S.No. 3) is as below: (Applicable for one IA Compressor & one SA Compressor)

	Description	Quantity for one IA Compressor	Quantity for one SA Compressor
	COMPRESSEOR		
11.1	**Screw Compressor (as per the type quoted)**		
11.1.1	HP STAGES OF COMPRESSOR		
i)	HP element	One (1) Set	One (1) Set
ii)	Packing Set	Four (4) Sets	Four (4) Sets
iii)	Axial thrust bearing.	Two (2) Sets	Two (2) Sets
iv)	Labyrinth oil seal or radial seals or double acting seals for drive shafts	Four (4) Sets	Four (4) Sets
v)	Bearing for male & female rotors (DE & NDE)	Two (2) each	Two (2) each
vi)	Timing Gears	One (1)	One (1)
vii)	Suction & discharge valves	Two (2) each	Two (2) each
11.1.2	LP STAGES OF COMPRESSOR		
i)	LP element	One (1) Set	One (1) Set
ii)	Graphitic ring shaft seals for compressor chamber or white metal	Four (4) Sets	Four (4) Sets
iii)	Packing Set	Four (4) Sets	Four (4) Sets
iv)	Axial thrust Bearing	Two (2) Sets	Two (2) Sets
v)	Bearing for male & female rotors {DE&NDE)	Two (2) each	Two (2) each
vi)	Timing Gears	One (1)	One (1)
vii)	Suction & discharge valves	Two (2) each	Two (2) each
11.2	**Centrifugal Compressor (as per the type quoted)**		
11.2.1	HP Stage		
i)	HP rotor assembly	One (1) Set	One (1) Set
ii)	Packing Set	Four (4) Sets	Four (4) Sets
iii)	Axial thrust bearing.	Two (2) Sets	Two (2) Sets
iv)	Labyrinth oil seal or radial seals or double acting seals for drive shafts	Four (4) Sets	Four (4) Sets
v)	Bearing for male & female rotors (DE & NDE)	Two (2) each	Two (2) each
vi)	Timing Gears	One (1)	One (1)
vii)	Suction & discharge valves	Two (2) each	Two (2) each
11.2.2	IP Stage		
i)	IP rotor assembly	One (1) Set	One (1) Set
ii)	Packing Set	Four (4) Sets	Four (4) Sets
iii)	Axial thrust bearing.	Two (2) Sets	Two (2) Sets
iv)	Labyrinth oil seal or radial seals or double acting seals for drive shafts	Four (4) Sets	Four (4) Sets
v)	Bearing for male & female rotors (DE & NDE)	Two (2) each	Two (2) each
vi)	Timing Gears	One (1)	One (1)
vii)	Suction & discharge valves	Two (2) each	Two (2) each
11.2.3	LP Stage		
i)	LP rotor assembly	One (1) Set	One (1) Set
ii)	Packing Set	Four (4) Sets	Four (4) Sets
iii)	Axial thrust bearing.	Two (2) Sets	Two (2) Sets
iv)	Labyrinth oil seal or radial seals or double acting seals for drive shafts	Four (4) Sets	Four (4) Sets
v)	Bearing for male & female rotors (DE & NDE)	Two (2) each	Two (2) each
vi)	Timing Gears	One (1)	One (1)
vii)	Suction & discharge valves	Two (2) each	Two (2) each
11.3	**Common for Screw/ Centrifugal Compressor (as per the type quoted)**		
11.3.1	Main Bearing	Two (2) each	Two (2) each
11.3.2	Set up gear/pinion	One (1)	One (1)
11.3.3	Air intake filter element with gaskets	Four (4) sets	Four (4) sets
11.3.4	Oil filter element with gaskets & seals	Four (4) sets	Four (4) sets
11.3.5	Safety valve springs & gaskets	Two (2) sets	Two (2) sets
11.3.6	One set of inbuilt automatic drain valve	Two (2) sets	Two (2) sets
11.3.7	Gearcase breather filter element	One (1)	One (1)
11.3.8	Drain valve kit	One (1)	One (1)
11.3.9	COMPRESSORS COOLERS		
i)	Gaskets & seals for inter cooler and after cooler	Four (4)	Four (4)
ii)	Inter cooler drain check valve	One (1)	One (1)
11.3.10	OIL PUMP / MOTOR		
i)	Oil pump complete assembly	One (1)	One (1)
ii)	Pump impeller/ rotor with shaft	One (1)	One (1)
iii)	Set of bearings	Two (2) Sets	Two (2) Sets
iv)	Oil pump motor bearing	Two (2)	Two (2)

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11.3.11	SHAFT DRIVEN OIL PUMP		
i)	Drive gear with shaft	One (1)	One (1)
ii)	Driven gear with shaft	One (1)	One (1)
11.3.12	Drain tap elements	Two (2)	Two (2)
11.3.13	Moisture tap elements	Two (2)	Two (2)
11.3.14	Oil cooler gaskets and seals	Four (4)	Four (4)
11.3.15	Seal Washer	Two (2)	Two (2)
11.4	**Flow Meter**	One (1)	One (1)
11.5	**AIR DRYING PLANT**		
i)	Pre filter element (ceramic candle)	One (1) Set	
ii)	After filter element (ceramic candle)	One (1) Set	
iii)	Heater element (if required)	One (1) Set	
iv)	Blower bearing (if required)	One (1) Set	
v)	Blower motor bearing (if required)	One (1) Set	
vi)	Valve actuators	One (1) Set	
vii)	Inlet & Outlet valve for Dryer	One (1) Set	
viii)	Automatic drain valves (No air loss type)	One (1) Set	
ix)	Expansion valves	One (1) Set	
x)	Filter Dryer	One (1) Set	
xi)	Air cooler condenser fan	One (1) Set	
xii)	Drive assembly consisting of motor, gear boxes, drive shaft & coupling	One (1) Set	
11.6	**Low Pressure Piping**		
i)	Valves all sizes & type (including solenoid valves, drain traps) NOTE: 1. If there is one no valve only of particular type, class, and size then only one no is required. 2. Wherever valves are specified as mandatory spare, complete valve along with actuator and all other accessories which are the part of original supply shall also be supplied.	5% of the total population of each type, size, and class OR minimum 2 nos. of each type size & class whichever is more	
11.7 (a)	**415V MOTORS (for IA & SA compressor, as applicable)**		
i)	Terminal plates for motors upto 30kw for each rating	1 nos. for each type & rating	1 nos. for each type & rating
ii)	Terminal plates for motors above 30kw for each rating	1 nos. for each type & rating	1 nos. for each type & rating
iii)	Heaters	1 set for each type & rating	1 set for each type & rating
iv)	Greasing arrangements	1 set for each type & rating	1 set for each type & rating
v)	Motor of each type and rating	10% of the installed quantity or minimum 1 no. whichever is more	10% of the installed quantity or minimum 1 no. whichever is more
vi)	Bearings (DE and NDE)	1 set for each type & rating	1 set for each type & rating
vii)	End shield cover driving of non driving end	1 set for each type & rating	1 set for each type & rating
viii)	Cooling fan	1 set for each type & rating	1 set for each type & rating
ix)	Motor terminal block	1 set for each type & rating	1 set for each type & rating
x)	Complete set of coupling	1 set for each type & rating	1 set for each type & rating
11.7(b)	**415V MOTORS (for Air drying plant, as applicable)**		
i)	Terminal plates for motors upto 30kw for each rating	1 nos. for each type & rating	
ii)	Terminal plates for motors above 30kw for each rating	1 nos. for each type & rating	
iii)	Heaters	1 nos. for each type & rating	
iv)	Greasing arrangements	1 nos. for each type & rating	
v)	Motor of each type and rating	1 nos. for each type & rating	
vi)	Bearings (DE and NDE)	1 nos. for each type & rating	
vii)	End shield cover driving of non driving end	1 nos. for each type & rating	
viii)	Cooling fan	1 nos. for each type & rating	
ix)	Motor terminal block	1 nos. for each type & rating	
x)	Complete set of coupling	1 nos. for each type & rating	

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11.8	**MEASURING INSTRUMENTS (including skid mounted instruments)**		
11.8.1	Transmitters		
i)	Transmitters (other than compressor skid) of all type, range and model no (For the measurement of Pressure, differential pressure flow, level, temperature etc.)	10% or minimum 2 nos. of each type and model whichever is more	
ii)	Transmitters within compressor skid of all type, range and model no (For the measurement of Pressure, differential pressure flow, level, temperature etc.)	10% or minimum 2 nos. of each type and model whichever is more	10% or minimum 2 nos. of each type and model whichever is more
11.8.2	Temperature elements		
i)	RTD's	10% or 2 nos. of each type and length, whichever is more	10% or 2 nos. of each type and length, whichever is more
ii)	Thermocouples	10% or 2 nos. of each type and length, whichever is more	10% or 2 nos. of each type and length, whichever is more
iii)	Thermo well for all applications (with head assembly, terminal block and nipple)	10% or 2 nos. of each type and length, whichever is more	10% or 2 nos. of each type and length, whichever is more
iv)-a	Pressure, Differential Pressure, Flow, Level and Temperature Switches (other than compressor skid)	20% of the total population or minimum 2 nos.	
iv)-b	Pressure, Differential Pressure, Flow, Level and Temperature Switches (within compressor skid)	20% of the total population or minimum 2 nos. of each type and model whichever is more	20% of the total population or minimum 2 nos. of each type and model whichever is more
v)-a	Pressure, Differential Pressure, Flow, Level and Temperature Gauges (other than compressor skid)	20% of the total population or minimum 2 nos.	
v)-b	Pressure, Differential Pressure, Flow, Level and Temperature Gauges (within compressor skid)	20% of the total population or minimum 2 nos. of each type and model whichever is more	20% of the total population or minimum 2 nos. of each type and model whichever is more
vi)	Dew point meter (including skid)	1 no. of each type and model	
11.8.3	Electrical Actuators		
i)	Actuators	1 no. of each type and rating	
ii)	Power unit for modulating actuator	2 nos. of each type	
iii)	DC-DC unit / Power Units	2 nos. of each type	
iv)	Electronic cards	2 nos. of each type	
v)	Position feedback transmitters	2 nos. of each type	
vi)	Control Unit	2 nos. of each type	
vii)	Torque And limit switch assembly of each unit	2 nos. of each type	
viii)	Electronic PCB of all types	10% of each type & model	
ix)	Absolute Encoder (replaceable part)	5% of each type & model	
x)	Electronic Torque sensor	5% of each type & model	
11.8.4	**PROCESS CONNECTION PIPING (FOR IMPULSE PIPING/TUBING, SAMPLING PIPING / TUBING AND AIR SUPPLY PIPING AS APPLICABLE)**		
i)	Valves of all types and models	20 Nos. of each type and model	
ii)	2 way, 3way, 5way valve manifolds	10 Nos. of each type, class, size and model	
iii)	Fittings	100 % of each type	
iv)	Purge meters	20 nos. of each type and model	
v)	Filter regulators	20 nos. of each type and model	
11.8.5	**INSTRUMENTATION CABLE, INTERNAL WIRING & ELECTRICAL FIELD**		
i)	Pre fabricated cable with connector of each type (other than DDCMIS application) (if applicable)	2 nos. of each type, size and model	
ii)	Other cables (Instrumentation and Control cable)	5% or 500 mtrs whichever is more for each type, pair and size and model of actual supplied quantity	
11.8.6	**MICROPROCESSOR BASED / PLC BASED/ ELECTRONIC BASED CONTROL PANEL (IF APPLICABLE)**		
i)	Fully programmed controllers and electronic module of each type (as applicable like all type IO card, Communication card, relay module, fuse, RAM, RAM Battery, network switch/ Module, etc.)	10% or 2 nos. whichever is more	10% or 2 nos. whichever is more
ii)	Power supply Module (If applicable)	10% or 2 nos. whichever is more	10% or 2 nos. whichever is more

Notes:

1	Wherever set is mentioned, one set of the spares of that item shall be for complete replacement of that particular item for one equipment.
2	Any fraction of a item shall mean the next higher integer.
3	Wherever quantity has been specified as percentage (%), the quantity of mandatory spares to be provided by contractor shall be the specified percentage (%) of the total population of the plant. In case the quantity so calculated happens to be fraction, the same shall be rounded off to next higher whole number.

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4	Wherever the quantities have been indicated for each type, size, thickness, material, radius, range etc., these shall cover all the items supplied and installed and the breakup for these shall be furnished in the bid.
5	In case spares indicated in the list are not applicable to the particular design offered by the bidder, the bidder should offer spares applicable to offered design with quantities generally in line with the approach followed in the above list.
6	IDENTIFICATION-Each spare shall be clearly marked and labeled on the outside of the packing with its description. When more than one spare part is packed in a single case, a general description of the contents shall be shown on the outside of such case and a detailed list enclosed. All cases, containers, and other packages must be suitably marked and numbered for the purpose of identification.
7	CONTRACT-QUANTITIES-The quantities & mandatory spares shall be as specified herein. Any other mandatory spares not listed above however required for any instrumentation item shall also be supplied by bidder. The final quantities may require addition/deletion during the contract stage. The Bidder shall furnish unit price for each mandatory spare under appropriate schedules which shall be used for adjusting the contract price in the event of addition/deletion from contract quantities specified herein.
8	DOCUMENTATION Bidder shall furnish detailed catalogue, part number and subassembly /assembly drawings with manufacturer's cross reference for each spare part. The data and information furnished shall be of nature and content as per owner's approval to enable owner procurement of these spare parts directly from the respective manufacturer.
9	Interchangeability and Packing: All spares supplied under this contract shall be strictly interchangeable with parts for which they are intended for replacements. These spares shall include all mounted accessories like components, boards, add or items, fittings, connectors etc.

BILL OF QUANTITY: 1 X 800 MW HPGCL YAMUNANAGAR

S. No.	Description	Quantity & Unit
A	Total lump sum firm price inclusive of all prevailing taxes, duties and other levies for **Supply part, Services part, Mandatory Spares,Engineering Charges and AMC** comprising of design (i.e. preparation and submission of drawing /documents including "As Built" drawings and O&M manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, maintenance tools & tackles (as applicable), fill of lubricants & consumables, mandatory spares along with spares for erection (as required), start-up spares and commissioning spares (as required), operational spares (as specified), forwarding, proper packing, shipment and delivery at site, unloading, handling, transportation & storage at site, in-site transportation, assembly, erection & commissioning, final painting at site, minor civil work, trial run at site, carrying out Performance guarantee tests at site, training of BHEL & Customer O&M staff at project site and handover in flawless condition of the package to the end customer complete with all accessories for the total scope defined as per BHEL NIT & tender technical specification as specified above, amendments & agreements till placement of order.	**1 Lot**
	BREAK-UP OF A	
1.0	Total lumpsum firm price inclusive of all prevailing taxes, duties and other levies for **Mandatory spares** comprising of manufacture, fabrication, assembly, inspection / testing (as applicable) at vendor's & sub-vendor's works, painting, forwarding, proper packing, shipment, delivery at site & handover of MS to BHEL/End Customer, for the total scope defined as per BHEL NIT & tender technical specification as specified above, amendments & agreements till placement of order.	**1 Lot**
2.0	Total lumpsum firm prices inclusive of all prevailing taxes, duties and other levies for **Services part** comprising of unloading, handling, transportation & storage at site, in-site transportation, assembly, erection & commissioning, connectivity of CAS with DCS, final painting at site, minor civil work, trial run at site and carrying out Performance guarantee tests at site as specified, travelling, lodging, boarding & other charges of E&C personnel's, training of BHEL & Customer O&M staff at project site and handover in flawless condition of the package to the end customer complete with all accessories for the total scope defined as per BHEL NIT & tender technical specification as specified above, amendments & agreements till placement of order.	**1 Lot**
3.0	Total lumpsum firm price inclusive of all prevailing taxes, duties and other levies for **Mandatory spares** comprising of manufacture, fabrication, assembly, inspection / testing (as applicable) at vendor's & sub-vendor's works, painting, forwarding, proper packing, shipment, delivery at site & handover of MS to BHEL/End Customer, for the total scope defined as per BHEL NIT & tender technical specification as specified above, amendments & agreements till placement of order.	**1 Lot**
4.0	Total lumpsum firm price for **Engineering Charges** comprising of design (i.e Preparation & submission of drawings/documents including " AS-BUILT" drawings and O&M Manuals and engineering as per tender technical specification above, amendments & agreements till placement of order.	**1 Lot**
5.0	Total lumpsum firm price inclusive of all prevailing taxes, duties and other levies for **AMC (Annual Maintenance Contract)**, for the total scope defined as per BHEL NIT & tender technical specification as specified above, amendments & agreements till placement of order.	**1 Lot**
B	**Break up of Supply part (S.No 1.0) are as below**	
(i)	Instrument air Compressors (Oil Free Screw / Centrifugal type) each of minimum 50 NM3/Min capacity @ 8.5 kg/cm2 (min.) discharge pressure with suction filter with silencer, inter cooler and after cooler with moisture separators, automatic drain traps, instruments, control system, cable lugs, glands and other accessories (as required / as specified) **but excluding electric motor drive**.	3 Nos.

BILL OF QUANTITY: 1 X 800 MW HPGCL YAMUNANAGAR

S. No.	Description	Quantity & Unit
(ii)	Air Drying Plants HOC **type (Twin Tower / Rotary Drum)** of minimum 55 NM3/min. capacity for Air Compressor with all instruments, control panels, including Electronic due point meter and other accessories as specified.	3 Nos.
(iii)	Service air Compressors (Oil Free Screw / **Centrifugal** type) each of minimum 50 NM3/Min capacity @ 8.5 kg/cm2 (min.) discharge pressure with suction filter with silencer, inter cooler and after cooler with moisture separators, automatic drain traps, instruments, control system, cable lugs, glands and other accessories (as required / as specified) **but excluding electric motor drive**.	3 Nos.
(iv)	Air Receivers required for Compressed Air System of minimum 15 Cu.M capacity each with instruments, relief valve, isolation valve, drain connection with automatic trap stations (zero purge air loss type) and other accessories as specified.	6 Nos.
(v)	Air Receivers required for Compressed Air System of minimum 10 Cu.M capacity each with instruments, relief valve, isolation valve, drain connection with automatic trap stations (zero purge air loss type) and other accessories as specified.	2No.
(vi)	Inter connecting cooling water, drain piping and compressed air piping as specified including fittings and valves etc. for complete Compressed air system.	1 Lot
(vii)	Instruments as specified.	1 Lot
(viii)	Interface module(s), JB's for the overall control & monitoring of compressed air system through DDCMIS including common Sequencing Panel.	1 Lot
(ix)	Operational spares for Compressed air system as given below.	
a	Lube oil (Qty. for 1 Lot in Ltr. shall be as per oil tank capacity for One Compressor)	6 lot
b	Lube oil filters with seals - 12 Nos.	12 nos
c	Air filters with gaskets - 12 Nos.	12 nos
d	Service kit including seals, washers and rings for inter cooler & after cooler	6 nos
	Break-up of Mandatory Spares(S.No. 3) is as below:	
1.01	Oil free Screw Air Compressor (as applicable)	
(i)	Complete HP Stage with HP element	1 No.
(ii)	Complete LP stage with LP element	1 No.
(iii)	Motor Bearings	2 'Set
(iv)	LP stage Pinion	1 No.
(v)	HP stage Pinion	1 No.
(vi)	Air Oil Filter Kit	4 Nos.
(vii)	After cooler Safety Valve (if applicable)	1 No.
(viii)	Inter Cooler Safety Valve (if applicable)	1 No.
(ix)	Oil Pump kit	2 Nos.
(x)	After cooler drain valve kit (if applicable)	1 No.
(xi)	Inter cooler drain valve kit (if applicable)	1 No.
(xii)	Air receiver drain/moisture trap	1 No.
(xiii)	'O' Rings for oil cooler	8 No.
(xiv)	Moisture separators for Aftercooler (if applicable)	2 No.
(xv)	Moisture separators for Intercooler (if applicable)	2 No.
1.02	Centrifugal Compressor (as applicable)	
1.02.01	HP Stage	
(i)	High speed rotor assembly, balanced, frame-2	1 Set
(ii)	Radial pinion bearing stage-4	2 Set
(iii)	Radial pinion bearing stage-3	2 Set
(iv)	Labyrinth seals (air & oil) for stage-3	2 Set

BILL OF QUANTITY: 1 X 800 MW HPGCL YAMUNANAGAR

S. No.	Description	Quantity & Unit
1.02.02	LP Stage	
(i)	Low speed rotor assembly, balanced, frame-2	1 Set
(ii)	Radialpinion bearing stage-1	2 Set
(iii)	Radialpinion bearing stage-2	2 Set
(iv)	Labyrinth seals (air & oil) for stage 1	2 Set
(vi)	Labyrinth seals (air & oil) for stage 2	2 Set
(vi)	Inlet guide vane	2 Set
1.02.03	RADIAL & THRUST BEARING ASSEMBLY	2 Set
1.02.04	MAIN DRIVE SHAFT & BULL GEARING ASSEMBLY	1 Set
(i)	Oil seals for main drive shaft DE&NDE	2 Set
1.02.05	AIR INTAKE FILTER ELEMENT WITH GASKETS	2 Set
1.02.06	OIL FILTER ELEMENT WITH GASKETS	2 Set
1.02.07	VALVES OF COMPRESSOR SKID	
(i)	Valve closure plate, for check valve at compressor discharge	1 Set
(ii)	Trim set (plug seat & spindle) for control valve	1 Set
(iii)	Control valve kit (gasket set, gland packing set, bottom ring, wiper ring, slide bearing & gland nut	
(iv)	HOV in compressor	1 Set
1.02.08	Gasket & seals for inter cooler	2 Set
1.02.09	Gasket & seals for after cooler	4 Set
1.02.10	Oil pump/motor	
(i)	Auxiliary oil pump with motor	1 No.
(ii)	main shaft driven oil pump	1 No.
(iii)	Lube oil heater	1 No.
1.02.11	Dry type flexible coupling	1 No.
1.02.12	Auto drain trap	2 Set
1.02.13	Oil cooler gaskets & seals	2 Set
1.02.14	Moisture trap element	4 Set
1.03.00	**CONTROL & INSTRUMENTATION (MANDATORY SPARES)**	
1.03.01	**Measuring & Field Instruments**	
1.03.01.01	Indicators, Recorders, Electrical Metering and Skid Mounted Instruments	
(i)	Indicators, recorders and meters offered from each model for the project. These instruments shall be supplied with three sets of blank scales.	Nos-10 % of Installed of each type/Model or a minimum of one number for each model and type, whichever is more
(ii)	For skid mounted instruments	Nos.-10% of total number of instruments for each Type and model or a minimum of one number for each model and type, whichever is more
(iii)	Panel and Wall mounted Indicators	Nos-10% of total number of instruments or a minimum of one number for each type, model, range etc. whichever is more

BILL OF QUANTITY: 1 X 800 MW HPGCL YAMUNANAGAR

S. No.	Description	Quantity & Unit
1.03.01.02	Temperature Elements and Thermowells	
(i)	Thermocouple/RTD elements	Nos-10% of flue gas temp, coal air mixture temp, boiler/TG metal temp thermocouples and 5% for other applications of total duplex thermocouple element assemblies and duplex RTD assemblies (with head assembly, terminal block and nipple) of each type and length whichever is more. The element assembly shall be suitable for direct replacement in the corresponding thermowell.
(ii)	Thermowells	Nos-10% for each type of temperature sensors or a minimum of one for each type & size, whichever is more.
1.03.01.03	Temperature Transmitters and Electronic Transmitters of all type, range and model no. (For Pressure, DP, Temp, Flow, Level), Process Transmitters, Radar type level transmitter, 3D type level Transmitter with local display,Magnetic/Electromagnetic flow meter with local display, mass flow meter with local display., Process meters, Junction Box, Position Transmitter, Transducer or any other instrument etc.	Nos-10% of total number of instruments /transducers offered for each model and type, rating or a minimum of one number for each model, rating and type , whichever is more.
1.03.01.04	Process actuated switch Devices- As applicable for each package as per following:	Nos-10% of total nos. or 1 no. of each make, model, range and type whichever is more
(i)	Temperature Switches	
(ii)	Differential pressure Switches	
(iii)	Pressure switches	
(iv)	Flow switches	
(v)	Level Switches	
(vi)	Safety Protection Switches	
1.03.01.05	Local Gauges like temperature gauges, pressure gauges, differential Pressure gauges, flow gauges, flow meters with local display etc.	Nos-10% of total number of instruments/transducers offered for each model and type, rating or a minimum of one number for each model, rating and type, whichever is more.
1.03.01.06	All type of Rota meters & Sight Flow Indicator.	Nos-1 no. of each range and type

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S. No.	Description	Quantity & Unit
1.03.01.07	Impact head type flow element	Nos-20% or 2 nos. of each make and type, whichever is more
1.03.01.08	Any other instruments not indicated in the tender P&ID but required for control, monitoring and operation of the equipment/plant/systems	Nos-10% or 2 nos. of each type whichever is more
1.03.01.09	Complete Electronic cards, PCB assembly and Power supply card assembly.	Nos-10% of Electronic card/PCB assembly for each type, model & rating or a minimum of one number for each model, rating and type , whichever is more for each type of Transmitter, switch & Flow Meters.
1.03.02	**Erection hardware mounted in field, LIE & LIR**	
(i)	Instrument valves, manifold, fittings, impulse pipe, impulse tubes, drains pipes etc.	Nos-Ten (10) percent of each type, rating, model number and size of devices.
(ii)	Condensate pots of each type & Size installed	Nos-Ten (10) percent of total number of Installed or four numbers whichever is higher .
(iii)	Manifold 2 way, 3 way, 5 way valve manifolds	Nos-Ten (10) percent of each type & Size installed
(iv)	Fittings	Nos-Twenty (20) percent of each type & Size installed
(v)	Purge meters	Ten (10) percent of each type & Size installed
(vi)	Air Filter cum Regulator	Ten (10) percent of each type, make and model installed
(vii)	MCB, and Power sockets used in LIE/LIR.	Ten (10) percent of each type
(viii)	Fuses used in LIE/LIR.	Fifty (50) percent of each type
1.03.03	**Control desk and Control Panels:-**	
(i)	Devices mounted on Control desk	Ten (10) percent or 2 nos (whichever is more) of each type
(ii)	LEDs for indicating lights shall be furnished.	100.00%
(iii)	control circuit fuses	One hundred percent spare replacement of each current rating required
(iv)	MCB/MCCB	Ten percent spare replacement of each current rating required

BILL OF QUANTITY: 1 X 800 MW HPGCL YAMUNANAGAR

S. No.	Description	Quantity & Unit
(v)	Blank Mosaic Grid Tiles.	Ten (10) percent or 20 nos (whichever is more)
(vi)	Push buttons, ILPBs.(complete with contact elements)	Ten (10) percent or 2 nos (whichever is more) of each type and color.
(vii)	Cooling Fans	20% or 2 nos. (whichever is more) of each type, model and rating.
(viii)	Electric meter.	Ten (10) percent or 2 nos (whichever is more) of each type
(ix)	Power supply modules.	Ten (10) percent or 2 nos (whichever is more) of each type
1.03.04	**Mandatory Spares for Solenoid Valves, Control valves, Power Cylinder, Control Dampers, Actuators, Flow Elements and Accessories**	
1	Following spares shall be furnished for control valves, Power Cylinder, Control Dampers as applicable.	
(i)	Set of spare control valve stem packing for each control valve.	
(ii)	Two molded rubber diaphragms for each control valve.	
(iii)	100% of Diaphragms, O rings and rubber gaskets, seals for each type, make etc. of control valve.	
(iv)	100 percent qty. of lubricants for gaskets for each control valve on one year consumption basis.	
(v)	2 sets of limit switches and 1 set of valve positioner for each control valve.	
(vi)	20 percent of position transmitter (4 20mA) and its accessories for total qty. of control valve.	
(vii)	One (1) set of valve trims (such as plug, stem, seat ring / cage, guide bushing, stem lock pin, packing retaining ring, etc) for each type of control valve.	
(viii)	One complete Pneumatic and electro-hydraulic actuator assembly of each type or min 10% for each type, model, rating and size whichever is more.	
(ix)	20 percent of Solenoid valves or min 2 no. of each type for total qty. of control valves.	
(x)	20% of I to P converters, Pressure regulators.	
(xi)	10% or 2 nos. of each type whichever is more Air Filter Regulator and air lock relays	
1.04.00	**Low Pressure Piping**	
(i)	Valves (Complete valve along with Actuators (pneumatic / hydraulic) and all other accessories which are the part of original supply shall be supplied)	5% of the total population of each type, size and class OR minimum 2 nos. of each type, size and class whichever is more.

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S. No.	Description	Quantity & Unit
1.05.00	**415 V Motors (for IA & SA Compressors, as applicable)**	
(i)	Terminal plates	10 Nos. each for small motors up to 30 kW & 4 Nos. each for more than 30 kW
(ii)	Heaters	2 sets
(iii)	Greasing arrangements	4 sets each type of motor
(iv)	Bearings (DE and NDE) for each type and rating of motor	4 sets
1.06.00	**415 V Motors (for Air drying plants, as applicable)**	
(i)	Terminal plates	10 Nos. each for small motors up to 30 kW & 4 Nos. each for more than 30 kW
(ii)	Heaters	2 sets
(iii)	Greasing arrangements	4 sets each type of motor
(iv)	Bearings (DE and NDE) for each type and rating of motor	4 sets
NOTE:		
1	Wherever set is mentioned, one set of the spares of that item shall be for complete replacement of that particular item for one equipment.	
2	Any fraction of a item shall mean the next higher integer.	
3	Wherever quantity has been specified as percentage (%), the quantity of mandatory spares to be provided by contractor shall be the specified percentage (%) of the total population of the plant. In case the quantity so calculated happens to be fraction, the same shall be rounded off to next higher whole number.	
4	Wherever the quantities have been indicated for each type, size, thickness, material, radius, range etc., these shall cover all the items supplied and installed and the breakup for these shall be furnished in the bid.	
5	In case spares indicated in the list are not applicable to the particular design offered by the bidder, the bidder should offer spares applicable to offered design with quantities generally in line with the approach followed in the above list.	
6	IDENTIFICATION-Each spare shall be clearly marked and labeled on the outside of the packing with its description. When more than one spare part is packed in a single case, a general description of the contents shall be shown on the outside of such case and a detailed list enclosed. All cases, containers, and other packages must be suitably marked and numbered for the purpose of identification.	
7	CONTRACT-QUANTITIES-The quantities & mandatory spares shall be as specified herein. Any other mandatory spares not listed above however required for any instrumentation item shall also be supplied by bidder. The final quantities may require addition/deletion during the contract stage. The Bidder shall furnish unit price for each mandatory spare under appropriate schedules which shall be used for adjusting the contract price in the event of addition/deletion from contract quantities specified herein.	
8	DOCUMENTATION Bidder shall furnish detailed catalogue, part number and subassembly /assembly drawings with manufacturer's cross reference for each spare part. The data and information furnished shall be of nature and content as per owner's approval to enable owner procurement of these spare parts directly from the respective manufacturer.	
9	Interchangeability and Packing: All spares supplied under this contract shall be strictly interchangeable with parts for which they are intended for replacements. These spares shall include all mounted accessories like components, boards, add or items, fittings, connectors etc.	

DOCUMENTATION REQUIREMENT

	TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM	PE-TS-510/ 527/ 528/ 529/ 530-555-A001 Rev. No. 0 Date: Dec 2025

DRAWINGS & DOCUMENTS TO BE SUBMITTED BY ALL THE BIDDERS ALONG WITH THE BID

S. No.	DOCUMENT TITLE
1	Supporting Documents meeting PQR requirements.
2	Compliance cum Confirmation certificate with bidder's sign & stamp.
3	"No Deviation" Certificate duly Stamped and Signed.
4	Un-priced bid- clearly indicating 'QUOTED' against each item.
5	Filled, Signed & Stamped copy of Guaranteed Power Consumption for Compressed Air System.

DRAWINGS & DOCUMENTS TO BE SUBMITTED BY SUCCESSFUL BIDDER AFTER AWARD OF CONTRACT ALONG WITH SUBMISSION SCHEDULE

S.No.	BHEL DRG/DOC No.	TITLE	BASIC ENGG DRG/DOC (Y/N)	SCHEDULED SUBMISSION, DAYS FROM LOI DATE
1	PE-V0-XXX-555-A001	QUALITY PLAN OF AIR COMPRESSOR FOR COMPRESSED AIR SYSTEM	Y	21
2	PE-V0-XXX-555-A002	QUALITY PLAN OF AIR DRYING PLANT FOR COMPRESSED AIR SYSTEM	Y	21
3	PE-V0-XXX-555-A003	QUALITY PLAN OF AIR RECEIVER FOR COMPRESSED AIR SYSTEM	Y	21
4	PE-V0-XXX-555-A027	QUALITY PLAN OF BOUGHT OUT ITEMS (BOI) FOR COMPRESSED AIR SYSTEM	Y	14
5	PE-V0-XXX-555-A029	SUB-VENDOR LIST WITH INSPECTION CATEGORISATION PLAN FOR COMPRESSED AIR SYSTEM	Y	15
6	PE-V0-XXX-555-A005	TDS & GA OF INSTRUMENT AIR & SERVICE AIR COMPRESSORS INCLUDING PERFORMANCE CURVES	Y	21
7	PE-V0-XXX-555-A006	TDS & GA OF AIR DRYING PLANT FOR COMPRESSED AIR SYSTEM	Y	21
8	PE-V0-XXX-555-A008	TDS & GA OF VALVES FOR COMPRESSED AIR SYSTEM	Y	42
9	PE-V0-XXX-555-A010	TDS & GA OF AIR RECIVER FOR COMPRESSED AIR SYSTEM	Y	28
10	PE-VO-XXX-555-A030	TDS & GA OF START UP COMPRESSOR & AIR DRYER FOR CENTRIFUGAL COMPRESSOR (IF APPLICABLE)	Y	28
11	PE-V0-XXX-555-A025	DATASHEET OF INSTRUMENT (INCLUDING, TEMPERATURE ELEMENTS, TRANSMITTERS AND LOCAL INDICATORS), I/O LIST, BOM AND MANDATORY SPARES FOR COMPRESSED AIR SYSTEM	N	42
12	PE-V0-XXX-555-A015	COMPRESSOR HOUSE LAYOUT	Y	21
13	PE-V0-XXX-555-A016	P&I DIAGRAM OF AIR COMPRESSOR FOR COMPRESSED AIR SYSTEM	Y	21
14	PE-V0-XXX-555-A017	P&I DIAGRAM OF AIR DRYER FOR COMPRESSED AIR SYSTEM	Y	21
15	PE-V0-XXX-555-A018	P&I DIAGRAM OF COMPRESSED AIR SYSTEM WITHIN COMPRESSOR HOUSE	Y	21
16	PE-V0-XXX-555-A019	OPERATION, CONTROL PHILOSOPHY & I/O LIST OF COMPRESSED AIR SYSTEM OF COMPRESSED AIR SYSTEM	Y	42
17	PE-V0-XXX-555-A020	ELECTRICAL & INTERNAL WIRING DIAGRAM FOR COMPRESSOR & DRYER PANEL FOR COMPRESSED AIR SYSTEM	Y	50
18	PE-V0-XXX-555-A021	ELECTRICAL FEEDER LIST FOR COMPRESSED AIR SYSTEM	Y	21
19	PE-V0-XXX-555-A022	CONTROL CABLE SCHEDULE FOR COMPRESSED AIR SYSTEM	Y	60
20	PE-V0-XXX-555-A023	PG TEST PROCEDURE FOR COMPRESSED AIR SYSTEM	N	75
21	PE-V0-XXX-555-A024	O&M MANUAL-COMPRESSED AIR SYSTEM	N	90
22	PE-V0-XXX-555-A026	CHECKLIST FOR STORAGE MAINTENANCE PRIOR COMMISSIONING OF COMPRESSOR AND AIR DRYER	N	90
23	PE-V0-XXX-555-A026A	CHECKLIST FOR PREVENTIVE/BREAK-DOWN MAINTENANCE POST COMMISSIONING OF COMPRESSOR AND AIR DRYER	N	90
24	PE-V0-XXX-555-A027	IO LIST FOR CAS	N	90
~~25~~	~~PE-V0-XXX-555-A031~~	~~E-LEARNING MODULE OF COMPRESSED AIR SYSTEM~~	~~N~~	~~90~~

Notes:

1	Bidder to follow the following drawing submission schedule: i)1st submission of drawings from date of LOI as per the submission schedule. ii)Every revised submission incorporating comments – within 7 days. Iii) BHEL review/ approval time shall be considered as 18 days from date of submission & re-submission.
2	Bidder to submit revised drawings complete in all respects incorporating all comments. Any incomplete drawing submitted shall be treated as non-submission with delays attributable to bidder's account. For any clarification/ discussion required to complete the drawings, the bidder shall himself depute his personal to BHEL for across the table discussions/ finalizations/ submissions of drawings.

COMPLIANCE CERTIFICATE

COMPLIANCE CERTIFICATE

The bidder shall confirm compliance with following by signing / stamping this compliance certificate (every sheet) and furnish same with the offer.

1	The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusions, other than those mentioned under “exclusion and those resolved as per ‘Schedule of Deviations’, with regard to same.
2	There are no other deviations w.r.t. specifications other than those furnished in the ‘Schedule of Deviations’. Any other deviation, stated or implied, taken elsewhere in the offer stands withdrawn unless specifically brought out in the ‘Schedule of Deviations’.
3	Bidder shall submit QP in the event of order based on the guidelines given in the specification & QP enclosed therein. QP will be subject to BHEL / CUSTOMER approval & customer hold points for inspection / testing shall be marked in the QP at the contract stage. Inspection / testing shall be witnessed as per same apart from review of various test certificates/ Inspection records etc. This is within the contracted price without any extra implications to BHEL after award of the contract.
4	All drawings/ data-sheets / calculations etc. submitted along with the offer shall not be taken cognizance off.
5	The offered materials shall be either equivalent or superior to those specified in the specification & shall meet the specified / intended duty requirements. In case the material specified in the specifications is not compatible for intended duty requirements then same shall be resolved by the bidder with BHEL during the pre-bid discussions, otherwise BHEL decision shall be binding on the bidder whenever the deficiency is pointed out. For components where materials are not specified, same shall be suitable for intended duty, all materials shall be subject to approval in the event of order.
6	The operational spares shall be supplied on ‘As Required Basis’ & prices for same included in the base price itself.
7	All sub vendors shall be subject to BHEL/CUSTOMER approval in the event of order.
8	Guarantee for plant/equipment shall be as per relevant clause of GCC / SCC / Other Commercial Terms & Conditions.
9	In the event of order, all the material required for completing the job at site shall be supplied by the bidder within the ordered price even if the same are additional to approved billing break up, approved drawing or approved Bill of quantities within the scope of work as tender specification. This clause will apply in case during site commissioning, additional requirements emerges due to customer and / or consultant’s comments. No extra claims shall be put on this account
10	Schedule of drawings submissions, comment incorporations & approval shall be as stipulated in the specifications. The successful bidder shall depute his design personnel to BHEL’s office for across the table resolution of issues and to get documents approved in the stipulated time.
11	As built drawings shall be submitted as and when required during the project execution.
12	The bidder has not tempered with this compliance cum confirmation certificate and if at any stage any tempering in the signed copy of this document is noticed then same shall be treated as breach of contract and suitable actions shall be taken against the bidder.

13	Successful bidder shall furnish detailed erection manual for each of the equipment supplied under this contract at least 3 months before the scheduled erection of the concerned equipment / component or along with supply of concerned equipment / component whichever is earlier.
14	Document approval by customer under Approval category or information category shall not absolve the vendor of their contractual obligations of completing the work as per specification requirement. Any deviation from specified requirement shall be reported by the vendor in writing and require written approval. Unless any change in specified requirement has been brought out by the vendor during detail engineering in writing while submitting the document to customer for approval, approved document (with implicit deviation) will not be cited as a reason for not following the specification requirement.
15	In case vendor submits revised drawing after approval of the corresponding drawing, any delay in approval of revised drawing shall be to vendor's account and shall not be used as a reason for extension in contract completion.

Signature of authorised Representative

Name and Designation :

Name & Address of the Bidder:

Date:

PRE- QUALIFICATION REQUIREMENT

(TECHNICAL)

S. No.	DESCRIPTION
1.	**TECHNICAL PRE-QUALIFICATION REQUIREMENT** **COMPRESSED AIR SYSTEM** • The bidder should have designed, manufactured, supplied, erected/supervised erection and commissioned/supervised commissioning of at least one (1) number non-lubricated oil free screw type air compressor of minimum capacity 20 NM^3/min or at least one (1) number centrifugal air compressor of minimum capacity 50 NM^3/min and at rated discharge pressure of 8 kg/cm^2 (g), which should have been in successful operation for at least one (1) year as on date of techno commercial bid opening. Bidder shall offer only the type of compressors for which he is qualified.

NOTES:

a.	The Bidder has to submit following supporting documents meeting above mentioned pre-qualifying requirement: Copy of minimum one (1) performance certificate (in English) from end user along with copy of related Purchase Order (PO) or Letter of Intent (LOI) or letter of Award (LOA) or Work Order (WO) in support of PQR clause mentioned at S. No. 1.0 above.
b.	Bidder shall submit design documents to substantiate technical parameters specified in PQR, if the same is not mentioned in performance certificate / purchase order.
c.	Bidder to submit all supporting documents in English. If documents submitted by bidder are in language other than English, a self-attested English translated document should also be submitted.
d.	Consideration of offer shall be subjected to customer's approval of bidders, if applicable.
e.	After satisfactory fulfilment of all the above criteria / requirement, offer shall be considered for further evaluation as per NIT and all the other terms of the tender.
f.	Notwithstanding anything stated above, CUSTOMER/BHEL reserves the right to assess the capabilities and capacity of the Bidder to perform the contract, should the circumstances warrant such assessment in the overall interest of the CUSTOMER/BHEL (Bidder to furnish details mentioned in Annexure-i Group I).
g.	The bidder shall meet PQR based on its own credentials. Bid from joint venture (JV) company / Consortium bid is not acceptable.
h.	**Sub-Supplier Qualification Requirement for Air Drying Plant (ADP):** The ADP proposed to be supplied for this package, shall be sourced from such manufacturers who have manufactured and supplied at least one (1) number Air Drying Plant each of capacity 50 NM^3/min or more and the type same as offered, which should have been in successful operation for at least one (1) year as on on date of techno commercial bid opening. Bidder has to furnish an undertaking to meet this sub-supplier Qualification Requirement. However, Bidder to furnish the required documents (as mentioned against Note no. a) for establishing ADP provenness as per Annexure-ii Group I of this PQR, after placement of order.

S. No.	DESCRIPTION
1.	**TECHNICAL PRE-QUALIFICATION REQUIREMENT** **COMPRESSED AIR SYSTEM** • The bidder should have designed, manufactured, supplied, erected/supervised erection and commissioned/supervised commissioning of at least two (2) number non-lubricated oil free screw type air compressor of minimum capacity 40 NM^3/min or at least two (2) number centrifugal air compressor of minimum capacity 50 NM^3/min and at rated discharge pressure of 8 kg/cm^2 (g), which should have been in successful operation for at least two (2) year prior to the date of techno commercial bid opening. Bidder shall offer only the type of compressors for which he is qualified.

NOTES:

a.	The Bidder has to submit following supporting documents meeting above mentioned pre-qualifying requirement: Copy of minimum one (1) performance certificate (in English) from end user along with copy of related Purchase Order (PO) or Letter of Intent (LOI) or letter of Award (LOA) or Work Order (WO) in support of PQR clause mentioned at S. No. 1.0 above.
b.	Bidder shall submit design documents to substantiate technical parameters specified in PQR, if the same is not mentioned in performance certificate / purchase order.
c.	Bidder to submit all supporting documents in English. If documents submitted by bidder are in language other than English, a self-attested English translated document should also be submitted.
d.	Consideration of offer shall be subjected to customer's approval of bidders, if applicable.
e.	After satisfactory fulfilment of all the above criteria / requirement, offer shall be considered for further evaluation as per NIT and all the other terms of the tender.
f.	Notwithstanding anything stated above, CUSTOMER/BHEL reserves the right to assess the capabilities and capacity of the Bidder to perform the contract, should the circumstances warrant such assessment in the overall interest of the CUSTOMER/BHEL (Bidder to furnish details mentioned in Annexure-i Group II).
g.	The bidder shall meet PQR based on its own credentials. Bid from joint venture (JV) company / Consortium bid is not acceptable.
h.	**Sub-Supplier Qualification Requirement for Air Drying Plant (ADP):** The ADP proposed to be supplied for this package, shall be sourced from such manufacturers who have manufactured and supplied at least two (2) number Air Drying Plant each of capacity 40 NM^3/min or more and the type same as offered, which should have been in successful operation prior to the date of techno commercial bid opening. Bidder has to furnish an undertaking to meet this sub-supplier Qualification Requirement. However, Bidder to furnish the required documents (as mentioned against Note no. a) for establishing ADP provenness as per Annexure-i Group II of this PQR, after placement of order.

PQR ANNEXURE i Group I

i.	***Item/Scope of Sub-contracting***			
ii.	***Address of the registered office***	***Details of Contact Person (Name, Designation, Mobile, Email)***		
iii.	***Name and Address of the proposed Sub-vendor's works where item is being manufactured***	***Details of Contact Person: (Name, Designation, Mobile, Email)***		
iv.	***Annual Production Capacity for proposed item/scope of sub-contracting***			
v.	***Annual production for last 3 years for proposed item/scope of sub-contracting***			
vi.	***Details of proposed works***			
1.	***Year of establishment of present works***			
2.	***Year of commencement of manufacturing at above works***			
3.	***Details of change in Works address in past (if any)***			
4.	***Total Area***			
	Covered Area			
5.	***Factory Registration Certificate***	***Details attached at Annexure – F2.1***		
6.	***Design/ Research & development set-up (No. of manpower, their qualification, machines & tools employed etc.)***	***Applicable / Not applicable if manufacturing is as per Main Contractor/purchaser design) Details attached at Annexure – F2.2 (if applicable)***		
7.	***Overall organization Chart with Manpower Details (Design/Manufacturing/Quality etc)***	***Details attached at Annexure – F2.3***		
8.	***After sales service set up in India, in case of foreign sub-vendor (Location, Contact Person, Contact details etc.)***	***Applicable / Not applicable Details attached at Annexure – F2.4***		
9.	***Manufacturing process execution plan with flow chart indicating various stages of manufacturing from raw material to finished product including outsourced process, if any***	***Details attached at Annexure – F2.5***		
10.	***Sources of Raw Material/Major Bought Out Item***	***Details attached at Annexure – F2.6***		
11.	***Quality Control exercised during receipt of raw material/BOI, in-process , Final Testing, packing***	***Details attached at Annexure – F2.7***		
12.	***Manufacturing facilities (List of machines, special process facilities, material handling etc.)***	***Details attached at Annexure – F2.8***		

PQR ANNEXURE i Group I

13.	***Testing facilities*** ***(List of testing equipment)***	***Details attached at Annexure – F2.9***
14.	***If manufacturing process involves fabrication then-*** ***List of qualified Welders*** ***List of qualified NDT personnel with area of specialization***	***Applicable / Not applicable*** ***Details attached at Annexure – F2.10*** ***(if applicable)***
15.	***List of out-sourced manufacturing processes with Sub-Vendors' names & addresses***	***Applicable / Not applicable*** ***Details attached at Annexure. –F2.11*** ***(if applicable)***
16.	***Supply reference list including recent supplies***	***Details attached at Annexure – F2.12*** ***(as per format given below)***

Project/ package	*Customer Name*	*Supplied Item (Type/Rating/Model /Capacity/Size etc)*	*PO ref no/date*	*Supplied Quantity*	*Date of Supply*

17.	***Product satisfactory performance feedback letter/certificates/End User Feedback***	***Attached at annexure - F2.13***
18.	***Summary of Type Test Report (Type Test Details, Report No, Agency, Date of testing) for the proposed product (similar or higher rating)*** ***Note:- Reports need not to be submitted***	***Applicable / Not applicable*** ***Details attached at Annexure – F2.14*** ***(if applicable)***
19.	***Statutory / mandatory certification for the proposed product***	***Applicable / Not applicable*** ***Details attached at Annexure – F2.15*** ***(if applicable)***
20.	***Copy of ISO 9001 certificate (if available)***	***Attached at Annexure – F2.16***
21.	***Product technical catalogues for proposed item (if available)***	***Details attached at Annexure – F2.17***

Name:		***Desig:***		***Sign:***		***Date:***	

Company's Seal/Stamp:-

PQR ANNEXURE i Group I

Sub : Sub-Qualifying Requirements for the Compressed Air System stipulated in Clause

Sl.No.	Item	Plant 1

A) Air Compressor

In line with the Sub-qualifying requirements stipulated in Clause 4.7 of Sub-Section-IA, Part-A, Section-VI, we / our sub-vendor confirm that we/our sub-vendor have designed, manfactured, supplied, erected /supervised erection and commissioned/supervised commissioning of atleast one (1) no. non-lubricated oil free screw type air compressor of minimum capacity 20 NM3/min each or atleast one (1) no. centrifugal air compressors of minimum capacity 50 NM3/min each and at rated discharge pressure of 8 Kg./cm2(g) which have been in successfull operation for atleast one (1) year.

1.	Name of the Project and its address where the system is installed	.....
2.	Name of the Client with address, name of Contact person(s) with tel.no. & fax no.	.....
3.	Order No. and date	
4.	Purchase order enclosed	Yes/No
5.	Name of the Manufacturer & Address	
6.	Date of commissioning of the compressors	
7.	No. of Compressors supplied	
8.	Whether the scope of work executed for the aforesaid compressors included the following	
	a) Designed	Yes/No
	b) Manufactured	Yes/No

Signature of authorized signatory.....

PQR ANNEXURE i Group I

Sl.No.	Item		Plant 1
	c)	Supplied	Yes/No
	d)	Erected/supervised erection	Yes/No
	e)	Commissioned/supervised commissioning	Yes/No
9.	Brief Technical particulars of the Compressors (Bidder to fill)		
	a)	whether the compressor supplied was non lubricated oil free screw/centrifugal type air compressor	
	b)	Make & Model	
	c)	Capacity	
	i)	Flow (NM3/Min)	
	ii)	Discharge pressure [Kg/cm2/(g)]	
10.	Whether atleast **one (01)** compressor have been in successful operation for a period of not less than one (01) year.		
11.	Whether documentary evidence in support of above enclosed?		Yes/No

Signature of authorized signatory.....

PQR ANNEXURE ii Group I

B) Air Drying plant

We/our sub-vendor further declare that the Air Drying Plant (ADP) to be supplied under the package shall be sourced from manufacturer(s) M/s..... who have manufactured and supplied atleast one (1) no. Air Drying Plant each of capacity 50 NM3/min or more and the type same as offered, which have been in successful operation for atleast one (01) year. The experience details of manufacturer are as follows :

Sl.No.	Item	Plant 1
1.	Name of the Project and its address where the system is installed	.....
2.	Name of the Client with address, name of Contact person(s) with tel.no. & fax no.	.....
3.	Order No. and date	
4.	Purchase order enclosed	Yes/No
5.	Name of the Manufacturer & Address	
6.	Date of commissioning of the Air drying unit	
7.	No. of Air drying unit supplied	
8.	Whether the scope of work executed for the aforesaid Air drying unit included the following	
	a) Manufactured	Yes/No
	b) Supplied	Yes/No
9.	Brief Technical particulars of the Air Drying unit (Bidder to fill)	
	a) Type	
	b) Flow (NM3/Min)	

Signature of authorized signatory.....

PQR ANNEXURE ii Group I

Sl.	Item	Plant 1
10.	Whether atleastone (01) air dryring plants have been in successful operation for atleast one year.	
11.	Whether documentary evidence in support of above enclosed?	Yes/No

Date :

(Signature).....

Place :

(Printed Name).....

(Designation).....

(Common seal).....

Signature of authorized signatory.....

PQR ANNEXURE i Group II

Sub : Sub-Qualifying Requirements for the Compressed Air System stipulated in Clause No. 4.4.8 of Chapter 04, “Provenness” , Volume II of Technical Specification of Bidding Documents.

In line with the Sub-Qualifying Requirements stipulated in clause no. 4.4.8 of Chapter 04, “Provenness” , Volume II of Technical Specification of Bidding Documents, we have designed, manufactured, supplied, erected/supervised erection and commissioned/supervised commissioning of atleast two (2) numbers non-lubricated oil free screw type air compressor of minimum capacity 40 NM3 /min each or atleast two(2) numbers centrifugal air compressors of minimum capacity 50 NM3 /min each and at rated discharge pressure of 8 kg/cm2 (g) which have been in successful operation for atleast two (2) years prior to the date of techno-commercial bid opening.

We have manufactured and supplied atleast two (2) numbers Air Drying Plant each of capacity 40 NM3/min or more and the type same as offered, which have been in successful operation prior to the date of techno- commercial bid opening

S No.	Item	Plant 1	Plant 2
A)	**Air Compressor**		
1.	Name of the Project and its address where the system is installed	.....	.....
2.	Name of the Client with address, name of Contact person(s) with tel.no. & fax no.	.....	.....
3.	Order No. and date		
4.	Purchase order enclosed	Yes/No	Yes/No
5.	Name of the Manufacturer & Address		
6.	Date of commissioning of the compressors		
7.	No. of Compressors supplied		

PQR ANNEXURE i Group II

8. Whether the scope of work executed for the aforesaid compressors included the following

a)	Designed	Yes/No	Yes/No
b)	Supplied	Yes/No	Yes/No
c)	Manufactured	Yes/No	Yes/No
d)	Erected	Yes/No	Yes/No
e)	Commissioned	Yes/No	Yes/No

PQR ANNEXURE i Group II

S No.	Item	Plant 1	Plant 2
9.	Brief Technical particulars of the Compressors (Bidder to fill)		
	a) whether the compressor supplied was non lubricated oil free screw/ centrifugal compressor		
	b) Make & Model		
	c) Capacity		
	i) Flow NM^3/Min)		
	ii) Discharge pressure (Kg/cm2/g)		
10.	Whether atleast two (2) compressor have been in successful operation for a period of not less than two (2) yeas prior to the date of techno-commercial bid opening		
11.	Whether documentary evidence in support of serial no 3) to 10) enclosed?	Yes/No	Yes/No
B)	**Air Drying plant**		
1.	Name of the Project and its address where the system is installed	.....	.....
2.	Name of the Client with address, name of Contact person(s) with tel.no. & fax no.	.....	.....
3.	Order No. and date		
4.	Purchase order enclosed	Yes/No	Yes/No
5.	Name of the Manufacturer & Address		
6.	Date of commissioning of the Air drying unit		

PQR ANNEXURE i Group II

Sl.	Item	Plant 1	Plant 2
7.	No. of Air drying unit supplied		
8.	Whether the scope of work executed for the aforesaid Air drying unit included the following		
	a) Supplied	Yes/No	Yes/No
	b) Manufactured	Yes/No	Yes/No
9.	Brief Technical particulars of the Air Drying unit (Bidder to fill)		
	a) Type		
	b) Flow NM3/Min)		
10.	Whether at least two nos. air drying plants have been in successful operation prior to the date of techno-commercial bid opening.		
11.	Whether documentary evidence in support of serial no 3 to 10) enclosed?	Yes/No	Yes/No

- Date :

Place :

(Signature).....

(Printed Name).....

(Designation).....

(Common seal).....