Sl. No.	Item Description	Vendor Name	
	(CAPACITANCE TYPE)	2	DK INSRTUMENTS
27	LEVEL SWITCH (DISPLACEMENT TYPE)	1	DRESSER VALVES INDIA LTD.
		2	CHEMTROLS
		3	DK INSRTUMENTS
		4	ECKARDT
28	LEVEL TRANSMITTER (ULTRASONIC TYPE)	1	EMERSON PROCESS
		2	ENDRESS + HAUSER
		3	SIEMENS MIL TRONICS
		4	VEGA
29	LEVEL TRANSMITTER (RADAR Type)	1	ENDRESS + HAUSER
		2	VEGA
30	BUNKER/SILO LEVEL 3D MONITORING (ULTRASONIC TYPE)	1	E & H
		2	SIEMENS
		3	VEGA-GERMANY
31	VIBRATION MONITORING SYSTEM /TURBINE SUPERVISORY MONITORING SYSTEM	1	GE (for BENTLY NEVADA SYSTEM)
		2	MEGGIT
		3	SHINKAWA, JAPAN
32	MERCURY MONITORING	1	DURAG GMBH AND CO KG
		2	SICK
		3	SHINKAWA
33	Dust Density Monitor	1	CODEL INTERNATIONAL LTD.
		2	DURAG GMBH AND CO KG
		3	LAND INSTRUMENTS INTERNATIONAL
		4	SICK GMBH
34	CO Analyzer (in situ type)	1	CODEL INTERNATIONAL LTD.
		2	LAND INSTRUMENTS INTERNATIONAL
		3	SICK GMBH
35	Oxygen Analyzer (Zirconia Probe type)	1	EMERSON PROCESS MANAGEMENT
36	SO_2-NOx/CO/CO_2 Analyzer(Insitu Type)	2	CODEL INTERNATIONAL LTD
		3	PROCAL
		4	SICK GMBH
37	SWAS system (with selected analysers from Rosemount Analytical / Hack Ultra-France, Orion – USA, Hach-USA. ABB – UK, Polymetron-France/Zeltwegger -Analyticals)	1	ABB LTD.
		2	EMERSON PROCESS MANAGEMENT INDIA PVT.
		3	FORBES MARSHALL
38	DUST MONITOR	1	SIEMENS MILLTRONICS

Sl. No.	Item Description	Vendor Name	
		2	FILTER SENSE
		3	BIN MASTER
39	PULSE JET CONTROLLER	1	SWITCHING CIRCUIT
		2	ADVANCE CONCEPT
		3	VOLTCRAFT
		4	SQUARE M
		5	MICRO SYSTEM
40	AIR FILTER REGULATOR	1	JRU INSTRUMENTS (Formerly PLACKA)
		2	SHAVO NORGREN (INDIA) PVT. LTD.
41	ELECTRO PNEUMATIC CONTROLLER	1	MTL INDIA PVT. LTD.
		2	WATSON SMITH LTD.
		3	FAIRCHILD
42	SMART POSITIONER	1	EMERSON PROCESS MANAGEMENT
		2	SIEMENS
		3	ABB
43	SOLENOID VALVE	1	ASCO (I) LTD.
		2	ROTEX AUTOMATION LTD.
		3	NUCON INDUSTRIES PVT LTD
44	FEP INSULATED CABLE (For TG control)	1	DELTON CABLES
		2	HABIA CABLES
		3	LAPP CABLES
		4	LEONI KERPEN
		5	TEMPENS INSTRUMENTS (I) PVT. LTD.
		6	THERMOELECTRIC
45	PTFE INSULATED CABLES (For TG control)	1	ADVANCE CABLES TECHNOLOGIES
		2	DELTON CABLES
		3	FLUTEF INDUSTRIES
		4	RELIANCE INDUSTEIES
		5	RJ INDUSTRIAL CORPORATION
		6	TEMPSENS INSTRUMENTS (I) PVT. LTD
		7	TOSHNIWAL CABLES PRIVATE LTD
		8	UNIVERSAL CABLES LIMITED
46	INSTRUMENTATION CONTROL CABLE/ COMPENSATING CABLE / THERMOCOUPLE EXTENSION CABLES	1	ADVANCE CABLES TECHNOLOGIES
		2	CORDS CABLE INDUSTRIES PVT. LTD.
		3	DELTON CABLES LTD.
		4	HAVIA CABLES
		5	KEI INDUSTRIES LTD.
		6	KERPEN CABELS

Sl. No.	Item Description	Vendor Name	
		7	LAPP CABLES
		8	NICCO CABLE
		9	POLYCAB WIRES PVT.LTD
		10	THERMO CABLES LTD.
		11	THERMO ELECTRIC
		12	UNIVERSAL CABLES LTD.
47	POWER CABLE (LT)	1	CCIL
		2	KEI INDUSTRIES LTD.
		3	POLYCAB
		4	RELIANCE ENGRS.
		5	THERMO ELECTRIC
		6	ADVANCE CABLES TECHNOLOGIES
		7	RELIANCE ENGRS.
		8	CORDS CABLES
		9	DELTON CABLES
		10	INCAB
		11	PARAMOUNT CABLES
		12	RADIANT CABLES
		13	TORRENT
		14	UNIVERAL CABLES
48	FO CABLES	1	SYSTIMAX
		2	TYCO/AMP
		3	MOLEX
49	UPS & ACDB	1	EMERSON NETWORK
		2	MERLINEGERINE
		3	HITACHI HIREL ELECTRONICS
50	24 V DC BATTERY CHARGER & DCDB	1	CALDYNE
		2	CHHABI ELECTRICALS
		3	HBL POWER SYSTEMS
		4	DB POWER
51	HART COMMUNICATOR (HAND HELD)	1	EMERSON PROCESS
		2	YOKOGAWA
		3	ABB
		4	HONEYWELL
52	MASTER & SLAVE CLOCK SYSTEM	1	HATHWAY
		2	HOPF
		3	SERTEL ELECTRONICS
		4	MASIBUS

Sl. No.	Item Description	Vendor Name	
53	PUBLIC ADRESSING SYSTEM (ANALOG SYSTEM)	1	BOSCH SECURITY SYSTEMS
	PUBLIC ADRESSING SYSTEM (IP ADDRESSABLE)	2	STENTOFONE (from ZENITAL GROUP)
		3	INDUSTRONIC
		4	COMMEND
54	EPABX	1	ABB INDIA PVT. LTD.
		2	BPL TELECOM PVT. LTD.
		3	CROMPTON GREAVES LTD.
		4	HCL INFINET LTD.
		5	SIEMENS LTD.
		6	ABC INDIA PVT LTD.
55	CCTV System	1	BOSCH
		2	HONEYWELL
		3	PELCO
56	LIE/LIR	1	CHEMIN CONTROLS
		2	ELECTRONICS CORP. OF INDIA LTD.
		3	PYROTECH
		4	FORBES MARSHAL
		5	INSTRUMENTATION LIMITED
		6	PRAMMEN INDUSTRIES
57	CONDENSATE POTS	1	FLOWTECH
		2	INSTRUMENTATION LIMITED
		3	PRECISION ENGG INDUSTRIES
		4	BALDOTA VALVE AND FITTING CO. PVT LTD.
		5	METPRESS ENGINEERING WORKS
		6	MICROPRECISION
58	IMPULSE PIPES	1	BHARAT HEAVY ELECTRICALS LTD.
		2	INDIA SEAMLESS METAL TUBES LTD. (only for CS Pipes)
		3	JINDAL SAW PIPES LTD.
		4	MAHARASHTRA SEAMLESS (only for CS Pipes)
		5	MANNESMANN AG
		6	SUMITOMO CORPORATION
		7	TPS TECHNITUBE ROHREN WERKE GMBH
		8	TROUVAY CAUVIN GULF E.C. DUBAI
		9	BALDOTA VALVE AND FITTING CO. PVT. LTD.

Sl. No.	Item Description	Vendor Name	
		10	BHARAT HEAVY ELECTRICALS LTD.
		11	EXCEL HYDRO – PHEUMATICS PVT. LTD.
		12	INSTRUMENTATION LTD.
		13	METPRESS ENGINEERING WORKS
		14	MAHALAKSHMI SEAMLESS
		15	RATNAMANI METALS & TUBES LTD.
59	INSTRUMENT VALVES / MANIFOLDS	1	BHARAT HEAVY ELECTRICALS LTD.
		2	BALDOTA VALVE AND FITTING CO PVT LTD.
		3	INSTRUMENTATION LIMITED
		4	METPRESS ENGINEERING WORKS
		5	EXCEL HYDRO-PNEUMATICS PVT. LTD.
		6	METPRESS ENGINEERING WORKS
		7	FLOWTECH
60	COMPRESSION FITTINGS	1	PARKER HANNIFIN
		2	PRECISION ENGG INDUSTRIES
		3	TROUVAY & CAUVIN
		4	HOKE (TECHNICAL PARTS CO. MUMBAI)
		5	SWAGELOCK
		6	METPRESS ENGINEERING WORKS
61	SOCKET WELD FITTINGS	1	EXCEL HYDRO-PNEUMATICS PVT. LTD.
		2	METPRESS ENGINEERING WORKS
		3	V.K. INDUSTRIES
		4	VIKAS INDUSTRIAL PRODUCTS
		5	BALDOTA VALVE AND FITTING CO PVT LTD.
		6	FLOWTECH
	FIRE DETECTION AND HYDRANT SYSTEM VENDORS		
1	HYDRANT VALVES	1	SHAH BHOGILAL
		2	SUKAN
		3	NEWAGE
		4	VENUS
		5	WINCO
2	FIRE HOSES	1	NEWAGE
		2	CHATTARIA RUBBER
3	WATER MONITOR & WATER-	1	SHAH BHOGILAL

Sl. No.	Item Description	Vendor Name	
		6	GENT
15	ADDRESSABLE HEAT DETECTORS	1	SIMPLEX
		2	SCHRACK
		3	ESSER HONEYWELL
		4	DETECTOMAT
		5	SECUTRON
		6	GENT
16	INFRA RED DETECTORS	1	PATOL
		2	SYSTEM SENSOR
17	COATING & WRAPPING MATERIAL/ TAPE (COAL TAR BASED)	1	IWL LTD.
		2	RUSTECH
18	INERT GAS SYSTEM	1	GINGEKERR
		2	ANSUL
		3	SRI
		4	SIEMENS
19	BATTERY	1	EXIDE
		2	AMCO
20	FIRE SURVIVAL CABLES	1	POLYCAB
		2	RRKABEL
		3	KEI
		4	DELTON
21	HOSE REEL	1	SIEMENS
		2	WINCO
23	FIRE EXTINGUISHER	1	BIS APPROVED SOURCES WITH VALID LICENSE
24	PROBE TYPE HEAT DETECTOR	1	KIDDE
		2	TYCO
	HVAC SYSTEM VENDORS		
1	AIR WASHER & UAF	1	HYDERABAD POLUTION CONTROL
		2	ADVANCE VENTILATION
		3	DRAFT AIR
		4	BLUE STAR
		5	VOLTAS
		6	STERLING WILSON
		7	ROOTS COOLING SYSTEM
		8	C DOCTOR
2	CENTRIFUGAL FAN	1	FLAKT
		2	KRUGER

Sl. No.	Item Description	Vendor Name	
		3	DRAFT AIR
		4	HYDERABAD POLUTION CONTROL
		5	ADVANCE VENTILATION
		6	PATEL AIR
		7	MARATHON
		8	CB DOCTOR
		9	SARLA
3	FRESH AIR/ SUPPLY/ EXHAUST/ RE UNIT FANS / PROPELLAR	1	HYDERABAD POLUTION CONTROL
		2	ADVANCE VENTILATION
		3	KRUGER
		4	NICOTRA
		5	MARATHON
		6	FLAKT
		7	CB DOCTOR
		8	KHAITAN
4	PUMPS	1	BEST & CROMPTON
		2	JYOTI
		3	SAM TURBO
		4	KBL
		5	KSB
		6	M&P
		7	VOLTAS
		8	WORTHINGTON
		9	FLOWMORE
		10	SULZER PUMPS INDIA LTD.
		11	FLOWSERVE INDIA CONTROL PVT LTD
5	LV MOTORS (NON FLAME PROOF)	1	SIEMENS
		2	ABB
		3	CGL
		4	MARATHON
		5	KEC
		6	BHARAT BIJLEE
		7	NGEF
6	AIR FILTER	1	PUROLATOR
		2	FMI
		3	ANFILCO
		4	JOHN FOWLER
		5	SPECTRUM

Sl. No.	Item Description	Vendor Name	
		6	AIR TECH
		7	PUROMATIC
7	INSULTATION MATERIAL	1	BEARDSHEL
		2	ARMAFLEX
		3	LLOYDS
		4	UP TWIGA
		5	AEROCELL
8	FIRE DAMPER	1	TSC
		2	CARRYAIRE
		3	RAVISTAR (SYSTEM AIR)
9	GRILL/ DIFFUSER/ VOLUME CONTROL DAMPER	1	CARRYAIRE
		2	RAVISTAR (SYSTEM AIR)
10	HUMIDISTAT	1	JHONSON CONTROL
		2	HONEYWELL AUTOMATION
		3	PENN
11	SCREW CHILLER	1	CARRIER
		2	KIRLOSKAR
		3	DUNHAM BUSH
		4	BLUE STAR
		5	VOLTAS
		6	MCQUAY (DAIKIN)
		7	CLIMAVENETA
12	PRECISION AC	1	STULZ
		2	UNIFLAIR
		3	BLUEBOX
		4	EMERSON PROCESS MANAGEMENT
		5	CLIMAVENETA
13	SPLIT AC	1	VOLTAS
		2	BLUE STAR
		3	CARRIER
		4	HITACHI
		5	DAIKIN
		6	LG
14	AIR HANDLING UNITS	1	VOLTAS
		2	BLUE STAR
		3	ZECO
		4	CARRYAIRE (flakt)
		5	EDGETECH

Sl. No.	Item Description	Vendor Name	
		6	ETHOS
		7	SYSTEM AIR
		8	WAVES AIRCON
15	AHU FAN (CENTRIFUGAL FAN)	1	CB DOCTOR
		2	FLAKT
		3	KRUGER
		4	NICOTRA
		5	COMEFRI
		6	MARATHON
		7	ADVANCE
		8	DRAFT AIR
		9	HYDERABAD POLLUTION
16	PUMPS	1	BEST & CROMPTON
		2	JYOTI
		3	SAM TURBO
		4	KBL
		5	KSB
		6	M&P
		7	VOLTAS
		8	BEACON-WEIR
		9	WORTHINGTON
		10	FLOWMORE
		11	SULZER PUMPS INDIA LTD.
		12	FLOWSERVE INDIA CONTROL PVT LTD
		13	V-FLOW PUMPS & SYSTEMS CO
17	COOLING TOWER	1	PAHARPUR COOLING TOWER
		2	FLOWTECH
		3	BELL
18	LV MOTORS (NON FLAME PROOF)	1	SIEMENS
		2	ABB
		3	CGL
		4	MARATHON
		5	KEC
		6	BHARAT BIJLEE
		7	NGEF
		8	JYOTI
19	AIR FILTER	1	PUROLATOR

Sl. No.	Item Description	Vendor Name	
		2	FMI
		3	ANFILCO
		4	TENACITY
		5	JOHN FOWLER
		6	SPECTRUM
		7	AIR TECH
		8	PUROMATIC
20	BALANCING VALVE	1	ADVANCE
21	4 WAY MIXING VALVE WITH ACTUATING MOTOR	1	SIEMENS BUILDING TECHNOLOGY
		2	JOHNSON
		3	BELIMO
		4	HONEYWELL AUTOMATION
		5	RAPID CONTROL
		6	ALC
22	Y / POT STRAINER	1	MULTITEX
		2	GREAVES COTTON
		3	JAYPEE
		4	SANT VALVES
		5	OTOKLIN
		6	GUJARAT OTOFILT
		7	DS ENGG
		8	SAROJINI ENTERPRISE
		9	BHATIA ENGINEERING
		10	FILTERATION ENGINEERS INDIA PVT LTD
23	STRIP HEATER	1	ESCORTS
		2	RACOLDS
		3	ALCO
		4	HEATCO
24	PAN HUMIDIFIER	1	RAPID COOL
		2	HOTSET
		3	ALCO
25	RELIEF / PURGE VALVE	1	BRASSOMATIC
26	THERMOSTATS	1	HONEYWELL AUTOMATION
		2	RANCO
		3	PENN
		4	DANFOSS
		5	RANUTROL
		6	INDFOSS JHONSON CONTROL

Sl. No.	Item Description	Vendor Name	
27	ANTI FREEZE THERMOSTAT	1	RANCO
		2	HONEYWELL AUTOMATION
		3	PENN
		4	DANFOSS
		5	INDFOSS
28	RH SENSOR/TEMP SENSOR	1	HONEYWELL AUTOMATION
		2	JOHNSON
		3	SIEMENS
		4	GENERAL INSTRUMENT CONSORTIUM
29	WATER SOFTENING PLANT	1	THERMAX
		2	ION EXCHANGE

SECTION-VII

ENGINEERING SERVICES

CONTENTS

SECTION-VII

OWNER'S ENGINEERING SERVICES

1.00.00 GENERAL

1.01.00 As part of the overall project management activity, the Successful Bidder shall be responsible for proper Owner's Engineering and co-ordination of activities during various phases of execution of the contract. The Successful Bidder shall identify a person, designated as Project Manager, with whom the Owner, the Consulting Owner's Engineer or the Review Consultant shall interact on matters related to Owner's Engineering as well as execution of the contract. The Project Manager shall be the single-point contact person on behalf of the Successful Bidder and shall be responsible for all Owner's Engineering co-ordination. The Owner /Consultant /Review Consultant shall interact with the Project Manager only on all matters of co-ordination between the Owner and the Successful Bidder or on matters involving the Successful Bidder, his manufacturing units and sub-vendors. For the purpose of expediting the Owner or his representative may sometimes interact with the manufacturing units or sub-vendors of the Successful Bidders. However such interaction will not, under any circumstance, dilute the responsibility of the Successful Bidder to provide a fully Owner's Engineered and coordinated package under this contract.

1.02.00 On finalization of the contract, a procedure for exchange of Owner's Engineering information will be mutually agreed and finalized between the Owner and the Successful Bidder.

2.00.00 DESIGN COORDINATION MEETING

The Successful Bidder and his sub-vendors will be called upon to attend design co-ordination meetings with the Owner's Engineer, other Successful Bidders and the Consultants of the Owner during the period of execution of contract. The Successful Bidder including his sub-vendors shall attend such meetings at their own cost at Owner's or Consultant's office in Kolkata/ or at mutually agreed venue as and when required and fully cooperate with such persons and agencies involved during those discussions.

3.00.00 CO-OPERATION WITH OTHER CONTRACTORS AND CONSULTING OWNER'S ENGINEERS

The Successful Bidder shall agree to cooperate with the Owner's other Contractors and Consulting Owner's Engineers and freely exchange with them such technical information as is necessary to obtain the most efficient and economical design and to avoid unnecessary duplication of efforts. The Owner's Engineer shall be provided with copies of all correspondences addressed by the Successful Bidder to other Sub- Vendors and Consulting Owner's Engineers in respect of such exchange of technical information.

4.00.00 GUIDELINES FOR OWNER'S ENGINEERING SERVICES

4.01.00 Prior to commencement of the Owner's Engineering work as part of design submissions, all aspects of design viz., criteria for selection and sizing of all equipment and systems, design margins etc. including that for structural steel and civil work shall be outlined and these shall form the basis for the detailed Owner's Engineering work.

4.02.00 Owner's Engineering work shall be performed on modern and proven concepts and internationally accepted good Owner's Engineering practices but fully compatible with the Indian environments. Owner shall have the right to review and approve the Owner's Engineering work by themselves and/or through consultant and ask for any clarifications and changes/modifications to the work performed by Successful Bidder.

4.03.00 At any stage during the performance of assignment, the Successful Bidder may be required to make certain changes/modification/improvements in design/ drawing/other documents, which in the opinion of the Owner could result in better improved design, layout, operability, plant availability, maintainability, reliability or economy of the plant and its systems/sub-systems in view of revised and more accurate information/data available at a later date(s) or feedback(s) received during execution/operation of similar units. Such changes/ modifications/improvements required could be identified by Owner and/or consultant and mutually discussed. Owner requires the Bidder to incorporate such action in the subject assignment appropriately without any additional cost liability and time implication to the Owner and same shall be within the responsibilities and Scope of the Successful Bidder.

4.04.00 During the course of review of detailed Owner's Engineering stages, it may be essential in the opinion of Owner to obtain certain classified data for review purposes only. In case Owner so desires, the Bidder shall submit such data to Owner.

4.05.00 During the course of review of detailed Owner's Engineering, it may be essential in Owner's opinion to obtain data and information on similar equipment and plants Owner's Engineered by the Bidder. In case Owner so desires the Bidder shall submit such data and information to the Owner.

4.06.00 It is not the intent to give details of every single task covered in the total Owner's Engineering work to be carried out by Successful Bidder, however, all Owner's Engineering work required for the satisfactory completion of the plant/systems as specified shall be carried out by the Successful Bidder. Broadly, the following are the minimum requirements in respect of scope of major items of work:

4.06.01 Preparation, updating and finalisation of scheme drawings, control and interlock diagrams, detailed and fully dimensioned layout drawings (plant layout and equipment layout detailed plan, elevation and cross-sectional drawings at different elevations/ floor levels) covering all mechanical, electrical, C&I, civil and structural items, equipment, systems and facilities. Drawings and Schedules prepared by the Successful Bidder from time to time, as detailed

designs are developed, shall be submitted for Owner's/ Consultant's approval before the work is taken up. Revisions, corrections, additions to drawings and schedules shall not be considered to change the scope of work.

4.06.02 Preparation of detailed technical specifications including data sheets, tender drawings and bill of material for all bought out items, as also finalisation of corresponding sub-Vendors.

4.06.03 Review of sub-Vendor's data, drawings, design calculations, schedules, bill of materials, instruction manuals etc. for all equipment, before forwarding them to Owner/Consultant for approval.

4.06.04 Preparation of civil construction drawings for all equipment showing foundation details and full details regarding equipment loads, floor openings, details of embedments, etc. required for preparation of civil construction drawings and also as referred at relevant sections of Scope & Exclusions. These documents shall be preceded by appropriate design calculations, static and dynamic analysis as necessary.

4.06.05 Preparation and finalisation of process piping and instrumentation diagrams and schematics, complete in all respects for all systems/packages of the power plant.

4.06.06 Preparation of consolidated schedules and bills of materials, including line numbers, tag numbers, source of supply, service conditions, specifications, materials, types and connections details, quantities for items of the plant including dampers, steam traps, strainers, instrumentations, ducting.

4.06.07 Sizing of all piping and equipment as per the stipulated design criteria; carrying out of flexibility analysis/dynamic analysis as necessary; hangers & support Owner’s Engineering.

4.06.08 Final revision of all documents including preparation and compilation of Instruction Manuals for installation, commissioning, operation and maintenance for all equipment and systems. Refer clause 5.00.00 for the specific requirement in this regard.

4.06.09 Certification and submission of final as-built drawings for all areas.

4.06.10 Preparation and compilation of all drawings, schedules and instructions which may be required at site, whether separately mentioned or not.

4.06.11 All erection and assembly drawings which may be required at site.

5.00.00 **INSTRUCTION MANUALS**

5.01.00 The Bidder shall provide all necessary instruction manuals for the Owner’s review, comment, and final acceptance as required in the contract. The instruction manual shall contain full details required for erection, commissioning, operation and maintenance of each equipment. The instruction manual shall be submitted in the form of one (1) soft copy in CD and 15 hard copies.

5.02.00 **Erection Manuals**

5.05.01 The erection manuals shall be submitted at least three (3) months prior to commencement of erection activities of particular equipment/system. The manuals shall contain the following as a minimum:

a) Erection strategy.

b) Sequence of erection.

c) List of tools, tackles, heavy equipments like cranes, dozers etc required for erection.

d) Bill of Materials.

e) Safety precautions to be followed during erection.

f) Erection instructions.

g) Critical checks and permissible deviation/tolerances.

h) Check-list for pre-commissioning activities

i) Check-list for commissioning of the system.

j) Procedure for initial checking, testing and acceptance norms.

5.03.00 **Operation & Maintenance Manuals**

5.03.01 The operating and maintenance instructions together with drawings of the equipment, as completed, shall be in sufficient detail to enable the Owner to operate, maintain, dismantle, reassemble, and adjust all parts of the equipment. They shall outline a step-by-step procedure for all operations likely to be carries out during the life of the plant/ equipment. Each manual shall include a complete set of drawings together with performance/ rating curves of the equipment and test certificates wherever applicable.

5.03.02 If after commissioning and initial operation of the plant, the manuals require any modification/ additions in the view of the Owner or Bidder, the same shall be incorporated and the updated final manuals shall be submitted to the Owner.

5.03.03 The manuals shall include the following:

a) List of spare parts along with their drawing and catalogue and Pro-forma for ordering spares.

b) Location and identification guide for bearings of various equipments and lubrication schedule including charts showing lubrication checking, testing and replacement procedure.

c) Wherever applicable, fault location charts shall be included to facilitate fault detection.

d) Detailed specification for all consumables (including lubricating oils, greases, chemicals etc.) required for each equipment.

6.00.00 **PLANT HANDBOOK**

The Bidder shall provide the plant handbook to the Owner as per provision of the contract.

The Plant Handbook shall contain the following as a minimum:

a) Design and performance data

b) Process & instrumentation diagrams

c) Single line diagrams

d) Sequence & Protection interlock schemes

e) Alarm and trip values

f) Performance curves

g) General layout plan and layout of Balance of Plant building and auxiliary buildings

h) Important Do's and Don'ts.

7.00.00 **TENDER STAGE DOCUMENT SUBMISSION**

7.01.00 The Bidder shall submit along with his bid all documents/drawings as specified in RFP and respective sections of the Technical Specifications in Vol-II and Vol-III. The documents shall include but not be limited to the following:

a) All Bid proposal sheets duly filled up.

b) Detailed experience list and financial resources of the Prime Bidder his collaborators/associates in this bid as well as the sub-vendors proposed.

c) Scheme drawings indicating scope of supply and service as offered by the Bidder indicating clearly exclusions, if any.

d) List of terminal points of the package offered together with quality and quantity of various input (i.e. water, air, electricity etc.) as required from the Owner at such interfaces.

e) Equipment GA, Layout, Design Calculations, interlock and other write-up, catalogues/literature etc. as required for clear understanding of the bid submitted.

f) High level project schedule network indicating target dates for intermediate milestones and final commissioning of plant systems; This network shall be supplemented by a detailed write-up on proposed sequence and method of execution for project implementation, deployment schedule for Key personnel with their bio-data, schedule of construction machinery etc.

8.00.00 CONTRACT STAGE DOCUMENT SUBMISSION AND APPROVAL PROCEDURE

8.01.00 Owner's Engineering schedule shall be submitted by the Bidder as indicated in the RFP. Owner's Engineering schedule shall be developed in format as desired by the Owner/consultant.

The documents shall be divided into two categories: a) for approval and b) for information/further Owner's Engineering and co-ordination by the Consultant.

In preparing this schedule, the Bidder shall allow one (1) week from date of receipt for review and comments by the Consultant for each submission of a document.

This document submission schedule shall require acceptance by the Owner/Consultant.

Bidder shall also develop and submit a Master drawing list to the Owner/consultant.

8.02.00 All contract documents shall be marked with the name of the Owner, the Project, the specification title and number and the unit designation.

All dimensions shall be in metric units.

All notes, markings etc. shall be in English.

8.03.00 Documents/Drawings, submitted during tender stage, shall be revalidated or revised as required and submitted as certified contract document for approval/information of the Owner/Consultant.

8.04.00 Unless specified otherwise, the following categories of documents/drawings would require approval of the Owner/Consultant:

a) System scheme and Process & instrumentation Diagrams (P & IDs).

b) Design basis documents / memoranda / calculations justifying sizing and selection of equipment, vessels, tanks, piping, valves & specialities as well as the process parameters.

c) Equipment data sheets and general arrangement drawings.

d) Materials of construction.

e) General Arrangement and Layout drawings.

f) Typical control schemes, circuit diagrams, drive/ feeder-wise control scheme showing all external interfaces.

g) Control System Configuration

g) Shop Inspection and Testing Procedures, Test Set-up & Instrumentation, Acceptance Criteria and Codes / Standards followed, correction curves / charts, etc.

h) Performance Test Procedures, Instrumentation, Acceptance Criteria and Codes / Standards followed, correction curves / charts, etc.

i) Schedules covering equipment delivery schedules, erection, testing and commissioning schedules at L1 and L2 levels.

8.05.00 Unless specified otherwise, the following categories of documents / drawings would be treated for information/further Owner's Engineering by the Owner/Consultant. The Bidder shall, however, incorporate all additional information and clarifications in these documents/ drawings as and when desired by the Owner/ Consultant.

a) Equipment foundation drawings.

b) Equipment cross-section drawings, product literature etc. which are of proprietary nature.

c) Predicted performance curves of equipment.

d) Various bills of quantity, schedules etc.

e) Piping fabrication drawings, isometrics etc.

f) Panel wiring diagrams.

g) Instruction/Operation manuals.

h) Service manuals and trouble shooting guide for C & I system including field instruments.

i) Operation logic diagrams.

j) Cable schedule and interconnection chart.

In essence, the Bidder is solely responsible for corrections and adequacy of design & Owner's Engineering for documents under this category.

8.06.00 Upon review, the Consultant shall put his remarks and one of the following action stamps on the drawing / document:

a) Approved.

b) Approved except as noted, forward final drawing

c) Approved except as noted, resubmission required.

d) Disapproved.

e) For information/reference only.

For action stamps in category (c) & (d), documents must be resubmitted for review by the Owner/Consultant. For action stamp in category (b), further review by Owner/Consultant would not be necessary provided the Bidder agrees & incorporates the minor comments made on the document.

Except for action stamp under category (c) & (d), the Bidder can proceed with manufacturing and other sequential activities for those areas of a drawing/document which do not have any review comment by the Owner/ Consultant.

The Consultant may accord approval in category (c) or (d) in more than one submission of a document till he is satisfied that the intent of the specification has been fully complied with. The Bidder shall be responsible for delay in such cases and no extension of time shall ordinarily be allowed on such grounds.

The Bidder's work shall be in strict accordance with the finally approved drawings and no deviation shall be permitted without written approval of the Consultant.

8.07.00 Except key plan/general yard plan, any layout drawing requiring scrutiny shall not be drawn to a scale less than 1:50.

8.08.00 For review by the Consultant, the Bidder shall furnish three (3) prints of each drawing (only for first submission). There upon all transaction of drawings including reviewed comments and stamping shall be done in soft. All transaction of drawings shall be accompanied by a reference letter mentioning the date, revision no. and document status. Only on receiving the Approval Stamping, bidder shall distribute 6 sets of drawings (2 at WBPDCL corporate office and 4 sets at WBPDCL site office).. The Bidder shall furnish three (3) CDs of all as built/final drawings for Owner/Consultant site.

8.09.00 In case of contradiction between the stipulations above and those stated elsewhere in the specification, the stipulations herein shall prevail.

SECTION-VIII

QUALITY ASSURANCE REQUIREMENTS

CONTENT

SECTION-VIII

QUALITY ASSURANCE REQUIREMENTS

1.00.00 QUALITY ASSURANCE PROGRAMME

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

a) His organisation structure for the management and implementation of the proposed quality assurance programme.

b) Documentation control system.

c) Qualification data for Bidder's key personnel.

d) The procedure for purchase of materials, parts, components and selection of Sub-Vendor's services including vendor analysis, source inspection, incoming raw-material inspection, verification of materials purchased etc.

e) System for shop manufacturing and site erection control including process controls and fabrication and assembly controls.

f) Control of non-conforming items and system for corrective actions.

g) Inspection and test procedure both for manufacture and all site related works.

h) Control of calibration and testing of measuring and testing equipments.

i) System for quality audit.

j) System for indication and appraisal of inspection status.

k) System for authorising release of manufactured product to the Owner.

l) System for handling storage and delivery.

m) System for maintenance of records.

n) Furnishing of quality plans for manufacturing and field activities detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of equipment/component as per format enclosed at Annexure-A to this section.

2.00.00 **GENERAL REQUIREMENTS - QUALITY ASSURANCE**

2.01.00 All materials, components and equipment covered under this specification shall be procured, manufactured and tested at all the stages, as well as Services provided for erection, commissioning and testing shall be as per a comprehensive Quality Assurance Programme. An indicative programme of inspection/tests to be carried out by the Bidder for some of the major items is given in the respective technical specification. This is however, not intended to form a comprehensive programme as it is the Bidder's responsibility to draw up and implement such programme and reviewed by by the Owner/Consultant. The detailed Quality Plans for manufacturing and field activities should be drawn up by the Bidder, separately in the format attached at Annexure-I and will be submitted to Owner/Owner's representative for review. Schedule of finalisation of such quality plans will be finalised before award.

2.02.00 Manufacturing Quality Plan will detail out for all the components and equipment, various tests/inspection, to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by Bidder's Quality Control organisation, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing.

2.03.00 Field Quality Plans will detail out for all the equipment, the quality practices and procedures etc. to be followed by the Bidder's site Quality Control organisation, during various stages of site activities from receipt of materials/equipment at site.

2.04.00 The Bidder shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans along with Quality Plans. These Quality plans and reference documents/standards etc. will be subject to Consultant's approval without which manufacture shall not proceed. In these approved quality plans, Owner/Authorised representative/Consultant shall identify Customer Hold Points (CHP), test/checks which shall be carried out in presence of the Owner/Consultant/Owners Owner's Engineer or his Authorised Representative and beyond which the work will not proceed without consent of Owner/Authorised representative/Consultant in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to Owner/Authorised Representative/Consultant for acceptance and dispositioning.

2.05.00 The Bidder shall provide adequate notice to the Owner for inspection before the material is dispatched as per the provisions of the Contract. No material shall be despatched from the manufacturer's works before the same is accepted subsequent to pre-despatch final inspection including verification of records of

all previous tests/inspections by Owner's Owner's Engineer/Authorised representative, and duly authorised for despatch issuance of Material Despatch Clearance Certificate (MDCC).

2.06.00 All materials used or supplied shall be accompanied by valid and approved materials certificates and tests and inspection report. These certificates and reports shall indicate the sheet numbers or other such acceptable identification numbers of the material. The material certified shall also have the identification details stamped on it.

2.07.00 All the individual and assembled rotating parts shall be statically and dynamically balanced in the works.

Where accurate alignment is necessary for component parts of machinery normally assembled on site, the Bidder shall allow for trial assembly prior to despatch from place of manufacture.

2.08.00 Castings and forgings used for construction shall be of tested quality. Details of results of chemical analysis, heat treatment record, mechanical property test results shall be furnished.

2.09.00 All welding and brazing shall be carried out as per procedure drawn and qualified in accordance with requirements of ASME Section-IX/BS-4870 or other International equivalent standard acceptable to the Owner.

All brazers, welders etc. employed on any part of the contract at Bidder's/Sub-Vendor's works or at site shall be qualified as per ASME Section-IX or BS-4871 or equivalent international standard approved by the Owner. Such qualification tests shall be conducted in presence of Owner/his authorised representative.

For welding of pressure parts and high pressure piping the requirements of IBR shall also be complied with.

Under no circumstances any repair or welding of castings be carried out without the consent of the Owner. Proof of the effectiveness of each repair by radiographic and/or other non-destructive testing technique, shall be provided to the Owner.

All pressure parts shall be subjected to hydraulic testing as per the requirements of IBR. Other parts shall be tested for one and half times the maximum operating pressure, for a period not less than thirty (30) minutes.

2.10.00 All non-destructive examination (NDT) shall be carried out in accordance with approved international standard. The NDT operator shall be qualified as per SNT-TC-IA (of American Society of non- destructive examination). Results of NDT shall be properly recorded and submitted for acceptance.

All welding procedures adopted for performing welding work shall be qualified in accordance with the requirements of Section-IX of ASME code or IBR as applicable. All welded joints for pressure parts shall be tested by liquid

penetrant examination according to the method outlined in ASME Boiler and Pressure Vessel code. Radiography, magnetic particle examination and ultrasonic testing shall be employed wherever necessary/ recommended by the applicable code. At least 10% of all major butt welding joints shall be radiographed. Statutory payments in respect of IBR approvals including inspection shall be made by Bidder. Bidder's scope and responsibility shall also include preparation and submission of all necessary documents in the specific formats and manner stipulated by the statutory bodies, coordination and follow up for above approvals.

2.11.00 All the Sub-Vendors proposed by the Bidder for procurement of major bought out items including castings, forgings, semi-finished and finished components/equipment list of which shall be drawn up by the Bidder and finalised with the Owner shall be subject to Owner's review. Quality Plans of the successful Sub-Vendors shall be discussed, finalised and accepted by the Owner/Authorised representative and form part of the Purchase Order between the Bidder and the Sub-Vendor.

2.12.00 All the purchase specifications for the major bought-out items, list of which shall be drawn up by the Bidder and finalised with the Owner shall be furnished to the Owner for comments and subsequent acceptance before orders are placed.

Owner reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the Bidder's or their Sub-Vendor's quality management and control activities. The Bidder shall provide all necessary assistance to enable the Owner carry out such audit and surveillance.

Quality audit/acceptance of the results of tests and inspection will not prejudice the right of the Owner to reject equipment not giving the desired performance after erection and shall not in no way limit the liabilities and responsibilities of the Bidder in earning satisfactory performance of equipment as per specification.

2.13.00 Quality requirements for main equipment shall equally apply for spares and replacement items.

2.14.00 Repair/rectification procedures to be adopted to make any job acceptable shall be subject to the acceptance of the Owner.

2.15.00 For quality assurance of all civil works refer to the specifications for civil works.

3.00.00 QUALITY ASSURANCE DOCUMENTS

3.01.00 The Bidder shall be required to submit two (2) copies and two (2) sets of microfilms of the following Quality Assurance documents within three (3) weeks after despatch of the equipment:

a) Material mill test reports on components as specified by the specification.

b) The inspection plan with verification, inspection plan check points, verification sketches, if used and methods used to verify that the inspection and testing points in the inspection plan were performed satisfactorily.

c) Non-destructive examination results /reports including radiography interpretation reports.

d) Factory tests results for testing required as per applicable codes and standards referred in the specification.

e) Welder identification list listing welder's and welding operator's qualification procedure and welding identification symbols.

f) Sketches and drawings used for indicating the method of traceability of the radiographs to the location on the equipment.

g) Stress relief time temperature charts.

h) Inspection reports duly signed by QA personnel of the Owner and Bidder for the agreed inspection hold points. During the course of inspection, the following will also be recorded :

i) When some important repair work is involved to make the job acceptable.

ii) The repair work remains part of the accepted product quality.

i) Letter of conformity certifying that the requirement is in compliance with finalised specification requirements.

4.00.00 **INSPECTION, TESTING AND INSPECTION CERTIFICATES**

4.01.00 The Successful Bidder shall give the Owner’s Engineer/Inspector fifteen (15) days written notice of any material being ready for testing. Such tests shall be to the Successful Bidder's account except for the expenses of the Inspector. The Owner’s Engineer/Inspector, unless the witnessing of the tests is virtually waived, will attend such tests within fifteen (15) days of the date on which the equipment is notified as being ready for test/inspection failing which the Successful Bidder may proceed with test which shall be deemed to have been made in the Inspector's presence and he shall forthwith forward to the Inspector duly certified copies of test reports in six (6) copies.

4.02.00 The Owner’s Engineer or Inspector shall within fifteen (15) days from the date of Inspection as defined herein give notice in writing to the Successful Bidder, or any objection to any drawings and all or any equipment and workmanship which is in his opinion not in accordance with the contract. The Successful Bidder shall give due consideration to such objections and shall either make modifications that may be necessary to meet the said objections or shall confirm in writing to the Owner’s Engineer/Inspector giving reasons therein, that no modifications are necessary to comply with the contract.

4.03.00 When the factory tests have been completed at the Bidder's or sub-Vendor's works, the Owner/Inspector shall issue a certificate to this effect fifteen (15) days after completion of tests but if the tests are not witnessed by the Owner/ Inspectors, the certificate shall be issued within fifteen (15) days of the receipt of the Bidder's test certificate by the Owner/Inspector. Failure of the Owner/Inspector to issue such a certificate shall not prevent the Bidder from proceeding with the works. The completion of these tests, or the issue of the certificates shall not bind the Owner to accept the equipment should it, on further tests after erection be found not to comply with the contract.

4.04.00 The Bidder shall furnish quarterly inspection programme indicating schedule dates of inspection at customer hold point and final inspection stages. Updated quarterly inspection plans will be made for each three consecutive months and shall be furnished before beginning of each calendar month.

FORMAT OF QUALITY ASSURANCE PROGRAMME

Name of Company / Successful Bidder	NAME OF CONTRACT PACKAGE			QUALITY PLAN FOR						
	Package No. : _____ Contractorr : _____			QP No. : _____ Date _____ Rev.No.: _____ Date _____						
Sl. No.	Component & Operation	Characteristics	Class	Type of Check	Quantum of Check	Reference Document	Acceptance Norm	Format of Record	Agency	Remarks

FIELD WELDING SCHEDULE

PROJECT : FWS NO :

CONTRACTOR : REV NO. :

PACKAGE : FIELD WELDING CODE :

SYSTEM : PAGE NO. :

Sl No.	Drawing No. for Weld Locations & Identification mark	Description of parts to be welded	Material specification	Dimensions	Process of Welding	Type of Weld	Electrode Filler Specification	WPS No.	Minimum Pre-heat Temperature	Heat Treatment Temperature [Holding Time in secs]	NDT Method Quantum	NDT Specifi-cation Number	Accep-tance Norm Ref.	Remarks

The Field Welding Schedule should be submitted for :

- o Pressure Parts
- o Tanks/Vessels
- o Piping
- o Heavy/Important Structural Steel
- o Heat Exchangers
- o Bus Ducts

SECTION-IX

PERFORMANCE GUARANTEES AND TESTS

CONTENT

SECTION-IX

PERFORMANCE GUARANTEES AND TESTS

1.00.00 PERFORMANCE GUARANTEES, PERFORMANCE/ACCEPTANCE TESTS & LIQUIDATED DAMAGES FOR SHORTFALL IN PERFORMANCE

1.01.00 The Bidder shall guarantee that the equipment offered shall meet the ratings and performance requirements stipulated for various equipment covered in this specification. The guarantees are categorised as:

a) Those, which attract liquidated damages, as listed below (Category-"A"). The Bidder shall furnish signed declarations in the manner prescribed in the bid proposal schedules for these guarantees.

b) Those, which do not attract liquidated damages, as listed below (Category-"B"). This guarantee list indicated in this section is not exhaustive and the Owner reserves the right to call upon the Bidder to demonstrate any parameter, operation, etc. of any equipment as specified and as required to meet the duty conditions.

1.02.00 The Bidder shall demonstrate all the guarantees as specified in this section. In case during tests it is found that the equipment/system has failed to meet the guarantees, the Contractor shall carry out all necessary modifications to make the equipment/systems comply with guaranteed requirements. However, if the Contractor is not able to demonstrate the guarantees, even after the modifications within ninety (90) days of notification by the Owner, the Owner will at his discretion:

i) reject the equipment and recover the payment already made or engage other agencies for making good all the deficiencies, the cost to be borne & recovered from the contractor or accept the equipment only after levying liquidated damages upto a ceiling 10% of contract price as identified in this section for those guarantees which are covered under category "A".

ii) reject the equipment and recover the payment already made or engage other agencies for making good all the deficiencies, the cost to be borne & recovered from the contractor or accept the equipment only after assessing and deducting from the contract price an amount equivalent to the deficiency of the equipment/system as assessed by the Owner, for those guarantees which are covered under Category-B.

For equipment/systems not covered under this section Bidder shall demonstrate the functionality and the rated performance for such equipment/systems before handover to the owner.

1.03.00 All guaranteed parameters shall necessarily be quoted by the Bidder based on the established proven results obtained from similar units in successful operation. Evidence for this shall necessarily include the test codes used, acceptance test results, and accuracies of various instruments used for the

performance test, details of tolerances, if allowed, etc. While quoting the guaranteed parameters, the Bidder shall keep in view the requirements specified in the specification especially regarding the reliability, operability and maintainability of the equipment proposed. The Owner reserves the right to evaluate the parameters quoted by the Bidder based on his experience and published material available.

1.04.00 The liquidated damages shall be calculated prorata for the fractional parts of the unit unless stated otherwise.

1.05.00 The turbine generator, boiler, auxiliaries, and all other plant equipment and system shall perform continuously without the noise level (individual or collectively) exceeding the values specified in respective equipment specification over the entire range of output and operating frequencies.

1.06.00 **Performance/Acceptance Tests**

1.06.01 The performance/acceptance tests for various equipment and systems shall be carried out as specified under the respective equipment specifications and those specified below shall be specifically applicable. All the guarantees shall be tested together as far as practicable.

1.06.02 In case of systems with stand-by equipment the liquidated damages for non-performance will be levied for normal operating number of equipment only. However, for this purpose all the equipment including standby equipment shall be tested and average values arrived at.

1.06.03 For instrument in-accuracies during PG Test, refer subsequent clauses of this section.

1.06.04 For Total Auxiliary Power Consumption of BTG island, Off site BOP facilities and the transformers listed under the respective clauses, shall be taken together for purposes of guarantee and not individually.

2.00.00 **START-UP, INITIAL OPERATION, TRIAL OPERATION AND PERFORMANCE TESTS**

2.01.00 The Contractor shall provide commissioning & start-up supervisory engineering staff specially identified for the period commencing with start-up and extending through initial & trial operation and all performance tests. During this period, the Contractor shall furnish the calibration devices, special test instruments, etc. required to prepare for and conduct the performance tests. The Owner will associate his operating personnel and necessary supporting staff and shall make available fuel, and the system electrical load. Contractor's commissioning, & start-up supervisory engineering personnel shall conduct training for the Owner's personnel prior to and during this period and shall train them so that they will be able to operate and maintain the new equipment satisfactorily after acceptance by the Owner.

2.02.00 The Owner proposes to carry out in association with the Contractor, the following field inspections and tests in the sequence detailed below, and the

successful performance and completion of all the tests taken together shall constitute the Owner acceptance tests. The Contractor shall provide supervisory services during field inspection and tests.

2.02.01 **Inspection and Checking of the Unit**

After completion of erection and/or installation, and before being put into operation, the unit and all its appurtenances shall be thoroughly cleaned and then inspected, for correctness and completeness of installation and acceptability for placing in operation. All piping system shall be flushed, chemically cleaned; steam blown, air blown as required and cleanliness demonstrated using acceptable industry standards. Procedures to accomplish this work shall be subject to Owner's approval.

The checkouts during the pre-commissioning period should be programmed to follow the construction completion schedule. Each system, as it is completed by construction and turned over to the commissioning (start-up) engineer(s), should be checked out and cleaned. The checking and inspection of individual systems should then follow a prescribed schedule. Also refer specification clause on commissioning management specified elsewhere.

On completion of inspection, checking and after the pre-commissioning tests are satisfactorily over, the complete equipment shall be placed on Initial Operation during which period the complete equipment shall be operated integral with sub-systems and supporting equipment as a complete plant.

When the equipment is operating properly, its characteristics shall be recorded on the start-up report sheets. Copies of typical start-up report shall be given to the Owner. Start-up reports for all equipment shall be completed before the start of the trial operation period.

2.02.02 **Initial Operation, Reliability Run/Trial Run**

The plant shall be on Trial Operation during which period all necessary adjustments shall be made while operating over the full load range enabling the plant to be made ready for performance and guarantee tests.

The duration of Trial Operation of the complete equipment, systems, sub-systems and their control system shall be in Automatic mode for fourteen (14) days out of which at least seventy two (72) hours shall be in continuous operation on full load or any other duration as may be agreed to between the Engineer, and the Contractor. The Trial Operation shall be considered successful, provided such item of the equipment can be operated, continuously at the specified operating characteristics for the period of Trial Operation.

For the period of Trial Operation, the time of operation with any load shall be counted; minor interruptions not exceeding four (4) hours at a time caused during the continuous operation shall not affect the total duration of trial operation. However, if in the opinion of the Owner, the interruption is long, the Trial Operation shall be prolonged for the period equivalent to the duration of interruption.

A trial Operation report comprising observations and recordings of various parameters to be measured, in respect of the above Trial Operation shall be prepared by the Contractor. This report besides recording the details of the various observations during trial run shall also include the dates of start and finish of the Trial Operation and shall be signed by the representatives of both the parties. The report shall have sheets, recording and print out of all the details of interruption occurred, adjustments made, any minor repairs done during the Trial Operation. Based on the observations, necessary modifications/ repairs to the plant shall be carried out to the full satisfaction of the Engineer to enable the later to accord permission to carry out Performance and Guarantee Tests on the plant. However, it is the prerogative of the Owner to grant permission for aforesaid test with minor defects, which do not endanger the safe operation of the equipments. .

Should any major failure or interruption occur in any portion of the plant due to or arising from faulty design, materials, workmanship or omissions or incorrect erection, sufficient to prevent safe and full commercial use of the plant, the reliability run shall be considered void and the reliability test period of 14 days shall recommence after the Contractor has remedied the cause of defect to the satisfaction of the owner

2.02.03 **Performance and Guarantee Test**

a) The final tests as to the performance and guarantees shall be conducted at site, by the Contractor with full involvement of the Owner. The necessary operating inputs shall be provided by the Owner. The Contractor's engineering staff for commissioning and start-up shall ensure that the equipment are ready for such tests. The Owner shall associate his necessary supporting staff with the Contractor to carry out the various activities related to P-G tests.

The necessary labour/supporting staff etc. shall be provided by the Contractor. Such tests will be conducted within a period of three (3) months after the successful completion of Trial Operation. Any extension of time beyond the above three (3) months shall be mutually agreed upon.

b) These tests shall be binding on both the parties of the Contract to determine compliance of the equipment with the performance guarantees.

The Contractor shall submit the test procedure for Owner's approval within thirty six (36) months from the date of letter of award of the contract. The test shall be carried out by the test grade instruments as stipulated in the applicable test code. These instruments shall be calibrated by the Contractor in a laboratory duly approved by Owner. Batch calibration will not be acceptable. The available instrumentation and control equipment in the plant if found suitable could also be used with the prior approval of the Owner after calibrations in the plant/outside laboratory. The tests will be conducted at the specified load points, and as near the specified cycle conditions as practicable. Proper corrections in calculations to take into account the conditions

which do not correspond to the specified conditions will be applied in the test report as brought out under the respective sections of the specification.

c) All special test grade instruments, equipment, tools and tackles, required for the successful completion of the Performance and Guarantee Tests shall be brought for the purpose of test, free of cost by the Contractor.

d) The guaranteed performance figures of the equipment shall be proved by the Contractor during these Performance and Guarantee Tests. The Contractor shall submit a detailed test report in the manner, already agreed to within one (1) month time of completion of the test, for Owner's approval. Should the Owner's assessment of these tests show any deterioration from the guaranteed values the Contractor/Owner shall modify the equipment as required to enable it to meet the guarantees to the satisfaction of the Owner. In such case, the Performance and Guarantee Tests shall be repeated within one (1) month, from the date the equipment is ready for retest and all costs for modifications including labour, materials and the cost of additional testing to prove that the equipment meets the guarantees, shall be borne by the Contractor.

e) The specific tests to be conducted on equipment have been brought out in the technical specifications. The procedure to be submitted by the Contractor should include the detailed methodology to conduct these tests/verify the guarantees offered by the Contractor notwithstanding whether these attract liquidated damages or not.

f) Instrument accuracies shall be in accordance with the relevant test codes. All instrument in-accuracies if applicable shall be computed as per the code and values will be corrected to the advantage of the Owner. No negative tolerance will be allowed. For example, if the inaccuracy of instrumentation has been worked out to be 1%, the measured values will be assessed to be 1% inferior for purpose of LD.

g) The Bidder shall establish the following modes of operation to the satisfaction of the Owner before acceptance test :

   i) Operation of each system by remote manual control.

   ii) Operation of the entire system in integrated manner on auto control.

   iii) Operation of the entire plant with auto-control loops fully implemented including different modes of load control with the help of control system.

h) Ten (10) copies of the test reports are to be furnished by the Contractor to the Owner backed up with jointly signed data sheets.

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3.00.00 **SCHEDULE OF GUARANTEES WHICH ATTRACT LIQUIDATED DAMAGES [CATEGORY-A]**

Sl. No.	Package System	Parameter for Performance Guarantee	Liquidated Damages	Acceptable Shortfall Limit with LD
3.01.00	**Steam Generator**			
3.01.01	Capacity	Capacity in T/HR of steam at 100% TMCR (660MW) Unit Load with rated steam parameters at super heater outlet with combination of mills working as per Owner's choice and the coal being fired within range specified.	Rs. 32,580,000/- or equivalent foreign currency for every 1T/hr. deficiency in Steam Generator capacity	(-) 1% of the Guaranteed Steam Generator capacity.
3.01.02	Efficiency	Efficiency in percentage corresponding to : i) 100% turbine load under rated steam parameters at Super- heater & reheater outlet, under Condenser Vacuum at 33 Deg.C CW temperature and zero percent make up with combination of mills working as per Owner's choice. ii) 80% turbine loads (with MS & RH Control Valve wide open condition) under corresponding sliding steam pressure with rated steam temperature (s) at Super- heater & reheater outlet, under corresponding Condenser Vacuum at 33 Deg.C CW temperature and zero percent make up with combination of mills working as per Owner's choice.	Rs. 206,980,000 /- or equivalent foreign currency for every 0.1% decrease in weighted average Steam Generator efficiency -	(-) 1% of the Guaranteed Steam Generator efficiency

Sl. No.	Package System	Parameter for Performance Guarantee	Liquidated Damages	Acceptable Shortfall Limit with LD
3.02.00	**Turbine Generator**			
3.02.01	Heat Rate	Heat rate in kCal/ kWh corresponding to : i) 100% turbine load under rated steam parameters, under Condenser Vacuum at 33 Deg.C CW temperature and zero percent make up ii) 80% turbine loads (with MS & RH Control Valve wide open condition) under corresponding steam parameters, under corresponding Condenser Vacuum at 33 Deg.C CW temperature and zero percent make up	Rs. 110,520,000/- or equivalent foreign currency for every kCal/ kWh increase in weighted average Turbine heat rate over guaranteed value.	(+) 2.5% of the Guaranteed Turbine heat rate.
3.02.00	Output	Output (100 % TMCR) in kW under rated steam conditions and Condenser Vacuum with CW temp. of 33ºC and zero percent make up and all heaters in service.	Rs. 270,000/- or equivalent foreign currency for every one (1) kW shortfall in output from guaranteed value.	(-) 2.0% of the Turbine generator output.
3.03.00	Total Auxiliary Power Consumption	Total Auxiliary power consumption (in kW) of the unit under rated steam conditions and Condenser Vacuum with CW temp. of 33ºC and zero percent make up at 100% Turbine load.	Rs. 462,000/- or equivalent foreign currency for every one (1) kW excess auxiliary power consumption over guaranteed value.	(+) 1% of the Guaranteed Auxiliary Power Consumption.
3.04.00	Coal Pulveriser wear parts warranty	Guaranteed wear life of all wear parts of the mill when grinding the specified range of coals.	To be calculated as per clause 6.02.04 of this section	(-) 500 hours

3.05.00 **Flue Gas Desulphurization Plant**

(i) SO_2 removal Efficiency at 100% TMCR unit load, worst Coal Firing

The Bidder shall guarantee that SO_2 removal efficiency shall not be less than 95.0% at 100% TMCR unit load, worst Coal Firing. In the Bid guarantee sheet specific reference to the concentration of SO_2 (mg/Nm^3) at 6% O_2 on dry basis (less than 100 mg/Nm^3) in the flue gas exit from FGD plant shall also be mentioned.

(ii) Limestone consumption of FGD system

Limestone consumption of FGD system in kg/hr at 100% TMCR unit load with worst coal firing and SO_2 removal efficiency of not less than 95.0%.

AMOUNT OF LIQUIDATED DAMAGES (LD) APPLICABLE

Sl. No.	GAURANTEE	RATEOF LIQUIDATED DAMAGES (LD)	ACCEPTABLE SHORTFALL LIMIT WITH LD
(i)	For shortfall in guaranteed SO_2 removal efficiency in percentage points under conditions stipulated in clause 3.05.00 above.	Rs 675,000/- (Rupees Six hundred Seventy Five Thousand only) or equivalent foreign currency for every 0.01% point shortfall in SO_2 removal efficiency from the guaranteed value	(-) 1% point from the guaranteed SO_2 removal efficiency.
(ii)	For increase in the limestone consumption of FGD system in T/hr under conditions stipulated in clause 3.05.00 above.	Rs 2,500,000/- (Rupees Two Million Five Hundred Thousand only) or equivalent currency for every 100 kg/hr increase in Lime stone consumption from guaranteed value.	(+) 10% of the guaranteed limestone consumption.

3.06.00 **Auxiliary Power Consumption**

The auxiliary power consumption shall be calculated using the following relationship:

Pa = Pu + TL
Pu = SUM (Pi x Di)

Pa = Guaranteed Auxiliary Power Consumption.
Pu = Power consumed by the auxiliaries of the unit under test.
TL = Losses of the transformers supplied by bidder based on works test reports.
Pi = Power consumed by each auxiliary
Di = Duty factor to be considered
(Where duty factor is not indicated, same to be considered as 1.0)

While guaranteeing the auxiliary power consumption the bidder shall necessarily include all continuously operating unit and Station auxiliaries.

Measurement Points:

Total power consumption (Pu) required for continuous unit operation corresponding to turbine heat rate guarantee points at 100% and 80% TMCR load shall be measured during PG test as sum of the power measurement at the following terminals-

1) 11KV/3.3KV Switchgear terminals for all 11KV/3.3KV motors

2) Switchgear Incomers/Switch Gear end terminals for LT Loads.

3) Switchgear Terminals of any other load connected to owner existing switchgear.

Further the power consumption for the equipment being fed from switchgear but not to be considered for guaranteed power consumption shall be measured separately at their respective MCC/LT & HT switchgear input terminals and shall be subtracted from the total power consumption measured. However if conditions permit, such equipment may not be operated during power measurement duration.

The auxiliaries to be considered shall include but not be limited to the following:

LIST OF AUXILIARIES	
A) UNIT AUXILIARIES	
STEAM GENERATOR & AUXILIARIES	
1.	ESP(with all fields of all ESP passes working and rapping system in normal operation (as measured at the input terminals of TR set)
2.	Pulverisers
3.	PA Fans
4.	FD Fans
5.	ID Fans
6.	Air Heaters drives
7.	Coal Feeders.
8.	Compressor of Mill Reject System (duty factor 1.0)
9.	Fuel Oil pressurising pump.
10.	Lube Oil pumps for fans, Air, heaters, Mills.
11.	Seal Air Fans.
12.	Scanner Air fans.
13.	DM Cooling Water pumps for SG Auxiliaries.
14.	Power consumption of one Instrument air compressor and its air drying plant,

	one service air compressor and its air drying plant.(Duty factor for IA compressor shall be 0.67 and that of SA compressor shall be 0.33, duty factor of ADP shall be 0.5)
15.	Steam Generator Startup Water Recirculation Pump (if in operation)
16.	Electricheaters for fans, Air heaters, Mills Lub Oil systems.
17.	Chemical Feed pumps (if any)
18.	Blowers/seal air fans for Guillotine gates/dampers
19.	Power consumption for electric Heat tracing of HFO line.
20.	Continuous running auxiliaries of selective Catalyst Reduction System.
21.	Power consumption of any other operating auxiliaries for unit operation at different guarantee point loads.
TURBINE & GENERATOR AUXILIARIES	
1.	Turbine Unit Oil purifiers.
2.	Turbine Unit control Oil purifiers.
3.	Electric oil heater for turbine Lube Oil system.
4.	Feed and discharge pumps of turbine oil purification system.
5.	Circulating Water (CW) Pumps.
6.	Auxiliary Cooling water (ACW) Pumps.
7.	Condensate Extraction Pumps.
8.	Main Turbine condenser air evacuation pumps.
9.	Main Turbine Condenser tube cleaning system pumps.
10.	DM Cooling Water pumps for TG Auxiliaries.
11.	BFP drive turbine condenser air evacuation pumps (if envisaged).
12.	BFP drive turbine condenser tube cleaning system pumps (if envisaged).
13.	Drip Pump (if envisaged).
14.	BFP drive turbine Condensate Extraction Pumps (if envisaged).
15.	Oil purifiers of 2x50% TDBFPs and their feed and discharge pumps.
16.	Lube oil pumps of 2x50% TDBFPs and the electrical oil heater for lube oil.
17.	Auxiliary oil Pump for MDBFP.
18.	Oil pumps for HP-LP bypass system.
19.	BFP Booster Pumps (if separately driven)
20.	Heater, Circulation pumps, Control fluid pump for control fluid system
21.	DMSW Pumps.
22.	Motor Driven Boiler Feed Pump (For this purpose only 15% of the deemed power consumed by the MDBFP at 100% TMCR unit load shall be considered. .
23.	Ammonia Dosing Pump
24.	Hydrazine Dosing Pump
25.	Power consumption of any other operating auxiliaries for unit operation at different guarantee point loads.
FGD System Auxiliaries-	
1.	Booster Fans- if provided separately (duty factor 1.0)
2.	Lub oil pumps and heaters for separate Booster Fans(duty factor 1.0)
3.	Absorber Recirculation Pumps(duty factor 1.0).
4.	Gypsum Bleed pumps(duty factor 1.0).
5.	Oxidation Air compressors(duty factor 1.0).
6.	Agitators (duty factor 1.0).
7.	Flue gas cooling pump (if any) (duty factor 1.0)
8.	Process Water Pumps, Mist eliminator wash pumps(duty factor 0.5)
9.	Scavanging Air Fans (duty factor 1.0)
10.	Absorber Drain Pit Pumps (duty factor 0.5)
11.	Seal Air Fans for duct dampers (duty factor 1.0).

12.	Power consumption of any other operating auxiliaries for unitoperation at different guarantee point loads.
AHP System Auxiliaries	
1.	Clinker Grinder(duty factor 0.5)
2.	BA Overflow Pump(duty factor 1.0)
3.	Ash slurry Pump (duty factor 0.5)
4.	HP Water Pump (duty factor 0.5)
5.	LP water pump (duty factor 1.0)
6.	Instrument Air Compressor and its air dryer (duty factor 1.0)
7.	Seal Water Pump (duty factor 1.0)
8.	Transport Air Compressors (duty factor 1.0)
9.	Recycle Water Pumps (duty factor 1.0)
10.	Ash conditioning water Pumps (duty factor 0.5)
11.	Vacuum Pumps (duty factor 1.0)
12.	ESP Fluidising Blowers and heaters (duty factor 1.0)
13.	SILO equipments like aeration Blower & heater, Vent Fan (duty factor 1.0)
14.	ECO Water Pumps (duty factor 1.0)
15.	Power consumption of any other operating auxiliaries for unitoperation at different guarantee point loads.
Auxiliaries of CHP	
1.	Power consumption figure provided by the bidder as per the following path, which shall be considered to arrive at guaranteed Power (GP) for Performance Guarantee purpose. The guaranteed power for Performance Guarantee purpose will be calculated by the following formula:- GP=1 x GP of Flow Path Flow Path: From wagon tippler to boiler bunker of Unit #5 through both conveyor no. BCN #27A and BCN #27B (longest path) running simultaneously (**Duty factor for CHP shall be 1.0**) The following facilities (auxiliaries) need not be considered for Auxiliary Power Consumption of CHP. • Coal Sampling unit, • Dust suppression & Dust extraction • Ventilation System, • Service Water System • Potable water system, • Service air system
Other Auxiliaries	
1.	Air Conditioning Plant Load for TG bdg., ESP control bdg., FGD control room and all other areas covered with Air Conditioning Plant. Non-plant buildings and areas covered with Split type air-conditioners (stand alone) need not be considered. Bidder shall consider Power consumption at motor input terminals of working units (i.e. excluding stand-by) at its rated duty point of Chilling machines, Chilled water Pumps, Condenser water Pumps, Air handling unit (AHU) fans, for the Air conditioning system of TG building, FGD control room, ESP control room.
2.	Ventilation System Loads for whole plant (except non-plant bdgs)

	Bidder shall consider Power consumption at motor input terminals for fans of Air washer units for TG building and fans of air filtration units for ESP and FGD buildings, and AHP switchgear at its rated duty point.
3.	Continuously running miscellaneous pumps like RO Feed Pump, RO clarifier, DMF feed pump, air blowers for DMF and UF, UF backwash pumps, RO High Pressure Pumps for Zero discharge system, hydrant pumps at its rated duty point. Intermediate operating pumps like waste water transfer pumps, Jockey pumps for firefighting system need not be considered.
4.	CW treatment and Chlorination Plant
5.	Illumination system Loads (Duty factor 1.0 for Indoor and 0.6 for outdoor area).
6.	Power consumption of UPS, DC system.
7.	Power consumption of any other operating auxiliaries during unit operation at different guarantee point loads.
Total Losses (No Load, Load Loss, Auxiliary Loss) of the Transformers	
1.	Generator Transformers (Three single phase + one spare single phase transformer)
2.	Station Transformers (One three winding transformer)
3.	Unit transformers (Two numbers)
4.	Unit Aux. Transformers (Two numbers)
5.	Stn. Aux Transformers (Two numbers)

Note :

1) The load of the followings items shall not be considered during measurement of Total Aux. power consumption for guarantee-
   a) Hoists and EOT cranes.
   b) Welding receptacles.
   c) Elevator.
   d) Sump pumps.

2) Number of coal mill and coal feeders shall be considered corresponding to the design coal, as applicable.

3) No Load Losses and, Aux. Losses of the transformers supplied by the bidder would be based on the works test report. For Load losses, bidder shall consider loading of transformer (100% TMCR guarantee condition) as per bidder's offered design/system corroborating the Works test report at the corresponding Transformer loading.

4) For items 3.01.02 & 3.02.01 the weightage factor shall be considered as 5 and 4 for 100% and 80% turbine rated loads respectively.

SECTION-X

REQUIREMENTS OF SPARES, TOOLS & TACKLES

CONTENTS

SECTION-X

REQUIREMENTS OF SPARES, TOOLS & TACKLE

1.00.00 **TOOLS & TACKLE**

The Bidder shall supply with the equipment one complete set of special tools and tackles required for the erection, assembly, dis-assembly & proper maintenance of the plant and equipments and systems (including software). These special tools shall also include special material handing equipment, jigs & fixtures for maintenance and calibration/ re-adjustment, checking & measurement aids etc. A list of such tools & tackles shall be submitted by the Bidder along with the offer. Detailed description of each tool/tackles, its function along with the equipment/part for which it is meant for, shall also be indicated in the offer. These tools & tackles shall be separately packed and sent to site before the first unit commissioning. The Bidder shall also ensure that these tools are not used for erection, commissioning and initial operation. For this period, the Bidder shall bring his own tools and tackles. All the tools and tackles shall be of reputed make acceptable to Owner.

2.00.00 **SPARES**

2.01.00 **General**

The Bidder shall indicate and include in his scope of supply all the necessary start-up, commissioning and recommended spares in addition to mandatory spares as specified elsewhere in the specification. The Bidder shall also state for each item of spares both mandatory and recommended, the normal expected service life.

2.01.01 All spares supplied under this contract shall be strictly interchangeable with the parts for which they are intended to replace. The spares shall be treated and packed for long storage under the climatic conditions prevailing at the site, e.g. small items shall be packed in sealed transparent plastic bags with dessicator packs as necessary.

2.01.02 Each spare part shall be clearly marked or labelled on the outside of the packing with the description. When more than one spare part is packed in a single case, a general description of the contents shall be shown on the outside and a detailed list enclosed. All cases, containers and other packages must be suitably marked and numbered for the purposes of identification.

2.01.03 All cases, containers or other packages are liable to be opened for examination as may be considered necessary by the Owner.

2.01.04 The Bidder shall also guarantee supply of spare parts, which shall be made, based on manufacturer's drawings on special order from the Owner for 30 years after commissioning of the plant.

2.01.05 Warranty period for all kinds of spares shall be six thousand (6000) hours of operation.

2.01.06 Design & Engineering details of all spares (make, model, rating, drawing, data sheet etc.) shall be submitted to the Owner prior to dispatch from manufacturers' works.

2.02.00 **Recommended Spares**

2.02.01 The Bidder shall provide a list of recommended spares for 3 years of normal operation of the plant for spares of indigenous origin, and for 5 years of normal operation for spares of non-indigenous origin. This list shall take into consideration the mandatory spares specified elsewhere in the specification and should be a separate list.

2.03.00 **Start-up Commissioning Spares**

2.03.01 Start-up commissioning spares are those spares which may be required during the start-up and commissioning of the equipment/system. The list of commissioning spares to be brought by the Bidder to ensure smooth commissioning of the plant shall be subject to the Owner's approval. All spares used until the plant is handed over to the Owner shall come under this category. Said spares, properly marked, shall be supplied together with the main equipment and shall be used by the Bidder, if needed, during erection & commissioning stage. All such spares which remain unused till issuance of Taking Over Certificate by the Owner, along with an equipment-wise quantitative consumption report shall be returned to the Owner during time of handover.

2.04.00 **Mandatory Spare Parts**

2.04.01 The Owner considers some of the spares are essential for running the equipment irrespective of whether they are included in the list of recommended spares by the Bidder as mentioned above.

Since the components involved can not be foreseen at the bidding stage, only broad requirements of the Owner in this respect are outlined hereinafter. The bidder shall include his proposal, on the basis of these guidelines, an item-wise list of all components recommended as mandatory spares with the quantity. This list shall be separate from the list of recommended spares and shall be used for bid evaluation purposes. Any clarification in this respect may be obtained by the Bidder at the pre-bidding stage. During finalization of detailed engineering if some component, equipment, system, sub-system found to undergo change, then the Owner/Consultant shall revise the list for compliance by the Bidder without any implication to the Owner.

2.04.02 For Mandatory Spares refer Annexure-I of this section.

Sl. No.	Equipment/Package Name	Quantity to be supplied for the Package
(i)	Axle Bearings	1Set for each type & capacity of EOT
(ii)	Set of Gearbox Bearings with Sleeves	1Set for each type & capacity of EOT
(iii)	Set of seals for Gearbox	1Set for each type & capacity of EOT
(iv)	Cross Travel end Shaft Bearing	1Set for each type & capacity of EOT
(v)	Cross travel Brake Shoes Liners	2Sets for each type & capacity of EOT
(vi)	Complete Set of Hydraulic Thruster for Brakes (if applicable)	1 No. for each type & capacity of EOT
(vii)	Brake Spring	1Set for each type & capacity of EOT
(viii)	Brake Coil	2Sets for each type & capacity of EOT
(ix)	Motor	1 No. for each type & capacity of EOT
6.01.03	Hoist	
(i)	Main Hoist Pulley Bearings [All Bearings of Each Type and size used in all Gear Assemblies, Lifting Hook, Trolley wheels etc.]	1 Set for each type & capacity of EOT
(ii)	Set of Bearings for Gear box	1 Set for each type & capacity of EOT
(iii)	Set of seals for Gearbox	1 Set for each type & capacity of EOT
(iv)	Aux. Hoist Gearbox Bearings	1 Set for each type & capacity of EOT
(v)	Aux. Hoist Gearbox Seals	1 Set for each type & capacity of EOT
(vi)	Complete Set of Hydraulic Thruster for Brakes (if applicable)	1 No. for each type & capacity of EOT
(vii)	Main & Aux. Hoist Brake Shoes [Brake shoes with lining for each size of brake (Pair of each size)]	2 Sets for each type & capacity of EOT
(viii)	Main & Aux. Hoist Brake Springs	2 Sets for each type & capacity of EOT
(ix)	Main & Aux. Hoist Brake shoe liners	2 Sets for each type & capacity of EOT
(x)	Motor for Main Hoist & Auxiliary Hoist	1 No. for each type & capacity of EOT
(xi)	Brake Coil	2 Sets for each type & capacity of EOT
(xii)	Wire Rope for Aux. Hook	100% of one crane for each type & capacity of EOT
6.01.04	Electrical	
(i)	Other Electrical Spares as applicable as per the Electrical List	Applicable Item & Quantity same as indicated in Electrical list 'B' Sl. No.7.08.00, 7.21.00.
(ii)	Limit Switches for:	
(a)	Main Hoist	1 Set for each type & capacity of EOT
(b)	Aux. Hoist	1 Set for each type & capacity of EOT
(c)	Cross Travel	1 Set for each type & capacity of EOT
(d)	Long Travel	1 Set for each type & capacity of EOT
(iii)	Master Controller for :	
(a)	Aux. Hoist	1 No. for each type & capacity of EOT
(b)	Cross Travel	1 No. for each type & capacity of EOT
(c)	Long Travel	1 No. for each type & capacity of EOT
(iv)	VVVF Drive Complete Set for:	
(a)	Main Hoist	1 No. for each type & capacity of EOT
(b)	Aux. Hoist	1 No. for each type & capacity of EOT
(c)	Cross Travel	1 No. for each type & capacity of EOT
(d)	Long Travel	1 No. for each type & capacity of EOT
6.02.00	Electrical Hoist	
6.02.01	Bearings for Long Travel Wheels [Bearing	1 Set for each type & capacity of Hoist

Sl. No.	Equipment/Package Name	Quantity to be supplied for the Package
	of each type and size used in motors]	
6.02.02	Bearings for Cross Travel Wheels [Bearing of each type and size used in motors]	1 Set for each type & capacity of Hoist
6.02.03	Bearings for each type of Gear Boxes of the Hoist	1 Set for each type & capacity of Hoist
6.02.04	Brake Liner for all the Brakes of the Hoist	100% for each type & capacity of Hoist
6.02.05	Hydraulic Thruster for Brakes	1 No. for each type & capacity of Hoist
6.02.06	Oil Seals for all types of the Hoist	100% for each type & capacity of Hoist
6.02.07	Brake Springs for all Brakes	100% for each type & capacity of Hoist
6.02.08	Wire Rope for Aux. Hook	100% of one Hoist for each type & capacity of Hoist
6.02.09	Electrical	
(i)	Other Electrical Spares as applicable as per the Electrical List	Applicable Item & Quantity same as indicated in Electrical list Sl. No.7.08.00,7.12.00 & 7.21.00
(ii)	Limit Switches for:	
(a)	Hoist	1Set. for each type & capacity of Hoist
(b)	Cross Travel	1Set. for each type & capacity of Hoist
(c)	Long Travel	1Set. for each type & capacity of Hoist
(iii)	Control Trailing Cable for Electrical Hoist	100% of one Hoist for each type & capacity of Hoist
(iv)	Power Trailing Cable for Electrical Hoist	100% of one Hoist for each type & capacity of Hoist
6.03.00	Elevator (Goods / Passenger)	
6.03.01	Control Panel Items	
(i)	Complete Set of Cortactors each type and rating	10% of total population or 1No. which ever is higher for each type of Elevator
(ii)	Coils for contactors	2Nos. of each type and rating for each type of Elevator
(iii)	Control Transformer	1No. each type, and rating for each type of Elevator
(iv)	Relays	2Nos. of each type & model for each type of Elevator
(v)	Relay Coils	2Nos. of each type & model for each type of Elevator
(vi)	Resistors	3Nos. for each type of Elevator
(vii)	Over Current Relay	1No. for each type of Elevator
(viii)	Capacitors	100% for each type of Elevator
(ix)	Control Rectifier	1No. of each type for each type of Elevator
(x)	Time Device	1No. of each type for each type of Elevator
(xi)	Suppressor Unit	100% for each type of Elevator
(xii)	Fuses	100% for each type of Elevator
(xiii)	Complete set of Controller	1No. of each type for each type of Elevator
(xiv)	VVVF Drive Complete Set for Speed Control	1No. each Card for each type of Elevator
6.03.02	Elevator Car	
(i)	Fixed contact assembly	6Nos. each type & rating for each type of Elevator
(ii)	Moving contact assembly	6Nos. each type & rating for each type of Elevator
(iii)	Operating Lever	4Nos. each type for each type of Elevator

Sl. No.	Equipment/Package Name	Quantity to be supplied for the Package
6.06.05	Flow Regulating Valve	
(i)	For Air Washer	1No. each type & size
(ii)	For Unitary Air Filtration Unit	1No. each type & size
6.06.06	Basket for POT Strainer	
(i)	Strainer Busket for Air Washer	1No. for each type and size
(ii)	Strainer Busket for Unitary Air Filtration unit	1No. for each type and size
6.06.07	Valves	
(i)	Gate valve for Air washer	2Nos. each type & size
(ii)	NR Valve for Air Washer	
(iii)	Gate valve for Unitary Air Filtration Unit	2Nos. each type & size
(iv)	NR valve for Unitary Air Filtration Unit	1No. each type & size
(v)	Gate Valve for Make-up Drain of Air washer	1No. each type & size
(vi)	Gate valve for UAF	2Nos. each type & size
6.06.08	Electrical Spares as applicable as per the Electrical List	Applicable Item & Quantity same as indicated in Electrical list Sl. No. 7.12.00, 7.13.00.
6.06.09	Field Instruments & Others as applicable as per the C&I List	Applicable Item & Quantity same as indicated in C&I list Sl. No. 8.04.00, 8.07.00 & 8.10.00
6.07.00	Air Conditioning System	
6.07.01	Reciprocating Compressors of all categories	
(i)	Piston Ring	1Set for each categories
(ii)	Piston	1Set for each categories
(iii)	Complete Set of Bearing	1Set for each categories
(iv)	Complete Set of Seal and other wear out parts	1Set for each categories
(v)	Complete set of Valve Head Assembly	2Sets for each categories
(vi)	Crank Shaft complete set	1Set for each categories
(vii)	Connecting Rod	1Set for each categories
6.07.02	Centrifugal pumps of all categories	
(i)	Impeller	1Set for each categories
(ii)	Wearing Rings	1Set for each categories
(iii)	Complete Set of Bearing	1Set for each categories
(iv)	Complete Set of Seal and other wear out parts	1Set for each categories
(v)	Strainer Basket	1Set for each categories
6.07.03	Centrifugal Blowers of All AHU	
(i)	Rotating Assembly	1Set for each categories
(ii)	Complete Set of Bearing	1Set for each categories
6.07.04	Heat Exchangers	
(i)	Plug for condenser Tube	10Nos.
(ii)	Sight Glass	2Nos. each type
(iii)	Safety Relief valves	1No. each type
6.07.05	Cooling Tower	
(i)	Spray nozzles	1Set (one set means complete replacement for one cooling tower)
(ii)	Set of fills	10% (ronded off to the next higher integer) of total quantity used one Tower
6.07.06	Valves	1No. for each type, Class and size

Sl. No.	Equipment/Package Name	Quantity to be supplied for the Package
6.07.07	Electrical Spares as applicable as per the Electrical List	Applicable Item & Quantity same as indicated in Electrical list Sl. No.7.12.00, 7.13.00 & 7.21.00
6.07.08	Field Instruments & Others as applicable as per the C&I List	Applicable Item & Quantity same as indicated in C&I list Sl. No. 8.04.00 & 8.10.00
6.07.09	PLC Spares as applicable as per the C&I List	Applicable Item & Quantity same as indicated in C&I list Sl. No. 8.03.00
6.08.00	Fire Protection & Detection System	
6.08.01	Diesel Engine	
(i)	Element for lub oil Filter	2Nos.
(ii)	Element for Fuel Filter	2Nos.
(iii)	Outer Element for Air cleaner	2Nos.
(iv)	Inner Element for Air cleaner	2Nos.
(v)	Turbo-charger	1No.
(vi)	Engine - starter Motor	1No.
(vii)	Injector	1No.
(viii)	Piston rings & liner set	1Set
6.08.02	Fire Water Pump	
(i)	Set of Impellers	1Set (one set means complete replacement for one pump)
(ii)	Set of shafts	1Set (one set means complete replacement for one pump)
(iii)	Casing wear rings	1Set (one set means complete replacement for one pump)
(iv)	Impeller wear rings	1Set (one set means complete replacement for one pump)
(v)	Shaft sleeves	1Set (one set means complete replacement for one pump)
(vi)	Shaft coupling	1Set (one set means complete replacement for one pump)
(vii)	Shaft nuts and keys	1Set (one set means complete replacement for one pump)
(viii)	Bearings Various types as applicable	1Set (one set means complete replacement for one pump)
(ix)	Electrical Spares as applicable as per the Electrical List	Applicable Item & Quantity same as indicated in Electrical list Sl. No.7.21.00
6.08.03	Fire Water Pump Control Panel	
(i)	Electrical Spares as applicable as per the Electrical List	Applicable Item & Quantity same as indicated in Electrical list Sl. No.7.08.00 & 7.12.00
(ii)	Field Instruments & Others as applicable as per the C&I List	Applicable Item & Quantity same as indicated in C&I list Sl. No.8.03.00
6.08.04	Valves	
(i)	Complete Hydrants Valves	4 Nos.each type and size
(ii)	Set of Seat & Rubber Ring of Hydrants Valves	3Sets for each type and size (one set means complete replacement for one particular type/size of valve)
(iii)	Deluge valve Assembly complete with	4Sets

Sl. No.	Equipment/Package Name	Quantity to be supplied for the Package
(d)	Voltmeter Selector Switch	3 nos of each type.
(xvii)	Isolation switch for the control supply (AC Supply On / Off Switch, DC Supply On / Off Switch, Motor Heater On /Off Switch etc.)	3 nos of each type.
(xviii)	Operating mechanism rod for each rating	3 nos
(xix)	Set of gaskets of each rating	2 sets
(xx)	Ammeter of each type & range	2 no of each type & range
(xxi)	Voltmeter of each type & range	1 no of each type &range
(xxii)	Circuit breaker aux. contact assembly:-	10% (ronded off to the next higher integer)of total nos. or minimum 5 nos whichever is higher for each type and rating used in each switchgear
(a)	52 a & b	
(b)	52 c & d	
(xxiii)	Indicating Lamps	
(a)	Indicating lamps (Red, amber, green, white, blue)	5% (ronded off to the next higher integer)of total nos. for each type
(b)	Indicating lamp covers of all colours, lamp resistors & holders	5% (ronded off to the next higher integer)of total nos. for each type and rating used in each switchgear
(xxiv)	Fuse base and holder of each type & rating	6 nos. of each type.
(xxv)	MCB & Fuse of each type & rating	12 nos of each.
(xxvi)	Maintenance tools and accessories for maintenance (bidder to list)	1 set.
(xxvii)	Carbon brushes for spring charging motor (if applicable)	20 sets
(xxviii)	Breaker jaw contact (Bus -end & breaker-end) assembly	2 sets (1 set consists of 3 nos.)of each rating
(xxix)	Terminal blocks	12 nos. of each type and rating
(xxx)	Arc chute (if applicable for each rating)	3 nos.
(xxxi)	DC Supply Source Selector Switch (3-position)	3 nos.
(xxxii)	Bearings for spring charging motor	6 sets
(xxxiii)	Multiple pin plug contact assy. with cables (male & female)	6 sets
(xxxiv)	Guide for moving contact set	6 sets (complete)
(xxxv)	Interphase barrier	3 nos. for each type
(xxxvi)	Contactors with HRC fuses	10 % (ronded off to the next higher integer)of each type and rating
(xxxvii)	Aux. contactors	10 % (ronded off to the next higher integer)of each type and rating
(xxxviii)	Control supply transformers (If applicable)	1 no of each type.
(xxxix)	Dash pot complete assembly	1 no. with each type
(XL)	Surge Arrester	5 nos. of each type and rating
(XLI)	Transducer	2 nos. for each type and Rating
(XLII)	Energy Meter	1 no of each type and rating
(XLIII)	HT fuse of PT	3 nos. of each type and rating
7.08.00	415V System	
7.08.01	11/0.415KV Transformer (for Each make, type and rating of Transformer)	
(i)	Door Limit Switch complete set	1 set (1 set means total requirement for one

Sl. No.	Equipment/Package Name	Quantity to be supplied for the Package
		Transformer)
(ii)	Neutral CT	1 no of each type and rating
(iii)	Temperature scanner	1 no.
(iv)	bhy	3 No
(v)	LV Bushing with metal parts, connectors and gaskets	3 No
(vi)	LV neutral Bushing with metal parts, connectors and gaskets	1 No
(vii)	Post Insulator	1 set (1 set means total requirement for one Transformer)
(viii)	Limb of complete LT & HT of temperature sensing devices	1 Set (1 set means total requirement for one Transformer)
7.08.02	415V Air Circuit Breaker (for Each make, type and rating of ACB)	
(i)	Trip Coil	20% of total nos. or minimum 5 nos whichever is higher for each type and rating used in each switchgear (PCC/PMCC/MCC/ACDB)
(ii)	Closing Coil	20% of total nos. or minimum 5 nos whichever is higher for each type and rating used in each switchgear (PCC/PMCC/MCC/ACDB)
(iii)	Spring Charging Motor	2 nos.
(iv)	Spring Charging Motor with complete Mechanism	2 nos.
(v)	Spring Charged Limit Switch	5 nos.
(vi)	Thermal Overload for Spring Charging Motor	2 nos.
(vii)	Main Contact (Fixed and moving) assembly	5 sets (1 set consists of 3 nos.) for each type and rating
(viii)	Arcing Contact (Fixed and moving) assembly	5 sets (1 set consists of 3 nos.) for each type and rating
(ix)	Breaker Jaw Contact (Bus-end & Breaker- end) assembly	5 sets (1 set consists of 3 nos.) for each type and rating
(x)	Sliding Contact (Fixed & Moving)	3 sets.
(xi)	Breaker Auxiliary Contact Block	5 nos.
(xii)	Arcing Chute	2 sets (1 set consists of 3 nos.) for each type and rating
(xiii)	Plug Socket with Prefab cable	3 nos
(xiv)	Position Limit Switch	5 sets
7.08.03	415V PCC, PMCC, MCC, ACDB, DCDB, Elect. Control Panel (For each PCC, PMCC, MCC, ACDB, DCDB and Elect. Control Panel) (applicable items of PCC, PMCC, MCC, ACDB, DCDB and Elect. Control Panel shall be considered)	
(i)	Indicating Lamps complete assembly	
(a)	Red	3 nos of each make and type.
(b)	Blue	3 nos of each make and type.
(c)	Green	3 nos of each make and type.
(d)	White	3 nos of each make and type.
(e)	Amber	3 nos of each make and type.
(ii)	CT	2 nos. for each make, type and Rating

Sl. No.	Equipment/Package Name	Quantity to be supplied for the Package
(iii)	Transducer	2 no for each make, type and Rating
(iv)	Trip / Neutral / close Control Switch	2 nos. for each make, type and Rating
(v)	Switch gear or MCC / Trial / Normal selector switch	2 nos. for each make, type and Rating
(vi)	Local/Remote selector switch	2 nos. for each make, type and Rating
(vii)	AC Supply On / Off Switch	1 no. for each make, type and Rating
(viii)	DC Supply On / Off Switch	1 no. for each make, type and Rating
(ix)	Motor Heater On /Off Switch	1 no. for each make, type and Rating
(x)	DC Supply Source Selector Switch (3-position)	1 no. for each make, type and Rating
(xi)	Ammeter Selector Switch	1 no. for each make, type and Rating
(xii)	Voltmeter Selector Switch	1 no. for each make, type and Rating
(xiii)	Voltmeter	2 no. for each make, type and Rating
(xiv)	Ammeter	2 no. for each make, type and Rating
(xv)	Auxiliary Control Contactor	
(a)	Auxiliary Control Contactor complete assembly	10% of total nos for each make, type and Rating.
(b)	Auxiliary Control Contactor spare kits	10% of total nos. for each make, type and Rating.
(c)	Auxiliary Control Contactor Coils	10% of total nos for each make, type and Rating.
(xvi)	Power Contactor	
(a)	Power Contactor Complete Assembly	10% of total nos for each make, type and rating
(b)	Power Contactor spare kits	10% of total nos for each make, type and Rating.
(c)	Power Contactor Coils	10% of total nos for each make, type and Rating.
(xvii)	MCCB	5% of total nos. for each make, type and rating.
(xviii)	MCB	5% of total nos. for each make, type and rating.
(xix)	Switch Fuse Unit (DC)	10% of total nos. for each make, type and rating.
(xx)	Power Fuse	5% of total nos. for each make, type and rating.
(xxi)	Control Fuse	5% of total nos. for each make, type and rating.
(xxii)	Thermal Overload Relay	5% of total nos. for each make, type and rating.
(xxii)	Sliding contact (Fixed and moving) Complete assembly	2 sets of each make, type and rating
(xxiii)	Busbar to module Lira Contact assembly	2 sets of each make, type and rating (1 set means all 3 ph+ neutral)
(xxiv)	Control and Aux. Transformer	1 no of each make, type and rating
(xxv)	Delay Timer	2 no of each make, type and rating
(xxvi)	Power Terminal Block	2 sets for each make, type and rating
(xxvii)	Control Terminal Block	2 sets for each make, type and rating
(xxviii)	End plate for Power and Control terminal block	2 sets for each make, type and rating
(xxix)	Energy meter	1 no for each make, type and rating
(xxx)	Relays (Other than numerical relay):	
(a)	Conventional (Electromagnetic/Static type) Relay	2 no for each make, type and rating
(b)	Aux. relays & Lock out relays & TIMERS	2 nos for each make, type and rating
(xxxi)	MCCB Status (On/off) Monitoring Switch/Contact	2 nos for each make, type and rating
(xxxii)	Push Button (On/Off) Complete Assembly	2 nos for each make, type and rating
(xxxiii)	Annunciation Facia with lamps complete set (if applicable)	1 set for each make, type and rating

Sl. No.	Equipment/Package Name	Quantity to be supplied for the Package
7.11.06	UPS Battery (Ni-Cad Type)	
(i)	Battery Cell (Uncharged, Dry)	10Nos. each type
(ii)	Inter connecting cell strips	10Nos. each type
(iii)	Vent cap	10Nos. each type
(iv)	Hydrometer	1No.
(v)	Rubber gloves	1Pair
(vi)	Voltmeter for measuring cell voltage (Center zero type)	1No.
(vii)	Funnel	1No.
(viii)	Jug	1No.
(ix)	Appron & Goggles	1Set
(x)	Cell lifting puller	1No.
(xi)	Insulated socket spanner with handle	1No.
(xii)	Terminal screw with Belleville washer	5% of total quantity used
(xiii)	Plastic filling bottle	1No.
(xiv)	Thermometer	1No.
7.11.06	Other Electrical Items	For other applicable items Sl No.7.12.00 & 7.08.00 of this document shall be followed.
7.12.00	Control Panel/Desk Mounted Items	
7.12.01	Push Button Complete assembly	10Nos for each colour
7.12.02	Push Button Contact Element (1NO + 1NC) Block	20Nos.
7.12.03	Selector Switch	10Nos. for each type and rating
7.12.04	Meter (Analog and Digital)	
(i)	Ammeter	2Nos. for each type and range
(ii)	Voltmeter	2Nos. for each type and range
(iii)	Frequency	2Nos. for each type and range
(iv)	MW	2Nos. for each type and range
(v)	MVAR	2Nos. for each type and range
(vi)	Power Factor	2Nos. for each type and range
(vii)	Synchroscope	1No. for each type and range
(viii)	Synchrocheck Relay complete set	1No. for each type and range
(ix)	Transducer	1No. for each type and range
7.12.05	Indicating Lamps complete assembly	20Nos. for each Colour and type
7.12.06	Mimic Lamps	10Nos. for each Colour and type
7.12.07	MCB	5Nos. for each type and rating
7.12.08	Door Limit Switch	5Nos.
7.12.09	Annunciation system	
(i)	Lamp Box with Facia & Lamps (LED type)	25Nos.
(ii)	Hooter	1No.
(iii)	Each type of PCB (for non-PLC driven system)	1(one) no.
7.13.00	Actuator	
7.13.01	Complete set of Actuator	2Nos. for each type, make and rating, 1 no. for H2 cooler Temperature controller and 1 no. for stator water temperature controller
7.13.02	Power Unit for Modulating Actuator	4Nos. of each type

Sl. No.	Equipment/Package Name	Quantity to be supplied for the Package
7.13.03	DC-DC Power Pack Unit	4Nos. of each type
7.13.04	Electronic cards	4Nos. of each type
7.13.05	Position Feed Back Transmitters	4Nos. of each type
7.13.06	Control Unit	4Nos. of each type
7.13.07	Limit Switch Assembly	2 Nos each type and rating
7.13.08	Torque Switch Assembly	2 Nos each type and rating
7.13.09	Power Contactor	5Nos. for each type and rating
7.13.10	Auxiliary Contactor	5Nos. for each type and rating
7.13.11	Thermal Over Load Relay	2Nos. for each type and rating
7.13.12	Motor	1No. each type and rating
7.13.13	Complete Seal kit	2Sets for each type and rating
7.13.14	Complete O-Ring Set	2Sets for each type and rating
7.14.00	Illumination	
7.14.01	Lighting fixtures without light	20 Sets for each make, type and rating
7.14.02	MCCB	5 Nos for each make, type and rating .
7.14.03	MCB	20 Nos for each make, type and rating .
7.14.04	Power and Control Contactor	5 Nos for each make, type and rating
7.14.05	Switches	5 Nos for each make, type and rating .
7.14.06	Receptacles with plug	5 Nos for each make, type and rating
7.14.07	Rotary switches	2 Nos for each make, type and rating .
7.14.08	LED light	50 nos for each make, type and rating .
7.14.09	Clock switch type Time Switch	2 nos for each make, type and rating .
7.14.10	Lighting Transformer	1 no for each make, type and rating .
7.15.00	Cable	
7.15.01	11KV Grade HT Power Cable	2 (Two) Kms. of each type, size & rating of Cables
7.15.02	3.3KV Grade HT Power Cable	2 (Two) Kms. of each type, size & rating of Cables
7.15.03	LT Power Cable	2(Two)Kms of each type, size & rating of Cables
7.15.04	Control Cable	2(Two)Kms. of each type, size & rating of Cables
7.15.05	Fire Survival Cable	1(One)Km of each type, size & rating of Cables
7.16.00	Neutral Grounding Registor	
7.16.01	NGR complete with all accessories	1 set of each make, type and rating
7.16.02	Insulator	2 nos for each make, type, rating and size
7.16.03	Neutral CT(if applicable)	1 no of each type and rating
7.17.00	DG Set	
7.17.01	Diesel Engine	
(i)	Element Corrosion Resistor	8Nos.
(ii)	Element lub oil Filter	8Nos.
(iii)	Element lub oil by pass Filter	8Nos.
(iv)	Element Fuel Filter	16Nos.
(v)	Plate corrosion Resistor	16Nos.
(vi)	Element Air cleaner outer	2Nos.
(vii)	Element Air cleaner Inner	2Nos.
(viii)	Fuel Oil Pump	1No.

Sl. No.	Equipment/Package Name	Quantity to be supplied for the Package
(viii)	Voltmeter for measuring cell voltage (Center zero type)	1No.
7.18.02	Float -cum- Boost Charger (For each make, Type and Rating)	
(i)	Electronic Module, PCB, Cards of each type and rating (with all components mounted)	2 Set
(ii)	Fuses of each type and rating	100% of total quantity.
(iii)	SCR of each type and rating	2 Nos.
(iv)	Blocking Diode of each type and rating	5 Nos. of each type
(v)	Potentiometer of each type and rating	1 Set
(vi)	Pulse transformer	1 Set of each type
(vii)	Main and Aux. transformer	1 no of each type and rating
(viii)	Capacitor	2 no of each type and rating
(ix)	Meters	1 No of each type
(x)	Transducer	1 No of each type
(xi)	Selector Switch	1 no of each type
(xii)	Control Switch	1 no of each type
(xiii)	Current transformer(if applicable)	1 no of each type and rating
(xiv)	Push button complete set	1 no of each type
(xv)	Annunciation window	1No.
(xvi)	Indicating Lamps complete assembly	2 Nos of each type.
7.19.00	24V DC System	
7.19.01	Battery	
(i)	Battery Cell (Uncharged, Dry)	10Nos
(ii)	Inter connecting cell strips	10Nos
(iii)	Vent plug	5Nos
(iv)	Teak wood cable clamps with hardware	2Nos
(v)	Hydrometer	1No.
(vi)	Rubber gloves	1pair
(vii)	Voltmeter for measuring cell voltage (Center zero type)	1No.
(viii)	Insulated socket spanner with handle	1No.
(ix)	Thermometer	1No.
7.20.02	Float -cum- Boost Charger	
(i)	Fuses & fuse links	100% of total quantity for each type, rating of fuses used in the system
(ii)	SCR	100% Used in the System
(iii)	Diode	100% Used in the System
(iv)	Indicating lamps	100% Used in the System
(v)	All types of Electronic Module/ PCB/Card	2Nos. each type used in the system
(vi)	pulse transformer	1 set
7.20.03	Othe DCDB Spares items as applicable as per the Electrical List	Item & Quantity same as indicated in Electrical list Sl. No.7.09.00
7.20.04	Other Electrical Spares as applicable as per the Electrical List	Item & Quantity same as indicated in Electrical list Sl. No.7.08.00 & 7.12.00
7.21.00	Motor	
7.21.01	11 KV & 3.3 KV Motor	
(i)	Motor of each type and rating (Note :	10% of the installed quantity or minimum 1

Sl. No.	Equipment/Package Name	Quantity to be supplied for the Package
	motors covered in mechanical spare items need not to be included here again)	number whichever be higher
(ii)	Neutral End Terminal Bushing with Fasteners	1 no. for each type and rating of Motor
(iii)	Bearing Temperature Gauge Driving & Non-Driving End	1 set for each type and rating of Motor
(iv)	Phase segregated terminal boxes	2 Nos. for each type and rating of Motor
(v)	Heaters	2 sets for each type and rating of Motor
(vi)	Complete Set of Coupling	1 set for each type and rating of Motor
(vii)	Bearings (DE) for each type and rating of motors	2 sets for each type and rating of Motor
(viii)	Bearings (NDE) for each type and rating of motors	2 sets for each type and rating of Motor
(ix)	Cooling Fan Internal & External	1 set for each type and rating of Motor
(x)	Neutral CT for differential protection (For motor rating >1000 KW)	2 no of each type and rating.
(xi)	End Termination kits	2 Nos. of each type and rating
(xii)	Indicating Instruments/gauges other then Bearing temperature gauge (as applicable)	1 set for each type and rating of Motor
(xiii)	Phase side Bushing and Insulator	1Set for each type and rating of Motor
(xiv)	Oil Seal Ring (as applicable)	1Set for each type and rating of Motor
7.21.02	415 Volt Motor	
(i)	Motor of each type and rating (Note : motors covered in mechanical spare items need not to be included here again) 10% of the installed quantity or minimum 1 number whichever be higher	10% of the installed quantity or minimum 1 number whichever be higher
(ii)	End Shield Cover Driving & Non-Driving End	1 set for each type and rating of Motor
(iii)	Heaters	2 sets for each type and rating of motor
(iv)	Bearings (DE and NDE) for each type and rating of motor	2 sets
(v)	Cooling Fan for all type and rating of LT motors	One (1) set
(vi)	Dust seals and gaskets for each type of motors	1 Set
(vii)	Motor Terminal Block	1 no. for each type and rating of Motor
(viii)	Complete Set of Coupling	1 set for each type and rating
7.21.04	DC Motor	
(i)	Motor of each type and rating (Note : motors covered in mechanical spare items need not to be included here again)	10% of the installed quantity or minimum 1 number whichever be higher
(ii)	Carbon brushes	2 sets for each type and rating of Motor
(iii)	Brush assemblies	2 sets for each type and rating of Motor
(iv)	Terminal blocks	1 set for each type and rating of Motor
(v)	Heaters	1 set for each type and rating of Motor
(vi)	Complete Set of Coupling	1 set for each type and rating of Motor
(vii)	Bearings (DE and NDE) for each type and rating of motor	1 set for each type and rating of Motor
(viii)	Cooling Fan	1 set for each type and rating of Motor
7.22.00	Local Control Station	

Sl. No.	Equipment/Package Name	Quantity to be supplied for the Package
~~8.03.27~~	~~Micro PLC system (i.e. inegrated CPU & I/O system, where above mentioned components are not applicable)~~	~~One Complete Set~~
8.04.00	Field Instrument	
8.04.01	Electronic Transmitters	
(i)	Pressure	1(One) no. complete set for each type and model/range used in the system
(ii)	Differential Pressure	1(One) no. complete set for each type and model/range used in the system
(iii)	Level	1(One) no. complete set for each type and model/range used in the system
(iv)	Speed	1(One) no. complete set for each type and model/range used in the system
(v)	FlowTransmitter	1(One) no. complete set for each type and model/range used in the system
(vi)	3-D Ultrasonic level Transmitter	1(One) no. complete set for each type and model/range used in the system
8.04.02	Different type of Switches	
(i)	Pressure Switch	2(two)no. of each type & model/range used in the system
(ii)	Differential Pressure Switch	2(two)no. of each type & model/range used in the system
(iii)	Level Switch	2(two)no. of each type & model/range used in the system
(iv)	Flow Switch	2(two)no. of each type & model/range used in the system
(v)	Temperature Switch	2(two)no. of each type & model/range used in the system
(vi)	Dust Detector	1(one)no. of each type & model used in the system
8.04.03	Thermocouple	100% of each type and length used in one unit
8.04.04	RTD	100% of each type and length used in one unit
8.04.05	Thermo-well for both TC and RTD	2(Two) nos. for each type and rating/length used in the system
8.04.06	Solenoid Valve	
(i)	Complete Solenoid Valve Assembly	2Nos. for each type and rating used in the system
(ii)	Coil (single or double coil type)	10% of total nos. used in the system or minimum 5(five) Nos. whichever is more for each type and rating.
8.04.07	Different types of Gauge	10% of total nos. used in the system or minimum 1(one) no. whichever is more for each type and range.
(i)	Pressure Gauge	10% of total nos. used in the system or minimum 1(one) no. whichever is more for each type and range.
(ii)	Differential Pressure Gauge	10% of total nos. used in the system or minimum 1(one) no. whichever is more for each type and range.
(iii)	Temperature Gauge	10% of total nos. used in the system or minimum 1(one) no. whichever is more for each type and range.

Sl. No.	Equipment/Package Name	Quantity to be supplied for the Package
(iv)	Magnetic Level Gauge	10% of total nos. used in the system or minimum 1(one) no. whichever is more for each type and range.
8.04.08	Air Filter Regulator including moisture separator complete set with pressure gauges	10Nos.
8.04.09	Rotameter	10% of total nos. used in the system or minimum 2(Two) nos. whichever is more for each type, rating,/model and size used in the system.
8.04.10	Gauge Glass	1No. for each type and size
8.04.11	Erection Hardware	
(i)	Transmitter's Manifold	10% of total nos. used in the system or minimum 2(Two) nos. whichever is more for each type, rating,/model and size used in the system.
(ii)	Impulse Line Root/Source valve	10% of total nos. used in the system or minimum 4(four) nos. whichever is more for each type, rating,/model and size used in the system.
(iii)	Impulse Line Isolation valve	10% of total nos. used in the system or minimum 4(four) nos. whichever is more for each type, rating,/model and size used in the system.
(iv)	Impulse Line Drain valve	10% of total nos. used in the system or minimum 4(four) nos. whichever is more for each type, rating,/model and size used in the system.
(v)	Impulse Line fittings	Each type/size 25Nos.
(vi)	Impulse Pipe	Each type/size 100Mtrs.
(vii)	Copper/SS Tube	Each type/size 100Mtrs.
(viii)	Fittings for Copper/SS Tube	Each type/size 100Nos.
8.04.13	Conductivity Type Level Switch	
(i)	Conductivity Ttype level Probes	10% of total nos. used in the system or minimum 4(four) nos. whichever is more.
(ii)	Complete Electronics unit	1Set
(iii)	Isolating/Root Valve	2Nos.
8.04.14	Cable This particulat items shall be common for BTG , CHP and AHP areas.	
(i)	Thermocouple Cable	3(three)Kms. of each type, size & rating of Cables
(ii)	Control & Instrumentation Cable	3(three)Kms. of each type, size & rating of Cables
8.04.15	Cold Junction Compensation Boxes	10% of total nos. used in the system or minimum 2(two) nos. for each type/size whichever is more.
8.04.16	Current/Voltage Transducers	1(one) no. each type/rating used in the system
8.04.17	MWatt/MVAR Transducer	1(one) no. each type/rating used in the system
8.04.18	Chlorine Leak Detector System	
(i)	Sensor Unit (complete)	2No.
(ii)	Transmitter/Processing Unit (complete)	2No.
8.05.00	SWAS	
8.05.01	Conductivity	
(i)	Conductivity Sensor/cell for each type of Cell Constant	20% of the total no. used in the system or minimum 2(two) nos. whichever is higher.
(ii)	Conductivity Transmitter Complete Set	20% of the total no. used in the system or

Sl. No.	Equipment/Package Name	Quantity to be supplied for the Package
8.07.03	I/P Converter for Control Valve/Power Cylinder (if applicable)	10% of total quantity used in the system or minimum 5(five) nos. whichever is more for each type and model.
8.07.04	Air Lock Relay	10Nos. for each type
8.07.05	Signal Air Booster Unit	2Nos. for each type
8.08.00	Turbine Supervisory Instruments & Plant Rotating Machinary Monitoring System	
8.08.01	Probes with extension cable	10% of total quantity used in the system or minimum 2(two) nos. whichever is more for each type and model.
8.08.02	Signal Converter/Proximitor for Transducer system	10% of total quantity used in the system or minimum 2(two) nos. whichever is more for each type and model.
8.08.03	Rack Mounted Monitors for Transducer system	10% of total quantity used in the system or minimum 1(one) no. whichever is more for each type and model.
8.08.04	Rack Interface Modules	10% of total quantity used in the system or minimum 1(one) no. whichever is more for each type and model.
8.08.05	Configurable type Relay Output Modules	10% of total quantity used in the system or minimum 1(one) no. whichever is more for each type and model.
8.08.06	Communication/Gateway Modules	10% of total quantity used in the system or minimum 1(one) no. whichever is more for each type and model.
8.08.07	Rack Mounted Power Supply Modules	10% of total quantity used in the system or minimum 2(two) nos. whichever is more for each type and model.
8.09.00	Closed Circuit Television System	
8.09.01	Complete Camera Unit	Each type 1(one) no.
8.10.00	Control Panel And Local/Remote Control Desk	
8.10.01	Mosaic/Conventional Type Push button Station	10% of total quantity used in the system or minimum 2(two) nos. whichever is more for each type and model.
8.10.02	Mosaic Type Push button Station with LED Indication	10% of total quantity used in the system or minimum 2(two) nos. whichever is more for each type and model.
8.10.03	Mosaic Type LED Indication Station	10% of total quantity used in the system or minimum 2(two) nos. whichever is more for each type and model.
8.10.04	Simaphore Indicator	2(two)Nos. each type
8.10.05	Annunciation System	
(i)	Each type of PCB (for non-PLC driven system)	1(one) No. each
(ii)	Lamp Box with Facia & Lamps (LED type)	10(ten)Nos.
(iii)	Hooter	1(one) No.
8.11.00	Thermocouple for Furnace Temperature Probes	2Nos.
8.12.00	Mill and Air Heater Fire Detection System	
8.12.01	Thermocouple	10% or 1 no. whichever is more
8.12.02	Process Actuator Switches	10% or 1 no. whichever is more

SECTION-XI

PROTECTIVE COATING AND PAINTING

CONTENTS

SECTION-XI

PROTECTIVE COATING AND PAINTING

1.00.00 INTENT OF SPECIFICATION

1.01.00 This specification addresses the requirements of all labour, material, and appliances necessary with reference to preparations for lining / painting, application as well as finishing of all lining / painting for all mechanical and electrical equipment, piping and valves, structures etc. included under the scope of this Package.

1.02.00 The Bidder shall furnish and apply all lining, primers including wash primers if required, under-coats, finish coats and colour bands as described hereinafter or necessary to complete the work in all respects.

2.00.00 CODES & STANDARDS

2.01.00 The Bidder shall follow relevant Indian and International Standards wherever applicable in cleaning of surface, selection of lining material / paints and their application. The entire work shall conform to the following standards / specifications (latest revision or as specified).

a)	SSPC SP 10 / NACE 2 / Sa2½	:	Near White Blast Cleaning
b)	SSPC PA 2	:	Measurement of dry film coating thickness with magnetic gauges.
c)	ASTM D 45	:	Method for pull off strength using portable Adhesion Tester.
d)	NACE RP 0274 – 2004	:	High-Voltage Electrical Inspection of Pipeline Coatings.
e)	NACE SP 0188 – 2006	:	Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
f)	NACE RP 0169 – 2002	:	Control of External Corrosion of Underground or Submerged Metallic Piping Systems.
g)	AWWA C 210 – 2007	:	Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
h)	IS 3589:2001 Annexure-B	:	Steel Pipes for Water and Sewage Specification.
i)	AWWA C222-2000	:	Polyurethane Coating for the Interior and Exterior of Steel Water Pipe and Fittings.

j)	IS 13213 : 2000	:	Polyurethane Full Gloss Enamel (Two pack)
k)	ISC HD 20 (11902)	:	Polyurethane coating for Interior and Exterior of steel pipe and fittings.
l)	ISC HD 20 (11055)	:	Solvent less Liquid epoxy system by application of Interior and Exterior surface of steel pipeline.

3.00.00 **GENERAL REQUIREMENTS**

3.01.00 The steel surface preparation prior to actual commencement of coating shall conform to SSPC SP 10 / NACE 2 / Sa2½ (near white metal) with sand blasting.

3.02.00 The contractor shall submit a detailed written description in the form of a manual covering coating equipment, procedures, materials inspection test, and repair etc. to Owner/Consultant for approval.

3.03.00 The contractor shall also provide copies of test reports from NABL approved laboratory (like National Test House, Kolkata) in support of the paint/primer materials to be used shall conform to the specification requirement.

3.04.00 The contractor shall also provide certificates from paint/primer manufacturer mentioning the batch numbers, date of manufacture and shelf life etc. of the materials to be used. In addition to that Manufacturing Quality Plan (MQP) and Field Quality Plan (FQP) shall also be submitted prior to commencement of supply of material and field application.

3.05.00 Paint/coating application work at site shall be done either by paint manufacturer or by their authorized applicator. The authorized applicator shall have proper training & certification from manufacturer. Applicator shall possess all the necessary specialized equipment and manpower experienced in similar job.

3.06.00 Applied coating shall be tested for dry film thickness, holiday (electrical inspection for continuity) and adhesion as per relevant standard such as SSPC PA 2, NACE RP 0274 and ASTM D 4541.

3.07.00 If necessary, the material may be heated and applied by airless spray / plural component spray system.

3.08.00 Manufacturer's specific recommendation, if any, shall be followed during application of lining / paints.

3.09.00 In areas where there is danger of spotting automobiles or other finally finished equipment or building by wind borne particles from paint spraying, a Purchaser approved method shall be adopted.

3.10.00 The colour scheme of the entire Plant, covered under this specification shall be approved by the Purchaser in advance before application.

3.11.00 All indoor and outdoor piping, insulated as well as uninsulated will have approved colour bands painted on the pipes at conspicuous places throughout the system, as approved by Purchaser.

3.12.00 Inside surfaces of vessels / tanks shall be protected by anticorrosive paints or rubber lining as required / specified elsewhere in the specification. External surfaces of all vessels / tanks shall be protected by anti-corrosive painting.

3.13.00 For vessels / tanks requiring lining and epoxy painting all inside surface shall be blast cleaned using non-siliceous abrasive after usual wire brushing.

3.14.00 Natural rubber lining shall be provided on the inside of vessels / tanks as required / specified elsewhere in the specification, in three layers resulting in a total thickness not less than 4.5 mm.

3.15.00 Surface hardness of rubber lining shall be 65 +/- 5 deg. A (shore).

3.16.00 After the lining is completed, the vessels / tanks shall not be subjected to any prolonged exposure to direct sunlight in course of its transportation, erection etc. They shall not be stored in direct sunlight. No further lining or burning shall be carried out on the vessel, after application of the lining.

3.17.00 All lining projecting outside of the vessel shall be protected adequately from mechanical damages during shipment, handling storage etc.

3.18.00 Suitable warnings, indicating the special care that must be taken with respect to these lined vessels shall be stenciled on their outside surface with the letters at least 12 mm high.

3.19.00 All insulated piping shall have aluminium sheet jacketing.

4.00.00 EQUIPMENT, MATERIAL AND SERVICES TO BE FURNISHED BY THE BIDDER

4.01.00 After erection at site, the outside surfaces of all equipment having a shop coat shall be given further priming coat and finished coats of paint as detailed in following clauses. However, if the painting system is such that the shop coat and primer coat to be applied at site are not compatible, then shop coat has to be removed from the surface of equipment before application of primer coat with prior blasting.

All factory finished paints shall be touched up at site as required.

All uninsulated piping shall be finished with final paintings after use of proper wash primer and primer. Aluminium sheet jacketed piping need not be painted. Colour bands of Purchaser's approved shade shall however be

applied on jacketed piping near walls or partitions, at all junctions, near valves and all other places as instructed by the Purchaser. All structures shall be painted with approved paint.

4.02.00 **Surface Preparation**

4.02.01 Unless mentioned otherwise, all rust and mill scale shall be removed by blasting up to SSPC SP10/NACE2/Sa2½ level to get "near white metal" surface before applying the primer.

4.02.02 Special care shall be taken to remove grease and oil by means of suitable solvents like Trichloroethylene or Carbon Tetrachloride.

4.03.00 **Painting**

4.03.01 Specification for application of paints for external surfaces protection of vessels / tanks / equipment / piping / fittings / valves shall be as follows :

a) Surface preparation shall be done by means of sand blasting, which shall conform to SSPC SP10/NACE 2/Sa2½ Standard.

b) Primer Coat shall consist of one coat (minimum DFT of 100 microns) of epoxy resin based zinc phosphate primer.

c) Intermediate Coat (or Under Coat) shall consist of one coat (minimum DFT of 100 microns) epoxy resin based paint pigmented with Titanium Dioxide.

d) Top Coat shall consist of one coat (minimum DFT of 75 microns) of epoxy paint of approved shade and colour with glossy finish. Additional one coat (minimum DFT of 25 microns) of Finish Coat of polyurethane shall be provided.

e) Total DFT of paint system shall not be less than 300 microns.

4.03.02 Specification for application of paints for external surfaces protection of steel pipes and fittings which are buried underground / laid inside a Hume Pipe & or submerged Under Water and laid under Pipe Trenches (in road/rail/pipe or trench crossings) shall be as follows :

a) Surface preparation by means of sand blasting and shall conforms to SSPC SP10/NACE2/ Sa2½.

b) External surface of the pipe, fittings, specialties etc. handling raw water/ clarified water/filter water shall be painted with one coat of two part chemically cured polyurethane primer of min 50 micron dry film thickness followed by three or maximum four coats of two part solvent less polyurethane to build up coating of dry film thickness of 1500 micron including primer coat.

4.03.03 Specification for application of paints for internal surface protection of large diameter pipes, if any, shall be as follows :

a) Surface preparation by means of sand blasting which shall conforms to SSPC SP10/NACE2/Sa2½ standard.

b) All Internal surfaces of steel pipes, fittings, specialties etc. buried underground or located within pipe trenches shall be given epoxy coating to protect them from (except for drinking water service, where the compatible painting shall be so selected to meet relevant quality standards) corrosion.

c) Internal surface of the pipe should be coated with one coat of two part epoxy primer with not less than 50 micron DFT (dry film thickness) followed by two part polyamide cured solvent less epoxy.

d) The minimum dry film thickness (DFT) of internal lining shall be 500 micron.

4.03.04 Specification for application of paints for protection of internal surfaces of DM Water Storage Tank(s) shall be as follows :

a) Primer - One coat of epoxy primer containing high level of Zinc Phosphate anticorrosive pigment. Total Dry Film Thickness (DFT) of primer shall not be less than 125 microns.

b) Finish Paint - Three (3) coats Polyamine HB Epoxy Paint. Total Dry Film Thickness (DFT) of finish paint shall not be less than 125 microns per coat.

c) Total thickness of primer and paint should not be less than 500 microns.

4.03.05 All motors, local push button stations, cable racks, structures used for supports etc. are to be painted with acid proof paint.

4.03.06 The following surfaces shall not be painted - stainless steel, galvanized steel, aluminum, copper, brass, bronze and other nonferrous materials.

4.03.07 No painting or filler shall be applied until all repairs, hydrostatic tests and final shop inspection are completed.

4.03.08 All machined surfaces shall have two (2) coats of water repellant grease after thorough cleaning.

5.00.00 COATING PROCEDURE AND APPLICATION

5.01.00 Surface preparation :

Pipe shall be blast cleaned by sand. The cleanliness achieved prior to application shall be in accordance with the requirement of SSPC SP 10 /

NACE 2 / Sa2½ of ISO 8501 (near white metal)

a) The blast pattern or profile depth shall be 40 to 100 micron and shall be measured by dial micrometer.

b) Before sand blasting is started or during blasting or coating, temperature of the pipe surface should be more than 3°C above dew point temperature. Blast cleaned surface should be primed within 4 hours and shall be protected from rainfall or surface moisture and shall not be allowed to flash rust. If the rust occurs, the surface again to be prepared by sand blasting or wire brushing.

5.02.00 **Application of Epoxy Coating**

a) Coating shall be applied when

i) When the pipe surface temperature shall be at least 3°C above dew point temperature.

ii) The temperature of mixed coating material and the pipe at the time of application shall not be lower than 10°C or greater that
50°C.

b) Material preparation shall be in accordance with manufacturer's recommendations.

c) Application of epoxy coating system :

The epoxy coating system shall be applied as per recommendation of the manufacturer and shall be applied by airless spray / plural component spray machine. For more than one coat, the second shall be applied with the time limits as recommended by the manufacturer.

5.03.00 **Application of PU Coating**

a) PU coating shall be applied when the pipe surface temperature at least 3°C above dew point temperature (when R.H is more than 85%).

b) Material preparation and application shall be done as per manufacturer recommendation.

6.00.00 **TEST REQUIREMENTS**

6.01.00 **Measurement of dry film thickness**

Measurement of dry film thickness of coating: Coating thickness shall be in the range of ±20% and as per SSPC PA 2.

6.01.01 **Apparatus / Instrument**

The instrument used for dry film thickness may be Type 1 pull of gauges or Type 2 electronic gauges.

6.01.02 **Procedures**

a) **Number of measurements**

For 100 square feet (9.29 square meters), five (5) spots per test area (each spot is 3.8 cm) in diameter. Three gauge readings per spot (average becomes the spot measurement).

b) If the structure is less than 300 square feet, each 100 square feet should be measured.

c) If the structure is between 300 and 1000 sq ft, select 3 random 100 square feet test areas and measure.

d) For structure exceeding 1000 square feet, select 3 random 100 square feet testing areas for the first 1000 sq ft and select 1 random 100 square feet testing area for each additional 1000 square feet

e) Coating thickness Tolerance: Individual reading taken to get a representative measurement for the spot are unrestricted (usually low or high readings are discarded). Spot measurements (the average of 3 gauge readings) must be within 80% of the minimum thickness and 120% of the maximum thickness.

Area measurement must be within specified range.

6.02.00 **Electrical Inspection (Holiday) Test**

6.02.01 All the coated / lined pipes shall be tested with an approved high voltage holiday detector preferably equipped with an audio visual signaling device to indicate any faults, holes, breaks or conductive particles in the protective coating.

6.02.02 The applied output voltage of holiday detector shall have a spark discharge of thickness equal to at least twice the thickness of the coating to assure adequate inspection voltage and compensate for any variation in coating thickness. The electrode shall be passed over the coated surface at approximately half the spark discharge distance from the coated surface only one time at the rate of approximately 10 to 20m/min. The edge effect shall be ignored. Excessive voltage shall be avoided as it tends to induce holiday in the coated surface thereby giving erroneous readings.

6.02.03 While selecting test voltages, consideration should be given to the tolerance on coating thickness and voltage should be selected on the basis of maximum coating thickness likely to be encountered during testing of a particular pipe.

The testing voltage shall be calculated by using following formula. (as per NACE 0274 : 2004)

Testing Voltage V = 7900 √T ± 10 percent where T is the average coating thickness in mm.

6.02.04 Any audio visual sound or spark leads to indicate pinhole, break or conductive particle.

6.03.00 **Adhesion Pull off Test**

After holiday the coated surface is subjected to adhesion pull off test as per ASTMD 4541.

6.03.01 Apparatus / Instrument: Adhesion tester consists of three basic components:

A hand wheel, a black column containing a dragging indicator pin and scale in the middle and a base containing three legs and a pulling “Jaw” at the bottom and also dollies.

6.03.02 **Prepare the test surface**

Once test area is selected, test area shall be free of grease, oil, dirt, water. The area should be flat surfaces and large enough to accommodate the specified number of replicate test.

6.03.03 **Prepare Dolly (Test Pull Stub)**

The dolly is a round, two sided aluminium fixture. Both sides of the dolly looks same, however, one side sloped on top surface while flat on bottom surface. As the surface of the dolly is polished aluminium, roughen the same using a coarse sand paper.

6.03.04 **Select an adhesive**

Use araldite, a 100% solid epoxy adhesive. This adhesive requires at least 24 hours at room temperature to cure.

6.03.05 **Attach the dolly to the surface**

a) Using a wooden stick, apply an even layer of adhesive to the entire contact surface area of the dolly.

b) Carefully remove the excessive adhesive by using a cotton swab. Allow the adhesive to fully cure before performing the adhesion test.

c) Attach the dolly to the coated surface and gently push downward to displace any excessive adhesive.

d) Push the dolly inward against the surface, then apply tape across the head of the dolly.

6.03.06 **Adhesion Test Procedure**

a) Attach the adhesion tester to the dolly by rotating the hand wheel counter clockwise to lower the jaw of the device.

b) Slide the jaw completely under the head of the dolly. Position the three legs of the instruments so that they are sitting flat on the coated surface.

c) Slide the dragging indicator pin on the black column to zero by pushing it downward.

d) Firmly hold the base of the instrument in one hand and rotate the hand wheel clockwise to raise the jaw of the device that is attached to the head of the dolly. The dragging indicator pin will move upward on the black column as the force is increased and will hold the reading. Apply the tension using a moderate speed. Continue to increase the tension on the head of the dolly until (a) the minimum PSI/MPa/Kg/cm² required by project specification is exceeded and the test is discontinued, (b) the maximum PSI/MPa/Kg/cm² of adhesion tester has been achieved and dolly is still attached, (c) The force applied by the adhesion tester causes the dolly to dislodge.

e) Read the scale and record the adhesion value.

6.04.00 **Coating Repair**

Defective Coating shall be repaired in accordance with the following subsections.

6.04.01 **Surface Preparation**

Accessible areas of pipe requiring coating repairs shall be cleaned to remove debris and damaged coating using surface grinders or other means. The adjacent coating shall be feathered by sanding, grinding or other method. Accumulated debris shall be removed by blowing with contaminant free air or wiping with clean rags.

6.04.02 Areas not accessible for coating repair such as interior surfaces of small diameter pipe shall be reprocessed and recoated.

6.04.03 **Coating Application**

The coating system shall be applied to the prepared areas in accordance with procedure.

6.04.04 Repair Inspection:

Repaired portion shall be electrically inspected using a holiday detector.

6.05.00 **Welded Field Joints**

6.05.01 **Preparation**

The weld joints shall be cleaned so as to be free from mud, oil, grease, welding flux, weld spatter and other foreign contaminants. The cleaned metal surfaces of the weld joint shall then be blasted or abraded using rotary abrading pads. The adjacent liquid Epoxy / PU coating shall be feathered by abrading the coating surface for a distance of 25 mm.

6.05.02 **Electrical Inspection**

After curing the coating system applied to the welding joints shall be holiday tested. Any holidays indicated by the detector shall be marked with chalk to identify the area of repair.

7.00.00 **INFORMATION/DATA REQUIRED**

The Bidder shall submit complete list of paints and primers proposed, giving detail information, such as, chemical composition, drying time etc. and also unit rates for application of each type of paint along with supply shall be furnished.

SECTION-XII

SALIENT DESIGN DATA

[TABLE-I TO TABLE-VIII]

CONTENT

ANALYSIS OF COAL

Sl. No.	Characteristics	Unit	Design Coal	Worst Coal	Best Coal
1.	**Proximate Analysis (As received basis) :-**				
	Total Moisture	%	13.1	13.7	12.4
	Ash	%	41.0	43.7	38.1
	Volatile Matter	%	20.2	22.2	17.7
	Fixed Carbon	%	25.8	23.7	28.2
2.	**Ultimate Analysis (As received basis) :-**				
	Carbon	%	37.87	33.74	42.52
	Hydrogen	%	1.74	2.09	1.09
	Nitrogen	%	0.92	0.45	1.84
	Oxygen	%	5.19	5.92	3.96
	Sulphur	%	0.18	0.40	0.09
	Carbonates	%	-	-	-
	Phosphorous	%	-	-	-
	Total Moisture	%	13.1	13.7	12.4
	Ash	%	41.0	43.7	38.1
	Gross Calorific Value	Kcal/Kg	3200	3100	3450
	Hard Grove Index		62.6	70.0	52.0
	YGP Index	mg/kg	-	-	-

ANALYSIS OF ASH

ASH ANALYSIS						
Sl. No.	**Description**	**Symbol**	**Design Coal**	**Worst Coal**	**Best Coal**	**Range of Adequacy Coal**
1	Silica	(SiO_2)%	59.79	61.30	56.70	62.00 - 56.00
2	Alumina	(Al_2O_2)%	25.36	26.00	23.00	28.00 - 23.00
3	Iron Oxide	(Fe_2O_2)%	7.20	6.00	1000	6.00- 10.00
4	Titania	(TiO_2)%	1.20	1.00	1.50	1.00- 1.70
5	Phosphoric Anhydride	(P_2O_5)%	2.60	1.50	3.00	1.00-3.00
6	Lime	(CaO)%	0.88	0.50	1.50	050-1.70
7	Magnesia	(MgO)%	0.55	0.40	1.00	0.40- 1.10
8	Sulphuric Anhydride	(SO_2)%	1.20	0.50	1.40	0.50- 1.70
9	Alkalies (by diff.)	(Na_2O+K_2O)%	1.22	080	1.40	0.60- 1.80
ASH FUSION RANGE (Under reducing atmosphere)						
1	Initial Deformation Temperature	IDT^{O}C	1100	1100	1100	1100-1150
2	Hemispherical Temperature	HT^{O}C	1300	1250	1350	1250-1400
3	Flow Temperature	ET^{O}C	1400	1400	1400	1400- 1450

HEAVY FUEL OIL ANALYSIS

		Heavy Fuel Oil (HFO)
	Properties	As per IS-1593 1971 Heavy Grade
1.0	Viscosity CS	370 maximum at 50 °C
2.0	Flash point, minimum, °C (pensky – Martens closed)	66
3.0	Pour Points °C	
4.0	GCV, Kcal/Kg.	10,000
5.0	Ash content (by weight) % maximum	0.1
6.0	Total sulphur (by weight) % maximum	4.5
7.0	Sediment (by weight) % maximum	0.25
8.0	Water content (by volume) % maximum	1.0
9.0	Acidity (inorganic)	Nil
10.0	Carbon residue (Ramsbottom) (by weight) % maximum	-

Note : For calculation, in case of HFO, 30% wax content with latent heat of fusion 54 Kcal/Kg. Has been assumed.

LIGHT DIESEL OIL ANALYSIS

1.	Specification	:	IS-1460 (latest revision).
2.	Acidity (Inorganic)	:	Nil.
3.	Ash Content	:	0.02% (Maximum) by weight.
4.	Flash Point (Pensky-Martens, closed)	:	66 Deg.C.
5.	Pour Point (Winter)	:	12 Deg.C.
	Pour Point (Summer)	:	18 Deg.C.
6.	Kinematic Viscosity at 38 Deg.C	:	2.5 to 15.7 Centi-stokes.
7.	Sediment by weight	:	0.10% (maximum).
8.	Water Content by volume	:	0.25% (maximum).
9.	Sulphur by weight	:	1.8% (maximum).
10.	Carbon Residue (Ramsbottom) by weight	:	1.5% (maximum).
11.	Gross Calorific Value	:	10,000 Kcal/Kg.
12.	Specific gravity	:	0.85 at 15^{o} C.

DESIGN RAW WATER ANALYSIS

SL.NO.	Different Characteristic	Results
1.	Calcium (Ca^{++}) as $CaCO_3$	86
2.	Magnesium (Mg^{++}) as $CaCO_3$	52
3.	Sodium & Potassium (Na^{+} & K^{+}) as $CaCO_3$	138
	Total Cations	**276**
4.	Bicarbonates (HCO_3) as $CaCO_3$	200
5.	Carbonates (CO_3) as $CaCO_3$	-
6.	Hydroxyde (OH) as $CaCO_3$	-
7.	Sulphate (SO_4) as $CaCO_3$	35
8.	Chloride (Cl) as $CaCO_3$	41
9.	Nitrate (NO_3) as $CaCO_3$	-
10.	Phosphate (PO_4) as $CaCO_3$	-
	Total Anions	**276**
11.	Total Hardness (as $CaCO_3$)	138
12.	Permanent Hardness (as $CaCO_3$)	-
13.	Temporary Hardness (as $CaCO_3$)	138
14.	Methyl Orange Alkalinity (as $CaCO_3$)	200
15.	Phenolphthalein Alkalinity (as $CaCO_3$)	-
16.	Iron (Original) (as Fe)	-
17.	Iron (in solution) (as Fe)	1.0
18.	Manganese (as Mn)	-
19.	Ammonia, free (as NH_3)	-
20.	Carbon Dioxide free (as CO_2)	-
21.	Silica (in solution (as SiO_2)	20.0
22.	Dissolved Oxygen (O_2)	-
23.	Suspended Solids	-
24.	Dissolved Solids	438
25.	pH at 25 °C	7.5 – 8.0
26.	Organic Matter (in terms of Oxygen absorbed from acid permanganate solution in 4 hours)	2.0
27.	Appearance	Turbid
28.	Odour	Nil
29.	Turbidity	500 NTU

DESIGN CLARIFIED WATER ANALYSIS

CONSTITUENTS	As	CONTENT
Calcium	$CaCO_3$	105 ppm
Magnesium	$CaCO_3$	52 ppm
Sodium and Potassium	$CaCO_3$	138 ppm
Hydrogen (FMA)	$CaCO_3$	--
TOTAL CATIONS	$CaCO_3$	295 ppm
Bicarbonate	$CaCO_3$	196.5 ppm
Carbonate	$CaCO_3$	-
Chloride	$CaCO_3$	41 ppm
Sulphate	$CaCO_3$	57.5 ppm
Nitrate	$CaCO_3$	-
TOTAL ANIONS	$CaCO_3$	295 ppm
M.O. Alkalinity	$CaCO_3$	196.5 ppm
P. Alkalinity	$CaCO_3$	
Total Hardness	$CaCO_3$	157 ppm
Carbon-di-oxide	CO_2	3.5
Dissolved Silica	SiO_2	20 ppm
Total Iron	Fe	1 ppm
pH Value	-	7.9 – 8.0
Turbidity, NTU	-	20
Organic Matter Content in terms of Oxygen in absorbed from ($KMnO_4$ (4 Hrs.)		5 ppm

Note:
The analysis of the clarified water is exhibited here, shall be multiplied with 5.0 COC to derive the circulating water analysis.

CHEMICAL COMPOSITION OF LIMESTONE

1.	CaO	%	45.9-51.0
2.	MgO	%	0.9-3.8
3.	Fe_2O_3	%	0.45-1.0
4.	Al_2O_3	%	1.19-2.1
5.	Si_2O_3	%	2.1-4.5
6.	Mn_2O_3	%	<0.12
7.	P_2O_5	%	Traces
8.	Cl_2	%	<0.015
9.	Na_2O	%	<0.16
10.	K_20	%	<0.01
11.	TiO_2	%	<0.02
12.	Total Sulphur	%	<0.1
13.	LOI	%	38.0-41.3
Physical Properties:			
1.	Bond Index	kWh/t	13
2.	Granule size		(-) 20

Note: The final chemical composition and properties shall be provided to successful bidder during detail engineering

DESIGN DM WATER ANALYSIS

Sl. No.	Description	Max. Limit
1.00	Total Electrolyte	0.1 ppm, max.
2.00	Total SiO_2	0.01 ppm, max.
3.00	Iron as Fe	Nil
4.00	Free CO_2 ppm as CO_2	Nil
5.00	Total Hardness	Nil
6.00	pH value at 25 Deg.C	6.8 – 7.2
7.00	Conductivity, micro mho/cm	Less than 0.1 at 25 Deg. C

SECTION: I

SUB-SECTION: C-3

TECHNICAL SPECIFICATION (ELECTRICAL PORTION)

THE WEST BENGAL POWER DEVELOPMENT CORPORATION LIMITED

SAGARDIGHI THERMAL POWER PROJECT
1X660MW UNIT NO. 5, PHASE-III

AIR CONDITIONING SYSTEM

TECHNICAL SPECIFICATION
(ELECTRICAL PORTION)

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA, UP (INDIA) – 201301

TITLE:	SPECIFICATION NO.
TECHNICAL SPECIFICATION FOR AIR CONDITIONING SYSTEM **SAGARDIGHI THERMAL POWER PROJECT 1 X 660 MW UNIT NO. 5, PHASE-III**	VOLUME NO. : **II-B** SECTION: **C** REV NO. : **00** DATE: SHEET: 1 OF 1

CONTENTS

THE REQUIREMENT MENTIONED IN SECTION-I SHALL PREVAIL AND GOVERN IN CASE OF CONFLICT BETWEEN THE SAME AND THHE CORRESPONDING REQURMENTS MENTIONED IN THE DESCRIPTIVE PORTION IN SECTION-II.

TITLE:	SPECIFICATION NO.
TECHNICAL SPECIFICATION FOR AIR CONDITIONING SYSTEM **SAGARDIGHI THERMAL POWER PROJECT 1 X 660 MW UNIT NO. 5, PHASE-III**	VOLUME NO. : **II-B** SECTION: **C** REV NO. : **00** DATE: SHEET: 1 OF 1

SPECIFIC TECHNICAL REQUIREMENT: ELECTRICAL

1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER:

The equipment and services to be provided by bidder under this specification shall be as detailed here below but shall not be limited to the following:

a) Services and Equipment as per "Electrical Scope between BHEL and Vendor".

b) Any item/work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the work for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification. The bidder without any extra charge shall provide the same.

c) Supply of mandatory spares as specified in the specifications of mechanical equipments.

d) Electrical load requirement for **Air Conditioning System.**

e) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.

f) Bidder to furnish list of makes for each equipment at contract stage, which shall be subject to customer / BHEL approval without any commercial and delivery implications to BHEL.

g) Various drawings including GA drg, data sheet as per required format, quality plans, calculations, test reports, test certificates, operation and maintenance manuals, characteristic curves, wiring diagrams/schemes etc. shall be furnished as specified at contract stage. All documents shall be subject to customer / BHEL approval without any commercial implications to BHEL.

h) The sub-vendor list for various electrical items is subject to BHEL/Customer approval without any commercial implications.

i) Motors shall meet minimum requirement of Electric motor specification.

j) All routine tests and type tests reports as per applicable standards shall be furnished at contract stage.

k) Vendor to clearly indicate equipment locations and local routing lengths in their cable listing furnished to BHEL.

l) Cable BOQ worked out based on routing of cable listing provided by the vendor for "both end equipment in vendor's scope" shall be binding to the vendor with +10 % margin to take care of slight variation in routing length & wastages.

2.0 EQUIPMENT & SERVICES TO BE PROVIDED BY PURCHASER FOR ELECTRICAL & TERMINAL POINTS:

Refer "Electrical Scope between BHEL and Vendor".

3.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

3.1 Bidder shall confirm total compliance to the electrical specification without any deviation from the technical / quality assurance requirements stipulated in the form of compliance certificate/ NO deviation certificate.

3.2 No technical submittal such as copies of data sheets, drawings, write-up, quality plans, type test certificates, technical literature, etc, is required during tender stage. Any such submission even if made, shall not be considered as part of offer.

4.0 LIST OF ENCLOSURES

4.1 Electrical scope between BHEL & vendor
4.2 Load Data Format. (Annexure –II)
4.3 BHEL Cable listing format (Annexure –III)
4.4 Technical specification – Specification for Electric Motors/Actuators.
4.5 Datasheets & quality plan for motors.

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR(FOR EPC PROJECTS)

PACKAGES : AIR CONDITIONING SYSTEM
SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT
PROJECT: 1X660 MW SAGARDIGHI TPS

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V MCC	BHEL	BHEL	240 V AC (supply feeder)/415 V AC (3 PHASE 4 WIRE) supply shall be provided by BHEL based on load data provided by vendor at contract stage for all equipment supplied by vendor as part of contract. Any other voltage level (AC/DC) required will be derived by the vendor.
2	Local Push Button Station (for motors)	BHEL	BHEL	Located near the motor.
3	Power cables, control cables and screened control cables for a) both end equipment in BHEL's scope b) both end equipment in vendor's scope c) one end equipment in vendor's scope	 BHEL BHEL BHEL	 BHEL Vendor BHEL	1. For 3.b) & c): Sizes of cables required shall be informed by vendor at contract stage (based on inputs provided by BHEL) in the form of cable listing. Finalisation of cable sizes shall be done by BHEL. Vendor shall provide lugs & glands accordingly. 2. Termination at BHEL equipment terminals by BHEL. 3. Termination at Vendor equipment terminals by Vendor.
4	Junction box for control & instrumentation cable	Vendor	Vendor	Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 10-12 mtrs) and trunk cable.
5	Any special type of cable like compensating, co-axial, prefab, MICC, optical fibre etc.	Vendor	Vendor	Refer C&I portion of specification for scope of fibre Optical cables if used between PLC/ microprocessor & DCS.
6	Cable trays, accessories & cable trays supporting system 100/ 50 mm cable trays/ Conduits/ Galvanised steel cable troughs for local cabling	BHEL Vendor	BHEL Vendor	Local cabling from nearby main route cable tray (BHEL scope) to equipment terminal (vendor's scope) shall be through 100/ 50 mm. cable trays/ conduits/ Galvanised steel cable troughs, as per approved layout drawing during contract stage.
7	Cable glands ,lugs and bimetallic strip for equipment supplied by Vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty tinned copper lugs for power and control cables.
8	Conduit and conduit accessories for cabling between equipment supplied by vendor	Vendor	Vendor	Conduits shall be medium duty, hot dip galvanised cold rolled mild steel rigid conduit as per IS: 9537.
9	Lighting	BHEL	BHEL	
10	Equipment grounding (including electronic earthing) & lightning protection	BHEL	BHEL	Refer note no. 4 for electronic earthing

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR(FOR EPC PROJECTS)

PACKAGES : AIR CONDITIONING SYSTEM
SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT
PROJECT: 1X660 MW SAGARDIGHI TPS

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
11	Below grade grounding	BHEL	BHEL	
12	LT Motors with base plate and foundation hardware	Vendor	Vendor	Makes shall be subject to customer/ BHEL approval at contract stage.
13	Mandatory spares	Vendor	-	Vendor to quote as per specification.
14	Recommended O & M spares	Vendor	-	As specified elsewhere in specification
15	Any other equipment/ material/ service required for completeness of system based on system offered by the vendor (to ensure trouble free and efficient operation of the system).	Vendor	Vendor	
16	a) Input cable schedules (Control & Screened Control Cables) b) Cable interconnection details for above c) Cable block diagram	Vendor Vendor Vendor	- - -	Cable listing for Control and Instrumentation Cable and electronic earthing cable in enclosed excel format shall be submitted by vendor during detailed engineering stage.
17	Electrical Equipment & cable tray layout drawings	Vendor	-	For ensuring cabling requirements are met, vendor shall furnish Electrical equipment layout & cable tray layout drawings (both in print form as well as in AUTOCAD) of the complete plant (including electrical area) indicating location and identification of all equipment requiring cabling, and shall incorporate cable trays routing details marked on the drawing as per PEM interface comments. Cabling arrangement of the same (wherever overhead cable trays, trenches, cable ducts, conduits etc.) shall be decided during contract stage. Electrical equipment layout & cable tray layout drawing shall be subjected to BHEL/ customer approval without any commercial implications to BHEL.
18	Electrical Equipment GA drawing	Vendor	-	For necessary interface review.

NOTES:

1. Make of all electrical equipment/ items supplied shall be reputed make & shall be subject to approval of BHEL/customer after award of contract.
2. All QPs shall be subject to approval of BHEL/customer after award of contract without any commercial implication.
3. In case the requirement of Junction Box arises on account of Power Cable size mis-match due to vendor engineering at later stage, vendor shall supply the Junction Box for suitable termination.
4. Vendor shall indicate location of Electronic Earth pit in their Civil assignment drawing.

LOAD TITLE	RATING (KW / A)		UNIT (U)/STN (S)	Nos.		VOLTAGE CODE*	FEEDER CODE**	EMER. LOAD (Y)	CONT.(C)/ INTT.(I)	STARTING TIME >5 SEC (Y)	LOCATION	BOARD NO.	CABLE		BLOCK CABLE DRG. No.	CONTROL CODE	REMARKS	LOAD No.	VERIFICATION FROM MOTOR DATASHEET (Y/N)	KKS NO
	NAME PLATE	MAX. CONT. DEMAND (MCR)		RUNNING	STANDBY								SIZE CODE	NOs						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

NOTES: 1. COLUMN 1 TO 12 & 18 SHALL BE FILLED BY THE REQUISITIONER (ORIGINATING AGENCY); REMAINING COLUMNS ARE TO BE FILLED UP BY PEM (ELECTRICAL)/ CUSTOMER

2. ABBREVIATIONS : * VOLTAGE CODE (7):- (ac) A=11 KV, B=6.6 KV, C=3.3 KV, D=415 V, E=240 V (1 PH), F=110 V (cc): G=220 V, H=110 V, J=48 V, K=+24V, L=-24 V

: ** FEEDER CODE (8):- U=UNIDIRECTIONAL STARTER, B=BI-DIRECTIONAL STARTER, S=SUPPLY FEEDER, D=SUPPLY FEEDER (CONTACTER CONTROLLED)

LOAD DATA (ELECTRICAL)					
JOB NO.	445	ORIGINATING AGENCY		PEM (ELECTRICAL)	
PROJECT TITLE	1X660 MW SAGARDIGHI TPS	NAME		DATA FILLED UP ON	
SYSTEM	AIR CONDITIONING SYSTEM	SIGN.		DATA ENTERED ON	
DEPTT. / SECTION	MAX	SHEET 1 OF 1	REV. 00	DE'S SIGN. & DATE	

CABLE SCHEDULE FORMAT

ANNEXURE III

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

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

1. For the purpose of clarity, it may please be noted that the information given in regard to the cables to be routed through WinPath as per the system elaborated below is called "Cable List", while the term "Cable Schedule" applies to the cable list with routing information added after routing has been carried out.
2. The cable list shall be entered as an MS Excel file in the format as per enclosed template EXT_CAB_SCH_FORMAT.XLS. No blank lines, special characters, header, footer, lines, etc. shall be introduced in the file. No changes shall be made in the title line (first line) of the template.
3. The field properties shall be as under:
   a. UNITCABLENO: A/N, up to sixteen (16) characters; each cable shall have its own unique, unduplicated cable number. In case this rule is violated, the cable cannot be taken up for routing.
   b. FROM: A/N, up to sixty (60) characters; the "From" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
   c. TO: A/N, up to sixty (60) characters; the "To" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
   d. PURPOSE: A/N, up to sixty (60) characters; the purpose (i.e. power cable/ indication/ measurement, etc.) to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
   e. REMARKS: A/N, up to forty (40) characters; Any information pertinent to routing to be specified here (e.g., cable number of the cable redundant to the cable number being entered). Information in excess of 40 characters will be truncated after 40 characters.
   f. CABLESIZE: A/N, 7 characters exactly as per the codes indicated below shall be specified here. The program cannot route cables described in any other way/ format.
   g. PATHCABLENO: Field reserved for utilization by the program. User shall not enter any information here.
4. One list shall be prepared for each system/ equipment (i.e., separate and unique cable lists shall be prepared for each system).
5. The cables shall be described as per the scheme listed below:

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

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

(B) CABLE VOLTAGE CODES:
A = 11KV (Power cables)

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

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

(C) CABLE CODES

PVC Copper

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

PVC Aluminium

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

XLPE Copper

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

XLPE Aluminium

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

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

SECTION - II

A.C. & D.C. MOTORS

1.00.00 SCOPE

1.01.00 This specification covers the general requirements of the electric motors for plant auxiliary equipment except for special application like crane, lift, submersible pump etc., motors for which are covered in individual equipment specifications.

1.02.00 Motors shall be furnished in accordance with both this general specification and the accompanying driven equipment specification.

1.03.00 In case of any discrepancy, the driven equipment specification shall govern.

2.00.00 STANDARDS

2.01.00 All motors shall conform to the latest applicable IS, IEC and CBIP Standards/Publications except when otherwise stated herein or in the driven equipment specification.

2.02.00 Equipment and materials conforming to any other standard, which ensures equal or better quality may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid.

3.00.00 SERVICE CONDITIONS

3.01.00 The motors will be installed in hot, humid and tropical atmosphere, highly polluted area.

3.02.00 Unless otherwise noted, electrical equipment/system design shall be based on the service conditions and auxiliary power supply given in the annexure of this specification.

3.03.00 For motor installed outdoor and exposed to direct sun rays, the effect of solar heat shall be considered in the determination of the design ambient temperature.

4.00.00 TYPE AND RATING

4.01.00 **A.C. Motors**

4.01.01 Motors shall be general purpose, constant speed, squirrel cage, three/single phase, induction type.

4.01.02 All motors shall be either totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) or closed air circuit air cooled (CACA) or closed air water cooled (CACW) type. Temperature rise shall be limited to 70 deg C by resistance method.

4.01.03 All motors shall be rated for continuous duty. They shall also be suitable for long period of inactivity.

4.01.04 All LT motor shall conform to minimum efficiency performance standards (MEPS) of IE2 mentioned in IS: 12615. All HT motors shall have efficiency and power factor higher than 90% and 0.83 respectively.

4.01.05 The motor name-plate rating at 50°C shall have at least 15% margin for LT system and 10% margin for HT system, over the input power requirement of the driven equipment at rated duty point and also covering the maximum load demand of the driven equipment under entire operating range, including voltage and frequency variations, unless stated otherwise in driven equipment specification or in general electrical specification.

4.01.06 The motor characteristics shall match the requirements of the driven equipment so that adequate starting, accelerating, pull up, break down and full load torques are available for the intended service. The direction of rotation of motor and its cooling fan should be properly matched with the driven equipment.

4.02.00 AC motor for VFD application (If applicable)

4.02.01 Inverter duty motors are designed according to the requirements of IEC/TS-60034 part17 & part 25 or NEMA MG-1, Part-30, Part 31 and have performance characteristics match with the driven equipment and variable speed requirement.

4.02.02 Induction motors to be operated in adjustable-speed drive applications should be de-rated as per NEMA/IEC standard due to the reduction in cooling resulting from any reduction in operating speed and the effect of additional losses introduced by harmonics generated by the control.

4.02.03 Inverter duty motors shall have VPI/improved insulation systems that do not degrade readily due to transient voltage spikes and have an adequate thermal margin.

4.02.04 Inverter duty motors shall be self ventilated without any auxiliary blower. Force ventilation shall be subject to purchaser approval.

4.02.05 Inverter motor shall be suitable for scalar (open loop) control, without any speed feedback signal, where fast response is not required. Vector (closed loop) control will be used with encoder if specified.

4.02.06 The breakdown torque at any frequency within the defined frequency range shall be not less than 150% of the rated torque at that frequency when rated voltage for that frequency is applied.

4.02.07 The motor should be capable of producing a breakaway torque of at least 140% of rated torque requiring not more than 150% rated current when the voltage boost is adjusted to develop rated flux in the motor and when the inverter is able to produce the required minimum fundamental frequencies

4.02.08 The motor shall be provided with insulated bearing on one side.

4.02.09 Normally the maximum safe speed shall be as per IEC/NEMA, however it should be coordinated with VSD requirement.

4.02.10 In case of a conflict, the requirement mentioned under clause no. 4.02.00 for motors for VFD application shall supersede the corresponding requirement for standard motors.

4.03.00 **D. C. Motors**

4.03.01 D.C. motor provided for emergency service shall be shunt wound type. It can also be of compound-wound type with the series field shorted.

4.03.02 Motor shall be sized for operation with fixed resistance starter for maximum reliability. Starter panel complete with all accessories shall be included in the scope of supply.

5.00.00 PERFORMANCE

5.01.00 **Running Requirements**

5.01.01 Motor shall run continuously at rated output over the entire range of voltage and frequency variations as given in the annexure.

5.01.02 The motor shall be capable of operating satisfactorily at full load for 5 minutes without injurious heating with 75% rated voltage at motor terminals.

5.02.00 **Starting Requirements**

5.02.01 Motor shall be designed for direct on line starting at full voltage. Starting current at rated voltage for LT motors shall be 6 times of full load current plus IS tolerance. For 3.3KV and 11KV motor except BFP, starting current shall be maximum 6 times of full load current inclusive IS tolerance. For Boiler feed pump motor, starting current shall be limited to 4.5times of full load current plus IS tolerance.

For D.C. Motors the starting current shall be limited to 2 times full load current.

5.02.02 The motor shall be capable of withstanding the stresses imposed if started at 110% rated voltage.

5.02.03 Motor shall start with rated load and accelerate to full speed with 80% rated voltage at motor terminals without exceeding acceptable winding temperature.

5.02.04 Motor shall be capable of three equally spread starts per hour, two starts in quick succession from cold condition and one restart from hot condition.

5.02.05 Pump motor subject to reverse rotation shall be designed to withstand the stresses encountered when starting with non-energized shaft rotating at 125% rated speed in reverse direction.

5.03.00 Stress During Bus Transfer

5.03.01 The motor may be subjected to sudden application of 150% rated voltage during bus transfer, due to the phase difference between the incoming voltage and motor residual voltage.

5.03.02 The motor shall be designed to withstand any torsional and/or high current stresses, which may result, without experiencing any deterioration in the normal life and performance characteristics.

5.04.00 Locked Rotor Withstand Time

5.04.01 For motors with starting time upto 20 secs, starting time at minimum permissible voltage should be less than the locked rotor withstand time under hot condition at highest voltage limit by at least 2.5 secs.

For motors with starting time more than 20 secs. and upto 45 secs, starting time at minimum permissible voltage should be less than the locked rotor withstand time under hot condition at highest voltage limit by at least 5 secs.

For motors with starting time more than 45 secs, starting time at minimum permissible voltage should be less than the locked rotor withstand time under hot condition at highest voltage limit by at least 10% of the starting time

5.04.02 To prevent unwanted tripping of a high inertia load at start-up, there may be need to shunt out the motor's overload trip device. Speed switches mounted on the motor shaft may be provided in such case. Heating experienced during start-up must still be considered when sizing the motor.

5.04.03 Hot thermal withstand curve shall have a margin of at least 10% over the full load current of the motor to permit relay setting utilising motor rated capacity.

5.05.00 Torque Requirements

5.05.01 Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque.

5.05.02 Pull out torque at rated voltage shall not be less than 205% of full load torque.

6.00.00 SPECIFIC REQUIREMENTS

6.01.00 Enclosure

6.01.01 Enclosures for the motor and the cable box shall conform to the degree of protection IP-55 unless otherwise specified.

6.01.02 Motors like circulating water pumps of large output ratings, located inside a building and not directly exposed to coal dust or fly ash, could have screen protected drip proof enclosure conforming to IP-23.

6.01.03 Motor located in hazardous area shall have flameproof enclosure conforming to IS: 2148 /Equiv. as detailed below:

a) Fuel Oil area : Group IIB
b) Hydrogen generation plant area : Group IIC (or Group-I, Div-II as per NEC or Class-1, Gr-B, Div-II as per NEMA/IEC60034)

Separate Canopy shall be provided for LT motors located in outdoor or semi-outdoor area.

6.02.00 **Cooling**

6.02.01 The motor shall be self ventilated type, either totally enclosed fan cooled (TEFC) or closed air circuit air cooled (CACA).

6.02.02 For large capacity motors, totally enclosed tube ventilated (TETV) may be considered for acceptance. In case of motors rated 3000kW and above, closed air circuit water cooled (CACW) motors may be offered for consideration before proceeding with design and manufacturing.

6.03.00 **Winding and Insulation**

6.03.01 All insulated winding shall be of copper.

6.03.02 HT motors shall have Class F insulation with winding temperature limited to 120ºC. Windings shall be impregnated to make them non-hygroscopic and oil resistant. The lightning impulse and coil inter-turn insulation surge withstand level shall be as per IEC-60034 – Part 15.

6.03.03 LT motors shall have Class F or higher insulation with temperature limited to 120ºC.

6.04.00 **Tropical Protection**

6.04.01 All motors shall have fungus protection involving special treatment of insulation and metal against fungus, insects and corrosion.

6.04.02 All fittings and hardware shall be corrosion resistant.

6.05.00 **Bearings**

6.05.01 Motor rated above 1000kW shall have insulated bearings to prevent flow of shaft currents.

6.05.02 Vertical shaft motors shall be provided with thrust and guide bearings.

6.06.00 **Noise & Vibration**

6.06.01 Noise level shall not exceed 85 db (A) except for BFP motor for which the maximum limit shall be 90 db (A).

6.06.02 Peak amplitude of vibration shall be limited within the values prescribed in IS:12075 / IEC 60034-14.

6.07.00 **Motor Terminal Box**

6.07.01 Motor terminal box shall be detachable type, made of cast iron or pressed steel and located in accordance with Indian Standards clearing the motor base- plate/ foundation.

6.07.02 Terminal box shall be capable of being turned 360° in steps of 90°, unless otherwise approved.

6.07.03 Terminal box for all LT motors shall be diagonally split type and shall have the same degree of protection as motor.

6.07.04 The terminal box shall have sufficient space inside for termination /connection of suitable sized HT cables. Where the specified main cable size demands, adopter/extension box of suitable size shall be provided as a part integral to the motor, for easy termination of the cable.

6.07.05 Terminals shall be stud or lead wire type, substantially constructed and thoroughly insulated from the frame.

6.07.06 The terminals shall be clearly identified by phase markings, with corresponding direction of rotation marked on the non-driving end of the motor.

6.07.07 The terminal box shall be capable of withstanding maximum system fault current for a duration of 0.25 sec.

6.07.08 For HT motor, the terminal box shall be phase segregated type. The neutral leads shall be brought out in a separate terminal box (not necessarily phase segregated type) with shorting links for star connection.

6.07.09 Motor terminal box shall be furnished with suitable cable lugs and double compression brass glands to match Owner's cable. All threads shall be ISO metric thread only.

6.07.10 The gland plate for single core cable shall be non-magnetic type.

6.08.00 **Grounding**

6.08.01 The frame of each motor shall be provided with two separate and distinct grounding pads complete with tapped hole, GI bolts and washer.

6.08.02 The grounding connection shall be suitable for accommodation of ground conductors as follows:

Motor above 90 kW	50 x 6 mm GI Flat
Motor above 30 kW upto 90 kW	35 x 6 mm GI Flat
Motor above 5 kW upto 30 kW	25 x 3 mm GI Flat
Motor upto 5 kW	8 SWG GI Wire

The above sizes shall be superseded by different sizes if so indicated in the relevant clause of the General Electrical Specification.

6.08.03 The cable terminal box shall have a separate grounding pad.

6.09.00 **Rating Plate**

In addition to the minimum information required by IS, the following information shall be shown on motor rating plate :

a. Temperature rise in ^{o}C under rated condition and method of measurement.
b. Degree of protection.
c. Bearing identification no. and recommended lubricant.
d. Location of insulated bearings.

7.00.00 ACCESSORIES

7.01.00 General

Accessories shall be furnished, as listed below, or if otherwise required by driven equipment specification or application.

7.02.00 Space Heater

7.02.01 Motor of rating 30 kW and above shall be provided with space heaters, suitably located for easy removal or replacement.

7.02.02 The space heater shall be rated 240 V, 1 phase 50 Hz and sized to maintain the motor internal temperature above dew point when the motor is idle.

7.03.00 Temperature Detectors

7.03.01 All HT motors shall be provided with minimum four (4) numbers simplex or two (2) numbers duplex platinum resistance type winding temperature detectors per phase.

7.03.02 Each bearing of HT shall be provided with minimum one (1) duplex or two (2) simplex type temperature detectors.

7.03.03 The temperature detector mentioned above shall be resistance type, 3 wire, platinum wound, 100 Ohms at 0^{o}C.

7.04.00 Indicator/Switch

7.04.01 Dial type local indicator with alarm contacts shall be provided for the following: -

a) HT motor bearing temperature.

b) Hot and cold air temperature of the closed air circuit for CACA and CACW motor.

7.04.02 Flow switches shall be provided for monitoring cooling water flow of CACW motor and oil flow of forced lubrication bearing, if used.

7.04.03 Alarm switch contact rating shall be minimum 0.5 A at 220V D.C. and 5A at 240V A.C.

7.05.00 Current Transformer for Differential Protection

7.05.01 Motor above 1000 kW shall be provided with three differential current transformers (PS class) mounted over the neutral leads within the enclosure. Matching three (3) numbers PS class CTs shall be mounted on the switchgear end.

7.05.02 The arrangement shall be such as to permit easy access for C.T. testing and replacement. Current transformer characteristics shall match Owner's requirements to be intimated later.

7.06.00 **Accessory Terminal Box**

7.06.01 All accessory equipment such as space heater, temperature detector, current transformers etc., shall be wired to and terminated in terminal boxes, separate from motor (power) terminal box.

7.06.02 Accessory terminal box shall be complete with double compression brass glands and pressure type terminals to suit owner's cable connections.

7.07.00 **Drain Plug**

Motor shall have drain plugs so located that they will drain the water, resulting from the condensation or other causes from all pockets of the motor casing.

7.08.00 **Lifting Provisions**

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

7.09.00 **Dowel Pins**

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

7.10.00 **Painting**

Motor including fan shall be painted with corrosion proof paints. The paint shade shall be as specified in the Annexure.

8.00.00 TESTS

8.01.00 Upon completion, each HT & LT motor shall be subject to routine tests as per Schedule-C of Section -I. In addition, any special test called for in the driven equipment specification shall be performed.

8.02.00 Unless and otherwise stated, Six (6) copies of routine test certificates shall be submitted for approval prior to the despatch of the motors from works.

8.03.00 The following type test reports shall be submitted for each type and rating of HT motor:

a) Degree of protection test for the enclosure followed by IR, HV and no load run test.

b) Fault level withstand test for each type of terminal box.

c) Lightning impulse withstand test on the sample coil as per IEC 60034, part-15.

d) Surge withstand test on inter-turn insulation as per clause no. 5.1.2 of IEC 60034, part-15.

8.03.04 The following type tests shall be performed on a representative sample of 11000V and 3300V motor of each type & rating, even if type test certificates of these tests are submitted by the Bidder for Purchaser's approval:

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

b. No load test at rated voltage to determine voltage, current, power input and speeds.

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

d. Full load test to determine efficiency, power factor and slip.

e. Temperature rise test. During heat run test, bearing temperature, Winding temperature, core temperature, coolant flow and its temperature shall be recorded. In case temperature rise test is carried at any load other than rated load, specific approval for test procedure and method has to be obtained.

f. Momentary overload test.

g. Test for noise level of motor.

9.00.00 SPARE

Recommended spares for three (3) years operation shall be quoted along with the bid clearly identifying the part numbers with recommended quantities.

10.00.00 DRAWINGS, DATA & MANUALS

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

10.01.00 Along with the bid

a) List of the motors
b) Individual motor data sheet as per Annexures
c) Scheme & write up on forced lubrication system, if any.
d) Type test report

10.02.00 After Award of Contract for Information (I)/ Approval (A)

a) Dimensional General Arrangement drawing (I)
b) Foundation Plan & Loading (I)
c) Cable end box details.(I)
d) Space requirement for rotor removal (I)
e) Thermal withstands curves hot & cold (I)
f) Starting and speed torque characteristics at 80%, 100% & 110% voltage (A)
g) Complete motor data sheet (A)
h) Erection & Maintenance Manual (I)

ANNEXURE-A

SECTION-I

DESIGN DATA

1.0 AUXILIARY POWER SUPPLY

Supply	Description	Consumer
H.T. Supply	11 kV, 3 Ø/, 3W, 50 Hz Non-effectively earthed Fault level 40 KA symm. for 3 second.	Motors above 1500 kW
H.T. Supply	3.3 kV, 3 Ø/, 3W, 50 Hz Non-effectively earthed Fault level 40 KA symm. for 3 second.	Motors above 160kW upto 1500 kW.
L.T. Supply	415V, 3 Ø/, 3W, 50 Hz Effectively earthed Fault level 50 KA symm. for 1 seconds.	Motors above 200W upto 160 kW
	240V, 1 Ø/, 2W, 50 Hz Effectively earthed	Motors below 200W Lighting, space heating, A.C. control protective devices
D.C. Supply	220V, 2W, unearthed Fault level 25* KA for 1 second (Min.)	D.C. alarm, control protective devices

* However actual value shall be substantiated by the bidder through calculation.

2.0 RANGE OF VARIATION

A.C. Supply

Voltage : ±10%

Frequency : ±5%

Combined Volt & frequency : 10% (absolute sum)

D.C. Supply

Voltage : 190 to 240 Volt

3.0 Paint Shade : RAL 7032

SECTION-I

TITLE	SPECIFICATION NO.
LV MOTORS **DATA SHEET-A**	VOLUME II B
	SECTION D
SAGARDIGHI THERMAL POWER PROJECT **1 x 660 MW UNIT NO. 5, PHASE – III**	REV NO. 00 DATE 05.04.21
	SHEET 1 OF 1

1.0	Design ambient temperature	:	50 °C
2.0	Maximum acceptable kW rating of LV motor	:	Upto & Including 160KW
3.0	Installation (Indoors/ Outdoors)	:	As required
4.0	Details of supply system		
	a) Rated voltage (with variation)	:	415V ± 10%
	b) Rated frequency (with variation)	:	50 Hz (Variation: +5% TO –5%)
	c) Combined voltage & freq. variation	:	10% (sum of absolute values)
	d) System fault level at rated voltage	:	50 kA for 1 sec
	e) Short time rating for terminal boxes		
	*Above 90 kW upto & including 160kW(Breaker Controlled)	:	50 KA for 0.25 sec.
	* Rated upto & including 90 kW (Contactor Controlled)	:	50 KA protected by MCCB
	f) LV System grounding	:	Solidly
5.0	Class of insulation	:	Class 'F', with temp rise limited to class B.
6.0	Minimum voltage for starting	:	80% of rated voltage
7.0	Power cables data	:	Shall be given during Detailed engg.
8.0	Earth Conductor Size & Material	:	Shall be given during Detailed engg.
9.0	Space heater supply **(30KW & ABOVE)**	:	240 V, 1Φ , 50 Hz
10.0	Rating up to which Single phase motor	:	Acceptable below 0.20 Kw
11.0	Locked rotor current a) Limit as percentage of FLC	:	As per IS 12615
12.0	Makes	:	BHEL/ Customer approval (Package owner to take care)
13.0	Paint shade	:	RAL 7032
15.0	Additional tests	:	As per QP
14.0	Degree Of protection for motor/ terminal box	:	IP 55

* LT motors of continuous duty shall be energy efficient IE3 class conforming to IS-12615

15.0 TESTING REQUIREMENTS: IN LINE WITH SPECIFICATION

- **Also detailed Customer spec. for Motors is to be referred as enclosed with technical spec.**

SECTION-I

ANNEXURE-I

SUB-VENDOR LIST

The list of approved make of the LT Motors are as mentioned below:

S.No.	LIST OF LT MOTORS
1.	BHARAT BIJLEE LTD.
2.	CROMPTON GREAVES
3.	ASEA BROWN BOVERI
4.	KIRLOSKAR ELECTRIC CO LTD.
5.	NGEF
6.	SIEMENS
7.	MARATHON
8.	GE-POWER
9.	RAJINDRA ELECT INDUSTRIES
10.	LAXMI HYDRAULICS PVT. LTD

However, the final list of makes for the LT Motors is subjected to BHEL/Customer approval, during contract stage, without any commercial implications.

	TITLE	SPECIFICATION NO.
BHEL	HT AND LT MOTOR DATA SHEET – C SAGARDIGHI THERMAL POWER PROJECT 1 x 660 MW UNIT NO. 5, PHASE – III	VOLUME II B SECTION D REV NO. 00 DATE SHEET 1 OF 2

S. No.	Description	Data to be filled by successful bidder
A.	**General**	
1	Manufacturer & country of origin	
2	Motor type	
3	Type of starting	
4	Name of the equipment driven by motor & Quantity	
5	Maximum Power requirement of driven equipment	
6	Rated speed of Driven Equipment	
7	Design ambient temperature	
B.	**Design and Performance Data**	
1	Frame size & type designation	
2	Type of duty	
3	Rated Voltage	
4	Permissible variation for	
5	a Voltage	
6	b Frequency	
7	c) Combined voltage & frequency	
8	Rated output at design ambient temp (by resistance method)	
9	Synchronous speed & Rated slip	
10	Minimum permissible starting voltage	
11	Starting time in sec with mechanism coupled	
12	a) At rated voltage	
13	b) At min starting voltage	
14	Locked rotor current as percentage of FLC (including IS tolerance)	
15	Torque	
	a) Starting	
	b) Maximum	
16	Permissible temp rise at rated output over ambient temp & method	
17	Noise level at 1.0 m (dB	
18	Amplitude of vibration	
19	Efficiency & P.F. at rated voltage & frequency	
	a) At 100% load	
	c) At 75% load	

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

	TITLE	SPECIFICATION NO.
BHEL	LV MOTOR DATA SHEET – C SAGARDIGHI THERMAL POWER PROJECT 1 x 660 MW UNIT NO. 5, PHASE – III	VOLUME II B SECTION D REV NO. 00 DATE SHEET 2 OF 2

S. No.	Description	Data to be filled by successful bidder
	c) At starting	
C.	**Constructional Features**	
1	Method of connection of motor driven equipment	
2	Applicable Standard	
3	DOP of Enclosure	
4	Method of cooling	
5	Class of insulation	
6	Main terminal box	
	a) Type	
	b) Power Cable details (Conductor, size, armour/unarmour)	
	c) Cable Gland & lugs details (Size, type & material)	
	d) Permissible Fault level (kArms & duration in sec)	
7	Space heater details (Voltage & watts)	
8	Flame proof motor details (if applicable)	
	a) Enclosure	
	b) suitability for hazardous area	
	i Zone	O / I / II
	ii Group	IIA / IIB / IIC
9	No. of Stator winding	
10	Winding connection	
11	Kind of rotor winding	
12	Kind of bearings	
13	Direction of rotation when viewed from NDE	
14	Paint Shade & type	
15	Net weight of motor	
16	Outline mounting drawing No (To be enclosed as annexure)	
D.	**Characteristic curves/ drawings** (To be enclosed for motors of rating ≥ 55KW)	
	a) Torque speed characteristic	
	b) Thermal withstand characteristic	
	c) Current vs time	
	d) Speed vs time	

NAME OF VENDOR					
			SEAL	REV.	
NAME	SIGNATURE	DATE			

BHEL	TITLE : GENERAL TECHNICAL REQUIREMENTs FOR LV MOTORS	SPECIFICATION NO. PE-SS-999-506-E101
		VOLUME NO. : II-B
		SECTION : D
		REV NO. : 00 DATE : 29/08/2005
		SHEET : 1 OF 1

GENERAL TECHNICAL REQUIREMENTS

FOR

LV MOTORS

SPECIFICATION NO.: PE-SS-999-506-E101 Rev 00

BHEL	TITLE : **GENERAL TECHNICAL REQUIREMENTs FOR LV MOTORS**	SPECIFICATION NO. PE-SS-999-506-E101
		VOLUME NO. : **II-B**
		SECTION : **D**
		REV NO. : **00** DATE : 29/08/2005
		SHEET : 1 OF 4

1.0 INTENT OF SPECIFIATION

The specification covers the design, materials, constructional features, manufacture, inspection and testing at manufacturer's work, and packing of Low voltage (LV) squirrel cage induction motors along with all accessories for driving auxiliaries in thermal power station.

Motors having a voltage rating of below 1000V are referred to as low voltage (LV) motors.

2.0 CODES AND STANDARDS

Motors shall fully comply with latest edition, including all amendments and revision, of following codes and standards:

IS:325	Three phase Induction motors
IS : 900	Code of practice for installation and maintenance of induction motors
IS: 996	Single phase small AC and universal motors
IS: 4722	Rotating Electrical machines
IS: 4691	Degree of Protection provided by enclosures for rotating electrical machines
IS: 4728	Terminal marking and direction of rotation rotating electrical machines
IS: 1231	Dimensions of three phase foot mounted induction motors
IS: 8789	Values of performance characteristics for three phase induction motors
IS: 13555	Guide for selection and application of 3-phase A.C. induction motors for different types of driven equipment
IS: 2148	Flame proof enclosures for electrical appliance
IS: 5571	Guide for selection of electrical equipment for hazardous areas
IS: 12824	Type of duty and classes of rating assigned
IS: 12802	Temperature rise measurement for rotating electrical machnines
IS: 12065	Permissible limits of noise level for rotating electrical machines
IS: 12075	Mechanical vibration of rotating electrical machines

In case of imported motors, motors as per IEC-34 shall also be acceptable.

3.0 DESIGN REQUIREMENTS

3.1 Motors and accessories shall be designed to operate satisfactorily under conditions specified in data sheet-A and Project Information, including voltage & frequency variation of supply system as defined in Data sheet-A

3.2 Motors shall be continuously rated at the design ambient temperature specified in Data Sheet-A and other site conditions specified under Project Information
Motor ratings shall have at least a 15% margin over the continuous maximum demand of the driven equipment, under entire operating range including voltage & frequency variation specified above.

3.3 Starting Requirements

3.3.1 Motor characteristics such as speed, starting torque, break away torque and starting time shall be properly co-ordinated with the requirements of driven equipment. The accelerating torque at any speed with the minimum starting voltage shall be at least 10% higher than that of the driven equipment.

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

The limiting value of voltage at rated frequency under which a motor will successfully start and accelerate to rated speed with load shall be taken to be a constant value as per Data Sheet - A during the starting period of motors.

3.3.3 The following frequency of starts shall apply

i) Two starts in succession with the motor being initially at a temperature not exceeding the rated load temperature.

ii) Three equally spread starts in an hour the motor being initially at a temperature not exceeding the rated load operating temperature. (not to be repeated in the second successive hour)

iii) Motors for coal conveyor and coal crusher application shall be suitable for three consecutive hot starts followed by one hour interval with maximum twenty starts per day and shall be suitable for mimimum 20,000 starts during the life time of the motor

3.4 **Running Requirements**

3.4.1 Motors shall run satisfactorily at a supply voltage of 75% of rated voltage for 5 minutes with full load without injurious heating to the motor.

3.4.2 Motor shall not stall due to voltage dip in the system causing momentary drop in voltage upto 70% of the rated voltage for duration of 2 secs.

3.5 **Stress During bus Transfer**

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

3.5.2 Motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torque under above condition.

3.6 Maximum noise level measured at distance of 1.0 metres from the outline of motor shall not exceed the values specified in IS 12065.

3.7 The max. vibration velocity or double amplitude of motors vibration as measured at motor bearings shall be within the limits specified in IS: 12075.

4.0 **CONSTRUCTIONAL FEATURES**

4.1 Indoor motors shall conform to degree of protection IP: 54 as per IS: 4691. Outdoor or semi-indoor motors shall conform to degree of protection IP: 55 as per IS: 4691and shall be of weather-proof construction. Outdoor motors shall be installed under a suitable canopy

4.2 Motors upto 160KW shall have Totally Enclosed Fan Cooled (TEFC) enclosures, the method of cooling conforming to IC-0141 or IC-0151 of IS: 6362.

Motors rated above 160 KW shall be Closed Air Circuit Air (CACA) cooled

4.3 Motors shall be designed with cooling fans suitable for both directions of rotation.

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

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

4.6 In case Class 'F' insulation is provided for LV motors, temperature rise shall be limited to the limits applicable to Class 'B' insulation.
In case of continuous operation at extreme voltage limits the temperature limits specified in table-1 of IS:325 shall not exceed by more than 10°C.

4.7 **Terminals and Terminal Boxes**

4.7.1 Terminals, terminal leads, terminal boxes, windings tails and associated equipment shall be suitable for connection to a supply system having a short circuit level, specified in the Data Sheet-A.

Unless otherwise stated in Data Sheet-A, motors of rating 110 kW and above will be controlled by circuit breaker and below 110 kW by switch fuse-contactor. The terminal box of motors shall be designed for the fault current mentioned in data sheet "A".

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

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

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

4.7.5 Motor terminals and terminal leads shall be fully insulated with no bar live parts. Adequate space shall be available inside the terminal box so that no difficulty is encountered for terminating the cable specified in Data Sheet-A.

4.7.6 Degree of protection for terminal boxes shall be IP 55 as per IS 4691.

4.7.7 Separate terminal boxes shall be provided for space heaters.. If this is not possible in case of LV motors, the space heater terminals shall be adequately segregated from the main terminals in the main terminal box. Detachable gland plates with double compression brass glands shall be provided in terminal boxes.

4.7.8. Phase terminal boxes shall be suitable for 360 degree of rotation in steps of 90 degree for LV motors.

4.7.9 Cable glands and cable lugs as per cable sizes specified in Data Sheet-A shall be included. Cable lugs shall be of tinned Copper, crimping type.

4.8 Two separate earthing terminals suitable for connecting G.I. or MS strip grounding conductor of size given in Data Sheet-A shall be provided on opposite sides of motor frame. Each terminal box shall have a grounding terminal.

4.9 **General**

BHEL	TITLE : **GENERAL TECHNICAL REQUIREMENTs** **FOR** **LV MOTORS**	SPECIFICATION NO. PE-SS-999-506-E101 VOLUME NO. : **II-B** SECTION : **D** REV NO. : **00** DATE : 29/08/2005 SHEET : 4 OF 4

4.9.1 Motors provided for similar drives shall be interchangeable.

4.9.2 Suitable foundation bolts are to be supplied alongwith the motors.

4.9.3 Motors shall be provided with eye bolts, or other means to facilitate safe lifting if the weight is 20Kgs. and above.

4.9.4 Necessary fitments and accessories shall be provided on motors in accordance with the latest Indian Electricity rules 1956.

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

4.9.6 Name plate with all particulars as per IS: 325 shall be provided

4.9.7 Unless otherwise specified, the colour of finish shall be grey to Shade No. 631 and 632 as per IS:5 for motors installed indoor and outdoor respectively. The paint shall be epoxy based and shall be suitable for withstanding specified site conditions.

5.0 INSPECTION AND TESTING

5.1 All materials, components and equipments covered under this specification shall be procured, manufactured, as per the BHEL standard quality plan No. PED-506-00-Q-006/0 and PED-506-00-Q-007/2 enclosed with this specification and which shall be complied.

5.2 LV motors of type-tested design shall be provided. Valid type test reports not more than 5 year shall be furnished. In the absence of these, type tests shall have to be conducted by manufacturer without any commercial implication to purchaser.

5.3 All motors shall be subjected to routine tests as per IS: 325 and as per BHEL standard quality plan.

5.4 Motors shall also be subjected to additional tests, if any, as mentioned in Data Sheet A.

6.0 DRAWINGS TO BE SUBMITTED AFTER AWARD OF CONTRACT

a) OGA drawing showing the position of terminal boxes, earthing connections etc.
b) Arrangement drawing of terminal boxes.
c) Characteristic curves:
(*To be given for motor above 55 kW unless otherwise specified in Data Sheet*).

i) Current vs. time at rated voltage and minimum starting voltage.
ii) Speed vs. time at rated voltage and minimum starting voltage.
iii) Torque vs. speed at rated voltage and minimum voltage.
For the motors with solid coupling the above curves i), ii), iii) to be furnished for the motors coupled with driven equipment. In case motor is coupled with mechanical equipment by fluid coupling, the above curves shall be furnished with and without coupling.
iv) Thermal withstand curve under hot and cold conditions at rated voltage and max. permissible voltage.

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
	CUSTOMER :		QP NO.: PE-QP-999-Q-006, REV-02	DATE: 17.04.2020
	PROJECT:		PO NO.:	DATE:
	ITEM: AC ELECT. MOTORS UPTO 55KW (LV (415V))	SYSTEM:	SECTION: II	SHEET 1 of 2

S. NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**		
					M	C/ N				D	M	C	N	
1.0	ASSEMBLY	1.WORKMANSHIP	MA	VISUAL	100%	-	MFG. SPEC.	MFG. SPEC.	LOG BOOK		P	-	-	
		2.DIMENSIONS	MA	VISUAL	100%	-	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	LOG BOOK		P	-	-	
		3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE	MA	VISUAL	100%	-	MFG.SPEC./	MFG.SPEC.	LOG BOOK		P	-	-	
2.0	PAINTING	1.SHADE	MA	VISUAL	SAMPLE	-	MFG. SPEC/ APPROVED DATASHEET	MFG. SPEC/ APPROVED DATASHEET	LOG BOOK	✓	P	V	-	
3.0	TESTS	1.ROUTINE TEST INCLUDING SPECIAL TEST	MA	VISUAL	100%	-	IS-325 / IS-12615/ APPROVED DATA SHEET	IS-325 / IS-12615/ APPROVED DATA SHEET	TEST/ INSPN. REPORT	✓	P	V *	-	* NOTE -1
		2.OVERALL DIMENSIONS & ORIENTATION	MA	MEASUREMENT & VISUAL	100%	-	APPROVED DRG/ DATA SHEET	APPROVED DRG/ DATA SHEET	TEST/ INSPN. REPORT	✓	P	V *	-	* NOTE -1 & NOTE-2

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:	HEMA KUSHWAHA	HEMA KUSHWAHA	Checked by:		KUNAL GANDHI
Reviewed by:	PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:	RITESH KUMAR JAISWAL	RITESH KUMAR JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
		CUSTOMER :		QP NO.: PE-QP-999-Q-006, REV-02	DATE: 17.04.2020
		PROJECT:		PO NO.:	DATE:
		ITEM: AC ELECT. MOTORS UPTO 55KW (LV (415V))	SYSTEM:	SECTION: II	SHEET 2 of 2

		3.NAMEPLATE DETAILS	MA	VISUAL	100%	-	IS-325 / IS-12615 / APPROVED DATA SHEET	SAME AS COL. 7	TEST/ INSPN. REPORT	✓	P	V	-	
4.0	PACKING	SURFACE FINISH & COMPLETENESS	MA	VISUAL	100%	100%	AS PER MFG. STANDARD / (#)	AS PER MFG. STANDARD / (#).	INSPC. REPORT	✓	P	W	-	(#) REFER NOTE-8

NOTES:
1. Routine tests on 100% motors shall be done by the vendor. However, BHEL/ Customer shall witness routine tests on random samples. The sampling plan shall be mutually agreed upon.
2. For exhaust/ventilation fan motors of rating up to 1.5 KW, only routine test certificates shall be furnished for scrutiny.
3. In case test certificates for these tests on similar type, size and design of motor from independent laboratory are available, the same is valid for 5 years.
4. BHEL reserves the right to perform repeat test, if required.
5. After packing and prior to issue MDCC, photographs of items to be despatched shall be sent to BHEL for review.
6. In case of any changes in QP commented by customer at contract stage, same shall be carried out by bidder without any implication to BHEL/ Customer.
7. Project specific QP to be developed based on customer requirement.
8. For export job, BHEL technical specification for seaworthy packing to be followed.
9. Packing shall be suitable for storage at site in tropical climate conditions.
10. Latest revision/ year of issue of all the standards (IS/ ASME/ IEC etc.) indicated in QP shall be referred.

LEGENDS:

*RECORDS, INDENTIFIED WITH "TICK"(√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION,
** **M**: SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, B: MAIN SUPPLIER/ BHEL/ THIRD PARTY INSPECTION AGENCY, **C**: CUSTOMER,
P: PERFORM, **W**: WITNESS, **V:** VERIFICATION, AS APPROPRIATE
MA: MAJOR, **MI**: MINOR**, CR:** CRITICAL
D: DOCUMENTATION

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
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Reviewed by:	PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:	RITESH KUMAR JAISWAL	RITESH KUMAR JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

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Reviewed by:			
Approved by:			

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	
	CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04	DATE:17.04.2020
	PROJECT:		PO NO.:	
	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))	SYSTEM:	SECTION: II	SHEET 1 OF 9

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
1.0	RAW MATERIAL & BOUGHT OUT CONTROL													
1.1	SHEET STEEL, PLATES, SECTION, EYEBOLTS	1.SURFACE CONDITION	MA	VISUAL	100%	-	-	FREE FROM BLINKS, CRACKS, WAVINESS ETC	LOG BOOK		P	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	LOG BOOK		P	-	-	
		3.PROOF LOAD TEST (EYE BOLT)	MA	MECH. TEST	SAMPLE	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	TEST REPORT		P/V	-		
1.2	HARDWARES	1.SURFACE CONDITION	MA	VISUAL	100%	-		FREE FROM CRACKS, UN-EVENNESS ETC.	TEST REPORT		P	-	-	
		2.PROPERTY CLASS	MA	VISUAL	SAMPLES	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	TC		P/V	-	-	PROPERTY CLASS MARKING SHALL BE CHECKED BY THE VENDOR
1.3	CASTING	1.SURFACE CONDITION	MA	VISUAL	100%	-	MANUFACTURER'S DRG./SPEC	FREE FROM CRACKS, BLOW HOLES ETC.	LOG BOOK		P/V	-		
		2.CHEM. & PHY. PROP.	MA	CHEM & MECH TEST	1/HEAT NO.	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	TC		P/V	-		HEAT NO. SHALL BE VERIFIED
		3.DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG.	MANUFACTURER'S DRG.	LOG BOOK		P/V	-		
1.4	PAINT & VARNISH	1.MAKE, SHADE, SHELF LIFE & TYPE	MA	VISUAL	100% CONTINUOUS	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	LOG BOOK		P/V	-		

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:	HEMA KUSHWAHA	HEMA KHUSHWAHA	Checked by:		KUNAL GANDHI
Reviewed by:	PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:	RITESH KUMAR JAISWAL	R K JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
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Reviewed by:			
Approved by:			

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:17.04.2020
	CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04	
	PROJECT:		PO NO.:	
	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))	SYSTEM:	SECTION: II	SHEET 2 OF 9

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
1.5	SHAFT (FORGED OR ROLLED)	1. SURFACE COND.	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		P	-	-	VENDOR'S APPROVAL IDENTIFICATION SHALL BE MAINTAINED
		2. CHEM. & PHYSICAL PROPERTIES	MA	CHEM. & PHYSICAL TESTS	1/HEAT NO. OR HEAT TREATMENT BATCH NO	-	MANUFACTURER'S DRG./ SPEC.	MANUFACTURER'S DRG./ STD.	TC		P/V	-		
		3. DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG./ SPEC.	MANUFACTURER'S DRG.	LOG BOOK		P/V	-		
		4.INTERNAL FLAWS	CR	ULTRASONIC TEST	100%	-	ASTM-A388	MANUFACTURER'S STD.	INSPECTION REPORT	✔	P/W	V	-	FOR DIA OF 55 MM & ABOVE
1.6	SPACE HEATERS, CONNEC-TORS, TERMINAL BLOCKS, CABLES, CABLE LUGS, CARBON BRUSH TEMP. DETECTORS, RTD, BTD'S	1. MAKE & RATING	MA	VISUAL	100%	-	MANUFACTURER'S DRG./STD.	MANUFACTURER'S DRG./STD.	INSPECTION REPORT		P/V	-	-	
		2. PHYSICAL COND.	MA	VISUAL	100%	-	MANUFACTURER'S DRG./STD.	NO PHYS. DAMAGE, NO ELECTRICAL DISCONTINUITY	INSPECTION REPORT		P/V	-	-	
		3.DIMENSIONS (WHEREVER APPLICABLE)	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG./ STD	MANUFACTURER'S DRG. / STD.	INSPECTION REPORT		P/V	-	-	
		4.PERFORMANCE/ CALIBRATION	MA	TEST	100%	-	MANUFACTURER'S DRG./ STD	MANUFACTURER'S DRG. / STD.	TEST REPORT		P/V	-	-	

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:	HEMA KUSHWAHA	HEMA KHUSHWAHA	Checked by:		KUNAL GANDHI
Reviewed by:	PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:	RITESH KUMAR JAISWAL	R K JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	
	CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04	DATE:17.04.2020
	PROJECT:		PO NO.:	
	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))	SYSTEM:	SECTION: II	SHEET 3 OF 9

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
1.7	OTHER INSULATING MATERIALS LIKE SLEEVES, BINDINGS CORDS, PAPERS, PRESS BOARDS ETC.	1. SURFACE COND. ETC.	MA	VISUAL	100%	-	-	NO VISUAL DEFECTS	TEST REPORT		P/V	-	-	
		2.DIMENSION(BORE DIA, WALL THICKNESS, BDV AS RECEIVED, BDV AFTER FOLDING AT 180°	MA	TEST	SAMPLE	-	MANUFACTURER'S STD.	MANUFACTURER'S STD.	LOG BOOK AND OR SUPPLIER'S TC		P/V	-	-	
1.8	SHEET STAMPING (PUNCHED)	1. SURFACE COND.	MA	VISUAL	100%	-	-	NO VISUAL DEFECTS (FREE FROM BURS)	LOG BOOK		P	-	-	
		2.DIMENSIONS INCLUDING BURS HEIGHT	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG. .	MANUFACTURER'S DRG.	LOG BOOK		P/V	-	-	
		3. ACCEPTANCE TESTS	MA	ELECT. & MECH TESTS	SAMPLE	-	MANUFACTURER'S DRG./ STD.	MANUFACTURER'S DRG./ STD.	TC		P/V	-	-	
1.9	CONDUCTORS	1. SURFACE FINISH	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		*P/V	-	-	* MOTOR MANUFACTURER TO CONDUCT VISUAL CHECK FOR SURFACE FINISH ON RANDOM BASIS (10% SAMPLE) AT HIS WORKS AND MAINTAIN RECORD FOR VERIFICATION BY
		2.ELECT. PROP, & MECH. PROP	MA	ELECT. & MECH.TEST	SAMPLES	-	MANUFACTURER'S DRG./ SPEC.	MANUFACTURER'S / SPEC.	TC & VENDOR'S TEST REPORTS		P/V	-	-	

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:	HEMA KUSHWAHA	HEMA KHUSHWAHA	Checked by:		KUNAL GANDHI
Reviewed by:	PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:	RITESH KUMAR JAISWAL	R K JAISWAL

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		3.DIMENSIONS	MA	MEASUREMENT	SAMPLES	-	MANUFACTURER'S DRG./ SPEC.	MANUFACTURER'S / SPEC.	LOG BOOK		P/V	-	-	
1.10	BEARINGS	1.MAKE & TYPE	MA	VISUAL	100%	-	MANUFACTURER'S DRG./ APPROVED DATASHEET	MANUFACTURER'S DRG./ APPROVED DATASHEET	LOG BOOK		P/V	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-	APPROVED DATASHEET	APPROVED DATASHEET/ BEARING MANUF'S CATALOGUES	LOG BOOK		P/V	-	-	
		3.SURFACE FINISH	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		P/V	-	-	
1.11	SLIP RING (WHEREVER APPLICABLE)	1.SURFACE COND.	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		P	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK		P	-	-	
		3.TEMP.WITH-STAND CAPACITY	MA	ELECT.TEST	SAMPLE	-	MANUFACTURER'S STD./ APPROVED DATASHEET	MANUFACTURER'S STD./ APPROVED DATASHEET	LOG BOOK		P/V	-	-	
		4.HV/IR	MA	-DO-	100%	-	MANUFACTURER'S STD./ APPROVED DATASHEET	MANUFACTURER'S STD./ APPROVED DATASHEET	LOG BOOK		P/V	-	-	
1.12	OIL SEALS & GASKETS	1.MATERIAL OF GASKET	MA	VISUAL	100%	-	MANUFACTURER'S DRG/SPECS	MANUFACTURER'S DRG./ SPECS.	LOG BOOK		P	-	-	
		2.SURFACE COND.	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		P	-	-	
		3.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK		P	-	-	

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Reviewed by:	PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:	RITESH KUMAR JAISWAL	R K JAISWAL

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					M	C/N				D	M	C	N	
2.0	IN PROCESS													
2.1	STATOR FRAME WELDING (IN CASE OF FABRICATED STATOR)	1.WORKMANSHIP & CLEANNESS	MA	VISUAL	100%	-	MANUFACTURER'S DRG	GOOD FINISH	LOG BOOK		P/W	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK		P	-	-	
2.2	MACHINING	1.FINISH	MA	VISUAL	100%	-	-DO-	GOOD FINISH	LOG BOOK		P	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK		P	-	-	
		3.SHAFT SURFACE FLOWS	MA	PT	100%	-	MANUFACTURER'S STD./ ASTM-E165	MANUFACTURER'S STD./ APPROVED DATASHEET.	LOG BOOK	✔	P	V	-	
2.3	PAINTING	1.SURFACE PREPARATION	MA	VISUAL	100%	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		2.PAINT THICKNESS (BOTH PRIMER & FINISH COAT)	MA	MEASUREMENT BY ELCOMETER	SAMPLE	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		3.SHADE	MA	VISUAL	SAMPLE	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		4.ADHESION	MA	CROSS CUTTING & TAPE TEST	SAMPLE	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	

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Reviewed by:	PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:	RITESH KUMAR JAISWAL	R K JAISWAL

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					M	C/N				D	M	C	N	
2.4	SHEET STACKING	1.COMPLETENESS	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S STD.	MANUFACTURER'S STD.	LOG BOOK		P	-	-	
		2.COMPRESSION & TIGHTENING	MA	MEASUREMENT	100%	-	MANUFACTURER'S STD.	MANUFACTURER'S STD.	LOG BOOK		P	-	-	
2.5	WINDING	1.COMPLETENESS	CR	VISUAL	100%	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		2.CLEANLINESS	CR	VISUAL	100%	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		3.IR-HV-IR	CR	ELECT. TEST	100%	-	IS-325//IS-12615/IEC-60034 PART-1	IS-325//IS-12615/IEC-60034 PART-1	TEST/INSPC. REPORT	✔	P	V	-	
		4.RESISTANCE	CR	ELECT. TEST	100%	-	IS-325//IS-12615/IEC-60034 PART-1	IS-325//IS-12615/IEC-60034 PART-1	TEST/INSPC. REPORT	✔	P	V	-	
		5.INTERTURN INSULATION	CR	ELECT. TEST	100%	-	IS-325//IS-12615/IEC-60034 PART-1	IS-325//IS-12615/IEC-60034 PART-1	TEST/INSPC. REPORT		P	-	-	
2.6	IMPREGNATION	1.VISCOSCITY	MA	PHY. TEST	AT STARTING	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK		P	-	-	
		2.TEMP. PRESSURE VACCUM	MA	PROCESS CHECK	CONTINUOUS	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK		P	-	-	
		3.NO. OF DIPS	MA	PROCESS CHECK	CONTINUOUS	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK	✔	P	V	-	THREE DIPS TO BE GIVEN

BHEL					
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Reviewed by:	PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:	RITESH KUMAR JAISWAL	R K JAISWAL

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	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))	SYSTEM:	SECTION: II	SHEET 7 OF 9

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
		4.DURATION	MA	PROCESS CHECK	CONTINUOUS	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK	✔	P	V	-	
2.7	COMPLETE STATOR ASSEMBLY	1.COMPACTNESS & CLEANLINESS	MA	VISUAL	100%	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK		P	-	-	
2.8	BRAZING/COMPRESSION JOINT	1.COMPLETENESS	CR	VISUAL	100%	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK		P	-	-	
		2.SOUNDNESS	CR	MALLET TEST & UT	100%	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	TEST/INSPC. REPORT	✔	P	V	-	
		3.HV	MA	ELECT. TEST	100%	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	TEST/INSPC. REPORT	✔	P	V	-	
2.9	COMPLETE ROTOR ASSEMBLY	1.RESIDUAL UNBALANCE	CR	DYN. BALANCE	100%	-	MANUFACTURER'S SPEC./ ISO 1940	MANUFACTURER'S DWG.	LOG BOOK		P	-	-	
		2.SOUNDNESS OF DIE CASTING	CR	ELECT. (GROWLER TEST)	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	TEST/INSPC. REPORT	✔	P	V	-	
2.10	ASSEMBLY	1.ALIGNMENT	MA	MEAS.	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	LOG BOOK		P	-	-	
		2.WORKMANSHIP	MA	VISUAL	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	LOG BOOK		P	-	-	
		3.AXIAL PLAY	MA	MEAS.	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	LOG BOOK	✔	P	V	-	
		4.DIMENSIONS	MA	MEAS.	100%	-	MANUFACTURER'S DRG./ MANUFACTURER'S SPEC.	MANUFACTURER'S DRG./ MANUFACTURER'S SPEC.	LOG BOOK		P	-	-	
		5.CORRECTNESS, COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE	MA	VISUAL	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	LOG BOOK		P	-	-	
		6. RTD, BTD & SPACE HEATER MOUNTING.	MA	VISUAL	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	LOG BOOK	✔	P	V	-	

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Reviewed by:	PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:	RITESH KUMAR JAISWAL	R K JAISWAL

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					M	C/N				D	M	C	N	
3.0	TESTS	1.TYPE TESTS INCLUDING SPECIAL TESTS	MA	ELECT.TEST	1/TYPE/SIZE	1/TYPE/SIZE	IS-325//IS-12615/APPROVED DATASHEET	IS-325/IS-12615/APPROVED DATASHEET	TEST REPORT	✔	P	W*	-	* NOTE - 1
		2.ROUTINE TESTS INCLUDING SPECIAL TEST	MA	ELECT.TEST	100%	-	IS-325//IS-12615/APPROVED DATASHEET	IS-325/IS-12615/APPROVED DATASHEET	TEST REPORT	✔	P	V$	-	$ NOTE - 2
		3.VIBRATION & NOISE LEVEL	MA	ELECT.TEST	100%	-	IS: 12075 / IEC 60034-14 & IS-12065	IS: 12075 / IEC 60034-14 & IS-12065	TEST REPORT	✔	P	V$	-	$ NOTE - 2
		4.OVERALL DIMENSIONS AND ORIENTATION	MA	MEASUREMENT & VISUAL	100%	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET &	TEST/INSPC. REPORT	✔	P	W	-	
		5.DEGREE OF PROTECTION	MA	ELECT. & MECH. TEST	1/TYPE/ SIZE	-	IEC 60034-5/IS-12615	APPROVED DATASHEET	TC	✔	P	V	-	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		6. MEASUREMENT OF RESISTANCE OF RTD & BTD	MA	ELECT. & MECH. TEST	100%	-	IS-325//IS-12615/IEC-60034 PART-1/IS: 12802	IS-325/IS-12615/IEC-60034 PART-1/IS: 12802	TC	✔	P	V$	-	$ NOTE - 2
		7. MEASUREMENT OF RESISTANCE, IR OF SPACE HEATER	MA	ELECT. & MECH. TEST	100%	-	IS-325//IS-12615/IEC-60034 PART-1	IS-325/IS-12615/IEC-60034 PART-1	TC	✔	P	V$	-	$ NOTE - 2
		8. NAME PLATE DETAILS	MA	VISUAL	100%	-	IS-325//IS-12615& DATA SHEET	IS-325//IS-12615 & DATA SHEET	TEST/INSPC. REPORT	✔	P	V$	-	$ NOTE - 2
		9.EXPLOSION FLAME PROOF NESS (IF SPECIFIED)	MA	EXPLOSION FLAME PROOF TEST	1/TYPE	-	IS 2148 / IEC 60079-1	IS 2148 / IEC 60079-1	TC	✔	P	V	-	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		10. PAINT SHADE, THICKNESS & FINISH	MA	VISUAL & MEASUREMENT BY ELKOMETER	SAMPLE	SAMPLE	APPROVED DATASHEET	APPROVED DATASHEET	TC	✔	P	W$	-	SAMPLING PLAN TO BE DECIDED BY INSPECTION AGENCY $ NOTE - 2

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					M	C/N				D	M	C	N	
4.0	PACKING	SURFACE FINISH & COMPLETENESS	MA	VISUAL	100%	100%	AS PER MANUFACT. STANDARD / (#)	AS PER MANUFACT. STANDARD / (#)	INSPC. REPORT	✔	P	W	-	(#): REFER NOTE-8

NOTES:

1 DEPENDING UPON THE SIZE AND CRITICALLY, WITNESSING BY BHEL SHALL BE DECIDED.

2 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL/CUSTOMER SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON.

3 IN CASE TEST CERTIFICATES FOR THESE TESTS ON SIMILAR TYPE, SIZE AND DESIGN OF MOTOR FROM INDEPENDENT LABORATORY ARE AVAILABLE, THE SAME IS VALID FOR 5 YEARS.

4 BHEL RESERVES THE RIGHT TO PERFORM REPEAT TEST, IF REQUIRED.

5 AFTER PACKING AND PRIOR TO ISSUE MDCC, PHOTOGRAPHS OF ITEMS TO BE DESPATCHED SHALL BE SENT TO BHEL PURCHASE GROUP FOR REVIEW.

6 IN CASE , ANY CHANGES IN QP COMMENTED BY CUSTOMER AT CONTRACT STAGE SHALL BE CARRIED OUT BY BIDDER WITHOUT ANY IMPLICATION TO BHEL/ CUSTOMER.

7 PROJECT SPECIFIC QP TO BE DEVELOPED BASED ON CUSTOMER REQUIREMENT.

8 FOR EXPORT JOB, BHEL TECHNICAL SPECIFICATION FOR SEAWORTHY PACKING TO BE FOLLOWED.

9 PACKING SHALL BE SUITABLE FOR STORAGE AT SITE IN TROPICAL CLIMATE CONDITIONS.

10 LATEST REVISION/ YEAR OF ISSUE OF ALL THE STANDARDS (IS/ ASME/ IEC ETC.) INDICATED IN QP SHALL BE REFERRED.

LEGENDS:

*RECORDS, INDENTIFIED WITH "TICK"(√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION,

** **M**: SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, B: MAIN SUPPLIER/ BHEL/ THIRD PARTY INSPECTION AGENCY, **C**: CUSTOMER,

P: PERFORM, **W**: WITNESS, **V:** VERIFICATION, AS APPROPRIATE

MA: MAJOR, **MI**: MINOR, **CR:** CRITICAL

D: DOCUMENT

BHEL					
ENGINEERING			QUALITY		
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Reviewed by:	PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:	RITESH KUMAR JAISWAL	R K JAISWAL

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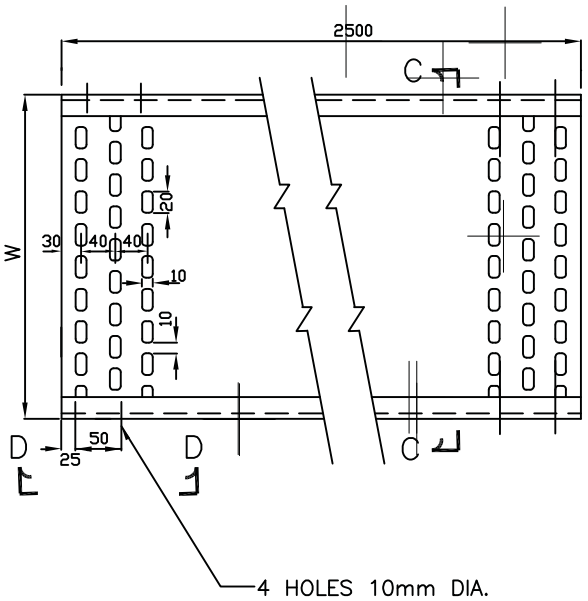
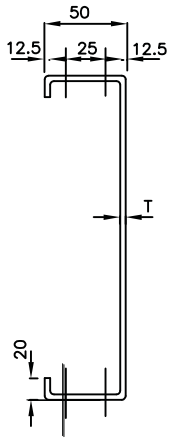
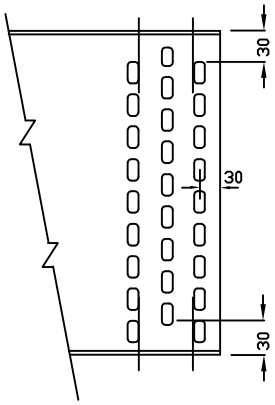
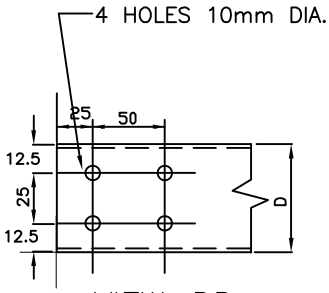




SECTION–CC
(100/50 TRAYS)



ARRANGEMENT OF
PERFORATIONS

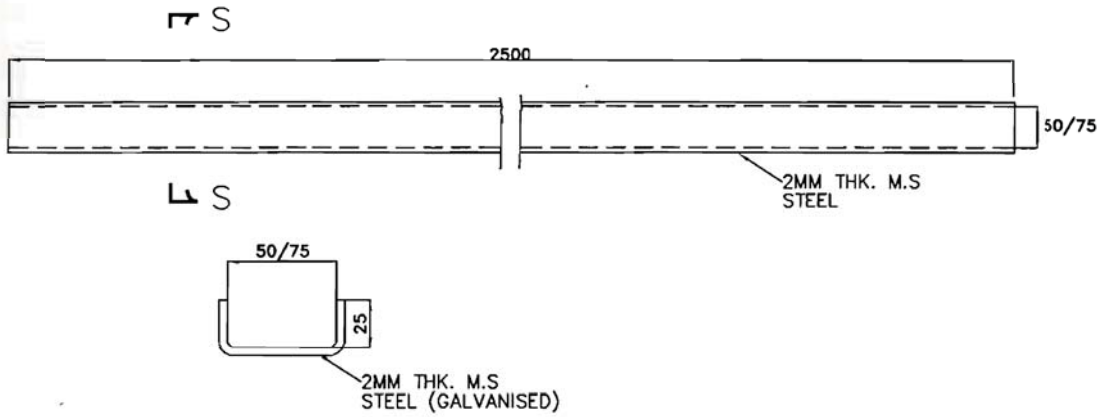


VIEW–DD
(100,50W TRAYS)

TRAY WIDTH W (mm)	100	50
TRAY DEPTH D (mm)	50	50
T (mm)	2	2

PERFORATED TYPE TRAY

TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES



SECTION S–S

CABLE TROUGHS

TYPICAL DETAILS OF
CABLE TRAY AND ACCESSORIES

SECTION: I

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

1X660MW SAGARDIGHI THERMAL POWER EXTENSION PROJECT (UNIT #5)

C&I TECHNICAL SPECIFICATION

FOR

AIR CONDITIONING SYSTEM

CONTROL AND INSTRUMENTATION DEPARTMENT
PROJECT ENGINEERING MANAGEMENT
BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
NOIDA

PREPARED BY	CHECKED BY	APPROVED BY
ANJALI RAMAN	SC SHARMA	SC SHARMA
MNGR. (C&I)	DGM (SH-I02,C&I)	DGM (SH-I02,C&I)

INDEX

GENERAL TECHNICAL SPECIFICATION
CONTROL & INSTRUMENTATION

	1X660MW SAGARDIGHI THERMAL POWER EXTENSION PROJECT (UNIT #5)	SECTION: C SUB SECTION : C&I
	C&I SPECIFICATION FOR AC SYSTEM	

GENERAL REQUIREMENT

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

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

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

4.0 The necessary root valves, impulse piping, drain cocks, gauge-zeroing cocks, valve manifold and all the other accessories required for mounting/ erection of these local instruments shall be furnished, even if not specifically asked for, on as required basis. The proposal shall include the necessary cables, flexible conduits, junction boxes and accessories for the above purpose. Double root valves shall be provided for all pressure tapping where the pressure exceeds 40 Kg / Cm2. The contacts of equipment mounted instruments; sensors, switches etc. for external connection including spare contacts shall be wired out to suitably located junction boxes.

5.0 In case of any contradiction most stringent clause/condition shall prevail.

C&I SPECIFIC TECHNICAL REQUIREMENT

Specific Technical Requirements (C&I):

1) The control of Air Conditioning system shall be through DDCMIS based control system (in BHEL scope). The operation and control philosophy of AC system shall be as per design memorandum given elsewhere in the specification. The DCS panel along with OWS/OEWS (in BHEL scope) shall be located in AC Plant Control Room.

2) The Contractor shall provide complete Instrumentation for control, monitoring and operation of entire AC system. The requirements given are to be read in conjunction with detailed Technical specification enclosed in the specification. Further in case of any discrepancy in the requirement within the same section noted by the bidder in the specification, the same will be brought to the notice of BHEL in the form of pre- bid clarification. In absence of any pre-bid clarification, the more stringent requirement as per interpretation of Customer shall prevail without any commercial implication.

3) The instrumentation to be provided for AC system shall be as per the technical specification document / drawings wherever provided for the respective systems as a minimum requirement for bidding purpose. However, for completeness of the system and its associated equipment, Bidder shall also provide all the necessary instruments to the process requirement even if not indicated in the given technical Specification document /drawings. During detail engineering if any additional instruments are required for safe & reliable operation of plant, bidder shall supply the same without any technical, commercial and delivery implication to BHEL.

4) The make/model of various instruments/items/systems shall be subject to approval of owner/purchaser during detailed engineering stage. No commercial and delivery implication in this regard shall be acceptable. In case of any conflict and repetition of clauses in the specification, the more stringent requirements among them are to be complied with.

5) Bidder to provide Local Control Panel for AC system given elsewhere in the specification.

6) Bidder to keep the provision for accepting fire signals from Fire Alarm & Protection System (supplied by others) and the closure of relevant fire dampers in Air Conditioning and Ventilation System. The no of IO & other specifications in this regard shall be finalized during detail engineering.

7) Provision for redundant soft interfacing and Hardwired interfacing shall be included for signal exchange between Air conditioning DDCMIS and chiller's Microprocessor based control panel. Bidder shall include required hardware at MP end.

8) Time synchronization of MP with DCS is to be carried out. Necessary hardware/software for same at MP end to be provided by Bidder.

9) VFD panels for applicable drives are in Bidders scope. Typical signal exchange with DCS has been indicated in the specification elsewhere.

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

11) The solenoid valves shall have limit switches for open/close feedback.

12) Interface of MCC, HT SWGR, Actuators, solenoid drives, control valves etc. with DCS based control system shall be as per Drive Control Philosophy attached in the specification.

13) All the instruments/drives shall be terminated on JBs/Panels in field. JBs/Panels shall be in Bidder's scope. Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 12-15 mtrs) and trunk cable.

14) RTD’s shall be of duplex type. Both the elements of duplex temperature sensors shall be terminated to junction boxes. Temperature measurement shall have up scale / down scale drive to protect from process upset in case of sensor failure. For RTDs ring - tong type lugs shall be used at Junction Boxes.

15) All local gauges, transmitters and switches shall be mounted on suitable enclosures, racks subject to owner’s approval. All transmitters shall be HART compatible.

16) Bidder to terminate all instrumentation and control elements in junction boxes. Bidder to provide input/output list, drives list, junction box schedule and termination details, recommended control logics / write-up etc. the list of documents to be submitted after award of contract is to be referred by bidder.

17) All field instruments enclosure shall be IP65. Local panel/cabinet enclosure shall be IP 55, unless otherwise specified. Electronics located outside control room shall be tropicalized and enclosed in dust & weatherproof cabinets (IP-65/67) suitable for the environment.

18) Components of instruments, control devices, accessories, piping etc. which contact steam, condensate or boiler feed water shall be manufactured from copper-free materials.

19) Primary sensor redundancy for Control/measurement shall be decided as per following general criteria:
    a. Critical controls & respective measurements, measurements required for protection of auxiliaries & for major CLCS- Triple redundant.
    b. Non-critical but important control & measurements and measurements required for other CLCS- Dual redundant.

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

21) Double root valve shall be provided for all pressure tapings where the line pressure is 40kg/cm2 and above. Single root valve for below 40Kg /sq. cm.

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

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

24) Bidder shall provide erection hardware as per installation drawings.

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

26) Bidder to perform tests of C&I items/instruments/systems as per Quality plans/type test attached in the specification. However, if any test not specified in the quality plan but specified in specification Tests for I&C equipment included elsewhere in specification will have to perform by Bidder without any cost implication. The make/model of various instruments/items/systems shall be as per Customer/BHEL approved vendor list. No commercial and delivery implication in this regard shall be acceptable. In case of any conflict and repetition of clauses in the specification, the more stringent requirements among them are to be complied with.

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

28) Redundant 230 VAC UPS feeders shall be provided by BHEL at a single point. Further distribution to various instruments shall be in Bidder's scope. Bidder to include necessary power distribution board (ACDB) (as per details attached elsewhere in this specification) in his scope. Any power supply other than the above, if required by any instrument/device, has to be derived by the Bidder from the above supply and all necessary hardware for the same shall be in bidder's scope. Bidder to furnish UPS power requirement along with the bid.

29) Bidder to furnish electrical load/UPS load data during detailed engineering.

30) Scope of Instrumentation cables (Screened Control Cables), Fibre Optic cable & Control cables shall be as per Electrical Cable scope matrix in Electrical portion of specification. Any cable in Bidder's scope shall be as per specification.

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

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

33) Any part/module of the C&I system which are not listed under recommended spares shall be deemed as having life expectancy not less than the expected life of the plant i.e. 30 years.

34) Instrument ranges shall be selected to have the normal reading, preferably between 50% and 70% of full scale for linear parameters and 70% to 80% for flow measurements. Deviation indicators shall have the null position at mid-scale. The normal operating parameter shall be identified with a clear green mark.

35) The above given scope is indicative & minimum. Any item/ equipment not indicated above however required for the completeness of the system is to be supplied by bidder without any technical, commercial and delivery implication to BHEL.

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

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

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

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

40) All the outdoor field instruments such as analysers/transmitters/meters etc. shall be provided with suitable Free standing cabinet(s)/panel/rack so that the equipments are protected against rain/ sunlight etc. Site fabricated racks are not accepted

41) Control & Instrumentation equipment shall be guaranteed against manufacturing defect for at least two (2) years from the date of handing over to Owner.

42) Bidder to delegate /depute their persons/experts (15 working days for minimum 3 tours) as per owner/consultants' requirement without any additional cost at site during commissioning.

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

44) Bidder to ensure participation of their senior personnel and experts in discussions with Owners and other equipment bidders during various stages of contract implementation as required by the Owner.

3.00.00 CONTROL PHILOSOPHY

3.01.00 Chilled Water Air Conditioning System

The chilled water plant shall operate with, 3 x 75% capacity Packaged Screw Chiller unit (Two (2) nos. working and One (1) no. Standby), 3x50% capacity (Two (2) nos. working and One (1) no. Standby), Condenser water (CW) pumps, 3x50% capacity (Two (2) nos. working and One (1) no. Standby) Chilled water (CHW) pumps and 2x100% capacity (One (1) no. working and One (1) no. Standby) induced draft Cooling Towers.

All system will operate from DCS . ~~There will be Connectivity from PLC to DCS for display of AC plant at running condition. No control is envisaged from DCS~~.. Furthermore cooling tower fans and make up Water Booster Pumps shall also be operated from their individual local Push-button stations.

One (1) no. Local Starter Panel shall be installed in each AHU room which will feed power to all the AHU fans, motors of 3-way mixing valves of AHUs, Fresh air fans (wherever applicable), Smoke Exhaust fans (wherever applicable) and their motorized isolating dampers, Fire damper motors, Electric heaters and Humidifiers.

One (1) no. Local starter Panel shall also be provided in each of the SWAS dry panel room and other rooms with Ceiling Suspended AHUs to feed power to the AHUs for SWAS room, These panels located in each AHU room, SWAS room, shall be operated and controlled from the workstation through DCS system located in the AC Plant Room as well as from these Local Panels.

Motor starters for the drive units of Packaged Screw Chiller Units are provided in the built in microprocessor based control panels of the respective Screw chiller units. The drives of these units will be normally controlled from these built in microprocessor based control panel panels. However, provision of operation & control of chillers shall also be kept with the AC Plant Room DCS based Control Panel through proper interfacing between the AC Plant

Room DCS based Control Panel and Built in Microprocessor based control panels of respective Screw chiller units.

This AC Plant Room DCS based Control Panel shall also be suitably interfaced with the DCS system for monitoring purpose.

The Packaged Screw Chilling units can be started only when its associated cooling tower fan, condenser & chilled water pumps are in operation.

All the drives of the AC system shall be manually started / restarted through DCS from the work stations after any trip.

The chilled water system shall be provided with the following safety & operating controls:

a) OPERATING CONTROL

- Room temperature control with the help of modulating 3-way chilled water flow regulating valve with the cooling coil of AHUs through the AC Plant Room DCS system, getting sense from the temperature sensor and associated transmitter placed in the return air path.
- Chilled water temp. Control based on the room load with the help of operating temperature sensor and through compressor's automatic unloading mechanism for screw chillers through the built-in Microprocessor based control panel of Packaged Screw Chiller. This control shall also be possible through the AC Plant Room DCS system.
- Room RH control with the help of humidifiers (if required) & duct mounted re-heaters through the AC Plant Room DCS system getting sense from the RH & Temperature sensors and their associated transmitters placed in the return air path inside AHU rooms.

b) SAFETY CONTROL

The chilled water system shall be incorporated with the following safety controls and interlocks:

- High discharge pressure cutout (HP)

  Applicable for Screw
- Low suction pressure cutout (LP) Chillers
- Low oil level cutout
- High winding temperature cutout through PTC sensors

- Low chilled water temperature cutout by anti-freeze thermostat /temperature sensor for Screw chiller.
- Cutout due to low flow of chilled water & condenser water by flow switches.
- Cutout due to overload of all drive motors
- High air temperature cutout by safety thermostat / temperature sensor for duct mounted electric heaters.
- Low cooling tower sump water level cutout for CW pumps. (Alarm for low water level in expansion tank & humidifier as applicable shall be provided).
- Stopping of AHU fans in case of fire in the respective zone through the central DCS system
- Short circuit protection
- Closing of fire dampers at the air supply duct from AHUs in case of fire with the sense from room mounted fire/smoke detector through zone fire panel and the DCS system.
- The Heater for compressors will be energized during compressor idling time. This safety control shall be actuated through the built-in Microprocessor based control panel of each Screw chiller.
- Safety controls of Screw chillers will also include Over/Under voltage and voltage unbalance protection, Single phase & Phase reversal preventer, over/under current and current unbalance protection and others as per manufacturer's standard.

c) INTERLOCKS

The system components shall be interlocked with one another in the following way:

The Screw Compressor shall not start unless:

- At least one cooling tower fan is running.
- At least one condenser water pump is running.
- At least one chilled water pump is running.

The duct mounted electric strip heater shall not be energized unless the

respective AHU fans are running.

All the above Interlocking shall be actuated through the DCS Panel.

On-Off-Trip status for all the drives, electric heaters & humidifiers (if required) shall be available at the work stations of the DCS Panel located in the respective AC plant rooms.

Motors of fire dampers provided in supply air duct of AHU shall remain energized in normal condition to effect opening of dampers. In the event of fire, the motors of fire dampers will be de-energized and the damper will close due to spring action, the relevant AHU fan motors will be tripped at the same time. The motorized isolating dampers connected to smoke exhaust fan will be energized to open and the smoke exhaust fan will start after getting signal from relevant room/ smoke detectors through the fire alarm panel and the Local Starter Panel located in the respective AHU rooms.

Provision for one common audio annunciation for any kind of malfunctioning in AC plant shall be kept through a hooter located in the AC Plant Control Room and suitably interfaced with the DCS Panel.

The control system shall comprise central DCS Panels, Local PLC panels , One engineering workstation PC and one operator workstation PC located in the AC Plant control room.

The basic function of the system is as follows: -

- To closely control and monitor inside temperature and humidity condition inside the air-conditioned spaces
- To optimize / minimize energy consumption by automated operation.
- To provide centralized monitoring and control for various mechanical facilities including sequential start / stop of the whole AC system.
- To generate maintenance data and alarms
- To maintain records of plant operation
- Programmed start / stop of individual AHU as per operating requirements and for maintaining the room temperature / RH by controlling the 3 way mixing valves at chilled water line, humidifier and duct heater.
- Safe and reliable operation, supervision & control, alarm & event management and optimization, maintenance management of the entire AC system shall be accomplished with the DCS system.
  The DCS system shall be interfaced with:
- The Air Conditioning MCC cum PDB

- The Microprocessor based control panels of Screw Chiller.
- The Local Starter Panels located in each AHU rooms and in the rooms served by Ceiling Suspended Air Handling Units.
- The Temperature and RH sensors and their associated transmitters located in the AHU rooms.
- The zone fire panels/ smoke detectors.
- The work station PC and the Hooter.

3.02.00 System Operation

3.02.01 Central AC Plant (Power House Building)

All controls and operation of the AC system equipment and its accessories with alarm annunciation of the entire AC system shall be achieved through the DCS in the central AC plant control room.

Over and above, all the screw chiller units shall be provided with built-in Microprocessor based control panels for their stand alone operation and control. These built-in control panels of the Chillers shall also be interfaced with the central DCS system so that all the operation and control for chillers can also be possible centrally.

A Hooter shall be provided in the AC Plant room and shall be suitably interconnected with the DCS system so that visual alarm generated in the DCS system for any malfunction of the AC system and equipment can be manifested as Audio alarm through the Hooter.

Room temperature and RH control with the operation of motorized 3-way Mixing Valves, heaters and Humidifiers as applicable and other fire safety control and operation of smoke exhaust system, AHU fans and fresh air fans (wherever applicable) shall also be actuated through the central DCS system.

3.02.02 Air Conditioning System with Water-cooled Precision Air Conditioner

This system shall operate round the clock for ESP Control Room.

Water Cooled Precision Air Conditioners of 3x50% or 2x100% capacity (depending upon the cooling requirement) shall be provided for ESP Control Rooms, at the discretion of Owner/Consultant.

The Precision Air Conditioners shall be operated from the respective unit mounted microprocessor based control console.

i) Operating Control

The Precision Air Conditioners shall have following operating controls:

- ON / OFF control of the compressor of Precision Air Conditioners to maintain the desired room temperature
- Superheat control as well as condenser head pressure control by means of Electronic expansion valve
- Room RH control (wherever required) with the help of humidifier & heater installed within AC units getting sense from the humidistat placed in the return air path.

ii) Safety Control

The compressor of each Precision Air Conditioner shall be incorporated with the following minimum safety controls and interlocks:

- High refrigerant pressure cutout.
- Low refrigerant pressure cutout.
- Low Oil Pressure Cut out (if applicable).
- Cutout due to overload of all drive motors.
- Stopping of evaporator fans in case of fire in the respective zone.
- Closing of fire dampers at the supply duct from Precision Air Conditioners in case of fire with the sense from duct/room mounted fire/smoke detector through zonal fire panel.
- Low condenser water flow cutout.

iii) Interlocks

The system components shall be interlocked with one another in the following way:

The compressor shall not start unless:

a) Condenser water flow is adequate.

b) The evaporator fans are running.

The electric strip heater shall not be energized unless the respective evaporator fans are running. The Strip heaters will trip with the help of safety thermostat in case the temperature of air at the downstream side of the heaters exceeds a pre-determined value.

On-Off-trip indications for all the drives & electric heaters shall be provided at the unit mounted microprocessor based control console.

C&I DELIVERABLES LIST

LIST OF VENDOR DELIVERABLES FOR C&I FOR AC SYSTEM
(1X660MW SAGARDIGHI THERMAL POWER EXTENSION PROJECT (UNIT #5))

DOCUMENT NUMBER PE-GL-445-553-I001 **SHEET 1 of 1**

Sl.No.	DRAWING NO.	DRAWING/DOCUMENT TITLE	CATEGORY
1	PE-V9-445-553-I901	INSTRUMENT DATA SHEETS	A
2	PE-V9-445-553-I902	INSTRUMENT SCHEDULE	I
3	PE-V9-445-553-I903	INSTRUMENT INSTALLATION/ HOOK UP DRAWINGS	A
4	PE-V9-445-553-I904	INSTRUMENT QP/CHECK LIST	A
5	PE-V9-445-553-I905	CONTROL & OPERATIONAL WRITE-UP FOR THE SYSTEM	A
6	PE-V9-445-553-I906	CONTROL SCHEMES/LOGIC DIAGRAM (TO BE IMPLEMENTED IN DCS)	A
7	PE-V9-445-553-I907	FIELD JB TERMINATIONS /GROUPING DOCUMENT	A
8	PE-V9-445-553-I908	DCS INPUT / OUTPUT LIST (ANALOG & BINARY)	I
9	PE-V9-445-553-I909	ANNUNCIATION & SOE LIST	I
10	PE-V9-445-553-I910	PROCESS GRAPHIC MANUSCRIPTS FOR DDCMIS	I
11	PE-V9-445-553-I911	CABLE SCHEDULE & INTERCONNECTION	I
12	PE-V9-445-553-I912	BILL OF MATERIAL	A
13	PE-V9-445-553-I913	LOCAL CONTROL PANEL DATA SHEET & WIRING DIAGRAM	A
14	PE-V9-445-553-I914	PANEL LAYOUT & EXTERNAL/INTERNAL GA DRAWING (INCLUDING FOUNDATION DETAILS & FLOOR CUT-OUT)	A
15	PE-V9-445-553-I915	LIST OF SIGNAL EXCHANGE WITH DDCMIS (BOTH HARDWIRED & SERIAL INTERFACE)	A
16	PE-V9-445-553-I916	LCP QUALITY PLAN	A

NOTES:

1. ANY OTHER DOCUMENT DECIDED DURING DETAILED ENGINEERING SHALL BE PROVIDED BY BIDDER WITHOUT ANY COMMERCIAL/TECHNICAL IMPLICATION.

2. CONTRACTOR TO SUBMIT REUSABLE DATABASE FORMATS IN BHEL/CUSTOMER APPROVED FORMATS LIKE MS EXCEL,MS ACCESS OF DOCUMENTS LIKE INSTRUMENT SCHEDULE, I/O LIST, DRIVE LIST,FIELD JB TERMINATIONS, CABLE SCHEDULE & INTERCONNECTION, etc. SOFT COPY OF FORMATS SHALL BE PROVIDED TO SUCCESSFUL BIDDERS.

SPECIFICATION FOR
MOTORISED VALVE ACTUATOR

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR	DOCUMENT NO.: PE-ID-445-145-I902	
		VOLUME II B	
		SECTION D	
		REV. NO. 01	DATE:27/03/2020
		SHEET 1 OF 5	

Data Sheet A & B

		DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
GENERAL*	* PROJECT	**1 X 660 MW SAGARDIGHI STPP**	
	OFFER REFERENCE		
	* TAG NO. SERVICE		
	* DUTY	☐ ON / OFF ☐ INCHING	
	* LINE SIZE (inlet/outlet): MATERIAL		
	* VALVE TYPE	☐ GLOBE ☐ GATE ☐ REG. GLOBE ☐ BUTTERFLY	
	* OPENING / CLOSING TIME		
	* WORKING PRESSURE		
	AMBIENT CONDITION	SHALL BE SUITABLE FOR CONTINUOUS OPERATION UNDER AN AMBIENT TEMP. OF -20 to70 DEG C AND RELATIVE HUMIDITY OF 0-95%IN HOT HUMID AND TROPICAL ATMOSPHERE AND HIGHLY POLLUTED AT PLACES OF COAL DUST AND FLY DUST	
	VALVE SEAT TEST PRESS	BIDDER TO SPECIFY	
	REQUIRED VALVE TORQUE	BIDDER TO SPECIFY	
	ACTUATOR RATED TORQUE	BIDDER TO SPECIFY	
CONSTRUCTION AND SIZING	CONSTRUCTION	TOTALLY ENCLOSED, WEATHER PROOF, DUST TIGHT SUITABLE FOR OUTDOOR USE WITHOUT CANOPY, NEMA6/IP:68	
	MECHANICAL POSITION INDICATOR	TO BE PROVIDED FOR 0-100% TRAVEL	
	BEARINGS	DOUBLE SHIELDED, GREASE LUBRICATED ANTI-FRICTION.	
	GEAR TRAIN FOR LIMIT SWITCH/TORQUE SWITCH OPERATION	METAL (NOT FIBRE GEARS). SELF-LOCKING TO PREVENT DRIFT UNDER TORQUE SWITCH SPRING PRESSURE WHEN MOTOR IS DE-ENERGIZED.	
	SIZING	OPEN/CLOSE AT RATED SPEED AGAINST DESIGNED DIFFERENTIAL PRESSURE AT 85% OF RATED VOLTAGE. FOR ISOLATING SERVICE THREE SUCCESSIVE OPEN-CLOSE OPERATIONS OR 15 MINS. WHICHEVER IS HIGHER. **FOR INCHING SERVICE - 150 STARTS/HR MINIMUM & FOR REGULATING SERVICE - 600 STARTS/HR MINIMUM as per IEC60034-1**	
HANDWHEEL as per standard EN 12570:2000	* REQUIRED	■ YES ☐ NO	
	* ORIENTATION	☐ TOP MOUNTED ☐ SIDE MOUNTED	
	*TO DISENGAGE AUTOMATICALLY DURING MOTOR OPERATION.		
ELECTRIC ACTUATOR	ACTUATOR MAKE/MODEL	BIDDER TO SPECIFY	
	MOTOR MAKE / MODEL / TYPE / RATING (KW) (REFER NOTE NO. 6 & 7)	BIDDER TO SPECIFY	
	@ MOTOR TYPE	SQUIRREL CAGE INDUCTION MOTOR, STARTING CURRENT LIMITED TO SIX TIMES THE RATED CURRENT-INCLUSIVE OF **I.S.** TOLERANCE	
	ACTUATOR APPLICABLE WIRING DIAGRAM	■ ENCLOSED (BIDDER TO CONFIRM) A: ■ DRG. NO. 3-V-MISC-24227 R00 B: □ DRG. NO. 3-V-MISC-24550 R00 C: □ DRG. NO. 3-V-MISC-24283 R00 D: □ DRG. NO. 4-V-MISC-90271 R11 E: □ For Thyristor based Integral starter, Bidder/Vendor to furnish wiring diagram	
	COLOUR SHADE	☐ BLUE (RAL 5012) ☐ ..... ■TO BE DECIDED DURING DETAILED ENGINEERING	
	PAINT TYPE	☐ ENAMEL ■ EPOXY CONFIRMING TO CORROSION CATEGORY C5-I	
	SHAFT RPM	BIDDER TO SPECIFY	
	OLR SET VALUE	BIDDER TO SPECIFY	

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR	DOCUMENT NO.: PE-ID-445-145-I902	
		VOLUME II B	
		SECTION D	
		REV. NO. 01	DATE:27/03/2020
		SHEET 2 OF 5	

Data Sheet A & B

		DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
	@ STARTING / FULL LOAD CURRENT	BIDDER TO SPECIFY	
	NO. OF REV FOR FULL TRAVEL	BIDDER TO SPECIFY	
	@ PWR SUPP TO MTR / STARTER	415V, 3PH, AC	
	@ CONTROL VOLTAGE REQUIREMENT	TO BE DERIVED FROM THE POWER SUPPLY TO THE STARTER ☐ 230 V ☐ 110 V	
	@ ENCLOSURE CLASS OF MOTOR	☐ IP 67 ■IP 68 ☐ FLAME PROOF	
	@MOTOR BEARING WITH 2 EARTH TERMINALS	DOUBLE SHIELDED; GREASE LUBRICATED ANTI FRICTION	
	@ INSULATION CLASS	CLASS-F TEMP. RISE LIMITED TO CLASS-B	
	@ WINDING TEMP PROTECTION	■ THERMOSTAT (3 Nos.,1 IN EACH PHASE)	
	SINGLE PHASE / WRONG PHASE SEQUENCE PROTECTION	REQUIRED (THERMISTOR PTC)	
INTEGRAL STARTER	INTEGRAL STARTER	■REQUIRED ☐ NOT REQUIRED	
	TYPE OF SWITCHING DEVICE	■ CONTACTORS ☐ THYRISTORS	
	TYPE	■ CONVENTIONAL ☐ SMART (NON-INTRUSIVE)	
	IF SMART (REFER BELOW POINT a – h)		
	a) SERIAL LINK INTERFACE	☐ INTEGRAL ☐ FIELD MOUNTED	
	b) SERIAL LINK PROTOCOL	☐ FOUNDATION FIELD-BUS ☐ PROFI-BUS ☐ DEVICE NET ☐.....	
	c) SERIAL LINK MEDIA	☐ TWISTED PAIR Cu-CBL ☐ CO-AXIAL Cu-CBL ☐ OFC	
	d) HAND HELD PROGRAMMER	☐ REQUIRED ☐ NOT REQUIRED	
	e) TYPE OF HAND HELD PROGRAMMER	☐ BLUETOOTH ☐ INFRARED ☐.....	
	f) MASTER STATION	☐ REQUIRED ☐ NOT REQUIRED	
	g) MASTER STN INTRFACE WITH DCS	☐ MODBUS ☐ TCP/IP	
	h) DETAILS OF SPECIAL CABLE	☐ ENCLOSED ☐ NOT REQUIRED	
	STEP DOWN CONT. TRANSFORMER	■ REQUIRED	
	OPEN / CLOSE PB	■REQUIRED ☐ NOT REQUIRED	
	STOP PB	■ REQUIRED ☐ NOT REQUIRED	
	INDICATING LAMPS	■ REQUIRED ☐ NOT REQUIRED	
	LOCAL REMOTE S/S	■REQUIRED ☐ NOT REQUIRED	
	STATUS CONTACTS FOR MONITORING	■REQUIRED ☐ NOT REQUIRED	
	INTEGRAL STARTER DISTURBED SIGNAL(Refer Note 14)	REQUIRED MOTOR THERMOSTSTTRIP O/L RELAY OPTD, CONT./POWER SUPPLY FAILED, S/S IN LOCAL/REMOTE/OFF MODE, TORQUE SWITCH OPEN/CLOSE CUT OFF/STOP PB OPTD, VALVE JAMMED ETC)	
	ACTION ON LOSS OF EXTERNAL ELECTRIC POWER	■STAYPUT ■ FAIL SAFE TO BE DECIDED DURING DETAILED ENGINEERING	
INTERPOSING RELAY/OPTO COUPLER (Applicable for integral Starter) **DATASHEET & WIRING DIAGRAM OF ISOLATION DEVICE TO BE PROVIDED**	TYPE OF ISOLATING DEVICE	■ INTERPOSING RELAY ☐ OPTO COUPLER TO BE DECIDED DURING DETAILED ENGINEERING	
	QUANTITY	☐ 2 NOs. ■ 3 NOs.	
	DRIVING VOLTAGE	■ 20.5 – 24V DC ☐ _____V DC	
	DRIVING CURRENT	■ 125mA MAX ☐ _____mA MAX	
	LOAD RESISTANCE	■ > 192 ohms - <25 k ohms ☐ > _____ohms - < _____ohms	

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR	DOCUMENT NO.: PE-ID-445-145-I902	
		VOLUME II B	
		SECTION D	
		REV. NO. 01	DATE:27/03/2020
		SHEET 3 OF 5	

Data Sheet A & B

		DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
TORQUE SWITCH (Not Applicable for Smart Actuator) **($$ Refer Notes)**	MFR & MODEL NO.	BIDDER TO SPECIFY	
	OPEN / CLOSE	■1 No. ☐2Nos. / ■1 No. ☐2Nos	
	CONTACT TYPE	2 NO + 2 NC	
	RATING	5A 240V AC AND 0.5A 220V DC	
	CALIBRATED KNOBS(OPEN&CLOSE TS)	REQUIRED FOR SETTING DESIRED TORQUE	
	ACCURACY	+3% OF SET VALUE	
LIMIT SWITCH (Not Applicable for Smart Actuator) **($$ Refer Notes)**	MFR & MODEL NO.	BIDDER TO SPECIFY	
	OPEN : INT : CLOSE	☐1 No ■2 Nos. / 2 Nos. (ADJ.) / ☐1 No. ■2Nos.	
	CONTACT TYPE	2 NO + 2 NC	
	RATING (AC / DC)	5A 240V AC AND 0.5A 220V DC	
	ACCURACY	2% OF SET VALUE	
POSITION TRANSMITTER	POSITION TRANSMITTER (For inching duty & other specific applications**)	■ REQUIRED ☐ NOT REQUIRED	
	MFR & MODEL NO.	BIDDER TO SPECIFY	
	TYPE	☐ ELECTRONIC (2 WIRE) R/I CONVERTER ■ ELECTRONIC (2 WIRE) CONTACTLESS	
	SUPPLY	■ 24V DC ☐	
	OUTPUT	■ 4-20mA	
	ACCURACY	± 1% FS	
SPACE HEATER	@SPACE HEATER	REQUIRED	
	@ POWER SUPPLY (NON INTEGRAL)	230V AC,1 PH.,50 Hz	
	@ POWER SUPPLY (INTEGRAL)	BIDDER TO SPECIFY	
	@ RATING		
TERMINAL BOX	ACTUATOR/MOTOR TERMINAL BOX	REQUIRED	
	ENCL CLASS ACTUATOR/MOTOR T.B.	@ ■ IP 68 @☐.....	
	@ EARTHING TERMINAL	REQUIRED	
	PLUG & SOCKET	☐ REQUIRED ■ NOT REQUIRED	
	NO. OF PINS REQUIRED(TO BE CHECKED AS PER SIGNALS IN DRIVE CONTROL PHILOSOPHY)		
	NOS. OF PLUG & SOCKET	☐ 1 Nos. for ON/OFF ☐ 2 NOS.(for inching duty) ☐ OTHER (TO BE SPECIFIED INLINE WITH DRIVE CONTROL PHILOSOPHY)	
CABLE GLANDS	@ POWER CABLE GLAND	SIZE:----------	
	@ SPACE HEATER CABLE GLAND	SIZE:----------	
	CONTROL CABLE GLANDS-1	CABLE GLAND SUITABLE FOR INSTRUMENTATION CABLE SIZE OF 4P X 1.5 SQMM	
	CONTROL CABLE GLANDS-2	CABLE GLAND SUITABLE FOR INSTRUMENTATION CABLE SIZE OF 8P X 0.5 SQMM	
	CONTROL CABLE GLANDS-3 (Additional for inching duty)	CABLE GLAND SUITABLE FOR INSTRUMENTATION CABLE SIZE OF 2P X 0.5 SQMM	
WEIGHT	TOTAL WEIGHT (ACTUATOR + ACCESSORIES)	BIDDER TO SPECIFY	_____ Kg.

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR	DOCUMENT NO.: PE-ID-445-145-I902	
		VOLUME II B	
		SECTION D	
		REV. NO. 01	DATE:27/03/2020
		SHEET 4 OF 5	

Data Sheet A & B

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

NOTES:

1. **SCOPE**: DESIGN, MANUFACTURE, INSPECTION, TESTING AND DELIVERY TO SITE OF ELECTRIC ACTUATOR FOR INCHING OR OPEN / CLOSE DUTY.
2. **CODES & STANDARDS**: DESIGN AND MATERIALS USED SHALL COMPLY WITH THE RELEVANT LATEST NATIONAL AND INTERNATION STANDARD. AS A MINIMUM, THE FOLLOWING STANDARDS SHALL BE COMPLIED WITH:
   IS-9334, IS-2147, IS-2148, IS-325, IS-2959, IS-4691, IS-4722, IEC 60947-5-1 AND EN 15714-3 :2010 OR LATEST VERSION.
3. TEMPERATURE RISE SHALL BE RESTRICTED TO 70 DEG. C FOR AMBIENT TEMPERATURE OF 50 DEG C.
4. CABLE GLANDS OF DOUBLE COMPRESSION TYPE, BRASS MATERIAL SHALL BE PROVIDED.
5. THE TORQUE SWITCHES SHALL BE PROVIDED WITH MECHANICAL LATCHING DEVICE TO PREVENT OPERATION WHEN UNSEATING FROM THE END POSITIONS. THE LATCHING DEVICE SHALL UNLATCH AS SOON AS THE VALVE LEAVES THE END POSITION. IF SUCH PROVISION IS NOT POSSIBLE, THE TORQUE SWITCHES SHALL BE BYPASSED BY END-POSITION LIMIT SWITCHES WHICH OPENS ON VALVE LEAVING END POSITION.THESE LIMIT SWITCHES ARE ADDITIONAL TO THE NUMBER OF LIMIT SWITCHES SPECIFIED ELSEWHERE.
6. THE MOTOR SHALL BE SUITABLE FOR DIRECT ON LINE STARTING.
7. THE MOTOR SHALL BE CAPABLE OF STARTING AT 85 PERCENT OF RATED VOLTAGE RUNNING AT 80 PERCENT OF RATED VOLTAGE AT RATED TORQUE AND 85 PERCENT RATED VOLTAGE AT 33 PERCENT EXCESS RATED TORQUE FOR A PERIOD OF 5 MINUTES EACH.
8. IN ADDITION TO ABOVE REQUIREMENTS FOR LIMIT/TORQUE SWITCH, **MECHANICAL END STOP** WITH ACCURACY OF 2% SHALL BE SUPPLIED.
9. IT SHOULD BE POSSIBLE TO OPERATE THE ACTUATOR LOCALLY. LOCKABLE LOCAL/REMOTE SELECTION SHALL BE PROVIDED ON THE ACTUATOR.
10. LOCAL POSITION INDICATOR SHALL BE PROVIDED FOR 0 TO 100 % TRAVEL.
11. CONTROL WIRING SHALL BE SUITABLE VOLTAGE GRADE COPPER WIRE 1.5 SQ. MM.
12. ENDURANCE: RATED TORQUE RANGE SHOULD BE BASED ON ISO 5211, ISO5210.
13. TAG PLATE SHALL BE CONFIRMING TO STANDARD BS-15714.
14. THE ACTUATORS SHALL BE DESIGNED TO BE SELF-LOCKING UPON LOSS OF POWER. MOTOR SHALL BE DESIGNED TO CLOSE IN 30 SECS. FROM FULL OPEN POSITION AND SHALL HAVE ADEQUATE CAPACITY TO OPEN AND CLOSE UNDER FULL UNBALANCED DESIGN PRESSURE.
15. AUTOMATIC PHASE CORRECTION FACILITY AND POTENTIAL FREE CONTACT FOR ANNUNCIATION OF POWER FAILURE SHALL BE PROVIDED.
16. LIMIT SWITCHES SHALL BE SILVER PLATED WITH HIGH CONDUCTIVITY AND NON-CORROSIVE TYPE. CONTACT RATING SHALL BE SUFFICIENT TO MEET THE REQUIREMENT OF CONTROL SYSTEM SUBJECT TO A MINIMUM OF 60 V, 6 VA RATING. PROTECTION CLASS SHALL BE IP67.
17. THE TERMINAL BOX SHALL BE WEATHER PROOF WITH REMOVABLE FRONT COVER & CABLE GLANDS FOR CABLE CONNECTION.IT SHALL BE SUITABLE FOR 2.5 SQ MM COPPER CONDUCTOR.
18. ACTUATOR SHALL ATTAIN FULL SPEED OPERATIONS BEFORE VALVE LOAD IS ENCOUNTERED AND IMPART AN UNSEATING BLOW TO START THE VALVE IN MOTION (HAMMER BLOW EFFECT).
19. **** VALVES WITH 10 DEGREE/20DEGREE FEEDBACK REQUIREMENT FOR APPLICATIONS SUCH AS CW/ACW/PLANT WATER SYSTEM SHALL BE CONSIDERED AS INCHING DUTY VALVES. ACCORDINGLY, POSITION FEED BACK TRANSMITTER, PLUG & SOCKET REQUIREMENT SHALL BE CONSIDERED.**

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

	PREPARED BY	CHECKED BY	APPROVED BY	VENDOR COMPANY SEAL
NAME	ANJALI RAMAN	VIPUL KUMAR VERMA	SURESH CHAND SHARMA	NAME
SIGNATURE				SIGNATURE
DATE	27.03.2020	27.03.2020	27.03.2020	DATE

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

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR	DOCUMENT NO.: PE-ID-445-145-I902	
		VOLUME II B	
		SECTION D	
		REV. NO. 01	DATE:27/03/2020
		SHEET 5 OF 5	

Data Sheet A & B

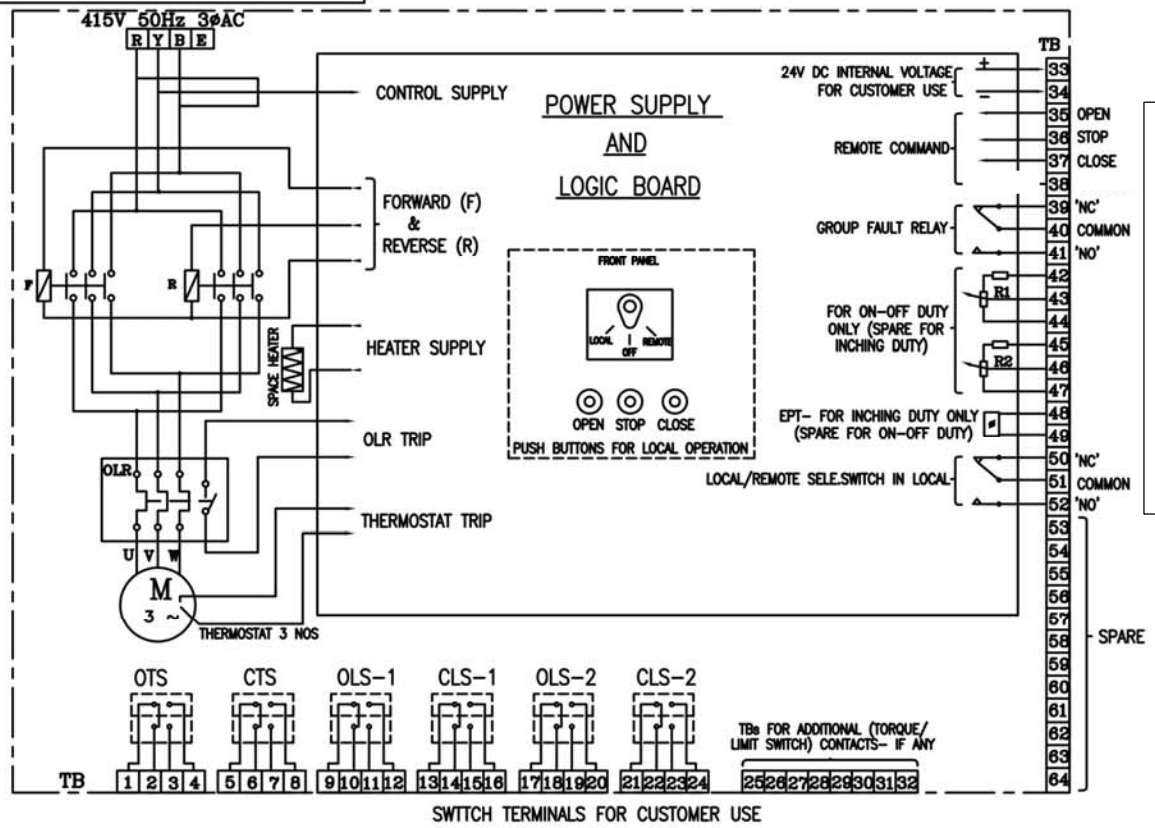
DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)

ADDITONAL NOTES FOR SAGARDIGHI PROJECT:

- TEST WITNESS: TESTS SHALL BE PERFORMED IN THE PRESENCE OF OWNER/PURCHASER'S REPRESENTATIVE SO DESIRED BY THE OWNER/ PURCHASER. THE CONTRACTOR SHALL GIVE AT LEAST FIFTEEN (15) DAYS ADVANCE NOTICE OF THE DATE WHEN THE TESTS ARE TO BE CARRIED OUT.
- ADVANCE NOTICE SHALL BE GIVEN TO THE OWNER AS AGREED IN THE CONTRACT, PRIOR TO THE STAGE OF MANUFACTURE BEING REACHED, AND THE PIECE OF PLANT MUST BE HELD AT THIS STAGE UNTIL THE OWNER HAS INSPECTED THE PIECE, OR HAS ADVISED IN WRITING THAT INSPECTION IS WAIVED, IF HAVING CONSULTED THE OWNER AND GIVEN REASONABLE NOTICE IN WRITING OF THE DATE ON WHICH THE PIECE OF PLANT WILL BE AVAILABLE FOR INSPECTION, THE OWNER DOES NOT ATTEND, THE SUCCESSFUL BIDDER MAY PROCEED WITH MANUFACTURE HAVING FORWARDED TO THE OWNER DULY CERTIFIED COPIES OF HIS OWN INSPECTION AND TEST RESULTS.
- ACTUATOR SHALL ATTAIN FULL SPEED OPERATIONS BEFORE VALVE LOAD IS ENCOUNTERED AND IMPART AN UNSEATING BLOW TO START THE VALVE IN MOTION (HAMMER BLOW EFFECT).
- A SPACE HEATER SHALL BE INCLUDED IN THE LIMIT SWITCH COMPARTMENT SUITABLE FOR 240V, 1 PHASE, 50 HZ SUPPLY.

ALL DIMENSIONS ARE IN MILLIMETRES. FOR TOLERANCES OF UNTOLERANCED DIMENSIONS DURING MANUFACTURE REFER RELEVANT QCP / QP.

DRAWING NO. 3-V-MISC-24227



Separate wire (no common wire) to be used for signal exchange between DCS and actuator. Additionally, separate TBs are to be used at actuator end. Please refer attached dwg 12A05-DWG-I0021 for the same.

CONTACT DEVELOPMENT DIAGRAM

OTS	1-2	OPEN AT OVER TORQUE DURING OPENING TRAVEL
	3-4	CLOSE AT OVER TORQUE DURING OPENING TRAVEL
CTS	5-6	OPEN AT OVER TORQUE DURING CLOSING TRAVEL
	7-8	CLOSE AT OVER TORQUE DURING CLOSING TRAVEL
OLS-1	9-10	
	11-12	
CLS-1	13-14	
	15-16	
OLS-2	17-18	
	19-20	
CLS-2	21-22	
	23-24	

SWITCH TERMINAL NO.: FULL OPEN | a | INTERMEDIATE | b | FULL CLOSE — VALVE POSITION

INDICATES CONTACT CLOSED
INDICATES CONTACT OPEN

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

SETTING PROCEDURE OF POSITION LIMIT AND TORQUE SWITCH

VALVES	OPEN		CLOSE	
	MAIN	BACK UP	MAIN	BACK UP
GATE VALVE OF 100 mm AND ABOVE IN 1500 CL AND ABOVE RATINGS	OLS	OTS *	CLS	CTS
ALL OTHER GATE & GLOBE VALVES	OLS	OTS *	CTS	#

– CLS NOT TO BE CONNECTED IN TRIP CIRCUIT
* – BYPASS OTS FOR INITIAL 5% OF TRAVEL (FOR GATE VALVES ONLY)

NOTE:-

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

REV	DATE	ALTERED
		CHD & APPD

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

BHARAT HEAVY ELECTRICALS LTD.,
UNIT: HIGH PRESSURE BOILER PLANT.
TIRUCHIRAPALLI-620014.
365-121

	NAME	SIGN	DATE
DRN	N.P.ESWAR	N.P	07.10.04
CHD	D.DINAKARAN	D.D	07.10.04
APPD	K.ARUNACHALAM	K.A	07.10.04

NO. OF VAR.

DEPT VL | CODE | SCALE | WEIGHT (KG). | REFERENCE INFORMATIONS | NO. OF ITEMS

TITLE: WIRING DIAGRAM (TERMINAL PLAN) FOR ACTUATOR WITH INTEGRAL STARTER

CARD CODE: U 01

DRAWING NO.: 3-V-MISC-24227

REV: 0

Size A3

SPECIFICATION FOR FIELD INSTRUMENTS

SECTION-VI

TECHNICAL SPECIFICATION

CONTROL AND INSTRUMENTATION SYSTEMS

1.00.00 FIELD INSTRUMENTS

This section provides general guidelines for field instruments and equipment to be supplied under this specification. All measuring instruments/equipment and subsystems offered by Bidder shall be from reputed experienced manufacturer of specified type and range of equipment, whose guaranteed and trouble free operation has been established. All instruments/equipment shall be of proven reliability, accuracy, repeatability requiring a minimum of maintenance and comply with the acceptable international standards. All instruments/equipment and accessories shall be supplied as per technical specifications, ranges, make as approved by Owner.

i) HART management system shall be integral feature of the DDCMIS and shall be provided for centralised configuration, maintenance, diagnostics & record-keeping for all electronic transmitters.

ii) Bidder shall provide following facilities as a minimum through software:

a) Constant scanning to monitor faults of changes to instrument configuration.

b) Owner-defined and standard calibration and configuration procedures for all transmitters.

c) Constant signal data collection facilities to maintain continuously updated records.

d) Automatic tracking of configuration changes made in the field, such as may be introduced by hand-held communicator. All configuration function associated with hand-held communicators shall be available in the system.

e) Event and log reports on screen as well as on printer.

f) Any addition/deletion of transmitter will be reported on printer and logged in hard disk.

1.01.00 PRESSURE TRANSMITTER

01.	Type	:	Microprocessor based Smart, HART protocol compatible
02.	Transmission	:	2 - Wire

03.	Output Signal	:	Simultaneous transmission of digital and 4-20 mA DC signal.
04.	Signal Processing	:	Silicon solid state electronic circuitry
05.	Sensor type	:	Capsule / Diaphragm
06.	Element material	:	AISI-316 or better
07.	Static Pressure	:	150 % of maximum span continuously, without affecting the calibration.
08.	Turn-down ratio	:	10 : 1 for vacuum/very low pressure application ; 30 : 1 minimum for other applications.
09.	Span and Zero	:	Locally adjustable non-interacting. Facility for elevation and suppression by 100% of span
10.	Enclosure Class	:	Weather proof as per IP-65 with durable corrosion resistant epoxy coating (Explosion proof for NEC Class-1, Division 1 area wherever required)
11.	Output Indicator	:	Backlit LCD type
12.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
13.	Body	:	Forged Carbon Steel (SS for DM Water & corrisve service).
14.	Power supply	:	16 - 48 Volts D.C.
15.	Load	:	500 Ohms (min.) at 24 Volts D.C.
16.	Ambient Temperature	:	0 - 50^{O}C
17.	Performance :		
i)	Accuracy	:	± 0.075% of Span or better
ii)	Repeatability	:	± 0.05% of Span or better
iii)	Response time	:	100 msec or better
iv)	Stability	:	± 0.1% of Calibrated Span for 6 months up to 70 Kg/cm2 and ± 0.25% of Calibrated Span for more than 70 Kg/cm2
v)	Zero and span drift	:	± 0.015% per deg. C at max span and 0.11% per deg. C at min span
18.	Sealing/Isolation	:	Extended diaphragm with 5 meters SS armored capillary for corrosive, viscous and dirty fluid applications. Material for separator

diaphragm shall be as per application. Where the process fluids are corrosive, viscous, solid bearing or slurry type, diaphragm seals shall be provided. Parts below the diaphragm shall be removable for cleaning. The entire volume above the diaphragm shall be completely filled with an inert liquid suitable for the application

19.	Diagnostics	:	Self indicating feature
20.	Accessories	:	a) Universal mounting bracket suitable for 2" pipe 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 for pressure transmitters constructed from SS316 bar stock. In case it becomes necessary to use a DP transmitter for gauge pressure measurement then a 2-valve manifold should be used in place of 5-valve manifold.
			f) Companion flange with nuts, bolts and gaskets.
			g) Hand held configurator kit for calibration of Smart Transmitter.

1.02.00 Differential Pressure Transmitter

01.	Type	:	Microprocessor based Smart, HART protocol compatible
02.	Transmission	:	2-Wire
03.	Output signal	:	Simultaneous transmission of digital and 4-20 mA DC signal.
04.	Signal Processing Unit	:	Silicon solid-state electronic circuitry
05.	Sensor type	:	Capsule/Diaphragm
06.	Element material	:	AISI-316 (Stainless Steel) or better
07.	Static Pressure/		

Overload Pressure		:	Maximum line (or static) pressure on either side without permanent deformation or loss of accuracy
08.	Turn-down ratio	:	10 :1for vacuum/very low pressure application; 30 : 1 minimum for other applications.
09.	Span and Zero	:	Locally adjustable, non-interacting
10.	Enclosure class	:	Weather proof as per IP-65 with durable corrosion resistant epoxy coating (Explosion proof for NEC Class-1, Division 1 area wherever required))
11.	Zero suppression / elevation	:	At least 100% of Span
12.	Output Indicator	:	Backlit LCD type
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 - 50^{O} C
16.	Power supply	:	16 - 48 Volts DC
17.	Load	:	500 Ohms (min.) at 24 Volts DC
18.	Performance :-		
i)	Accuracy	:	±0.2 % of span or better
ii)	Repeatability	:	± 0.05 % of span or better
iii)	Response time	:	100 msec or better
iv)	Stability	:	± 0.1% of Calibrated Span for 6 months up to 70 Kg/cm2
v)	Zero and span drift	:	± 0.015% per deg. C at max span and 0.11% per deg. C at min span
19.	Sealing/Isolation	:	Extended diaphragm with 5 meters. SS armored capillary for corrosive, viscous and dirty fluid applications. Material for separator diaphragm, depending on application.
20.	Diagnostics	:	Self indicating feature
21.	Accessories	:	a) Universal mounting bracket suitable for2" pipe 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 5-valve stainless steel manifold, constructed from SS316 bar stock.

f) Companion flange with nuts, bolts and gaskets.

g) Hand held configurator kit for calibration of Smart Transmitter.

1.02.00 DISPLACER TYPE LEVEL TRANSMITTERS

01.	Type		:	SMART
02.	Stages of operation		:	Continuous
03.	Material -			
	i)	Displacer	:	AISI 316 SS
	ii)	Suspension wire	:	AISI 316 SS
	iii)	Torque tube housing	:	Carbon steel or SS as per application
	iv)	Torque tube	:	Inconel
	v)	Displacer chamber	:	Carbon steel or SS as per process application
	vi)	Transmitter Housing	:	Die cast aluminium or better
04.	Power supply		:	16-48 Volts D.C.
05.	Transmission		:	2-wire
06.	Output Signal		:	Simultaneous transmission of digital and 4-20 mA DC signal. Standard HART protocol.
07.	Signal processing		:	Solid-state electronic circuitry
08.	Static / overload pressure		:	Maximum static pressure without permanent deformation or loss of accuracy.
09.	Turn-down ratio		:	10 : 1 or better

10.	Zero & Span	:	Easily accessible (local zero & span adjustment and non-interactive type)
11.	Enclosure Class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
12.	Output Indicator	:	Yes, Backlit LCD type
13.	Nameplate	:	Tag number and Service engraved in stainless steel tag plate
14.	Ambient Temperature	:	0 - 50^{O}C
15.	Load Impedance	:	500 Ohms at 24 Volts (minimum)
16.	Process Connection	:	2" Companion flange with nuts, bolts and gaskets
17.	Performance -		
	Accuracy	:	$\pm$ 0.2% of span or better
18.	Accessories	:	a) Counter Flange, nuts, bolts, gaskets etc. b) Weights for 5 point calibration of instruments. c) Vent and drain plugs d) Special calibration tool/configurator,if any.
19.	Preferred Features	:	a) Test plug connection and cutout terminals physically separated from other electronics. b) Electronic Damping facility (adjustable).

1.03.00 MASS FLOW METER

A.	Sensor		
01.	Measuring Principle	:	Coriolis Mass flow.
02.	Primary Element	:	Flow Tube of 316SS or better
03.	Temperature Control For Heating	:	To be provided for heavy fuel oil application. Heating arrangement shall be integral.
04.	Process Connection	:	Flanged and rating as per process requirement.
05.	Drain	:	Self-draining facility

	06.	Enclosure	:	Stainless steel
	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 with HART protocol, selectable from four measured quantities & field bus output for softlink with DCS
	05.	Load	:	< 750 ohms.
	06.	Power supply	:	"UPS", (if the external power supply is 230V AC, 50 HZ).
	07.	Turn Down	:	100:1
	08.	Accuracy	:	± 0.2% of measured value
	09.	Housing	:	IP 65 (Explosion proof for NEC Class-1, Division 1 area).
	10.	Hazardous duty Version	:	FM Standards.
	11.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
	12.	Accessories	:	a) As required for field mounting b) Handheld configurator c) Mounting U-bolts, nuts, bolts, prfab cable etc.
1.04.00	Turbine Flow meter			
	A.	Sensor		
	01.	Type	:	Turbine (in line full-bore, based on magnetic pick up 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, flanged		
09.	Enclosure	:	IP 65		
B.	Transmitter				
01.	Electronics	:	Solid State		
02.	Power Supply	:	"UPS", if the external power supply is 230V AC, 50 HZ.		
03.	Input	:	Input from Sensor		
04.	Display	:	Backlit LCD		
05.	Output	:	Isolated 4-20mA DC with HART protocol.		
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 cofigurator kit.	

1.05.00 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	:	± 1% or better.
07.	Repeatability	:	±0.2% or better.
08.	Ambient temperature	:	$50^{O}C$
09.	Mounting	:	On-Line, flanged.
10.	Enclosure	:	IP 65
11.	Accessories	:	Nuts, bolts, gaskets etc.
B.	Transmitter		
01.	Electronics	:	Solid State-remote mounting
02.	Power Supply	:	24 V DC.
03.	Input	:	Input from Sensor
04.	Display	:	Backlit LCD
05.	Output	:	Isolated 4-20mA DC.
06.	Protocol	:	HART
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 .

1.06.00 Rotameter

01.	Type	:	Online upto 2" and Bypass above 2" line size"
02.	Metering tube	:	Borosilicate glass
03.	Float	:	AISI 316-SS unless the process fluid demands some other material.
04.	Body MOC	:	SS as per fluid condition.
05.	Scale	:	Aluminium Graduated - Engraved black on white background.
06.	Process connection	:	Flanged to line size or threaded for connection size ½" or less.
07.	Accuracy	:	± 2% of full scale detection or better for on-line type and ±4% of full-scale detection or better for by-pass type.
08.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
09.	Accessories	:	Slip-on orifice plate of 316-SS and taps of / SS as per application. Applicable SS Isolation valves and SS Range Orifice - for bypass type rotameters.
10.	Housing protection class	:	IP- 65.

1.07.00 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..
05.	Bezel Material	:	SS 304.
06.	Socket Material	:	SS 316
07.	Enclosure	:	IP-65.
08.	Dial Size	:	150 mm

09.	Scale	:	Black lettering on white background in 270 Deg. arc.
10.	Window	:	Shatterproof glass
11.	Range Selection	:	Normal process pressure – 50 ~ 70 % of range (approximately).
12.	Over-range Protection	:	125% of maximum range by internal stop. External stop at zero
13.	Adjustment	:	Micrometer screw for zero adjustment. Internal micrometer screw for range adjustment. External zero adjustment for glycerine filled gauges.
14.	Element Connection	:	Argon welding
15.	Process Connection	:	1/2" NPT(M) Bottom connection for local mounting, back connection for panel mounting.
16.	Performance	:	Accuracy of $\pm$ 1.0 % of span or better.
17.	Operating ambient temperature	:	0 - 50^{O}C
18.	Safety Feature	:	Blow out disc./diaphragm at the back
19.	Accessories	:	a) Snubbers and Glycerin filled for pulsating fluid applications and at pump discharge. b) Stainless steel Diaphragm chemical seals for corrosive, viscous and solid-bearing or slurry type process fluids. diaphragm chemical seal shall be provided with the following: 1) Top chamber : SS 304 2) Bottom Chamber: SS 316 3) Sealing fluid: Silicon DC 200 4) Diaphragm: SS 316 c) 3-way SS gauge cock/ 2-Valve SS-316 barstock manifold for pressure gauges with 1/2" NPT process connection..

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.

f) Syphons for steam and hot water services.

	20.	Applicable standard	:	IS-3624 / 1996 , EN-837-1
	21.	Nameplate	:	Tag number, service engraved in stainless steel tag plate

1.08.00 Temperature Gauge

	01.	Type	:	Inert gas filled remote mounting system.
	02.	Sensing Element Material	:	Bourdon - AISI-316 SS
	03.	Capillary Armoring	:	Stainless steel flexible
	04.	Movement Material	:	AISI 304 SS
	05.	Bulb / Stem Diameter	:	12 mm
	06.	Bulb / Stem Material	:	AISI 316
	07.	Capillary	:	Stainless Steel
	08.	Thermometer connection to well	:	½" NPT
	09.	Case Material	:	Stainless steel
	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	:	Normal temperature – 50 ~ 70% of range approximately.
16.	Zero adjuster	:	Micrometer screw adjustable from front.
17.	Window	:	Shatterproof glass.
18.	Accuracy	:	± 1 % or better
19.	Enclosure Class	:	IP-65
20.	Capillary	:	5 meters (local)/15.0 meters (local panel) - armoured stainless steel
21.	Compensation	:	Capillary and Case Compensation
22.	Accessories	:	a) Forged/barstock SS316 thermowell screwed as per ASME PTC code. Process connection M 33X2 (M). Material of construction of thermowell: 1) SS 316: in general 2) Inconel: For flue gas application 3) Tungsten carbide: For coal mill application b) Installation accessories as required.
23.	Nameplate	:	Tag number, service engraved in stainless steel tag plate

1.09.00 Thermocouples

01.	Type	:	a) Type-K (Chromel Alumel) / Type-R (Pt.-Rhodium Pt.) / Type-E (Chromel Constantan) [As per application] b) Duplex (Triplex incase of turbine/Generator/excitor bearing temperature may be used) c) Ungrounded
02.	Wire gauge	:	16 AWG for Type-K, 24 AWG for Type-R
03.	Standard	:	ANSI-MC 96.1.
04.	Protecting Tube :-		
i)	O.D.	:	8 mm
ii)	Material	:	316-SS Seamless
iii)	Filling	:	Magnesium Oxide (Purity above 99.4%)

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

1.10.00 Passing condition of various drain valves shall be monitored by measuring drain pipe metal temperature at the downstream of the drain valves. Also Drum, SH, RH metal temperature measurement shall be provided. Necessary thermocouples shall be provided as per the following specification.

01.	Measuring medium	:	Metal temperature
02.	Metal of thermocouple element	:	Chromel-Alumel Type-K
03.	Type of thermocouple ungrounded type.	:	Duplex with separate hot junctions,
04.	Insulation	:	Mineral insulation Magnesium Oxide
05.	Thermocouple wirer gauge	:	16 AWG
06.	Protective Sheath	:	SS 321
07.	Protective Sheath Dia	:	8 mm O.D.
08.	Characteristics of thermocouple	:	Special limits of error as in ANSI MC 96.01.1975
09.	Mounting Accessories	:	1/2" BSP SS sliding end connector, weld pad, weld on clamps of heat resistant steel SS 310.
10.	Cold end sealing	:	SS pot seal with colour coded PTFE headed sleeve insulated flexible tails. Sealing compound - Epoxy resin
11.	Minimum Bending Radius	:	30 mm
12.	Length of T/C	:	30 mtrs. (minimum)

1.11.00 Resistance Temperature Detector

01.	Type	:	Platinum (Duplex), Ungrounded
02.	Resistance	:	100 ohm at $0^{O}C$
03.	Base	:	Wound on ceramic (anti-inductive)
04.	Wiring	:	3 /4 Wire

05.	Protecting Tube :-			
	i)	O.D.	:	8 mm
	ii)	Material	:	SS-316, Seamless
	iii)	Filling	:	Magnesium oxide (Purity above 99.4%).
06.	Response time		:	a) $<$ 20 seconds for measurement. b) $<$ 10 seconds for control.
07.	Calibration		:	DIN 43760
08.	Accuracy		:	$\pm$ 0.5% of range
09.	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		:	½" NPT gland and grommet.
	v) Others		:	Terminal head cover with SS chain and suitable gasket. All thermowells in the high velocity steam service shal be checked for Strouhal's frequency limit to arrive at a safe size and design of thermowells"
10.	Accessories		:	a) Adjustable nipple-union-nipple [1/2" Sch 80 X ½" NPT (M)] with thermowell connection b) Compression fittings/unions c) Flanges etc. (for flanged connections only) d) Barstock thermowell of stepless tapered design as per ASME PTC19.3 code. Process connection M33x2 (M) in general or 11/2"flanged for flue gas/Furnace/air etc. application. Material of construction of thermowell: 1) SS 316: in general 2) Inconel: For flue gas application

3) Tungsten carbide: For coal mill application.

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

1.12.00 Pressure Switch

	01.	Type	:	i) Piston for high pressure application (above 40 bar) ii) Bellow /Diaphragm for low pressure application (below 40 bar)
	02.	Sensing element material	:	AISI SS-316. All other wetted part SS316.
	03.	Case Material	:	Die-cast aluminum alloy with neoprene gasket.
	04.	Setter Scale	:	Black graduation on white linear scale. Graduation 0-100% with red pointer for set points.
	05.	Over range	:	150 % of maximum pressure
	06.	Adjustments	:	a) Internal Set Point b) Differential adjustment
	07.	End Connection	:	1/2" NPT (M) bottom connected
	08.	Switch configuration	:	Two SPDT
	09.	Switch Rating	:	240V, 5A AC/220V, 0.5A DC
	10.	Switch Type	:	Snap acting, shock & vibration proof
	11.	Terminal Block	:	Suitable for full ring lugs for cable connection.
	12.	Elect connection	:	Plug in socket
	13.	Enclosure Class	:	IP-65 weather and dust proof (Explosion proof for NEC Class-1, Division 1 area).
	14.	Performance	:	a) Repeatbility $\pm$ 0.5% of full range b) Accuracy of Setting Indication of $\pm$ 1.5%
	15.	Ambient temperature	:	0 – 50^{O}C

16.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
17.	Accessories	:	a) Remote diaphragm seal with SS-316 capillary for viscous & corrosive application. MOC of seal material shall be as per process fluid requirement.
			b) Snubbers for pulsating fluid application.
			c) Syphons for steam and hot water services.
			d) Retention ring and screws for surface mounting.
			e) 1/2” NPT 2 Valve SS-316 manifold constructed from barstock
			f) Brass cable gland

1.13.00 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	:	Die-cast aluminum alloy with neoprene gasket.
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.	Adjustments	:	a) Internal set point adjustment b) Differential adjustment
07.	Process Connection	:	1/2" NPT (M) bottom connected / back connected.
08.	Switch configuration	:	Two SPDT
09.	Switch rating	:	240V, 5A AC/220V, 0.5A DC.
10.	Switch type	:	Snap acting type contacts, shock and vibration proof.

11.	Terminal Blocks	:	Suitable for full ring lugs for cable connection.
12.	Elect connection	:	Plug in socket
13.	Performance	:	a) Repeatbility ± 0.5% of full range b) Accuracy of set point Indication: ± 1.5%
14.	Operating Ambient Temperature	:	0 - 50^{O}C
15.	Enclosure	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area).
16.	Accessories	:	a) Snubbers for pulsating fluid application. b) Syphons for steam and hot water services. c) Retention ring and screws for surface mounting. d) 1/2" NPT 3-Valve SS-316 manifold constructed from barstock
17.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
18.	Remote Seal type for special application	:	a) Silicone oil / fluorolube filled remote diaphragm seal for dirty / viscous / corrosive fluid. b) SS armoured capillary at least 3 meters each. c) Adapter flanges with nuts, bolts and gaskets for instrument and process side.

1.14.00 Temperature Switch

01.	Type	:	Inert gas filled-in
02.	Sensing Element Material	:	Bellow / Bourdon AISI SS-316
03.	Bulb Material	:	AISI SS-316
04.	Capillary	:	Stainless steel armoured
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
11.	Switch rating	:	240V, 5A AC/220V, 0.5A DC
12.	Switch type	:	Snap acting, shock and vibration-proof.
13.	Adjustability	:	Internal Set point adjustable over span range
14.	Elect connection	:	Plug in socket
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	:	Thermowell from SS barstock, Mounting accessories, ½" NPT cable gland.

1.15.00 Level Switch

01.	Type	:	External cage float operated. Magnetically coupled.
02.	Float Material	:	AISI-316 stainless steel or better
03.	Other wetted parts	:	AISI-316 stainless steel or better
04.	External Cage	:	Carbon steel / Stainless steel or better 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.
06.	External cage connection	:	25 NB socket welded.
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.)
09.	Contact rating	:	5A, 240V/AC, 0.25A, 220V DC
10.	Accessories	:	a) Counter flange, nuts & bolts, suitable gasket etc. b) Steel globe type drain valve. c) ½"NPT cable gland d) Stainless steel alpha-numeric engraved for service and tag. e) Globe drain valve
11.	Preferred feature	:	Switch operating point marked on cage
12.	Mounting	:	On standpipe

1.16.00 Conductivity Type Level Switch

01.	Type	:	Conductivity discrimination.
02.	Application	:	Drain pots viz. on CRH line
03.	Mounting	:	Flanged – on external cage.
04.	Probe MOC	:	Stainless steel with high purity ceramic.
05.	Probe rating	:	> Maximum design pressure of vessel.
06.	Input	:	Four 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	:	2SPDT or 1 DPDT @ 5A 30V DC.
09.	Local Display	:	Coloured LEDs for Hi, Lo, Hi-Hi, Lo-Lo, Power & fault.
10.	Power supply	:	Dual 240V AC, 50 Hz, 1Ph UPS supply.
11.	Enclosure	:	IP–65, corrosion resistant & wall mounting type (Explosion proof for NEC Class-1, Division-1 area).
12.	Accessories	:	a) PTFE cable from probe to electronics b) Mounting accessories c) External cage d) Washer & gasket
13	Test pressure	:	Two times rated pressure
14.	Elect connection	:	Plug in socket

1.17.00 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 1.5 meters. c) Reference rod for non grounded tank.
03.	Probe Mounting :	:	1-1/2” Flanged
04.	Material of construction	:	316 SS and to suit fluid type
05.	Insulation	:	PTFE/PP/Kynar Part/Full as required
06.	Enclosure	:	Powder coated Die cast aluminium. with neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
07.	Ambient temperature	:	0-60ºC.
08.	Mounting	:	Top Mounting
09.	Supply voltage	:	240V AC, 50 Hz, 1Ph UPS supply/ 24V DC

	10.	Relay output	:	2 SPDT
	11.	Contact rating	:	5A min. at 240V AC on resistive load
	12.	Response time	:	100 msec or better
	13.	Elect connection	:	Plug in socket
	14.	Accessories	:	Counter flange, cable gland, prefab cable and stainless steel name plate engraved with alpha-numeric.
1.18.00	RF Type Level Switch			
	Sensing Probe		:	
	01.	Type	:	Rigid
	02.	Material	:	SS-316
	03.	Mounting	:	Threaded
	04.	Probe Head Housing	:	Cast Aluminium
	05.	Protection	:	IP-66
		Electronic Controller	:	
	01.	Supply Voltage	:	240V AC (UPS)
	02.	Relay Output	:	2 nos. SPDT
	03.	Contact Rating	:	240V AC,5A/ 220V DC, 0.25A
	04.	Housing Material	:	Cast Aluminium
	05.	Protection	:	IP-65
	06.	Local LED Indication	:	Power On, Alarm Level, Probe Healthy
	07.	Switching Repeatability	:	±0.5%
	08.	Accessories	:	Coaxial cable probe connection to controller ½"NPT Cable Gland
1.19.00	Ultrasonic Level Switch			
	01.	Principle of operation	:	Ultrasonic contact level technology
	02.	Input Power	:	24V DC/ 240V AC

	03.	Output Contact	:	2 SPDT (240V AC, 5A/ 220V DC, 0.25A)
	04.	Switch Mounting	:	Integral
	05.	Sensor Material	:	SS-316
	06.	Enclosure	:	Cast Aluminium (IP-65)
	07.	Process Connection	:	2” Flanged
	08.	Repeatability	:	2 mm
	09.	Power supply	:	240V AC, 50 Hz, 1Ph UPS supply/ 24V DC
	10.	Cable connection	:	½” NPT with cable gland
	11.	Accessories	:	Cable gland, cable, companion flange, bolts & nuts, gaskets etc. along with all mounting hardware

1.20.00 Ultrasonic Level Transmitter

	01.	Principle of operation	:	Detection of reflected ultrasonic pulse
	02.	Signal processing	:	Microprocessor Controlled Signal Processing
	03.	Type	:	Smart
	04.	Display	:	Large alpha-numeric back lit LCD/LED
	05.	Calibration & configuration	:	Accessible from front of panel
	06.	Diagnostic	:	On-line
	07.	Status	:	For power, Hi / Lo / V. Hi / V. Lo-level indication, fault etc.
	08.	Construction	:	Plug-on board
	09.	Power supply	:	240V AC, 50 Hz, 1Ph UPS supply/ 24V DC
	10.	Signal Output	:	4-20 mA DC (isolated) - 500 Ohm load with HART protocol.
	11.	Hysteresis	:	Fully adjustable preferred
	12.	Output contacts	:	2SPDT Potential free changeover contacts @ 5A 230V AC.

13.	Accuracy & Repeatability	:	0.25% of span or better
14.	Resolution	:	0.1% of span
15.	Operating temp.	:	Transmitter- 0 to 50° C and Sensor 0 to 80° C
16.	MOC Sensor	:	SS 316 in general / PTFE, PP for corrosive application.
17.	Humidity	:	1% to 95% non condensing.
18.	Enclosure	:	IP-65 powder coated die cast aluminium
19.	Cable connection	:	½" NPT with cable gland
20.	Mounting	:	2" flanged for sensor and Transmitter on panel / surface.
21.	Accessories	:	Cable gland, prefab cable, mounting accessories.

1.21.00 Conductivity Type E lectronic Level Indicator

01.	Type	:	Conductivity discrimination.
02.	Application	:	Separator drum Level .
03.	No. of Probes	:	As per manufacturer standard.
04.	Probe Mounting	:	Flanged – on standpipe.
05.	Probe MOC	:	Stainless steel with high purity ceramic.
06.	Probe rating	:	> Maximum design pressure of vessel.
07.	Input	:	Independent channel with selectable switching threshold for water conductivity.
08.	Relay Output	:	Four isolated output relays for Hi, Lo, Hi-Hi, Lo-Lo.
09.	Contact type & rating	:	2 SPDT or 1 DPDT @ 5A 30V DC.
10.	Current output	:	Isolated 4-20 mA DC
11.	Local Display	:	a) Coloured (Red & Green) LEDs for level. b) Flashing LEDs for fault.
12.	Remote Display	:	Red, Green & flashing yellow LEDs for steam, Water & Fault indication respectively.

	13.	Power supply	:	Dual 240V AC, 50 Hz, 1Ph UPS supply.
	14.	Enclosure	:	a) IP–65, corrosion resistant & wall mounting type for local electronics. b) IP-42 for remote indicator
	15.	Accessories	:	a) PTFE cable from probe to electronics b) Mounting accessories. c) Standpipe d) Washer & gaskets e) Double isolation valves on each connection, double drain valves & double vent valves with mechanical lock. f) ½" NPT cable gland
	16.	Test pressure	:	Two times design pressure

1.22.00 Air Filter Regulator

	01.	Filter Element	:	Sintered Bronze
	02.	Filter Size	:	5 microns
	03.	Input Air	:	10.0 Kg/Sq. cm (maximum)
	04.	Output	:	Adjustable from 0-2.0 Kg / Sq. cm or 0-7.0 Kg / Sq. cm (continuous) as applicable.
	05.	Effect of Supply	:	Maximum 0.02 Kg/Sq. cm for a change pressure variation in supply pressure of 4 Kg/Sq. cm
	06.	Bowl Material	:	Metallic.
	07.	Accessories	:	2" dial size output pressure gauge
	08.	Feature	:	No perceptible drop of pressure on opening the drain port.

1.23.00 SOLENOID VALVE

non UPS 240 V AC supply is not acceptable for solenoid

	01.	Operating Principle	:	Electromagnetic (noiseless)
		Coil voltage rating	:	24V DC (in general) other 220V DC /240V AC /110V AC as required

	03.	Ways	:	3 ways in general other depending on requirement
	04.	Port size	:	1/4" NPT all ports
	05.	Body	:	SS Bar Stock
	06.	Trim	:	AISI SS-316
	07.	Manual Operator	:	In built
	08.	Duty	:	Suitable for continuous energization
	09.	Sealing	:	Airtight and leak proofing with nitrile (NBR) and polyurethane (PUR) material
	10.	Ambient Temperature	:	0 - 50^{O} C
	11.	Fluid Temperature	:	0-150^{O} C (approx.)
	12.	Coil Enclosure	:	Stainless Steel
	13.	Insulation	:	Class-H
	14.	Coil Casing	:	IP-65 (Explosion proof for NEC Class-1, Division-1 area)
	15.	Response time	:	4-7msec
	16.	Mounting	:	On pipe or on panel
	17.	Cable Connection	:	½" NPT cable gland
	18.	Accessories	:	Mounting brackets, nuts and bolts
	19.	Special feature	:	(i) LED indication for power (ii) Double coil type for open & close operation of valve / damper. (iii) Solenoid valve directly integral to actuator body shall have NAMOOR interface for uniformity

1.24.00 ORIFICE PLATE

	01.	Application	:	Low fluid velocity flow measurement
	02.	Design Standard	:	Concentric as per ASME PTC-19.5 (Part –II), ISA RP-3.2 or BS-1042, Part-I
	03.	Number of Tapings	:	As required plus one additional pair of taps
	04.	Diameter Ratio	:	Between 0.34 to 0.7

	05.	Thickness	:	3mm for main pipe of diameter upto 250mm, 6mm for main pipe of diameter above 250mm and 10mm for diameter above 500 mm
	06.	Document	:	Beta ratio calculation, assembly drawing and Flow vs. DP curve.
	07.	Meter run pipe	:	Same as pipe material
1/2" SS316 globe	08.	Accessories	:	Flanges, gaskets, nuts & bolts, root valves (1" 316 SS globe) jack screw, meter run pipe, Drain & vent hole as per application etc.

NOTE: One flow element of each type shall be calibrated in the test laboratory for validation of computed flow calculations.

1.25.00 FLOW NOZZLE

	01.	Application	:	High fluid velocity flow measurement
	02.	Design Standard	:	ASME PTC 19.5
	03.	Tapings	:	D and D/2 (Numbers as required plus one additional pair of taps)
	04.	Diameter Ratio	:	Between 0.4 and 0.7
	05.	Material	:	316 SS
	05.	Document	:	Beta ratio calculation, assembly drawing and Flow vs. DP curve.
	06.	Meter run pipe	:	Same as pipe material
	07.	Accessories	:	Meter run pipe, nipples and root valves (1" 316 SS globe).(Inspection port assembly for nozzles used in plant performance purpose)

NOTE: One flow element of each type shall be calibrated in the test laboratory for validation of computed flow calculations.

1.26.00 GAUGE GLASS

	01.	Type	:	Reflex
	02.	Glass	:	Toughened borosilicate. Resistant to mechanical and thermal shocks.
	03.	Body material	:	Carbon steel / stainless 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.

1.27.00 LEVEL GAUGE (FLOAT & BOARD)

	01.	Type	:	Float and Board
	02.	Float & Tape MOC	:	AISI 316
	03.	Pulley and Pulley Housing material	:	SS 304
	04.	Guide wire	:	SS 316 Stainless steel
	05.	Accuracy	:	+/- 2 mm
	06.	Indication	:	Vertical dial
	07.	Rating	:	Twice the design pressure
	08.	Spring tension assembly	:	SS 304
	09.	Anchor plate	:	SS304
	10.	Calibrated scale board:		Aluminium with black graduation

Note: The measuring rope/tape shall be passed through conduits

1.28.00 POWER CYLINDERS (PNEUMATIC)

	01.	Mounting Type	:	a) Fixed position mounting (End mounting).
			:	b) Trunnion mounting
	02.	Control Signal	:	4-20 mA DC to smart positioner with HART protocol for modulating purposes. 24V/48VDC operated solenoid valve operating on pneumatic line for open & closing purpose of on & off drive.
	03.	Supply Air	:	0-7 Kg / Cm^2.
	04.	Selection	:	Based upon thrust / torque, stroke length, angular movement, full-scale travel time, repeatability, space factor etc. Provision for air-to-open and air-to-close operation.
	05.	Casing	:	IP-65.

06.	Accessories (as required)	:	a)	Air lock relay
			b)	Hand wheel.
			c)	Air filter regulator with gauge.
			d)	Volume Booster.
			e)	Limit Switches.
			f)	Smart Positioner with integral I-P convertor, feedback position Transmitter (4-20 mA DC output),Input & Output pressure gauges, local keypad & display.
			g)	Solenoid Valve
			h)	Junction box with cable gland
07.	Fail-safe operation	:	Stay put for regulating duty.	
08.	Repeatability	:	Better than 0.5% of full travel.	
09.	Hysterisis	:	Less than ±1% of full travel	
10.	Operating Temp. limit	:	80^{O} C (min.)	

1.29.00 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

1.30.00 SMOKE DENSITY ANALYZER

01.	Type	:	Insitu dry visible light (through LED)
02.	Principle of		

05.	Alarm/ Annunciation	:	Four Relay contacts, dual alarm set points (240V AC, 5A)
06.	Indication	:	LCD Display
07.	Sampling System	:	Extractive
08.	Enclosure	:	IP-65
09.	Power Supply	:	240V AC (UPS)
10.	Location	:	On Chimney
10.	Accessories	:	a) Inbuilt calibration facility through calibrator. Inbuilt cell for Zero & Span calibration to be provided. Handling of Liquid Mercury to be avoided. b) Remote calibration facility to be provided. c) The Mercury analyser cabinet to be placed inside an enclosed AC environment.

1.36.00 DEW POINT METER

01.	Type	:	Direct mounting capacitance type with change in output proportional to moisture present
02.	Sensing Element	:	Ceramic/ Aluminium Oxide sensor
03.	Service	:	Dry Air
04.	Range	:	-90 Deg.C to 10 Deg.C Dew point temperature
05.	Sensor Accuracy	:	±2 Deg.C Dew point
06.	Repeatability	:	0.5 Deg.C Dew point
07.	Op.Ambient		
	Temperature	:	-40 Deg.C to 50 Deg.C
08.	Op. Pressure	:	0-10 Kg/cm2
09.	Display	:	Combined enclosure with 5 digit seven segments LED display
10.	Element Filter	:	80 micron sintered stainless steel
11.	Output	:	4~20 mA DC loop powered
12.	Power Supply	:	24V DC nominal

	13.	Enclosure Class	:	IP-65
	14.	Interchangeability	:	Fully Interchangeable Transmitters
	15	Accessories	:	Sampling System, cables, sensor holder, dessicant chambers, souble compression fittings, ¾" cable gland, mounting fixture etc.

1.37.00 DENSITY METER

	01.	Operating Principle	:	Vibration Density measurement
	02.	Wetted Part Material	:	SS-316L
	03.	Case Material	:	Cast Aluminium
	04.	Output	:	4~20 mA DC
	05.	Electrical connection	:	½" NPT
	06.	Enclosure Class	:	IP-65
	07.	Local Display	:	Digital 5 digit, density display with temp. compensation
	08.	Accuracy	:	±1.0 %
	09.	Power Supply	:	240V AC (UPS)
	10.	Location	:	At the discharge of Gipsum bleed pump in FGD system.

1.38.00 RADAR TYPE LEVEL MEASUREMENT

	01.	Type	:	Radar based on Time Domain Reflectometry
	02.	Antena	:	Co axial / single rod type guided wave or Horn type as required for the application
	03.	Communication	:	Two wire 4-20mA DC, HART protocol
	04.	Environmental temperature	:	0 – 50ºC
	05.	Enclosure	:	Explosion proof /IP 65 as per application
	06.	Cable Entry	:	½" NPT
	07.	Calibration	:	a) Self calibration with internal reference b) Zero & Span calibration
	08.	Programming	:	Handheld programmer & Local key pad
	09.	Process Connection	:	Flanged /screwed

10	Transmitter Beam Angle	:	10 degree or less
11	Blocking distance	:	less than 300 mm
12.	Electronic Housing	:	Epoxy painted Die-Cast aluminium alloy
13.	Antenna / Flange assembly	:	316 SS or Hestalloy (as required)
14.	Output Indicator	:	Digital Integral Display (Backlit LCD/LED)
15.	Accuracy	:	5 mm or 0.1% of probe length
16.	Accessories	:	a) Programming tool kit b) Gasket

1.39.00 CHLORINE LEAK DETECTOR

01.	Type	:	Electrochemical
02.	Resolution	:	0.1 ppm
03.	Display Type	:	Digital Indicating Meter
04.	Operating Temperature	:	0~45°C
05.	Alarm Contacts	:	Dual Alarm setpoints (240V AC, 5A)
06.	Enclosure Class	:	IP-65
07.	Mounting	:	Wall mounting
08.	Power Supply	:	240V AC
09.	Output	:	4~20 mA DC (600 Ω load)

1.40.00 RESIDUAL CHLORINE ANALYZER

01.	Type	:	Amperometric
02.	Electrode	:	Platinum/ Gold and copper electrode shall be provided with cell cleaning system
03.	Display Type	:	LCD in Analyzer Panel
04.	Range	:	0 to 20.0 mg/L (ppm)
05.	Accuracy	:	2% or better . The measurement accuracy shall not be affected by presence of treatment chemicals as chromates,

phosphates, de-former highly polluted water, change in temperature etc.

06.	Sensitivity	:	0.01 mg/L
07.	Alarm Contacts	:	Dual Alarm setpoints (240V AC, 5A)
08.	Enclosure Class	:	IP-65
09.	Power Supply	:	240V AC
10.	Output	:	4~20 mA DC (600 Ω load)
11.	Calibration	:	Zero & Span adjustment. Final calibration adjustments of the analyzer to be done at site and duly verified bt titration. Temperature compensation range 0-50°C.
12.	Mounting	:	Field mounting conform to IP-65
13.	Accessories	:	Chemical reagents, sample drain, pumping system (if required) etc.

1.41.00 ELECTRIC TO PNEUMATIC (E/P) CONVERTERS

01.	Air Supply	:	1.5 kg/cm2
02.	Max. supply Pressure	:	7 kg/cm2
03.	Input Signal	:	4-20 mA DC (as required by the design of control system).
04.	Output Signal	:	0.2 to 1.0 kg/cm2
05.	Control Action	:	Air to Close, Air to Open and Fail freeze-field selecable
06.	Response Time	:	5 seconds for 0 to 90% output pressure
07.	Repeatibility	:	+/- 0.1% span typical
08.	Accuracy	:	+/- 0.25% span typical
09.	Linearity	:	0.5% of span or better
10.	Hysteresis	:	0.1% of span or better
11.	Ambient Temp. effect	:	Less than 0.02% of span per ºC between

-20 ºC to +60 ºC

12. Supply pressure effect: less than 1%

13. Span and zero adjustment : screw

14. Mounting : Close to Actuator (but not on the actuator)

15. Output Capacity : To suit the actuator

16. Protection Class : IP 65

17. Allowable Drift Rate : ± 2% of set point / hour maximum

On loss of control signal, the last set point pressure shall be maintained so that the associated control valve remains in stay put condition.

1.42.00 SMART POSITIONER

01. Type : Universal design (linear or rotary application)

02. Input Signal : 4-20mA DC , 2 wire loop with 24V DC.

03. Output Signal (position F/B) : i) 4-20mA
ii) Configurable end position switch

04. Supply Pressure : Single acting 1.2 to 7.0 bar
Double acting 1.2 to 10.5 bar

05. Air Delivery : Single acting 10.0 SCFM at 2.1 bar supply
Double acting7.2 SCFM at 2.1 bar supply

06. Housing : IP 65

07. Repeatibility : +/- 0.3% of span or better

08. Accuracy : +/- 0. 1% of span or better

09. Communication : Hart protocol

10. Power-up with position : < 150 ms or better control

11 Power interruption without reset : <100ms or better

12. Body Material : Aluminium

13. Response Time : Less than 10 sec

14. Features	:	i) Noncontact position feedback sensor ii) Integral Electro-Pneumatic convertor ii) Self calibration with tunable response time iii) Online diagnostics iv) Pressure guages to be provided on positioner (I/P & O/P pressure)

1.43.00 MAGENETIC LEVEL INDICATOR

01.	TYPE	:	Magnetically coupled level indicator
02.	Display	:	Coloured flags
03.	Chamber material	:	Stainless steel
04.	Wetted part material	:	Stainless steel
05.	Process connection	:	Side Side Flanged
06.	Drain & Vent	:	Flanged
07.	Scale	:	Standard, Stainless steel
08.	Accessories	:	Counter flange, gaskets

1.44.00 FLOW SWITCH

01.	Type	:	Paddle /Piston/Disk
02.	Wetted part material	:	Stainless steel or Hastelloy for acidic application
03.	End connection Tee	:	i) Threaded upto 1" line size with integral ii) Flanged for line size > 1 ½"
04.	Enclosure material	:	Die cast aluminium
05.	Enclosure class	:	IP 65
06.	Switch configuration	:	2 SPDT
07.	Contact rating	:	240V AC 15A
08.	Repeatibility	:	2%
09.	Cable connection	:	½"NPTF

10.	Accessories	:	Tee, counter flange

1.45.00 ULTRA SONIC TYPE FLOW METER

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

b) 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.

c) CW flow shall be measured by redundant Ultrasonic Flow meter.

d) 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.

e) 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.

f) Technical Requirements

01.	Type	:	Transit time Clamp On Ultrasonic meter
02.	Mounting Style	:	Dual path with two sets of transducers on the same pipe
03.	Flow measurement	:	Instantaneous Flow rate as well as totalized flow & velocity
04.	Power supply	:	240V AC, 50Hz with built –in battery back up.
05.	Analog Outputs	:	Isolated 4-20mA linear outputs for each path with HART for volumetric flow and velocity
06.	Binary Output	:	Contact relay outputs, 2 NO + 2 NC for alarm
07.	Communication ports	:	RS 232 C digital Hand held terminal port
08.	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.
09.	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.
10.	Software features	:	Compensation for any cross path errors Programming, configuration, shall be possible from front panel.
11.	Diagnostics	:	False signal tolerance , power supply failure etc.
12.	Protection Class	:	IP-65 or better, Weather protection against direct sunlight, rain etc for Flow meter and suitable for Cooling water for Transducer.
13.	Accuracy	:	± 1%
14.	Electrical connection	:	Plug and socket
15.	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 SS 316

g) Bidder shall submit certified flow calculation and differential pressure Vs. flow curves for each element for Owner's approval. Sizing calculation, precise flow calculation for all the flow elements, fabrication and assembly drawings and installation drawings shall be submitted for Owner's approval.

2.00.00 NOT USED

3.00.00 CONTROL PANEL/DESK MOUNTED INSTRUMENTS AND ELECTRICAL SYSTEM ACCESSORIES.
(For electrical System's Meter and for synchronisation, bidder shall refer to Electrical volume of specification)

3.01.00 Digital Indicator (If requird)

01.	Type	:	Five and half digit LED seven-segment display with sign.
02.	Display Character	:	13.8 mm, RED (LED)
03.	Accuracy	:	0.1% of reading, ±2 digit

	04.	Input	:	4-20mA DC/1-5 V DC/ pulse (as applicable)
	05.	Mounting	:	Flush Panel
	06.	Power Supply	:	240V ±10%, 50 ±2.5 Hz

3.02.00 PUSH BUTTON

	01.	Type	:	Shrouded square format
	02.	Face Dimension	:	32 x 32 mm (maximum)
	03.	Contact Configuration	:	2 NO + 2 NC
	04.	Contact Addition	:	Add-on block up to 4 each with 2 pairs of contacts
	05.	Contact Material	:	Hard Silver Alloy
	06.	Contact Rating	:	500V / 10 A
	07.	Utilization Category	:	AC11 / DC11
	08.	Insulation Voltage	:	2 KV for 1 minute between terminals and earth
	09.	Mechanical Life	:	1 million operation
	10.	Construction	:	Aluminum shrouding with plastic lens
	11.	Colors	:	Red, Green, Yellow, Black, etc.
	12.	Connection	:	Screw terminals
	13.	Enclosure Class	:	IP-52
	14.	Legend	:	Engraving

3.03.00 ILLUMINATED PUSH BUTTON

	01.	Type	:	Square format
	02.	Face Dimension	:	32 x 32 mm (maximum)
	03.	Contact Configuration	:	2 NO + 2 NC (minimum)
	04.	Contact Addition	:	Add-on-Block up to 4 each with 2 pairs of contacts
	05.	Contact Material	:	Hard Silver Alloy
	06.	Contact Rating	:	500 V/ 10A

	07.	Utilization Category	:	A C11 / DC11
	08.	Insulation Voltage	:	2 KV for 1 minute between terminals and earth
	09.	Mechanical Life	:	1 Million Operation
	10.	Lamp	:	LED with built-in resistors as required
	11.	Lamp Rating :-		
	a)	Voltage	:	240 V AC
	b)	Watt	:	2 Watt (approx.)
	12.	Lamp and Lens Replacement	:	From front
	13.	Construction	:	Transparent Plastic Lens
	14.	Color	:	Red, Green, Amber, Yellow etc.
	15.	Connection	:	Screw terminals
	16.	Enclosure Class	:	IP-52
	17.	Legend	:	Engraving

3.04.00 SELECTOR SWITCH

	01.	Type	:	2/3/4 position stay put type with rotary lever actuator.
	02.	Face Dimension	:	32 x 32 mm (maximum)
	03.	Contact Configuration	:	4 pair of contacts
	04.	Contact Addition	:	Add-on-Block up to 4 each with 2 pairs of contact
	05.	Contact Material	:	Hard silver Alloy
	06.	Contact Rating	:	500 V/10 A
	07.	Utilization Category	:	AC11 / DC11
	08.	Insulation Voltage	:	2 KV for 1 minute between terminals and earth
	09.	Mechanical Life	:	1 million operation
	10.	Construction	:	Aluminum shrouding
	11.	Connection	:	Screw terminals

	12.	Enclosure Class	:	IP-52
3.05.00	INDICATING LAMP			
	01.	Type	:	LED with built-in resistor
	02.	Face Dimension	:	32 x 32 mm (maximum)
	03.	Voltage	:	240 V AC
	04.	Watt	:	2.5 Watt (approximate)
	05.	Lamp and Lens Replacement	:	From front
	06.	Construction	:	Transparent Plastic lens
	07.	Color	:	Red, Green, Amber, Yellow etc.
	08.	Connection	:	Screw terminals
	09.	Legend	:	Engraving
3.06.00	INDICATING METERS (A.C)			
	01.	Type	:	Rectifier type taut band
	02.	Face Dimension	:	96 x 96 mm
	03.	Scale	:	Radial arc of 240 Deg.
	04.	Accuracy	:	1.5% of full scale. ±0.5 Hz for frequency meter
	05.	Input	:	0-1/0-5A for current measurement, 0-240V for voltage measurement, 50 ± 2.5 Hz for Frequency measurement
	06.	Zero Adjustment	:	Screw on meter face
	07.	Enclosure	:	Shielded Case IP-52
	08.	Mounting	:	Flush Panel
	09.	End Scale Suppression	:	6 times the measuring range only for motor ammeters
3.06.01	INDICATING METERS (D.C)			
	01.	Type	:	Taut band moving coil
	02.	Face Dimension	:	96 x 96 mm

	03.	Scale	:	Radial arc of 240 Deg.
	04.	Accuracy	:	1.5% of full scale
	05.	Input	:	0-75 mA for current measurement. Direct reading for voltage measurement.
	06.	Zero Adjustment	:	Screw on meter face
	07.	Enclosure	:	Shielded case IP-52
	08.	Mounting	:	Flush Panel
	09.	End Scale		
		Suppression	:	2 times the measuring range only for motor ammeters.

3.07.00 AUXILIARY RELAY

	01.	Type	:	Plug-in type with base/DIN rail Mounted
	02.	Coil voltage	:	240 V AC/24V DC / 220V DC
	03.	Contact Configuration	:	2 NO & 2 NC (Minimum), additional contacts as per requirement
	04.	Contact rating	:	250V/5A (A.C/D.C.)
	05.	Operating range	:	80 to 110% of rated voltage
	06.	Insulation	:	2 KV for 1 minute between terminals & earth.
	07.	Mechanical life	:	20 million operations
	08.	Enclosure	:	Transparent cover
	09.	Connection	:	Screw terminals.
	10.	Mounting	:	Projection mounting inside panel /DIN rail Mounting

Note : Coil protection: diode/surge suppressor shall be provided

3.08.00 COUPLING RELAY

	01.	Type	:	Miniature plug-in type/ DIN rail Mounting
	02.	Coil voltage	:	24 V D.C. / 48 V DC or others as required.
	03.	Contact	:	2 NO & 2 NC (Minimum)-Additional contact as per requirement

04.	Contact rating	:	250 V/10A (A.C)/220V/2A (D.C)
05.	Operating range	:	70 to 110% of rated voltage.
06.	Insulation	:	2 KV for 1 minutes between terminal & earth.
07.	Mechanical life	:	20 million operations
08.	Coil protection	:	Diode
09.	Indication	:	Coil on LED
10.	Enclosure	:	Transparent cover
11.	Connection	:	Screw terminals.
12.	Mounting	:	Projection mounting inside panel / DIN rail mounting

3.11.00 Push Button Station (Emergency Stop)

01.	Function	:	Hardware communication between P/B Station & DCS
02.	Type	:	Mechanical keys Shrouded
03.	Size	:	48 mm
04.	Mounting	:	On Auxiliary Console
05.	Signal Level	:	24V DC Binary
06.	Ambient temperature	:	0-50 ^{O} C
07.	Ambient Humidity	:	0-95% RH (max.)

4.00.00 CONTROL VALVES, ACTUATORS & ACCESSORIES

4.01.00 GENERAL REQUIREMENTS

4.01.01 Bidder shall exercise extreme caution in selecting severe service control valves like BFP recirculation valves, HP & LP bypass valves, superheater & reheater attemperator valves, PRDS valves for Boiler & Turbine, Soot blower steam pressure control valve, control valves whose down stream are connected to condenser and in vacuum such as HP/LP heater emergency level control, condenser make up water control valve and CEP minimum flow control valve etc. For such critical applications, Bidder shall offer valves which are proven for similar application for not less than 2 years of continuous service in power plant environment. All the above valves shall have leakage class equal or better than class-V or as specified hereunder with metal-to-metal seating. For Severe Service Control Valves viz. BFP Recirculation Valves, PRDS Valves,Feed Control Valve, SH/RH Attemperation valve, Soot blower steam pressure control valve etc. multistage-multipath discrete pressure drop stage design shall be provided. HP and LP Bypass valves shall be designed for 60% bypass capacity with twin valves. Typical Requirements for these Control Valves shall be as follows:

Service	:	BFP Recirculation Valve/RH-SH Attemperator Valves
Type	:	Multi Stage, Multi Path stack Plate radial Flow design
Trim	:	Angle Design (side inlet and bottom outlet, over the plug flow) or Globe design (for straight pipe)
Trim exit v*elocity*	:	Not exceeding 23m/sec
Pressure reducing /drop	:	Achieved in multi stage orificed, drilled hole or axial flow cage design
Seat Leakage	:	In accordance with MSS-SP-61
Actuator type	:	Pneumatic Piston type ensuring MSS-SP-61 seat leakage

4.01.02 Control valves for regulating service shall normally be globe body, cage guided, metal-to-metal seated, pneumatically operated and shall be provided with characterized plugs having ANSI leakage class-IV as minimum. All steam temperature conditioning control valves shall be ANSI leakage class-V.

4.01.03 Where the operating time is critical for the operation of the plant, as in case of HP or LP bypass valves, hydraulic actuators with electro-hydraulic interface shall be offered. Block valve in the spray water line for HP or LP bypass valves shall also be hydraulically operated.

4.01.04 Bidder shall provide redundant control valves for main condensate control station, Superheat attemperation control and Reheat attemperation control as a minimum. For other application, if the availability criteria for the plant can not be met even with the best established product, redundant control valves shall be provided.

4.01.05 All control valves shall be located near floor or platform for ease of access with adequate clearances for maintenance and lay-down and shall be placed as control station with up-stream and down-stream motorized isolating valves, manual drain valves and motorized inching bypass valve. For Superheat attemperation control and Reheat attemperation control, upstream and down stream isolation valves shall be solenoid operated pneumatic on-off valves. Block valve in the spray water line shall also be solenoid operated pneumatic on-off valve.

4.01.06 Control Valves and accessories shall be designed and tested in accordance with the latest applicable requirements of code for pressure piping ANSI B 31.1, ASME Boiler and pressure vessel code, Indian Boiler Regulation (IBR), ISA and other standards as specified elsewhere and in accordance with the applicable requirements of the Federal Occupational Safety and Health Standards, USA or acceptable equal standards.

4.01.07 The start–up system control valves and HP & LP bypass control valves shall be proven in similar application.

4.01.08 All control valves shall meet the specification requirements and process requirements.

4.01.09 For large flow conditions with low pressure drops, as in case of cooling water applications, butterfly valves shall be used.

4.01.10 High Pressure Bypass Control Valve

1. Body shall be designed to withstand thermal cycling. Thin walled sections shall be provided in areas after pressure reduction to reduce thermal fatigue.

   Transitions between thick and thin wall sections shall be gradual. The body shall be a single shape steam entry from the bottom (under the plug) to facilitate easy and clean installation.

2. Valves shall be designed that they can operate in any orientation. For maintenance purposes the preferred orientation is vertical.

3. The HP bypass shall have desuperheating function in the valve body. Water injection must be at a fixed point inside the valve spraying into the turbulent steam flow. Water shall not be injected through the stem due to leakage potential past internals seals and to eliminate possibility of stem cracking due to combined thermal and mechanical stress. Water spray should be fully atomized within 1m of valve outlet to ensure uniform reheater temperature and flexibility in downstream piping layout.

4. Body shall be protected from damage due to water injection by means of multi function contoured cage. Contoured cages shall be used as they have higher mechanical strength and no tendency to resonate.

5. Cage material must be of a high alloy material such as X20Cr Mo V121 for good thermal cycling and erosion resistance.
6. Contour of cage to be of hour glass shaped form to improve the strength of the cage. The cage shall be firmly attached at one end and located radically at the other end to provide good guiding and allow axial growth due to thermal differentials.
7. Plug type shall be channel slotted design for acoustic attenuation and to allow passages of nominal contamination. Plugs of multiple holes design are unacceptable due to contamination catching between plug and seat. Contoured plug designs are not allowed because of poor acoustic performance.
8. Packing box design shall consist of two independent sets of rings separated by a metallic spacer. Packing to be compressed by means of a bolted flange design. Screwed gland type packing retainers shall not be provided.
9. Bolted bonnets are preferred. If pressure seal bonnet are used, seal areas shall be inlayed with corrosion resistant materials to minimize leakage potential.
10. The bypass valve should conform to MSS SP-61 or EN12266-1 Rate C leakage class (block/isolation valve tightness). Bidder to provide calculation.

4.01.11 Low Pressure Bypass Control Valve

1. Body shall be designed in angle shape for ease of installation and maintenance.
2. Valves shall be designed that they can operate in any orientation.

   Note that the typical orientation for LP-Bypass valves is horizontal with straight outlet to the condenser.
3. Skirted-plugs shall not be used due to potential for contamination and sticking between plug and seat. A combination of cage guiding and top guiding for plugs shall be provided to eliminate possibility of vibration.
4. No components may be screwed or welded inside the valve body for ease of maintenance.
5. Inlet cage and seat shall be easily removable for inspection maintenance and replacement. They shall be hold in place by the bonnet bolting and flexible gaskets shall accommodate differential thermal expansion.
6. Water injection to be downstream of pressure reduction to maximize evaporation.
7. Diffuser in the outlet to reduce noise and guide steam towards spray nozzles for good mixing of water and steam.
8. Water shall not be injected through the stem due to leakage potential past internals seals and to eliminate possibility of stem cracking due to combined thermal and mechanical stress.
9. Water injection shall be performed through spray nozzles. Spring loaded nozzles are preferred to maximize atomization at lower flow

rates. Multiple nozzles shall be used for uniform spray pattern. Water injection shall be perpendicular to stem flow for good penetration and mixing.

10. Packing to be compressed by means of a bolted flange design. Screwed gland type packing retainers shall not be provided.

11. Bolted Bonnets are preferred. If pressure seal bonnets are used, seal areas shall be inlayed with corrosion resistant materials to minimize leakage potential.

12. The bypass valve should conform to MSS SP -61 or EN12266 – 1 Rate C leakage class (block/isolation valve tightness). Vendor to provide calculation.

4.01.12 Spray water Valves

1. Valves shall be provided with rated cavitation index (Kcr) above Cavitation index for the process (Kc) where Kc=(P1-P2)/(P1-Pv)

2. Valves shall be free of cavitation. Should process condition produce cavitation, valve design shall be upgraded to eliminate cavitation.

3. The trim should be quick change type. No parts should be screwed or welded.

4. Isolation valves must be provided upstream of the HP-Bypass spraywater control valves, to ensure tightness of the spraywater line whenever the steam valve is closed. Individual isolation valves per control valve are recommended. Isolation valves are to be shut whenever the steam valve is closed.

5. Isolation valves upstream of the LP-Bypass spraywater control valves are recommended to allow shut-off of the water line. Isolation valves are to be shut whenever the steam valve is closed.

6. The valves should conform to MSS SP -61 or EN12266 –1 Rate C leakage class (block/isolation valve tightness). Valve trim exit velocity should be below 23 m/sec.

4.01.13 Hydraulic System

Hydraulic actuation is used for positioning of bypass control valves to fulfill the high stroking speed, high actuation forces and accurate positioning requirements. The hydraulic actuation system consists of one or more hydraulic supply units as required by the capacity and the distances between the valves and the hydraulic actuators and accessories.

4.01.14 Hydraulic supply unit

The hydraulic supply unit shall have the following features:

- fully redundant main pumps with 100% capacity. Switch over from main to standby pump should be fully automatic. Both pumps can be main or standby pump.
- Operating pump should run continuously to avoid unnecessary switching of main pumps and power peaks.

- Filter loop with continuous filtration of the oil. Filter change possible without switching off main pumps to avoid shutting down bypass for filter change.
- Oil filling must take place with the filter pump through the filter.
- Oil cooler with controlled fan to keep oil temperature within limits for the used hydraulic oil.
- Optional oil heater if ambient temperatures are getting below minimum limits of hydraulic fluid.
- The hydraulic supply unit should be able to generate constant outlet pressure of 160 bars and should have constant pressure and forces at the actuator.
- Accumulator pressure should be above the controlled outlet pressure to ensure sufficient reserve volume in the accumulators.
- Reserve volume in accumulator should be sufficient to allow min. 2 strokes of all actuators after trip of main pumps.
- Hydraulic supply unit should be equipped and completely wired and tested with local control and power switches. Manual control of the hydraulic supply unit through push buttons on the front panel for commissioning and testing.
- Drip tray shall be supplied together with the hydraulic supply unit.

4.01.15 Hydraulic actuators

- Hydraulic actuators shall be of compact heavy duty design and shall fulfill all force, stroke and stroke speed requirements of the valves.
- Actuators shall be of compact design with proportional valves and auxiliary elements directly flanged to the actuator, without connection pipes between these elements and the actuator
- Position control shall be performed with the help of proportional valves
- System must include accessories for quick stroking and safe opening and safe closing. Quick stroking accessories are not required if control through proportional valves meets quick stroking speeds (typically 2-3 seconds).
- Energy for safe opening or closing (e.g. condenser protection) shall be independent of the oil pressure from the HSU, either through steam force or a separate hydraulic accumulator.

4.01.16 Hydraulic positioner

- Hydraulic positioned shall be of digital smart type featuring simple adjustment through digital interface.
- For easy commissioning and maintenance positioners are located close to the valve/actuator and must be suitable for the harsh environment. Connections to the actuator shall be prefabricated and pluggable.
- The positioned is the only connection point for the plant cabling to the valve/actuator.

- Positioner should be absolutely stable at stroke speeds of 2 seconds
- Positioner shall have standard 4-20 mA signals for position demand and position feedback.
- Power supply options must be available for easy adaptation to the power supply available in the plant.

4.01.17 Bypass Controller

- Control system shall be state of the art, digital type.
- Control system should have redundant power supply to ensure reliability
- Control system shall be suitable to operate from 0 to 50 degree Celsius.
- Input/output modules, Power supply modules and CPU modules shall have hot swap feature and shall be replaceable while the plant is in operation without any disturbance of the other module.
- Input/output modules, Power supply modules and CPU modules shall have no slot dependencies for easier use.
- Interface with main DCS shall be MODBUS.

4.02.00 VALVE CONSTRUCTION

4.02.01 All valves shall generally be of globe body design and straight through pattern with single seat unless otherwise is specified or recommended by the manufacturer for particular application. However, Bidder may offer angle body valve for high pressure drop applications. For high pressure drop applications, construction of the valve shall be such that the gland is not exposed to full line pressure.

4.02.02 Valves with high lift cage guided plugs and quick replacement trims shall be provided for easy maintenance.

4.02.03 Plug shall be one piece construction either cast, forged or machined from solid stock. Plug shall be screwed and pinned to valve stem or shall be integral with valve stem.

4.02.04 Bonnet joint shall be of flanged and bolted type or manufacturer standard acceptable to Owner. Bonnet joints of internal threaded or union type is not acceptable.

4.02.05 Extension Bonnet shall be provided for fluid temperatue above 280 deg C.

4.02.06 Valve characteristics shall match with the process characteristics.

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

maximum

4.02.08 Flanged valves shall have ~~minimum~~ body rating ANSI 300 lbs.

4.02.09 The direction of flow shall be clearly marked/engraved on the body.

4.02.10 Valve body rating shall meet the process pressure and temperature requirement as per ANSI B 16.34.

4.02.11 Control valve body shall be selected as per the ISA guideline. Generally control valve body shall be cast and machined for pressure rating up to 1500 lbs. Above 1500 lbs, valve body shall be of forged steel. For Demineralized Water application valve body shall be Stainless Steel.

4.03.00 VALVE BODY

Valve body material shall generally be guided as per the Table below:

SR. NO.	SERVICE		BODY MATERIAL
1.	Non corrosive, non-flashing and non cavitating service for fluid temperature upto 275ºC (like Aux steam flow to Deaerator, condensate flow to Deaerator, CRH flow to Deaerator)	:	Compatible with piping material but not inferior to Cast carbon steel ASTM A216 Gr. WCB
2.	Severe flashing / cavitating services (like HP & LP heaters emergency drain, Deaerator overflow drain to hotwell etc.)	:	Alloy steel as per ASTM A217 Gr. WC9
3.	Low flashing / cavitating services (like HP & LP heaters normal drain level control, GSC minimum flow, gland seal steam pressure control etc.)	:	Alloy steel as per ASTM A217 Gr. WC6
4.	DM water application (like condenser hotwell normal and emergency make up, ECW DP control etc.)	:	316 stainless steel ASTM A351 Gr. CF8M

4.04.00 VALVE TRIM

4.04.01 Valve trim for most applications up to leakage class-V shall be stainless steel 316 SS for pressure drop up to 7 Kg/ Sq. cm.. For pressure drops above 7 Kg/Sq. cm hard trim (stelliting or equivalent) shall be used. Other alloys shall be substituted if required for corrosion and other fluid conditions.

4.04.02 Balanced trim valves shall be offered for high shut-off pressure or high pressure drop condition to reduce the size of the actuators. For flashing services and two stage mixtures, the trim material shall be 17-4 PH or equivalent. If cavitating condition is foreseen, Bidder shall offer multistage or labyrinth trim valves. Trim of severe service valves as indicated in Cl. 4.01.01 shall be of multistage and multipath design with sufficient no. of discrete

pressure drop stages to eliminate the chances of erosion, cavitation, noise and vibration throughout the control range of the valve.

4.04.03 Quick replacement type trim shall be considered for easy maintenance.

4.04.04 Trim Material

Valve trim material shall generally be guided as per the Table below :

SR. NO.	SERVICE		MATERIAL
1.	Non corrosive, non-flashing and non cavitating service for fluid temperature upto 275ºC.	:	316 SS with satellite faced guide posts and bushings
2.	Severe flashing / cavitating services	:	400 series SS or equivalent to suit the specific requirement
3.	Low flashing / cavitating services	:	400 series SS or equivalent to suit the specific requirement
4.	DM water application (condenser hotwell normal, emergency make up etc.)	:	316 SS

cavitation resistance, corrosion resistance, temperature resistance, erosion resistance, hardness etc. of the offered material vis-à-vis the specified material for Bidder may offer valves with body and trim material better than the specified material and in such cases Bidder shall furnish the comparison of properties including Owner's approval.

4.05.00 VALVE END PREPARATION

Valve body ends shall be either butt welded/socket welded, or flanged (Rubber lined for condensate service). Control valves of size 65 mm and above shall have butt welded ends as per ANSI B 16.25. For valve size 50 mm and below welded ends shall be socket welded as per ANSI B 16.11. Flanged ends shall be of ANSI pressure-temperature class equal to or greater than that of control valve body.

4.06.00 VALVE SIZE

The control valve sizing (Cv / Kv) shall be based on following guidelines :

a) The valves shall pass normal rate of flow (MCR condition) with 65 to 75 percent opening for linear characterised valves and 75 to 85 percent opening for equal percentage characterised valves.

b) The valves shall have adequate rangeability to pass the minimum and maximum rated flows at 10% and 80% of the valve opening

respectively. Valve stem travel range from minimum to maximum flow condition shall not be less than 50% of the total valve stem travel.

c) Valve Cv shall be selected in such a way that the valve shall be capable of handling at least 120% of required rated flow.

d) The valve selection shall be based on the highest size dictated by the above considerations unless noise, flashing or other factors dictate the final selection.

e) The sizing procedure followed shall be as per latest edition of ANSI/ISA or equivalent standard.

f) While deciding the valve size, Bidder shall ensure that valves port outlet velocity does not exceed 8 m/sec for liquid services, 150 m/sec for steam services and 50% of sonic velocity for flashing services.

g) Control valve induced noise shall not greater than 85 dBA at 1 meter from the valve surface under actual operating conditions. The noise abatement shall be achieved by valve body and trim design and not by use of silencers.

h) Bidder shall submit the sizing calculation clearly indicationg the valve outlet velocity, noise calculation during detail engineering stage for Ownner's approval.

4.07.00 VALVE TOPWORK

4.07.01 Topwork shall be sized so that the valve shall operate properly when upstream pressure is 10 percent above maximum inlet pressure and downstream pressure is atmospheric.

4.07.02 Bonnet material shall be same as that of valve body or equivalent forged material.

4.07.03 Extended bonnet/Finned bonnet and high temperature packing shall be used for high temperature application. Extension bonnet shall be used when the fluid temperature is high and may damage valve stem packing.

4.07.04 The gland material shall be chosen to suit the operating temperature. PTFE may be chosen for low temperature application and for high temperature application graphited asbestos glands are to be provided. For vacuum services, the glands shall be dry seal type.

4.08.00 NOISE LEVEL

The equivalent sound level measured at 1.5 M above nearest floor level in elevation and 1 M horizontally from the control valve expressed in decibels to a reference of 0.0002 microbar shall not exceed 85 dBA. If the calculated noise is more than the above limit, even with low noise trim design, diffusers shall be included. Diffusers shall be made of stainless steel and shall be integrally connected to the control valve with necessary spool piece. The spool piece shall be in conformity with the main line piping specification.

4.09.00 VALVE ACTUATORS

4.09.01 Spring-diaphragm type valve actuators shall be used in general applications. However piston type actuators shall be offered in case of high shut-off pressure & quick response requirement. Bidder shall provide piston type actuators for regulating services for the following services as a minimum requirement. Piston actuator shall be of double acting type for the regulating duty valves with long stem travel for better regulation and quick response.

a) Auxiliary Pressure reducing & De-super heating stations.

b) Superheat and Reheat Spray Control Valves.

c) Condensate extraction pump minimum recirculation valve.

d) Feed control valves

4.09.02 The actuator shall be designed for 150% thrust required for the valve (at shut-off pressure) at an air line supply pressure of 5.5 Kg/Sq. cm.

4.09.03 All the actuators shall be supplied mounted on the valve with all the accessories integrally mounted. The diaphragms shall be designed for 200% maximum operating pressure.

4.09.04 Nylon reinforced neoprene shall be used as diaphragm material.

4.09.05 Valve actuators shall be capable of operating at 60 deg C ambient, continuously.

4.09.06 Entire actuator assembly shall be painted with corrosion inhibiting paint.

4.09.07 Air connection size shall be 1/4" NPT (F) unless otherwise dictated by process response time. Integral tubing shall be of stainless steel construction.

4.09.08 Bidder shall indicate the stroking time of the valve assemblies with positioner, which shall not exceed 10 sec unless otherwise stated.

4.09.09 All actuators shall be of fail safe design signifying that the spring direction will tend to move the valve (open or close) in a direction safe for the process. “Failure to Open” or “Failure to Close” shall be marked on the actuator.

4.09.10 HP and LP bypass and spray valves, turbine inlet stop & control valves shall be electro-hydraulic actuators and all other control valves shall have pneumatic actuators.

4.10.00 VALVE POSITIONERS

4.10.01 All regulating service valves shall be offered with HART protocol based Smart Electro Pneumatic Positioners to ensure accuracy and repeatability of response.

4.10.02 Positioners shall have integral I-P converter, Position feedback transmitter, input and output gauges, local keypad & display .

4.10.03 Positioners shall be capable of functioning under hot, humid and vibrating conditions.

4.10.04 Positioner casings shall be dust tight, corrosion resistant and weatherproof (IP-55).

4.10.05 In general, positioner shall operate at signal range 4 – 20 mA DC for the full travel of the valve. Split range operation in few cases may be required. Remote calibration from control room shall be possible through HART management station.

4.11.00 VALVE ACCESSORIES

The accessories of the valves shall include side mounted hand wheels, smart positioner, limit switches, tubing and air set, junction boxes, airlock relays, volume booster, solenoid valves, and any other devices as required.

4.12.00 TESTS

All valves shall be tested in accordance with the Quality Assurace Programme (QAP). Bidder shall submit QAP for Owner's approval. The tests shall include but not be limited to the following :

01. Non destructive test as per ANSI B 16.34.

02. Hydrostatic shell test as per ANSI B 16.34 prior to seat leakage test.

03. Valve closure test and seat leakage test as per ANSI B 16.34 and as per the leakage class

04. Functional test : The fully assembled valves with actuator and all accessories shall be functionally tested to demonstrate from open to close position and vice versa. Valve lift shall be checked at 5 points at 0, 25, 50, 75 and 100% in both the directions with increasing and decreasing inputs. Performance of the valve with Positioner shall be as follows :

    a. Linearity : +/- 1%
    b. Hysteresis : +/- 1%
    c. Sensitivity : +/- 0.5%
    d. Deadband : +/- 1%
    e. Reproducibility : 0.3% of total stroke
    f. Overall accuracy : +/- 1%

05. CV test : Cv test shall be carried out as type test on each size, type and design of the valves as per ISA 75.02 standard and test report shall be submitted for Owner's approval.

5.00.00 CONTROL DESK / PANEL / RACK

5.00.01 Convenient and logical approach to operational interfaces shall be considered to enhance aesthetics in the overall view of the control room..

5.00.02 For items susceptible to vibration, suitable rubber gaskets or padding shall be provided to prevent damage or malfunction.

5.00.03 All items like MCB, Terminals, instruments, lamps etc. inside the panels/cabinets shall be neatly arranged with easy access/ maintenance approach to avoid undue disturbing the wiring.

5.00.04 Incoming power supply feeders shall be Redundant UPS Power supply feeders, so that a single failure shall not affect the operation of the unit. Required isolation & protection through MCB shall be provided in all cases. Alarm shall be provided against failure of a single power supply. Duplication/looping of Power supply feeders at the Panel terminal is not acceptable. Redundant UPS power supply feeders shall form Primary & Secondary power supply Bus and further power distribution shall be from these busbars.

5.00.05 Desk / panel shall be provided with interior illumination lampwith door switch, space heater with thermostat and 5A, 3 Pin receptacle with plug. Exhasut/cooling fans with fan failure alarm shall be provided.

5.00.06 Lamp, heater, exhaust fan and receptacle circuits shall be suitable for available AC supply and furnished with individual ON-OFF switch. The ON-OFF switch of the 3 pin receptacle circuit shall be Illuminating type.

5.00.07 Panel / Desk shall have gland plate at cable entry to panel. Thickness of gland plate shall not be less than 3 mm.

5.00.08 Panels / enclosure shall be provided with 20% spare terminals. In addition, the spare hot on rail mounted input output channels /modules shall be in fully wired & terminated condition for system cabinets.

5.00.09 Wire shall be routed/laid in the covered PVC cable trough/tray.

5.00.10 Nameplate

a) Nameplate shall be furnished for each instrument or device mounted on the panel/desk.

b) The material shall be laminated phenolic, 3 mm thick with white letters on black background.

c) The nameplates for panels / consoles shall be provided both on the front and the rear.

d) Nameplates for all devices shall be located adjacent to the respective devices.

5.01.00 UNIT CONTROL DESKS

5.01.01 All devices mounted on the control desks shall be flush type. Instruments / devices shall be so mounted that the removal and replacement can be accomplished individually without interruption of services to others.

xiv) Front and Rear door shall be considered.

5.02.00 BACK UP PANEL / ELECTRICAL PANEL

5.02.01 Back Up Panel shall be of free standing type vertical panel with doors at the back. Construction shall be made from sheet steel of thickness not less than 3mm with mosaic grid structure of approximate size 24 X 48 on the front surface. Grid shall be heat resistant, flame retardant, self extinguishing, shrinkage free, non reflecting type. Finish shall be mat type without flaring. Indicators /ammeters, conductivity type EWLI for seperator, electromatic safety valve controls etc. shall be mounted on the panel..

5.02.02 Electrical Panel construction & design shall be similar to back up panel. Required control switches, meters, indicators, synchronizer, excitation control switch, annunciation window etc. alongwith associated mimic diagram shall be provided for manual synchronization of generator.

5.02.03 Crating of the panels shall protect against shock, vibration, inappropriate handling and inclement weather conditions during transportation and warehousing. Mounted equipment shall have protection against damage during handling, transit and storage. Suitable desiccant shall be used inside the packing case.

5.03.00 CABINETS / ENCLOSURE / PANELS

01.	Material of construction	:	Cold rolled steel sheet
02.	Thickness of Sheet	:	a) 3.0 mm for faces supporting instruments / terminals. Mounting plate shall also be 3.0 mm. b) 2.0 mm for other sides inclusive of top.
03.	Construction	:	Welded throughout as per (metallic parts) approved National Standards.
04.	Panel height	:	2300 mm maximum
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. Doors shall have 4 point IP Lock
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. Door swing shall be Min. 110-120 Degree
vi)	Louvers	:	With removable wire mesh to ensure dust and vermin proof.
07.	Color of interior	:	Brilliant white (Approval shall be accorded by owner during detail engineering)
08.	Colour external	:	RAL 7032 (Approval shall be accorded by Owner during engineering)
09.	Painting	:	Epoxy powder coated or better. Minimum Paint thickness shall be 80-100 microns
10.	Gland plates	:	Removable 4 mm thick (bottom)
11.	Cable entry	:	Bottom
12.	Hardware	:	a) Anti vibration pad- 15 mm b) Predrilled base channel ISMC - 100 or equivalent for all sides. c) Lifting hook / Eye bolt d) Drawing pocket e) Door switch, lamps, thermostat, heaters and fans
13.	Enclosure Protection	:	As per environment condition of the area of installation. Refer to Section-I of Vol-IIE clause 6.16.00.

5.04.00 LOCAL INSTRUMENT RACKS & ENCLOSURE (EXCEPT OFFSITE/BOP AREAS)

Transmitters and switches located in the field shall be grouped together and shall be installed in the enclosure (Closed Transmitter Racks) in case of outdoor area such as Boiler area etc. and in Open Type Rack in case of

covered area. Racks shall be factory prefabricated & painted and complete with internal tubing, manifold, isolation valves, integral junction box with outside access door, illumination etc. Racks used for furnace, flue gas and air application shall be provided with intermittent & continuous air purging. Following requirements for LIE/LIR shall be met:

1) Not more than Six (6) Instruments shall be grouped in a single Rack/enclosure".

2) Racks shall be installed above the tapping points for air, flue gas and coal air mixture application where as for applications such as for water and steam, racks to be installed below the source point.

3) Service air connection shall be provided for continuous and intermittent purging of impulse pipe in dusty medium. Continuous purging shall be adopted for differential and guage Pressure measurements such as flue gas, furnace and coal air mixture applications. Intermittent purging shall be adopted for Pressure measurements in air application or wherever required.

5.04.01 Closed Type Transmitter Racks

a) Required number of transmitter racks shall be furnished to house transmitters, switches and converters by grouping them suitably, area-wise / function-wise. Closed type Instrument rack to have the list of the Transmitters & Switches along with the service and KKS tag on the inner face of the front door. Moreover each Transmitter/switches mounted on the 2" pipe shall have label indicating the KKS tag.

b) The transmitter enclosures shall be constructed of 3 mm thick steel plate. The enclosures shall preferably be of modular construction and with two end plate assembly bolted to the frame. Base frame shall be made of ISMC 100 and black colour finish

c) The enclosure shall approximately be 1200 millimeters wide, 1000 millimeters deep and 2200 millimeters high to allow easy access to the internals. Racks shall be reinforced as required to ensure true surfaces and to provide adequate support for instruments and equipment mounted therein. Double interlocking doors shall be provided and shall be arranged for maximum possible access to the interior. Center posts or any member which would reduce access shall not be provided.

d) 2"NB Galvanised pipes shall be laid horizontally and supported at two end channels to mount transmitters/switches at accessible height. Adequate support for Manifold, impulse pipe and cable tray to be provided and the same shall be adjustable.

e) Doors shall have concealed quick removal type pinned hinges and locking handles. Doors locks shall accept the same key all over the plant. Gaskets shall be used between all mating sections to achieve dust proof enclosure rating for the modules and a IP-65 waterproof

and dust tight rating on the terminal boxes. All enclosures shall have access doors on front side. Doors shall have three point Locking system. Doors shall have concealed quick removal type pinned Stainless steel hinges.

f) Bulkheads, especially designed to provide isolation from process line vibration shall be installed on modular bulkhead plates of the transmitter enclosures to meet the process sensing line connection requirements. Removable top and bottom plates shall be furnished. Removable bulk head plates of thickness not less than 6mm shall be mounted on the racks with suitable high temperature gasket impulse line within the enclosures shall be properly clamped..

g) All internal wirings and/or data bus connections, if any, between the transmitters and terminal junction box shall run through flexible dust tight conduits connected to the terminal box hub. No exposed wirings within transmitter racks, both open and closed type, is admissible.

h) All racks shall have a common closed drain trough to connect transmitter drain points to a common header after suitable pressure breaking. Covered funnels shall be used for saturated liquid and steam service, whereas, open funnels may be used for cold liquid services. The trough shall be suitably sloped and shall have one end flanged and extending beyond the rack for connection to plant drain header. Individual Instrument blowdown line shall be connected to the common blowdown drain header through regulating globe type blowdown valves. The common blowdown drain header shall be 2" NB ASTM A106, Sch-80 Gr. C installed at a slope of 1:25

i) Vibration dampeners shall be installed for supporting each enclosure. The loading at each corner of the enclosure shall be determined by actual test weighting when construction is complete to determine the correct length of each dampener for proper loading of the dampener in accordance with manufacturer's recommendations.

j) Service Power and Lighting

i) Each enclosure shall be provided with one receptacle, one light fixture with wire guard and one lighting switch. Lighting switches may be door actuated & mounted inside the panel. Outlet box, switch box and device covers shall be of galvanized stamped steel. Light switches and receptacles shall be installed inside the enclosure on the wall near the latch side of the enclosure door. Light fixtures shall be installed on the ceilings of the enclosures.

ii) Power supplies for miscellaneous devices shall be provided with MCB located within the enclosures. MCB shall be mounted in fuse blocks. Nameplates shall be furnished above the MCB blocks, identifying the devices being served.

k) Control Air

i) A control air supply header shall be furnished in each enclosure having pneumatic devices. The header shall be 25 mm NB brass header stock drilled and tapped for 8 millimeter valves.

ii) A valve with double compression end fittings shall be installed in each tap. Not less than three spare connections shall be furnished in each enclosure. The air header shall originate at a bulkhead penetration or fitting located in one of the bulkhead plates. Each pneumatic instrument shall have an individual air shut-off valve.

iii) Pressure reduction shall be achieved by air filter regulator sets. One filter regulator shall be furnished for each group of components making a system.

l) Service Air

In case of Continuous air purging, a 25NB (1") service header shall be formed which shall receive air through isolation valve and air filter regulator. Air shall be fed from air header to impulse pipes near to take-off points through isolation valves and flow regulators. Service Air header shall be Stainless steel. Impulse pipe for such applications shall have four-way valve. one port of the valve shall have an adaptor to connect flexible stainless steel braided nylon to the service air. Rating of the hose having a burst pressure 15 Kg/Sq.cm. four way valve shall have two position operations. One position for service and other one for purging. Required pressure guages shall be provided for monitoring of air pressure. Complete purging arrangement shall be integral to the enclosure and racks.

m) Power Supplies

Contractor shall supply all required transformers, regulators and other power supply equipment to adapt sources of power to the requirements of the enclosure mounted equipment. This shall include but not be limited to internal instrument illumination transformers. The circuits shall be separately isolated with MCBs.

n) Equipment Installation

Special attention shall be given in the piping layout to avoid air traps in liquid filled piping, or water pockets in piping.

o) Impulse Piping /Tubing

i) Transmitter enclosures shall be complete with impulse piping & tubing, valves from enclosure bulkhead connection to all instruments and necessary drain / blow down connections. The type, size, material and pressure class of pipes/tubes, fittings, valves etc. shall be suitable for the intended applications.

ii) Blow down piping / tubing may be shared, but individual instrument piping / tubing and valves shall be furnished. Piping / Tubing material

within enclosures shall conform to the application requirements. The final flexible connection to each instrument shall be fabricated with a double offset so that it may readily be disconnected to permit "in situ" calibration of the instrument.

iii) Bulkhead connection shall be used when instrument piping/ tubing enters the enclosure. For instrument lines which enter through the bottom of the enclosure, the primary process line from the instrument valve shall be neatly installed, anchored and terminated at approximately 150 millimeters above the floor of the enclosure. The enclosure shall have a removable, gasketted floor plate to provide an effective seal around the incoming field primary process line. An angle shall be installed 600 millimeters above the floor, running the length of the enclosure for anchoring of incoming field process lines.

iv) Pulsation dampeners shall be furnished wherever required.

v) Drain pots shall be furnished for instruments measuring flue gas parameters and vacuum.

vi) All liquid filled blow down lines, except those measuring vacuum shall be connected to a header extended through one end of the enclosure and turned downward for directing the blow down into drain. Gas filled lines and lines equipped with drain pots shall not be connected to the blow down header. The connection between the blow down valve and blow down header shall be constructed so that it can be removed to permit the connection of test instruments to the blow down valves.

vii) The draft instrument line four-way valves shall be installed so that the quick disconnect fitting is readily accessible for connection with the service air hose.

viii) Pipe and stainless steel tube welding shall comply with the provisions of the latest applicable ANSI Code for Pressure Piping.

ix) Instrument piping and tubing shall be hydrostatically tested at one and one-half times the maximum system pressure for that instrument except for low pressure and vacuum measurement the test pressure will be as per piping standard.

p) Instrument Tubing

i) Pneumatic tubing shall be installed in a neat workmanlike. It shall be supported frequently enough that it does not shake when subjected to vibration. All tubes which enter or leave the enclosure shall be terminated on bulkhead fittings in the bulkhead plate.

ii) Pneumatic tubing material shall be 6 mm OD stainless steel tubing, unless otherwise specified. Flareless tubing fittings shall be used for tubing connections smaller than one inch. Tubing shall be stretched before installation to assure straightness. Special tools shall be used for all bending and forming operations. Tubing shall be carefully

handled to avoid flat spots, kinks, and short bends. All piping and tubing shall be air blown after erection and before attachment to equipment at either end.

5.04.02 Open Type Transmitter Racks

a) Open type transmitter racks may be provided for mounting transmitters, switches, gauges, converters and other accessories in rooms, buildings and closed areas like the power house building.

b) The open type racks shall be shop fabricated. Transmitters, switches, converters and transducers of enclosure class IP-65 or better can be directly mounted on open racks. However, enclosures not conforming to the above protection standard shall have to be housed in enclosures conforming to IP-65 class prior to mounting them on open structures.

c)The following shall be provided for open type transmitter racks:

1. Rack shall be constructed from 6mm thick steel channel frame.
2. Canopy shall be of 3mm thick CRCA steel.
3. 2"NB Galvanised pipes shall be laid horizontally and supported at two end channels to mount transmitters/switches at accessible height.
4. Adequate support for Manifold, impulse pipe and cable tray to be provided and the same shall be adjustable.
5. Individual Instrument blowdown line shall be connected to the common blowdown drain header through regulating globe type blowdown valves. The common blowdown drain header shall be 2" NB ASTM A106, Sch-80 Gr. C installed at a slope of 1:25

d) For operational convenience, the open type racks shall be used for mounting pressure and temperature gauges and switches and the local operating stations for electrical drives in the vicinity. Gauges mounted in racks shall be bottom connected and secured by double lock nuts. All gauges shall be located within 1500 mm from the floor for easy readability.

e) The structural design shall be such that no item shall interfere with maintenance and removal of instrument, equipment and their accessories.

f) Service Power and Lighting

i) Each rack shall be provided with one receptacle, one light fixture with wire guard and one lighting switch. Outlet box, switch box and device covers shall be galvanized stamped steel. Light fixtures shall be installed on the canopy of the rack.

ii) Power supply for receptacles and lighting shall be arranged. Power supplies for miscellaneous devices shall be provided with MCB located within the rack JB. MCBs shall be mounted in blocks. MCB ratings will be given on electrical schematic diagrams. Nameplates

shall be furnished above the MCB blocks, identifying the devices being served.

g) Control Air

Same as for closed type transmitter rack. Refer 5.01.01 (j) above

h) Service Air

Same as for closed type transmitter rack. Refer 5.01.01 (k) above

i) Power Supplies

Same as for closed type transmitter rack. Refer 5.01.01(l) above

j) Equipment Installation

Contractor shall prepare rack fabrication and piping drawings indicating the layout of each instrument. The drawings shall clearly indicate Contractor's piping arrangement for the sharing of process connections between two or more instruments. Special attention shall be given in the piping layout to avoid air traps in liquid filled piping or water pockets in piping intended to be dry.

k) Impulse Piping / Tubing

Same as for closed type transmitter rack. Refer 5.01.01 (n) above

l) Instrument Tubing

Same as for closed type transmitter rack. Refer 5.01.01 (o) above

5.04.03 Wiring of the Racks

a) A fully enclosed IP 65 type junction box shall be provided in each rack for housing the terminal blocks connectors, power supply fuses and other electrical accessories, as required.

b) Junction boxes for modular enclosures shall be fabricated externally on one end of each enclosure assembly to accept field wiring/cabling through the top or bottom of the junction box. A hinged door shall give access to the interior of the junction box.

c) All electrical connections between instruments and the junction box terminal blocks shall be made. In addition all utility wiring for lighting and service power shall be installed.

d) All wiring used within the enclosures shall conform to NEC /IEC standards. All wiring shall run though flexible or rigid conduits and shall be terminated at suitable terminal blocks. Sufficient clearance shall be provided for all control and instrument leads and all incoming

and outgoing leads shall be connected to terminal blocks suitably located for connecting external circuits.

e) High impedance circuits shall be connected using shielded or coaxial wire suitable for the service.

f) Conduits shall be supported properly at regular intervals with suitable conduit clamps.

g) Wire shall be neatly arranged and routed/laid in PVC trough/tray.

5.04.04 Junction Box

Junction boxes shall be of metallic construction.

a) Junction box shall be provided with front opening type cover. Junction box shall be of sheet steel construction with thickness not less than 2 mm. Junction box shall be complete with DIN rail mounted terminals, MCB, receptacles and earth bar. Earth bar shall be made of tinned copper of 25 X 6 MM size. Earth stud shall be furnished for safety grounding.

b) Terminals shall be screwless cage-clamp type and 20% spare terminals shall be furnished. Power terminals shall be screw type.

5.23.00 Miscellaneous Instruments

5.23.01 The space humidistat and thermostat shall be of reputed make. The humidistat and thermostat shall be complete with suitable metallic enclosures and shall be mounted in the walls of the handling unit space or conditioned space. The instruments shall be complete with wiring encased in 3/4" diameter conduits, terminating in the suitable terminal box.

Digital Humidity Indicator in the equipment room having local digital indication and 4-20 mA DC output for interfacing with the PLC in the central AC control room .

Digital Temperature indicator in the equipment room having local digital indication and 4-20 mA DC output for interfacing with the PLCC in the central AC control room . Temperature & Relative Humidity Indication(At least Three Nos) shall be provided at CCR.

5.23.02 The pressure indicators and temperature indicators shall have minimum 160 mm size dial. The pressure gauges shall be complete with isolating cocks/valves.

5.23.03 Apart from the thermostats, pressure switches, level switches and level indicators specified in this tender document, the local instruments as required shall also be furnished as a part of the system.

5.23.04 The range of controls and instruments should be such that the operating range are preferably in the mid-scale or in line with the recommendation of the manufacturer. The accuracy should not be less than ± 1% of full scale deflection. The differential in controls should be such that the equipment is able to operate at desired settings or maintain desired conditioned.

5.23.05 The scale of pressure indicators for refrigeration units will be in kg /Sq. cm. Saturation temperature of the refrigerant in use, at the corresponding pressure should also be indicated in the scale. The suction and oil gauge shall be compound gauge.

5.23.06 All instruments should be such selected and installed that they are easily readable from the floor.

CLAUSE NO.	TECHNICAL REQUIREMENTS
20.00.00	**AC PLANT RELATED SPECIAL INSTRUNMENTS**
20.01.00	**HUMIDITY SENSOR** Sensor : Capacitance type Accuracy : +/-3% R.H Range : 0-100% R.H Output : 4-20 ma Time constant : 2 mins. Output from the sensor is to be connected to respective control system. Contractor can also provide combined instrument for measurement of humidity and temperature subject to Employer's approval during detailed engineering. In all such cases, 4-20 ma outputs, each for temperature and humidity measurements are to be provided.
20.02.00	**TEMPERATURE/ HUMIDITY INDICATOR** Sensor : RTD for(Pt 100) for temperature : Capacitance Type for Humidity (specs for humidity and temperature shall be as mentioned above) Display : Combined enclosure with two three digit seven segments LED display with decimal point after two digits. LED height shall be 4 inches, clearly legible from a distance of at least 10 meters. Range : 0-60 Deg C for temperature. : 0-95.0 % for Relative Humidity. Accuracy : Better than +/_0.5 % for Temperature : Better than +/_2.5 % for Relative Humidity Mounting : Table Top/ wall mounting. Power supply : 240 V AC, 50 Hz. Output : 4-20 mA signal each for temperature. Qty. : 15 nos. each of temperature & Humidity indicators (combined indicators for Humidity and temperature is also applicable). One Set of output signal is to be connected to respective control system. Apart from displaying the temperature/humidity values on indicator.

6.00.00 DESIGN CRITERIA

This section lays down the general design criteria to be adapted in designing the Control & Instrumentation system of the plant.

6.01.00 General Requirements

6.02.00 Instrumentation, control and automation devices and accessories shall be designed with the following considerations:

a) Stable in spite of temperature fluctuations.

b) Able to withstand high humidity.

c) Weather proof.

d) Dust proof.

e) Corrosion resistant.

f) Erosion resistant.

g) Able to withstand high vibration.

h) Easily accessible for operation & maintenance.

6.03.00 Parts subject to high pressure, temperature or other severe duty shall be of materials and construction suitable for the service conditions and long operating life.

6.04.00 Components of instruments, control devices, accessories, piping etc. which contact steam, condensate or boiler feed water shall be manufactured from copper-free materials.

6.05.00 Instrument Accuracy, Standard Scales and Ranges

6.05.01 Instrument Accuracy

Instruments shall meet the following general requirements.

a) Pressure measurement shall be linear with respect to the measured pressure.

b) Flow meter shall meet the specified accuracy criteria when operating between 25 and 100 % of full-scale flow. The accuracy shall include the effect of errors in the differential head measuring device, square root converter and signal generator.

c) Level measurement shall be linear with respect to the measured level based on a water specific gravity of 1.00.

d) Wherever the measured parameter is influenced by process pressure & temperature, required compressibility correction shall be introduced.

6.05.02 Instrument Scale Displays

a) All displays shall be in engineering units. Instrument scales displayed on screen will have graduations with scale divisions based on multiples of 10. The smallest division shall preferably be a whole number approximately 1% of the scale range if not otherwise impracticable.

b) Pressure instrument shall have the unit suffixed with ‘a’ or ‘g’ to indicate absolute or gauge pressure, respectively.

c) Scales and charts of all instruments shall have linear graduations

6.05.03 Instrument Ranges

Instrument range shall be selected to have the normal reading, preferably between 50% and 70% of full scale for linear parameters and 70% to 80% for flow measurements. Deviation indicators shall have the null position at mid scale. The normal operating parameter shall be identified with a clear green mark.

6.08.02 Measurement & Channel Redundancy

To meet the failure and self checking criteria for the control system, measurement redundancy shall be provided for all the critical parameters. Throughout the control system, the security and validity of signals are to be ensured based on the following design principles.

a) Where a plant measurement is to be duplicated or triplicated such signals shall be separately fed to the different input modules.

b) Signals, after due security and validity checking by means of voting, averaging, median, difference monitoring or similar technique shall be used for control functions.

c) Where duplex measurements are used, provision shall be there for selecting any one as the duty signal. Continuous monitoring of Deviation between the signals shall be made in the system.

d) For binary and analog inputs required for protection of SG , TG and major auxiliaries whose non availability may result in loss of generation triple sensing devices shall be provided . Binary and analog inputs , which are required for protection of more than one equipment as well as protection signals for important auxiliaries and HT drives etc. triple sensing devices shall be provided .Also other binary and analog inputs required for CLCS dual sensing devices shall be provided . However,for those binary and analog inputs which are also required for protection in addition to CLCS, triple sensing devices shall be provided.

e) Measurement system, CLCS and OLCS shall all be configured with redundancy at processor modules,communication modules, data bus and power supply modules.Triple redundancy shall be followed as described elsewhere in the specification. All servers shall be dual redundant.

f) Both CLCS & OLCS shall be configured with Redundant I/O channels for each sensor/signals. Where redundant sensors are provided redundant I/O channels shall be provided for each sensors/signals.

g) Redundant sensors shall be provided for all control applications. For all major closed loop controls (CLCS) triple redundant sensors shall be provided. For other CLCS loops dual redundant sensors shall be provided.

h) Similarly for critical protection logic requirements triple redundant sensors for 2 out of 3 logic shall also be provided to avoid spurious tripping. For all other control application dual redundant sensors shall be provided. Dual and Triple redundant sensors shall also be provided as described elsewhere in the specification.

6.11.00 Burn-In And Elevated Temperature Test

Solid-state equipment / system shall be certified to be tested for a minimum period of 168 hours continuously under power. Solid-state logic systems shall be subject to the elevated temperature test and burn-in test as complete assemblies.

6.12.00 Elevated Temperature Test

a) During the first 48 hours the ambient temperature shall be maintained at 50^{O} C and the equipment shall be made to repeatedly perform operations it will be expected to perform in service with loads on various components being equal to those which will be experienced in actual service.

b) The 48 hours test period shall be continuous but shall be divided into four 12-hour segments. The power supply voltage during each 12 hours segment shall be nominal voltage for 11 hours; followed by 110 percent of nominal voltage for 30 minutes; followed by 90 percent of nominal voltage for 30 minutes.

c) During the elevated temperature test the cubicle doors shall be kept closed and inside temperature in the zone of highest heat dissipating

component /module shall be monitored. Temperature rise inside the cubicle shall not exceed 10 Deg.C above the ambient temperature of 50 Deg.C.

6.13.00 Burn in Test

The 48 hours elevated temperature test shall be followed by 168 hours of burn in test at normal operating temperature. This test shall also be conducted as per above procedure.

6.14.00 Panels, Cubicles and Enclosures

6.14.01 General

a) All panels, cubicles and enclosures shall be furnished complete with integral piping, internal wiring, convenience outlets, internal lighting, grounding, ventilation, space heating, vibration isolating pads and other accessories.

b) Unless otherwise specified cable entry for panels / desks / cabinets shall be through bottom via glanding plate. Fireproof seal shall be used to seal the bottom to prevent entry of dust.

c) Panels and cabinets shall be constructed from steel sheet reinforced as required to provide true surface and adequate support for devices mounted thereon. Thickness of the CRCA steel for UCP / backup panel and other panels/cabinets shall be as described in Section VII of this volume of the specification. Panels and cabinets shall be of adequate strength to support mounted components during shipment

and to support a concentrated load of 100 Kilograms on their top after erection.

d) Panel /cabinet shall have eyebolt on top for lifting.

e) Mounting , wiring , powering of all items to be mounted / installed on desks irrespective of the source of procurement shall fall in the scope of erection of Bidder ,this shall include freeissue items furnished by Owner.

6.14.02 Surface Preparation and Painting

Sheet metal exterior steel surfaces shall be sand blasted, ground smooth and painted as specified below:

a) Suitable filler shall be applied to all pits, blemishes and voids in the surface. The filler shall be sanded so that surfaces are level and flat; corners are smooth and even. Exposed raw metal edges shall be ground burr-free. The entire surface shall be blast clean to remove rust and scale. Oil, grease and salts etc. shall be removed from by one or more solvent cleaning methods prior to blasting.

b) Two spray coats of epoxy primer □urface shall be applied to all exterior and interior surfaces, each coat of primer □urface shall be of dry film thickness of 1.5 mil. A minimum of two spray coats of final finish color (Catalyzed epoxy or polyurethane) shall be applied to all surface of dry film thickness 2.0 Mil. The Min. Paint shade thickness at exterior & Interior shall be 80 to 100 Microns.The finish colors for exterior and interior surfaces shall conform to the following shades:

i) Exterior : RAL 7032

ii) Interior – Brilliant White (Preferred) / RAL 7032.

c) Paint films, which show sags, cheeks, blisters, teardrops, fat edges or other painting imperfections shall not be acceptable.

6.14.03 Wiring

Wiring within the panels shall conform to NEC standards and shall be factory installed and tested at the works. All interior wiring shall be installed neatly. Features shall not be limited to the following :

a) All spare contacts of relays, switches and push buttons shall be wired up to the terminal blocks.

b) Each wire shall be identified at both ends with wire designation as per approved wiring diagram. Heat shrinkable type ferrules with indelible computerized print shall be used with cross- identification.

c) Wire termination shall be made with insulated sleeve and crimping type lugs. All external connections shall be made with one wire per terminal. Wire shall not be spliced or tapped between terminals. Open-ended terminal lugs shall not be used.

d) Internal wiring shall be terminated uniformly on one side of the terminal block leaving the other side available for termination of outgoing cables.

e) Thermocouple lead wires, analyzer measuring lead wires, or any other lead wires carrying measuring signal of the order of low mili volt or micro volt shall be electrically and physically isolated from other AC and DC wiring.

f) All low-level signal cables shall be separately bundled from control cable.

g) Wires shall be dressed and run in troughs with clamp-on type covers. Wirings shall be neatly bunched in groups by non-metallic cleats or bands. Each group shall be adequately supported along its run to prevent sagging or strain on termination.

h) Shield wires shall be terminated on separately.

i) Common connections shall be limited to two wires per terminal. Looping of wires for power distribution in the panel to be avoided. Busbars to be provided for Power distribution".

j) Wiring to door mounted devices shall be provided with multi-strand wires of (49 strands minimum) adequate loop lengths of hinge-wire so that multiple door openings will not cause fatigue to the conductor.

k) Wiring shall be arranged to enable instruments or devices to be removed and/or serviced without disturbing the wiring. No wire shall be routed across the face or rear of any device in a manner, which will

impede the opening of covers or obstruct access to leads, terminals or devices.

l) Panel internal wiring shall follow distinct color-coding to segregate different voltage levels viz. 24V DC, 48V, 110V AC, 240V AC, 220V DC etc.

m) Panels /cabinets /desks shall be provided with removable gasketted cable gland plates and cable glands. Split type grommets shall be used for prefab cables.

n) Wire shall be multistranded annealed flexible high purity copper conductor with heat resistant FRLS PVC insulation and shall pass vertical flame test per IPCEAS-1981.

o) Wire sizes used for internal wiring shall not be lower than the followings :

Control wiring (switches, pushbuttons etc.)	: 1.5 Sq.mm
Power supply /receptacle /illumination wiring	: 2.5 sq. mm or higher as per load

4-20mA DC current and low voltage signal upto 48V DC	: 0.5 Sq. mm

p) Identification of conductors shall be done by insulation color-coding identified on drawings or by printed wiring lists.

6.14.04 Grounding

a) System cabinet AC and DC ground shall be electrically isolated from each other and also electrically isolated from the Instrumentation signal ground. All the above ground shall be individually connected to the single point on the ground pit. Dedicated redundant earth pit shall be provided which shall be away from the HV equipment. This earth pit shall not be shared with other electrical equipment ground and shall also be insulated from other electrical system ground to ensure single point grounding of the system. Grounding resistance shall be better than 1.0 ohm. IEEE guideline shall be followed while designing the grounding system.

b) Panels and cabinets shall be provided with a continuous tinned copper ground bus bar of minimum 25 mm x 6 mm cross section, extending along the entire length of the panel / desk / cabinet assembly. The ground bus shall be bolted to the panel structure and effectively ground the entire structure.

c) The panel /desk /enclosure /JB ground shall have two (2) bolt drilling with GI bolts and nuts at each end to connect to GI/ copper flat ground riser by means of insulated copper ground cable of required cross section with lug.

d) Circuits requiring grounding shall be individually and directly

connected to the panel ground bus.

e) For electronic system cabinets, the electronic system ground bus shall be similar but insulated from the cabinet and shall be separately connected to the system ground. Signal cable shields shall be grounded at the panel end only and shall not be left open. The ground in between panels of a shipping section shall be firmly looped.

f) Electrical meters, relays, transmitters and switching devices, operating at a voltage less than 50V may be grounded through the steel structure.

6.15.00 Panel / Cabinet/ Desk/ Enclosures / junction boxes & instruments Environmental Protections

a) Panels, cabinets, desks, distribution boxes, racks ,junction boxes, terminal boxes , instruments and all other field mounted equipment / enclosures shall suit the environmental condition of the area and shall not be inferior than the requirement indicated in the following table.

SL. NO.	LOCATION	ENCLOSURE TYPE
1.	Indoor type non- ventilated enclosure in non-hazardous area	IP-54
2.	Indoor type ventilated enclosure in non-hazardous area	IP -42
3.	Enclosure in Air conditioned area	IP-32 with suitable canopy at top to prevent ingress of dripping water.
4.	Outdoor type in non-hazardous areas	IP-65 with anticorrosion coating.
5.	Outdoor in hazardous areas	As per requirements of the NEC Code for the location

b) The construction of electrical enclosures located in areas subject to conditions classified in the National Electrical Code (NEC) as hazardous shall be of a type designated suitable for the environment in which they are located.

6.16.00 Terminal Blocks

a) Terminals shall be chromated galvanized DIN rail mounted screwless cage clamp type or maxi termi type. Terminals shall have screwed connection for conductor cross-section above 2.5 mm^2. Terminal blocks shall conform to IEC 947-7-1.

b) The characteristics of the terminal blocks shall be as follows.

- High contact force, independent of conductor cross-section and large contact surface area.
- Integrated self-loosening protection to avoid shifting of contact surface that may allow contamination of connection point.
- Inspection and maintenance free (resistant to thermal aging and vibration)
- Low and constant voltage drop

c) Material of the clamping yoke of screwed terminals shall be electroplated, chromated, case hardened steel with high strength clamping screw. For screwless terminals, the tension spring shall be made of high quality, non-rusting, acid-resistant steel. The current bar shall be of tin-lead plated copper or brass.

d) Terminals shall be of non flammable suitable thermoplastic material such as polyamide.

e) Terminal blocks shall be mounted vertically in panels and cubicles with clearance for at least 100 mm between two sets and between wall and terminal block.

f) Terminal blocks shall be provided with white marking strips / self-adhesive marker cards. Power terminals shall have protection covers.

g) At least 20 percent spare unwired terminals shall be provided for all panels /cabinets /desks /junction box etc... This shall be in addition to 20% spare wired terminals of spare IO channels.

h) Bottom of the terminal block shall be at least 200 mm above the cable gland plate for bottom entry type panels.

i) For extending 24 V DC supply to panels, the size of the terminals shall be decided based on voltage drop and not based on current.

j) Other requirements of the terminal blocks are as follows:

i) The last terminal in a rail-mounted assembly shall be closed with an end plate and end bracket.

ii) For visual and electrical separation of terminal groups, partition plates shall be provided, which can be push fitted after forming an assembly.

iii) Design shall permit testing of incoming and outgoing signals by using suitable test plug and socket without disconnecting the cable connections.

iv) It shall be possible to use jumper plugs through the above test plug socket to connect adjacent terminals. Adequate number of short circuit jumper plugs shall be provided for the purpose.

v) Where more than one connection to a terminal block is required, two tier terminals shall be used.

vi) The terminal blocks for Power, control and signal cable terminal block shall be seperate with seperate colour coding for ease in recognition..

7.00.00 METERING BASES AND CHART UNITS

The following system of units shall be followed for various displays and scales unless otherwise mentioned:

i)	Pressure	: Kg/cm^2
	Differential Pressure	: mm of H_2O column / Kg/cm^2
ii)	Draught	: mm of H_2O column
iii)	Vacuum	: Kg/cm^2 (abs)/mm of Hg column

iv)	Temperature	: Degree Celsius (^{O} C)
v)	Flow (Steam, Water)	: Tonnes / hr, M^3/Hr
vi)	Flow (Oil)	: M^3 / Hr, Liter/Hr
vii)	Flow Air	: Tonnes / hr / M^3 / Hr.
viii)	Density	: gms / c.c.
ix)	Level	: mm /%
x)	Conductivity	: Micro Siemens / cm
xi)	Gas Analyzer	: Percentage by weight or as specified in respective case.
xii)	Dissolved Oxygen / Silica / Sodium	: ppm /ppb

8.00.00 PROCESS CONNECTION & INSTRUMENT HOOK UP

8.01.00 Instrument connection to the process system (piping, vessel etc.) shall be according to the process & piping specification upto and including the root valves. Root valves shall be installed as close as possible to the piping or vessel.

8.02.00 Each instrument shall have its own independent connection to the process except for instruments located on standpipe. Each instrument shall be connected independently to the standpipe through isolation valve.

8.03.00 Process connection for instruments lines and vessels shall be in accordance to standards such as ASME or other recognized international standards.

FORM NO. PEM-6666-0

	SPECIFICATION FOR LOCAL PANELS	SPECIFICATION NO.: PE-SS –999- 145 –054A	
		VOLUME II B	
		SECTION D	
		REV. NO. 03	DATE : 16-09-2013
		SHEET 1 OF 6	

1.0 SCOPE

This specification covers the Design, Manufacture, Inspection and Testing at the manufacturer's works, proper packing for transportation and delivery to site, supervision, erection, and commissioning at site of Local Panels required for control and monitoring of the Auxiliary Plant & Equipment.

2.0 CODES AND STANDARDS

2.1 All the equipments specified herein shall comply with the requirements of the latest issue of the relevant National and International standards.

2.2 As a minimum requirement, the following standards shall be complied with:

a)	IS-6005 : 1998	:	Code of practice for phosphating of iron and steel.
b)	IS-5 : 2007	:	Colors for ready mixed paints and enamels.
c)	IS-1248:2003	:	Direct Acting Indicating Analog Elec Measuring Instruments.
d)	IS/IEC 60947:Part 1:2004	:	Low Voltage switchgear & control gear: Part-I (General Rules)
e)	IS-8828:1996	:	Circuit breaker for household and similar installations.
f)	IS-13947 (Part-I):1993	:	Low Voltage switchgear & control gear : Part-I (General Rules)
g)	ISA-18.1:1979	:	Annunciator Sequences and Specification
h)	NFPA-496:2003	:	Purged & Pressurised Enclosure for Electrical Equipment in Hazardous Locations.

3.0 TECHNICAL REQUIREMENTS

3.1 Panel Construction

3.1.1 The local panels shall house the secondary instruments, annunciation system, Single loop controller, Control switches / push buttons, indicating lamps/LED cluster, relays, timers and other devices required for operation and monitoring of the equipment locally.

3.1.2 The panels shall be of free standing type either welded construction on angle iron (minimum section of 50 x 50 x 4 mm) structure or folded construction by sheet metal formation depending upon the equipments to be mounted on it. The panels shall be robustly built and stiffeners as necessary shall be provided.

3.1.3 The panel shall be suitably reinforced to ensure adequate support for all instruments mounted thereon. All welds on exposed panel surfaces shall be ground smooth.

3.1.4 The salient features of construction shall be:

Sheet material: Cold rolled sheet steel
Frame thickness: Not less than 3.0mm
Enclosure thickness: Not less than 3.0 mm for load bearing sections (Mounted with instruments) 2.0 mm for doors and Not less than 2.0 mm for others
Panel Height: Not less than 2365 mm (Refer data sheet-A (No. PES-145A-DS1-0)
Gland plate thickness: 3.0mm
Base channel: ISMC 100 with anti-vibration mounting & foundation bolts.

3.1.5 The panel shall be provided with rear doors with integral lockable handle. The door when locked shall be held at minimum three places. The door width shall not be more than 550mm.The doors shall be provided with suitable stiffeners to prevent buckling. The handle shall be on the right side of the door. The door shall be removable type with concealed hinges to facilitate maintenance work. Suitable pocket inside the door shall be provided for keeping the drawings / documents. Double door shall be provided with suitable glass windows, as per the requirement.

3.1.6 Suitable neoprene gasket shall be provided on all doors and removable covers. Suitable ventilation system along with louvers shall be provided at bottom and top of the doors covered with removable wire mesh.

FORM NO. PEM-6666-0

	SPECIFICATION FOR LOCAL PANELS	SPECIFICATION NO.: PE-SS –999- 145 –054A	
		VOLUME II B	
		SECTION D	
		REV. NO. 03	DATE : 16-09-2013
		SHEET 2 OF 6	

3.1.7 The class of protection shall be in accordance with IP-55 unless otherwise specified in the data sheet – A (No. PES-145-54A-DS1-0).

3.1.8 All steel surfaces shall be cleaned by sand / pellet blasting, treated for pickling, degreasing and phosphating etc. by seven tank method. The panel shall have a high quality finish and appearance. The panel shall be painted with two coats of primer followed by two coats of epoxy / synthetic enamel based final paint of color shade and finish as given in data sheet-A (No. PES-145A-DS1-0). Minimum thickness of the paint shall be 85 microns for external paint and 70 microns for internal paint.

3.1.9 The cable glands of the required size and type as given in data sheet-A (No. PES-145A-DS1-0) shall be supplied alongwith the Panel.

3.1.10 All operable and indicating devices shall be mounted on the front of the panel while aux. Relays / timers MCBs etc. required for realization of control logics shall be mounted on a mounting plate inside the panel. Auxiliary relays and timers etc. shall be grouped according to the control function.

No operable or indicating devices shall be mounted below 750 mm and above 1800 mm (w.r.t. finished ground level). The devices shall be located in such a way so as to ensure easy access for operation / maintenance.

3.1.11 Single / dual control power supply feeders of voltage class as specified in data sheet-A (No. PES-145A-DS1-0) shall be provided by the purchaser. In case redundant power supply feeders are provided then auto changeover unit shall be mounted on the panel are in the panel supplier's scope. Where DC control power supply is specified an additional 240V, 50 Hz AC supply feeder for powering of space heater and lighting shall be provided by the purchaser. Suitable arrangement shall be provided inside the panel to receive and terminate the power supply feeder(s). For this purpose MCBs of suitable current rating shall be provided by the vendor. A supervisory relay along with a pilot lamp to indicate control supply 'ON' shall be provided on the panel. Any other power supply required for the operation of the devices mounted in the panel shall be arranged by the vendor.

3.1.12 The internal wiring shall be carried out with 1100 volt grade PVC insulated copper multi strand wire / flexible of 1.5mm2 size. AC & DC wires shall be kept separate from each other. Separate coloured wires to be used for AC and DC circuits. All wires shall be properly numbered and identified with ferrules as per the Control scheme / wiring diagram. Wires shall be routed and run through PVC troughs.

3.1.13 Terminal blocks shall be clip on type, 1100 volts grade. Separate terminal blocks shall be used for AC & DC circuits. The terminals shall be suitable for terminating 0.5 mm2 to 2.5mm2 external cables. The TB points in terminal block shall be cage clamp type / screw type. The terminal for ammeters shall be provided with removable links for shorting CTs. Each terminal strip shall be provided with identification strip. The terminal shall not be mounted below 250 mm height from finished floor. The panel shall have ten (20) percent spare terminal.

3.1.14 The interior of each panel shall be suitably illuminated through fluorescent lamps / tube lights with shrouded cover of minimum 15W operable on 240V 50 Hz AC power supply through panel door switch. A 15 Amp. 3-pin Power receptacle shall be provided.

3.1.15 Suitable space heaters operable on 240 Volts 50 Hz AC power system shall be provided at the panel bottom. These shall be designed to maintain the panel temperature five (5) deg. C above the ambient temperature during maintenance shutdown. Suitable isolating and control devices comprising of MCB, thermostat etc. shall be provided for the space heater.

3.1.16 The panel shall be provided with a copper earth bus of 25 x 6 mm size running throughout the width of the panel. It shall be terminated internally with 10 mm bolts at extreme ends for connection to; main station earth. The panel mounted equipments / devices shall be connected to earth bus through green coloured PVC insulated stranded copper conductor of 2.5 mm2 size.

3.1.17 Local Panel shall be provided with main name plate of 150 mm x 40 mm size having inscription of 20 mm height. The individual devices on the panels shall be as provided with separate name plate with inscription of 3 mm height. The instrument / devices shall be provided with stick on label plates inside the panel. The material of the main and individual labels shall be three (3) ply 3 mm thick Traffolyte

FORM NO. PEM-6666-0

	SPECIFICATION FOR LOCAL PANELS	SPECIFICATION NO.: PE-SS –999- 145 –054A	
		VOLUME II B	
		SECTION D	
		REV. NO. 03	DATE : 16-09-2013
		SHEET 3 OF 6	

Sheet / 2 mm Anodised Aluminium Plate. The inscription shall be with white letters on black background on traffolyte sheet. The labels shall be fixed by self tapping non-rusting screws.

3.1.18 Vendor shall furnish electric load and heat load list (in case panel is to be placed in ac environment) of each panel.

3.2 Hazardous Area Panel Requirement

3.2.1 The Local Panel located in hazardous area shall be pressurized as per NFPA-496 requirements to render it non-hazardous. Alarms shall be provided for local and remote annunciation when pressurisation falls below 2.5 mm of water column. Protection shall be of type Z of NFPA-496. It shall not be possible to switch ON the power of purged section unless it is purged as per the recommendation of NFPA-496. Vendor must provide a protective device on the panel to protect the panel from over pressurisation.

3.2.2 Vendor shall supply pressurisation kit consisting of valves, restriction orifices, dual filter regulation, pressure gauges, pressure switches, rotameter etc. Pressurisation kit shall be surface mounting on a metal board and located outside the local panel. Pressurisation kit shall further consist of solenoid valve flow switch, timer blow off safety device etc., so as to make purging fully automatic. However final start shall be manual. Panel protection against over pressure to be provided as per NFPA-496.

3.2.3 Pressurised local control panel pressurization kit assembly design shall provide minimum leakage flow through the Local Control Panel. Panel venting shall be as per NFPA-496.

3.2.4 All components in the local panel like indicating instruments, push buttons switches, lamps etc., which are required to be energized without panel pressurization or before completion of purge cycle shall be explosion proof as per NEMA-7 & suitable for area classification.

3.2.5 All push buttons etc. requiring frequent operation during machine running shall have good positive sealing. Weatherproof housing or cover to be provided wherever necessary. Vendor shall provide pressurisation bypass switch outside explosion proof enclosure of pressurized panel with lamp indication. This shall be used only during maintenance. All hinges, screws, other non-painted metallic parts shall be of stainless steel material.

3.2.6 Provision to switch off manually all types of power shall be provided in the panel. In addition, it shall also be possible to switch off power circuits / components which are powered from motor control centre or control room manually in case of pressurization failure. All such cables from MCC and main control room shall be terminated in explosion proof boxes (NEMA-7).

3.3 Control & Monitoring devices

3.3.1 Instruments like Indicators, recorders, single loop controllers etc. as applicable and specified elsewhere for the plant / equipment shall be supplied and mounted on the panel.

3.3.2 Alarm Annunciator System

It shall be solid state discrete facia type having a sequence of ISA-S18.1A or as specified, opaque facia windows of 70 mm x 50 mm size, having two (2) lamps per window, and hooter of 10W, and provision for repeat group alarm at remote. The annunciator shall be provided with ten (10) percent spare windows or minimum two (2) windows along with electronics.

3.3.3 Relays

The relays shall be electromagnetic type suitable for specified control supply. Its contact configuration and rating shall be suitable for the specified control function. However minimum contact rating shall be 5 Amp AC & 2 Amp DC as applicable. There shall be ten (10) percent spare contacts.

3.3.4 Timers

The timers shall be electronic type suitable for specified control supply. Its contact configuration and rating shall be suitable for the specified control function. However, minimum contact rating shall be 5 Amp AC & 2 Amp DC as applicable.

FORM NO. PEM-6666-0

	SPECIFICATION FOR LOCAL PANELS	SPECIFICATION NO.: PE-SS –999- 145 –054A	
		VOLUME II B	
		SECTION D	
		REV. NO. 03	DATE : 16-09-2013
		SHEET 4 OF 6	

3.3.5 Control / Selector Switches

Switches shall be Rotary Cam type with minimum of 5 Amps AC & 2 Amp DC continuous current rating. Selector switches shall be stay put type while control switches shall be spring-return-to-neutral type. Contact configuration and rating shall be as per the control function requirement. The switches shall be lockable type wherever specified. Each switch shall be provided with engraved plates indicating the switch position / functions.

3.3.6 Push Buttons / Indicating Lights

The push buttons shall be momentary action self-resetting type, however stop P.B. for unidirectional drives shall be provided with manual reset facility. Its contact configuration & rating shall be as required for the control function but minimum 2 NO + 2 NC of 5 Amp. AC rating. It shall have round coloured projecting tab and engraved escutcheon plate / inscription plate. Colour coding of push buttons shall be as under:

RED	Motor OFF / Valve CLOSE	YELLOW	Alarm acknowledge	Left Hand Side
GREEN	Motor ON / Valve OPEN	BLACK	Lamp test	Right Hand Side

Indicating lights shall be suitable for direct connections across specified power supplies. It shall be fitted with built in resistance to prevent circuit tripping on shorting of lamp filament. It shall be fitted with LED cluster type lamp replaceable from front.

GREEN	Motor OFF / Valve CLOSED condition	AMBER	Motor tripped	Left Hand Side
RED	Motor ON / Valve OPEN condition	WHITE	Normal / healthy	Right Hand Side

3.3.7 Ammeters

Ammeter shall be 96 x 96 mm size, 90 deg. deflection, 1.5% accuracy, 1 Amp. CT operated or with 4-20mA input and Flush mounting type as called for in the data sheet-A (No. PES-145-54A-DS1-0). Ammeters for motors shall have six (6) times folded scale at upper end to enable motor starting current indication

3.3.8 Miniature Circuit Breaker (MCB)

These shall be instantaneous magnetic trip type for short circuit in addition to current time inverse delayed thermal trip feature for over current protection. The housing of MCB shall be made of non-ignitable, high impact material. It shall have minimum short circuit rating of 9 KA for AC Voltages and 4 KA for DC Voltages.

3.3.9 Makes of various instruments / devices shall be as given below

1.	Alarm Annunciators	:	Procon / IIC
2.	Ammeters	:	AEP / IMP
3.	Control / Selector Switches	:	Alsthom / Kaycee / Siemens / L&T
4.	Push Buttons / Indicating Lamps	:	Siemens / L&T / Teknic / Alsthom
5.	Auxiliary Relays	:	Jyoti / Siemens / L&T / OEN
6.	Timers	:	L&T / Alsthom / Bhartiya Cutler Hammer
7.	MCBs	:	S&S Power Engg. / Indo Asian / MDS
8.	Terminal Blocks	:	Jyoti / Elmex

4.0 TESTING AND INSPECTION

4.1 The bidder shall adopt suitable quality assurance program to ensure that the equipments offered will meet the specification requirements in full.

4.2 BHEL's standard Quality Plan for LCP is enclosed with the specification. The bidder shall furnish his acceptance to BHEL's QP and submit the signed and stamped copy of QP along with the offer.

FORM NO. PEM-6666-0

	SPECIFICATION FOR LOCAL PANELS	SPECIFICATION NO.: PE-SS –999- 145 –054A	
		VOLUME II B	
		SECTION D	
		REV. NO. 03	DATE : 16-09-2013
		SHEET 5 OF 6	

4.3 The vendor shall conduct the following tests as a minimum requirement:

4.3.1 Routine Tests

1. High Voltage (H.V.)
2. Insulation Resistance (I.R.)
3. Functional

4.3.2 Type Tests

1. Enclosure Class Test

5.0 SPARES AND CONSUMABLES

5.1 Commissioning Spares and consumables

The bidder shall supply all commissioning spares and consumables 'as required' during Start-up, as part of the main equipment supply.

5.2. Mandatory Spares

The bidder shall offer alongwith main offer, the Mandatory Spares as specified elsewhere in the specification. The Mandatory Spares offered shall be of the same make and type as the main equipment.

5.3. Recommended Spares

The bidder shall furnish a list of Recommended Spares indicating the normal service expectancy period and frequency of replacement; quantities recommended for 3 years operation alongwith unit rate against each item to enable BHEL/BHEL's Customer to place a separate order later, if required.

6.0 DRAWINGS AND DOCUMENTS

6.1 The bidder shall furnish the following documents in required number of copies along with the bid :

1. Data Sheet no. PES-145A-DS1-0
2. General Arrangement Drawing.
3. Catalogue and technical information for instruments and devices.
4. Quality Plan.

6.2 The vendor shall furnish the following documents in required number as agreed after the award of contract:

1. Data Shee No. PES-145A-DS2-0
2. GA Drawing indicating layout of instruments, construction details, foundation details, cable gland plate alongwith cable glands and all details mentioned in this specification.
3. Control Schematic Diagram along with grouping of different terminals for various functions.
4. Catalogue and technical information for instruments and devices with selected options clearly marked.
5. O&M Manuals.
6. "As Built" Drawing.
7. CDs.

7.0 MARKING AND PACKING

7.1 Panel with all instruments / devices mounted on it shall be suitably packed & protected for the entire period of despatch, storage and erection against impact, abrasion, corrossion, incidental damage due

FORM NO. PEM-6666-0

	SPECIFICATION FOR LOCAL PANELS	SPECIFICATION NO.: PE-SS –999- 145 –054A	
		VOLUME II B	
		SECTION D	
		REV. NO. 03	DATE : 16-09-2013
		SHEET 6 OF 6	

to vermin, sunlight, high temperature, rain moisture, humidity, dust, sea-water spray (where applicable) as well as rough handling and delays in Transit and storage in open.

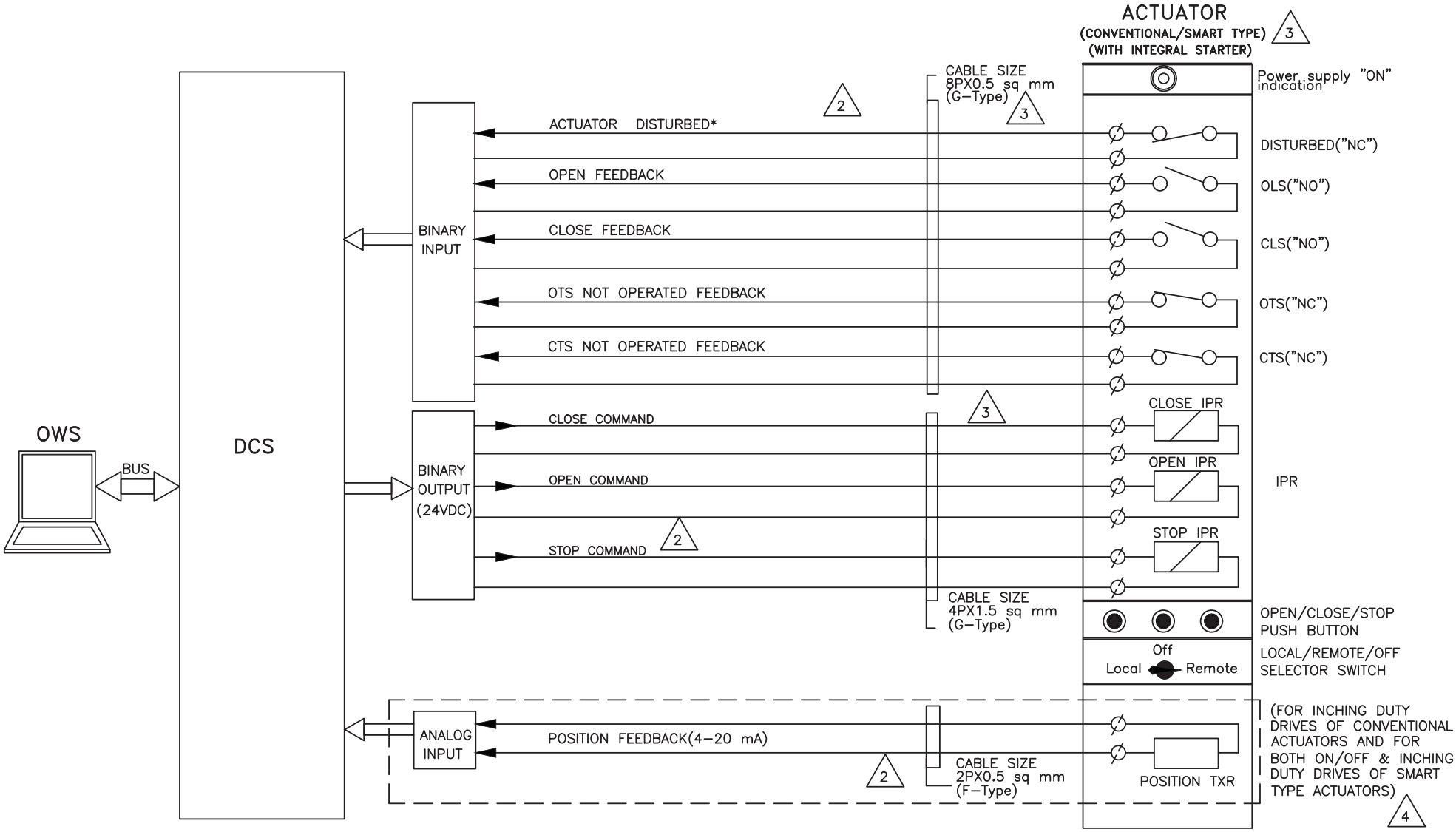
8.0 APPLICABLE DATA SHEET FORMS

This document shall be read with one or more of the following data sheet forms :

- Data sheet A&B for Local Panels : Data sheet no. PES-145A-DS1-0
- Data sheet C for Local Panels : Data sheet no. PES-145A-DS2-0

SIGNL EXCHANGE BETWEEN DRIVES & DCS

DCS INTERFACE FOR BIDIRECTIONAL DRIVE(WITH INTEGRAL STARTER)



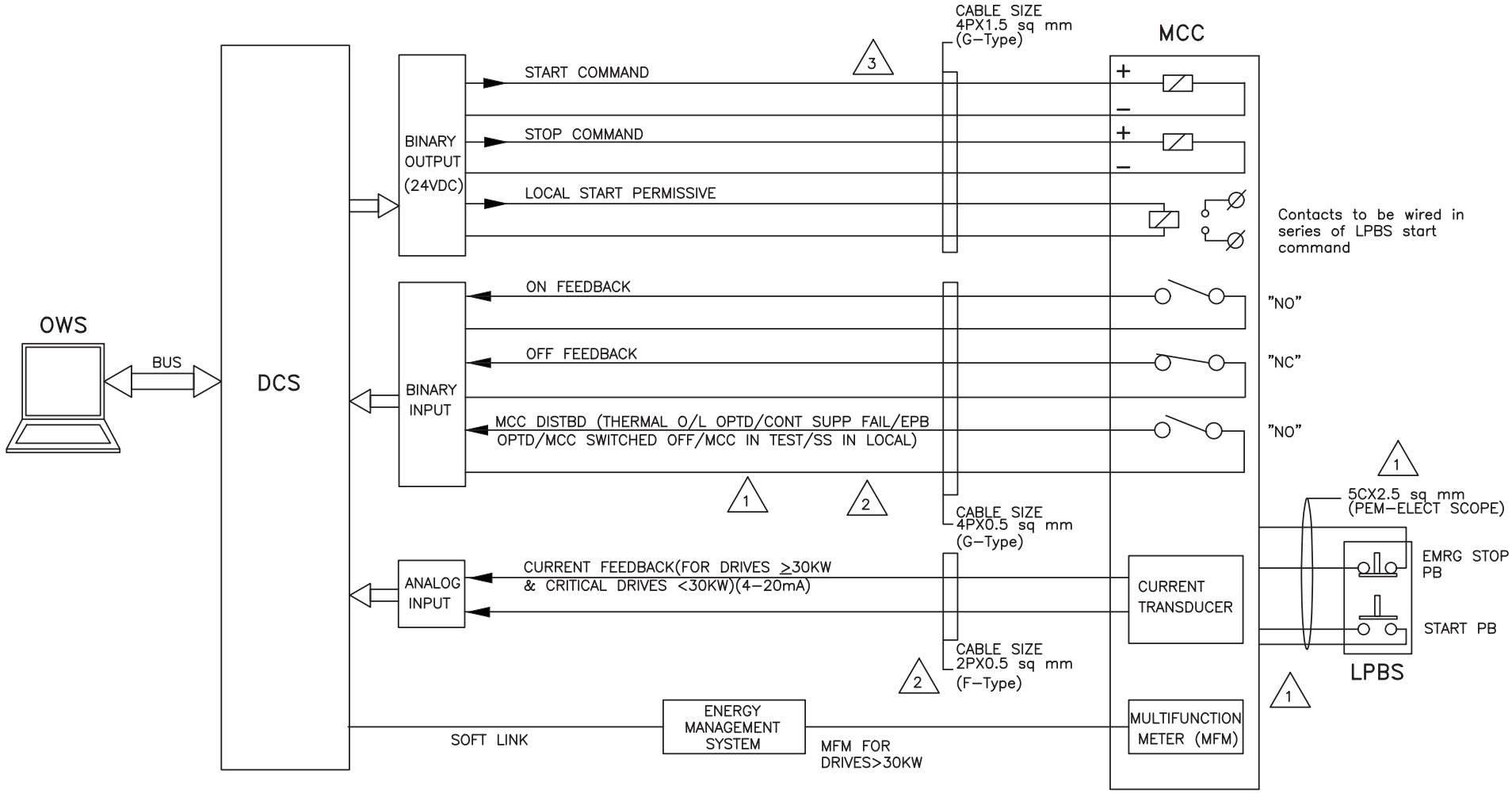
NOTE:

* DISTURBED= Loss of Power supply (1 Phase/3 Phase)/ Loss of control supply/ Motor thermostat trip/ Thermal over load/ Local/Off/Remote Sel. switch in local or off mode/ Stop PB optd/ Torque open/close cutoff/ Valve jammed

1

BHEL	PROJECT: 1X660MW SAGARDIGHI THERMAL POWER EXTENSION PROJECT (UNIT #5)	DRG.NO.	PE-DM-445-145-I002
		DATE	15.03.2021
	TITLE DDCMIS INTERFACE FOR BIDIRECTIONAL DRIVE	REV.NO.	04
		SHT	7 OF 11

DCS INTERFACE FOR UNIDIRECTIONAL LT DRIVE (CONTACTOR OPERATED) △1

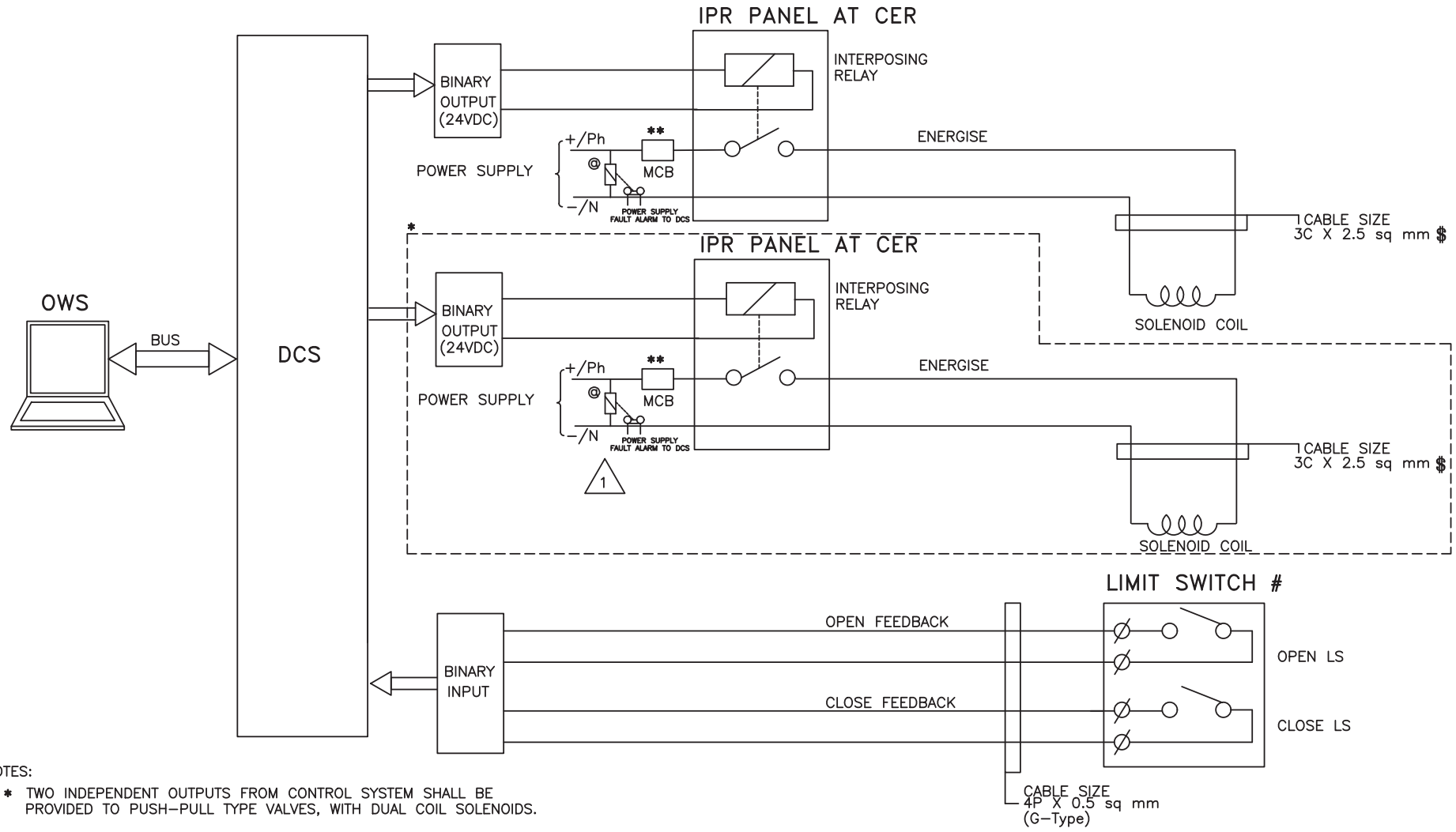


NOTES:

REDUNDANCY IN OUTPUT SHALL BE PROVIDED FOR ALL CRITICAL LT DRIVES △2

BHEL	PROJECT: 1X660MW SAGARDIGHI THERMAL POWER EXTENSION PROJECT (UNIT #5)	DRG.NO.	PE-DM-445-145-I002
		DATE	15.03.2021
	TITLE DDCMIS INTERFACE FOR UNIDIRECTIONAL LT DRIVE (CONTACTOR OPERATED)	REV.NO.	04
		SHT	8 OF 11

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



NOTES:

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

** MCB SHALL BE PROVIDED FOR EACH SOLENOID

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

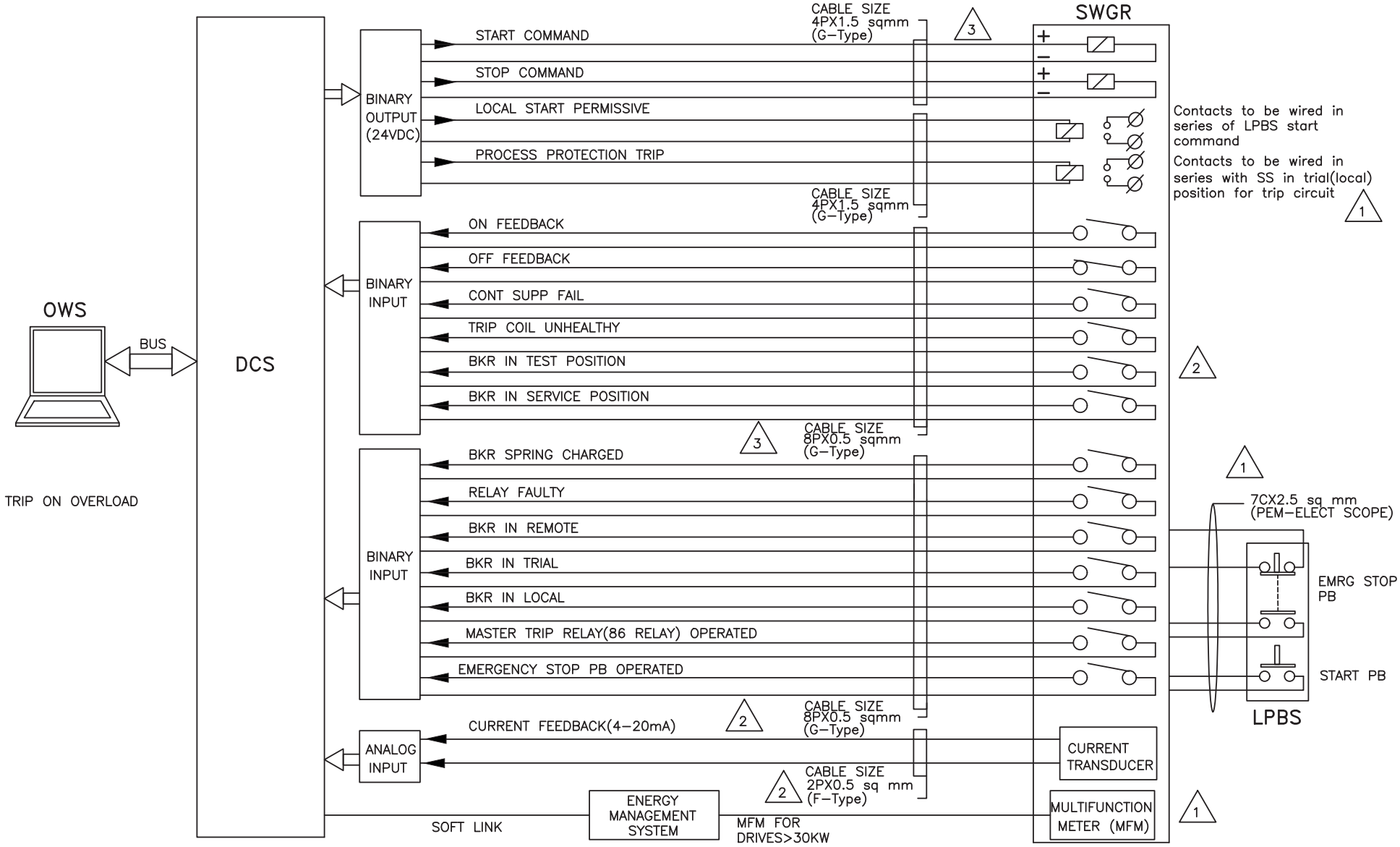
@ COMMON FOR ALL SOLENOID VALVES SIMILAR COIL VOLTAGE RATING PER PANEL.

$ POWER CABLE CROSS SECTION SHALL BE AS PER CABLE SIZING CALCULATION.

1 2 3

BHEL	PROJECT: 1X660MW SAGARDIGHI THERMAL POWER EXTENSION PROJECT (UNIT #5)	DRG.NO.	PE-DM-445-145-I002
		DATE	15.03.2021
	TITLE: DDCMIS INTERFACE FOR SOLENOID DRIVE	REV.NO.	04
		SHT	9 OF 11

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

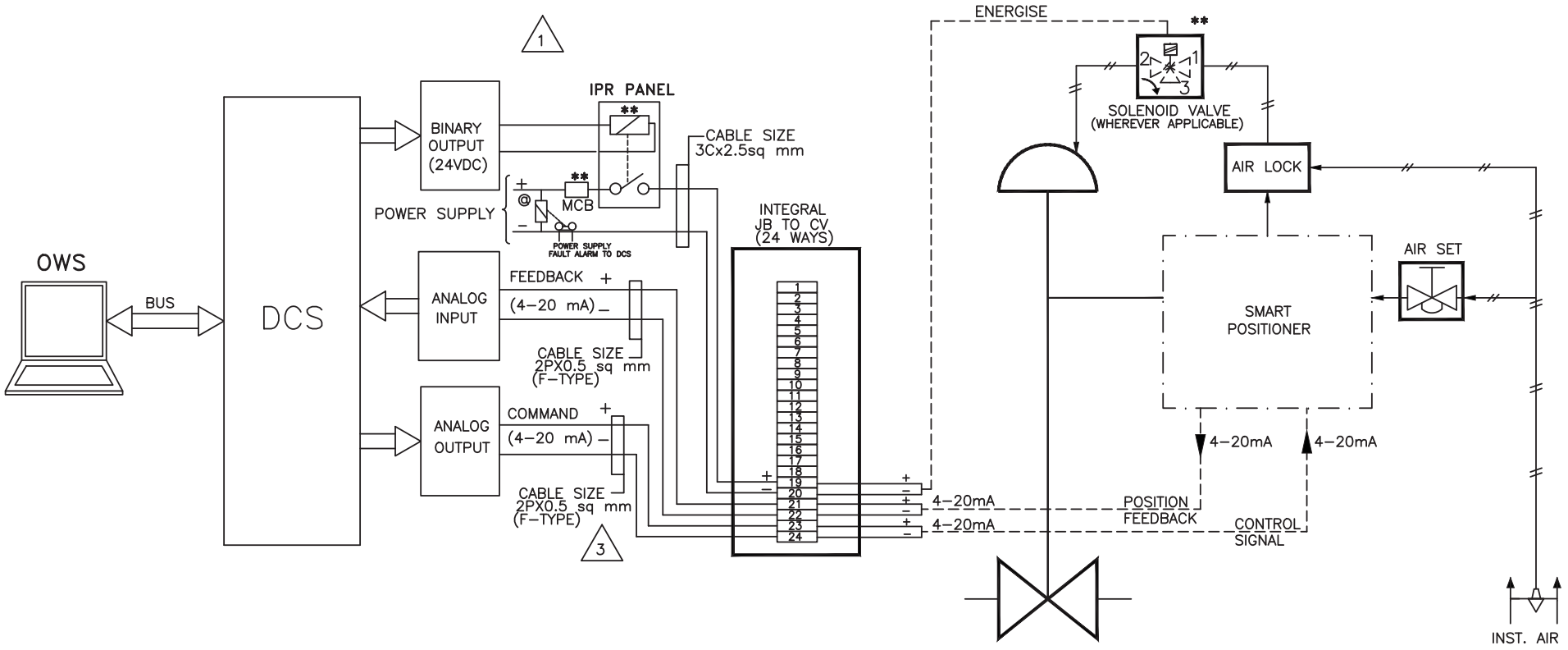


NOTES:

REDUNDANCY IN OUTPUT SHALL BE PROVIDED FOR ALL HT AND CRITICAL LT DRIVES

BHEL	PROJECT: 1X660MW SAGARDIGHI THERMAL POWER EXTENSION PROJECT (UNIT #5)	DRG.NO.	PE–DM–445–145–I002
		DATE	15.03.2021
	TITLE DDCMIS INTERFACE FOR UNIDIRECTIONAL HT DRIVE	REV.NO.	04
		SHT	10 OF 11

DCS INTERFACE FOR ANALOG DRIVE (WITH SMART POSITIONER)



NOTES:

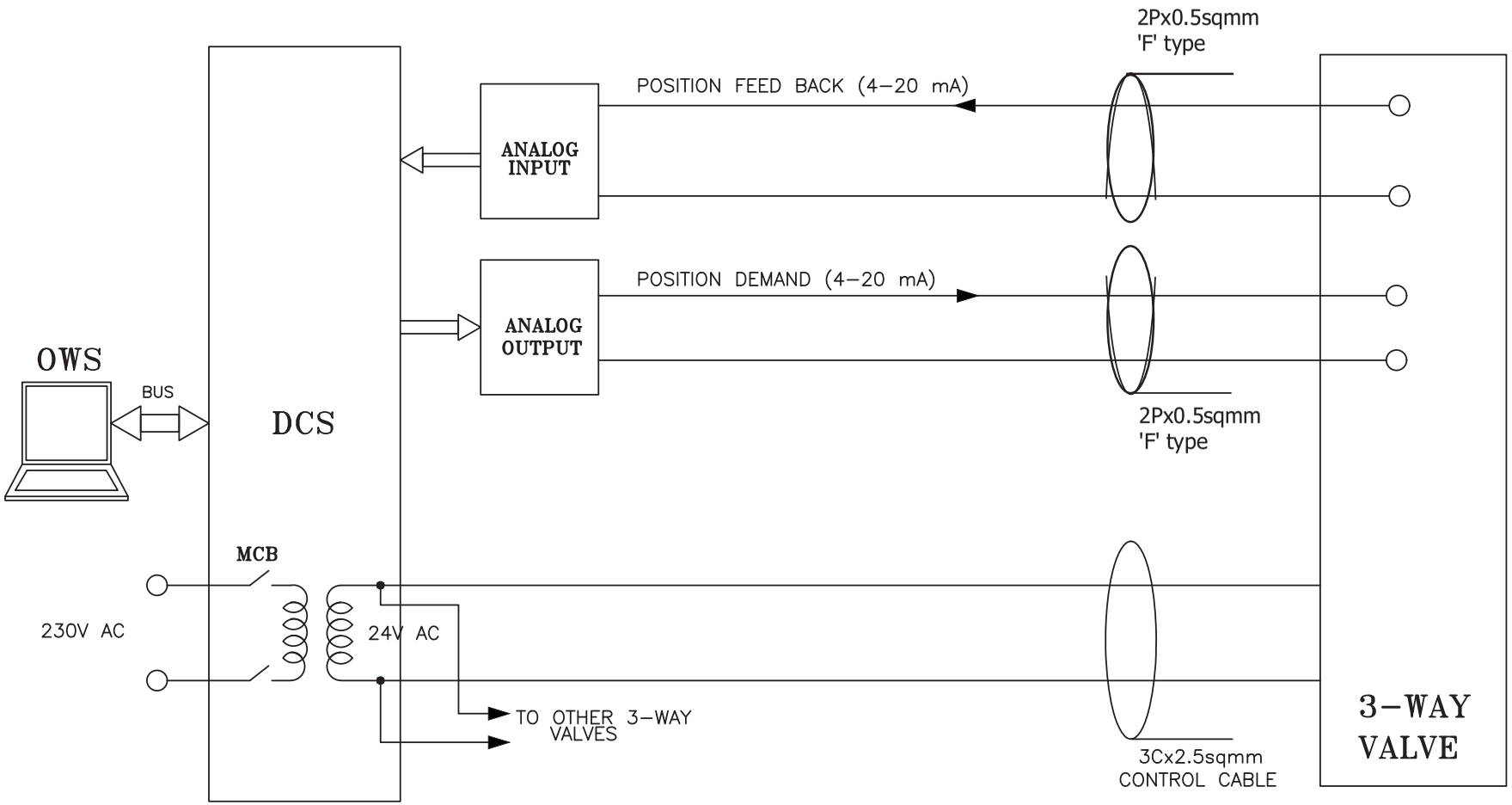
** APPLICABLE TO VALVES WHERE PROTECTION OPEN/CLOSE ACTION FOR CONTROL DEMAND OVERRIDING IS REQUIRED.

@ COMMON FOR ALL SOLENOID VALVES PER PANEL.

1 REDUNDANCY IN OUTPUT SHALL BE PROVIDED FOR ALL MODULATING DRIVES

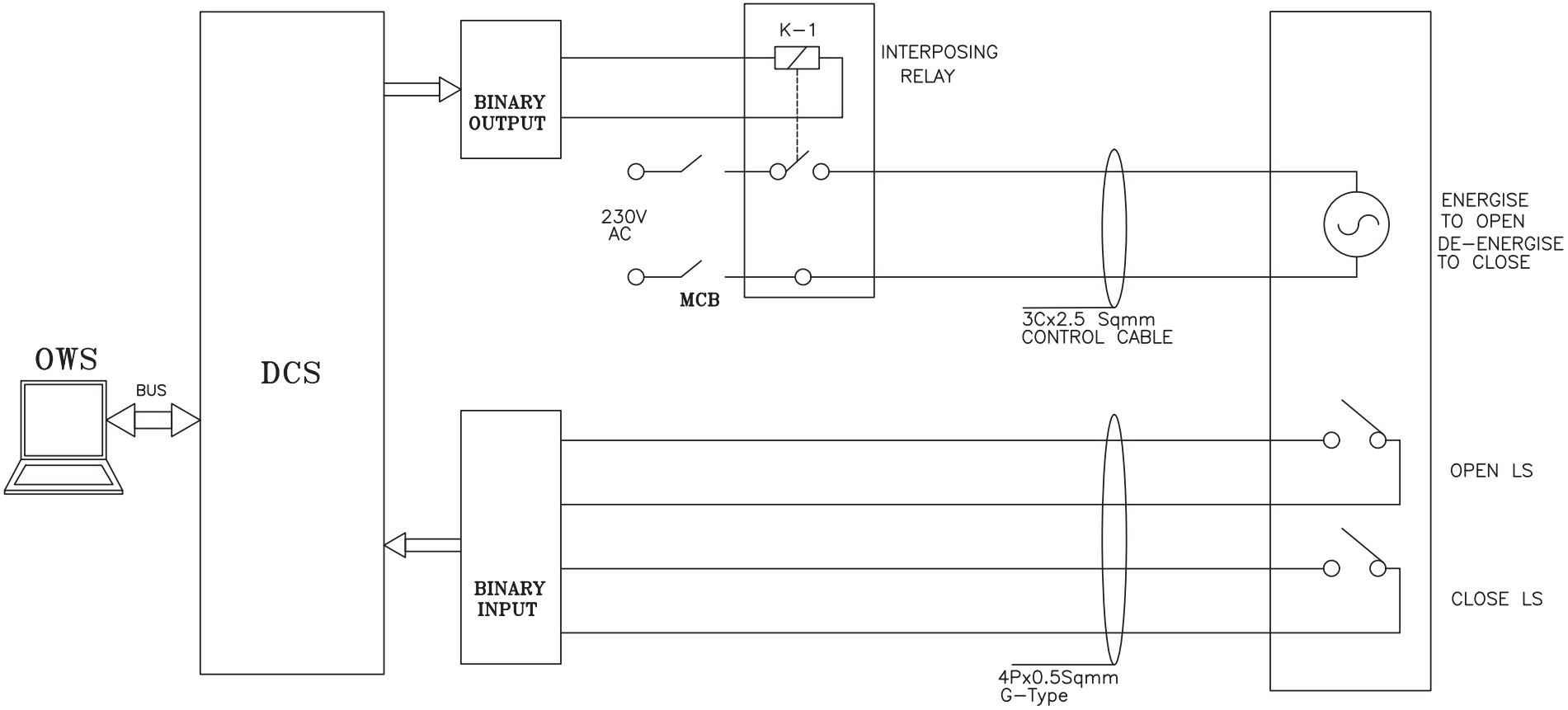
BHEL	PROJECT: 1X660MW SAGARDIGHI THERMAL POWER EXTENSION PROJECT (UNIT #5)	DRG.NO.	PE–DM–445–145–I002
		DATE	15.03.2021
	TITLE: TYPICAL HOOK–UP DIAGRAM ANALOG DRIVE (WITH SMART POSITIONER)	REV.NO.	04
		SHT	11 OF 11

DCS INTERFACE FOR 3-WAY MIXING VALVE (MOD-AC)



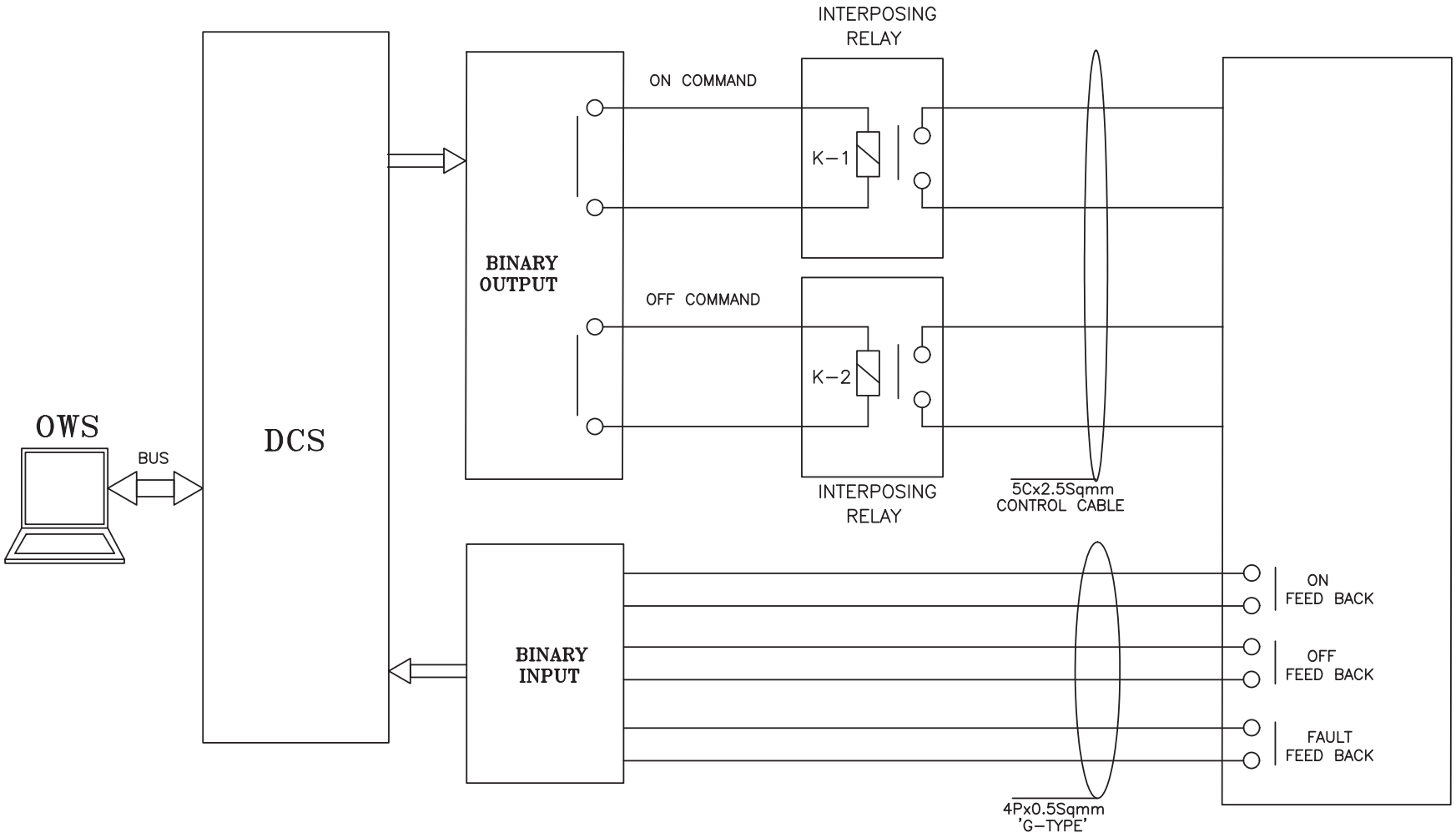
BHEL	PROJECT: 1X660MW SAGARDIGHI TPP EXTENSION PROJECT (UNIT #5)	DRG.NO.	
		DATE	03.06.2021
	TITLE: REFERENCE DRIVE INTERFACE SCHEME	REV.NO.	00
		SHT 2	OF 6

DCS INTERFACE FOR MOTORIZED OPERATED FIRE DAMPER (BID-FD)



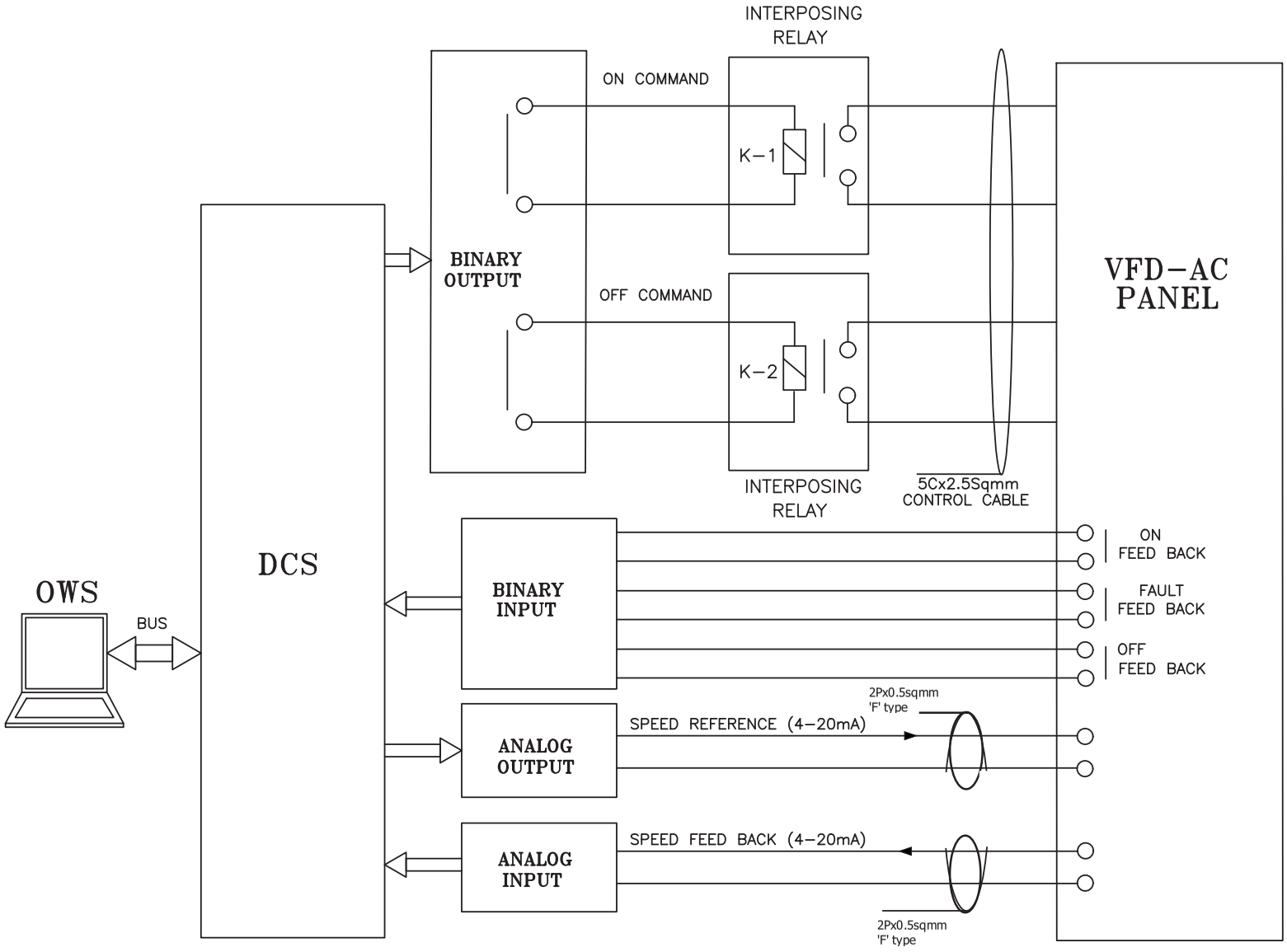
BHEL	PROJECT: 1X660MW SAGARDIGHI TPP EXTENSION PROJECT (UNIT #5)	DRG.NO.	
		DATE	03.06.2021
	TITLE: REFERENCE DRIVE INTERFACE SCHEME	REV.NO.	00
		SHT 3	OF 6

HOOK–UP DIAGRAM FOR SCM/PAC/VAM/ACCU



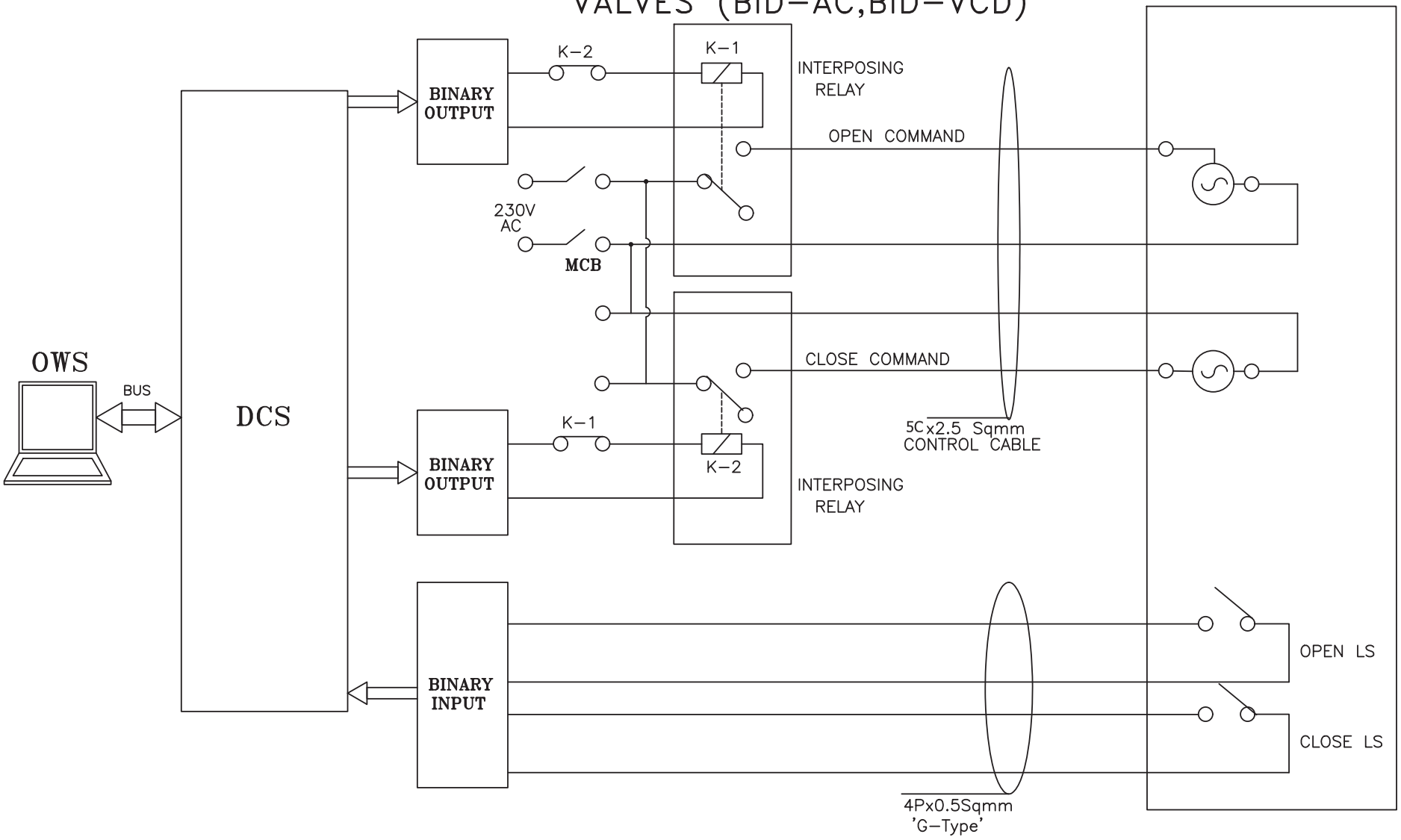
BHEL	PROJECT: 1X660MW SAGARDIGHI TPP EXTENSION PROJECT (UNIT #5)	DRG.NO.	
		DATE	03.06.2021
	TITLE: REFERENCE DRIVE INTERFACE SCHEME	REV.NO.	00
		SHT 4	OF 6

DCS INTERFACE FOR VFD(VFD-AC)



BHEL	PROJECT: 1X660MW SAGARDIGHI TPP EXTENSION PROJECT (UNIT #5)	DRG.NO.	
		DATE	03.06.2021
	TITLE: REFERENCE DRIVE INTERFACE SCHEME	REV.NO.	00
		SHT 5	OF 6

DCS INTERFACE FOR MOTORIZED OPERATED VALVES (BID-AC,BID-VCD)



BHEL	PROJECT: 1X660MW SAGARDIGHI TPP EXTENSION PROJECT (UNIT #5)	DRG.NO.	
		DATE	03.06.2021
	TITLE: REFERENCE DRIVE INTERFACE SCHEME	REV.NO.	00
		SHT 6	OF 6

INSTRUMENT CABLE INTERCONNECTION AND TERMINATION PHILOSOPHY

11.00.00 INSTRUMENTATION CABLES

11.01.00 General Requirements

11.01.01 Bidder shall supply, erect, terminate and test all instrumentation cables for control and instrumentation equipment/devices/systems included under his scope.

11.01.02 Any other application where it is felt that instrumentation cables are required due to system/operating condition requirements, are also to be provided by Bidder.

11.01.03 Other type of cables like co-axial cables for system bus, cables for connection of peripherals etc. (under Bidder's scope) are also to be furnished by the Bidder.

11.01.04 Bidder shall supply all cable erection and laying hardware like cable trays, supports, flexible conduits, cable glands, lugs, pull boxes etc. on as required basis for all the systems covered under this specification.

11.01.05 All instrumentation cables covered in this specification shall comply with VDE 0815, VDE 0207, Part 4, Part 5, Part 6, VDE 0816, VDE 0472, SEN 4241475, ANSI MC 96.1, IS-8784, IS-10810 (latest editions) and its amendments read along with this specification.

11.01.06 The thermocouple extension cables shall be of Two pair/multi pair, twisted & shielded, PVC insulated, FRLS PVC sheathed and compatible for the type of thermocouples employed. The material of conductor shall be as per ANSI MC-96.1.

paired instrumentation cable acceptable

11.01.07 Traid cables shal be used for all RTD (3-wire) measurements. In case of 4-wire RTD, 2 pair instrumentation signal cables shall be used.

11.01.08 All cables near high temperature zone like burner front devices, metal temperature thermo-couples on main steam & turbine casing etc. shall be high temp cables, which shall be terminated at a junction box in normal temperature zone. Thermocouple extension cables and copper conductor cables for high temperature applications shall be with insulation of individual conductor and outer sheath of extruded FEP (i.e., Teflon) as per VDE 0207 Part 6 and ASTMD 2116. The thickness of insulation shall be 0.5 mm nominal (i.e., 0.4 mm minimum). These cables shall be single/ multipair, twisted & shielded.

11.01.09 Cable accessories such as harnessing components, markers, bedding, cable joiner, binding tape etc. shall have flame retardant quality.

11.01.10 The thickness of outer sheath shall be as per the guidelines given in VDE 0816. Thickness of outer sheath shall not be less than 1.8 mm in any case. Allowable tolerance of overall diameter of the cables shall be ± 2 mm max. over the declared value in technical data sheets. The variation in diameter and the ovality at any cross section shall not be more than 1.0 mm.

11.01.11 The Cables shall be supplied in non returnable standard seasoned drums. The drum length shall be 1000m (± 5%) up to & including 8 pairs and 500 m (± 5%) above 8 pairs. Drum shall be anti rodent, anti termite and smooth finish. Both ends of cable shall be capped by means of non hygroscopic sealing material.

11.01.12 Durible marking shall be provided on the outer sheath of the cable at intervals not exceeding 5 metres. Marking shall include Manufacturer's name, Year of manufacture, Voltage grade, Type of cables (Conductor size & no. of pairs / type of compensating /extension cable, Analog or Binary), Insulation material, FRLS etc.

Sequential length marking shall also be provided at every metre interval on outer sheath of cable.

11.01.13 Bidder shall furnish all documentary evidence including cross-sectional drawings, test certificates to substantiate the suitability of cables offered for different applications. Bidder shall also clearly bring out the application wise details for each type of cable offered.

11.01.14 All prefabricated cables shall have 10% spare cores which will not be connected to pin connectors.

11.01.15 All the instrumentation cables i.e. twisted and shielded multipair cables, compensating cables, pre fabricated cables etc. shall be flame retardant low smoke and low halogen (FRLSH) type.

11.01.16 For all Digital Output (DO) signal from DCS or PLC, Minimum 1.5 Sq mm cable shall be used, except for Solenoid valves where 2.5 Sqmm cable shall be used. Moreover, bidder shall submit the calculations for selecting the cable size.

11.02.00 Instrumentation Cable Specifications

11.02.01 INSTRUMENTATION MULTI PAIRED SIGNAL CABLE

01.	Conductor type	:	Multi-stranded annealed tinned high conductivity copper
02.	Conductor size	:	0.5 / 1.0 / 1.5 Sq.mm (as required)
03.	Conductor resistance	:	39 Ω/Km/18 Ω/Km/12 Ω/Km
04.	Conductor Insulation	:	Extruded PVC meeting the requirements of VDE 0207 Part 4 compound Y I3. Insulation thickness for individual core shall be between 0.28 and 0.35 mm for 0.5 mm^2 cables, 0.5 to 0.6 mm for 1.0 mm^2 cables and 0.8 to 0.9 for 1.5 mm^2 cable.
05.	Voltage Grade	:	225 V (peak value)
06.	Twisting	:	Twin twisted with lay of 50 mm (max)
07.	Twisting Direction	:	All pairs in the same direction. Lapped to form bunch with mylar tape.
08.	Screen (Pair & Overall)	:	Aluminium mylar tape with a thickness of 28 μm (min.) for individual pair screen and 60 μm (min.) for overall screen with 100% coverage and 25% overlapped edges. Over the individual pair screening tape two laps of 0.05 mm thick (min.) polyster tape shall be

			applied with minimum overlap of 25%. Metallic side of the screen shall be in contact with drain wire. Analog signals - Individual pair & overall shield. Binary signals - overall shield.
09.	Drain wire	:	Annealed tinned copper wire, stranded. Size 0.5 Sq. mm. (No. of strands / size:- 7 / 0.3mm). Separate drain wire for individual pair shield (wherever applicable) as well as overall shield.
10.	Inner Sheath	:	Extruded PVC (compound YM1) as per VDE 0207 Part 5 (anti rodent, anti termite & moisture resistant properties) and shall be of flame retardant low smoke (FRLS) type
11.	Fillers	:	Non metallic flame & moisture retardant
12.	Armouring	:	GI wire / strip
13.	Outer Sheath	:	Extruded PVC (compound YM1) as per VDE 0207 Part 5 and shall be of flame retardant low smoke low halogen (FRLSH) type
14.	Temperature Range	:	70^{O}C (continous) except for high temperature resistant Teflon insulated cables which shall be suitable for continous operation at 205^{O}C
15.	Sheath colour	:	Inner- Black and Outer- Sky Blue
16.	Tests on outer sheath	:	a) Oxygen Index: Min.29% at room temp. (ASTMD-2863) b) Acid Gas Gen.: Max.20% by weight as per IEC 754 Part-I c) Temp Index : Min 250^{O} C (ASTMD-2863) d) Smoke Density Rating :Max.60% (ASTMD-2843). e) Complete cable assembly shall pass Swedish Chimney Test- as per SEN-4241475 AND Flammability Test as per IEEE-383.

f) Halogen Content Measurement as per ICEA T-33-655 (Permissible limit for halogen shall not be more than 0.2%)

17. High voltage test
a) Core to core - 1.5 KV for 1 min.
b) Core to screen - 1.0 KV for 1 min.
c) Screen to Armour – 1.0 KV for 1 min

18. Rodent & Termite repulsion test Presence of lead shall be confirmed

19. Colour of core insulation for Instrumentation Cable

PAIR	CORE	COLOR
1st	1st	Blue
1st	2nd	Red
2nd	1st	Gray
2nd	2nd	Yellow
3rd	1st	Green
3rd	2nd	Brown
4th	1st	White
4th	2nd	Black

Above 4 Pairs, 4 Pairs making a unit shall have indelible printed colour coded bands like Pink for 1st unit, Orange for 2nd unit and Violet for 3rd unit and so on. In addition band marking, for example single band for 1st. unit, double band for 2nd. unit and so on, shall be provided on each conductor for identification of unit. Band marking on individual core shall be provided at regular intervals not exceeding 50 mm.

11.02.02 THERMOCOUPLE EXTENSION & COMPENSATING CABLE (TWO PAIR & MULTI-PAIR)

01. Conductor : Solid conductor

02. Conductor size : 16 AWG (1.31 Sq. mm)

03. Type : Kx (Extension) (Chromel Alumel),
Rx (Compensating) (Copper-Copper alloy),

04. Conductor Insulation : Extruded PVC meeting the requirements of VDE 0207 Part 4 compound Y I3. Insulation thickness for individual core shall be between 0.35 to 0.45 mm for 1.31 mm^2 cables

05. Voltage Grade : 225 V (peak value)

06.	Twisting	:	Twin twisted with lay of 50 mm (max)
07.	Twisting Direction	:	All pairs in the same direction. Lapped to form bunch with mylar tape.
08.	Screen (Pair & Overall)	:	Aluminium mylar tape with a thickness of 28 μm (min.) for individual pair screen and 60 μm (min.) for overall screen with 100% coverage and 25% overlapped edges. Over the individual pair screening tape two laps of 0.05 mm thick (min.) polyster tape shall be applied with minimum overlap of 25%. Metallic side of the screen shall be in contact with drain wire.
09.	Drain wire	:	Annealed tinned copper wire, stranded. Size 0.5 Sq. mm. (No. of strands / size:- 7 / 0.3mm). Separate drain wire for individual pair shield as well as overall shield.
10.	Inner Sheath	:	Extruded PVC (compound YM1) as per VDE 0207 Part 5 (anti rodent, anti termite & moisture resistant properties) and shall be of flame retardant low smoke (FRLS) type
11.	Fillers	:	Non metallic flame & moisture retardant
12.	Armouring	:	GI wire / strip
13.	Outer Sheath	:	Extruded PVC (compound YM1) as per VDE 0207 Part 5 and shall be of flame retardant low smoke low halogen (FRLSH) type
14.	Temperature Range	:	70^{O}C (continous) except for high temperature resistant Teflon insulated cables which shall be suitable for continous operation at 205^{O}C
15.	Sheath colour	:	Inner- Black and Outer- Yellow for Type Kx, Green for Rx.
16.	Tests on outer sheath	:	a) Oxygen Index: Min.29% at room temp. (ASTMD-2863) b) Acid Gas Gen.: Max.20% by weight as per IEC 754 Part-I c) Temp Index : Min 250^{O} C (ASTMD-2863) d) Smoke Density Rating :Max.60% (ASTMD-2843).

e) Complete cable assembly shall pass Swedish Chimney Test- as per SEN-4241475 AND Flammability Test as per IEEE-383.

f) Halogen Content Measurement as per ICEA T-33-655 (Permissible limit for halogen shall not be more than 0.2%)

g) Thermal EMF Test as per ANSI MC96.1

17. High voltage test
a) Core to core - 1.5 KV for 1 min.
b) Core to screen - 1.0 KV for 1 min.
c) Screen to Armour – 1.0 KV for 1 min

18. Rodent & Termite repulsion test Presence of lead shall be confirmed

19. Conductor material & sheath color for thermocouple extension /compensating cable as per ANSI MC 96.1

CABLE TYPE	OVERALL SHEATH COLOR	WIRE	SHEATH COLOR	CONDUCTOR MATERIAL
Kx	Yellow	Positive	Yellow	Nickel / Chromium
		Negative	Red	Nickel / Aluminum
Rx	Green	Positive	Black	Copper
		Negative	Red	Copper Alloy

11.02.03 INSTRUMENTATION TRIAD CABLES

01. Conductor type : Stranded tinned Electrolytic copper

02. Conductor size : 1.0 Sq.mm

03. Stranding : 7 x 0.43 mm

04. Conductor Insulation : HRPVC Type-C, 0.6 mm thick

05. Twisting : Triad twisted with lay of 50 mm

06. Twisting Direction : All triads in the same direction. Lapped to form bunch with mylar tape.

07. Colour : Outer sheath colour shall be black for non-IS cable and light blue for IS cable.

Individual traid color code shall be Light blue-Brown-Black.

08.	Individual Pair Overall Shield mm thick).	:	Polyethylene coated aluminum foil with 100% coverage with 25% Overlap (0.06
09.	Drain wire	:	Annealed Tinned copper wire, Size 0.5 Sq. mm. minimum
10.	Inner Sheath	:	Extruded FR PVC, Thickness as per International Standard
11.	Armoring	:	N/A
12.	Outer Sheath	:	Extruded FR PVC, Thickness as per International Standard
13.	Rip Cord	:	Yes
14.	Operating Voltage	:	300 V / 500V R.M.S (Core to Earth / Core to Core.)
15.	Temperature Range	:	Up to 85 °C
16.	Electrical Characteristics Resistance	:	18.4 Ohms/Km (max.) at 20 ^{O}C
Mutual Capacitance at 1 kHz		:	a) Between adjacent cores 150 nf / Km. b) Between conductor and Screen 400 nf / Km
L/R ratio		:	25 µH/Ohms (max)
Insulation at 20^{0} C		:	100 M Ohms/Km (Min)
17.	Codes & Standards	:	a) IPCEA-S-61-402 b) IEC 332-1 ASTM-B-33
18.	Tests	:	a) Oxygen Index: Min.29 at room temp. (ASTM-D-2863) b) Temp Index : Min 250 ^{O}C at 21Oxy. Ind. (ASTM-D-2863) c) Flammability Test : as per IEC 332 Part-I d) Swedish Chimney Test-S-424-1475 e) High Voltage Test :1.0 KV for1 Min

f) Type Test for material

19. No. of Triads : 2T, 6T, 12T

11.02.04 Cable parameters such as mutual capacitance between conductors, conductor resistance, insulation resistance, characteristic impedance, cross talk and attenuation figures at 20 deg. C (± 3 deg. C) for various types of cables as applicable shall be as specified in TABLE-1.

TABLE- 1

CABLE PARAMETERS

SL. NO.	PARAMETER / TYPE	TYPE – E, F	TYPE – G, I	TYPE – A, B & C	REMARKS
01.	Mutual Capacitance at 0.8 kHz (max.)	120 nF/Km.	100 nF/Km.	120 nF/Km.	
02.	Conductor Resistance (max.)	73.4 Ohm/km (Loop) For Type F, 13.3 ohm/km (loop) for Type E	73.4 ohm/km (loop)	26.6 ohm/km (loop)	
03.	Insulation Resistance (minimum)	100 M ohm/km	100 M ohm/km	100 M ohm/km	
04.	Cross-talk figure at 0.8 kHz (minimum)	60 dB	60 dB	60 dB	
05.	Characteristic Impedance (maximum) at 1 kHz	320 ohm	340 ohm	320 ohm	
06.	Attenuation at 1 kHz (maximum)	1.2 dB/Km for Type F; 0.8 dB/Km for Type E	1.2 dB/Km	1.2 dB/Km	

11.02.05 Identification of the cores & pairs shall be done with suitable colour coding & band marking as well as by numbering of cores/pairs as per VDE: 0815. The details of colour coding etc. shall be as approved by Owner during detailed stage. Also refer TABLE - 2 for description of various type of cables.

TABLE- 2

DESCRIPTION OF VARIOUS TYPES OF CABLES

SL. NO.	TYPE	CONDUCTOR SIZE IN SQ.MM	REMARKS
01.	A	1.31	Two pair shielded and twisted pair thermo-couple, extension cable, ANSI type Kx, solid alloy conductor.
02.	B	1.31	Two pair shielded & twisted thermo-couple, extension cable, ANSI type Sx, solid alloy conductor.
03.	C	1.31	Two pair shielded & twisted Heat resistant Teflon insulation & outersheath thermo-couple, extension cable, ANSI type Kx, solid alloy conductor.
04.	E	0.5	Two pair individual pair and overall shielded twisted pair instrumentation cable for both analog and digital signal to be used from field mounted instruments to local junction box.
05.	F	0.5	Multipair individual pair & overall shielded twisted pair instrumentation cable (4/8/12pair) for analog signals with stranded copper conductor.
06.	G	0.5	Multipair overall shielded & twisted pair instrumentation cable (4/8/12pair) for binary signals with stranded copper conductor.
07.	H	1.0	2 Triad / MultiTriad individual pair & overall shielded instrumentation cable (2/6/12Triad) for RTD signals with stranded copper conductor.
08.	I	0.5	Type F cable / type G cable with heat resistant Teflon insulation & outersheath for high temperature application.
09.	S	As per specific standard / requirement for each applicable	Multicore / multipair shielded cable for system specific cables like conductivity type level switches, system bus cable, flame scanner etc. as applicable.

11.03.00 Instrumentation Cable Interconnection and Termination Philosophy

The cable interconnection philosophy to be adopted shall be such that extensive grouping of signals by large scale use of field mounted Group JBs at strategic locations (where large concentration of signals are available, e.g. switchgear) is done and consequently cable with higher number of pairs are extensively used. JB's to be furnished under this specification shall be of 6/12/24/36/48 way. The material dimension and interior / exterior colour of JB's shall be subject to Owner's approval. The details of termination to be followed is mentioned in TABLE – 3 :

TABLE- 3

CABLE TERMINATION TO BE FOLLOWED

SL. NO	APPLICATION		TYPE OF TERMINATION		TYPE OF CABLE
	FROM (A)	TO (B)	END (A)	END (B)	
01.	Valves / Dampers Drive (Integral Junction Box)	Marshalling Cubicle / Local Group JB / Termination Control Cabinets / System Cabinets	Plug-in Connector	Post mounted Maxitermi / Cage Clamp type	G
02.	Transmitters, Process actuated switches to be mounted in LIE / LIR	Integral Junction Box of LIE / LIR	Plug-in Connector	Maxitermi / Cage Clamp (Rail mounted) type.	F, G
03.	RTD Heads	Local Junction Box	Plug-in Connector	Maxitermi / Cage Clamp (Rail mounted) type.	H
04.	Thermocouples	CJC Box	Manufacturer's standard	Screwed / Cage Clamp Type	A,B,C*
05.	Local Junction Box, CJC Box, Int. Junction Box of LIE / LIR / Group JB / MCC / Switchgear	Marshalling Cubicle / Local Group JB / Termination / Control Cabinets / System Cabinets	Maxitermi / Cage Clamp (Rail mounted) type.	Post mounted Maxitermi / Cage Clamp type	F, G
06.	Local Junction Box, MCC / Switchgear	Group JB	Maxitermi / Cage Clamp (Rail mounted) type.	Maxitermi / Cage Clamp (Rail mounted) type.	F, G
07.	Field mounted Instrument	Group JB	Maxitermi / Cage Clamp (Rail mounted) type.	Maxitermi / Cage Clamp (Rail mounted) type.	F, G
08.	Marshalling Cubicle /	Electronic System	Post mounted Maxitermi /	Post mounted Maxitermi /	F, G

SL. NO	APPLICATION		TYPE OF TERMINATION		TYPE OF CABLE
	FROM (A)	TO (B)	END (A)	END (B)	
	Termination Cabinet	Cabinet	Cage Clamp type.	Cage Clamp type.	
09.	UCP mounted equipments	Post mounted Maxitermi / Cage Clamp type	Post mounted Maxitermi / Cage Clamp type.	Plug in Connector / Cage Clamp type (rail mounted)	F, G (with connector at one end)
10.	DCS/ PLC Cabinets	PC, Printers etc.	Plug in connector	Plug in connector	Manufacturer Standard

NOTES :

01. For Sl. No. 05, 06, 07 & 08, normally 10% spare core shall be provided.

02. For analog signals individual pair shielding & overall shielding & for Binary signals only overall shielding of instrumentation cables shall be provided.

03 *For high temperature application only.

11.04.00 CONTROL & POWER CABLE

Bidder shall refer to Volume IIF of the electrical specification for detail.

11.05.00 OPTICAL FIBER CABLE

11.05.01 This specification defines the minimum general requirements for the Design, manufacture, supply, inspection, installation, testing & commissioning of optical fiber cables and accessories, such as fiber distribution (patch) panels, adapters, connectors, joint boxes, pigtails and other components, as required to complete the system. Bidder shall consider all related activities, such as cable stripping, cable entry in boxes and panels, cable fiber splicing/fusion, cable performance testing and other services, to achieve a properly documented and operational cable network. all Fibre Optic cables shall be Single Mode type.

11.05.02 Fiber Optic Cables shall be installed on cable tray, duct bank, cable trench installation as necessary. For outdoor applications the cable shall be armoured with Poly Ethylene sheathing. In all cases cable shall be routed through suitable grade HDPE permanently lubricated protection pipe as per IS 4984, IS 12235 & TEC.G/CDS-08 /01of suitable size @ 53% fill factor. Permanent route marking in FRP (Fibre Reinforced Plastic) material shall be provided at intervals not exceeding 5 meters for all FO cables layed outdoor buried under the ground.

11.05.03 The Optical Fiber core shall be of ultra pure fused silica glass coated with UV-cured acrylate suitable to withstand temperature of about 80°C (continuous).

11.05.04 Fiber optic cable shall be of loose tube design. Typically, fibers shall be housed in-groups of 6 (minimum) within gel-filled buffer tubes to protect against ingress of moisture and vibration. The tubes shall be manufactured with industry standard material like Poly-Butylenes Terathylate (PBT). They shall be colored for easy identification. Buffer tubes shall be approachable with industry standard tools and practices. The buffer tubes shall be stranded around the Central Strength Member utilizing Reverse Oscillating Lay (ROL). Blank fillers shall be used as necessary to maintain circular cable structure. The fiber optic cable shall withstand water penetration when tested with a one meter static head or equivalent continuous pressure applied at one end of a one meter length of filled cable for one hour. No water shall leak through the open cable end.

11.05.05 The central strength member of the cable shall be Fiberglass Reinforced Plastic (FRP) or other material with equivalent mechanical strength to provide both tensile and anti buckling strength to the cable.

11.05.06 In addition to central strength member, additional strengthening substance like aramid yarns shall be helically applied over the cable core to provide additional tensile strength to the cable.

11.05.07 The cable shall be of dual jacket & armoured. Inner sheath consists of a medium density polyethylene (MDPE) jacket extruded over the cable core. Two highly visible ripcords are placed under the jacket to aid in sheath removal. A co-polymer coated steel tape is corrugated and wrapped around the inner jacket to provide additional cable compression strength and rodent protection. The armor is covered with an outer black FRLS MDPE jacket. A ripcord is also placed underneath the armor for easy outer jacket removal.

11.05.08 Minimum bending radius shall be equal or more to 15 D (D= Diameter). A continuous strength member shall be provided for the entire length of the cables. Every tube and fiber shall be colour coded to provide easy identification. The outer sheath shall be marked to show fiber type and cable classification at suitable intervals.

11.05.09 The entire length of each cable shall be marked with the following items:

- Manufacturer's Name
- Month and year of manufacturing
- Coded description of the cable based on Telcordia's (Bellcore) SR-2014 Suggested Optical Cable Code (SOCC).
- Sheath Identification Number
- Sequential Length Marking in meter
- A Telephone Handset symbol to distinguish communication from power cable as per NESC section –35 G.

11.05.10 Fiber optic cable shall provide a long life expectancy of minimum 25 years and shall meet the industrial standard of operation at temperature of 55^0 C

and humidity to 100% without degradation to optical or mechanical performance.

11.05.11 Optical fiber used in the plant shall generally conform to the following specification.

SPECIFICATION FOR G.652 MONOMODE FIBER

	ATTRIBUTES	VALUE
1.	Cladding Diameter	125 μm ± 1.0 μm
2.	Cladding non-circularity	≤ 1.0%
3.	Attenuation Coefficient at (a) 1290 nm to 1340 nm (b) 1525 nm to 1575 nm	 < 0.36 dB/km < 0.25 dB/km
4.	Chromatic Dispersion Coefficient at (a) 310 nm (b) 1550 nm	 < 3.5 ps/nm.km < 18 ps/nm
5.	Polarization Mode Dispersion (PMD)	≤ 0.5 ps/√ km
6.	Mode Field Diameter at (a) 1310 nm (b) 1550 nm	 9.2 ± 0.4 μm 10.50 ± 1.0 μm
7.	Mode Field Concentricity Error	≤ 0.5 μm
8.	Proof Test	≥1%
9.	Fiber Curl (ROC)	≥ 4.0 m
10.	Macro-bend Test on Fiber at 1550 nm	≤ 0.1 dB

11.06.00 Cable Assembly

11.06.01 Optical Fiber Environmental Splice Enclosure

Optical fiber environmental splice joint enclosures shall be re-enterable and rack / wall mountable. The interior splice case shall be equipped to mechanically accommodate single-mode optical fibers connected by the fusion method. Splice case shall be equipped to organize the splice trays and the required service loops of buffered incoming optical fibers and outgoing 'pigtails' in such a way that allows each completed splice and associated optical fiber to be maintained in an unstrained configuration. Splice enclosure shall be dust and weather proof.

11.06.02 Fiber Optic Distribution Patch Panel

Fiber optic distribution panels shall be provided as required. The fiber optic distribution panels shall be of a standard wall mounted sheet metal enclosure type. Fiber optic distribution panels shall be equipped to secure optical fiber patch cables and pigtails to prevent damage during all operation and maintenance functions. In general splice enclosure are envisaged. However, If no optical fiber splice enclosures are implemented, than the fiber optic distribution panels shall be equipped with splice trays for storage and protection of fusion splice connections of single-mode fiber optic cable and pigtails. Each fiber optic distribution panel shall be fully equipped with 'SC' type bulk head connector sleeves or equivalent. Unused sleeve ports shall be equipped with reusable caps to prevent the intrusion of dust.

11.06.03 Pigtail and Patch Cord

All pigtails shall be factory SC-connectorized, and satisfy specified performance for optical links. All unused pigtails (including spares) shall be terminated with the connector to a bulkhead connector sleeve, protected by a reusable cap on the opposite sleeve port, to prevent the intrusion of foreign material or dust. All necessary connectorized pigtails shall be provided in the lengths required.

11.06.04 Fiber Optic Tool Kit

Fiber Optic Splicer, Terminator And Tool Kit Box

Bidder shall provide new unused tools comprise of Splicer and Fusion Jointer and tool kit comprise of cutter, stripper, polishing tool, handheld microscope, heat shrinkable sleeve, scissor, knife etc. as required for maintenance and commissioning.

11.07.00 Tests

Following minimum test as per any approved standards shall be carried out on the cables

a. Attenuation And Dispersion Characteristics Tests
b. Proof Tests
c. Macro-Bend Resistance Test
d. Mechanical Tests
e. Low And High Temperature Cable Bend Test
f. Impact Resistance Test
g. Compressive Strength Test
h. Tensile Strength Test
i. Cable Twist Test
j. Cable Cyclic Flexing Test
k. Environmental Characteristics Test
l. Temperature Cycling Test

m. Color Permanence Test Cable Aging Test

n. Water Penetration Test

o. Lightning Test

p. Routine Test / Sample Test

Site Test (Like Continuity & Attenuation)

ERECTION HARDWARE

12.00.00 ERECTION HARDWARE

This section provides the general technical guidelines for the erection materials for instruments. All erection materials shall be of good quality and conform to the operating environment of the corresponding instrument.

12.01.00 ELECTRICAL ACCESSORIES

Electrical conduit and associated materials shall conform to the requirements of the articles which follow :

a) Rigid Steel Conduit

i) Conduits up to and including 25 mm shall be of 16 SWG and conduits above 25 mm shall be of 14 SWG. Minimum size of conduits shall be 19 mm.

ii) Each piece of conduit shall be straight, free from blister and other defects and covered with capped bushing at both ends.

iii) All rigid conduit couplings and elbows shall be hot dip galvanized rigid mild steel in accordance with ANSI C 80.1 and UL6. The conduit interior and exterior surfaces shall have a continuous zinc coating with an over coat of transparent enamel or zinc chromate. Conduits shall be furnished in standard length of 3 meters, threaded at both ends.

iv) All conduit fittings shall conform to the requirements of ANSI C 80.4 and UL-514 where these standards apply.

b) Flexible Conduit

i) Flexible conduit shall be of three layer construction of very high quality of lead coated steel. Outside and inside layer shall be reinforced with heat resistant material.

ii) Lead coating outside and inside of the conduit steel surface shall provide a non-corrosive characteristic particularly in acidic atmosphere. Besides flexibility, this shall be strong enough to stay at the desired profile without support and shall be durable and strong so as to offer sufficient mechanical protection. It shall also be fully liquid dust and air tight and shall withstand a continuous hydraulic pressure up to 2 Kg/Sq. cm and temperature up to 200 °C.

c) Special Fittings

i) Conduit sealing and fittings shall be provided as required and shall be consistent with the area and equipment with which they are installed.

ii) Double locknuts shall be provided on all conduit terminations not provided with threaded lugs and couplings. Locknuts shall be designed to securely bond the conduit to the enclosure when tightened. Locknuts shall not loosen due to vibration.

12.01.01 Junction Box

01.	Type of Enclosure	:	Dust tight & weatherproof conforming to IP 65
02.	Material	:	2 mm sheet steel
03.	Type of Cover	:	Solid Hinged Door with steel handle and IP lock
04.	Paint	:	631 IS 5 Epoxy Powder Coated
05.	Mounting	:	Surface
06.	Cable Entry	:	3 mm (min) Gland plate
07.	Gasket	:	Neoprene
08.	Grounding	:	Brass earth lug with green screw head External-2 nos , Internal-1no.M6.
09.	Number of Drain Holes	:	Two at bottom capped.
10.	Identification	:	Label for JB and Tags for cable
11.	Accessories	: a)	Rail mounted cage clamp type screwless terminals with markers
		b)	Cable gland
		c)	Ferrules
		d)	Canopy at top

12.01.02 Cable Gland

01.	Type	:	Double compression
02.	Entry Thread	:	NPT
03.	Material	:	Brass
04.	Finish	:	Cadmium Plated.
05.	Protection	:	IP 65 or better

06. Accessories : Neoprene gasket, locknuts, reducers etc.

12.01.03 Cable Tray

01. Material : Mild steel

02. Thickness : not less than 2.0 mm

03. Finish : Hot dip galvanized

04. Perforation : As per MFR standard.

05. Cover : Suitable for tray

06. Height of the cable tray : 100 mm for 450mm and above width. (width cannot be less than 100 mm)

12.02.00 PROCESS HOOK UP ACCESSORIES & SPECIFICATION

Material and rating of the hook up items shall suit the piping and fluid condition. Hook up materials shall be IBR certified for applicable cases. Bidder shall furnish hook up drawings and the drawings for open racks & closed racks for Owner's approval.

12.02.01 Specification for Process Hook Up Materials

PROCESS CONNECTION PIPING

SL. NO.	SYSTEM / LINE DESCRIPTION	PIPING CLASS	IMPULSE PIPING MATERIAL	SCHEDULE (SIZE)	MATERIALS FOR FITTING / VALVE BODY	VALVE STEM MATERIAL	RATING OF PIPING / FITTINGS	PRESS. CLASS OF VALVE
01.	MAIN STEAM / UPSTREAM OF HP BYPASS AND AUXILIARY STEAM PRESSURE REDUCING VALVE	A	ASTM-A335 GR. P-91/22 (NOTE-2)	XXS (½ INCH)	ASTM-A182 Gr. F-22	ASTM-A182 Gr. F-6a	9000 LB	3000 SPL
02.	BFP DISCHARGE / SUPERHEATER ATTEMPERATOR / SPRAY TO PRDS	B	ASTM-A106 GR. C	160 (½ INCH)	ASTM-A105	ASTM-A-182 GR. F6A	6000 LB	2500
03.	REHEATER ATTEMPERATOR	C	ASTM-A106 GR. C	160 (½ INCH)	ASTM-A105	ASTM-A-182 GR. F6A	6000 LB	1500

04.	HOT REHEAT / DOWN STREAM OF AUX. STEAM PRESSURE REDUCING VALVE UPTO DESUPER-HEATER / FLASH TANK DRAIN MANIFOLD	D	ASTM-A335 GR. P-91/22 (NOTE-2)	160 (½ INCH)	ASTM-A182 GR.F-22	ASTM-A182 Gr.F-6a	3000 LB	900
05.	COLD REHEAT UPTO TEE-OFF FOR HP BYPASS / EXTRACTION STEAM NO. 5 TO HPH	E	ASTM-A335 GR. P-22	80 (½ INCH)	ASTM-A182 GR.F-22	ASTM-A-182 GR. F6A	3000 LB	800
06.	COLD REHEAT DOWN-STEAM OF TEE-OFF (HP BYPASS)	F	ASTM-A106 GR. C	80 (½ INCH)	ASTM-A105	ASTM-A-182 GR. F6A	3000 LB	800
07.	BFP SUCTION / CONDENSATE SYSTEM / EXTRACTION TO LPH / EXTRACTION-4 TO BFP-T, DEAERATOR / AUXILIARY STEAM	G	ASTM-A106 GR. B	80 (½ INCH)	ASTM-A105	ASTM-A-182 GR. F6A	3000 LB	800
08.	AIR / FLUE GAS OUTSIDE FURNACE	M	ASTM-A106 GR. B/C	80 (¾ INCH)	ASTM-A105	ASTM-A-182 GR. F6A	3000 LB	800
09.	AIR / FLUE GAS INSIDE FURNACE	N	ASTM-A335 GR. P-22	80 (¾ INCH)	ASTM-A182 GR. F-22	ASTM-A-182 GR. F6A	3000 LB	800
10.	Purge Air	–	ASTM-A106 Gr. C	80 (3/4 inch)	ASTM-A 105 Gr. F-22	SS or better	3000 lb	800
11.	DM Cooling Water	–	ASTM A312 TP 316	40 (1/2 inch)	ASTM A182 F316	SS or better	3000 lb	800
12.	CW & ACW	–	ASTM-A106 Gr. C	80 (½ inch)	ASTM-A 105	SS or better	3000 lb	800

NOTE :

(1) RATING OF PIPING / FITTINGS / VALVES ETC. IS SUBJECTED TO THE DESIGN PRESSURE & TEMPERATURE DURING THE DETAILED ENGINEERING.

(2) IN CASE TEMPERATURE IS MORE THAN 540 DEG. C, THE MATERIAL SHALL BE P-91 ONLY.

12.02.02 Seamless Stainless Steel Pipe

01.	Reference	:	ASTM A-312 TP 316
02.	Material Grade	:	TP 316
03.	Type	:	Seamless /Plain end
04.	Size	:	½" NB
05.	Schedule	:	40
06.	Standard Length	:	5 meter

12.02.03 Stainless Steel Pipe Fittings

01.	Reference	:	ASTM A-182 F 316 / ANSI B16.11
02.	Type	:	Forged
03.	Rating	:	3000 lbs / 6000 lbs / 9000 lbs
04.	Size	:	½" NB
05.	End connection	:	Generally socket weld
06.	Type of Fittings	:	Reducing coupling, male-female reducer, straight coupling, equal tee, three piece union, elbow, cap etc.

12.02.04 Seamless Stainless Steel Tube

01.	Reference	:	ASTM A-213 TP 316
02.	Material Grade	:	TP 316
03.	Size	:	½" OD X 2.1 MM Thick
04.	Type	:	Cold drawn annealed, pickled, passivated, de-scaled, ,hydraulically cleaned seamless tube.
05.	Properties	:	The tube shall be free from scratches and suitable for bending and capable of being flared by hardened and tapered steel pin. The expanded tube shall show no crack or rupture. Hardness shall be RB 80.
06.	Test Pressure	:	400 Kg/Sq. cm (minimum)
07.	Tolerance	:	± 0.13 mm for outside diameter ± 15 % for wall thickness

	08.	Standard Length	:	5 meter
	09.	Test	:	Flare, Hardness, Ball and Bubble Test

12.02.05 Stainless Steel Tube Fittings

	01.	Reference	:	ASTM-A-182
	02.	Type	:	Double ferrule double compression
	03.	Material	:	316 Stainless steel forged
	04.	Ferrule	:	316 Stainless Steel
	05.	Type of Fittings	:	Male / female connector, elbow, cross /equal tee, straight connector, bulkhead union, ferrule etc. as required to suit installation.
	06.	Size	:	To suit SS tubing and NPT end connection

12.02.06 C.S. Pipe

	01.	Reference	:	ASTM-A 106 Gr. C
	02.	Material	:	Cold drawn seamless black C.S.
	03.	Type	:	Seamless / Plain ends
	04.	Size	:	½" NB
	05.	Schedule	:	80, 160, XXS as required
	06.	Standard Length	:	5 meter

12.02.07 C.S. Pipe Fittings

	01.	Reference	:	ASTM-A 105 / ANSI B16.11
	02.	Type	:	Forged
	03.	Rating	:	3000 lbs / 6000 lbs / 9000 lbs
	04.	Size	:	½" NB
	05.	End connection	:	Generally socket weld
	06.	Type of Fittings	:	Reducing coupling, male-female reducer, straight coupling, equal tee, three piece union, elbow, cap etc.

12.02.08 A.S. Pipe

01.	Reference	:	ASTM-A 335 P22 AS PER ANSI B 36.10
02.	Material	:	Cold drawn seamless A.S.
03.	Type	:	Seamless / Plain ends
04.	Size	:	½" NB
05.	Schedule	:	XXS
06.	Standard Length	:	5 meter

12.02.09 A.S. Pipe Fittings

01.	Reference	:	ASTM-A 182 F22 AS PER ANSI B 16.11
02.	Type	:	Forged
03.	Rating	:	9000 lbs
04.	Size	:	½" NB
05.	End connection	:	Generally socket weld
06.	Type of Fittings	:	Reducing coupling, male-female reducer, straight coupling, equal tee, three piece union, elbow, cap etc.

12.02.10 Carbon Steel Globe Valve

01.	Reference	:	ASTM A-105
02.	Type	:	Globe
03.	Construction	:	Forged Body Cadmium Plated
04.	End Connection	:	½" Socket Weld
05.	Rating	:	Cl. 800 / CL. 2500
06.	Material	:	Body - Carbon steel Stem - Hardened Steel Plug - AISI 316 SS Seat- Stainless steel stellited
07.	Packing	:	Teflon / Grafoil as required

	08.	Yoke	:	ASTM A105
	09.	Handwheel	:	Carbon steel
	10.	Design standard	:	As per ANSI B 16.34

12.02.11 Stainless Steel Globe Valve

	01.	Reference	:	ASTM A-182 F316
	02.	Type	:	Globe
	03.	Construction	:	Forged Body
	04.	End Connection	:	Socket Weld
	05.	Proof Pressure	:	400 Kg/Cm2
	06.	Material	:	Body - Stainless steel Stem - Hardened Steel Plug - AISI 316 SS Seat- Stainless steel stellited
	07.	Packing	:	Teflon as required
	08.	Yoke	:	ASTM A182 F316
	09.	Handwheel	:	Carbon steel
	10.	Design standard	:	As per ANSI B 16.34

12.02.12 Alloy Steel Globe Valve

	01.	Reference	:	ASTM A-182 F22
	02.	Type	:	Globe
	03.	Construction	:	Forged Body
	04.	End Connection	:	½” Socket Weld
	05.	Rating	:	CL. 2500
	06.	Material	:	Body - Alloy steel Stem - Hardened Steel Plug - AISI 316 SS Seat- Stainless steel stellited

	07.	Packing	:	Grafoil as required
	08.	Yoke	:	ASTM A182 F22
	09.	Handwheel	:	Carbon steel
	10.	Design standard	:	As per ANSI B 16.34

12.02.13 Condensate Pot

	01.	Reference	:	ASTM A182 F22 /ASTM A105
	02.	Material	:	Alloy steel / carbon steel as per application
	03.	Construction	:	Drilled from barstock
	04.	End connection	:	3 nos. ½" socket weld end
	05.	Accessories	:	Vent valves

12.02.14 Instrument Valve Manifold

	01.	Type	:	a) Two valve manifold b) Five valve manifold
	02	Mounting	:	Remote 2" Pipe Mounting
	03.	Construction	:	Single block (bar stock)
	04.	Material	:	Forged body and bonnet AISI 316 stainless steel
	05.	Ports	:	1/2 " NPT (F)
	06.	Rating	:	420 Kg/Sq. cm at ambient
	07.	Operating Temperature	:	(-) 30 to (+) 170 Deg C
	08.	Packing	:	PTFE Wafer
	09.	Seat & Stem	:	AISI 316 SS
	10.	Plug	:	AISI 316 SS free to turn on stem / 17-4 PH
	11.	Handle Bar	:	AISI 316 SS
	12.	Connection	:	Straight
	13.	Accessories	:	i) Plugs for all ports

ii) Mounting Bracket , bolts , nuts

12.03.00 PNEUMATIC HOOK UP ACCESSORIES

12.03.01 Air Header

Technical Particulars :

			For Panel	For Field
01.	Material of Construction	:	Stainless steel	Stainless steel
02.	Inlet Connection	:	2" NPT (M)	1" NPT (M)
03.	Header Take-off	:	Stainless steel	Stainless steel
04.	Take off connection	:	1 / 2” NPT (M)	1/ 2” NPT (M)
05.	Take-off Valves	:	stainless steel	stainless steel
06.	Tube Take-off	:	Tube adapter on valve	Tube adapter on valve
07.	Drain	:	SS drain valve at lowest point	SS drain valves at lowest point

12.03.02 Seamless Stainless Steel Tube

01.	Reference	:	ASTM A-269 TP 31605
02.	Material Grade	:	TP 316
03.	Size	:	¼” OD X 0.049” wall thickness
04.	Type	:	Cold drawn annealed, pickled, passivated, de-scaled, ,hydraulically cleaned seamless tube.
05.	Properties	:	The tube shall be free from scratches and suitable for bending and capable of being flared by hardened and tapered steel pin. The expanded tube shall show no crack or rupture. Hardness shall be RB 80.
06.	Test Pressure	:	400 Kg/Sq. cm
07.	Tolerance	:	± 0.13 mm for outside diameter ± 15 % for wall thickness
08.	Standard Length	:	5 meter

09. Test : Flare, Hardness, Ball and Bubble Test

QUALITY ASSURANCE

SECTION-VIII

QUALITY ASSURANCE REQUIREMENTS

1.00.00 QUALITY ASSURANCE PROGRAMME

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

a) His organisation structure for the management and implementation of the proposed quality assurance programme.

b) Documentation control system.

c) Qualification data for Bidder's key personnel.

d) The procedure for purchase of materials, parts, components and selection of Sub-Vendor's services including vendor analysis, source inspection, incoming raw-material inspection, verification of materials purchased etc.

e) System for shop manufacturing and site erection control including process controls and fabrication and assembly controls.

f) Control of non-conforming items and system for corrective actions.

g) Inspection and test procedure both for manufacture and all site related works.

h) Control of calibration and testing of measuring and testing equipments.

i) System for quality audit.

j) System for indication and appraisal of inspection status.

k) System for authorising release of manufactured product to the Owner.

l) System for handling storage and delivery.

m) System for maintenance of records.

n) Furnishing of quality plans for manufacturing and field activities detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of equipment/component as per format enclosed at Annexure-A to this section.

2.00.00 **GENERAL REQUIREMENTS - QUALITY ASSURANCE**

2.01.00 All materials, components and equipment covered under this specification shall be procured, manufactured and tested at all the stages, as well as Services provided for erection, commissioning and testing shall be as per a comprehensive Quality Assurance Programme. An indicative programme of inspection/tests to be carried out by the Bidder for some of the major items is given in the respective technical specification. This is however, not intended to form a comprehensive programme as it is the Bidder's responsibility to draw up and implement such programme and reviewed by by the Owner/Consultant. The detailed Quality Plans for manufacturing and field activities should be drawn up by the Bidder, separately in the format attached at Annexure-I and will be submitted to Owner/Owner's representative for review. Schedule of finalisation of such quality plans will be finalised before award.

2.02.00 Manufacturing Quality Plan will detail out for all the components and equipment, various tests/inspection, to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by Bidder's Quality Control organisation, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing.

2.03.00 Field Quality Plans will detail out for all the equipment, the quality practices and procedures etc. to be followed by the Bidder's site Quality Control organisation, during various stages of site activities from receipt of materials/equipment at site.

2.04.00 The Bidder shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans along with Quality Plans. These Quality plans and reference documents/standards etc. will be subject to Consultant's approval without which manufacture shall not proceed. In these approved quality plans, Owner/Authorised representative/Consultant shall identify Customer Hold Points (CHP), test/checks which shall be carried out in presence of the Owner/Consultant/Owners Owner's Engineer or his Authorised Representative and beyond which the work will not proceed without consent of Owner/Authorised representative/Consultant in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to Owner/Authorised Representative/Consultant for acceptance and dispositioning.

2.05.00 The Bidder shall provide adequate notice to the Owner for inspection before the material is dispatched as per the provisions of the Contract. No material shall be despatched from the manufacturer's works before the same is accepted subsequent to pre-despatch final inspection including verification of records of

all previous tests/inspections by Owner's Owner's Engineer/Authorised representative, and duly authorised for despatch issuance of Material Despatch Clearance Certificate (MDCC).

2.06.00 All materials used or supplied shall be accompanied by valid and approved materials certificates and tests and inspection report. These certificates and reports shall indicate the sheet numbers or other such acceptable identification numbers of the material. The material certified shall also have the identification details stamped on it.

2.07.00 All the individual and assembled rotating parts shall be statically and dynamically balanced in the works.

Where accurate alignment is necessary for component parts of machinery normally assembled on site, the Bidder shall allow for trial assembly prior to despatch from place of manufacture.

2.08.00 Castings and forgings used for construction shall be of tested quality. Details of results of chemical analysis, heat treatment record, mechanical property test results shall be furnished.

2.09.00 All welding and brazing shall be carried out as per procedure drawn and qualified in accordance with requirements of ASME Section-IX/BS-4870 or other International equivalent standard acceptable to the Owner.

All brazers, welders etc. employed on any part of the contract at Bidder's/Sub-Vendor's works or at site shall be qualified as per ASME Section-IX or BS-4871 or equivalent international standard approved by the Owner. Such qualification tests shall be conducted in presence of Owner/his authorised representative.

For welding of pressure parts and high pressure piping the requirements of IBR shall also be complied with.

Under no circumstances any repair or welding of castings be carried out without the consent of the Owner. Proof of the effectiveness of each repair by radiographic and/or other non-destructive testing technique, shall be provided to the Owner.

All pressure parts shall be subjected to hydraulic testing as per the requirements of IBR. Other parts shall be tested for one and half times the maximum operating pressure, for a period not less than thirty (30) minutes.

2.10.00 All non-destructive examination (NDT) shall be carried out in accordance with approved international standard. The NDT operator shall be qualified as per SNT-TC-IA (of American Society of non- destructive examination). Results of NDT shall be properly recorded and submitted for acceptance.

All welding procedures adopted for performing welding work shall be qualified in accordance with the requirements of Section-IX of ASME code or IBR as applicable. All welded joints for pressure parts shall be tested by liquid

penetrant examination according to the method outlined in ASME Boiler and Pressure Vessel code. Radiography, magnetic particle examination and ultrasonic testing shall be employed wherever necessary/ recommended by the applicable code. At least 10% of all major butt welding joints shall be radiographed. Statutory payments in respect of IBR approvals including inspection shall be made by Bidder. Bidder's scope and responsibility shall also include preparation and submission of all necessary documents in the specific formats and manner stipulated by the statutory bodies, coordination and follow up for above approvals.

2.11.00 All the Sub-Vendors proposed by the Bidder for procurement of major bought out items including castings, forgings, semi-finished and finished components/equipment list of which shall be drawn up by the Bidder and finalised with the Owner shall be subject to Owner's review. Quality Plans of the successful Sub-Vendors shall be discussed, finalised and accepted by the Owner/Authorised representative and form part of the Purchase Order between the Bidder and the Sub-Vendor.

2.12.00 All the purchase specifications for the major bought-out items, list of which shall be drawn up by the Bidder and finalised with the Owner shall be furnished to the Owner for comments and subsequent acceptance before orders are placed.

Owner reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the Bidder's or their Sub-Vendor's quality management and control activities. The Bidder shall provide all necessary assistance to enable the Owner carry out such audit and surveillance.

Quality audit/acceptance of the results of tests and inspection will not prejudice the right of the Owner to reject equipment not giving the desired performance after erection and shall not in no way limit the liabilities and responsibilities of the Bidder in earning satisfactory performance of equipment as per specification.

2.13.00 Quality requirements for main equipment shall equally apply for spares and replacement items.

2.14.00 Repair/rectification procedures to be adopted to make any job acceptable shall be subject to the acceptance of the Owner.

2.15.00 For quality assurance of all civil works refer to the specifications for civil works.

3.00.00 QUALITY ASSURANCE DOCUMENTS

3.01.00 The Bidder shall be required to submit two (2) copies and two (2) sets of microfilms of the following Quality Assurance documents within three (3) weeks after despatch of the equipment:

a) Material mill test reports on components as specified by the specification.

b) The inspection plan with verification, inspection plan check points, verification sketches, if used and methods used to verify that the inspection and testing points in the inspection plan were performed satisfactorily.

c) Non-destructive examination results /reports including radiography interpretation reports.

d) Factory tests results for testing required as per applicable codes and standards referred in the specification.

e) Welder identification list listing welder's and welding operator's qualification procedure and welding identification symbols.

f) Sketches and drawings used for indicating the method of traceability of the radiographs to the location on the equipment.

g) Stress relief time temperature charts.

h) Inspection reports duly signed by QA personnel of the Owner and Bidder for the agreed inspection hold points. During the course of inspection, the following will also be recorded :

i) When some important repair work is involved to make the job acceptable.

ii) The repair work remains part of the accepted product quality.

i) Letter of conformity certifying that the requirement is in compliance with finalised specification requirements.

4.00.00 **INSPECTION, TESTING AND INSPECTION CERTIFICATES**

4.01.00 The Successful Bidder shall give the Owner’s Engineer/Inspector fifteen (15) days written notice of any material being ready for testing. Such tests shall be to the Successful Bidder's account except for the expenses of the Inspector. The Owner’s Engineer/Inspector, unless the witnessing of the tests is virtually waived, will attend such tests within fifteen (15) days of the date on which the equipment is notified as being ready for test/inspection failing which the Successful Bidder may proceed with test which shall be deemed to have been made in the Inspector's presence and he shall forthwith forward to the Inspector duly certified copies of test reports in six (6) copies.

4.02.00 The Owner’s Engineer or Inspector shall within fifteen (15) days from the date of Inspection as defined herein give notice in writing to the Successful Bidder, or any objection to any drawings and all or any equipment and workmanship which is in his opinion not in accordance with the contract. The Successful Bidder shall give due consideration to such objections and shall either make modifications that may be necessary to meet the said objections or shall confirm in writing to the Owner’s Engineer/Inspector giving reasons therein, that no modifications are necessary to comply with the contract.

4.03.00 When the factory tests have been completed at the Bidder's or sub-Vendor's works, the Owner/Inspector shall issue a certificate to this effect fifteen (15) days after completion of tests but if the tests are not witnessed by the Owner/ Inspectors, the certificate shall be issued within fifteen (15) days of the receipt of the Bidder's test certificate by the Owner/Inspector. Failure of the Owner/Inspector to issue such a certificate shall not prevent the Bidder from proceeding with the works. The completion of these tests, or the issue of the certificates shall not bind the Owner to accept the equipment should it, on further tests after erection be found not to comply with the contract.

4.04.00 The Bidder shall furnish quarterly inspection programme indicating schedule dates of inspection at customer hold point and final inspection stages. Updated quarterly inspection plans will be made for each three consecutive months and shall be furnished before beginning of each calendar month.

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QUALITY PLAN FOR CONTROL VALVE (PNEUMATIC)

QUALITY PLAN NO.:	**PE-QP-445-145-I 006**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 04.06.2021
SHEET	1 OF 6

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $ P	Agency $ W	Agency $ V	Remarks
1.0	**MATERIAL**											
1.1	Body & Bonnet casting / forgings, plug, valve stem, seat ring/cage	1. Physical, Chemical properties	MA	Physical, Chemical tests	One/ Heat(HT Batch)	Approved drg. / data sheet	Approved drg. / data sheet	Test Certificate	3	---	2,1	TC for body/bonnet from foundry only
		2. Heat Treatment	MA	Review of H.T. Chart	Each H.T.	Approved drg. / data sheet	Approved drg. / data sheet	Test Certificate	3/2	2	1	1.IBR Certification (if applicable) to be verified by BHEL. 2.Applicable for body /bonnet only
		3. Internal quality of castings	MA	RT for Body & UT for Bonnet	100%	ASME B 16.34	ASME B 16.34	Test Report / FILM	3/2	2	1	Applicable for Body and Bonnet for rating ANSI 900 and above.
		4. Surface Quality	MA	1. Visual	100%	ANSI/ MSS-SP-55	ANSI/ MSS-SP-55	Test Certificate	3/2	---	2	
				2. MT/PT	100%	ASME B 16.34	ASME B 16.34	Test Certificate	3	2	1	After Machining on machined surface only
		5. Pressure test for shell	MA	Hyd. Test	100%	ISA-S-75.19/ ASME B 16.34	ISA-S-75.19/ ASME B 16.34	Test Certificate	2	2	1	For Body & Bonnet after machining

LEGEND: * CR - Critical characteristics; MA - Major characteristics; MI - Minor characteristics
RT- Radiographic Test; UT – Ultrasonic Test; PT – Dye penetrant Test; MT- Magnetic Test
$ P - Agency Performing the Test.; W - Agency Witnessing the Test.; V - Agency Verifying the Test.
1 - BHEL; 2 - Vendor; 3 - Sub-vendor; 4 - WBPDCL

1

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QUALITY PLAN FOR CONTROL VALVE (PNEUMATIC)

QUALITY PLAN NO.:	**PE-QP-445-145-I 006**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 04.06.2021
SHEET	2 OF 6

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $ P	Agency $ W	Agency $ V	Remarks
1.2	Diaphragm	1. Surface Quality	MA	Visual	100%	Mfr. standard	Mfr. standard	Test Certificate	3/2	---	2	
		2. Hardness	MA	Measurement	100%	Mfr. standard	Mfr. standard	Test Certificate	3/2	---	2	
		3. Endurance / Life cycle	MA	Cyclic test 10,000 cycles	One / Type	10,000 cycles/ Mfr. standard.	No damage	Test Certificate	3/2	---	2,1	
1.3	Spring	1. Composition	MA	Chemical-Analysis	One sample/ Heat	Material spec. / Mfr. standard	Material spec. / Mfr. standard	Test Certificate	3	---	2	
		2. Mech. Properties	MA	Mech. Test	One sample/ Heat	Material spec. / Mfr. standard	Material spec. / Mfr. standard	Test Certificate	3	---	2	
		3. Performance	MA	1. Stiffness ratio	100%	Material spec. / Mfr. standard	Material spec. / Mfr. standard	Test Certificate	3	---	2	
				2. Scragging	100%	Material spec. / Mfr. standard	Material spec. / Mfr. standard	Test Certificate	3	---	2	
				3. Cyclic test (Endurance)	One / type	10,000 cycles	Material spec. / Mfr. standard	Test Certificate	3	---	2,1	
				4. Dimension (Measurement)	One sample/ Lot	Mfr. standard	Mfr. standard	Record	3	---	2	
1.4	Electrical items [Limit switches, Solenoids, Position Transmitter(if provided externally)]	1. Routine Test	MA	HV, IR, Continuity function	100%	Relevant Standards	Relevant Standards	---	3	---	2	Certificate of Conformance (C.O.C)
		2. Degree of protection	MA	IP/NEMA Tests	One sample / type	Approved Data sheet	Approved Data sheet	---	3	---	2,1	C.O.C

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1

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QUALITY PLAN FOR CONTROL VALVE (PNEUMATIC)

QUALITY PLAN NO.:	**PE-QP-445-145-I 006**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 04.06.2021
SHEET	3 OF 6

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
1.5	Pressure Gauges (if provided externally)	1. Performance	MA	Review of calibration certificates	100%	Mfr. Standard	Mfr. Standard	---	3	---	2	C.O.C
		2. Marking	MA	Visual	100%	Mfr. standard	Mfr. standard	---	3	---	2	C.O.C
2.0	**IN PROCESS INSPECTION**											
2.1	After machining, i. Body ii. Bonnet iii. Plug iv. Valve Stem v. seat ring/cage	1. Surface flaws	MA	Visual & MT/PT	100% (on accessible surfaces)	ASME B 16.34	ASME B 16.34	Test Records	2	---	1	Butt weld ends shall be included.
		2. Dimensional checks	MA	Measurement	100%	Mfr. Standard	Mfr. Standard	Records	2	---	1	
		3. Hard facing (wherever applicable)	MA	Hardness Measurement	One sample/Lot	Mfr. Standard	Mfr. Standard	Records	2	---	1	
3.0	**TESTS ON COMPLETED VALVE**											
3.1	Actuator Chamber	Leakage & Strength	MA	Pneumatic test	100%	Mfr. Standard	No Leakage	Test Certificate	2	1	1,4	Refer Note-4
3.2	Body	Leakage and Pressure test (Body Mount Leakage)	MA	Hydro test	100%	ISA - S-75.19/ ASME B16.34	No Leakage	Test Certificate	2	1	1,4	Refer Note-4
3.3	Seat leakage test for completed valve	Seat Leakage	MA	Pneumatic Test	100%	FCI-70.2	FCI-70.2	Test Certificate	2	1	1,4	Refer Note-4
4.0	**OPERATION TEST ON COMPLETED VALVE (Final inspection)**	1. Valve Travel	MA	Measurement	100%	Mfr. Procedure	Approved drg. / data sheet	Test Report	2	1	1,4	Refer Note-4
		2. Opening/Closing time	MA	Measurement	100%	Mfr. Procedure	Approved drg. / data sheet	Test Report	2	1	1,4	Refer Note-4
		3. Linearity/cam characteristic	MA	Measurement	100%	Mfr. Procedure	Approved drg. / data sheet	Test Report	2	1	1,4	Refer Note-4

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PEM :: C&I

QUALITY PLAN FOR CONTROL VALVE (PNEUMATIC)

QUALITY PLAN NO.:	**PE-QP-445-145-I 006**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 04.06.2021
SHEET	4 OF 6

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $ P	Agency $ W	Agency $ V	Remarks
		4. Repeatability	MA	Measurement	100%	Mfr. Procedure	Approved drg. / data sheet	Test Report	2	1	1,4	Refer Note-4
		5. Hysteresis	MA	Measurement	100%	Mfr. Procedure	Approved drg. / data sheet	Test Report	2	1	1,4	Refer Note-4
		6. Sensitivity	MA	Measurement	100%	Mfr. Procedure	Approved drg. / data sheet	Test Report	2	1	1,4	Refer Note-4
		7. Accuracy (Overall)	MA	Measurement	100%	Mfr. Procedure	Approved drg. / data sheet	Test Report	2	1	1,4	Refer Note-4
		8. Control Valve characteristics / CV Test	MA	♦Measurement (Press. vs. discharge and discharge vs. opening 0-100% in steps of 10%)	One per type	Mfr. Procedure	Approved drg. / data sheet	Test Certificate	2	--	1,4	♦Size = Body & port size Or Body size & CV for non std port. Refer Note 1.
		9. Operation of limit switch & solenoids and other accessories	MA	Function	100%	Mfr. Procedure	Approved drg. / data sheet	Test Report	2	1	1,4	On assembled valve Refer Note-4
		10. Overall dimensions	MI	Visual and dimensional	100%	Approved drg. / data sheet	Approved drg. / data sheet	Records	2	1	1,4	Refer Note-4
		11. Pre defined valve position in case of air failure	MA	Visual	100%	Approved drg. / data sheet	Approved drg. / data sheet	Test Certificate	2	1	1,4	1
		12. Cleanliness, painting, stamping (for direction of flow), Tag No.	MA	Visual and dimensional, paint thickness	100%	Mfr. Procedure	Approved drg. / data sheet	Test Certificate	2	1	1,4	
		13. Surface Quality	MA	Visual	100%	ANSI/ MSS-SP-55	ANSI/ MSS-SP-55	Test Certificate	3/2	--	2,1, 4	

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QUALITY PLAN FOR CONTROL VALVE (PNEUMATIC)

QUALITY PLAN NO.:	**PE-QP-445-145-I 006**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 04.06.2021
SHEET	5 OF 6

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $ P	Agency $ W	Agency $ V	Remarks
5.0	**AUXILIARY ITEMS (Performance test of auxiliary items shall be performed on the completely assembled valve)**											
5.1	Positioner	Overall leakage after assembly including Nozzles leakage	MA	Leak Test (in the steady state input signal)	100 %	Mfr. Standard	No leakage	---	3/2	---	---	Certificate of Conformance (C.O.C)
5.2	Air filter regulator	1. Normal air consumption	MA	Measurement	Each type	Mfr. Standard	No leakage	---	3/2	---	---	(C.O.C)
		2. Overall leakage	MA	Visual (soap solution)	100 %	Mfr. Standard	No leakage	---	3/2	---	---	(C.O.C)
5.3	Air lock relay	Performance Test	MA	Leakage test	100%	Mfr. Standard	No leakage	---	3/2	---	---	(C.O.C)
5.4	Electronic position transmitter(not applicable if provided integral to smart positioner)	1. Accuracy	MA	Operation	100%	Approved data sheet /	Approved data sheet /	---	2	1	---	(C.O.C)
5.5	Current to Pneumatic converter(not applicable for smart positioner)	1. Physical Verification Make/Model	MA	Visual	100%	Approved drg. / data sheet	Approved drg. / data sheet	---	2	---	---	(C.O.C)
		2. Degree of Protection	MA	IP/NEMA test	Each type	Relevant Standard	Relevant Standard	---	3	---	---	(C.O.C)
		3. Linearity	CR	Measurement	100%	Approved drg. / data sheet /	Approved drg. / data sheet /	---	2	---	---	(C.O.C)
		4. Hysterisis	CR	Measurement	100%	Approved drg. / data sheet /	Approved drg. / data sheet /	---	2	---	---	(C.O.C)

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1

PEM :: C&I

QUALITY PLAN FOR CONTROL VALVE (PNEUMATIC)

QUALITY PLAN NO.:	**PE-QP-445-145-I 006**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 04.06.2021
SHEET	6 OF 6

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
5.6	Smart Positioner (As Applicable)	1. Physical Verification Make/Model	MA	Visual	100%	Approved drg. / data sheet	Approved drg. / data sheet	---	2	---	---	(C.O.C)
		2. Degree of Protection	MA	IP/NEMA test	Each type	Relevant Standard	Relevant Standard	---	3	---	---	(C.O.C)
		3. Linearity	CR	Measurement	100%	Approved drg. / data sheet /	Approved drg. / data sheet /	---	2	---	---	(C.O.C)
		4. Hysterisis	CR	Measurement	100%	Approved drg. / data sheet /	Approved drg. / data sheet /	---	2	---	---	(C.O.C)
		5. Calibration with Hand Held Communicator	MA	Measurement	Each type	Mfr. Standard	Mfr. Standard	---	2	---	---	(C.O.C)
6.0	**PAINTING**	Soundness of Painting	MA	Visual and Measurement	100%	Mfr. Standard	Mfr. Standard	Inspection Report	2	---	---	Refer Note-2
7.0	**PACKING**	Soundness of Packing against transit damage	MA	Visual	100%	Mfr. Standard	Mfr. Standard	Inspection Report	2	---	---	Refer Note-3

NOTES:

1. In case valid CV test certificate for a similar control valve(same size, same CV, same trim characteristics) is not submitted to BHEL by the vendor, CV test shall be conducted at FCRI/Any govt. approved laboratory/ BHEL approved Laboratory.
2. In the absence of BHEL spec. for painting, vendor to obtain BHEL's approval on their painting specification / procedure.
3. Sea worthy packing shall be provided, if called for in the Data sheets.
4. The quantum of check shall be 100% for manufacturer and 10% for BHEL/BHEL nominated inspection agency.
5. IBR certificates in Form III-C shall be submitted if called for in the specification/datasheet.
6. Copies of all TC's(Test Certificates) for materials duly correlated with Heat Nos., TC's for electrical items and mechanical tests(Leak/Operation), C.O.C's(Certificates of Conformance) shall be submitted to BHEL for verification and acceptance.

LEGEND: * CR - Critical characteristics; MA - Major characteristics; MI - Minor characteristics
RT- Radiographic Test; UT – Ultrasonic Test
PT – Dye penetrant Test; MT- Magnetic Test
$ P - Agency Performing the Test.; W - Agency Witnessing the Test.; V - Agency Verifying the Test.
1 - BHEL; 2 - Vendor; 3 - Sub-vendor; 4 - WBPDCL

PEM :: C&I

QUALITY PLAN
FOR
FLOW ORIFICE PLATE ASSEMBLY

QUALITY PLAN NO.:	**PE-QP-445-145-I005**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 04.06.2021
SHEET	5 OF 6

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $ P	Agency $ W	Agency $ V	Remarks
1.0	**MATERIAL**											
1.1	Orifice Plate	1. Physical, Chemical properties	MA	Physical, Chemical Tests	One / Plate OR One/ Heat	AP / DS / SP	AP / DS / SP	Lab Report	3/2	---	2,1	IBR certification (if applicable) to be verified by BHEL
		2. Dimensions	MA	Measurement	100%	AP	AP	IR	3/2		1	
1.2	**Flanges** A. Forgings	Chemical,Mech Properties, UT & Heat Treatment	MA	Chem & Mech UT test	Sample	Material Spec as per ASTM A 388 for UT	ANSI B 16.34	MTC,UT cert,HT cert	3/2	---	1	
	B. Machining	Dimensions	MA	Measurement	100 %	AP / DS	AP / DS	IR	3/2	----	1	
2.0	**IN PROCESS** Machine	1. Dimension	MA	Measurement	100%	AP	AP	IR	3/2	2	2	
		2. Surface finish	MA	Visual	100%	IS ARP 3.2	Mirror Finish	-------	3/2	2	---	
		3. Surface flaw on machined surface	MA	Penetrant test	100%	ASTM 165 / IS:3658	No surface flaw	IR / TC	3/2	2	1	
3.0	**ASSEMBLY and FINAL INSPECTION**	1. Overall dimensions	MA	Measurement	100%	AP	AP	IR	3/2	2,1	----	
		2. Marking, Tag no. Direction of flow	MA	Visual	100%	AP / DS	AP / DS	IR	3/2	2	1	
		3. Calibration	MA	Performance Test	One per type	AP / DS	SP	TC	3/2	----	1	
		4. Painting	MA	Visual	100%	SP / MS	SP / MS	IR / MR	3/2	----	1	
		5. Root valve BOQ (if applicable in vendor scope)	MA	Measurement	100%	AP / DS	AP / DS	IR	2	----	1	

1

LEGEND: * CR - Critical characteristics; MA - Major characteristics; MI - Minor characteristics
IR - Inspection Reports; TC - Test Certificates; AP – Approved Drawings/doc; DS – Data Sheet; SP – Tech. Spec.
MR- Manufacturer records; MS- Manufacturer standards
$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.
1 - BHEL; 2 - Vendor; 3 - Sub-vendor

PEM :: C&I	QUALITY PLAN FOR FLOW ORIFICE PLATE ASSEMBLY	QUALITY PLAN NO.: **PE-QP-445-145-I005**
		VOLUME IIB
		SECTION D
		REV. NO. 01 DATE: 04.06.2021
		SHEET 6 OF 6

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
4.0	**PACKING**	Soundness of Packing against transit damage	MA	Visual	100%	SP / MS	SP / MS	----	3/2	----	----	Refer Note 4

NOTE:

1. All test reports & dimension reports shall be verified by BHEL wherever verification is by BHEL at the time of Final Inspection. Positive material identification testing (One per type) shall be performed by vendor and the same shall be witnessed by BHEL at the time of final inspection.
2. Minimum 2 coats of primer paint to be applied before dispatch.
3. CALIBRATION Test to be carried out at IIT-DELHI / FCRI or BHEL approved laboratory.
4. Sea worthy packing shall be provided, if called for in the Data sheets.

LEGEND: * CR - Critical characteristics; MA - Major characteristics; MI - Minor characteristics; IR - Inspection Reports; TC - Test Certificates; AP – Approved Drawings/doc; DS – Data Sheet; SP – Tech. Spec.; MR- Manufacturer records; MS- Manufacturer standards; $ P - Agency Performing the Test.; W - Agency Witnessing the Test.; V - Agency Verifying the Test.; 1 - BHEL; 2 - Vendor; 3 - Sub-vendor

PEM :: C&I

QUALITY PLAN
FOR
ULTRASONIC FLOWMETER

QUALITY PLAN NO.:	**PE-QP-445-145-I011**
VOLUME	IIB
SECTION	D
REV. NO.	02 DATE: 25.05.21
SHEET	2 OF 3

Sl. No.	Component / operation	Characteristics Checked	Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
1 1.0	Electronic Housing	Chemical Property	Major	Visual	100%	Approved drg/ Data sheet	Technical catalogue/ Approved documents	Technical catalogue/ Approved documents	2	---	1	
2.0	Standard Certificates	Certificate of Compliance, Warranty Certificate	Major	Visual	As applicable	Technical documents/ Approved documents	Technical catalogue/ Approved documents	Technical catalogue/ Approved documents	2	---	2,1	
3.0	Visual Check	Mechanical	Major	Visual	100%	Technical catalogue/ Approved documents	Technical catalogue/ Approved documents	Technical catalogue/ Approved documents	2	1	1	
1 4.0	Complete assembly	Overall dimension and end connection	Major	Measurement	100%	Approved drg/ Data sheet	Technical catalogue/ Approved documents	Inspection Report	2	2	1	
		Marking-Tag No, direction of flow	Minor	Visual	100%	Approved drg/ Data sheet	Technical catalogue/ Approved documents	Inspection Report	2	2	1	
5.0	Function test & power ON	Electrical	Major	Visual	100%	Functional test report for meter & transducer	Approved documents	Technical catalogue/ Approved documents	2	---	1	
6.0	HART Communication	Electrical	Major	---	100%	Technical catalogue/ Approved documents	Technical catalogue/ Approved documents	Technical catalogue/ Approved documents	--	---	1	

LEGEND:

$ P - Agency Performing the Test.
W - Agency Witnessing the Test.
V - Agency Verifying the Test.

1 - BHEL
2 - Vendor/Sub-vendor

1

PEM :: C&I

QUALITY PLAN
FOR
ULTRASONIC FLOWMETER

QUALITY PLAN NO.:	**PE-QP-445-145-I011**
VOLUME	IIB
SECTION	D
REV. NO.	02 DATE: 25.05.21
SHEET	3 OF 3

Sl. No.	Component / operation	Characteristics Checked	Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
1	7.0	PACKING & DISPATCH	Soundness of Packing against transit damage	Major	Visual	100%	Manufacturer Standard	Technical catalogue/ Manufacturer Standard		2	1	---	

NOTE:

1. Protection class shall be IP-65 or better or as per approved datasheet.
2. Type test certificates/Type test reports for “Protection class” & “Accuracy” shall be verified by BHEL.
3. CALIBRATION Test to be carried out at NABL or BHEL approved laboratory.
4. All test reports / test certificates shall be submitted to WBPDCL for information.

LEGEND:

$ P - Agency Performing the Test.
W - Agency Witnessing the Test.
V - Agency Verifying the Test.

1 - BHEL
2 - Vendor/Sub-vendor

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR FLOW SWITCH

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	100%	APPROVED SPEC./ DATA SHEETS	P	W	V	
	TYPE						
	RANGE						
	MODEL / TAG No.						
	END CONNECTION						
	DIMENSIONS						
	SIZE						
2	ACCURACY & REPEATABILITY (WET CALIBRATION)	100%		P	W	V	
3	HV / IR	100%		P	W	V	
4	CONTACT RATING / No. OF CONTACTS	RANDOM		P	W	V	
5	MATERIAL TC FOR BODY, WET PARTS, SENSING ELEMENT	ONE / LOT		P	W	V	
6	ACCESSORIES AS APPLICABLE	100%		P	W	V	
7	DEGREE OF PROTECTION	ONE / LOT		P	W	V	
8	OVER PRESSURE TEST	100%		P	W	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out routine test for 100%
4. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR TEMPERATURE SWITCH

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	100%	APPROVED SPEC./ DATA SHEETS	P	W	V	
	TYPE						
	MODEL/TAG NO.						
	RANGE/SCALE						
	END CONNECTION						
2	DIMENSIONS CHECK	100%		P	W	V	
3	ACCURACY	100%		P	W	V	
4	SWITCHING DIFFERENTIAL	100%		P	W	V	
5	CONTACT RATING / No. OF CONTACTS	RANDOM		P	W	V	
6	MATERIAL TC FOR BULB, CAPILLARY, ARMOUR	ONE / LOT		P	V	V	
7	HV / IR	RANDOM		P	W	V	
8	DEGREE OF PROTECTION	TYPE TEST		P	V	V	
9	THERMOWELLS						
	DIMENSIONS,PROCESS CONN	100%		P	W	V	
	MATERIAL TC	ONE / LOT		P	V	V	
	HYD TEST	100%		P	W	V	
	IBR CERTIFICATE, IF APPLICABLE			P	V	V	
10	REPEATABILITY	100%		P	V	V	
11	HYSTERISIS	100%		P	V	V	
12	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW		P	W	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.
4. Manufacturer to carry out routine test for 100%

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR PRESSURE SWITCH

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	V	V	
	1.1 MODEL NO/TAG NO						
	1.2 RANGE						
	1.3 END CONN						
	1.4 NO. OF CONTACT						
2	CALIBRATION			P	V	V	
	2.1 REPEATABILITY						
	2.2 SET POINT ADJUSTMENT						
	2.3 DIFFERENTIAL						
3	OVER PR & LEAK TEST			P	V	V	
4	ELECT. INSULATION/HV TEST	ONE		P	V	V	
5	REVIEW OF TC FOR MATERIALS OF	FOR LOT		V	V	V	
	5.1 SENSOR						
	5.2 MOVEMENT						
	5.3 PROCESS CONNECTION						
	5.4 HOUSING						
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	V	
7	REVIEW OF TC OF MICROSWITCH	FOR LOT		V	V	V	

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to carry out ROUTINE TEST on 100 %.
3. Contractor to provide compliance certificate for tests/checks verifid by contractor and the same alongwith test certificates to be verified by BHEL

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR FLOAT OPERATED LEVEL SWITCH

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	V	V	
	MODEL NO/TAG NO						
	TYPE						
	END CONNECTION						
2	ON/OFF DIFFL			P	W	V	
3	REPEATABILITY			P	W	V	
4	IR TEST			P	W	V	
5	HV TEST			P	V	V	
6	PR. TEST ON CHAMBER	SEE NOTE-5		P	V	V	
7	MATL. TC FOR CHAMBER & FLOAT	FOR LOT	---	V	V	V	
8	CONTACT CONFIG. & RATING FOR MICROSWITCH	FOR LOT	---	V	V	V	
9	TC FOR DEGREE OF PROTECTION	TYPE TEST	---	V	V	V	
10	MANUFACTURER TO ENSURE WELDING PROCEDURE,WELDERS & NDT AS PER ASME FOR PR >40 KG/CM2		---	P	V	V	
11	CHECK FOR TEMP. SUITABILITY FOR MICROSWITCH AND LEAD WIRE	SEE NOTE-1 BELOW	---	V	V	V	
12	ACCESSORIES AS APPLICABLE		APPROVED SPEC./ DATA SHEETS	V	V	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out ROUTINE TEST on 100 %.
4. When material corelation is not available, MFR's compliance to be provided
5. IBR certificates shall be provided wherever required.
6. Contractor to provide compliance certificate for tests/checks verifid by contractor and the same alongwith test certificates to be verified by BHEL

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR ANALYTICAL INSTRUMENTS

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	V	V	
	VISUAL						
	MAKE, MODEL No.						
	POWER SUPPLY						
	TYPE						
2	DIMENSIONS CHECK			P	V	V	
3	FUNCTIONAL CHECK			P	V	V	
4	LEAKAGE TEST			P	V	V	
5	HV / IR TEST			P	V	V	
6	LINEARITY			P	V	V	
7	RESPONSE TIME			P	V	V	
8	ENCLOSURE CLASS			P	V	V	
9	ACCESSORIES, AS APPLICABLE			P	V	V	
10	ACCURACY / CALIBRATION			P	V	V	
11	ALARM CONTACT TEST			P	V	V	
12	ANALOG OUTPUT CHECK			P	V	V	
13	BURN-IN TEST OF ELECTRONIC PARTS	1/LOT		P	V	V	
14	IN-BUILT INDICATOR, ZERO, SPAN, RANGE SCALE SELECTION ETC	SEE NOTE-1 BELOW		P	V	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR ANNUNCIATORS

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	TYPE/ MODEL						
	DIMENSIONS OF HARDWARE						
	MODULARITY						
	SEQUENCE						
	FACIA DETAILS						
2	FUNCTIONAL TEST	100%		P	W	V	
3	IMMUNE TO STEP VARIATIONS IN THE POWER SUPPLY	SEE NOTE-1 BELOW		P	W	V	
4	DEGREE OF PROTECTION FOR ENCLOSURE	TYPE TEST		P	W	V	
5	I/R CHECK	SEE NOTE-1 BELOW		P	W	V	
6	RESPONSE			P	W	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out ROUTINE TEST on 100 %.
4. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR TRANSMITTER

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECKS FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	VISUAL.						
	MODEL/TAG No						
2	PROCESS CONNECTION			P	W	V	
3	ACCURACY			P	W	V	
4	REPEATABILITY			P	W	V	
5	HYSTERESIS			P	W	V	
6	EFFECT OF TEMP VARIATION ON ACCURACY			P	W	V	
7	SPAN / ZERO ADJUSTMENT	ONE / TYPE		P	W	V	
8	EFFECT OF SUPPLY VOLTAGE VARIATION			P	W	V	
9	EFFECT OF LOADING (500 OHM METERS)			P	W	V	
10	HIGH PRESSURE TEST	SEE NOTE-1 BELOW		P	W	V	
11	BURN-IN TEST	ONE / TYPE		P	W	V	
12	DEGREE OF PROTECTION			P	W	V	
13	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW		V	V	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. When material corelation are not available manufacturer's compliance to be provided.
4. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.