COPYRIGHT AND CONFIDENTIAL
The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED,
It must not be used directly or indirectly in any way detrimental to the interest of the company.

TECHNICAL SPECIFICATION OF HYDRAULIC COUPLING for 660MW / 700MW POWER PLANTS

1.0.0 INTENT OF SPECIFICATION:

This specification is intended to cover the technical requirements of the hydraulic coupling required between Boiler Feed Pump and its drive motor for achieving variable speed drive.

2.0.0 SCOPE OF SUPPLY:

2.1.0 Design Engineering, manufacture, inspection, testing, packing and forwarding the hydraulic coupling and accessories to site.

2.2.0 Each hydraulic coupling shall be supplied with following accessories.

a. 2 x 100% Working oil coolers and 2 x 100% Lube oil coolers(duplex type) along with change-over device on oil side.

b. 1 No. AC motor driven auxiliary lube oil pump to cater for external lubrication.

c. An electrical actuator and linkages along with the necessary power amplifier unit shall be provided by the Bidder to operate the fluid coupling scoop tube. The time required by the actuator to operate the scoop from its minimum position to the maximum position shall be indicated in the Bid. The actuator and the power amplifier unit shall be compatible with microprocessor based Distributed Digital Control, Monitoring & Information system (DDCMIS) procured by Owner.

d. Oil tank

e. Pump insert: Working oil pump (Centrifugal pump) and lube oil pump (gear pump) jointly driven as gear-tooth system drive via the pump shaft.

f. Instrumentation as specified at Cl.No. 6.0.0.

g. Complete lube oil piping, working oil piping and vent piping to be connected between hydraulic couplings and coolers and drain piping with a valve to drain the oil from oil tank of hydraulic coupling. All necessary flanges, packing's, reducers, elbows, bolts and nuts required in these lines shall be included in the scope. 40 meters of pipe and 30 Nos. of elbows per straight run per cooler shall be supplied.

h. Duplex filter in lube oil line.

i. Foundation rails, bolts and nuts as suitable for civil foundation.

COPYRIGHT AND CONFIDENTIAL
The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED .
It must not be used directly or indirectly in any way detrimental to the interest of the company.

j. Counter flanges, bolts, nuts & gaskets for cooling water flanges.

k. J-type foundation bolts & nuts for coolers.

l. Rapid start device to accelerate the pump from stand by condition to normal running speed, within 15 seconds. Solenoid valves of rapid start device shall be suitable for 24 V, DC power supply.

m. Vibration pads for mounting the vibration probes shall be provided on bearing housings.

3.0.0 TECHNICAL PARAMETERS (AT 50 Hz):

(Powers & speed as per cl. no. 15.0.0)

Direction of rotation of BFP seen from drive end	:	CW
GD^2 Value on BFP (kg. Sq.m)	:	21.9
GD^2 Value on BP (kg. Sq.m)	:	47.5
GD^2 Value on shaft coupling between HC and Motor (kg.sq.m)	:	45
GD^2 Value of shaft coupling between BFP and HC (kg.sq.m)	:	10
Total Oil quantity required for external lubrication	:	350 lpm
1) Drive motor	:	50 lpm
2) Boiler feed pump	:	270 lpm
Booster pump	:	30 lpm

4.0.0 SPECIFIC REQUIREMENTS:

4.1.0 Hydraulic Coupling:

Hydraulic coupling shall be of full duty, generously designed, infinitely variable, remote controlled and totally enclosed type. It shall be adequately rated to meet the requirement of the boiler feed pump characteristics during start-up and load fluctuations. Operating range on lower side shall be up to 20% of the maximum output speed.

The hydraulic coupling shall be Complete with stainless steel impellers and casing, self supported double duty roller bearings, pillow blocks and Kingsbury or Mitchell thrust bearing or proven thrust bearing as per bidder's standard practice for input/output with removable Covers, oil sump, duplex filters to remove all particles upto 5 microns, oil temperature and pressure gauges, control pump for oil regulation if provided, regulating valves, stainless steel scoop tube, oil coolers etc., shall be furnished to form a centralized lubrication system for the total pump set. Bidder shall also state in their offer the effect on fluid coupling if a reversal of pump rotation occurs through the failure of the non return valve.

COPYRIGHT AND CONFIDENTIAL
The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED .
It must not be used directly or indirectly in any way detrimental to the interest of the company.

The starting time from minimum scoop position to 100% scoop position shall be less than 15 seconds after receipt of starting signal by motor, which operating single or in parallel with another Boiler Feed Pump. A quick start device shall be incorporated to meet the above requirement for auto stand by operation of Motor Driven Boiler Feed Pump.

4.2.0 Step-Up Gear Unit:

Gear boxes shall be totally enclosed and oil lubricated. Positive lubrication shall be provided to all the bearings and particularly to the working surfaces of the gear teeth.

The gear unit shall be specifically designed for continuous service at the speeds required by the application. Precision and accuracy of manufacture is essential in order to minimize problems of vibration impact-stresses, noise distortion and lubrication.

Double helical gear cut by hobbing process, or approved equal, and dynamically balanced shall be used. The high speed pinion shall be of heat treated forged steel with integral shaft. The low speed gear shall be of forged steel securely keyed to the input shaft. Bidders shall submit detailed specification of the materials used including factor of safety etc.

The gears shall be enclosed in an oil and dust proof gear casing made of grained cast iron or fabricated steel. Oil used to be same as for the pump, motor and turbine and supplied from pump lubricating system. Gear to be designed for continuous service.

The gear case shall be horizontally split and stress relieved before machining. The faces of adjoining sections shall be accurately machined to provide oil tight joints. Two oil level gauges, drain, fill vent, thermometer dipstick and other required connections equipped with approved mountings, valves and fittings shall be furnished for the gear casing.

The housing shall be generously proportioned and of rigid construction to provide permanent alignment of rotating parts and protection from possible external vibration. The arrangement shall be such that it will be possible to lift gear case cover without disturbing the alignment of shaft, gear and pinion.

Service factor for the gearing shall not be less than the following values:-

Motor driven pumps (Combined gearing/Hydraulic coupling) …**1.4**

The gear design shall be in accordance with **AGMA 6011 (Latest)**, as applicable. The gearing and bearing shall be pressure lubricated with oil supplied from the central lubrication system of the respective pump sets.

The gear box shall be provided with separate thrust bearings of conservative design to meet the worst duties under transients.

4.3.0 Bearings:

The bearings shall be amply proportioned and designed to withstand all operating conditions. They shall be of split sleeve type; bronze/steel backed with high grade centrifugally cast tin base Babbitt lining. Bearings shall be accurately machined to

assure perfect alignment. Gear journal bearings shall have babbited thrust faces next to the gear to act as locating surfaces for the gear train.

4.4.0 Lubrication & Working Fluid System :

Each hydraulic coupling shall be provided with built in lubrication system to also cater for external lubrication of 350 lpm. It shall comprise oil reservoir, main oil pump, auxiliary oil pump, duplex oil filter, and oil coolers with interconnecting piping and fittings.

The main oil pump shall be driven by the motor shaft and shall be capable to supply lube oil for external requirement also.

Aux. Oil pump shall be driven by an AC motor mounted on the hydraulic coupling itself AC motor shall be suitable for 415 V, 3-phase, and 50Hz supply.

Discharge system shall be common for main oil pump and aux. Oil pump with suitable NRVs in each line. The oil to be used shall be the same for lubrication and torque transmission. Oil piping shall be sch. 80 and shall be supplied in pickled condition.

4.5.0 Oil Coolers:

Each hydraulic coupling set shall be provided with 2 x 100% working oil coolers and 2 x 100% lube oil coolers.

The coolers shall be adequately rated and shall have the necessary arrangements for change over the cooler without interrupting the oil flow.

Both the coolers (Lubricating oil and working oil) shall be utilized in a closed loop system employing demineralized water of condensate quality as the cooling medium. The coolers shall be designed to accept the above system arrangement.

The shell of the coolers shall be of mild steel construction. Suitable corrosion allowance shall be added to all the carbon steel and cast iron parts including shell, flanges etc.

The tubes shall be of type 304 stainless steel. The tube bundle shall be of removable type. The tubes shall be roller expanded and flared at the ends. Provision for differential expansion shall be suitably incorporated.

The coolers shall be so designed that the cooling medium will flow in the tube side. The coolers shall be adequately rated with suitable fouling allowance in accordance with TEMA with necessary arrangements for changing over the cooler without interrupting the oil flow.

The design pressure of the coolers on the water side shall not be less than 10.0 kg/sq.cm.

Provision shall be made for complete venting and draining of all the parts of the heat exchangers. Connections along with temperature and pressure indicators shall be provided on the inlet and outlet branches of the water side and also on the shell side of each heat exchanger.

COPYRIGHT AND CONFIDENTIAL
The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED .
It must not be used directly or indirectly in any way detrimental to the interest of the company.

COPYRIGHT AND CONFIDENTIAL
The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED .
It must not be used directly or indirectly in any way detrimental to the interest of the company.

4.6.0 Scoop Tube Actuator:

Electrical actuator shall be provided for positioning the scoop tube. Following accessories shall be provided along with the actuator:

a. Servo Motor
b. Position feed back transmitter.
c. Four signaling contacts.
d. Electronic power positioner with IP-55 enclosure and suitable for field mounting.
e. Transformer (if required)
f. Mains rectifier (if required)
g. Hand wheel arrangement to manually position the actuator.

The servomotor of the actuator should be designed for 240V AC, single phase, 50HZ supply with possible variation of ±10% on voltage ±5% variation on frequency. If necessary, a transformer can be supplied to suit the actuator voltage requirement. The motor shall be capable of withstanding electrodynamic stresses and heating if started at 110% voltage. The motor shall be capable of running at 80% voltage for a period of at least 5 minutes.

The actuator shall have IP55 enclosure. Position feed back transmitter shall be of 2 wire, 4-20 mA DC output type and suitable for 24V DC supply. Actuator shall have all metal gear trains self linked gearing shall be provided. Electronic power positioner shall be suitable to accept 4-20 mA control signal.

Motors shall have class-B, non hygroscopic insulation scaled with two additional dips and bakes of epoxy finish. Motors shall be furnished with totally enclosed self ventilated, weather proof, dust tight enclosures suitable for outdoor service. Double shielded, grease prelubricated, regreasable, antifriction bearings having minimum life rating of 40,000 hours shall be furnished. Motor leads shall be terminated in the limit switch compartment.

5.0.0 MATERIALS OF CONSTRUCTION:

The materials of construction shall be as mentioned in this spec. and where not specifically mentioned shall be those with which the Supplier has had previous successful operating experience in similar applications for a period of at least 5 years. Material standards shall be indicated in the quality plans.

6.0.0 INSTRUMENTATION & CONTROL:

6.1.0 General:

The controls and instrumentation shall meet the following requirements:

6.1.1 All pressure and temperature instruments shall have metric scales; Graduation shall be in kg/sq cm for pressure instruments and in degree centigrade for temperature instruments.

6.1.2 All the instruments furnished shall be of the latest proven design for which performance and high availability have been demonstrated by a record of successful operation.

COPYRIGHT AND CONFIDENTIAL
The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED .
It must not be used directly or indirectly in any way detrimental to the interest of the company.

6.1.3 All instruments, devices must be capable of operating continuously under ambient temperature of 55 deg C and relative humidity of 95% without losing performance, accuracy etc.

6.1.4 Supplier shall furnish detailed information for each & every type of instrument included in his offer with their make, model, technical literature for BHEL/Owner's review and approval. Measuring instruments and sub-systems offered by the Supplier shall be reputed & experienced manufactures, whose guaranteed and trouble free performance has been proven for at least two years.

6.1.5 All **Electronic Pressure Transmitters** shall be suitable for 24V DC ±10% power supply.

6.1.6 **RTDs** shall be cabled and terminated in temperature transmitters.

~~**6.1.7** Temperature transmitters shall be supplied for all RTDs.~~

6.1.8 Out put signal and power supply wiring of **Electronic Pressure Transmitters** shall be terminated on separate junction box.

6.1.9 Stainless steel tags shall be fastened to each instrument. Instrument tag nos. as indicated by Customer/BHEL shall be punched on these tags before dispatch.

6.1.10 Pressure Gauges, DP Gauges, Temp Gauges, RTDs, Electronic Pressure Transmitters and Level gauges as per attached specification.

6.2.0 **Resistance Temperature Detectors:**

All resistance temperature detectors shall be ungrounded, duplex, 4 wire type, platinum one hundred ohm at 0 deg.C and shall conform to DIN 43760.

~~**6.3.0** **Temperature Transmitters:**~~

~~2-wire temperature transmitter (directly powered from 4-20mA input cards of DDCMIS) shall be provided.~~

6.4.0 **Temperature Gauges:**

The accuracy of the temperature gauges shall be ±1 %. All pipe thermometers shall be provided with thermowells. Contact rating of contact thermometers shall be 5A, 240 V AC with 2xSPDT contacts.

6.5.0 **Pressure Gauges:**

Pressure gauges shall have sensing element as bourdon tube / bellows / diaphragm depending on the system pressure. The accuracy of pressure gauges shall be ± 1%. All required accessories i.e. snubbers, pulsation dampers, syphons shall be provided with pressure gauges wherever required.

6.6.0 **INSTRUMENTS:**

The following instrumentation shall be necessarily included in the scope of supply. However, any additional instrumentation required for the safe operation of the equipment shall also be included.

COPYRIGHT AND CONFIDENTIAL
The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED .
It must not be used directly or indirectly in any way detrimental to the interest of the company.

a) 3 nos. of Electronic Pressure Transmitters in the lubrication oil supply piping down stream of filter shall be provided for interlocks & annunciation for AOP Motor & BFP Drive Motor.

b) 1 No. Pressure indicator on lube oil supply header downstream of filter.

c) 1 No. Pressure indicator for control oil.

d) 3 Nos. Electronic Pressure transmitters for control oil.

e) Capillary dial thermometers at all journal bearings and thrust bearings.

f) 4 Wire type temperature elements (Duplex RTDS) for each journal and thrust bearing ~~with temperature transmitters~~.

g) 1 No. Capillary dial thermometer at lube oil inlet to cooler.

h) 1 No. Capillary dial thermometer at lube oil outlet from cooler.

i) 1 No. 4 wire duplex RTD at lube oil inlet to cooler ~~with temperature transmitters.~~

j) 3 Nos. 4 wire duplex RTDs at lube oil outlet from cooler ~~with temperature transmitters~~.

k) 1 No. Capillary dial thermometer at working oil inlet to cooler.

l) 1 No. Capillary dial thermometer at working oil outlet from cooler.

m) 3 Nos. 4 wire duplex RTDs at working oil inlet to cooler ~~with temperature transmitters~~.

n) 1 No. 4 wire duplex RTD at working oil outlet from cooler ~~with temperature transmitters.~~

o) 1 No. differential pressure indicator across oil filter.

p) 1 No. differential pressure transmitter across oil filter.

q) 1 No. Level gauge on oil tank for local indication.

r) 1 No. Level transmitter (Guided wave radar type) on oil tank for annunciation.

s) Position feed back transmitter (In actuator).

t) Signaling contacts (in actuator) suitable for giving 4-20 mA galvanically isolated position feedback signal.

u) 3 no's of speed transducers with necessary accessories to give galvanically isolated 4-20ma DC out put signal for owners DDCMIS (Distributed digital control, monitoring and information system)

COPYRIGHT AND CONFIDENTIAL
The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED .
It must not be used directly or indirectly in any way detrimental to the interest of the company.

v) Limit switch for 0% scoop tube position.

w) Temperature and pressure indicators shall be provided on the inlet and outlet branches of the waterside and on the shell side of each heat exchanger.

Note: For Variant 05, Hydraulic coupling in Cl in 15.0.0, all field instruments and equipment to be supplied as per guidelines mentioned in Annexure-1.

6.7.0 Tests on various instruments shall be as per the standards indicated below

Pressure Gauge	:	IS 3624/1996
Temperature Gauge	:	BS 5235
Pressure Transmitters	:	IEC 770
RTD	:	DIN 43760
Electrical actuator	:	IS 9334

7.0.0 QUALITY ASSURANCE AND INSPECTION:

7.1.0 General:

A quantity plan detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of equipment / component shall be furnished in the format suggested by BHEL / Owner and abide by the same without any extra cost. If required, supplier shall depute his representative for discussions and finalization of quality plans with BHEL and Customer.

Quality plan furnished for review / approval of Owner shall include all the reference documents such as material specifications, heat treatment procedure and acceptance norms, Balancing procedure, pressure test procedures and performance test procedure.

Supplier shall abide by all decisions made during finalization of quality plans.

Test certificates shall be furnished as per the finalized quality plans. BHEL / Owner shall be given reasonable notice of the tests which are identified as customer hold points during finalization of quality plans and shall have right to witness such tests and shall have access to the works of the Supplier and his Sub-contractor. The performance tests on hydraulic couplings can be witnessed by Customer and BHEL engineers.

BHEL / Owner will identify the Customer hold points of the final quality plan beyond which work shall not proceed without BHEL / Owner's consent in writing. Supplier shall furnish vendor details for actuators, filters, coolers castings and forgings and instruments for BHEL / Owner's approval.

"Owner" mentioned in the above paragraph is a customer of BHEL and ultimate owner of the equipment.

Routine test reports of all instruments after duly calibrated at the factory shall be submitted. It should include insulation testing as applicable. Routine test reports for electrical actuators and AC motors of aux. oil pump shall be submitted.

COPYRIGHT AND CONFIDENTIAL
The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED .
It must not be used directly or indirectly in any way detrimental to the interest of the company.

7.2.0 **<u>An indicative programme of inspection / tests envisaged, is given below:</u>**

7.2.1 Material shall be checked for chemical composition, mechanical properties for major components like gears, pinions, primary & secondary wheels, shell, shafts and cooler tubes etc.

7.2.2 Fully machined shafts, gear / pinion rims, primary / secondary wheels and shell be subjected to magnetic particle test.

7.2.3 Dimensional conformity and Interchangeability to be checked.

7.2.4 Hydraulic pressure testing of the coupling body, oil tank, main oil and lubricating oil coolers shall be carried out.

7.2.5 Dynamic balancing of rotating elements and all rotor assemblies shall be carried out.

7.2.6 Backlash of gear wheels and pinions and teeth contact before and after functional testing.

7.2.7 Conditions of the bearings after functional test shall be checked.

8.0.0 **<u>PERFORMANCE TESTS</u>:**

The tests on each hydraulic coupling shall include the following:

- Check for smooth running of hydraulic coupling on no load.
- Check and set the oil flow rates.
- Check for smooth functioning of scoop tube positioning.
- Measure and record oil pressures, temperatures and bearing temperatures.
- Measure and record vibration and noise levels.
- Measure and record mechanical losses on no load.
- Check for smooth operation of aux. oil pump motor.
- Check for proper functioning of actuator.

9.0.0 **<u>DRAWINGS AND DATA TO BE ENCLOSED ALONG WITH OFFER</u>:**

- Slip percentage
- Mechanical and slip losses for rated parameters along with power loss curve.
- Mechanical and slip losses and torque slip characteristics at various scoop positions.
- AOP motor rating.

COPYRIGHT AND CONFIDENTIAL
The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED .
It must not be used directly or indirectly in any way detrimental to the interest of the company.

- Complete electrical load list.
- Materials of construction of hydraulic coupling and coolers
- Standard followed for design of gears
- Expected vibration & noise levels at supplier's test bed & at site.
- Cooling water requirement of coolers
- List of instrumentation
- Data of the actuators and their accessories
- Assy. Plan of hydraulic coupling.
- Assy. Plan of working oil cooler
- Assy. Plan of lube oil cooler
- P & I diagram of lube system
- Quality plan
- Test procedure

10.0.0 <u>DOCUMENTS TO BE FURNISHED AFTER AWARD OF CONTRACT</u>:

10.1.0 Eight copies each of the following drawings / documents shall be furnished.

- Sectional assly. Drg. of hydraulic coupling
- Sectional assly. Drg. of working oil cooler
- Sectional assly. Drg. of lube oil cooler
- Scheme drawing showing instrumentation
- List of instrumentation
- Technical data of the actuator
- Quality plan
- Test procedure
- Thermal load calculations for coolers
- Logic diagrams
- Technical catalogues for all instruments, Speed indicator, Level indicator or switch and power amplifier.
- O & M instruction manuals
- List of despatchable items with quantities (shall include all minor items also)

10.2.0 Soft copies in CD ROM for each of the following drawings / documents shall be furnished.

- Assy. plan of hydraulic coupling
- Assy. plan of working oil cooler
- Assy. Plan of lube oil cooler
- Scheme drawing showing instrumentation
- List of instrumentation

10.3.0 Vendor shall submit the order confirmation copy with in 2 weeks after award of contract.

11.0.0 TEST CERTIFICATES:

5 Copies of documentation package shall be furnished. This shall include material certificates & test certificates as per agreed quality plan & test procedure.

12.0.0 PACKAGING AND TRANSPORTATION :

12.1.0 All the equipment shall be suitably protected, coated covered or boxed and crated to prevent damage or deterioration during transit, handling the storage at site till the time of erection. The contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing.

12.2.0 Protection:

All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves and piping's and conduit equipment connections shall be properly sealed. Parts which are likely to get rusted, due to exposure to weather should also be properly treated and protected in a suitable manner. EMI / static charge proof packaging should be used for PLC / Electronic hardware.

13.0.0 PRESERVATIVE SHOP COATING:

13.1.0 All exposed metallic surface to corrosion shall be protected by shop application of suitable coatings. All surfaces which will not be easily accessible after the shop assembly, shall beforehand be treated and protected for the life of the equipment. All surfaces shall be thoroughly cleaned of all mill scale oxide and other coatings and prepared in the shop, the surfaces that are to be finish painted after installation or require corrosion protection until installation shall be shop painted with at least two coats of primer. Transformers and other electrical equipment, if included shall be shop finished with one or more coats of primer and two coats of high grade resistance enamel. The finished colors shall be as per manufacturer's standards to be selected and specified by the Engineer at a later stage.

13.2.0 Shop primer for all steel surfaces which will be exposed to operating temperature below 95ºC shall be selected by the Contractor. Special high temperature primer shall be used on surface exposed to temperature higher than 95ºC.

13.3.0 All other steel surface which are not to be painted shall be coated with suitable dust preventive compound subject to the approval of the Engineer.

COPYRIGHT AND CONFIDENTIAL
The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED.
It must not be used directly or indirectly in any way detrimental to the interest of the company.

COPYRIGHT AND CONFIDENTIAL
The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED.
It must not be used directly or indirectly in any way detrimental to the interest of the company.

14.0.0 RATING PLATES, NAME PLATES AND LABELS:

14.1.0 Each main and auxiliary item of plant is to have permanently attached to it in a conspicuous position a rating plate of non-corrosive material upon which is to be engraved manufactures name, equipment, type or serial number together with details of the loading conditions under which the item of plant in question has been designed to operate and such diagram plates as may be required by the Engineer.

14.2.0 Each item of plant is to be provided with name plate or label designating the service of the particular equipment. The inscriptions are to be approved by the Engineer or as detailed in the appropriate sections of the Technical Specifications.

14.3.0 Such name plates or labels are to be of white non-hygroscopic material with engraved black lettering or alternatively in the case of indoor circuit breakers, starters, etc. of transparent plastic material with suitably colored lettering engraved on the back.

14.4.0 Terms of plant such as valves and dampers which are subject to handling are to be provided with engraved chromium plated or label with engraving filled with enamel. The name plates for valves shall be marked in accordance with MSS standard SP-25 and ANSIB 16.34 as a minimum.

14.5.0 Housing shall be painted with 2 coats of epoxy primer and 2 coats of suitable finish paint of sea green colour of ISL No. 217 conforming to IS-15 which shall with stand the surface temperatures of Hydraulic coupling during operation.

14.6.0 Packing shall be done with suitable quality of wood which can withstand transport by sea and storage at site for minimum period of 18 months. Packing case shall be stiffened adequately to avoid the transport damage. Moisture absorbents (like silica gel) shall be put in liberal quantities to avoid corrosion.

15.0.0 VARIANT NOS:

Var No	GD^2 Value of drive motor (kg.sqm)	Input speed (rpm)	Maximum output speed (rpm)	Maximum input power to BFP (kW)	Material Code / PROJECT
01	4800	1495	5900	13200	FP9760215012 KPCL BELLARY 1 x 700MW STPP
02	4800	1495	5800	12600	FP9760215020 3X660MW LPGCL LALITPUR
03	4800	1495	5800	12100	FP9760215039 2 X 660 MW SURATGARH STPS
04	4800	1495	5750	13600	FP9760215047 1 x 660 MW - Panki
05	4800	1495	5800	13650	FP9760215055 2X660MW UANGUDI STPS

Note for Variant - 04:

Travel time from minimum scoop position to 100% scoop position shall be less than 7 seconds.
Refer Annexure-2 of Customer specification extracts for Mechanical and C&I requirements.

COPYRIGHT AND CONFIDENTIAL
The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED .
It must not be used directly or indirectly in any way detrimental to the interest of the company.

SPARES FOR HYDRAULIC COUPLING FOR 660/700 MW

VAR No.	ITEM DESCRIPTION	HYDRAULIC COUPLING	MATERIAL
50	AUXILIARY OIL PUMP ASLY + MOTOR 660MW	R111 KGS	FP9760215500
51	MOTOR FOR HC AOP - 660 MW	R111 KGS	FP9760215519
52	DUPLEX OIL FILTER COMPLETE 660 MW	R111 KGS	FP9760215527
53	OIL FILTER ELEMENTS	R111 KGS	FP9760215535
54	AUXILIARY OIL PUMP ASLY 660 MW	R111 KGS	FP9760215543
55	LUBRICATING OIL PUMP BEARING	R111 KGS	FP9760215551
56	DUPLEX FILTER ELEMENT	R111 KGS	FP9760215560
57	FUSIBLE PLUG FOR HYD COUPLING	R111 KGS	FP9760215578
58	BFP SPEED TRASMITTER FOR	R111KGS	FP9760215586
59	LIMIT SWITCH FOR HC SCOOP TUBE R111KGS	R111KGS	FP9760215594
64	HC SPEED TRANSDUCER WITH INDICATOR	R111KGS	FP9760215640
65	AOP MOTOR DE&NDE BEARINGS FOR VAR-04 HC	R111KGS	FP9760215659
66	STATOR WINDING COILS FOR AOP MTR OF HC - VAR-04 HC	R111KGS	FP9760215667
67	DUST SEALS & GASKETS FOR AOP MTR HC- VAR-04 HC	R111KGS	FP9760215675
68	TERMINAL PLATES FOR AOP MTR HC R111KGS- VAR-04 HC	R111KGS	FP9760215683
70	RADIAL BEARINGS HC R111KGS FOR VAR-04	R111KGS	FP9760215705
71	THRUST BRG ASSY FOR HC R111KGS VAR04	R111KGS	FP9760215713
72	SET OF SEAL&GASKETS FOR HC R111KGS VAR4	R111KGS	FP9760215721
73	FUSIBLE PLUG FOR HYD COUPLING VAR-05	R111KGS	FP9760215730
74	LUBE OIL PUMPS (AOP & MOP) FOR H.C. VAR-05	R111KGS	FP9760215748
75	HEATERS FOR AOP MOTOR HC R111KGS - VAR-04 HC	R111KGS	FP9760215756

COPYRIGHT AND CONFIDENTIAL
The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED,
It must not be used directly or indirectly in any way detrimental to the interest of the company.

RECORD OF REVISIONS

Rev. No.	Date	Revision Details	Revised By	Approved By
01	04.09.2012	Var-02 Added for 3x660 mw Lalitpur	D.K.Gupta	P.Srinivas
02	10.12.2013	Var-03 added for 2 x 660 MW Suratgarh Temperature transmitters are excluded from the scope of supply. The same is shown with text strike off at the clause no.6.1.7, 6.3.0, 6.6.0 (f), i, j, m & n	A. Satish	M.M.R
03	27.04.2014	Var Nos 50 to 54 added	A. Satish	M.M.R
04	15.11.2014	Var Nos 55 to 57 added Var Nos 58 & 59 added	DK Gupta Satish	Avinash Avinash
05	31.01.2018	Var No 64 added	NVKS	AJK
06	13.08.2019	1. Var Nos 65 to 68 & 70 to 75 are added. 2. Var No. 05 added. 3. Cl.no 4.1.0 revised as per latest customer Specifications. 4. Cl.no 4.2.0 AGMA Code revised. 5. Cl.no 6.6.0 (w) added. 6. Cl.no 2.2.0 (i) updated.	Rohit. P	AJK
07	14.01.2020	Var No.74 description modified.	Rohit. P	Avinash
08	24.01.2020	Var No.04 Parameters updated. Note for Var 04 added.	Rajesh CH	Avinash

Ref. Doc.

Annexure-1

		dog timer) time-out checking, processor status display LED, processor fault.
14. Indication	:	Processor status and fault display

C. MACHINERY MONITORING SYSTEM

i) Vibration Monitor

01. Sensitivity	:	100 mV/mil or better
02. Frequency Response	:	User programmable
03.Accuracy	:	±0.5% of full scale
04.Transducer Supply Voltage	:	-24 V DC (Typical)
05. Alarm Adjustment	:	Digitally adjustable over full scale for alert and danger set-points.

ii) Thrust Position Monitor

01. Sensitivity	:	100 mV/mil or better
02. Accuracy	:	±0.5% of full scale
03. Transducer Supply Voltage	:	-24 V DC (Typical)
04. Alarm Adjustment	:	Digitally adjustable over full scale for alarm set points
05. Repeatability	:	± 0.5% or better

iii) Case Expansion Monitor

01. Sensitivity	:	100 mV/mil or better
02. Accuracy	:	±0.5% of full scale
03. Transducer Supply Voltage	:	-24 V DC (Typical)
04. Alarm Adjustment	:	Digitally adjustable over full scale for alert and damager set-points.

iv) Tachometer/ RPM Monitor

01. Sensitivity	:	100 mV/mil or better
02. Accuracy	:	± 1 RPM for speed output. and within ±20 RPM/min for rotor acceleration output.
03. Transducer Supply Voltage	:	-24 V DC (Typical)
04. Alarm set points	:	Over speed and under speed Set points
05. Alarm Adjustment	:	Digitally adjustable over full scale for over speed / under speed set points.
06. RPM Range	:	1 to 99, 999 rpm
07. Accuracy and Resolution	:	± 1 rpm

v) Eccentricity / Key Phasor Monitor

01. Input signal	:	Two proximity probes, one for eccentricity and one for key-Phasor
02. Frequency response	:	0 to 10 Hz
03. Accuracy	:	± 0.5% of full scale

vi) Temperature Monitor

01. Input	:	3 wire RTDs (Pt 100) as per DIN43760 K/T type thermocouple Sensor selection programmable

02. No. of channels	:	12 / 16 / 24
03. Range	:	0 – 200 / 600 Degrees Centigrade or as per application
04. Accuracy	:	+ / - 1 ^{o}C
05. Display	:	LCD display, 3 ½ digits
06. Input Scan rate	:	12 Channel / sec or fast. (Any channel Skip provision shall be made)
07. Display Dwell Time	:	1 to 25 sec adjustable
08. Display Mode	:	Auto / Manual selection of channels Alarm and Trip set points independent for the selected channel.
09. Alarm display	:	To be provided for Alarm (Flashing) &Trip (steady) for each Channel
010. Sensor status Display	:	For open/short condition.(On Digital display)
011. Fail Safe Condition	:	During sensor open / short condition the Alarm / trip output of the respective channel should not energize the common relays.
012. Keys	:	4 No. Reset, Mode, Next, Previous(Min)
013. Common Output relays	:	4 No. (configurable for any channel or group of channels for alarm or trip) for 12 / 16 channels 6nos. for 24 channels.
014. Contact configuration	:	2 'NO' contacts per relay
015. Contact Rating	:	5A at 220V AC resistive (24V DC, 1A)
016. Set point programming	:	through front panel keys (membrane Type)
017. Set point / relay memory	:	non volatile (w / o battery backup)
018. Power supply	:	230V AC + / - 10%, 50Hz
019. Mounting	:	Flush panel in a powder coated cabinet
020. Termination	:	Plug & socket with best connection (for power supply and Input)
021. Environment	:	up to 600 ^{o}C bad environment with high humidity
022. Communication connectivity	:	soft link with DDC MIS through HART or standard protocol
023. Configuration & diagnostics from DDC MIS	:	through HART Protocol or standard protocol

vii) VIBRATION PICK-UPS

01. Type	:	Proximity type
02. Mounting	:	The Proximity Probe shall be mounted outside the machine case using protective housing with adjustable sleeves (stingers) that will be extended to the shaft surface.
03. Frequency response	:	0 - 10 KHz
04. Linear Range	:	Begins at 10 mils from probe face.
05. Linearity	:	Within ±1 mil of a straight line.
06. Temperature sensitivity	:	3% of span for 60° C change or better
07. Relative Humidity	:	95% non condensing
08. Module Housing	:	Fibre glass
09. Enclosure class	:	IP-65
10. Power supply	:	24V DC from monitoring units
11. Accessories	:	i) Non conductive mounting plates for housing ii) Extension cables (S.S armored) iii) Suitable junction boxes etc.

D. CONTROL BOARD

I. Control Desk / Console / Panel Construction

01. Applicable for	:	Indoor Panel, Desk & console.
02. Material of construction	:	Cold rolled steel sheet (Metal and plastic - Heat resistant, shrinkage free for mosaic tiles).
03. Thickness of Sheet	:	a) 3.2 mm for faces supporting instruments / terminals. b) 2 mm for other sides and top.
04. Construction	:	Welded throughout as per (metallic parts) approved National Standards.
05. i) Corners	:	7 mm inner radius
ii) Dimensional Tolerances	:	a) In height & length - 3 mm b) In height between adjacent sections - 2 mm. c) Total for a group - 6 mm
06. Doors	:	Double, recessed, turned back edges
i) Thickness of Sheet	:	2 mm
ii) Hinges	:	Stainless steel
iii) Door latches	:	Three point type
iv) Door gaskets	:	Neoprene rubber on fixed frame to result dust proof / weatherproof enclosure.
v) Opening of the doors	:	Outward
vi) Louvers	:	With removable wire mesh to ensure dust and vermin proof.
07. Color of interior	:	Glossy white
08. Colour external	:	IS 5 No. 628 (Typical) [To be decided later]
09. Protection of painting	:	Plastic peel coating
10. Gland plates	:	Removable 4 mm thick (bottom)
11. Cable entry	:	Bottom
12. Hardware	:	a) Vibration dampeners b) Predrilled base channel ISMC - 100 or equivalent for all sides. c) Stainless steel buff- finished 2 mm thick kick plate for all sides. d) Stainless steel scratch strips along desk edges fixed with pan-head recessed screws. e) Rubber strips to ensure air tightness between kick plate and finished floor. f) Power supply points 5/15 A plug point with indication lamp 5 Nos.
13. Enclosure Protection Class	:	IP-42 or as per environment condition.
14. Earthing	:	4 per standards

E. FIELD INSTRUMENTS

I. PRESSURE

This section provides general hardware guidelines for field instruments and equipment to be supplied under this specification.

Field transmitters shall be smart type with **HART** protocol. Temperature & Pressure switches shall be of Dual Snap type for vibration prone areas.

A. Pressure Transmitter

01.	Working Principle	:	Smart
02.	Type	:	2 - Wire
03.	Output Signal	:	Simultaneous transmission of digital and 4-20 mA DC signal isolated linear standard protocol (HART).
04.	Signal Processing	:	Silicon solid state electronic circuitry
05.	Measuring Element	:	Capsule / Diaphragm
06.	Measuring element	:	AISI-316 (Stainless Steel) Diaphragm material
07.	Static Pressure	:	150 % of maximum span continuously, without affecting the calibration.
08.	Turn-down ratio	:	100 : 1 minimum.
09.	Span and Zero	:	Locally adjustable with interacting facility or remotely accessible with HART based communicator for elevation and suppression by 100% of span
10.	Enclosure Class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
11.	Output Indicator (Digital display)	:	LCD type in % and engineering unit and LCD failure shall not affect the transmitter operation.
12.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
13.	Body	:	Forged Carbon Steel (SS for DM Water).
14.	Operating Voltage	:	18 - 36 Volts D.C.
15.	Load	:	750 Ohms (min.) at 24 Volts D.C.
16.	Ambient Temperature	:	0 - 85 ^{O}C
17.	Performance:		
	i) Accuracy	:	+ 0.04% or better of FSR for BTG package, + 0.065% or better of FSR for BOP packages and + 0.2% for remote seal type transmitter.
	ii) Repeatability	:	± 0.05% of calibrated Span or better
	iii) Warranty & stability	:	min. of 5 yrs or better
18.	Sealing/Isolation	:	10 meters SS armoured capillary with suitable fill fluid and flange remote seal diaphragm of SS 316 or suitable material as per application, for corrosive, viscous and dirty fluid application. Flange size and pressure rating as per application.
19.	Accessories	:	a) Universal mounting bracket suitable for 2" pipe and wall mounting. b) High tensile carbon steel U- bolts. c) Installation accessories as per relevant installation drawing. d) Syphons for steam and hot water services. e) ½" NPT 2-valve stainless steel manifold, constructed from SS316 bar stock.

f) Companion flange with nuts, bolts and gaskets.
g) Hand held configuration kit for diagnostics and calibration of Smart Transmitter locally or in remote.
h) ¾" ET cable gland
i) Flushing facility at process end diaphragm.
j) Reverse polarity protection required.
k) Three way SS manifold for (gauge) vacuum

B. Differential Pressure Transmitter

01.	Working Principle	:	Smart
02.	Type	:	2-Wire
03.	Output signal	:	Simultaneous transmission of digital and 4-20 mA DC signal isolated linear standard protocol -HART.
04.	Signal Processing Unit	:	Silicon solid-state electronic circuitry
05.	Measuring element	:	Capsule/Diaphragm
06.	Measuring element Material	:	AISI-316 (Stainless Steel)
07.	Static Pressure/ Overload Pressure	:	Maximum line (or static) pressure on either side without permanent deformation or loss of accuracy
08.	Turn-down ratio	:	100: 1 minimum
09.	Span and Zero	:	Locally adjustable, non-interacting
10.	Enclosure class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
11.	Zero suppression / Elevation	:	At least 100% of Span
12.	Output Indicator (Digital display)	:	LCD type in % and Engineering units
13.	Nameplate	:	Tag number and Service engraved in stainless steel tag plate
14.	Body	:	Forged Carbon Steel (SS for DM Water)
15.	Ambient temperature	:	0 - 85 ^{O} C
16.	Operating Voltage	:	18 - 36 Volts DC
17.	Load	:	750 Ohms at 24 Volts DC
18.	Performance:-		
	i) Accuracy	:	± 0.025 % of calibrated span or better
	ii) Repeatability	:	± 0.05 % of calibrated span or better
19.	Sealing/Isolation	:	6 meters SS armoured capillary with suitable fill fluid and flange remote seal diaphragm of SS 316 or suitable material as per application, for corrosive, viscous and dirty fluid application. Flange size and pressure rating as per application.
20.	Accessories	:	a) Universal mounting bracket suitable for 2" pipe and wall mounting. b) High tensile carbon steel U-bolts. c) Installation accessories as per relevant installation drawing. d) Syphons for steam and hot water services. l) ½" NPT 5-valve stainless steel manifold, constructed from SS316 bar stock. e) Companion flange with nuts, bolts and gaskets. f) Hand held configurator kit for diagnosis and calibration of Smart Transmitter. g) ¾" ET cable gland

h) Flushing facility at process end diaphragm.
i) Reverse polarity protection required.

C. Pressure Switch

01.	Type	:	Seal diaphragm, piston actuated.
02.	Sensing element material	:	AISI SS-316 diaphragm / piston. All other wetted part SS316.
03.	Case Material	:	Epoxy coated steel plate or die-cast aluminum alloy with neoprene gasket and clear glass where applicable.
04.	Setter Scale	:	Black graduation on white liner scale. Graduation 0-100% with red pointer for set points.
05.	Over range	:	150 % of maximum pressure
06.	Process Connection	:	1/2" NPT (M) bottom connected
07.	Switch configuration	:	Two SPDT Lead wires (3+3 Nos.) are to be brought externally to the male connector wherein the female pug connector will be inserted to connect the control room cables for easy removal & re - calibration
08.	Switch Rating	:	240V, 5A AC/220V, 0.5A DC
09.	Switch Type	:	Dual Snap acting, shock & vibration proof
10.	Adjustability	:	a) Set-point adjustable over span range. b) Differential adjustable by 10 percent of span (minimum).
11.	Sealing Ring	:	Viton, Buna-N
12.	Terminal Block	:	Suitable for full ring lugs for cable connection.
13.	Cable connection	:	3/4" ET compression gland.
14.	Enclosure Class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area).
15.	Performance	:	a) Accuracy ±1.0% b) Accuracy of Setting Indication of ±1.5%
16.	Ambient temperature	:	0 – 50 Deg.C
17.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
18.	Accessories	:	a) Remote diaphragm seal with SS-316 armored capillary for typical application. MOC of seal material shall be as per process fluid requirement. b) Snubbers for pulsating fluid application. c) Retention ring and screws for surface mounting. d) 1/2” NPT 2 Valve SS-316 manifold constructed from bar stock e) ¾” ET cable gland

D. Differential Pressure Switch

01.	Type	:	Bellows / Diaphragm / Piston actuated
02.	Sensing element material	:	AISI SS-316. For all other wetted part SS 316
03.	Case Material	:	Epoxy coated steel plate or die-cast aluminum alloy with neoprene gasket and clear glass where applicable.
04.	Setter Scale	:	Black graduation on white scale with 0-100% graduation and provided with red pointer for set point adjustment
05.	Over range	:	Static pressure on any one side, the other side being open to atmosphere.
06.	Process Connection	:	1/2" NPT (M) bottom connected / back connected.

07.	Switch configuration	:	Two SPDT Lead wires (3+3 Nos.) are to be brought externally to the male connector wherein the female pug connector will be inserted to connect the control room cables for easy removal & re - calibration
08.	Switch rating	:	240V, 5A AC/220V, 0.5A DC.
09.	Switch type	:	Dual Snap acting type contacts, shock and vibration proof.
10.	Adjustability	:	a) Set point adjustable over span range. b) Differential adjustable by 10 % of span (minimum).
11.	Terminal Blocks	:	Suitable for full ring lugs for cable connection.
12.	Cable Connection	:	3/4" ET compression gland.
13.	Performance	:	a) Accuracy of repeatability: ±1.0% of span. b) Accuracy of set point Indication: ±1.5%
14.	Operating Ambient Temperature	:	0 - 50 ^{O} C (Maximum Continuous)
15.	Enclosure	:	IP – 65 (Explosion proof for NEC Class-1, Division 1 area).
16.	Accessories	:	a) Snubbers for pulsating fluid application. b) Retention ring and screws for surface mounting. c) 1/2” NPT 5 Valve SS-316 manifold constructed from bar stock d) 3 / 4” Cable gland
17.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
18.	Preferred Features	:	Free floating bellows attached to high-pressure bellows for temperature compensation.
19.	Remote Seal type for special application	:	a) Silicone oil / fluorolube filled remote diaphragm seal for dirty / viscous / corrosive fluid. b) SS armored capillary at least 3 meters each. c) Adapter flanges with nuts, bolts and gaskets for instrument and process side

E. Pressure Gauge and Differential Pressure Gauge

01.	Type	:	Bourdon/Bellows/Diaphragm
02.	MOC Sensing & Socket	:	AISI-316 SS
03.	Movement Material	:	AISI-304 SS
04.	Case Material	:	Stainless steel casing bayonet type. Enclosure IP-65.
05.	Dial Size	:	Generally 150 mm (100 mm for SWAS gauges)
06.	Scale	:	Black lettering on white background in 270 Deg. arcs.
07.	Window	:	shatterproof toughened glass
08.	Range Selection	:	Normal process pressure – 50 ~ 70 % of range (approximately).
09.	Over-range Protection	:	125% of maximum range by internal stop. External stop at zero
10.	Adjustment	:	Micrometer screw for zero adjustment. Internal micrometer screw for range adjustment.
11.	Element Connection	:	Argon welding
12.	Process Connection	:	1/2" NPT (M) Bottom connection for local mounting, back connection for panel mounting.
13.	Performance	:	Accuracy of ± 1.0 % of span or better for Pressure gauge

			Accuracy of ± 1.6 % of span or better for Differential Pressure gauge
14.	Operating ambient Temperature	:	0 - 50 ^{O}C
15.	Safety Feature	:	Blow out disc. /diaphragm at the back
16.	Accessories	:	a) Snubbers and Glycerin filled for pulsating fluid applications and at pump discharge. b) Stainless steel 316 Diaphragm with Teflon coated seals for corrosive, viscous and solid-bearing or slurry type process fluids. c) 3-Way stainless steel Gauge cock for pressure gauges. Process connection ½" NPT. d) 5-valve SS316 manifold constructed from barstock for differential pressure gauge. Process connection ½" NPT. e) Union, nut & tail piece and other Installation accessories as required.
17.	Applicable standard	:	IS-3624 / 1996
18.	Electrical Contact rating	:	240V, 5A AC/ 220V, 0.5A DC (for gauges with alarm contact). Number of Contacts:2 SPDT
19.	Nameplate	:	Tag number, service engraved in stainless steel tag plate

II. LEVEL

A. Radar Level Transmitters

01.	a) Type	:	1. Guided wave Radar type transmitter of TDR type 2-10 GHz for liquids 2. Radar type transmitter of FMCWR type 24-26 GHz, drop in antenna for coal level
	b) Probe	:	Coaxial
	c) Probe material	:	SS 316 / SS 316L
02.	calibration range	:	as per application
03.	Process medium	:	as per application
04.	Process temperature	:	as per application
05.	Static Pressure	:	Capable of working in vacuum also
06.	Power supply	:	range to be specified by the bid (Loop power available = 24V DC)
07.	Reverse polarity protection	:	required
08.	Output	:	4 to 20mA, 2wire & HART
09.	Accuracy	:	±.03% of measure distance or ±3 mm
010.	Stability	:	Contractor specify
011.	Communication	:	Communication / configuration shall be possible either through integral key pad and display or through hand communicator. If integral key pad is not available, one number hand held communicator common for all the transmitters shall be supplied
012.	Load limitation	:	max 600 ohm at 24V
013.	Span & zero	:	adjustable
014.	Flange mounting	:	yes
015.	Environmental protection	:	IP 66 or better
016.	Process connection	:	traditional flange with ¼" – 18 NPT on flange with process adapters (Flange & drain vent- 316SST)
017.	Electronic housing	:	Aluminium alloy
018.	Electrical connection	:	Preferably ½" – 14 NPT with gland.

B. Capacitance Type Level Transmitter

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

01.	Type	:	Capacitance type
02.	Probe	:	a) Rod or suspended electrode. b) Rope type probes may be used only where required probe length is greater than 3 meters
03.	Probe Mounting :	:	Stainless steel 1-1/2 ANSI RF Flange / ¾“ NPT (M)
04.	Material of construction	:	316 SS
05.	Insulation	:	PTFE Part/Full as per service.
06.	Transmitter	:	The transmitter shall receive output of the preamplifier and convert it into 4-20 mA DC output signals.
07.	Accuracy	:	±0.1%
08.	Load	:	750 Ohms or more
09.	Enclosure	:	Powder/Epoxy coated Die cast aluminium. with neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
10.	Ambient temperature	:	0-60 ºC.
11.	Mounting	:	Wall / Surface
12.	Supply voltage	:	(90-250) V AC, 50 Hz / (18-36) V DC
13.	Response time	:	100 msec or better
14.	Cable connection	:	¾” ET Compression gland
15.	Accessories	:	Counter flange, Cable gland, prefab cable if any
16.	Preferable features	:	Alarm output contacts with adjustable set point facility

C. Ultrasonic Level Transmitter

01.	Type of Transmitter	:	Non contact Microprocessor based 2 wire type, HART protocol Compatible
02.	Output Signal	:	Galvanically isolated 4 – 20 mA DC along with superimposed digital signal (HART protocol)
03.	Sensor Accuracy	:	± 0.25% of calibrated span
04.	Sensor Repeatability	:	3 mm or better
05.	Power Supply	:	18 - 36V DC
06.	Temperature Compensation	:	To be provided within transducer
07.	Configuration	:	Sensor and electronic unit are separate. Electronic unit shall be possible to mount on the accessible location near the transducer. All cables, weather proof fittings for connection between transducer and electronic unit.
08.	Housing	:	IP 55 with durable corrosion resistant Epoxy coating
09.	Calibration	:	Through HART communicator
10.	Zero and Span adjustment	:	Continuous, Tamper proof, Remote as well as manual adjustability. Provision to calibrate the instrument without any level in the tank or sump etc.
11.	Sensor Material	:	Corrosion resistant to suit the individual application
12.	False signal tolerance	:	Facility to be provided. Shall have adjustable damping circuitry.
13.	Range	:	To be decided during detail Engg, with a facility to take care of frequency attenuation due to different obstructions (Surface, vapor)

14.	Display	:	Minimum 4 character display with integral key pad, access protected features.
15.	Diagnostics	:	Loss of echo alarm
16.	Load impedance	:	500 Ω minimum or as per vendor specification.
17.	Electrical connection	:	Plug and socket
18.	Accessories	:	Canopy for protection sunlight and rain Mounting hardware's and accessories shall be SS 316

D. Level Switch

01.	Type	:	External cage float operated. Magnetically coupled.
02.	Float Material	:	AISI-316 stainless steel
03.	Other wetted parts	:	AISI-316 stainless steel
04.	External Cage	:	Carbon steel / Stainless steel as per process requirements, welded type / flanged construction. Cage pressure rating shall equal or exceed the rating of the main vessel.
05.	External cage mounting	:	Side – Side with drain valve.
06.	External cage connection	:	25 NB socket weld to vessel or RF flanged.
07.	Switch housing	:	Epoxy coated die-cast aluminum alloy with neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
08.	Type of switch Configuration	:	2 SPDT (two nos.) Snap acting magnetically operated hermetically sealed.
09.	Contact rating	:	5A, 240V/AC, 0.5A, 220V DC
10.	Accessories	:	a) Counter flange, nuts & bolts, suitable gasket etc. b) Steel globe type drain valve. c) ¾ " ET cable gland d) Stainless steel alpha-numeric engraved for service and tag.
11.	Preferred feature	:	Switch operating point marked on cage
12.	Temperature rating	:	As per application

E. Conductivity Type Level Switch

01	Type	:	Conductivity discrimination.
03	Mounting	:	Flanged – on standpipe.
04	Probe MOC	:	Stainless steel with high purity ceramic.
05	Probe rating	:	> Maximum design pressure of vessel.
06	Input	:	four independent channels with selectable switching threshold for water conductivity.
07	Relay Output	:	Four isolated output relays for HI, LO, HI-HI, LO-LO.
08	Contact type & rating	:	2SPDT @ 0.5A 220V DC / 5 A 240V AC
09	Local Display	:	Colored LEDs for HI, LO, HI-HI, LO-LO. Power & fault.
10	Power supply	:	Dual (90-250) V AC, 50 Hz, 1Ph.
11	Enclosure	:	IP–65, corrosion resistant & wall mounting type (Explosion proof for NEC Class-1, Division-1 area).
12	Accessories	:	Teflon (PTFE) cable having Teflon wrapped individual cores and necessary sheathing shall be used to connect the probe with electronics
13	Test pressure	:	Two times rated pressure
14.	Cable connection	:	¾" ET Compression gland

F. Capacitance Type Level Switch

01	Type	:	Capacitance type
02	Probe	:	a) Rod or suspended electrode b) Rope type probes may be used only where required probe length is greater than 3 meters.
03.	Probe Mounting	:	Stainless steel 1 ½" ANSI RF Flange / ¾ "NPT (M)
04.	Material of construction	:	316 SS
05.	Insulation	:	PTFE Part/Full as per service.
06.	Enclosure	:	Powder/Epoxy coated Die cast Aluminium with neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
07.	Ambient temperature	:	0-60 ºC.
08.	Mounting	:	On Tap
09.	Supply voltage	:	(90-250) V AC, 50 Hz / 18-36 V DC
10.	Relay output	:	2 SPDT @ 0.5 A 220V DC / 5A 240V AC
11.	Response time	:	100 msec or better
12.	Cable connection	:	¾" ET Compression gland
13.	Accessories	:	Counter flange, Cable gland, prefab cable and stainless steel name plate engraved with alpha-numeric.

G. Level Switch (Ultrasonic Type)

Ultrasonic type level switch, IP-65 protection; Switch with 2 nos. of SPDT contacts (1 NO and 1 NC) rated for 0.2 A, 220 V DC; Accuracy ±0.25%; Resolution 1mm; Repeatability ±0.1%; Linearity ±1%; Response time 150ms; Beam angle <12º; Auto false echo-suppression; Accessories like integral cable between sensor and transmitter unit with connectors on both side, gasket and cable gland, digital panel meter, name plate & metal tag; the material of accessories will be SS.

H. Level Switch (Radar Type)

Radar type level switch, top mounted, IP-65 protection; Switch with 2 nos. of SPDT contacts (1 NO and 1 NC) rated for 0.2 A, 220 V DC, Accuracy ±1%; Resolution 0.04"; Repeatability ±0.04"; Linearity ±0.01%; Beam angle <20º; Accessories like integral cable between sensor and transmitter unit with connectors on both side, gasket and cable gland, name plate & metal tag; the material of accessories will be SS.

I. Conductivity Type Electronic Level Indicator

01	Type	:	Conductivity discrimination.
02	No. of Probes	:	14, 16 or 32 as per application.
03	Probe Mounting	:	Screw type / Flanged – on standpipe.
04	Probe MOC	:	Stainless steel with high purity ceramic.
05	Probe rating	:	> Maximum design pressure of vessel.
06	Input	:	Independent channel with selectable switching threshold for water conductivity.
07	Relay Output	:	Four isolated output relays for Hi, Lo, Hi-Hi, Lo-Lo.
08	Contact type & rating	:	2 SPDT @ 0.5 A 220V DC / 5A 240V AC
09	Current output	:	Isolated 4-20 mA DC & HART
10	Local Display	:	Red, Green and flashing yellow LED's for steam, water and fault indication respectively.
11	Remote Display	:	Red, Green & flashing yellow LEDs for steam, Water & Fault indication respectively.
12	Power supply	:	Dual (90-250) V AC, 50 Hz, 1Ph.

13	Enclosure	:	i) IP–65, corrosion resistant & wall mounting type for local electronics. ii) IP-42 for remote indicator
14	Accessories	:	i) PTFE cable from probe to electronics ii) Mounting accessories. iii) Standpipe iv) Washer & gaskets
15	Test pressure	:	Two times design pressure
16.	Alarm levels	:	Probe number shall be selectable for HI, LO, HIHI, LOLO

J. Level Gauge (Float & Tape)

01.	Type	:	Float and Tape
02.	Float & Tape MOC	:	AISI 316
03.	Pulley material	:	Aluminium
04.	Guide wire	:	SS 316 Stainless steel
05.	Accuracy	:	+/- 2 mm
06.	Indication	:	On circular or vertical dial
07.	Rating	:	Twice the design pressure

K. Silo pilot

01.	Application	:	Solid material in Material bins, silos, etc.
02.	Power supply	:	(90-250) V AC, + 10%, 50 Hz selectable.
03.	Mounting	:	Top with ANSI RF Flange
04.	Protection class	:	IP-65.
05.	Ambient	:	65 ^{O} C (Max.) dust laden atmosphere
06.	Housing	:	Cast aluminum with sun Cover
07.	Measuring rope	:	Corrosion resistant steel
08.	Counting step	:	1 pulse/1-10cm depending on application
09.	Output from sensor	:	Change over contact
10.	Motor	:	1 phase

Electronics

01.	Type	:	Microprocessor based
02.	A/M Switch	:	Yes, in auto mode level measurement in regular interval as set in the instrument.
03.	Output	:	a) 4-20 mA DC (stored D/A) & if applicable HART protocol b) 2 nos. SPDT contacts
04.	No. of set points	:	2 nos.
05.	Min. counting pulse	:	20 mins.
06.	Mounting	:	Wall or 19” rack
07.	Enclosure	:	IP 65

III. FLOW INSTRUMENTS

1. Mass Flow Meter

A Sensor

01.	Measuring Principle	:	Coriolis Mass flow.
02.	Primary Element	:	Flow Tube of 316SS or better (Suitable for the process fluid)
03.	Heating Arrangement	:	Integral with Flow Element.
04.	Temperature Control For Heating	:	To be provided.
05.	Process Connection	:	ANSI RF Flanged and rating as per process requirement.
06.	Drain	:	Self-draining facility

07.	Accessories	:	Counter flanges, Mounting nuts, bolts, gaskets etc.

B Transmitter

01.	Measured quantities	:	Mass Flow rate, Total Mass Flow, Density, Temperature as minimum.
02.	Input Signal Processing	:	Digital Processing.
03.	Display	:	Digital Display (LCD).
04.	Output	:	2 Nos. isolated output of 4-20mA DC selectable from four measured quantities.
05.	Load	:	< 750 ohms.
06.	Power supply	:	(90-250) V AC, 50 Hz.
07.	Turn Down	:	100:1
08.	Accuracy	:	± 0.2% of measured value
09.	Ambient Temperature	:	85°
10.	Repeatability	:	± 0.05%
11.	Housing	:	IP 65 (Explosion proof for NEC Class-1, Division 1 area)
12.	Hazardous duty Version	:	FM Standards.
13.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
14.	Accessories	:	a) As required for field mounting b) Handheld configurator c) Mounting U-bolts, nuts, bolts, prefab cable etc. d) ¾" ET cable gland

2. Turbine Flow Meter

A. Sensor

01.	Type	:	Turbine (in line full-bore, based on magnetic pick of pulses)
02.	Output Signal	:	Pulse
03.	Material of Construction	:	a) Body : AISI 316 b) Rotor: AISI 431 or 410 c) Bearings: Tungsten Carbide / Stellited Sleeve
04.	Flow rate range	:	As required.
05.	Linearity	:	±0.25% or better.
06.	Repeatability	:	± 0.02% or better.
07.	Ambient temperature	:	50 ^{O}C
08.	Mounting	:	On-Line mounting with ANSI RF flanges of stainless steel.
09.	Enclosure	:	IP 65

B. Transmitter

01.	Electronics	:	Solid State
02.	Power Supply	:	(90-250) V AC, 50 Hz.
03.	Input	:	Input from Sensor
04.	Display	:	4 1/2 digit LCD
05.	Output	:	Isolated 4-20mA DC & HART
06.	Measuring Accuracy	:	± 0.5% of full scale range
07.	Totalized Value	:	Required
08.	Housing	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
09.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
10.	Accessories	:	a) clamping strip, bracket, prefab cable etc. b) Calibration or configurator kit. c) ¾" ET cable gland

3. Vortex Flow Meter

A. Sensor

01.	Type	:	Vortex
02.	Output Signal	:	Pulse
03.	Material of Construction	:	AISI 316
04.	Sensor Seal	:	PTFE / higher based on temperature
05.	Flow range	:	As required.
06.	Linearity	:	±0.25% or better.
07.	Repeatability	:	± 0.1 of actual flow rate or better.
08.	Ambient temperature	:	85 ^{O}C
09.	Mounting	:	On-Line mounting with flanges of stainless steel.
10.	Enclosure	:	IP 65
11.	Accessories	:	Nuts, bolts, gaskets etc.

B. Transmitter

01.	Electronics	:	Solid State
02.	Power Supply	:	(90-250) V AC, 50 Hz.
03.	Input	:	Input from Sensor
04.	Display	:	4 ½ digit LCD
05.	Output	:	Isolated 4-20mA DC & HART
06.	Measuring Accuracy	:	± 0.025% of span
07.	Totalized Value	:	Required
08.	Housing	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
09.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
10.	Accessories	:	a) Clamping strip, bracket, prefab cable etc. b) Special tool kit for calibration / configuration. c) ¾" ET cable gland

4. Electro-Magnetic Flow Meter

A. Sensor

01.	Measuring Principle	:	Faraday's law of Electro-magnetic induction.
02.	Primary Element	:	Flow Tube of 316SS or better
03.	Service	:	Conductive Liquids and Slurries
04.	Sensor type	:	Insertion style / Wafer style
05.	Process Connection	:	ANSI RF Flanged and rating as per process requirement.
06.	Accessories	:	Counter flanges, Mounting nuts, bolts, gaskets etc.

B. Transmitter

01.	Measured quantity	:	Volumetric Flow rate
02.	Input Signal Processing	:	Digital Processing.
03.	Display	:	Digital Display (LCD).
04.	Output	:	Isolated output of 4-20mA DC & HART
05.	Load	:	< 750 ohms.
06.	Power supply	:	(90-250) V AC, 50 Hz.
07.	Turn Down	:	100:1
08.	Ambient Temperature	:	74℃
09.	Accuracy	:	± 0.25% of measured value
10.	Repeatability	:	± 0.1% of Reading.
11.	Housing	:	IP 65 (Explosion proof for NEC Class-1, Division 1 area)
12.	Hazardous duty Version	:	FM Standards.

13. Nameplate : Tag number, service engraved in stainless steel tag plate

14. Accessories :
    a) As required for field mounting
    e) Handheld configurator
    f) Mounting U-bolts, nuts, bolts, prefab cable etc.
    g) ¾" ET cable gland

5. Ultra sonic type Flow Meter

Ultra sonic type flow elements shall be provided for measurement of CW flow.

i) Ultrasonic Flow meter shall be dual path transit time clamp-on type.

ii) The flow meters shall be of proven reliability, accuracy and repeatability requiring a minimum of maintenance. They shall comply with relevant international standards and shall be subject to approval.

iii) All accessories required for mounting/erection of these instruments shall be furnished, erected and installed as necessary for completeness of the system though not specifically asked for. Also the equipment shall include necessary cables, flexible conduits, junction boxes required for the purpose.

iv) Flow meters shall be provided with suitable environment protection devices/structures such that they shall be suitable for continuous operation in the operating environment of a coal fired utility station without any loss of function or departure from the specification requirements.

Type	Transit time Clamp On Ultrasonic meter
Mounting Style	Dual path with two sets of transducers on the same pipe
Flow measurement	Instantaneous Flow rate as well as totalized flow
Power supply	230 V AC
Outputs :	
Analog Current	Isolated 4-20mA linear outputs for each path
Binary	Contact relay outputs, 2 NO + 2 NC for alarm
Communication ports	RS 232 C digital Hand held terminal port
Display/Indication	Flow meter with LCD screen backlight based local display and keypad. If required, transmitter shall be suitably located away from the sensor for better access and visibility.
Recording / Totalizing /Logging Facilities	Yes. Should be able to compute cumulative flow over intervals selectable by owner i.e., daily, weekly, monthly etc. The data shall be stored in the memory of flow computer for access in future
Software features	Compensation for any cross path errors Programming, configuration, shall be possible from front panel.
Diagnostics	False signal tolerance , power supply failure etc
Protection class	IP-65 or better, Weather protection against direct sunlight, rain etc for Flow meter and suitable for Cooling water for Transducer
Accuracy	+/- 1%
Electrical connection	Plug and socket
Accessories	All mounting hardware required like clamping fixtures, mechanism to remove the transducers online, interconnecting cables etc All weather canopy for protection from direct sunlight and direct rain. Material of all fittings shall be SS316.

6. Rotameter

01.	Type	:	On-line and by-pass
02.	Metering tube	:	Borosilicate glass
03.	Float	:	AISI 316-SS unless the process fluid demands some other material.
04.	Packing material	:	Teflon
05.	Body MOC	:	CS or SS as per fluid condition.
06.	Scale	:	Graduated- Engraved black on white background.
07.	Process connection	:	Flanged (RF) to line size as per ANSI standards.
08.	Accuracy	:	± 2% of full scale detection or better for on-line type and ±4% of full-scale detection or better for by-pass type.
09.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
10.	Accessories	:	Slip-on orifice plate of 316-SS and taps of CS / SS as per application requirements. Applicable CS / SS Isolation valves and SS Range Orifice - for bypass type rotameters.
11.	Pressure Rating	:	As per application
12.	Flow & Scale length	:	To be decided by Contractor.

7. Orifice Plate

01.	Type	:	Ring joint / Flange type or other required type (To be decided by Contractor)
02	Material I	:	316 SS connection office
03.	Application	:	Low fluid velocity flow measurement
04.	Design Standard	:	BS-1042, Part-I
05.	Number of Tapings	:	One additional pair of taps for performance test. (i.e. for control measurement, 3+1 pair of taps to be provided, for monitoring measurement, 2+1 pair of taps to be provided)
06.	Diameter Ratio	:	Between 0.4 to 0.7
07.	Accessories	:	Flanges, gaskets, nuts & bolts, root valves jack screw etc.

8. Flow Nozzle : flow element shall have 3 pair of differential pressure tapping

01.	Application	:	High fluid velocity flow measurement
02.	Design Standard	:	ASME PTC 19.5
03.	Number of Tapings	:	One additional pair of taps for performance evaluation (i.e. for control measurement, 3+1 pair of taps to be provided, for monitoring measurement, 2+1 pair of taps to be provided)
04.	Diameter Ratio	:	Between 0.4 and 0.7
05.	Accessories	:	Meter run pipe, nipples and root valves. (Inspection port assembly for nozzles used in plant performance purpose)

9. Sight Glass

01.	Type	:	Flap-type
02.	End connection	:	Screwed / Flanged
03.	Material:		
	a) Body	:	SS-304
	b) Cover Plate	:	SS-304
	c) Indicator	:	SS-316
04.	Sight Glass	:	Toughened Borosilicate
05.	Gasket	:	Neoprene
06.	Bolts & Nuts	:	High tensile steel

07.	Hydraulic Test Pressure	:	1.5 times maximum working pressure
08.	Accessories	:	As required

10. Gauge Glass : flow element shall have 3 pair of differential pressure tapping

01.	Type	:	Reflex
02.	Glass	:	Toughened borosilicate. Resistant to mechanical and thermal shocks.
03.	Body material	:	SS-304 / 316 / Carbon steel – As per process requirements (Flanged Connection)
04.	Pressure rating	:	Twice the maximum working pressure
05.	Temperature rating	:	300 ^{O} C
06.	Bolts and nuts	:	Rust proof alloy steel
07.	Accessories	:	Suitable ball check valves of SS- 304/316 body, gaskets, companion flange etc.

11. Flow Switches

Indicating, Differential pressure, flapper type on line flow switches for line sizes up to 80 mm with an accuracy of +/-0.5% of span and dial size of min. 50 mm having 316 SS flapper/SS 316 bellows housed in die cast aluminium. Micro switch with adjustable range with 2 SPDT contacts rated for 0.2 A, 220 V DC. IP 65 or equivalent degree of protection for enclosure. The material of accessories shall be SS. Repeatability shall be +/-0.5% of span. Over range protection shall be 50% above maximum flow. Setting shall be tamper proof external adjustment & scale shall be provided for setting. Range spring & orifice plate shall be SS 316 for DP type. NPT for sizes below 2" & for sizes above 2" ANSI 150 RF shall be provided. Accessories like nameplate, mating flanges with gaskets, bolts & nuts, pipe assembly with orifice plate, etc. 5 way manifold, pipe, fittings (DP type), etc. shall be supplied

IV TEMPERATURE INSTRUMENTS

1. Thermocouples

01.	Type	:	a) Type-T (Copper Constantan) or Type-K (Chromel Alumel) [As per specification requirement] b) Duplex c) Ungrounded
02.	Wire gauge	:	16 AWG
03.	Standard	:	ANSI-MC 96.1.
04.	Protecting Tube:-		
	i) O.D.	:	8 mm (approx.)
	ii) Material	:	316-SS Seamless
	iii) Filling	:	Magnesium Oxide (Purity above 99.4%)
05.	Response time	:	a) Less than 2 to 6 seconds. . b) Less than 10 seconds for control.
06.	Head:		
	i) Type	:	IP-65 universal screwed type. (Explosion proof for NEC Class-1, Division 1 area)
	ii) Material	:	Die cast aluminum or better
	iii) Terminal blocks	:	Nickel plated Brass - screw type / silver plated
	iv) Cable connection	:	3/4" ET gland and grommet.
	v) Others	:	Terminal head cover with SS chain and suitable gasket
07.	Accessories	:	a) Adjustable nipple-union-nipple with thermowell connection

			b) Compression fittings/unions c) Flanges etc. (for flanged connections only) c) SS 316 forged thermowell as per ASME PTC code.
08.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
09.	Static Pressure Limit	:	As per application.
10.	Length	:	As per application
11.	Limits of error @ 0 Deg Ref.:		For K type + 1 Deg C or 0.4% (Greater Value) For T type + 0.5 Deg C or 0.4% (Greater Value)

2. Resistance Temperature Detector

01.	Type	:	Platinum (Duplex), ungrounded class 'A'
02.	Resistance	:	100 ohm at 0 ^{O}C
03.	Base	:	Wound on ceramic (anti-inductive)
04.	Wiring	:	3 Wire
05.	Protecting Tube :-		
	i) O.D.	:	8 mm (approx).
	ii) Material	:	SS-316, Seamless
	iii) Filling	:	Magnesium oxide (Purity above 99.4%).
	iv) Length	:	As per application
06.	Response time	:	a) 1 to 2 seconds
07.	Head:		
	i) Type	:	IP-65 universal screwed type. (Explosion proof for NEC Class-1, Division 1 area)
	ii) Material	:	Die cast aluminum or better
	iii) Terminal blocks	:	Nickel plated Brass-screw type / silver plated
	iv) Cable connection	:	3/4" ET gland and grommet.
	v) Others	:	Terminal head cover with SS chain and suitable gasket
08.	Accessories	:	a) Adjustable nipple-union-nipple with thermowell connection b) Compression fittings/unions c) Flanges etc. (for flanged connections only) d) SS 316 forged thermowell as per ASME PTC code.
09.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
10.	Standard	:	Standard DIN 43760
11.	Limit of error	:	@ 0 Deg C ± 0.06 Ohm @ 100 Deg C + 0.13 Ohm @ 200 Deg C ± 0.20 Ohm @ 300 Deg C ± 0.27 Ohm

3. Field Mounted Temperature Transmitters

01.	Working Principle	:	Smart
02.	Type	:	Two wire
03.	Input	:	Universal (T/C of different types, PT 100 RTD and other RTDs)
03.	Output Signal	:	Simultaneous transmission of digital and 4-20 mA DC signal with HART.
04.	Signal Processing Circuitry	:	Microprocessor based Solid State Electronic
05.	Span and Zero	:	Adjustable in field, Non-interacting facility for elevation and suppression of zero.
06.	Enclosure Class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
07.	Output Indicator	:	LCD type

08.	Span Adjustability	:	Yes
09.	Nameplate	:	Tag number to be engraved on metallic tag plate rigidly fixed to the body.
10.	Body	:	Die Cast aluminum
11.	Operating Voltage	:	18-36 V DC
12.	Load	:	600 Ohms at 24V DC (Min.)
13.	Performance		
	i) Accuracy	:	0.2% of span
	ii) Repeatability	:	±0.05% of span
	iii) Cold Junction Compensation	:	Built-in
	iv) Calibration	:	As per N.I.S.T Monograph 125 for T/C and European Curve Alpha = 0.00385 for RTD
14.	Accessories	:	a) Universal mounting bracket suitable for pipe and surface mounting. b) Hi-tensile Carbon Steel U-bolts.

4. Thermo Well

Thermo wells Pipe/equipment mounted temperature test wells of 316 SS with a process connection of M33x2 thread or 150 RF flanged and instrument connection of ½" NPT (F) in general or 150 RF flanged.. Accessories like name plate, plug with chain, etc. shall be provided. Material of accessories shall be SS. Thermowell shall be hex head of barstock assembly. In case flanged wells are required for any specific application, the same shall be supplied as required. The thermo well construction shall meet the ANSI 19.3 (latest) requirements. Thermo well shall be designed such that the resonant frequency is above the exciting frequencies generated by vortex shedding in the process fluid. All Test thermo well shall have the plug of SS316.

For measurement of pulveriser outlet temperature tungsten carbide block thermowells abrasion resistant not tungsten carbide coated thermowell shall be used. Also the terminals of Thermocouple shall not be at the top of Mills itself. The thermocouple wires are to be laid up to JB through SS tubing of required diameter and the head shall be placed nearer to the JB. Compensating cable exposed to atmosphere in the conventional method melts away due to high temperature at the top of Mill.

For measurement of sea water temperature SS with titanium sleeve thermo wells or better, shall be used.

5. Temperature Switch

01.	Type	:	Mercury filled-in
02.	Sensing Element Material	:	Bellow / Bourdon AISI SS-316
03.	Bulb Material	:	AISI SS-316
04.	Capillary	:	Stainless steel armored
05.	Movement Material	:	AISI SS-304
06.	Case material	:	Epoxy coated steel plate or die-cast aluminum alloy with neoprene gasket and clear glass where applicable cover conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
07.	Scale	:	Black lettering on white background
08.	Over range Protection	:	120 %
09.	Instrument connection	:	Bottom
10.	Switch configuration	:	Two SPDT Lead wires (3+3 Nos.) are to be brought externally to the male connector wherein the female pug connector will be inserted to connect the control room cables for easy removal & re - calibration

11.	Switch rating	:	240V, 5A AC/220V, 0.5A DC
12.	Switch type	:	Snap acting, shock and vibration-proof.
13.	Adjustability	:	a) Internal Set point adjustable over span range b) Differential adjustable by 10% of span (minimum)
14.	Cable connection	:	3/4" ET compression gland.
15.	Compensation	:	a) Capillary compensation with invar wire throughout the capillary length. b) Case compensation
16.	Performance:		
	i) Scale Accuracy	:	±1.0 % of full scale
	ii) Repeatability	:	< 0.5 % of full range
	iii) Response time	:	Less than 40 seconds with thermowell
17.	Capillary length	:	5 meters (minimum) for local mounting/15 meters for local panel mounting.
18.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
19.	Accessories	:	Mounting accessories, 3/4”ETcable gland

6. Temperature Gauge

01.	Type	:	Mercury filled-in remote mounting system Capillary armoured / rigid system type (backward entry / bottom entry)
02.	Sensing Element Material	:	Bourdon - AISI-316 SS
03.	Capillary Armoring	:	Stainless steel flexible
04.	Movement Material	:	AISI 304 SS / Direct Bourdon tip connection to pointer spindle
05.	Bulb Diameter and Length	:	As required
06.	Bulb Material	:	AISI 316
07.	Capillary	:	Stainless Steel
08.	Thermometer	:	M 20 x 1.5 Male adjustable gland on stem to suit associated Thermowell
09.	Case Material	:	Stainless steel bayonet type with clear glass cover conforming to IP-65.
10.	Dial Size	:	150 mm in general (100 mm for SWAS gauges)
11.	Scale	:	Black lettering on white background in 270 Deg. arc.
12.	Mounting	:	Surface/Panel
13.	Over range Protection	:	125 % of range or more
14.	Instrument connection	:	Bottom connection for local mounting and back connection for panel mounting.
15.	Range	:	50% ~ 70% range of operating temperature of application approximately.
16.	Compensation	:	Case compensation
17.	Zero adjuster	:	Micrometer screw adjustable from front.
18.	Window	:	Shatterproof toughened glass.
19.	Performance	:	Accuracy of ± 1 % of full-scale deflection or better.
20.	Enclosure Class	:	IP-65
21.	Capillary	:	5 meters (local)/15.0 meters (local panel) - armored stainless steel
22.	Preferred Feature	:	Capillary Compensation
23.	Accessories	:	a) Forged SS 316 thermowell weldable or screwed as per ASME PTC code b) Installation accessories as required.
24.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
25.	Immersion length	:	Adjustable up to 300 mm including bulb length or as per application

ANNEXURE-2

PANKI PROJECT CUSTOMER SPECIFICATION EXTRACT

7.6 Hydraulic coupling and Gear Boxes

(a) The hydraulic coupling of MD-BFP shall be of combined gearbox and fluid coupling type and shall be adequately rated to meet the requirement of pump characteristic over its entire operating range.

(b) The hydraulic coupling shall be complete with stainless steel impellers, casing, self supported double duty roller bearings, pillow blocks and thrust bearing or proven thrust bearing as per OEM's standard practice, oil sump, duplex filters to remove all particles up to 25 microns, oil temperature and pressure gauges, control pump for oil regulation if provided, regulating valves, stainless steel scoop tube, lube oil coolers / working oil coolers as indicated in clause 7.3 (e), one portable type oil purifier of adequate capacity.

(c) The gearboxes shall be of double helical type manufactured by hobbing process and shall be dynamically balanced. The gear casing shall be horizontally split and accurately machined to provide oil tight joints. Oil used shall be same as for the pump, motor and turbine and supplied from pump lubrication system.

(d) Gear boxes shall be designed for continuous service with following service factors:

(a) TD-BFP (gearbox between turbine drive: 2.0 and booster pump)
(b) MD-BFP (combined gearing/hydraulic coupling): 1.4

(e) Design and manufacturing of gearboxes shall be as per AGMA 6011.

6. PADO (Performance & Optimization System)

   i. Simulated functional test (Note-1)
   ii. Tests for server, LED monitor, Printer, Keyboard
   iii. Testing of various models operation and its result validation.
   iv. Performance verification of various calculations.
   v. System data base results verifications.

7. HMS System

   i. Simulated functional test (Note-1)
   ii. Tests for server, LED monitor, Printer, Keyboard

8. MIS System

   i. Simulated functional test (Note-1)
   ii. Tests for server, LED monitor, Printer, Keyboard

Note-: Test shall be witnessed by Owner or Owner's representative.

NOTES:

1. The intent of the FAT is to demonstrate and ensure that the I&C system meets all the functional requirements as intended in the specification / contract. A completed integrated test of the system shall be carried out at vendor's works in the presence of Owner or Owner's representative, on completion of integration / manufacturing of the system. The shipment of I&C equipment to site will be effected only after the FAT has been accepted by Owner.

2. FAT procedure shall be prepared by vendor and to be submitted for Owners approval well in advance prior to the commencement of FAT.

17.02.04.21 **Calibration of Instruments**

The Bidder shall carry out the calibration of instruments as indicated below by submitting the test procedure and quality assurance plan for the Owner's approval. Bidder shall also prepare detailed checklist/calibration sheets for each of the systems/equipment clearly indicating the step-by-step procedures to be carried out for calibration pre commissioning, loop checking, powering and commissioning.
The calibration of all instruments shall be checked and calibration records prepared for the Owner's use. If the instruments require recalibration, Bidder shall recalibrate the instruments and revise the calibration records and submit to the Owner.

TESTS TO BE PERFORMED FOR FIELD INSTRUMENTS & EQUIPMENTS

1.	Pressure Gauges
	Calibration, Accuracy Test, Over range test (1.5 times max. pr.)

2.	Pressure switches
	Calibration test / Over range test / Contact rating test / Accuracy test / Repeatability test
3.	Pressure Transmitter
	Calibration test / H / Leak test / Over range test / Accuracy test / Repeatability test.
4.	Differential Pressure Gauges
	Calibration test / / Leak test / Over range test / Accuracy test / Repeatability test.
5.	Differential Pressure Switches
	Calibration test / Over Range test / Contact rating test / Leak test / Accuracy test / Repeatability test.
6.	Differential pressure transmitter
	Calibration test / test / Leak test / Over range test / Accuracy test / Repeatability test.
7.	Thermometers
	Calibration / Material test / Accuracy test / Bore concentricity: ± 5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.)
8.	Temperature switch
	Calibration / Material test / Accuracy test / Bore concentricity: 1.5% of wall thickness / Hydrostati test for TW (1.5 times max. pr.) / Contact rating test.
9.	Resistance temperature detector assembly.
	Calibration / Material test / Bore concentricity test / Insulation test (≤ 500 MΩ at 500V DC) as per ISA, Hydro test for TW. Bore concentricity: ± 5% of wall thickness, Accuracy test.
10.	Thermocouple assembly
	Calibration / Material test, Insulation test (≤ 500 Ω at 500 V, DC) as per ISA, Hydro static test (1.5 times max. pr.), Bore concentricity: ± 5% of wall thickness.
11.	Temperature Transmitter
	Calibration test / Accuracy test /Ambient temperature error test
12.	Thermowells
	Material test / Bore concentricity: ± 5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.)
13	Interposing Relay
	Functional Test/temperature rise test/high voltage test/limits of operation test/insulation.
14.	Level Gauges
	Hydrostatic test / Material test / Seat leakage test / Ball check test.
15.	Level switches (Magnetic)
	Material test / Contact rating test / Hydro test / Calibration test.
16.	Level gauge (prope)

	Material test/contact rating test/Hydro test/Calibration test
17.	Flow Switch
	Material test / Hydro static test (1.5 times max. pr.) / functional test.
18.	Flow glasses
	Material test / Hydrostatic test (1.5 times max. pr.) / functional test.
19.	Variable area flow meters
	Calibration test / Material test / Hydrostatic test (1.5 times max. pr.)
20.	Flow element
	100% Radiography test / Hydro test / Calibration test, IBR Certificate.
	Calibration test for flow element shall be witnessed by Owner/Consultant.
21.	Control valves/Pneumatic block valve/Pressure regulating valve –Refer Vol-V Part-B chapter 11.
22.	Pneumatic Block Valves
	a) IBR certificate form III C b) Hydrostatic test : ANSI B 16.34 c) Seat leakage test : As per ANSI B 16-104 d) CV test: As per ISA procedure e) Magnetic particle test ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC) f) Liquid penetration test: ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC) g) Radiography test: ANSI B 16.34 special class h) Calibration and Hysteresis test i) Actuator leakage test j) Also refer Vol-V Part-B chapter 11 for further details.
23.	Pressure Regulating Valve
	a) IBR certificate form III C b) Hydrostatic test : ANSI B 16.34 c) Seat leakage test : As per ANSI B 16-104 d) CV test: As per ISA procedure e) Magnetic particle test ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC) f) Liquid penetration test: ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC) g) Radiography test: ANSI B 16.34 special class h) Calibration and Hysteresis test i) Actuator leakage test j) Also refer Vol-V Part-B chapter 11 for further details.
24.	Position transmitters
	Calibration / hysteresis and Accuracy test

25.	Electro Pneumatic Convertors
	Calibration test / Accuracy test
26.	Solenoid valves
	/ Seat leakage test / CV test / Coil insulation test
27.	Air filter regulators
	Calibration test / Accuracy test
28.	Junction Boxes
	Test for degree of protection / Material test
29.	Transmitter Racks :
	Hydro test, air leak test for piping / tubing and fittings. IBR certification as required for tubing / piping and fittings.
30.	Tests for terminal blocks
	Test for moulding for flame resistant, Non-hygroscopic and Decarbonised / Insulation test between terminals / Insulation between terminal block and frame.
31.	Thermocouple extension cable & Instrumentation Cables and Fiber Optical Cables
	Thermo-emf characteristic / Continuity test / Measurement on capacitance, inductance and loop resistance / Insulation resistance / High voltage test as per latest IS / Tensile and elongation test / Oxygen index test / Any other test applicable. (Also refer Vol-V Part-B chapter 9 for further details). For Deatils of type and acceptance tests for Instrumentation Cables refer Vol-V Part-B chapter 9. For Deatils of tests for Fiber Optical Cables refer Vol-V Part-B chapter 9.
32.	Mass flow meter
	Performance test / Calibration test / Hydrostatic test.
33.	Boiler Level Gauge
	Hydrostatic test / Material test / Seat leakage test / IBR Certificate
34.	pH/Conductivity measurement / Silica / Dissolved oxygen analysers:
	Calibration test, Accuracy test
35.	Sample cooler :
	Hydro test, IBR Certificate
36.	Sampling racks :
	Hydro test, IBR Certificate for tubes and fittings.
37.	S02 / Nox analyser / SPM analyser:
	Calibration test, accuracy test
38.	Interposing relay
	Functional test, temperature rise test, H.V test, Insulation test
39.	Local Panels : Visual inspection, wiring & continuity check, H.V. and I.R. tests on panels, checking of bill of materials, functional tests.

40	Wiring Termination & Accessories
	Routine test: Conductor resistance test/High voltage test/Impulse dielectric test/insulation test/Humidity test/Temperature rise test on power circuits/short time current test on power circuits.
	Type test:Annealing test/Test for insulation and sheath/ Flame retardance test - a) Oxygen index, b) Flammability / Test for acid gas generation/test for water absorption/wet dielectric test
41	Marshalling/System cabinets
	Verification of degree of protection/Electrical tests as detailed under wiring Termination& accessories/Type test and routine test as per relevant Indian standards.
	Notes:
	1. Test Certificates in addition to inspection at manufacturer's works shall be furnished for all the instruments for Owner / Consultant's review. 2. Above Test to be witnessed shall be finalized by Owner.
	3. In addition to above test, test as per approved QAP shall also be witnessed by owner.

QUALITY PLAN SUBMISSION PROGRAMME FOR THE BIDDERS

In addition to above requirements, The Quality Assurance Plans as conceived for the project are also enclosed in Volume II. Bidders to follow the NIT specification in totality i.e both Volume II & Volume V to submit QAP for Approval.

17.02.05 Testing at Site [Prior to commercial operation]

a. All equipment shall be checked thoroughly in respect of the following:

i. Visual and mechanical testing

ii. Complete system configuration loading functions; system diagnostics; system proper operation specified power supply specifications.

iii. Checking of loop configuration & OS displays; correct functioning of all keyboards; correct change-over of redundant devices; proper functioning of printer, sample printing of all types of log reports, shutdown reports and MIS reports; shutdown system.

iv. Loading of user's programme and checking out of results.

Repeating any or all such tests (as necessary) as performed at works.

b. Modulating Control Loop Test

Loop test performed after calibration of all instruments and leak test of signal lines to check the functional performance of all elements of loop.

i) This section describe the scope of Bidder's responsibilities for erection & commissioning of the equipment / system, supplied by the bidder as part of this specification though even not specifically brought out under Clause No. 23.02.02. In general, bidder shall erect and commission all the equipments supplied as part of this specification.

ii) The Bidder shall prepare detailed installation drawings for each equipment furnished under this specification for owner review. Installation of all equipment / system furnished by this specification shall be as per owner approved drawings. In general bidder shall erect and commission all the equipments supplied as part of this specification..

iii) Erection procedures not specified herein shall be in accordance with the recommendations of the equipment manufacturers. These procedures shall be acceptable to the Owner.

iv) Instrumentation workshop must be prepared first of all before starting the C&I erection work, in order to ensure proper calibration of various instruments.

23.02.02 DETAIL OF WORK

1 This specification covers the various jobs listed below though not strictly limited to them. The scope of work shall also include all other items of work required to complete the job in all respects as per specifications, drawings and instruction of the OWNER. Bidder to follow the safety procedures as per the instruction of OWNER

2 The scope of systems shall be limited to calibration and installation of the following types of instruments and accessories. The bidder shall submit and get approval for the detailed procedures for calibration and installation of the following instruments:-

i) Pressure transmitters (Electronic) with output indicator and with manifolds.
ii) Differential Pressure Transmitters (Electronic) with output indicator for flow and differential pressure with manifolds.
iii) Level switches, Pressure switches & Flow switches
iv) Proximity switches, vibration sensors & speed sensors
v) All type of gauges
vi) Control system as described.
vii) Solenoid valves.
viii) Thermocouples, RTDs with/without thermo-wells.
ix) Air filter regulators.
x) Displacement transducers & other field mounted transducers (I/P converters, P/I converter etc.)
xi) Junction boxes (Analog/Digital/Thermocouple K type).
xii) Control valves.
xiii) Water & Flue gas Analysers.
xiv) Instrument enclosures.

xv) Steam and water analysis system dry and wet panel. Analysis system
xvi) Any other field instrument included in the specification.

23.02.03 Work Included

The Bidder shall be responsible for furnishing materials and performing field construction as outlined below:

The Bidder shall be responsible for furnishing materials and performing Instrumentation & electrical field construction, erection, installation & commissioning as outlined, but not limited to the followings: -

1. Erection & commissioning of UPS and 24V DC sytem for C&I system. The bidder shall include all required tools and special instruments required for the installation, testing, erection & commissioning of the UPS and 24V DC sytem.

2. Refurbishment & Erection of junction boxes. The bidder to supply of necessary JBs as per site requirement.

3. Refurbishment & Erection of control valve instruments i.e. I/P converter, air lock switches, and air header.

4. Loop checking of field signals up to field JBS and between field JBS and control system cabinet.

5. Erection, installation & commissioning of SWAS panels such as sample conditioning panel and analyser panel..

6. Erection, installation & commissioning of STG panels, SG panels, BOP panels, DDCMIS panels, PLC panels, relay based control panels, GIU panels, and any other control panels as part of this specification..

7. Fabricated panels supporting framework shall be provided with a drilled base plate capable of supporting the weight of the panel. The bare plate shall not extend beyond the out line base dimensions of the panel.

8. Vibration damping equipments shall be installed wherever required. Control panels and desks shall be mounted on vibration dampeners which are secured to channels mounted on control room floor. The channel shall be field welded to steel plate set into the control room floor concrete. The panels and cabinet in bidder's scope shall be appropriately mounted so as to match the cutouts provided for each cabinet and panel

9. Cable entry shall be from the bottom connecting directly into junction boxes. Cable shall enter the panel via a stuffing gland, with base frame.

10. Installation & calibration of air lock valves.

11. Junction box and terminal boxes shall be placed with the bottom entry gland at least 300mm above the panel base. Termination shall not be

The Bidder shall perform additional tests and construction checks in accordance with the sections of this specification dedicated to shop and site tests.

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

S.No.	Details
1	Crimp pliers, for ferrules as per DIN 46228 Part 1+4, 0.14 - 10 mm², lateral insertion, square crimp
2	Cable cutter for copper and aluminum conductors
3	Stripping tool, for wires and conductors of 4 - 16 mm², self-adjusting, stripping length up to 18 mm, cutting capacity up to 10 mm² stranded /1.5 mm² solid
4	Screwdriver, bladed, matches all screw terminal blocks up to 4.0 mm² connection cross section, blade: 0.6 x 3.5 mm, without VDE approval
5	Screwdriver, blade: 0.6 x 3.5 x 100 mm, length 180 mm
6	The digital multimeters with volt sensor function as per the internationally applicable standards IEC/EN 61010. The devices can be used in the case of voltages of up to 600 V, category III or 1000 V, category II.

23.04.00 Calibration, Testing, Installation and Commissioning:

Bidder shall provide all testing facilities for each and every equipment/instrument in his scope as per detailed description provided in this specification. It is Bidder's responsibility for correct installations and commissioning of all equipment/ instruments in his scope. Bidder shall provide a group of highly skilled personnel for installation and commissioning of the entire equipments supplied under this scope.

23.04.01 **CALIBRATION**

a) All instruments shall be calibrated strictly as per the manufacturer's instructions prior to installation. The scope of calibration includes all field instruments of all types namely electronic, electrical etc. Bidder shall use his own oil free instruments and air compressor for calibration purposes. Conversion from one unit to another for the purposes of calibration is not allowed.

b) Procedures for calibration for different items are as outlined below. However, the detailed procedure shall be submitted to Owner for approval before proceeding with the calibration:-

i. All pressure and differential pressure transmitters shall be calibrated to the settings as per instrument data/specification sheet

and instruction of Owner. Pressure instruments shall be calibrated by applying pressure to the instrument using dead weight tester and manometer (for low pressure).

ii. Receiver instrument shall be calibrated and aligned using test hookup as per instruction from the manufacturers/Owner.

iii. Pressure transmitters shall be calibrated at 0%, 25%, 50%, 75% and 100% and vice-versa of range using dead weight tester.

iv. DP transmitters shall be calibrated at 0%, 25%, 50%, 75% and 100% and vice-versa of range using dead weight tester.

v. Control valves and positioners shall be checked for hysteresis and linearity and calibrated for rated strokes. Prior to calibration, valves shall be cleaned externally. The stem shall then be lubricated, if required and stroked few times to extreme positions of plug to ensure that movement is free from friction. The valve shall then be calibrated for rated stroke and linearity also. Subsequently, the valve shall be checked for hysteresis to the accuracy of 1% FS.

All calibration readings shall be recorded in the prescribed format and submitted to the Owner for approval. Where significant deviations from specifications are obtained, the matter shall be brought to the immediate notice of Owner for corrective actions. The bidder is responsible for calibration of all instruments/ items covered under the scope of works. The test reports shall be submitted to Owner on a daily basis. Calibration test facility shall be located near the work site.

23.04.02 LOOP TEST

a) Loop test shall be performed after calibration of all instruments and leak test of signal lines. Loop test is conducted to check the functional performance of all elements comprising the loop thereby ensuring proper connections and operations. Before proceeding for loop test, the calibration results of individual elements shall be recorded on the prescribed Performa and shall get it approved by Owner for correctness of installation, measurement and calibration results. Loop testing for all control loops shall be generally by simulation of process conditions and shall fix points namely 0%, 25%, 50%, 75% and 100% of full scale inputs. Detailed procedure shall be submitted to Owner for approval before proceeding with the loop testing.

b) The field/receiver pressure switches are simulated for abnormality by disconnecting the wires of terminals and function of all associated system are checked. Performance of individual loops may be accepted for an overall accuracy of $\pm$0.5%. Where deviations exist, bidder shall recalibrate the instruments, which forms part of the loop checking where required, at no extra cost. After the loop test is complete, the bidder shall connect back any terminations and connection removed for loop check. A loop shall be considered as completed, only after measurements in that particular loop are complete and certified by the Owner, in addition to loop sheets