

**CONTRACT NO.**

**GUJARAT WATER SUPPLY & SEWERAGE BOARD**

**GANDHINAGAR**

**(A WHOLLY OWNED GOVERNMENT OF GUJARAT UNDERTAKING)**



**“Working Survey, Design & Construction of Intake Well with Approach Bridge, Providing, Supplying, Lowering, Laying and Jointing various dia. of DI-K9/MS Rising Main Pipelines, RCC Sump, Pump House, Staff Quarter, Compound Wall, Supplying and erecting Pumping Machinery Including all Electro-Mechanical-Instrumentation and SCADA Works at Various HWs to SHWs under Water Supply Scheme Based on Bhadbhut Barrage (RHS) for Industries (GIDC) and Rural Areas of Bharuch and Vadodara Districts with 10 Years of Comprehensive O&M of entire scope of work. Dist.: Bharuch”**

**Estimated Cost: Rs. ₹ 8,28,08,62,369.00**

**VOLUME – 2C**

**TECHNICAL BID**

**Technical Specification Mechanical , Electrical and Instrumentation**

**Chief Engineer**

**Gujarat Water Supply & Sewerage Board**

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***Enclosure (01)–Technical Specification for  
Mechanical Works***

***Enclosure (02)–Technical Specification for Electrical  
Works***

***Enclosure (03)–Technical Specification for  
Instrumentation Works***

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***Enclosure –Technical Specification for Mechanical Works***

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## LIST OF CONTENT

### Chapters and Annexure

1.	Scope of Work .....	9
1.1	General.....	9
1.2	Pump House.....	9
1.2.1	VT Pump .....	9
1.3	Valves.....	9
1.4	Piping and Fittings.....	9
1.5	Other Mechanical Components.....	10
1.5.1	Rising Main (Valves and Fittings).....	10
1.6	Codes & Standards .....	10
2.	Vertical Turbine Pumps (VT Pumps).....	14
2.1	Scope .....	14
2.2	Codes & Standards .....	14
2.3	Design & Features .....	14
2.4	Features Of Construction .....	15
2.4.1	GENERAL .....	15
2.4.2	SUCTION STRAINER.....	16
2.4.3	BOWLS .....	16
2.4.4	IMPELLER.....	16
2.4.5	IMPELLER SHAFT.....	17
2.4.6	LINE SHAFT.....	17
2.4.7	LINESHAFT COUPLING.....	17
2.4.8	LINESHAFT BEARINGS.....	17
2.4.9	COLUMN PIPE.....	18
2.4.10	DRIVER.....	18
2.4.11	THRUST BEARING.....	18
2.5	TEST AND INSPECTION .....	18
2.5.1	PREMANUFACTURING INSPECTION / DOCUMENTS.....	18
2.5.2	HYDROSTATIC TEST .....	18
2.5.3	PERFORMANCE TEST .....	18
2.5.4	STANDARD RUNNING TEST .....	19
2.6	VISUAL INSPECTION .....	19
2.7	WELDING.....	20
2.8	DRAWING AND DOCUMENTS .....	20
2.9	NAME PLATE.....	20
3.	H.T. Induction Motors .....	22
3.1	General.....	22

3.2	Performance and Characteristics.....	22
3.3	Stator Winding And Insulation.....	23
3.4	Constructional Features .....	24
3.5	Bearings .....	25
3.6	NO. Of Starts.....	25
3.7	Torque Requirements .....	26
3.8	Starting Times .....	26
3.9	Terminal Box .....	26
3.10	Rotor.....	26
3.11	Paint and Finish .....	27
3.12	Anti-Condensation Heaters and Temperature Detectors.....	27
3.13	Noise Level.....	27
3.14	Motor Vibration .....	27
3.15	Name Plate.....	28
3.16	Accessories .....	28
3.17	Inspection And Testing at manufacturer's Premises .....	28
3.17.1	QAP , Testing And Inspection of Motor.....	28
3.17.2	General Conditions.....	28
3.18	Routine Test.....	30
3.19	TypeTest .....	30
3.20	MOTOR Acceptance After Test .....	31
4.	<b>L.T. Induction Motor .....</b>	<b>32</b>
4.1	GENERAL .....	32
4.2	Performance and Characteristics.....	32
4.3	Stator Winding and Insulation .....	33
4.4	Constructional Features .....	34
4.5	Bearings .....	35
4.6	NO. Of Starts.....	35
4.7	Torque Requirements .....	36
4.8	Starting Times .....	36
4.9	Terminal Box .....	36
4.10	Rotor.....	36
4.11	Paint and Finish .....	37
4.12	Anti-Condensation Heaters and Temperature Detectors.....	37
4.13	Noise Level.....	38
4.14	Motor Vibration .....	38
4.15	Name Plate.....	38
4.16	Accessories .....	38
4.17	Inspection And Testing at manufacturer's Premises .....	38

4.17.1	QAP, Testing and Inspection of Motor .....	38
4.17.2	General Conditions.....	38
4.18	Routine Test.....	40
4.19	Type Test .....	40
4.20	MOTOR Acceptance After Test .....	41
5.	Pipes and Specials.....	42
5.1	GENERAL .....	42
6.	Electrically/Manually Operated Butterfly Valve .....	44
6.1	General.....	44
6.2	Design Criteria.....	44
6.3	Service Applications.....	44
6.4	Nominal Pressures .....	45
6.5	Pressure/Temperature ratings .....	45
6.6	Body Ends .....	45
6.6.1	Double Flanged Body Ends .....	45
6.6.2	Water Body Ends (Where ever applicable).....	45
6.6.3	Face to Face Dimension .....	46
6.6.4	Bodies .....	46
6.6.5	Disc and shafts.....	46
6.6.6	Seating and linings .....	46
6.6.7	Bearings .....	46
6.7	Operation.....	47
6.7.1	Electrically and Manually Operated.....	47
6.7.2	Direction of Operation .....	47
6.8	Testing.....	47
6.8.1	Performance Testing.....	47
6.8.2	Body Test .....	47
6.8.3	Seat Test.....	48
6.8.4	Disc Strength Test.....	48
6.9	Test Certificates .....	49
6.10	Inspection .....	49
6.11	Witnessing of Tests .....	49
6.12	Marking.....	49
6.13	Preparation for dispatch .....	49
6.14	Fixing of Valves.....	50
6.15	Electric Actuator .....	50
6.16	Technical Particulars of Electrically/Manually Operated Butterfly Valve(PN – 1.6).....	51
7.	DUAL PLATE CHECK VALVE (DI/PN 1.6) .....	53
7.1	Design requirements .....	53

7.2	Cleaning .....	53
7.3	Painting .....	53
7.4	Testing and Inspection .....	53
7.5	Fixing of Valves .....	54
7.6	Technical Particulars of Dual Plate Check Valve (DI/PN 1.6) .....	54
8.	Manually / Gear Operated Sluice valve .....	56
8.1	General .....	56
8.2	DESIGN FEATURES .....	56
8.3	FEATURES OF CONSTRUCTION .....	56
8.4	Operation .....	57
8.4.1	Electrically and Manually Operated .....	57
8.5	INSPECTION AND PERFORMANCE TESTS .....	58
8.6	VARIOUS TESTS .....	58
8.6.1	Material Test .....	58
8.6.2	Non-destructive Test .....	58
8.6.3	Hydrostatic Test .....	58
8.6.4	Performance Test .....	58
8.7	TESTS AT SITE .....	58
8.8	CLEANING .....	58
8.9	PAINTING .....	59
8.10	HANDWHEEL .....	59
8.11	TESTS AND INSPECTION .....	59
8.12	Material of construction .....	59
8.13	DUCTILE IRON SLUICE VALVES .....	59
8.14	Fixing of Valves .....	59
8.15	Electric Actuator .....	59
8.16	Technical Particulars of Sluice Valve (PN – 1.6) .....	61
9.	Metallic Expansion Bellow (PN 1.6) .....	62
9.1	General .....	62
9.2	Operating Principal .....	62
9.3	Tests and Inspection .....	63
9.4	Mechanical Data .....	63
9.5	Cleaning .....	64
9.6	Painting .....	64
9.7	Accessories and Installation .....	64
9.7.1	Accessories .....	64
9.7.2	Installation of Accessories .....	65
9.8	Tender Drawings .....	66
9.9	Technical Particulars of Metallic Expansion Bellow (PN 1.6) .....	66



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10.	Electrically Operated Travelling (EOT) Crane .....	67
10.1	General.....	67
10.2	Codes and Standards .....	67
10.3	Construction Features.....	67
10.4	Bridge Girder .....	68
10.5	End Carriages .....	68
10.6	Travelling Trolley.....	68
10.7	Ladders .....	68
10.8	Rope Drums .....	68
10.9	Wire Ropes.....	69
10.10	Sheaves .....	69
10.11	Gears.....	69
10.12	Bearings .....	69
10.13	Shafts, Axles, Couplings, Keys and Splines .....	69
10.14	Brakes .....	70
10.15	Lifting Hooks.....	70
10.16	Wheels and rails.....	70
10.17	Walkways and ladders .....	71
10.18	Buffers, Stops and Seeps .....	71
10.19	Guards.....	71
10.20	Lubrication.....	72
10.21	Nameplate .....	72
10.22	Electrical Equipment .....	72
10.23	Motors .....	72
10.24	Controls .....	73
10.25	Controllers .....	73
10.26	Crane Control Equipment.....	73
10.27	Protection .....	74
10.28	Operating and indicating device.....	74
10.29	Resistors .....	75
10.30	Limit Switches .....	75
10.31	Conductors .....	75
10.32	Safety Switches.....	76
10.33	Cables and Conduits.....	76
10.34	Safety Earthing.....	77
10.35	Control Schematic and Wiring Diagrams .....	77
10.36	Performance Guarantee.....	77
10.37	Additional technical requirement.....	78
10.37.1	General.....	78

---

10.38	Manufacturing Tolerances.....	78
10.39	Brake Tests: .....	80
10.40	Technical Specification .....	80
10.40.1	General.....	80
10.40.2	Structural Details .....	81
10.41	Technical Particulars for Electrically Operated Travelling (E.O.T) Crane.....	82
11.	Vertical Non Clog Pump Set .....	84
11.1	General.....	84
12.	Ventilation System .....	85
13.	DOUBLE ACTING KINETIC AIR VALVE WITH ISOLATING SLUICE VALVE .....	86
13.1	SPECIFICATION.....	86
13.1.1	General.....	86
13.2	JOINTING MATERIAL .....	86
13.3	BALL.....	87
13.4	HIGH PRESSURE ORIFICE.....	87
13.5	VALVE FLANGE .....	87
13.6	CLEANING .....	88
13.7	PAINTING .....	88
13.8	INSPECTION AND TESTING AT MANUFACTURER'S WORKS .....	88
13.9	DOCUMENTS / DRAWINGS TO BE SUBMITTED ALONGWITH TENDER.....	88
14.	GI PIPE AND FITTINGS .....	89
15.	SURGE CONTROL SYSTEM FOR PUMPING MAIN .....	90
15.1	Accepted Control System.....	90
15.2	Water Hammer Control .....	90
15.2.1	Specification for Water Hammer Control Device with Zero Velocity Valve and Air Cushion Valve	90
15.2.2	Specification for Air Cushion Valve.....	90
15.2.3	Surge Control System – Requirements.....	91
16.	Inspection and Testing at Manufacturer's Premises .....	93
16.1	General.....	93
16.2	Induction Motor.....	94
16.2.1	Routine Tests .....	94
16.2.2	Acceptance Tests.....	94
16.2.3	Type Tests.....	94
16.3	Valve .....	94
16.4	MS Pipe work (Pump house) .....	95
16.5	E.O.T Crane .....	95
17.	Installation, Testing and Commissioning .....	96
17.1	Erection - General .....	96

17.1.1	Levelling and Grouting of Machinery.....	97
17.2	Records, Procedures and Reports.....	98
17.3	General Preparations before Completion of the Plant .....	99
17.3.1	Necessary Documents .....	99
17.4	Manpower.....	100
17.5	Completion of Erection.....	100
17.6	Pre-commissioning.....	101
17.7	Pumps, Piping and Valves .....	102
17.8	Pump motors.....	103
17.9	Cranes.....	103
17.10	Instrumentation.....	103
17.11	Commissioning.....	104
18.	<b>DATA SHEETS FOR MECHANICAL WORKS - PUMP HOUSE .....</b>	<b>106</b>
18.1	Pump.....	106
18.1.1	Vertical Turbine Pump (For Each Pumping Station).....	106
18.1.2	Vertical Turbine Pump (For Palej To WTP) .....	109
18.2	HT Induction Motor.....	112
18.2.1	HT Induction MOTOR (For Each Pumping Station).....	112
18.3	LT Induction MOTOR .....	114
18.4	MS Pipe Work (For Each pumping) .....	116
18.5	ButterFly Valve .....	117
18.5.1	Butterfly Valves (Electrically Operated) (For Each Pumping) .....	117
18.6	Non-Return Valve (Dual Plate Check Valve) (For Each Pumping).....	118
18.6.1	Sluice Valves (Gear Operated) (Delivery Side) (For Each Pumping).....	119
18.7	Metallic Expansion Bellow.....	120
18.7.1	Metallic Expansion Bellow (For Each Pumping) .....	120
18.8	Electrically Operated Travelling (E.O.T.) Crane-Overhead (For Each Pumping).....	121
18.9	Vertical Non Clog Pump (For Each Pumping) .....	124
18.10	DOUBLE ORIFICE TAMPER PROOF KINETIC AIR VALVE -(For Each Pumping) .....	126
18.12	Manual Chain Pulley Block ((For Each Pumping Station).....	127
18.13	SURGE CONTROL DEVICES ((For Each Pumping Station).....	129
	(Zero Velocity and Vacuum Breaker cum Air Cushion Valves) .....	129

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#### **LIST OF ABBREVIATION**

<b>Acronym</b>	<b>Description</b>
GWSSB	Gujarat Water Supply and Sewerage Board
HDPE	High Density Polythene Pipe
HP	Horse Power
KW	Kilo Watt
MS	Mild Steel
RCC	Reinforced Cement Concrete
ROU	Right Of Use
SoR	Schedule of Rates

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## **1. Scope of Work**

### **1.1 General**

- a. The scope of mechanical system includes Design, Manufacturing, Supply, Installation, Testing and Commissioning and Operation and Maintenance for 10 years including 3 years of Defect Liability Period.
- b. The minimum Design life of pump with motor shall be 15 years (Minimum) 140000 operating hours (minimum).
- c. The Contractor shall supply Mechanical Tools & Test Equipment for O &M Period & Mandatory Spare Parts as per specified.
- d. The contractor shall submit to the department such as QAP / data sheets / drawings / catalogues etc. and any other supporting documents (each 3 sets) of equipment / items of mechanical system before start of manufacturing and approval of Engineer-in-charge to be obtained. Before shipping of such items, the contractor shall obtain inspection release note / dispatch clearance from the Engineer-in-charge.
- e. The Contractor shall submit operation and maintenance (O & M) manuals.
- f. Where provisions of the pertinent codes and standards conflict with these Specifications, Drawings and Datasheets or with each other, comply with the more stringent provision.
- g. Use the latest issue of Standards. Make available at least one copy of Standards for reference before construction at site office.

The following Pump-house Machineries, Valves, Piping & Fittings and Rising main valves & fittings are to be covered under Contractor's scope.

### **1.2 Pump House**

#### **1.2.1 VT Pump**

12 Nos. (8 working + 4 stand by) VT with HT Induction Motor.

06 Nos. (4 working + 2 stand by) VT with HT Induction Motor.

04 Nos. (2 working + 2 stand by) VT with LT Induction Motor.

### **1.3 Valves**

Electrically operated Butterfly Valve, Sluice Valve Gear Operated, Dual Plate Check Valve (DPCV) etc. to be provided on each pump discharge pipeline.

### **1.4 Piping and Fittings**

Metallic Expansion Bellow is to be provided on each pump discharge pipeline. MS piping with fittings

## 1.5 Other Mechanical Components

- a. One (1) no. Double girder Electrically Operated Traveling (E.O.T) Crane for pump house building.
- b. Two (2) nos. of Dewatering Pumps and drives along with associated piping & accessories for dewatering of the pump house.

### 1.5.1 Rising Main (Valves and Fittings)

- a. Manually Operated Butterfly Valves with Dismantling Joints are to be provided.
- b. Temper Proof Kinetic Air valves and Scour Valves are to be provided.
- c. Surge control devices are to be provided.

## 1.6 Codes & Standards

The machinery, equipment, component and material shall conform to the latest revision of the following standards:

Sr.No.	CODE	DESCRIPTION
01	IS -5	Colours for ready mixed paints and enamels.
02	IS -104	Ready mixed paint,brushing,zinc chrome, priming
03	IS -807	Code of practice for design, manufacture, erection and testing (structural portion) of cranes and hoists
04	IS -816	Code of practice for use of metal arc welding for general construction in mild steel
05	IS -900	Code of practice for installation and maintenance of induction motors.
06	IS – 1239	Mild steel tubes, tubular and other wrought steel fittings
07	IS – 1710	Vertical turbine pumps for clear, cold, freshwater.
08	IS – 2062	Steel for general structural purposes.
09	IS – 2629	Recommended practice for hot dip galvanizing on iron and steel
10	IS – 2633	Hot dip galvanizing
11	IS – 4691	Degree of protection provided by enclosures for rotating electrical machinery.

Sr.No.	CODE	DESCRIPTION
12	IS – 4137	Code of practice for heavy duty electric overhead travelling cranes including special service machines for use in steel work.
13	IS – 4722	Rotating electrical machines.
14	IS – 4889	Method of determination of efficiency of rotating Electrical machines.
15	IS – 12776	Galvanized strand for Earthling
16	IS – 13095	Wafer type butterfly valve size from 40 mm to 2000 mm
17	IS – 14846	Non rising stem type sluice valve size from 50 mm to 1200 mm
18	IS -3589	Steel Pipes for Water and Sewage (168.3 to 2540 mm Outside diameter- Specification
19	IS-4711	Methods for sampling of Steel Pipes, Tubes and Fittings
20	IS- 5312	Swing Check type reflux (non- return)valves for water work purposes- Specification Part-1
21	IS-14845	Resilient seated Cast Iron Air Relief Valves for water Works Purposes- Specification
22	IS -12615	Three Phase Induction Motors Specification
23	IS-10981	Class Of Acceptance Test For Centrifugal Mixed Flow And Axial Pumps - Class B
24	IS -1570(Part V)	Schedules For Wrought Steels - Part 5: Stainless And Heat-resisting Steels
25	IS -9866	Marking system for valves
26	IS- 638	Sheet Rubber Jointing and Rubber Insertion Jointing
27	IS-1363 (Part-1)	Hexagon Head Bolts, Screws and Nuts of Product Grade C - Part 1 : Hexagon Head Bolts (Size Range M 5 to M 64)
28	IS-1363(Part	Hexagon Head Bolts, Screws and Nuts of Product Grade C - Part 2 : Hexagon

Sr.No.	CODE	DESCRIPTION
	2)	Head Screws (Size Range M 5 to M 64)
29	IS-1363(Part 3)	Hexagon Head Bolts, Screws and Nuts of Product Grade C - Part 3 : Hexagon Nuts (Size Range M5 to M64)
30	IS- 6603	Stainless Steel Bars and Flats
31	IS-3444	Corrosion Resistant High Alloy Steel And Nickel Base Castings for General Applications
32	IS -1367	Technical Supply Conditions for Threaded Steel Fasteners
33	IS-5620	Recommendations for Structural Design Criteria for Low Head Slide Gates
34	IS-4622	Recommendations for Structural Design of Fixed-Wheel Gates
35	IS-4029	Guide for Testing Three Phase Induction Motors
36	IS-807	Design, erection and testing (structural portion) of cranes and hoists - Code of practice
37	IS-3177	Code of Practice for Electric Overhead Travelling Cranes and Gantry Cranes other than Steel Work Cranes
38	IS-3938	Electric Wire Rope Hoists
39	IS-13834	Crane Classification
40	IS-2048	Parallel Keys and Keyways
41	IS-2291	Tangential keys and keyways
42	IS-2292	Taper Keys and Keyways
43	IS-2293	Gib-head Keys and Keyways
44	IS-2327	Straight sided splines for cylindrical shafts with internal cantering - Dimensions, tolerances and verification
45	IS-2610	Power transmission - Straight sided splines for machine tools - Dimensions



Sr.No.	CODE	DESCRIPTION
46	IS 10981	Test setup and test procedure & Details of instrumentation along with their least counts and calibration certificates
47	HI 20.3-2010	Hydraulic Institute Guideline for Rotodynamic (Centrifugal and Vertical) Pump Efficiency Prediction
48	IS-5749	Specification for Forged Ramshom hooks
49	HIS	Hydraulic Institute Standards
50	API 594	Check Valves: Wafer, Wafer lugs and Double Flanged type
51	API 598	Valve Inspection and Testing
52	IS -13159	Pipe Flanges and Pipe fittings – part-1: Dimension
53	IS – 2500	Sampling Inspection Procedure
54	BS -5155	Specification for Butterfly Valves

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## 2. Vertical Turbine Pumps (VT Pumps)

### 2.1 Scope

This specification covers the design, performance, manufacturing, construction features, testing, delivery, installation and commissioning of vertical turbine pumps at Pumping Station with suction strainer, bell mouth, column assembly, discharge elbow, motor stool, thrust bearing, non reversing device etc.

### 2.2 Codes & Standards

The design, manufacturing, performance of vertical turbine pumps shall comply to all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. The equipment shall conform to IS 1710 (latest edition). The performance test shall be carried out as per IS 10981 Class - B.

### 2.3 Design & Features

The vertical turbine pump shall be capable of developing the specified required total flow & head at duty point at 50 Hz (rated frequency) for continuous operation.

- a. The pumps will be required to work satisfactorily in the entire operating range, while operating in solo as well as in any combination for parallel operation. The pumps of a particular category shall be identical & shall be suitable for parallel operation with equal load sharing. Components of identical pumps shall be interchangeable.
- b. The pump characteristics shall be of stable nature and such that efficiency is fairly constant for the operation under varying water levels as specified. The best efficiency point of pump should be near to specified duty point.
- c. The head capacity curve should be continuously rising towards shut off with highest at shut off. The pump curve should be of non overloading type. The pump set should be designed to operate up to a period of 5 minutes at shut off head without causing any damage to pump set. The shut-off head should not be less than 115 % of the total head of the pump.
- d. NPSH required by pumps offered should be lesser by at least 0.5 M than NPSH available at any point of operation in the entire range with solo and parallel operation.
- e. The pumps shall be suitable for non stop continuous 24 hours operation without interruptions. However, the actual hours of operation per day shall be as per the approved design report of the system.
- f. The impeller adjustment shall be such that the impeller runs free in any installed condition despite extension of line shaft (caused by hydraulic down thrust, the weight of shafting and weight of impellers).

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- g. The rating of the motor, driving the pump, shall have the power sufficient to drive the pump throughout the entire range of head capacity curve.
  - h. Necessary lifting arrangement on equipment shall be provided for easy handling of the Pumps & Motors.
  - i. The pump shall be designed considering the worst condition of raw water having turbidity, maximum up to 500 NTU and the suspended solid sizes which are entering during flood time and in monsoon season.
  - j. The velocity of vibration shall be limited to 3.0 mm/sec at the thrust bearing. The noise level measured at pump, motor & discharge head shall be limited to 85 Db at a distance of 1.86 meters. The pump discharge head shall be of MS fabricated or CI construction & suitably reinforced to withstand all types of static dynamic loads, torsion loads etc. & design shall be rugged to limit vibrations within acceptable limits. The pump discharge head/ motor stool shall be suitable to accommodate thrust bearing with cooling arrangement & contain stuffing box with Gland packing. A sufficient opening should be provided between adjacent pump-sets so as to have easy access & working on thrust bearing & stuffing box.
  - k. The Thrust Bearing shall be of heavy duty anti friction type. The bearing shall be designed to withstand all the loads under normal operation & shut off & shall be suitable for reverse rotation. The bearing should be oil lubricated type and shall be provided with an oil level indicator & a local as well as remote temperature measuring and indication arrangement. The Thrust Bearing shall have a water cooling system preferably in the oil bath. The following shall be provided as minimum requirement. (a) Temperature probe suitable for dial type thermometer. (b) RTD for use with temperature scanner with an indication/ annunciation/ tripping protections in the PLC panel.
  - l. The Cooling Water supply for the thrust bearing shall be of clean water and may be taken from a tapping from pump discharge line with a suitable replaceable water filtering arrangement. The life of thrust bearing shall not be less than 75,000 hours of operation.
  - m. The Clearance between strainer & sump bottom, between adjacent pumps, as well as clearance from side walls should be such that the vortex free operation is ensured. Static balancing test shall be carried out.
  - n. The line shaft bearing shall be having a Self water lubrication system.

## **2.4 Features Of Construction**

### **2.4.1 GENERAL**

- a. Pumps shall be of vertical turbine type complete with bowl and column assemblies, suction strainer, bell mouth, discharge elbow, motor stool, thrust bearing, non reversing device etc.

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- b. Suction strainer shall be designed with a net opening area not less than 4 times the area at suction bell mouth diameter. Pump shall work satisfactorily even when strainer gets clogged up to 50%.
  - c. The bowl assembly shall consist of a rotating impeller/ impellers housed in a stationery bowl/ bowls having fixed guide vanes. The bowl/ bows shall also include the housing of the pump shaft bearing.
  - d. The column assembly shall consist of a column pipe/ pipes to convey the liquid handled from bowl assembly to column assemblies and shaft bearings, discharge elbow.
  - e. Generally, the VT pump discharge shall be located in the discharge head and shall be taken out from the upper side of the supporting floor of the discharge head, unless otherwise specified.
  - f. The Successful bidder /Contractor has to carry out CFD (Computational Fluid Dynamics) analysis of pump sump house through pump manufacturer to predict the flow characteristics and shall satisfy to owner for vortex free flow for Pump house.
  - g. The pumps showing any abnormal behaviour during performance test shall be stripped down for a thorough examination.
  - h. Manufacturer shall demonstrate at site the trouble free mechanical running, parallel operation and equal load sharing by the pumps and noise and vibration level.

#### **2.4.2 SUCTION STRAINER**

Each pump shall be provided with a suitable suction strainer to prevent entry of foreign materials and debris which can damage the pump. The strainer shall be fabricated from SS: 304. The net opening area of the strainer shall be at least 4 times the area at suction diameter of the bell mouth. It shall be designed such that, it will cause minimum choking or clogging.

#### **2.4.3 BOWLS**

- a. The bowls shall be of Cast steel WCB and shall be free from blow holes and other detrimental defects. The surface shall be smooth.
- b. The bowl assembly shall be equipped with replaceable wearing rings. Liquid passage shall be smooth finished and the bowl shall contain bushes to serve as bearings for the impeller shaft.
- c. The pump shall be painted from inside and outside with anti corrosive primer and epoxy based paint.

#### **2.4.4 IMPELLER**

- d. The impeller shall be of S.S. CF8M, enclosed type and shall be balanced dynamically. The impeller shall be properly machined, with finished liquid passages. They shall be adjustable vertically by means of an adjusting nut in the head assembly.

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- e. Impeller shall be securely fastened to the impeller shaft with keys, and lock-nuts.
  - f. To avoid any internal resonance, the number of vanes on diffuser shall not be equal to or be a multiple or number of vanes on the impeller.

#### **2.4.5 IMPELLER SHAFT**

- g. The impeller shaft shall be made of hardened stainless steel SS-410 as per IS 1570. It shall have a surface finish between 0.75 microns or less. The butting faces of the shaft shall be machined square to the axis and the shaft ends & shall be chamfered on the edges.
- h. The shaft shall be straight and the shaft deflection shall be within 0.125 mm (total dial indicator reading) for the 3 meter length of the shaft.

#### **2.4.6 LINE SHAFT**

- a. The size of the shaft shall be calculated on the basis of maximum combined shear stress. This shall not exceed 30% of the elastic limit, in tension or more than 18% of the ultimate tensile strength.
- b. The design of the shaft shall also take into consideration the critical speed of the shaft which shall not coincide with the operating speed.
- c. The shaft shall be furnished with interchangeable sections having a nominal length equal to column pipe length. The maximum permissible error in the axial alignment of the coupling axis with the axis of the shaft shall be 0.05 mm in 150 mm.
- d. Shaft shall be provided with shrunk or snug fitted shaft sleeves of compatible wear/corrosion resistant material precision ground and polished where pass through bearings.

#### **2.4.7 LINESHAFT COUPLING**

Couplings shall be designed with a minimum safety factor of 1.5 times the shaft factor.

#### **2.4.8 LINESHAFT BEARINGS**

Bearings shall be thordon type integral with replaceable sleeves of metallic material with suitable securing arrangement in the bearing housing. Lubrication shall be by self water.

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#### **2.4.9 COLUMN PIPE**

- a. The standard lengths of the column pipe shall be maximum 2.5 meters. The column pipe shall be of welded flanged design.
- b. The velocity of water in column pipe shall not exceed 2.5 M/Sec at rated discharge.

#### **2.4.10 DRIVER**

Driver shall be coupled through flexible coupling to the head shaft.

#### **2.4.11 THRUST BEARING**

Pump design with single thrust bearing at motor top or separate thrust bearing for pump and motor. In case the thrust bearing is located in the pump, the coupling shall be flexible type in such case.

### **2.5 TEST AND INSPECTION**

#### **2.5.1 PREMANUFACTURING INSPECTION / DOCUMENTS**

- a. Pump manufacturer will submit - (i) Test setup and test procedure (ii) Details of instrumentation along with their least counts and calibration certificates before commencing manufacturing/testing as per IS 10981CL B.
- b. Engineer In-charge & TPI will have to inspect the test setup along with instrumentation.
- c. Only after finalization/ acceptance of test setup and test procedures, the manufacturer will commence manufacturing/testing.

#### **2.5.2 HYDROSTATIC TEST**

- a. A standard hydrostatic test shall be conducted on all pump columns; discharge elbow and bowl assemblies at 1.5 times the maximum discharge pressure of the pump or twice the rated pressure, whichever is higher.
- b. The hydrostatic test shall be conducted for a minimum duration of 30 minutes.

#### **2.5.3 PERFORMANCE TEST**

Performance Test will be carried out as per IS 10981 (Class B). Performance test at rated speed shall be conducted at manufacturers works in presence of third party inspection agency appointed by client & Engineer-in-charge representatives for all pumps. No negative tolerance on bowl efficiency, overall pump efficiency as well as capacity & head will be permitted.

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The performance test shall include determination of head, discharge, power & efficiency over the entire range from shut off to full valve open condition. At least 6 different readings need to be taken in addition to shut off & duty point.

The minimum submergence test shall be carried out at manufacturer's work i.e. the value of minimum submergence available at site should be simulated (i.e. water level above impeller eye) & it should be demonstrated that the pumps run satisfactory & without any vibrations or cavitations or any other harmful effects at this level. At least one pump of each type will be subjected to minimum submergence test.

All the instruments used for testing should be calibrated & latest available calibration certificates are to be submitted before testing. Also the test set up & test procedure shall be submitted for Engineer's approval before testing.

The vibrations & noise levels shall be recorded at manufacturer's works.

#### **2.5.4 STANDARD RUNNING TEST**

- o. Bowl assemblies shall be given running test over the full operating range, covering from free discharge with delivery valve fully open to the shut off head. The duration of tests shall be minimum one hour. A minimum of six readings apart from duty point and shut off readings shall be taken for plotting the performance curves.
- p. The pump shall be tested for parallel operation at site. The pumps should work satisfactorily in parallel operation with equal load sharing. The velocity of vibrations shall be limited to 3.0 mm/sec at thrust bearing top & noise level should not exceed 85 Db at a distance of 1.86 meters.
- q. Impeller shall be dynamically balanced at rated or reduced speed as per ISO standard. However the bidders should furnish the co-relation of accuracy and limits of unbalance.
- r. Necessary test certificates of the above tests shall be furnished for the purchaser's approval.
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- s. Pump bowls shall be offered for Dye penetration test and if found defective, it shall be rejected and destroyed to avoid reuse. The pump impellers shall be offered for Dye penetration test as per approved procedure. Ultrasonic test of impeller shaft shall be carried out along with above test.

#### **2.6 VISUAL INSPECTION**

Pumps shall be offered for the purchaser's visual inspection before dispatch. Pump components shall not be painted before inspection. After the inspection, test certificate shall be furnished. Inspection for critical dimensions of components viz. shafts diameter, wall thickness of column pipes; flange thickness etc. will be witnessed.

Inspection of verification of metallurgy of various components shall be done by reviewing the certificates of the metallurgical tests carried out by the manufacturer.

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## **2.7 WELDING**

All welding and related operation shall be done as per code. Welders shall be qualified as per codes. All welding procedures shall be submitted for approval.

## **2.8 DRAWING AND DOCUMENTS**

The following drawings shall be submitted by the manufacturer.

- a. Preliminary outlined GA (general arrangement) & dimensional drawings, showing details of pump, motor, civil foundation, clearances, minimum submergence, etc.
- b. Performance curves for capacity v/s head, efficiency, and KW requirement shall be furnished. The capacity range shall be zero flow to maximum flow.
- c. Typical cross sectional (CS) drawing showing constructional details with the complete bill of material, bill of quantity (BOM & BOQ) & relevant standards. Catalogues of all the components with part number shall be furnished.
- d. Pump House General Arrangements drawing of all the pumps with dimensional details.
- e. Test reports for chemical analysis of material of construction (MOC) of major components like impellers shafts bowl assembly etc.
- f. Performance test reports and curves for similar model of pumps with a list of installations.
- g. O & M manual & spare part list.
- h. Start up & shut down instructions
- i. Quality Assurance Plan (QAP) to be submitted for approval prior to the manufacturing.
- j. Dimensional similarity / inter changeability certificates shall be submitted so as to ensure inter changeability of components.

## **2.9 NAME PLATE**

Each pump shall be provided with a stainless steel name plate of the manufacturer, indicating minimum following details.

- a. Rated capacity in M<sup>3</sup>/hr
- b. Total head in MWC
- c. Speed in RPM.
- d. Rated Power in KW at 50 Hz.
- e. Test pressure



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- f. Make & Model number
  - g. Manufacturer's serial number
  - h. Weight of equipment
  - i. Material of bowl.
  - j. Material of impeller & shaft
  - k. Details of Thrust Bearings with grade of lubricants

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### 3. H.T. Induction Motors

#### 3.1 General

The specification covers the design, manufacture, performance testing at manufactures works, supply, delivery, storage at site; erection, testing and commissioning of Squirrel cage induction motors complete with instrumentation controls and safety devices, equipment for the cooling water system, lubricating system oil, water piping with valves, fitting and other accessories at each pumping station as detailed in the Schedule of Requirements and as described in the various sub sections of the specifications. The scope of supply shall include spares for 5 years of operation of the pumping station, special tools and testing devices, all parts accessories etc. which are essential for construction, operation and maintenance of all the motors even though these are nor individually or specifically stated or enumerated. Corresponding components of all the motors and associated equipment and spares shall be of the same material, dimensions and finish and shall be interchangeable.

The motor shall perfectly match in respect of speed, runaway speed, moment of inertia, overload capacities, couplings and any other requirement with that of pump.

#### 3.2 Performance and Characteristics

- a. Motors shall be suitable for satisfactory and efficient operation of pumps for application and duty assigned. The rating of the motor shall be such that it should not get over loaded when the pump would be delivering high discharge due to water level in the sump at its highest level.
- b. Motors shall be capable of satisfactory operation at full load at a supply voltage of 80%of the rated voltage for 5 minutes, commencing from hot conditions.
- c. Motors shall be capable of developing the rated full load torque even the supply voltage drops to 70% of the rated voltage. Such operation is envisaged for a period of one second. The pull out torque of the motor to meet this requirement shall be at least 205% of full load torque.
- d. The locked rotor current of the motors shall not exceed 550% of full load current inclusive of 20% tolerance.
- e. The motor vibration shall be within the limit specified in IS 12075. The permissible noise level shall not exceed the stipulations laid down in IEC 60034-9. The motor shall be designed to withstand 120% of rated speed for two minutes without any mechanical damage.
- f. Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously under following supply conditions.
- g. Variation in supply voltage : + 10%  
Variation in supply frequency : + 3%  
Combined voltage and frequency variation :  $\pm 10\%$
- h. The locked rotor withstand time under hot condition at 110% rated voltage shall be more than

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the starting time at 80% voltage by at least two seconds or 15% of the accelerating time whichever is greater.

- i. The motor shall be so designed that it shall have maximum efficiency on load varying from 60% to 100% of full load. Dropping efficiencies from 100% full load to 60% of full load will not be acceptable.
- j. The rating of motor shall be 110% of the maximum power required by the pump over the entire operating range from shut off to run out flow or 125% of power required at duty point whichever is less. Motors shall be provided with eye bolts, lugs or other means to facilitate safe lifting.
- k. The rating of motor shall be 10% margin of the maximum power required by the pump over the entire operating range from shut off to run out flow (or 10% on duty point, whichever is higher). Motors shall be provided with eye bolts, lugs or other means to facilitate safe lifting.
- l. All motors shall be so designed that the maximum inrush currents, and locked rotor and pull out torques developed by them at highest voltage and frequency limits do not endanger the motor and the driven equipment.
- m. Induction motors shall be designed to be capable of withstanding the voltage and torque stresses developed due to the difference between the motor residual voltage and incoming supply voltage equal to 150% of the rated motor voltage during changeover of buses.
- n. Motor not meeting min guaranteed parameters shall not be accepted till required parameters are achieved in performance testing.

### **3.3 Stator Winding And Insulation**

- a. Motor winding shall be of proven high quality and reliability. For HT motors the insulation system of stator winding shall be of the epoxy type.
- b. Stator coils and rotor bars shall be tight fit in their slots. Any stator slot packing used for winding of HT motors shall comprise of material impregnated with a conducting medium and shall be compatible with the system of stress control.
- c. All winding overhangs and leads shall be adequately supported, braced and blocked.
- d. Case winding and all joints shall be designed to give an adequate safety factor on the fatigue due to thermal and mechanical stresses, taking into account the specified starting and running conditions. All electrical joints and connections shall be of brazed or welded construction.
- e. Motors shall be given power house treatment. This comprises an additional treatment to the winding over and above the normal specified treatment. After the coils are placed in slots and all connections have been made, the entire motor assembly shall be impregnated by completely submerging in suitable insulating compound or varnish followed by proper baking. At least three such submersion and baking shall be applied to the assembly, class of insulation 'F'. Motor winding shall be given a further treatment with epoxy paint to withstand atmospheric conditions,

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polluted by hydrogen sulphide.

- f. The slot and overhang insulation of windings of HT shall also be based essentially on mica. Windings of HT shall be provided with stress control and corona protection. The anti corona protection shall be adequately earthed and be resistant to damage due to abrasion or vibration.
- g. All windings insulation shall be non hygroscopic, oil resistant to flame propagation. All windings shall be impregnated and suitably processed to effectively seal them to prevent deterioration from adverse environmental conditions at site.
- h. Temperature rises shall not exceed the values for insulation equivalent to class B. More than 60°C to 75°C. These temperature rises are acceptable for an ambient temperature of 50°C.
- i. The motor construction shall be suitable for easy disassembly and reassembly. The enclosure shall be sturdy and shall permit easy removal of any part of the motor for inspection and repair.
- j. The rotor bars shall not be insulated in the slot portion between the iron core lamination and the bars.
- k. Motor shall be closed air circuit air cooled (without external cooling fan) machine mounted heat exchanger (CACA/CACW) and the degree of protection shall be IP 55, and duty cycle S1 as per IS-12615-2011, IS: 6362 & IS: 4691.
- l. The cooling fans shall be capable of being connected for rotation in either direction or due care for cooling etc.
- m. Motor shall be provided with PT 100 grade and terminals shall be brought in separate RTD box.

### **3.4 Constructional Features**

- a. Motor and its components (such as stator, rotors, end shields, terminal boxes, bearings and heat exchangers) shall be designed to be readily interchangeable as integral units for the same design and rating.
- b. All nonmetallic components used shall be of resistant to flame propagation.
- c. The motor construction shall be suitable for easy disassembly and reassembly. The enclosure shall be sturdy and shall permit easy removal of any part of the motor for inspection and repair.
- d. Motor shall be provided with eye bolts, lugs or other means to facilitate safe lifting.
- e. Vertical motor shall be flange mounted type provided with thrust bearing.
- f. All enclosures shall be designed to provide an effective sealing between the primary and secondary air circuits. All totally enclosed type of motors shall have suitable means of breathing.

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### **3.5 Bearings**

- a. Motors shall have bearings of grease lubricated ball or roller type. Unless otherwise agreed the bearing shall be selected to give a minimum L-10 rating i.e. 75000 hours at rated operating conditions.
- b. Greased ball / roller / thrust bearings shall be of reputed make subject to the Owner's approval. The life expectancy of the bearings shall be stated.
- c. Bearings shall be adequate to absorb axial thrust in either direction produce by the motor itself or due to shaft expansion. Motor bearings exposed to high temperature (i.e. motors for hot oil pumps) shall have adequate provisions for cooling of bearings. Bearings shall have steel / brass cages. Bearings with polyamide cages shall not be acceptable.
- d. The bearings shall be so constructed that the loss of lubricating fluid is kept to a minimum and greasing shall be possible without any dismantling operation
- e. The bearings shall prevent dirt and water from getting into the motor. Bearing lubricant shall not find access to motor windings. Bearings shall be capable of grease injection from outside without removal of covers. The bearing boxes shall be provided with labyrinth seals, to prevent loss of grease or entry of dust or moisture. When grease nipples are provided, these shall be associated, where necessary, with appropriately located relief devices which ensure passage of grease through the bearings.
- f. The bearings shall permit running of the motor in either direction of rotation.
- g. If the bearings are oil lubricated, a drain plug shall be provided for draining residual oil and oil level sight gauge shall be provided to show precise oil level required for stand-still and running conditions.
- h. Unless otherwise approved, bearing lubricating system shall be such that no external forced oil or water is necessary to maintain the required oil supply or keep bearing temperature within design limits.
- i. Lubricants shall be selected for prolonged storage and normal use of the motors in tropical climate and shall contain corrosion and oxidation inhibitors. Grease shall have suitable bleeding characteristics to minimize setting.
- j. Safety measures for bearing temperature for tripping to be added. (High temperature).

### **3.6 NO. Of Starts**

Continuous duty motors shall be suitable for two starts in succession and three equally spread starts in an hour under the specified conditions of load, torque and inertia, with the motor initially at its normal running temperature.

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### 3.7 Torque Requirements

- a. The accelerating torque at any speed with the lowest starting voltage shall be at least 10% of rated full load torque of the motor.
- b. The pull out torque at rated voltage shall not be less than 205% of the full load torque.

### 3.8 Starting Times

- a. For motors with starting time up to 20 seconds at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 2.5 seconds more than starting time.
- b. For motors with starting time more than 20 seconds but not exceeding 45 seconds at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 5 seconds more than the starting time.
- c. For motors with starting time more than 45 seconds at minimum permissible starting voltage, the locked rotor withstand time under hot conditions at highest voltage limit shall be more than the starting time by at least 10% of the starting time.

### 3.9 Terminal Box

- a. Terminal box shall be of weather proof construction designed for indoor service, to eliminate entry of dust and water, gaskets of approved make shall be provided at cover joints and between box and motor frame.
- b. Terminal box shall be suitable for single compression cable jointing kit. The terminal box shall be suitable for top and bottom entry of cables.
- c. Unless otherwise approved, the terminal box shall be capable of being turned through 360 degree in steps of 90 degree.
- d. The terminals shall be of the stud type with necessary plain washers, spring washers and check-nuts. They shall be substantially designed for the current carrying capacity and shall ensure ample phase to phase and phase to ground clearances. Suitable cable jointing kit shall be supplied by the motor vendor to match Owner's cable.

### 3.10 Rotor

- a. The rotor shall be of squirrel cage type, dynamically balanced to provide a low vibration level and a long service life to the bearings. The accepted values of peak to peak vibration amplitudes for a motor at a rated voltage and speed on a machine surface bed plate with the motor levelled and with a half key or coupling fitted shall not exceed those given in IS 4729. The shaft ends shall be provided with a suitably threaded hole or holes to facilitate the assembly or removal of couplings and bearing races.
- b. The rotor bars shall not be insulated in the slot portion between the iron core laminations for

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squirrel cage motors.

- c. Rotor will be made up of electrical steel followed by environmental protection coating for anti corrosion.
- d. All motor rotors shall be dynamically balanced. Rotors shall be so designed as to keep the combined critical speeds with the driven equipment away from the running speed by at least 20%.

### **3.11 Paint and Finish**

- a. Motor external parts shall be finished and painted to produce a neat and durable surface which would prevent rusting and corrosion. The equipment shall be thoroughly degreased, all rust, sharp edges and scale removed and treated with one coat of zinc epoxy primer and two coats of Epoxy paints.
- b. The motor fan shall also be painted to withstand corrosion.

### **3.12 Anti-Condensation Heaters and Temperature Detectors**

- a. All motors shall be provided with 240 volt anti condensation heaters, sized and located so as to prevent condensation of moisture during shut down period. The heater shall remain "ON" when the motor is not in service, and shall not cause damage to the windings.
- b. At least 3 wire simplex and 6 wire duplex resistance type embedded temperature defectors for the stator winding each having D.C. resistance of 100 at 0°C embedded in the stator winding at locations where highest temperature may be expected and at bearings. The material of the RTD shall be platinum. Temperature Detectors detector leads, external to the slot shall be provided with a protective covering. These RTDS shall be wired to PLC controls for monitoring temperature rise.
- c. The heater leads shall be brought out to a separate terminal box of the same specification and grade of protection as the main power terminal box excepting that the nickel plated brass glands provided shall be suitable for 2 core 4 Sq. mm aluminium conductor, armoured cable.
- d. A warning label with indelible red inscription shall be provided on the motor to indicate that isolation of the power line alone is not sufficient and that the heater supply should also be isolated before carrying out any work on the motor. Motor supplied shall be complete with all double compression cable glands, crimp type cable lugs.
- e. Motor supplied shall be complete with all double compression cable glands, crimp type cable lugs.

### **3.13 Noise Level**

- a. The permissible noise level shall not exceed the stipulations laid down in IEC 34-9 & IS – 12065.

### **3.14 Motor Vibration**

- a. Motor vibrations shall be within the limits of IS 12075 unless otherwise specified for the driven

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equipment.

### **3.15 Name Plate**

- a. Each motor shall have a nameplate displaying all the particulars specified in relevant standards. In addition, the nameplate shall indicate identification, number of bearings used for motor and recommended lubricant indicating required quantity of lubricant and interval at which the bearings are to be lubricated.
- b. Nameplate shall be made of 2-mm thick stainless steel with the relevant details embossed on it in English.

### **3.16 Accessories**

Two independent earthing points shall be provided on opposite sides of the motor, for bolted connection of the Owner's earthing conductors. These earthing points shall be in addition to earthing stud provided in the terminal box.

### **3.17 Inspection And Testing at manufacturer's Premises**

#### **3.17.1 QAP , Testing And Inspection of Motor**

The general QA requirement is attached; the vendor is advised to go through the same before submitting the bid.

All tests shall be conducted as per relevant IS/IEC/IEEE standards

Quality Assurance plan shall be submitted by the bidder along with the vendor documents for the approval.

#### **3.17.2 General Conditions**

- a. OEM (Original equipment manufacturer) shall have ISO certification
- b. All the tests are to be carried out in the presence of any authorized representative of the client and third party as per direction of Engineer of Contract.
- c. The contractor shall have to offer stage inspection during manufacturing process where required by the client / final inspection on completion of manufacturing for Routine test & type test inspection.
- d. Routine test shall be performed by manufacturer on all equipments (100%) in presence of EPC agency/ contractor, client and TPA and minimum one motor to be type tested.
- e. The proposed date of stage/ final inspection shall be informed to Owner FIFTEEN days in advance.
- f. The contractor shall submit the following during commencement period.



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- A) Name of raw material as well as bought out accessories and the names of sub suppliers selected from those furnished after award of work.
  - B) The contractor shall submit the routine/ type test
  - C) certificate of bought out items& raw materials at the time of routine testing of the fully assembled equipment.
  - D) List of standards; according to which the raw materials are tested, list of tests normally carried out on raw materials in presence of contractor's representative, copies of test certificates.
  - E) Type test certificates of the raw material and bought out accessories.
- g. Instruments
- A) The manufacturer should keep the precise and accurate measuring instruments.
  - B) The periodical calibration should be carried out of all the instruments /equipments used for the measurement during tests and for assessing the various properties of the material and accessories.
  - C) The proper record of the same should be maintained during manufacturing stage and shall be shown to the inspecting officer on demand.
  - D) Allmeasuring instruments used in inspection and testing shall be properly calibrated and sealed once in a year with tag of competent authority.
- h. Equipment offered shall have all Type Test Certificates from accredited laboratory (accredited based on ISO/IEC Guide 25 / 17025 or EN 45001 by the National Accrediting Body of the country where laboratory is located), as per IEC /IS /technical specification.
- i. The type test conducted shall be on similar equipment and on similar capacity.
- j. Equipment not type tested in the last five years, type tests need to be performed without any extra cost. The purchaser may select the transformer for type tests randomly. Also Consider Type test Report of As per the guide line of Central Electrical Authority.
- k. The acceptance of any quantity of equipment shall in no way relieve the vendor of his responsibility for meeting all the requirements at this specification & shall not prevent subsequent rejection, if such equipments are later, found to be defective.
- l. EPC agency shall arrange for commissioning test at site by the OEM/ OEM approved agency confirm equipments are healthy at site & test result at site are same & committed figures are achieved.

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- m. Four sets of certified type tests reports shall be submitted for approval prior to dispatch of the equipment. The equipment shall be dispatched only when all the
  - n. required acceptance & routine tests have been carried out & the test reports have been approved by the client & TPA.
  - o. Certificates shall be clearly identified by serial or reference number where possible to the material being certified and shall include information required by the relevant reference standard or specification clause.
  - p. Job pump of each type shall be tested with job motor and shall be witnessed by client's representative.
  - q. Soft starter shall be tested with job motor & Job pump to check that Starting current of motor shall be as per the value given during bid evaluation. In case this type of testing not done during factory test, agency shall be responsible to prove the starting current value during commissioning stage. Any dispute between pump/motor/ soft starter shall be resolve by the agency.

### **3.18 Routine Test**

- a. Insulation resistance test before and after HV test
- b. High voltage test
- c. No load running of the motor and measurements of currents and voltages on all three phases.
- d. Locked rotor test at suitable voltage.
- e. Testing of accessories/auxiliaries for correct functioning.
- f. Vibration test.
- g. Noise Level test.
- h. Reduced voltage running up test at no load to check the ability of motor to run up to full.

### **3.19 TypeTest**

Measurement of stator resistance and rotor resistance of motor.

- a. No load running of motor and reading of voltage, current, power and speed.
- b. Open circuit voltage ration on motors.
- c. Reduced voltage running up test at no load to check the ability of motor to run up to full
- d. Speed on no load in each direction of rotation with  $1/\sqrt{3}$  of the line voltage applied to the motor.
- e. Locked rotor reading of voltage, current, power input and torque of motors.
- f. Full load reading of voltage, current, power input at 125%, 110%,100%, duty point,
- g. 75%, 60%, 50 % load
- h. Temperature rise test.
- i. Momentary over load test
- j. Insulation resistance test with before and after the high voltage test.
- k. High voltage test
- l. IP 55 test as per applicable standard.

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### **3.20 MOTOR Acceptance After Test**

Motor not meeting min guaranteed parameters shall not be accepted till required parameters are achieved in performance testing.

Though the motors shall be accepted on the basis of the satisfactory results of the tests at the works, it shall not absolve the vendor from liability regarding the proper functioning of the motor coupled to the driven equipment at site.

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## 4. L.T. Induction Motor

### 4.1 GENERAL

The specification covers the design, manufacture, performance testing at manufactures works, supply, delivery, storage at site; erection, testing and commissioning of Squirrel cage induction motors complete with instrumentation controls and safety devices, equipment for the cooling water system, lubricating system oil, water piping with valves, fitting and other accessories at each pumping station as detailed in the Schedule of Requirements and as described in the various sub sections of the specifications. The scope of supply shall include spares for 5 years of operation of the pumping station, special tools and testing devices, all parts accessories etc. which are essential for construction, operation and maintenance of all the motors even though these are nor individually or specifically stated or enumerated. Corresponding components of all the motors and associated equipment and spares shall be of the same material, dimensions and finish and shall be interchangeable.

The motor shall perfectly match in respect of speed, runaway speed, moment of inertia, overload capacities, couplings and any other requirement with that of pump.

### 4.2 Performance and Characteristics

- a. Motors shall be suitable for satisfactory and efficient operation of pumps for application and duty assigned. The rating of the motor shall be such that it should not get over loaded when the pump would be delivering high discharge due to water level in the sump at its highest level.
- c. Motors shall be capable of satisfactory operation at full load at a supply voltage of 80%of the rated voltage for 5 minutes, commencing from hot conditions.
- d. Motors shall be capable of developing the rated full load torque even the supply voltage drops to 70% of the rated voltage. Such operation is envisaged for a period of one second. The pull-out torque of the motor to meet this requirement shall be at least 205% of full load torque.
- e. The locked rotor current of the motors shall not exceed 550% of full load current inclusive of 20% tolerance.
- f. The motor vibration shall be within the limit specified in IS 12075. The permissible noise level shall not exceed the stipulations laid down in IEC 60034-9. The motor shall be designed to withstand 120% of rated speed for two minutes without any mechanical damage.
- g. Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously under following supply conditions.

Variation in supply voltage : + 10%

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Variation in supply frequency : + 3%

Combined voltage and frequency variation :  $\pm 10\%$

- h. The locked rotor withstand time under hot condition at 110% rated voltage shall be more than the starting time at 80% voltage by at least two seconds or 15% of the accelerating time whichever is greater.
- i. The motor shall be so designed that it shall have maximum efficiency on load varying from 60% to 100% of full load. Dropping efficiencies from 100% full load to 60% of full load will not be acceptable.
- j. The rating of motor shall be 110% of the maximum power required by the pump over the entire operating range from shut off to run out flow or 125% of power required at duty point whichever is less. Motors shall be provided with eye bolts, lugs or other means to facilitate safe lifting.
- k. The rating of motor shall be 10% margin of the maximum power required by the pump over the entire operating range from shut off to run out flow (or 15% on duty point, whichever is higher). Motors shall be provided with eye bolts, lugs or other means to facilitate safe lifting.
- l. All motors shall be so designed that the maximum inrush currents, and locked rotor and pull out torques developed by them at highest voltage and frequency limits do not endanger the motor and the driven equipment.
- m. Induction motors shall be designed to be capable of withstanding the voltage and torque stresses developed due to the difference between the motor residual voltage and incoming supply voltage equal to 150% of the rated motor voltage during changeover of buses.
- n. Motor not meeting min guaranteed parameters shall not be accepted till required parameters are achieved in performance testing.

#### **4.3 Stator Winding and Insulation**

- a. Motor winding shall be of proven high quality and reliability. For LT motors the insulation system of stator winding shall be of the epoxy type.
- b. Stator coils and rotor bars shall be tight fit in their slots. Any stator slot packing used for winding of LT motors shall comprise of material impregnated with a conducting medium and shall be compatible with the system of stress control.
- c. All winding overhangs and leads shall be adequately supported, braced, and blocked.
- o. Case winding and all joints shall be designed to give an adequate safety factor on the fatigue due to thermal and mechanical stresses, taking into account the specified starting and running conditions. All electrical joints and connections shall be of brazed or welded construction.
- p. Motors shall be given powerhouse treatment. This comprises an additional treatment to the winding over and above the normal specified treatment. After the coils are placed in slots and all

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connections have been made, the entire motor assembly shall be impregnated by completely submerging in suitable insulating compound or varnish followed by proper baking. At least three such submersion and baking shall be applied to the assembly, class of insulation 'F'. Motor winding shall be given a further treatment with epoxy paint to withstand atmospheric conditions, polluted by hydrogen sulphide.

- q. The slot and overhang insulation of windings of LT shall also be based essentially on mica. Windings of LT shall be provided with stress control and corona protection. The anti-corona protection shall be adequately earthed and be resistant to damage due to abrasion or vibration.
- r. All windings insulation shall be non-hygroscopic, oil resistant to flame propagation. All windings shall be impregnated and suitably processed to effectively seal them to prevent deterioration from adverse environmental conditions at site.
- s. Temperature rises shall not exceed the values for insulation equivalent to class B. More than 60°C to 75°C. These temperature rises are acceptable for an ambient temperature of 50°C.
- t. The motor construction shall be suitable for easy disassembly and reassembly. The enclosure shall be sturdy and shall permit easy removal of any part of the motor for inspection and repair.
- u. The rotor bars shall not be insulated in the slot portion between the iron core lamination and the bars.
- v. Motor shall the degree of protection shall be IP 55, and duty cycle S1 as per IS-12615-2011, IS: 6362 & IS: 4691.
- w. The cooling fans shall be capable of being connected for rotation in either direction or due care for cooling etc.
- x. Motor shall be provided with PT 100 grade and terminals shall be brought in separate RTD box.

#### **4.4 Constructional Features**

- a. Motor and its components (such as stator, rotors, end shields, terminal boxes, bearings and heat exchangers) shall be designed to be readily interchangeable as integral units for the same design and rating.
- b. All non-metallic components used shall be of resistant to flame propagation.
- c. The motor construction shall be suitable for easy disassembly and reassembly. The enclosure shall be sturdy and shall permit easy removal of any part of the motor for inspection and repair.
- d. Motor shall be provided with eye bolts, lugs or other means to facilitate safe lifting.
- e. Vertical motor shall be flange mounted type provided with thrust bearing.
- f. All enclosures shall be designed to provide an effective sealing between the primary and secondary air circuits. All totally enclosed type of motors shall have suitable means of breathing.

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#### **4.5 Bearings**

- a. Motors shall have bearings of grease lubricated ball or roller type. Unless otherwise agreed the bearing shall be selected to give a minimum L-10 rating i.e. 75000 hours at rated operating conditions.
- b. Greased ball / roller / thrust bearings shall be of reputed make subject to the Owner's approval. The life expectancy of the bearings shall be stated.
- c. Bearings shall be adequate to absorb axial thrust in either direction produce by the motor itself or due to shaft expansion. Motor bearings exposed to high temperature (i.e. motors for hot oil pumps) shall have adequate provisions for cooling of bearings. Bearings shall have steel / brass cages. Bearings with polyamide cages shall not be acceptable.
- d. The bearings shall be so constructed that the loss of lubricating fluid is kept to a minimum and greasing shall be possible without any dismantling operation
- e. The bearings shall prevent dirt and water from getting into the motor. Bearing lubricant shall not find access to motor windings. Bearings shall be capable of grease injection from outside without removal of covers. The bearing boxes shall be provided with labyrinth seals, to prevent loss of grease or entry of dust or moisture. When grease nipples are provided, these shall be associated, where necessary, with appropriately located relief devices which ensure passage of grease through the bearings.
- f. The bearings shall permit running of the motor in either direction of rotation.
- g. If the bearings are oil lubricated, a drain plug shall be provided for draining residual oil and oil level sight gauge shall be provided to show precise oil level required for stand-still and running conditions.
- h. Unless otherwise approved, bearing lubricating system shall be such that no external forced oil or water is necessary to maintain the required oil supply or keep bearing temperature within design limits.
- i. Lubricants shall be selected for prolonged storage and normal use of the motors in tropical climate and shall contain corrosion and oxidation inhibitors. Grease shall have suitable bleeding characteristics to minimize setting.
- j. Safety measures for bearing temperature for tripping to be added. (High temperature).

#### **4.6 NO. Of Starts**

Continuous duty motors shall be suitable for two starts in succession and three equally spread starts in an hour under the specified conditions of load, torque and inertia, with the motor initially at its normal running temperature.

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#### **4.7 Torque Requirements**

- c. The accelerating torque at any speed with the lowest starting voltage shall be at least 10% of rated full load torque of the motor.
- d. The pull out torque at rated voltage shall not be less than 205% of the full load torque.

#### **4.8 Starting Times**

- a. For motors with starting time up to 20 seconds at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 2.5 seconds more than starting time.
- b. For motors with starting time more than 20 seconds but not exceeding 45 seconds at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 5 seconds more than the starting time.
- c. For motors with starting time more than 45 seconds at minimum permissible starting voltage, the locked rotor withstand time under hot conditions at highest voltage limit shall be more than the starting time by at least 10% of the starting time.

#### **4.9 Terminal Box**

- a. Terminal box shall be of weatherproof construction designed for indoor service, to eliminate entry of dust and water, gaskets of approved make shall be provided at cover joints and between box and motor frame.
- b. Terminal box shall be suitable for single compression cable jointing kit. The terminal box shall be suitable for top and bottom entry of cables.
- c. Unless otherwise approved, the terminal box shall be capable of being turned through 360 degrees in steps of 90 degree.
- d. The terminals shall be of the stud type with necessary plain washers, spring washers and check-nuts. They shall be substantially designed for the current carrying capacity and shall ensure ample phase to phase and phase to ground clearances. Suitable cable jointing kit shall be supplied by the motor vendor to match Owner's cable.

#### **4.10 Rotor**

- a. The rotor shall be of squirrel cage type, dynamically balanced to provide a low vibration level and a long service life to the bearings. The accepted values of peak-to-peak vibration amplitudes for a motor at a rated voltage and speed on a machine surface bed plate with the motor levelled and with a half key or coupling fitted shall not exceed those given in IS 4729. The shaft ends shall be provided with a suitably threaded hole or holes to facilitate the assembly or removal of couplings



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and bearing races.

- b. The rotor bars shall not be insulated in the slot portion between the iron core laminations for squirrel cage motors.
- c. Rotor will be made up of electrical steel followed by environmental protection coating for anti-corrosion.
- d. All motor rotors shall be dynamically balanced. Rotors shall be so designed as to keep the combined critical speeds with the driven equipment away from the running speed by at least 20%.

#### **4.11 Paint and Finish**

- a. Motor external parts shall be finished and painted to produce a neat and durable surface which would prevent rusting and corrosion. The equipment shall be thoroughly degreased, all rust, sharp edges and scale removed and treated with one coat of zinc epoxy primer and two coats of Epoxy paints.
- b. The motor fan shall also be painted to withstand corrosion.

#### **4.12 Anti-Condensation Heaters and Temperature Detectors**

- a. All motors shall be provided with 240 volt anti condensation heaters, sized and located so as to prevent condensation of moisture during shut down period. The heater shall remain "ON" when the motor is not in service and shall not cause damage to the windings.
- b. At least twelve simplex or six duplex resistance type embedded temperature defectors for the stator winding each having D.C. resistance of 100 at 0°C embedded in the stator winding at locations where highest temperature may be expected and at bearings. The material of the RTD shall be platinum. Temperature Detectors detector leads, external to the slot shall be provided with a protective covering. These RTDS shall be wired to PLC controls for monitoring temperature rise.
- c. The heater leads shall be brought out to a separate terminal box of the same specification and grade of protection as the main power terminal box excepting that the nickel-plated brass glands provided shall be suitable for 2 core 4 Sq. mm aluminium conductor, armoured cable.
- d. A warning label with indelible red inscription shall be provided on the motor to indicate that isolation of the power line alone is not sufficient, and that the heater supply should also be isolated before carrying out any work on the motor. Motor supplied shall be complete with all double compression cable glands, crimp type cable lugs.
- e. Motor supplied shall be complete with all double compression cable glands, crimp type cable lugs.

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#### **4.13 Noise Level**

- a. The permissible noise level shall not exceed the stipulations laid down in IEC 34-9 & IS – 12065.

#### **4.14 Motor Vibration**

- a. Motor vibrations shall be within the limits of IS 12075 unless otherwise specified for the driven equipment.

#### **4.15 Name Plate**

- a. Each motor shall have a nameplate displaying all the particulars specified in relevant standards. In addition, the nameplate shall indicate identification, number of bearings used for motor and recommended lubricant indicating required quantity of lubricant and interval at which the bearings are to be lubricated.
- b. Nameplate shall be made of 2-mm thick stainless steel with the relevant details embossed on it in English.

#### **4.16 Accessories**

Two independent earthing points shall be provided on opposite sides of the motor, for bolted connection of the Owner's earthing conductors. These earthing points shall be in addition to earthing stud provided in the terminal box.

#### **4.17 Inspection And Testing at manufacturer's Premises**

##### **4.17.1 QAP, Testing and Inspection of Motor**

- a. The general QA requirement is attached; the vendor is advised to go through the same before submitting the bid.
- b. All tests shall be conducted as per relevant IS/IEC/IEEE standards
- c. Quality Assurance plan shall be submitted by the bidder along with the vendor documents for the approval.

##### **4.17.2 General Conditions**

- a. OEM (Original equipment manufacturer) shall have ISO certification.
- b. All the tests are to be carried out in the presence of any authorized representative of the client and third party as per direction of Engineer of Contract.
- c. The contractor shall have to offer stage inspection during manufacturing process where required by the client / final inspection on completion of manufacturing for Routine test & type test inspection.

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- d. Routine test shall be performed by manufacturer on all equipments (100%) in presence of EPC agency/ contractor, client and TPA and minimum one motor to be type tested.
  - e. The proposed date of stage/ final inspection shall be informed to Owner FIFTEEN days in advance.
  - f. The contractor shall submit the following during commencement period.
  - g. Name of raw material as well as bought out accessories and the names of sub suppliers selected from those furnished after award of work.
  - h. The contractor shall submit the routine/ type test certificate of bought out items& raw materials at the time of routine testing of the fully assembled equipment.
  - i. List of standards; according to which the raw materials are tested, list of tests normally carried out on raw materials in presence of contractor's representative, copies of test certificates.
  - k. Type test certificates of the raw material and bought out accessories.
  - l. Instruments
    - A) The manufacturer should keep the precise and accurate measuring instruments.
    - B) The periodical calibration should be carried out of all the instruments /equipments used for the measurement during tests and for assessing the various properties of the material and accessories.
    - C) The proper record of the same should be maintained during manufacturing stage and shall be shown to the inspecting officer on demand.
    - D) All measuring instruments used in inspection and testing shall be properly calibrated and sealed once in a year with tag of competent authority.
  - m. Equipment offered shall have all Type Test Certificates from accredited laboratory (accredited based on ISO/IEC Guide 25 / 17025 or EN 45001 by the National Accrediting Body of the country where laboratory is located), as per IEC /IS /technical specification.
  - n. The type test conducted shall be on similar equipment and on similar capacity.
  - o. Equipment not type tested in the last five years, type tests need to be performed without any extra cost. The purchaser may select the motor for type tests randomly.
  - p. The acceptance of any quantity of equipment shall in no way relieve the vendor of his responsibility for meeting all the requirements at this specification & shall not prevent subsequent rejection, if such equipments are later, found to be defective.

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- q. EPC agency shall arrange for commissioning test at site by the OEM/ OEM approved agencies confirm equipments are healthy at site & test result at site are same & committed figures are achieved.
  - r. Four sets of certified type tests reports shall be submitted for approval prior to dispatch of the equipment. The equipment shall be dispatched only when all the required acceptance & routine tests have been carried out & the test reports have been approved by the client & TPA.
  - s. Certificates shall be clearly identified by serial or reference number where. possible to the material being certified and shall include information required by the relevant reference standard or specification clause
  - o. Job pump of each type shall be tested with job motor and shall be witnessed by client's representative.
  - p. soft starter shall be tested with job motor & Job pump to check that Starting current of motor shall be as per the value given during bid evaluation. In case this type of testing not done during factory test, agency shall be responsible to prove the starting current value during commissioning stage. Any dispute between pump/motor/ soft starter shall be resolve by the agency.

#### **4.18 Routine Test**

- i. Insulation resistance test before and after HV test
- j. High voltage test
- k. No load running of the motor and measurements of currents and voltages on all three phases.
- l. Locked rotor test at suitable voltage.
- m. Testing of accessories/auxiliaries for correct functioning.
- n. Vibration test.
- o. Noise Level test.
- p. Reduced voltage running up test at no load to check the ability of motor to run up to full.

#### **4.19 Type Test**

Measurement of stator resistance and rotor resistance of motor.

- a. No load running of motor and reading of voltage, current, power and speed.
- b. Open circuit voltage ration on motors.
- c. Reduced voltage running up test at no load to check the ability of motor to run up to

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full

- d. Speed on no load in each direction of rotation with  $1/\sqrt{3}$  of the line voltage applied to the motor.
- e. Locked rotor reading of voltage, current, power input and torque of motors.
- f. Full load reading of voltage, current, power input at 125%, 110%, 100%, duty point, 75%, 60%, 50 % load
- g. Temperature rise test.
- h. Momentary overload test
- i. Insulation resistance test with before and after the high voltage test.
- j. High voltage test
- k. IP 55 test as per applicable standard.

#### **4.20 MOTOR Acceptance After Test**

Motor not meeting min guaranteed parameters shall not be accepted till required parameters are achieved in performance testing.

Though the motors shall be accepted on the basis of the satisfactory results of the tests at the works, it shall not absolve the vendor from liability regarding the proper functioning of the motor coupled to the driven equipment at site.

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## 5. Pipes and Specials

### 5.1 GENERAL

The scope of work is to manufacture & supply pipes, which shall be in conformity with IS: 3589 – 2000 (latest) & IS 5504 (latest) from M. S. Plates conforming to IS: 2062 -1999 or hot rolled steel coils conforming to IS: 10748-2004 of required sizes with internal lining of solvent free Food-grade Epoxy (confirming to BS-6920) and external coating of 3 Layer Poly Ethylene (3 LPE) - confirming to DIN 30672 or any other appropriate standard. The Dry Film Thickness (DFT) of internal epoxy lining shall be minimum 406 micron and total thickness of external 3 LPE coating shall be 3.7 mm on body of pipe and 3.3 mm on weld joint.

The M. S. Pipes, manufactured at the factory shall be provided with bevel ends. After the final inspection of the pipe, the pipe bevel ends on both the sides shall be covered with suitable protectors such that the pipe ends does not get damaged during transportation, loading and unloading work. Also, varnishing will be carried out at the inside and outside of the pipe cut back portion to avoid the corrosion of the un- coated metal during storage period. The varnishing can be removed after wards at the time of the welding and field joint coating. The spiders on both ends of the pipe shall be of adequate size and stiffness to keep the pipe in circularity during handling and storage. It will not be less than 80 mm OD pipe. The spider pipe shall be a heavy duty pipe with at least 6 mm wall thickness. If possible, the pipe vendor shall avoid the welding of the spider pipe with the main pipe and adopt some other means for this purpose as it damages the internal surface of the pipe metal.

All the Piping Work in side of the Pump House shall be externally coated with Zinc Rich Primer & suitable Epoxy Paint (Total DFT 200 microns). All the piping work out side of the Pump House including the pump discharge piping and discharge header shall be externally coated with 3 LPE coating of 3.7 mm DFT on body of pipe and 3.3 mm on weld joint.

The pipes shall be of uniform bore and straight in axis.

The flanges of the straight pipes shall be square to the axis of the pipe. The faces of the flange shall be parallel. The bolt holes circle shall be concentric with the bore and bolt holes equally spaced. In straight pipes, the bolt holes in one flange shall be located in line with those in other.

The faces of the flanges of the fittings shall be square to the directional axes. The holes shall be located symmetrically off the center line. The intersecting axes of the tees shall be perpendicular to each other.

The bolt holes on flanged pipes and fittings shall be drilled with the help of drilling jig. The blank flanges are to be machined and drilled.

All nuts and bolts used for jointing the pipes and fittings shall be of hot dipped galvanized.

The approximate quantity for the pipe and fittings shall be furnished in schedule of quantity.

The quantity of pipes is for tender purpose only. So during ordering of pipes & fittings, Contractor has to measure the actual quantities required as per execution of the site & prior approval should be taken from Engineer-In-Charges / client.

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The Pump discharge pipe lines in the pump house, shall be provided with necessary air venting arrangement like, air valves or ball valves (manually operated) of adequate size & rating for venting of air during start-up of the pumps.

The reducers shall be prepared by conical bending of M S Plates in either single piece (with one long seam weld joint) or half round pieces (with 2 nos. of long seam weld joints). The minimum length of reducers shall be at least equal to or more than the major diameter of the pipes to be connected. At Shop, the testing of the welding joints shall be carried out by UT and Die Penetrating Testing to ensure the soundness of the weld joints. Required pre-heating shall be done while welding of field joints on the pipe to ensure that there is no moisture present. Coil joint weld seam should not be failed at any time during testing. The LCM of ultra-sonic thickness gauge must be 0.01 mm at pipe manufacturing unit.

Sr. No.	Description	Particulars
1	Plates / HR coil	IS:2062, Gr, E 250 BR / IS : 10748 Gr. III Fe 410
2	Welding & Electrodes	ASME-SECT-IX, IS-7310, IS:7307, IS:814, IS:3613, IS:6419, IS:7280
3	Inside Food Grade Epoxy / Outside Epoxy Coating	Relevant detail Specification
4	Fabrication & Manufacturing of Pipe	IS : 3589 and / or IS: 5504

## **6. Electrically/Manually Operated Butterfly Valve**

### **6.1 General**

- a. This specification covers the design, engineering, manufacturer, transportation to site, installing, testing double flanged and wafer type of metal seated, dual eccentricity ductile iron electrically/manually operated butterfly valves.
- t. Valves covered under this specification are electrically and manually operated. Fabricated valve will not be considered.

### **6.2 Design Criteria**

- a. Butterfly valve shall be as per IS 13095 /BS 5155. Valve shall be suitable for mounting in any position.
- u. Butterfly valve shall be provided with bypass arrangement (Minimum 4" or as per manufacturer whichever is high). This may be integral with valve or connected between pipes.
- v. Valves shall be double flanged type and the face shall be parallel to each other and flange face should be at right angles to the valve centreline.
- w. The valve stem, thrust washers, screws, nuts and all other components exposed to the water shall be of a corrosion resistant grade of stainless steel and free from sharp projections.
- x. The valve seat shall be of integrally cast or renewable design. When the valve is fully closed, the seal shall seat firmly so as to prevent leakage. The seat surfaces shall be machined smooth to provide a long life for the seal.
- y. All fasteners shall be set flush so as to offer the least resistance possible to the flow through the valve.
- z. Valve shall be suitable for throttling purpose.
- aa. All valve, spindles and hand wheels shall be positioned to give good access for operational personnel.
- bb. All hand wheels shall be arranged to turn in a clockwise direction to close the valve, the direction of rotation for opening and closing being indicated on the hand wheels.

### **6.3 Service Applications**

- a. Valves shall be suitable for one or more of the following applications
- b. Tight Shut off- A valve having no visible leakage on the disc in closed position under test conditions
- c. Regulating - A valve intended for regulating purpose and which may have a Clearance between



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the disc and the body in close position.

- d. Low leakage - A valve which has specified maximum leakage rate on the disc in the closed position.
- e. Vacuum Condition

Where valves are to be used under vacuum conditions, the detailed design provision shall be mutually agreed between the purchaser and the manufacturer

#### **6.4 Nominal Pressures**

Valve shall be designated by nominal pressure (PN) defined as the maximum permissible working pressure (MPa) at 20 0 C temperatures as follows:

PN 0.25, PN0.6, PN1.0, PN 1.6, PN 2.0 & PN 2.5

#### **6.5 Pressure/Temperature ratings**

Maximum permissible gauge working pressure and operating temperatures shall be in accordance with IS 6418: 1971 and IS 13159 (Part-1):1991 except that restriction on temperature may be placed by the manufacturer on valves in accordance with this standard by reason of valve type, trim materials or other factors. However, all valves shall be suitable for continuous use at their PN designation within the temperature range of –10 0°C.to 65 0°C.

#### **6.6 Body Ends**

##### **6.6.1 Double Flanged Body Ends**

- a. The dimensions of flanged body ends and drillings shall be in accordance with the IS 1538 (latest). Flanges as per any other specific requirements of the Owner may also be given “As Agreed” between the manufacturer and the Owner.
- b. Flanges shall be at right angles to the axis of the bore and concentric with the bore. Flanges shall be drilled unless otherwise specified and bolt holes shall be off centres.

##### **6.6.2 Water Body Ends (Where ever applicable)**

- a. Body ends shall be capable of being fitted between the pipe flanges complying with the requirements of flange drilling.
- b. The joint faces shall be at right angles to the axis of the bore and concentric with the bore.
- c. Holes may be provided, where required by the design, for the passage of the bolts securing the flanges and the valve. Where through bolting is not practicable due to the presence of valve shaft, bearing housing, tapped holes may be provided for individual bolting of each flange.

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### 6.6.3 Face to Face Dimension

Face to face dimensions of double flanged and wafer types of valve shall be as per standard. Face to face dimensions are exclusive of the sealing gaskets at both ends. The manufacturer shall ensure that adequate space will be available between valve flanges for bolting when flanged valve with short body face to face or wafer type face to face are manufactured. Tolerance on face to face dimension shall be as follow

<u>Face to face Dimension of the Valve (mm)</u>		<u>Tolerance (mm)</u>
<u>Over</u>	<u>Up to and Including</u>	
0	250	<u>+2</u>
250	500	<u>+3</u>
500	800	<u>+4</u>
800	1,000	<u>+5</u>
1,000	2,400	<u>+6</u>

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### 6.6.4 Bodies

Bodies end ports shall be circular and the numerical valves of the diameter shall be as close as possible to the valve of DN.

### 6.6.5 Disc and shafts

The disc and shaft shall be designed to withstand the maximum pressure differential across the valve in either direction of flow. The shaft may be of one piece design attached to the disc. Any means of attachment between the shaft and the disc shall be such as to preclude components becoming loose in service.

### 6.6.6 Seating and linings

Non-integral seating, and lining where used, and their means of attachment shall be such as to preclude their becoming loose in service.

### 6.6.7 Bearings

- a. The bearings shall be suitable for the maximum loads imposed by the shaft during testing and in service.

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- b. For valves DN 350 and above, a bearing shall be provided to take the axial thrust; spring retaining clips (circlips) shall not be used as thrust bearing. Suitable sealing shall be provided for the shaft where it passes outside the pressure containing en closer.

## **6.7 Operation**

### **6.7.1 Electrically and Manually Operated**

All valves shall be electrically (pump house valve) and manually operated (rising main valves) and capable of operate at a differential pressure across the disc as marked on the valve.

### **6.7.2 Direction of Operation**

Unless otherwise, specified manually operated valves shall be closed by turning hand wheel or lever in a clockwise direction when facing the hand wheel or lever. The design of lever when fitted shall be such that the lever may only be assembled to the valve so that it is parallel to the direction of flow when the valve is open.

All gear traveling nut operators shall be provided with suitable stops to prevent movement of the shaft beyond the limit corresponding to the fully closed position of the disc.

All gear traveling nut operators shall be packed with grease for life time operation. Gear / traveling nut operators shall be totally enclosed and weather proof for general application. For special applications such as marine, submerged service, etc. the purchaser may specify special enclosure.

All gear/traveling nut operators shall be self-locking type. All leaver operated valve shall be capable of being locked at least three intermediate position.

The operating hand-wheels shall be marked 'CLOSE' or 'SHUT' to indicate the direction of closer.

The operator shall be provided with arrangement to indicate the disc position.

## **6.8 Testing**

All valves shall hydrostatically tested by the manufacturer before dispatch. The pressure shall be obtained without any significant hydraulic shock. Testing shall be carried on before application of paint. There shall be no air entrapped within the part of the valves subjected to test pressure.

### **6.8.1 Performance Testing**

Each valve shall be shop operated from fully closed to fully open position and reverse, under no pressure and no flow condition to demonstrate that the complete assembly is workable.

### **6.8.2 Body Test**

- a. Completely assembled valve shall be tested as follows:

- b. The body ends shall be blanked so that the valve is subjected to the full pressure in all directions include by the test pressure water. Valves may be tested in any suitable manner as directed by Engineer-In-Charge. The valve disc shall be in slightly open position and pressure equivalent to 1.5 times the maximum permissible working pressure shall be applied with water. The duration of this test shall be as per standard.

### 6.8.3 Seat Test

- a. The seating surface of the valve shall be cleaned unless a surface treatment forms an integral part of the design or the use of a temporary surface treatment has been agreed between the manufacture and the Owner to avoid the possibility of damage under the condition of the test.

Nominal Diameter (MM)	MINIMUM TEST DURATION (MINUTES)	
	Body Test	Seat Test
Up to and including 50	0.25	0.25
65 to 150	1.00	1.00
200 to 300	2.00	2.00
350 to 1000	5.00	2.00
1200 to 2.000	5.00	3.00

- b. Each valve shall be shop tested for leaks in close position. The test shall be conducted with the body flanges in a horizontal position. Pressure shall be applied to the upstream end of the valve, the downstream being open to atmosphere. The duration of test shall be as per Table above. There shall be no indication of leakage the valve disc during test and valves shall be drop tight. Seat test shall be carried out in both the direction of valve.
- c. The seat pressure applied on upstream side shall be equivalent to 1.6 (16 Kg/Cm<sup>2</sup>) times the maximum permissible working pressure at 20°C and shall be applied with water.

### 6.8.4 Disc Strength Test

- a. The test shall be conducted with the body flanges in horizontal position. The test pressure shall be 1.5 times the maximum permissible pressure at 20°C With disc in closed position, hydro test pressure shall be applied to the lower face of the disc for duration as per above table.
- b. There shall be no damage to the valve disc nor shall any part of valve or disc be permanently deformed by the test. The purpose of this test is to provide evidence of the adequacy and structural integrity of disc and body (Sampling test sample as per IS 2500).
- c. Pouring witness and sampling of the integral test bar shall be carried out at the foundry by TPI for the valves above 500 mm diameter. Necessary provision shall be made in the quality

assurance plan(QAP) submitted by the agency for review and approval.

#### 6.9 Test Certificates

When specified by Owner, the manufacturer shall issue a test certificate confirming that the valves have been tested in accordance with this standard and stating the actual pressures and medium used in the test.

Valve Test	LEAKAGE RATE
Tight shut of	No Visible leakage for duration of test
Low leakage	$0.1 \text{ mm}^2 / \text{s} \times \text{DN (sec 5)}$
Regulating	Not specified (outside the scope of this standard)

#### 6.10 Inspection

- The Owner& TPI representative shall have access to the manufacturer's works at all reasonable times to inspect assembled valve at factory. The Contractor has to make necessary arrangements for testing facilities of the valves as per the relevant IS at factory.
- Pouring witness and sampling of the integral test bar shall be carried out at the foundry by TPI for the valves above 500 mm diameter. Necessary provision shall be made in the quality assurance plan(QAP) submitted by the agency for review and approval

#### 6.11 Witnessing of Tests

When the Owner desires to witness the tests, this shall be specifically agreed in advance by Owner representative,

#### 6.12 Marking

Marking shall be cast integral on the body or on a plate securely attached to the body for 'DN' size and 'PN' rating. The markings shall be in accordance with I.S. 9866:1981or Latest Edition.

#### 6.13 Preparation for dispatch

- Valve shall be complete in all respect when dispatched. Each valve shall be drained, cleaned, prepared and suitable protected with 2 coats of red oxide on machined surfaces and rust preventive coats on machined and flanged surfaces for 'seaworthy dispatch' in such a way as to minimize the possibility of damage and deterioration during transit and storage.
- Disc shall be unseated when dispatched, but care shall be taken to ensure that there is no risk of damage to the disc.

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- c. When specified, the body ends shall be suitably sealed to exclude foreign matter during transit and storage.
  - d. Components shipped unattached shall be adequately protected and identified to permit correct field assembly.

#### **6.14 Fixing of Valves**

- a. Loading at store and unloading at site of works shall be done carefully using suitable mechanical handling devices such as crane, chain pulley etc. Valves used in pipeline shall be straight through type. Each valve or its operation equipment shall bear an approved name plate stating its function. All operation spindles, gears and head stocks shall be provided with adequate points for lubrications.
- b. The Contractor has to provide dismantling joint in rising main for easy assembly /disassembly and maintenance or replacement of the manually operated butterfly valve.

#### **6.15 Electric Actuator**

- a. Each actuator shall be adequately sized to suit the application and be continuously rated to suit the modulating control required. The gearbox shall be oil or grease filled, and capable of installation in any position. All operating spindles, gears and head stocks shall be provided with adequate points for lubrication.
- b. The valve actuator shall be capable of producing not less than 1½ times the required valve torque and shall be suitable for at least 15 minutes continuous operation.
- c. The actuator starters shall be integrally housed with the actuator in robustly constructed and totally enclosed weatherproof housing. The motor starter shall be capable of starting the motor under the most severe conditions.
- d. The starter housing shall be fitted with contacts and terminals for power supply, remote control and remote positional indication, and shall also be fitted with internal heaters so as to provide protection against damage due to condensation. Heaters shall be suitable for single phase operation. The heaters shall be switched "ON" when the starters are "OFF" and shall be switched "OFF" when the starters are "ON".
- e. Only for pump house BFV shall be attached with electric actuator.
- f. However, for rising main "CI BFV" (Refer Technical Particulars 5.16 3b) shall be with suitable size manually gear attachment because of its isolated cross-country different locations.
- g. Electric actuator for "DI BFV" (Refer technical Particulars 5.16 3a) of pump house shall be suitable for frequent operation as well as operation after long periods of idleness in either open or closed position. If required in future, these positions (open or closed position) shall be computable for extending its signals with RS 485 Ethernet port to central control room through PCB-SCADA system.

- h. Each starter shall be equipped as follows:
  - i. A.C. electric motor.
  - ii. Reduction gear unit.
  - iii. Torque switch mechanism complete with set of torque switches.
  - iv. Limit switch mechanism complete with set of limit switches.
  - v. Hand wheel for manual operation.
  - vi. Hand-auto changeover lever with suitable locking arrangement.
  - vii. Local control switch / push buttons
  - viii. 415 V / 240 V AC control transformer
- i. The actuator shall be suitable for operation in the climate conditions and power supply conditions given in the specification. The actuator shall be capable of producing not less than 1½ time the maximum required torque and shall be suitable for at least 15 minutes continuous operation.
- j. All local controls shall be protected by a lockable cover.

#### 6.16 Technical Particulars of Electrically/Manually Operated Butterfly Valve(PN – 1.6)

Sr. No.	DESCRIPTION	PARTICULARS
1	Make	(As per approved vendor list)
2	Design Code	IS: 13095-1991 or latest
3a	(For Pump House) Size (mm)	As Per Design
4	Fluid	Raw water
5	Ends	Flanged Ended, Flat Faced flanged(As per IS: 1538 Table IV & VI)
6	Disc	Dual Eccentrically Solid Wedge
7	Operation	Manual and Electrically Actuator Operated (As described)
8	Seat	Body – Renewable. Disc – Renewable.
9a	(For Pump House) Body	Ductile Iron
9b	(For Rising main) Body	Ductile Iron
10	Disc	SG Iron IS 1865 GR. 500/7
11	Stem	Stainless Steel AISI 316
12	Drive Shaft	Stainless Steel AISI 316
13	Stub Shaft	Stainless Steel AISI 316
14	Body Seat Ring	Stainless Steel BS 970 Gr. 304 S-16
15	Disc Seal	Nitrile Rubber

Sr. No.	DESCRIPTION	PARTICULARS
16	Bolts, Studs & Nuts	Carbon Steel IS 1367 Class 4.6/4
17	Body Test Pressure	As per Design Code
18	Disc Test Pressure	As per Design Code
19	Seal Leakage Test	As per Design Code
20	Total Weight (kg) of the Complete Assembly	As per Design Code
21	Over-all dimensions of the complete assembly – L X B X H (mm)	As per Design Code
22	By-pass Valve to Main Valve	Required(Minimum 4”) or As per manufacturer whichever is high



## **7. DUAL PLATE CHECK VALVE (DI/PN 1.6)**

### **7.1 Design requirements**

- a. The design and manufacture of the valves shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. Nothing in this specification shall relieve the Contractor of his responsibility.
- b. The non-return valves shall be of dual plate check valve type design. It shall be free from sharp projections.
- c. The valves shall be designed for minimum head loss. The valves shall have flanged ends.
- d. The valve shall be suitable for mounting on a horizontal pipeline and flow direction shall be clearly embossed on the valve body.
- e. Valves shall possess high speed closing characteristics and be designed for minimum slam condition when closing.
- f. Dual plate check valves shall conform to API 594. They shall have metal to metal sealing. The spring action shall optimise the equal closing rates of each plate especially when the friction coefficients are uneven due to one plate resting upon one another. The plates shall not drag on the seat while opening. The plates shall not vibrate under full or partial flow condition.
- g. In case of the nozzle check valve, the disc shall be correctly positioned at all times to achieve fully non-slam closure. The spring shall be fully shielded from the flow stream by the central flow diffuser.
- h. Sealing shall be metal to metal. The disc shall be stable and shall not vibrate under full or partial load conditions. The pressure designation of the valve shall be as per the Data Sheet.

### **7.2 Cleaning**

Prior to factory inspection, all manufacturing waste such as metal chips debris and all other foreign matter shall be removed from interior of valve. All mill scale, rust, oil, grease, chalk and all other deleterious material shall be removed from the interior and exterior surfaces.

### **7.3 Painting**

Valves shall first be given two coats of zinc base primer after completely cleaning the surface and then it shall be coated with three coats of coal tar epoxy paint. The resulting coating shall be uniform and smooth and shall adhere perfectly to the surface.

### **7.4 Testing and Inspection**

- a. Valves shall be tested as per the relevant Indian standards. Specification IS 5312, Part – II, with latest revisions.

- b. Valves shall be offered for visual inspection and dimensional checks.
- c. The hydrostatic and water tightness testing shall be witnessed by the Owner.

### 7.5 Fixing of Valves

- a. Loading at store and unloading at site of works shall be done carefully using suitable mechanical handling devices such as crane, chain pulley etc. Valves used in pipeline shall be straight through type. Each valve or its operation equipment shall bear an approved name plate stating its function. All operation spindles, gears and head stocks shall be provided with adequate points for lubrications.
- b. The Contractor has to provide dismantling joint in rising main for easy assembly /disassembly and maintenance or replacement of the manually operated butterfly valve.

### 7.6 Technical Particulars of Dual Plate Check Valve (DI/PN 1.6)

Sr. No.	DESCRIPTION	PARTICULARS
1	Make	As per approved vendor list
2	Design. /Testing Code	API 594/API 598
3	Size (mm)	As Per Design
4	Pressure (Kg/cm2)	16
5	Type	Non slam, spring action dual plate
6	Ends	Flanged. Flanges shall be flat faced and confirming to IS 1538 part IV & VI having off centre bolt holes
7	Seat	Body - Renewable Plate - Renewable
8	Liquid	Raw Water
9	Body	Ductile Iron (DI)
10	Disc/Plate	Cast Steel
11	Seat rings	S.S AISI 304
12	Spring	S.S. AISI 304
13	Bearings	Teflon

Sr. No.	DESCRIPTION	PARTICULARS
14	Hinge Pin / stop pin	S.S. BS 970 Gr 304 (M)
15	Bolts, Studs & Nuts	Carbon Steel IS :1367 Class 4.6 / 4 hot dipped galvanized
16	Body Test Pressure	As per Design Code
17	Disc Test Pressure	As per Design Code
18	Face to face dimension	As per Design Code
19	Companion flanges and erection hardware	As per Design Code
20	Total Weight (kg) of the Complete Assembly	To be furnished by Contractors
21	Over-all dimensions of the complete assembly – L X B X H (mm)	As per Design Code

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## 8. Manually / Gear Operated Sluice valve

### 8.1 General

- a. This specification covers the design, engineering, manufacturer, transportation to site, installing, testing double flanged manually operated Sluice valves.
- b. Valves covered under this specification are manually operated. Fabricated valve will not be considered.

### 8.2 DESIGN FEATURES

- a. Sluice valve shall conform to IS 14846. Except pump house, these valves are to be installed in valve chamber
- b. All valves of pump house and rising mains shall be non-rising stem type. However, for rising main, it shall be complete with its “**as required length**” “valve key” for valve operation from outside of chamber.
- c. The valves shall be free from sharp projections, which are likely to catch and hold stringy materials.
- d. Valves shall close with clockwise rotation of the hand wheel. The direction of closing and opening shall be marked on the hand wheel.
- e. The stuffing box gland shall be of one piece design.
- f. other technical data required please refer technical datasheet of volume –III (E)

### 8.3 FEATURES OF CONSTRUCTION

- a. The valves shall have non-rising spindle. The valves shall be provided with a valve position locking arrangement (Mechanical).
- b. Valves shall be provided with back seating arrangement. Renewable body and wedge ring shall be provided. Valve shall be double flanged and holes drilling on flange shall conform to the standard IS1538-1976.
- c. The valves shall be completely overhauled before placing in position.
- d. Necessary joining materials viz. bolts, nuts, washers, packing etc. shall be provided by the contractor at this cost. The valves shall be fixed so as to have axis perfectly horizontal.
- e. If required the contractor shall also carry out drilling of holes of appropriate diameter in flanges in required numbers.
- f. A hand wheel shall be provided for emergency operation. The hand wheel drive shall be mechanically independent.

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- g. The valve design shall take care of the pressure drop across the valve disc in case of partial opening of the valve and shall take care of the erosion and cavitations effect on the body and disc during such operation.
  - h. Valve(s) subjected to back pressure shall have the valve seat, disc and the operator suitably designed to ensure trouble-free operation.
  - i. Valve body shall be of Ductile iron with flanged ends.
  - j. The shaft diameter shall take into consideration, the maximum torque required for the valve operation, the maximum differential pressure across the valve disc when the valve is closed and the shock load due to accidental closure of the valve disc.
  - k. The disc shall be designed for maximum differential pressure across the valve as well as the shock load due to accidental closure of the valve. Disc design shall offer minimum head loss. Disc shall also offer minimum resistance to flow Disc shape shall be contoured.
  - l. Valve seats shall be of a design that permits removal and replacement at site and shall be securely clamped on the body or disc of the valve.
  - m. Seat material shall be suitable for the operating conditions and handling fluid and may be suitably reinforced, if required.
  - n. The seat design shall permit easy removal for replacement purposes with out the need for removing the valve from the line. No deposited or welded seat rings permitted.
  - o. The valve bearings shall be of 'self lubricated' type and shall not have any harmful effect due to handling fluid.
  - p. Adjustable thrust bearing(s) shall be provided to hold the valve disc securely in the centre of the valve seat.
  - q. Each Sluice Valve shall be provided with a hand wheel for manual operation. The hand wheel and associated gearing arrangement shall be designed to limit the maximum manual effort to around twenty(20) kg for valve operation. For the Valves located at in accessible position, it shall be provided with extension spindle and floor stand or hand lever / round chain to facilitate manual operation.

## **8.4 Operation**

### **8.4.1 Electrically and Manually Operated**

All valves shall be electrically (pump house valve) and manually operated (rising main valves) and capable of operate at a differential pressure across the disc as marked on the valve.

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## **8.5 INSPECTION AND PERFORMANCE TESTS**

- a. Manufacturer shall conduct all tests and stage inspections required to ensure that the equipment offered by him conform to the specification requirement.
- b. Test certificates for all shop tests shall be furnished to Consultant / Owner for approval. The Client may witness the tests, if he so desires.
- c. The Contractor shall arrange for inspection of valves at manufacturer's premises and shall arrange for testing of valves for body test pressure and seat test pressure of all the valves to be supplied in presence of Consultant / Owner in line with the approved Quality Assurance Plan.
- d. Defects noted during inspection, test and operation of valves shall be rectified by the contractor at his own cost without any extra claim to the entire satisfaction of the Consultant / Owner.

## **8.6 VARIOUS TESTS**

### **8.6.1 Material Test**

Material to be used for the valve components shall be of tested quality. Chemical analysis and mechanical tests on materials to be used shall be done as per relevant standard.

### **8.6.2 Non-destructive Test**

Valve body and disc shall be subjected to Non – Destructive Testing(NDT). Components subjected to NDT and shall be stamped for identification.

### **8.6.3 Hydrostatic Test**

Each valve body shall be subjected to hydro static test as specified. For valves subjected to back pressure condition, leakage test shall be carried out on both sides of the disc.

### **8.6.4 Performance Test**

Each valve complete with operator shall be shop operated at least three(3) times from fully closed to fully open conditions and reverse, hold at intermediate positions under no flow condition, to prove the workability of the assembly.

## **8.7 TESTS AT SITE**

Performance of the valves shall be tested at site at actual working condition.

## **8.8 CLEANING**

Prior to factory inspection, all manufacturing waste such as metal chips debris and all other foreign matter shall be removed from interior of valve. All mill scale, rust, oil, grease, chalk and all

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other deleterious material shall be removed from the interior and exterior surfaces.

## **8.9 PAINTING**

Valves shall first be given two coats of zinc base primer after completely cleaning the surface and the nit shall be coated with three coats of epoxy paint. The resulting coating shall be uniform and smooth and shall adhere perfectly to the surface.

## **8.10 HANDWHEEL**

A hand wheel shall be provided for emergency operation. The hand wheel drive shall be mechanically independent of the motor drive and any gearing should be such a stop permit emergency manual operation in a reasonable time.

## **8.11 TESTS AND INSPECTION**

Valve shall be offered by vendor for visual inspection before shipment. Valves shall be tested as per the relevant standards. The hydrostatic testing shall be witnessed by the purchaser

## **8.12 Material of construction**

All sluice valves shall be of body Cast Steel, Spindle SS. All valves shall be supplied with matching companion flanges with necessary bolts, nuts and gaskets.

## **8.13 DUCTILE IRON SLUICE VALVES**

End flanges shall be Ductile iron with the body.

The body to bonnet joint shall be flanged, male & female, tongue & groove or ring joint type. The bonnet joint shall have at least four through bolts.

## **8.14 Fixing of Valves**

- a. Loading at store and unloading at site of works shall be done carefully using suitable mechanical handling devices such as crane, chain pulley etc. Valves used in pipeline shall be straight through type. Each valve or its operation equipment shall bear an approved name plate stating its function. All operation spindles, gears and head stocks shall be provided with adequate points for lubrications.
- b. The Contractor has to provide dismantling joint in rising main for easy assembly /disassembly and maintenance or replacement of the manually operated Sluice valve.

## **8.15 Electric Actuator**

- a. Each actuator shall be adequately sized to suit the application and be continuously rated to suit the modulating control required. The gearbox shall be oil or grease filled, and capable of installation in any position. All operating spindles, gears and head stocks shall be provided with adequate points for lubrication.
- b. The valve actuator shall be capable of producing not less than 1½ times the required valve torque

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and shall be suitable for at least 15 minutes continuous operation.

- c. The actuator starters shall be integrally housed with the actuator in robustly constructed and totally enclosed weatherproof housing. The motor starter shall be capable of starting the motor under the most severe conditions.
- d. The starter housing shall be fitted with contacts and terminals for power supply, remote control and remote positional indication, and shall also be fitted with internal heaters so as to provide protection against damage due to condensation. Heaters shall be suitable for single phase operation. The heaters shall be switched "ON" when the starters are "OFF" and shall be switched "OFF" when the starters are "ON".
- e. Only for pump house Sluice Valve shall be attached with electric actuator.
- f. However, for rising main "CI SV" (Refer Technical Particulars 7.16 3b & 3c) shall be with suitable size manually gear attachment because of its isolated cross-country different locations.
- g. Electric actuator for "DI SV" (Refer technical Particulars 7.16 3a) of pump house shall be suitable for frequent operation as well as operation after long periods of idleness in either open or closed position. If required in future, these positions (open or closed position) shall be computable for extending its signals with RS 485 Ethernet port to central control room through PCB-SCADA system.
- h. Each starter shall be equipped as follows:
  - ix. A.C. electric motor.
  - x. Reduction gear unit.
  - xi. Torque switch mechanism complete with set of torque switches.
  - xii. Limit switch mechanism complete with set of limit switches.
  - xiii. Hand wheel for manual operation.
  - xiv. Hand-auto changeover lever with suitable locking arrangement.
  - xv. Local control switch / push buttons
  - xvi. 415 V / 240 V AC control transformer
- i. The actuator shall be suitable for operation in the climate conditions and power supply conditions given in the specification. The actuator shall be capable of producing not less than 1½ time the maximum required torque and shall be suitable for at least 15 minutes continuous operation.
- j. All local controls shall be protected by a lockable cover.



### 8.16 Technical Particulars of Sluice Valve (PN – 1.6)

Sr. No.	DESCRIPTION	PARTICULARS
1	Make	(As per approved vendor list)
2	Type and Design Standard	Non rising sluice valve/IS 14846 (latest)
3a	(For Pump House) Size (mm)	Manual Operated / Gear Operated
4	Pressure Rating	PN – 1.6
5a	(For Pump house) Body	Ductile Iron
5b	(For Rising Main) Body	Ductile Iron
6	Stem	Stainless Steel
7	Operation	Manually / Gear Operated (Pump House)
8	Application	Raw Water
9a	Hand Wheel (For pump house without valve key)	Ductile Iron
9b	Hand Wheel (For rising main's below kinetic air valve and without valve key)	Cast Iron
10	Total Weight (kg)of the complete assembly	As per Design Code
11	Over-all dimensions of the complete assembly – L X B X H (mm)	As per Design Code

## 9. Metallic Expansion Bellow (PN 1.6)

### 9.1 General

- a. Design, fabrication, testing and installation of metallic expansion bellows with necessary hardware have to be provided at delivery side of each pump.
- b. Expansion joint shall be a metallic flexible connector fabricated of plies of metal corrugation to provide stress relief in piping systems due to thermal, mechanical and other moments and movements.
  - Compensate, Lateral, Axial, Torsion and Angular movements.
  - Low movement forces
  - Reduced fatigue factor
  - Reduced heat loss
- c. It provides flexibility and concurrent movements.
- d. Expansion bellows shall be designed as per the details furnished in the data sheet and shall be in accordance with the **EJMA** standard. All expansion bellows shall be free from dirt, moisture, grease, oil, etc. and all reports for hydrostatic test shall be furnished. Fatigue life expectancy to be considered for bellows is minimum 7000 cycles.
- e. The bellows shall be metallic corrugated design and shall have double flange. The material for Bellows shall be SS 304.
- f. In order to avoid pipe buckling, guide collars must be provided regularly along the pipe length. A guide collar must also be provided on either side of the SS Expansion Joint
- g. Maximum service life depends on careful and correct installation. Transport Expansion Joints to area of installation in packed condition. Flange face of companion flanges in pipeline should be smooth and without any sharp edges. For large size of Expansion Joints installed in horizontal ducts, lifting lugs welded to flanges should be used to hoist joint in position. Joints should only be fitted after all work on the pipeline and flanges have been complete and anchors and supports have been established. This is to avoid any accidental damage due to welding splatter or sharp objects and to ensure that the joints are not overstressed.
- h. The bolts on the flanges must be tightened evenly. Uneven tightening may lead to hazardous leakage. Faulty fitting may lead to failure of the expansion joints.

### 9.2 Operating Principal

- a. Expansion Joints are flexible, reinforced bellows which are used in piping systems to meet the following major needs

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- b. To protect piping by absorbing any difference in dimension due to temperature variation or line movement.
  - c. It shall be protect equipment such as supports & anchors, pumps & valves etc., other equipment.
  - d. It shall be useful for simple connection of misaligned pipes.
  - e. Movement Accommodation

Expansion and contraction, as well as rapid movements (dynamic stresses), are absorbed multidirectional and often simultaneous deflections:

### **9.3 Tests and Inspection**

- a. Bellows shall be tested as per the relevant Standards with latest revisions.
- b. Bellows shall be offered for visual inspection and dimensional checks.
- c. The hydrostatic and water tightness testing of one of each size shall be witnessed by the Owner.
- d. Compression and expansion test shall be offered for one no. for each size and to be witnessed by the Owner.
- i. UTS
- xvii. Liquid Penetration test
- xviii. Deflection
- xix. Life Cycle Test with load
- xx. Vacuum test
- xxi. Hydraulic test
- xxii. Stiffness test
- xxiii. Vibration test

### **9.4 Mechanical Data**

- i. M.O.C. of Tie Rods & Nuts shall be as per IS 1367.
- xxiv. M.O.C. of Weld ends & Lugs shall be as per IS 2062.
- xxv. All Bellows shall have IS: 2062 plate flanges. The hole-drilling dimension shall be as per IS: 1538 to match with the pump outlet flange or valve flange as the case may be, however, selection of the flange thickness as per IS: 6392, Table 17 for

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PN 1.6 & IS: 6392 Table 23 for PN 2.5 may be done for these M. S. flanges of the expansion bellows.

xxvi. All Bellows shall be hydro tested, by our internal inspection department at 24 kg/sq. cm pressure For PN 1.6 & 37.5 kg/sq. cm for PN 2.5.

xxvii. M.O.C. of Bellows element and liner shall be SA 240 TP 304

Piping Stress Analysis shall be carried out by successful Contractor with expansion joints of the complete pump house pumps, valves and complete piping loops. The vendor shall revise the thrust blocks as per the requirement of the flexibility output.

## **9.5 Cleaning**

- a. Prior to factory inspection, all manufacturing waste such as metal chips debris and all other foreign material shall be removed from interior of bellows. All mill scale, rust, oil, grease, chalk and all other deleterious material shall be removed from the interior and exterior surfaces.

## **9.6 Painting**

- a. Bellows shall first be given two coats of zinc base primer after completely cleaning the surface and then it shall be coated with three coats of coal tar epoxy paint. The resulting coating shall be uniform and smooth and shall adhere perfectly to the surface.
- b. Bellows used in pipes carrying water, the inside coating shall not contain any constituent soluble in water or any ingredient which could impart any taste or odour to the water.

## **9.7 Accessories and Installation**

### **9.7.1 Accessories**

- a. The Control Unit assembly, consisting of two or more control rods & stretcher plates are placed according to SS Expansion Joints from flange to flange. This minimizes possible damage of the SS Expansion Joint caused by excessive motion of the bolt line, due to failure of anchor or equipment, it also absorbs static pressure thrust developed at the joint and limits the extension and compression movements, if required to prevent damage to the main equipment without hampering its basic need. Inadequate support of pipelines, incorrect anchoring, and considerable temperature variations may cause

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many abnormal movements. As such undesirable and destructive movements can effectively be encountered by using control units.

- b. The Protective Shields/Cover should be used on the SS Expansion Joint that carries high temperature. It protects the environment in the event of leakage/ splash & protects the SS Expansion Joint from fire during a flash fire.
- c. A device which minimizes contact between the inner surface of the bellow & the liquid flowing it, so as to protect the inner surface from corrosion and to ensure that no foreign materials remain on the corrugation.
- d. Companion/ Counter Flanges for the pipeline for which the SS Expansion Joint is to be fitted can also be supplied with the SS Expansion Joint, if required.

#### **9.7.2 Installation of Accessories**

- a. Piping sections where SS Expansion Joints are accommodated should be anchored properly to take care of stresses/ Reaction forces due to internal pressure.  
Taking into consideration the above, solid & belting anchor points should be selected particularly where change in direction of piping elbows are near to the pump etc.
- b. An SS Expansion Joint must always be installed between two anchoring points (fixed supports). If it is not possible to install anchoring points (support points), stabilizing devices must be used.
- c. In order to avoid pipe buckling, guide collars must be provided regularly along the pipe length. A guide collar must also be provided on either side of the SS Expansion Joint. Maximum service life depends on careful and correct installation. Transport Expansion Joints to area of installation in packed condition. Flange face of companion flanges in pipeline should be smooth and without any sharp edges. For large size of Expansion Joints installed in horizontal ducts, lifting lugs welded to flanges should be used to hoist joint in position. Joints should only be fitted after all work on the pipeline and flanges have been complete and anchors and supports have been established. This is to avoid any accidental damage due to welding splatter or sharp objects and to ensure that the joints are not overstressed.

The bolts on the flanges must be tightened evenly. Uneven tightening may lead to hazardous leakage. Faulty fitting may lead to failure of the expansion joints.

### 9.8 Tender Drawings

The Dimensional drawings with material of construction shall be submitted by Contractor along with their offer.

### 9.9 Technical Particulars of Metallic Expansion Bellow (PN 1.6)

Sr. No.	DESCRIPTION	PARTICULARS
1	Make	(As per approved vendor list)
2	Item	Corrugation Design Metallic Expansion Bellow
3	Size(mm)	As Per Design
4	Fluid	Raw Water
5	Location	Pump House
6	Pressure Rating (Kg/cm2)	PN – 1.6
7	Temperature	50 degree °C Ambient
8	End Connection	Flanged. Flanges shall be flat faced.(As per IS 1538)
9	Material of Flange	M.S
10	Material of Bellows	Stainless Steel 304
11	Material of Hardware	Alloy Steel (As per IS 1367)
12	(To be revised during detail engineering as per pump vendor data) Axial expansion (mm)	15(Min.)
13	(To be revised during detail engineering as per pump vendor data) Axial compression(mm)	15(Min.)
14	(To be revised during detail engineering as per pump vendor data) Lateral Movement (mm)	+/- 1(Min.)
15	Hydrostatic Test Pressure (Kg/cm2)	15 (Min.)
16	Mode of Installation	Horizontal
17	No. of Tie rods	Three no.(120 deg. Orientation)

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## **10. Electrically Operated Travelling (EOT) Crane**

### **10.1 General**

- a. This specification covers the general design, materials, construction features, manufacture, shop inspection and testing at the manufacturer's works, delivery at site, handling at site, erection, testing, commissioning, performance testing and handing over of Double girder Electrically Operated Travelling Crane (Overhead).

### **10.2 Codes and Standards**

- a. The design, materials, construction, manufacture, inspection, testing and performance of the crane shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment is to be installed. The equipment shall also conform to the latest applicable Indian or equivalent standards. Other international standards are also acceptable, if these are established to be equal or superior to the listed standards. Nothing in this specification shall be construed to relieve the Contractor of his responsibility.

The following are some of the codes and standards relevant to this specification.

IS 807 Design, Manufacture, Erection and Testing (Structural Portion) of Cranes and Hoists

IS 3177 Electric Overhead Travelling Cranes and Gantry Cranes other than Steel Works Cranes.

IS 3938 Electric Wire Rope Hoists

IS 13834 Cranes – Classification.

### **10.3 Construction Features**

- a. The crane shall be a complete unit with bridge girder, end carriages for long travel, travelling trolley for cross travel, rope drums, wire ropes, sheaves, drive units, brakes, rails and fixtures, rail clamps, end stops, buffers, conductors, all electrical etc. to make the equipment complete in all respects. All materials used shall be of recent manufacture, free from defects, mill scales, laminations, pitting, flakes, rust etc. All welds shall be free from defects like blow holes, lack of penetration, slag intrusions etc. Impact factor for structural design shall be considered as per Table 1 of IS 3177.

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#### **10.4 Bridge Girder**

- a. The crane bridge shall consist of double girder as specified. The bridge girder shall have enough strength to carry the rated load without causing undue stress or deflection.

#### **10.5 End Carriages**

- a. End carriages connected with bridge girder at the two (2) ends shall be made from structural steel.
- b. End carriage design shall be such that it facilitates easy removal of the wheels for maintenance. Suitable jacking pads shall be provided for maintenance and easy removal of crane wheels.
- c. The wheels shall be double flanged for overhead crane. The wheels shall be machined on their treads to match the runway rail section for overhead.
- d. Wheel base and structural frame of the end carriages shall be designed and connected with bridge girder in such a way that the crane remains square and scenes is prevented. The ratio between wheel base and crane span shall be as stipulated in IS 807.

#### **10.6 Travelling Trolley**

- a. Trolley frames shall be fabricated from rolled structural steel sections.
- b. For double girder crane, the trolley shall be provided with chequered plate platforms with openings for ropes, sheaves etc. Hand railings shall be provided all around the platform.
- c. Suitable jacking pads shall be provided for maintenance and easy removal of wheels.

#### **10.7 Ladders**

- a. The contractor shall be provided with necessary access from operating floor to gantry girder level.

#### **10.8 Rope Drums**

- a. Rope drums shall be MS seamless type, as per ASTM 106, Gr. B made out of tested quality of plates. Drums shall be machine grooved right and left with grooves of a proper shape for the rope used. Grooving shall be of proper length to handle all rope needed to make the required lift plus the two dead laps at each anchor point, without overlapping. Drum shall be flanged at both the ends. Flanges shall project above the rope by a distance not less than two-rope diameter.



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### **10.9 Wire Ropes**

Hoist ropes shall be extra flexible, improved plough steel rope with a well lubricated hemp core and having six strands of 36 wires per strand with an ultimate tensile strength of 160/175 kg/sq. mm. The rope shall be fastened to the drum with an attachment having strength equal to that of the rope. The rope shall be of sufficient length so that two full laps shall remain on the drum at the extreme low position of the hook. Reverse bends or cross bends are to be avoided. The breaking loads for the hoist ropes shall not be less than six times the calculated load in the ropes at the drum, based on rated load on hooks, plus the weight of the bottom block, plus the weight of rope. Wire slings with U-bolts (2 nos.) shall be supplied with the hoist hook.

### **10.10 Sheaves**

- a. Rope sheaves shall be rolled steel. Grooves shall be machined to the proper shape for the rope used. Sheaves shall be equipped with anti-friction type bearings. Sheaves shall be fully guarded so that the rope cannot come off.

### **10.11 Gears**

- a. Gears shall be from solid forged steel blanks or shall be of stress-relieved welded steel construction or built-up from steel billets and welded together to form a one-piece gear section.

### **10.12 Bearings**

- a. All anti-friction bearings are to be of standard make & interchangeable with corresponding other standard sizes of the bearings. Bearings shall have a minimum life expectancy of 40,000 hours and may be ball, roller, or removable bronze-bushing type except that motor bearings shall be of the ball or roller type.

### **10.13 Shafts, Axles, Couplings, Keys and Splines**

- a. Shafts and axles shall be of forged steel and shall have ample strength, rigidity and adequate bearing surface for intended duties. Shafts and axles shall be accurately machined and properly supported. Shafts shall, as far as possible, be furnished straight. If shouldered, these shall be provided with fillets of ample radius or shall be tapered to avoid loss of strength and stress concentration. These shall be designed considering allowances for keys and splines.
- b. All couplings shall be of steel. Keys and keyways shall conform to IS as applicable.

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Splines and serrations shall be of involutes or straight sided form. Straight sided splines shall comply to IS as applicable.

#### **10.14 Brakes**

- a. Hoisting motors shall be equipped with electrically released, spring set, friction, shoe type brakes having torque capable of holding 125% of the full rated hook load. Brakes shall apply when either the motor controller or the main power switch is in "OFF" position, or in the event of power failure. Breaker should be equally effective in both the direction of rotation.

#### **10.15 Lifting Hooks**

- a. Hooks shall be solid, forged, heat treated alloy steel of rugged construction of the single hook type and provided with a standard depress type safety latch. They shall have swivels and operate on ball or roller thrust bearings with hardened races. Lock to prevent hooks from swiveling shall be furnished.

#### **10.16 Wheels and rails**

- a. Bridge and trolley track wheels shall be of forged or cast steel with cylindrical straight tread. The minimum hardness of the wheel rim shall be maintained between 300 and 350 BHN with minimum depth of 10 mm. Steel used for wheels shall not contain more than 0.060 per cent of either sulphur or phosphorus. The wheels shall be mounted in such a manner as to facilitate easy removal and placement.
- b. The wheel diameter and rail sizes shall be suitably selected so as to meet the requirements of wheel loading for the specified duty class of crane. The rail fasteners shall be suitably machined to ensure full contact with the rail flanges. The bridge and trolley track wheel bearings shall be anti-friction roller bearing and shall be carried on specially designed bearing support blocks of 'L' type design (commonly known as 'L' type bearing housings).
- c. Cross travel rails of required strength and rigidity along with rail clamps and other accessories shall be provided.
- d. In case of outdoor installation of overhead travelling crane, suitable rail clamps shall be provided for locking the crane on the runway when not in use or during storm condition. The rail clamps shall be capable of preventing the movement of crane under storm conditions.

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#### **10.17 Walkways and ladders**

- a. Access walkways of minimum 500 mm clear inside width with hand railings on both sides of bridge girders for the full span length for inspection and maintenance of the crane shall be provided. Walkways shall be of chequered plate or non-slip steel surface of minimum 6 mm thick. Walkways shall be of rigid construction and designed to sustain a distributed live load of not less than 3 kN/M<sup>2</sup>.
- b. Walkway platform shall be complete with hand railings, posts and toe plate all around. The hand railings shall consist of 32 mm NB pipe in two (2) tiers. Top pipe shall be at about one (1) M and middle pipe shall be at about 450 mm height from the walkway platform level. Posts shall be spaced at 1.5 M maximum centres. Toe plate shall be 6 mm thick and shall project 100 mm above the walkway platform.
- c. Ladder shall be provided to reach the walkway platform from the operating floor. Ladder shall be at least 450 mm clear width with 20 mm diameter rungs spaced at 300 mm centres and shall be equipped with safety cages when the ladder is more than three (3) M high.
- d. One ladder for access from the crane girder walkway to long travel walkway on each side of crane span shall be provided, if long travel walkway is provided as per data sheet.

#### **10.18 Buffers, Stops and Seeps**

- a. Spring or rubber buffers shall be provided on the trolley. Suitable end stops welded to the bridge girder shall be provided to contact the buffers mounted on the trolley. Spring or rubber buffers shall also be provided on the end carriages. Suitable end stops welded to the long runway girder shall be provided to contact the buffers mounted on the end carriages.
- b. Bridge and trolley wheel stops shall be provided before the end stops. These shall match to wheel radius. Wheel stops to prevent rails from creeping and trolley from running off the bridge shall be abutted against ends of rails. Wheel stops shall be welded to the girder.
- c. Sweeps shall be attached to the end carriages and to the trolley, to remove foreign material from the rails.

#### **10.19 Guards**

- a. All exposed couplings, shafts, gear wheels, pinions, drives etc. shall be safely encased and guarded.

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- b. The sheaves of hook blocks shall be guarded to prevent trapping of hand between a sheave and the in-running rope.

#### **10.20 Lubrication**

- a. Centralised grease lubrication unit with hand operated grease pump shall be provided for anti-friction bearings. One unit shall be provided on bridge platform for line shaft anti-friction bearings and another unit shall be provided on trolley for top sheave and drum anti-friction bearings.
- b. All other anti-friction bearings shall be lubricated manually by hand operated grease pump through respective grease nipples. Accessibility shall be such that parts may be safely lubricated from the walkways or ladders.

#### **10.21 Nameplate**

- a. A name plate showing rated capacity and year of manufacture shall be placed on either side of the girder in such a manner as to be legible from the ground or operating floor. Manufacturer's name, make, model number etc. may appear on the name plate.

#### **10.22 Electrical Equipment**

- a. All accessories and auxiliary electrical equipment including drive motors, electrically operated brakes, controllers, resistors, conductors, protective devices, operating devices, cables, conduits, etc. necessary for the safe and satisfactory operation and maintenance of the crane shall be included in the Contractor's scope of supply. Electrical equipment shall be adequately rated to permit simultaneous operation of any combination of motions of the crane for its duty service.

#### **10.23 Motors**

- a. Drive motors shall be as per IS 12615 and companion specifications indicated in data sheet. Motors for long travel and cross travel, main and auxiliary hoist shall be totally enclosed, slip ring type induction motors. Motors for creep speed operation of all motions and thrust or brake may be squirrel cage type. Motors shall be suitable for frequent reversal, braking and acceleration. Pull-out torque shall be 2.15 times the rated torque.
- b. In case motors with synchronous speed above 1000 rpm are selected, it shall be subject to Owner's approval

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#### **10.24 Controls**

- a. All motors and control circuit components for the long and cross travel motions shall be suitable for plugging control. Speed control of various motors shall be achieved by adjusting the resistance in the rotor circuit of the drive motors. Resistors shall be suitable for speed control duty cycle and inching operation. Relays and controllers shall be suitable for start-stop operation of around 150 times per hour.

#### **10.25 Controllers**

- a. Controller for crane motors shall comprise reversing type magnetic contactors.
- b. Controllers shall have at least five (5) uniformly proportioned steps of control. Independent controllers shall be provided to control each crane motion. Also each main and creep drive shall have independent controller.
- c. Controller contact shall require current capacity for the duty cycle, type and number of auxiliary contacts for required electrical interlocks.

#### **10.26 Crane Control Equipment**

- a. All control equipment for the crane shall be housed in dust tight, sheet steel cabinets. The control cabinets shall conform to the requirements of companion specifications. Separate panels shall be provided for the following:
  - b. Main power panel comprising the following:
    - i. 415 V, 4 pole gang operated, manual air break isolating switch together with a set of three (3) suitably rated HRC fuses for the incoming power supply to the crane.
- xxviii. Red and green indicating lamps with series resistors to indicate 'ON' and OFF' conditions of the main power
- xxix. Suitably rated 415V / 110 V single phase transformer for the crane control supply.
- xxx. 110 V double pole, air break isolating switch across the secondary of the control transformer.
- xxxi. 415 V / 240 V single phase, lighting transformer to supply the crane lighting loads (g) 415 V double.
- xxxii. 415 V double pole air break isolating switch together with suitably rated HRC fuses on the primary side of the lighting transformer.
- xxxiii. 415 V triple pole air break isolating switch, and a set of three suitable rated thermal overload relays for each motor serving as drive for all driven on the crane.

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- xxxiv. Small wiring up to terminal blocks
    - c. 415 V triple pole main Contractor for controlling the incoming power supply, together with 'START' and 'STOP' push buttons.
    - d. Compartmentalised panel(s) for housing the control gear comprising contactors, timers, isolators switches, HRC fuses, moulded case circuit breakers all brought up to terminal blocks, etc. inside the panel and push buttons, indicating lamps, operating handles, etc. brought out on the panel door. If necessary, separate compartments may be provided for various crane motions.
    - e. The control panel shall essentially house the following:
      - i. A suitable sensing device for each drive motor for stopping the drive motor at zero speed during plugging
  - xxxv. Two pole reversing contactors mechanically interlocked for each main as well as creep motion
    - f. Magnetic reversing type contact controllers as follows:
      - i. Two pole magnetic reversing contacts mechanically interlocked, accelerating contactors and suitable time relays for each controller.
  - xxxvi. Three pole contactors required for control of the lowering motion of Hoisting

#### **10.27 Protection**

- a. Operation of the overload relays for any of the motors shall operate the main supply contactor to cut off power supply to all the motors.
- b. Under voltage interlock shall be provided to operate the main supply contactor and open the main contactor contacts and its holding contact.
- c. Start' push button of the main supply shall be wired in series with the 'Off' position contacts of all the controllers, thus requiring that all controller circuits are in 'Off' position before the main supply contactor can be switched on.

#### **10.28 Operating and indicating device**

- a. In case the crane is operated the following devices shall be provided:
  - ii. 415 V, triple pole air break isolating switch across the incoming power supply to the crane.
- xxxvii. 'Start' push button
- xxxviii. 'Stop' push button

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- xxxix. 'Horn' foot switch for sounding warning horn.
  - xl. Red and Green indicating lamps with series resistors to indicate main supply contactor 'ON' and 'OFF' conditions.
  - xli. 240 V single phase, double pole miniature circuit breakers to control the main lighting circuit.
  - xlii. 240 V single phase, single pole miniature circuit breakers to control each of the following circuits:

All control equipment mounted on the crane shall be furnished with uniform indelible name plate identifying various controls and indicating the direction wherever necessary.

#### **10.29 Resistors**

- a. Resistors shall be adequately protected to prevent contact with live parts.
- b. Resistors shall be provided with terminal boards equipped with brass or copper terminal studs.
- c. Resistors shall be mounted in pressed sheet steel and plates with drip proof and louvered side covered in separate units. All resistors shall be located on alongside and adjacent to control cabinet with provision of at least 100 mm clear space at front and rear of each panel.
- d. Temperature of any exposed portion of the resistor enclosure shall not exceed 353° K.

#### **10.30 Limit Switches**

- a. Automatic reset type of limit switches shall be provided to prevent over-travel for each of the following motions:
  - i. For over-hoisting and over-lowering motions of the main hook.
  - ii. Long travel motion
  - iii. Cross travel motion

#### **10.31 Conductors**

- a. Crane shall be provided with three (3) phase power conductors and an earthing conductor for the entire length of crane runway and trolley runway complete with necessary power feed arrangement, insulators, brackets, mounting supports and access platform.
- b. Crane runway conductors carried on suitable insulators shall be rigidly fixed to the

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structural bracket pieces. All conductors are mounted in vertical formation. Insulators shall be spaced not more than two (2) metres apart along each conductor. Design shall be such that provision shall be made for future extension of conductors and conductor joints are properly welded to ensure smooth surface to the conductors. Conductors shall be provided with protective wire mesh guard over the entire length to prevent injury to personnel and to guard against mechanical damage. Provision shall be made to access the conductors for maintenance and replacement. A suitable inspection cage shall be provided with access ladder for the collectors for maintenance purposes. Flexible trailing cable arranged in festoon configuration with festoon trolley on rollers, travel rail, supports etc.

- c. Cross travel motion shall be achieved by flexible trailing cable arranged in festoon configuration with festoon trolley on rollers, travel rail, supports etc. In case fixed conductors are specified for cross travel option, all necessary feed boxes, insulators, brackets and supports for mounting hall are furnished on top of bridge girder along the cross travel side. Conductor shall be provided with protective wire mesh guard over the entire length to prevent injury to personnel and to guard against mechanical damage.

#### **10.32 Safety Switches**

- a. Four (4) non-fusible air break isolating switches of adequate rating (not less than 15 amps) shall be fitted at the four corners of the crane so as to be accessible while standing on the crane platform. These shall be wired up in series with the emergency stop to open the main power contactors.

#### **10.33 Cables and Conduits**

- a. All wiring shall be furnished and shall be installed in rigid galvanised steel conduit with threaded type fittings, galvanised outlet and pull boxes. Pull boxes shall be located at frequent intervals to allow cable or conductors to be pulled without abrasion or injury. Conduits shall form a continuous system and shall be rigidly supported and clamped within the structural of the crane. The entire conduit system shall be installed so that any moisture is drained away from terminal boxes and electrical devices. Power wiring and control wiring shall be kept in separate conduits. Flexible conduits shall be used as required.
- b. Wiring of all equipment and control devices located on the trolley bridge for the crane shall be completed in the shop and wires shall be terminated on terminal blocks housed in a junction box.



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- c. Wiring adjacent to resistors and control panel wiring shall be of stranded 50 V grade, flame, heat and moisture resistant with proper insulation for operation at elevated temperatures.
  - d. Wires for motor primary and secondary circuits shall have adequate current carrying capacities to carry maximum plugging control of the motors for the duty service of the crane. Wires shall be properly connected to withstand vibrations. No splices shall be made in any wiring on the panel or in conduit. All insulation and all clearances to ground shall be designed so that the live parts will withstand a high potential test of not less than 2500 V at 50 Hz for 60 seconds.
  - e. Conductors for main power circuits shall be selected taking into consideration simultaneous operation of the main hoist and bridge motors.

#### **10.34 Safety Earthing**

- a. Crane structures, motor frames and metal cases of all electrical equipment including metal conduit and cable guards shall be effectively earthed.
- b. All motors, brakes, limit switches, panels, drum, controllers, resistor unit sets, etc. shall be provided with two studs for earthing.
- c. A separate long travel conductor rail shall be fitted on the runway gantry girder in the same plane as the three main power rails to serve as the earth bus. The earth bus shall be solidly bonded to effective earthing stations at two independent points by Owner.
- d. An additional earth collector shall be provided to engage with the cross travel earthing rail located below all other rails.
- e. All electrical equipment on the bridge and crane shall be solidly bonded to the bridge earth circuit. All electrical equipment in the trolley shall be solidly bonded to earthing circuit tapped from the cross travel earth collector.

#### **10.35 Control Schematic and Wiring Diagrams**

- a. One (1) set of as-built control connection diagrams shall be fitted inside the control cabinet for ready reference for the operating staff.

#### **10.36 Performance Guarantee**

- a. Performance parameters to be guaranteed by the Contractor and tolerances permitted shall be as indicated specification. Crane or any portion thereof is liable for rejection, if it fails to give any of the guaranteed performance parameters.

### 10.37 Additional technical requirement

#### 10.37.1 General

- a. The lift of the crane hook/hoist shall be such that the crane/hoist hook can reach the bottom most floor of the building. The span of the crane and its hook approach shall be suitable for maintenance of all heavy equipment within the building.
- b. The lift of hoists shall be suitable to lift directly any equipment and move the same over other equipment into the maintenance bay inside the building.

### 10.38 Manufacturing Tolerances

Sr. No	PARAMETER	TOLERANCE
1	Span over LT Wheels	+6mm up to 40 metres
2	Wheel base :LT	±5 mm
3	Wheel base: C.T	±3 mm
4	Difference in diagonal: LT	±5 mm
5	CT	±3 mm
6	Long travel wheel alignment	±1 mm
7	Tilt of wheels or balancer axle	+ 1 mm/1000mm (Horizontal & Vertical)
8	Trolley wheel gauge	+3mm up to 7500 mm span + 5mm above 7500 mm span
9	Trolley track gauge	+ 3mm up to 7500 mm span + 5mm above 7500 mm span
10	Difference in height between trolley rails (H) in relation to the trolley track gauge (S) shall be within the following tolerances	

Sr. No	PARAMETER	TOLERANCE
	Up to 2500	4
	Above 2500 and up to 4500	6
	Above 4500	10
11	Shift of the web plates of main & end girders from vertical over height 'H' measured near the mid span & close to the main diaphragm.	H/1500
12	Tolerances on camber	+4
	Up to 4 mm	-0
	Above 4 mm and up to 8 mm	+5
		-0
	Above 8 mm and up to 16mm	+6.3
		-0
	Above 16mm and up to 31.5mm	+ 8
		- 0
	Above 31.5 mm and up to 63 mm	+ 10
		- 0
13	Over buffer length (over buffer dimension on two sides shall be same)	+ 5 mm
14	Height of centre of buffer (from top of track rail)	+ 5 mm

- a. The Contractor shall ensure that minimum amount of assembly at site is necessary for early commissioning of the crane after delivery. Site welding and riveting shall be avoided as far as possible. The Contractor, before proceeding with design details shall satisfy himself about the site conditions so as to avoid any difficulty in erection arising out of design

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- b. The crane shall be completely assembled and tested in the Contractor's works for full load and 25 % overload on hoisting and cross traverse motion, in presence of Owner's representative in addition to other tests as specified in IS: 3177.
  - c. The following tests shall be carried out at manufacturer's works during inspection. The crane after erection shall be tested as follows:
    - i. Insulation tests and other tests mentioned in IS: 3177 shall be carried out.
  - xliii. Deflection Test: The deflection test of the bridge girders shall be carried out as per IS: 3177 After the deflection test with safe working load, the crane shall be tested for deflection with 25% overload and there shall not be any permanent set after the removal of the load.
  - xliv. Speed Tests
    - d. All motion of the crane shall be tested with rated load on all notches at the time of commissioning of the crane at site and the speeds shall be attained within the tolerance limit.
    - e. All motions of the crane shall be tested with 25% over load in which case the specified speeds need not be attained but the crane shall show itself capable of dealing with the overload without difficulty.

#### **10.39 Brake Tests:**

- a. The hoist brakes shall be capable of braking the movement with rated as well as overload. However, the braking path with rated load shall not exceed hoisting speed.
- b. The long travel and cross travel brakes shall be capable of arresting the motion within a distance in metres equal to 10% of the speed in metres/min.

#### **10.40 Technical Specification**

##### **10.40.1 General**

- a. All parts requiring replacement or inspection or lubrication shall be easily accessible without the need for dismantling of other equipment or structures. All electrical cables shall be so laid that they are not liable to be damaged and can be easily inspected and maintained and when necessary any damaged cable can be accessed and replaced individually.
- b. No cast iron parts shall be used except for electrical equipment and no wood or other combustible material shall be used unless specifically mentioned otherwise.
- c. For welded construction such as that of bridge girders, end-carriages, rope drums, gear-

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boxes etc. steel shall be as per IS: 2062 quality. For welding these members low hydrogen electrodes be used.

- d. All wheels, couplings, open gears etc. shall be provided with covers, opening on strong hinges. All heavy covers shall be provided with inspection windows.
- e. Where down shop leads are located below runway rails, guards shall be provided on the crane to prevent the hoist ropes from coming in contact with down shop leads. For down shop leads, suitable guards of welded mesh type shall be provided covering the bottom and side fitted to the girder keep of machine hall.
- f. All bolts except those with nuts shall be provided with grip lock nuts or spring washers.
- g. The end-carriages shall be fitted with substantial safety stops to prevent the crane from falling more than 25 mm in the event of breakage of a track wheel. Bogie or axle. These stops shall not interfere with the removal of wheels.
- h. Power & control cables shall be clamped in groups separately. All trailing cables shall be clamped with PVC or non-metallic clamps. Group dating factor shall be appropriately taken according to the 'recommendations of the cable manufactures based on the method of lying and number of cables being laid together.
- i. Guards of approved design, which shall push forward off the-track, any object placed across it, will be attached to each 'end of the end carriages.
- j. Parts of steel frames carrying machinery shall be provided with doubling plates of adequate thickness, riveted or welded and machined to true surface.

#### **10.40.2 Structural Details**

- a. The crane bridges shall be of welded double web box construction and shall be designed as per IS: 807- and/or AISE No.6. The materials of construction shall be weldable mild steel in compliance with the relevant standard. However, high strength weldable structural steel also may be used wherever required in compliance with the relevant standards.
- b. The crane bridge girders up to 12 m span shall be in one piece. The number of such splices shall not exceed 2 up to 36m span. Beyond 36m span, the number of splices may be 3. Splices shall be designed to resist all the forces and moments to which it is subjected to, plus 50% thereof.
- c. Splices shall be proportioned and arranged so that the gravity axis of the splice is in line with the gravity axis of the members joined so as to avoid eccentricity of the loading.
- d. Black bolts shall not be used in the main structure of the Crane.
- e. Transverse fillet welding on load carrying members shall be avoided. All butt welds on

tensile zone shall be X-rayed.

- f. Plates, bars, angles and where practicable other rolled sections used in the load bearing members of structures shall not be less than 6 mm in thickness.
- g. The end-carriages shall be of double web plate box construction and shall be connected to the girders by welding at shop or by large gusset plates and fitted bolts to ensure maximum rigidity. Drop stops and jacking pads shall be built-in features of the Crane. Full length chequered plate platforms shall be provided along both sides of the Crane in order to ensure easy access to crane crab, long travel gears and other parts. Safety railings shall be provided on crane bridges and crab frame. Access to the Crane shall be via staircases only and not through ladders. Platforms to facilitate inspection and dismantling of long travel wheels and main current collectors shall be provided.
- h. The crab frame shall be made of steel plates and rolled sections in welded construction. Crab frame shall be fabricated in one piece if there are no transport limitations. If the trolley is fabricated in more than one piece due to transport limitation, the design of the splice shall be such that one unit of mechanism mounted on one part of the trolley, does not come over the other part.
- i. Foot walks shall be of sufficient width to give at least 500 mm clear passage at all points except between railing and bridge girder where this clearance may be reduced to not less than 440mm.
- j. The Platforms along the bridge girders and over the crab shall allow convenient access for replacement, inspection, lubrication etc. for different mechanical and electrical components.
- k. The minimum thickness of chequered plates shall be 6 mm for indoor crane

#### 10.41 Technical Particulars for Electrically Operated Travelling (E.O.T) Crane

Sr. No.	DESCRIPTION	PARTICULARS
1	Make	(As per approved vendor list)
2	Location/Type	Pump house Building/Overhead Double Girder E.O.T Crane
3	Crane Rail support	R.C.C. brackets
4	Capacity(Ton)/Number Required	As Per design
5	Location in Hazardous area	No

Sr. No.	DESCRIPTION	PARTICULARS
6	Location	Pump house building
7	Span(Mtr.)	As Per Site Condition
8	Run way length (Mtr.)	As Per Site Condition
9	Operating floor	Pump house floor level
10	Test Load	125% of rated load of pumps, motor and accessories
11	Range of Lifting height(Mtr.)	As Per Site Condition
12	Type of Hook	Solid Forged Steel, IS:3815
13	Hook Approach(Mtr.)	0.5(Minimum)
14	Crane Classification	IS 13837 M5-Mechanical M7-Electrical
15	Hoist Drive	Electric motor
16	Gearing	Totally enclosed
17	Break	Electrically released spring set or friction disc type
18	Drum	Steel plates
19	Sheaves	Rolled Steel
20	Bearing	To be furnished by Contractors
21	Motor	Variable speed motor.
22	Creep speed control	As per requirement
23	Long travel walkway required	YES
24	Ladder	Required for servicing Crane & hoist
25	GA Drawing indicating overall dimensions weight, height and necessary details	To be furnished by contractors

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## **11. Vertical Non Clog Pump Set**

### **11.1 General**

- a. The scope includes supply installation testing & commissioning of Non clog Vertical submersible pump set with starter panel, cable up to starter panel, GI (class C) delivery pipe, non-return valve, fittings, hardware's etc. The pumps shall have auto stop operation.
- b. The total head capacity curve shall be continuously rising towards the shutoff with the highest at shut off.
- c. The pump shall run smooth without undue noise and vibration.
- d. The power rating of the pump motor shall not be less than the power required from zero discharge to zero head.
- e. Pump shall be submersible, single stage.
- f. It shall be suitable for handling turbid water containing stringy materials.
- g. Delivery pipe shall be GI class C. The required length of pipes and fittings up to discharge point shall be provided with necessary fittings.
- h. Level switch (mercury/magnetic reed) to stop the pump automatically shall be supplied with the pump. Pump shall have three phase connection.



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## **12. Ventilation System**

- a. The capacity of Supply air fans, exhaust air fans shall be designed as per the Design Philosophy & Equipment specification elaborated below. Sizing calculations for all the equipment's shall be submitted for approval of Owner.
- b. All ventilation system shall operate on 100% fresh air.
- c. All mechanically ventilated areas shall be positively ventilated by means of supply air fans, generally in combination with exhaust fan. Wherever exhaust fan are not provided, such as MCC/ switch gear rooms, the pressurised condition shall be maintained with gravity operated back draft dampers. However, as exception, hazardous areas and fumes/odour generating areas such as toilets shall be negatively ventilated by means of exhaust air fans and inlet louvers.

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## **13. DOUBLE ACTING KINETIC AIR VALVE WITH ISOLATING SLUICE VALVE**

### **13.1 SPECIFICATION**

#### **13.1.1 General**

kinetic Air valve with isolation valve confirming to IS 14845 (latest), AWWA C 512, having one outlet of large capacity for admission and release of bulk volume of air during emptying and filling of the pipeline and another having small outlet for escape of smaller quantities of trapped air.

The ball sealed orifice shall always remain open while air is exhausting and is immediately closed when Water rises in the chamber, lifts the ball and seals the orifice. It shall also ensure that there are no recesses or pockets, sheltering, escaping air for the large orifice (low pressure) ball to drop into when the valve open. Turbulent air at the time of filling of pipe shall not circulate in such cavities and cause the ball to blown into when the valve is open. Turbulent air at the time of filling of pipe shall not circulate in such cavities and cause the ball to blown into the discharging air streams, blowing the valve shut prematurely.

The cone angle of the lower pressure chamber shall be such that even at the critical velocity of all air escape at 300 m/sec. The total impact force on the ball is less than the suction force on the angular area between the ball and the cone. The design of the valve should be such as to allow maximum free air discharge at various pressure differentials.

The low pressure cover shall be massive and designed to withstand full operating thrust in working Conditions.

The seat ring shall be held securely in place under the low pressure cover by a joint support ring to prevent it from sagging when the ball is not sealing the orifice.

The valve body, the orifice cover, cowl of the air valves shall be made of as per IS: 210 grade FG 260.

### **13.2 JOINTING MATERIAL**

Each valve shall be supplied with all necessary joints on all the flanges of valve supplied under this Contract including those flanges which will be jointed to pipe system. The lengths of bolts shall be assumed to be suitable for jointing MS pipes.

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The cost of all jointing material supplied under the contract shall be inclusive of rates. Joint ring shall be of flat section at least 3 mm thick. It shall be of rubber in accordance with IS: 638 Or its latest edition (specification for rubber and insertion jointing) of hardness proven in practice so as to form a water tight joint and use of jointing paste shall not be allowed. Bolt holes shall be drilled according to centre lines. Bolt heads and nuts shall be hexagonal and shall confirm to IS: 1363 (Specification for black hexagonal bolts, nuts and black hexagonal Screws).

### **13.3 BALL**

The ball of large orifice shall bear a calculated mathematical relation with inlet diameter of the valve (i.e. the average cross section area of escaping air stream) so that it will result in the ball being blow shut by a stream of water but held down by a stream of air.

The buoyancy of the floats shall be such that it will ensure effective sealing of large orifice even at low pressures.

The weight of floats of the same size and type shall not differ by more than 2%. The SS material used in the manufacture of floats shall be suitable for perfectly sitting on the large orifice. The float provided in high pressure chamber, manufactured from SS, shall be also being suitable for seating on the small orifice.

### **13.4 HIGH PRESSURE ORIFICE**

The high pressure orifice and the high pressure chamber shall be so designed that the orifice is effectively sealed in working condition by float.

The material of the orifice shall be SS. The orifice shall be of size not less than 3 mm and tapering to 100 mm suitable to release accumulated air within the pipe. The profile of the orifice shall be carefully chosen to avoid damage to the float surface. The orifice shall be protected by a suitable plug of stainless steel.

### **13.5 VALVE FLANGE**

All valve flanges shall be designed to withstand the stresses to which they would be subjected under hydraulic tests. Flanges shall be machined flat. The flanges shall be drilled in accordance with IS: 1538 (Specification of CI fittings for pressure pipes for water etc.). All flanges shall be supplied with matching companion flanges, nuts, bolts and gaskets.

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### **13.6 CLEANING**

Prior to the factory inspection, all manufacturing waste such as metal chips, debris and all other foreign material shall be removed from interior of valve. All mill scale, rust, oil, grease, chalk and all other deleterious material shall be removed from the interior and exterior surfaces.

Valves shall first be given two coats of zinc base primer after completely cleaning the surface and then it shall be coated with three coats of epoxy paint. The resulting coating shall be Uniform and smooth and shall adhere perfectly to the surface.

Valves used in pipes carrying water, the inside coating shall not contain any constituent soluble in water or any ingredient which could impart any taste to the water.

### **13.7 PAINTING**

Valves shall first be given two coats of zinc base primer after completely cleaning the surface and then it shall be coated with three coats of epoxy paint. The resulting coating shall be uniform and smooth and shall adhere perfectly to the surface.

### **13.8 INSPECTION AND TESTING AT MANUFACTURER'S WORKS**

All valves shall be offered for visual inspection and dimensional check and performance testing. Valves shall be tested as per IS 14845.

### **13.9 DOCUMENTS / DRAWINGS TO BE SUBMITTED ALONGWITH TENDER**

- (a) Preliminary outline dimensional drawings.
- (b) Typical cross section drawings with bill of material and material of construction and necessary Supports for mountings.
- (c) Flow v/s head loss curve for valves.
- (d) List of spare

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## **14. GI PIPE AND FITTINGS**

Providing and supplying ISI-marked Galvanized Iron (G.I.) pipes of 50 mm to 150 mm diameter, heavy duty, with couplings, complete with all taxes, insurance, transportation, freight charges, octroi (if applicable), inspection charges, loading, unloading, stacking, and conveyance to site or departmental stores, as per IS:1239 (Part-1).

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The pipes shall be suitable for use as column pipes and general water conveyance piping, and shall be hot-dip galvanized with uniform coating thickness, sound threads, and straight alignment.

Providing and supplying G.I. pipe fittings suitable for 50 mm to 150 mm diameter G.I. pipes, including G.I. elbows, G.I. nipples (6" long), C.I. flange sets complete with rubber packing, PTFE (Teflon) tape, and all other accessories as specified in Schedule-B, complete in all respects.

All fittings, welding, threading, sealing materials, and accessories required to achieve a complete, leak-proof, and serviceable installation shall be deemed included in the scope of work, and no separate payment shall be made for incidental items.

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## **15. SURGE CONTROL SYSTEM FOR PUMPING MAIN**

### **15.1 Accepted Control System**

- a. Following types of control systems are only accepted for control of water hammer pressures in the pumping mains. a) Zero Velocity Valves and Air Cushion Valves (only for pumping main).
- b. The manufacturer of these systems must have previous experience of manufacturing such systems and must produce test results on at least two systems manufactured and installed by him. In case of on way surge tanks, the valves used should be of reputed accepted make with proper opening characteristics.
- c. The agency has to submit the design of surge protection device and get approved by owner's engineer. Water hammer control devices shall be procured only after approval of the design as per design requirement.

### **15.2 Water Hammer Control**

#### **15.2.1 Specification for Water Hammer Control Device with Zero Velocity Valve and Air Cushion Valve**

The valve has an outer fabricated casing ('Main Body') in which a 'Central Rod' is held by struts. A 'Stationary Central Dome' creates an annular streamlined passage for smooth flow of water. Closing Disc is mounted on 'Central Rod'. Disc is held in closed position by a number of 'Stainless Steel Springs' (as per AISI 304). Two 'Anti Rotation Guides' are provided on the edge of 'Central Disc' with minimum resistance to flow. 'Anti Rotation Guide' is clad with Stainless Steel Strip (as per AISI304) and 'Guide Fork' with brass liners. A 'Bypass' with a 'Valve' connects upstream and downstream sides of valve. A 'Man Hole' is provided on 'Outlet' cone of main body, for maintenance and replacement of spring (if required) without removing the valve from line. The 'Outer Shell', 'Dome' & 'Disc' are fabricated out of M.S. plates as per IS 2062. A stainless steel sleeve (as per AISI 304) is fitted on 'Central Shaft' and moves in brass bush in 'Disc' for free movement. The Valve will be painted in Zinc Rich Epoxy Paint from inside and food grade epoxy from outside both in min two layers with total thickness of 406 microns.

#### **15.2.2 Specification for Air Cushion Valve**

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The valve consists of a 'Main Body' and 'Top Housing'. On the side of main body, two 'Air Inlet Valves' loaded with a light spring are fitted. The 'Inlet' is protected by a cover. The 'Top Housing' has an opening for air escape. A spring loaded 'Poppet' with a brass seat and Neoprene 'Sealing Ring' covers the top of the opening. The spring pressure on the valve is adjustable by a screw (S.S. as per AISI-304). The 'Housing' has a tapered outlet, the opening of which is adjustable by a tapered plug and Screw (S.S. as per AISI- 304). The outlet is protected by a cover. On its lower side a cage holding a ball float is fitted. 'Main Body', 'Top Flange', are fabricated from M.S. (as per I.S.2062/I.S.1239). The 'Top Housing' is made from high grade Ductile iron. Main body, float ball and air inlet flange are hydraulically pressure tested. Stems of valves are in stainless steel (as per AISI-304), and work in 'Brass Bushes'. Sealing rings are of good quality rubber and seats are of brass The Valve will be painted in Zinc Rich Epoxy Paint from inside and food grade epoxy from outside both in min two layers with total thickness of 406 microns.

All branched outlets including outlets for Air valves will be with compensation pads (Dia of Main / For branch Dia ratio greater than 3). Diameter of compensation pad will not be less than 1.75 times the O.D. of the branched outlet. Plate thickness for pads will be same that of the main.

For outlets with above ratio less than three, then the joints will be of plate reinforcement type.

All branched outlets including air valve, tees will be provided with one ½" BSP coupling duly plugged for measurement of pressure in due course. The closing plug will be in Stainless Steel (AISI 304 or equivalent) with Hex. Head and will be provided with copper washer for sealing.

All flanges will be drilled as per I.S. 1538. Thickness of all flanges will be as per I.S. Thickness of pipes Strength of steel pipes is verified to check effect of positive and negative pressures during transients due to power failure and surge protection devices shall be provided to avoid any damage to the pipeline integrity, shape and structure.

### **15.2.3 Surge Control System – Requirements**

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- a. The requirements given are tentative. The contractor, after award of contract, must carry out the surge analysis based on the Longitudinal section, Pump and Motor characteristics of the selected pumps by the contractor. Surge analysis along with the selected system.
  - b. During detailed engineering following information must be submitted based on the Surge Control System' selected by the contractor. For design of surge control system following limits will be adhered to (The surge pressures will be estimated after all working pumps at designed discharge, trip simultaneously)
    - 1. Maximum upsurge anywhere in the system will not exceed 10.0 Kgf/Cm<sup>2</sup> or 1.2 times the Normal Working Pressure at manifold whichever is lower. Beyond half the length of pipeline, the limit will be 6.0 Kgf/Cm<sup>2</sup> or 1.5 times the Normal Working Pressure at mid length.
    - 2. The lowest pressure (Minimum Down surge) anywhere in the system will not be lower than (-) 0.4 Kgf/Cm<sup>2</sup> (i.e @ 0.6 Kgf/Cm<sup>2</sup> above absolute zero) (Only 50% of the installed air valves can be assumed as operative for this condition.).
    - 3. The contractor will submit Surge analysis without any control system to ascertain the requirement of surge control system and the results along with details will be submitted during detailed engineering in case of award of contract.



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## **16. Inspection and Testing at Manufacturer's Premises**

### **16.1 General**

- a. All inspection and testing shall be carried out in accordance with the Specification and in absence of Specification relevant Indian Standard or internationally approved equivalent standard code.
- b. The Contractor shall carry out at the place of manufacture tests of the Plant /Equipment at any part of the Works.
- c. The Owner shall be entitled to attend the aforesaid inspection and/or tests by his own duly authorized and designated representatives.
- d. The Owner and his duly authorised representative shall have access to the manufacturer's premises at all suitable times to inspect and examine the material and workmanship of the mechanical and electrical plant and equipment during its manufacture there. If part of the plant and equipment is being manufactured on other premises, the Contractor shall obtain permission for the Owner or his duly authorised representative, Testing (including testing for chemical analysis and physical properties) shall be carried out by the Contractor.
- e. The Contractor shall forward to the Owner 3 duly certified copies of the test certificates and characteristics performance curves for all equipment.
- f. The test equipment, meters, instruments etc., used for testing shall be calibrated at recognised test laboratories at regular intervals and valid certificates shall be made available to the Owner representatives at the time of testing. The calibrating instrument used as standards shall be traceable to National/International standards.
- g. The following Testing shall be carried out for all the equipment as applicable
  - i. Visual Inspection.
  - xliv. Material Certificates for all the specified material shall be furnished.
  - xlvi. Welding Qualifications
  - xlvii. Dimension Checking
  - xlvi. Stage Inspections (in process inspection)
  - xlix. Dynamic balancing for all rotating parts
  - l. Hydrostatic / Leak testing for all pressure parts, Pneumatic Leak Test wherever applicable

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- li. Operation check
  - lii. Liquid penetrant tests or magnetic particle tests for all machined surfaces of pressure parts.
  - liii. Ultrasonic test for forging materials viz.
  - liv. Radiographic testing for all butt welded parts, as per applicable codes.
  - lv. l) Hardness tests for all Hardened surfaces.
    - a. The Contractor shall maintain proper identification of all materials used, along with reports for all internal / stage inspection work carried out, based on the specific job requirement and or based on the datasheets / drawings / specifications.

## **16.2 Induction Motor**

### **16.2.1 Routine Tests**

- a. All routine tests shall be carried out as per the latest edition of IS 325.

### **16.2.2 Acceptance Tests**

- a. Full load test to determine efficiency, power factor and slip shall be conducted on all the motors.

### **16.2.3 Type Tests**

- a. The following type tests shall be carried out on one motor of each rating
  - i. Temperature rise test
  - lvi. Vibration measurement test
  - lvii. MOMENTARY OVERLOAD TEST shall be conducted based on interpolation Method.
  - lviii. Noise level test
  - lix. Full load test to determine efficiency, power factor and slip
  - lx. Starting current and starting torque at reduced voltage

## **16.3 Valve**

- a. During testing there shall be no visible evidence of structural damage to any of the valve component.
- b. Motorized valves shall be tested with their actuators, with a differential head

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equivalent to their maximum working pressure, to prove that the actuators are capable of opening and closing the valves under maximum unbalanced head condition within the specified opening or closing period.

- c. Sluice valves for isolation purpose shall be offered for open end test.
- d. The following test shall be carried out for butterfly valves:
  - i. Seat leakage test at rated pressure.
  - ixi. Body hydrostatic test at 1.5 times the rated pressure.
  - ixii. Disc strength test at body test pressure.
  - ixiii. Valve operation.
  - ixiv. 15 ° opening and closing test.
- e. The following test shall be carried out for sluice valves:
  - ii. Seat leakage test at rated pressure
  - ixv. Hydrostatic test at 1.5 times the rated pressure
  - ixvi. Valve operation with and without actuator
- f. The following test shall be carried out for Non-Return valves:
  - i. Seat leakage test at rated pressure
  - ixvii. Body hydrostatic test at 1.5 times rated pressure
  - ixviii. Operation

#### **16.4 MS Pipe work (Pump house)**

Testing of pipes and fitting shall be carried out in accordance with relevant Indian Standard. Pipes shall be hydrostatically tested as per as per specification available as per this tender document (AS per Vol-III (B)).

#### **16.5 E.O.T Crane**

The cranes shall be completely assembled in the Contractor's works and shall be subjected to the tests as specified in IS 807/IS 3177 or relevant internationally approved standard.

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## **17. Installation, Testing and Commissioning**

### **17.1 Erection - General**

- a. The Contractor's staff shall include adequate and competent erection engineers with proven, suitable, previous experience on similar contracts to supervise the erection of the Works and sufficient skilled, semi-skilled and unskilled labour to ensure completion of Works in time. The Contractor shall not remove any representative, erector or skilled labour from the Site without prior approval of the Engineer's Representative.
- b. The Contractor shall ensure that no installation or erection work shall commence until full and unconditionally approved working drawings, signed and stamped by the Employer are available at Site.
- c. The Contractor's erection staff shall arrive on the Site on dates to be agreed by the Engineer. Before they proceed to the Site, however, the Contractor shall first satisfy himself, as necessary, that sufficient plant of his (or his sub-contractor's) supply has arrived on Site so that there will be no delay on this account.
- d. One erection engineer who shall be required to be the Contractor's representative shall be conversant with the erection and commissioning of the complete Works. Should there be more than one erector, one shall be in charge and the Contractor shall inform the Engineer's Representative in writing which erector is designated as his representative and is in charge. Erection engineer is to report to Project Manager.
- e. The Contractor shall be responsible for setting up and erecting the plant to the line and levels of reference and of the positions, levels dimensions and alignment, appliances and labour in connection therewith. The checking of setting out of any line or level by the Engineer or Engineer's Representative shall not in any way relieve the Contractor of his responsibility for the correctness thereof.
- f. Erection of Plant shall be phased in such a manner so as not to obstruct the work being done by other contractors or operating staff who may be present at the time. Before commencing any erection work, the Contractor shall check the dimension of structures where the various items of Plants are to be installed and shall bring any deviations from the required position, lines or dimensions to the notice of the Engineer. Plant shall be erected in a neat and workmanlike manner on the foundations and at the locations shown on the approved drawings. Unless otherwise directed by the Engineer, the Contractor shall adhere strictly to the

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aforesaid approved drawings. If any damage is caused by the Contractor during the course of erection to new or existing Plant or buildings or any part thereof, the Contractor shall, at no additional cost to the Employer, make good, repair or replace the damage, promptly and effectively as directed by the Engineer and to the Engineer's satisfaction.

- g. The Contractor shall align all equipment and holding down bolts and shall inform the Employer before proceeding with grouting-in the items concerned. The Contractor shall ensure that all equipment is securely held and remains in correct alignment before, during and after grouting-in.
- h. The approval by the Employer of the Contractor's proposals for rigging and hoisting any items of the Plant into final positions shall not relieve the Contractor from his responsibility for damage to completed structures, parts or members thereof or other installed equipment. He shall at his own cost make good, repair or replace any damaged or injured items, whether structural, electrical, architectural, or of any other description, promptly and effectively to the satisfaction of the Employer.
- i. No Plants or other loads shall be moved across the floors of structures without first covering the floors with timber of sufficient size so that applied loads will be transferred to floor beams and girders of steel or concrete. If it is required to reduce bending stresses and deflection, the beams and girders shall be provided with temporary supports.
- j. During erection of the Plant the Engineer will inspect the installation from time to time in the presence of the Contractor's Site representative to establish conformity with the requirements of the Specification. Any deviations and deficiencies found or evidence of unsatisfactory workmanship shall be corrected as instructed by the Engineer.

#### **17.1.1 Levelling and Grouting of Machinery**

- a. He shall undertake sufficiently in advance chipping of any unevenness of concrete on foundations, anchor bolt pockets, cutouts etc., to achieve uniform level of reference for erection. All concrete surfaces receiving grout shall be hacked as required to ensure better bonding with grouting.
- b. Contractor shall undertake the inspection of all components to be erected sufficiently in advance to check their soundness and conformity to drawings and the inspection records shall be signed by the Engineer as approval for undertaking the installation of the components. Any damage, shortfalls etc. shall be made good to

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the satisfaction of the Engineer.

- c. All grout for equipment shall be carried out using non-shrinkable continuous grout materials with suitable frame work of at least 12mm thickness. Surfaces to receive the grout shall be hacked and roughened and laitance shall be removed by wire brushing or blast of air. Concrete surface shall be blown off by compressed air before commencing grouting. Grouting shall be done in one continuous operation from one side such that grout flows in a single wave until grout reaches all confined spaces with no air pockets and air from all confined spaces is expelled. A hydro static head of 150 mm shall be maintained during grouting operations. All grouting shall be carried out in the presence of the Engineer's Representative. All lines and levels shall be checked up after grout is set. Block outs shall be closed using cement concrete of the same grade as that of the parent structure.

#### **17.2 Records, Procedures and Reports**

- a. The Contractor shall maintain records pertaining to the quality of installation/erection work and inspection, testing, compliance with all technical requirements in respect of all his works as described in the previous paragraphs. The reporting formats shall be in the approved formats. The Contractor shall submit such records to the Engineer after the completion of any particular work before submitting the bill of supply/progress of work. Such report shall comprise shop inspection reports, shop testing reports, material test reports, based on which dispatch clearances are provided, all the quality control reports of welding, erection and alignment records.
- b. All the above mentioned records shall be submitted in the final form duly countersigned by the Engineer's Representative attesting conformity to specifications and his approval of installation, and duly incorporating all the additions, alternations, and information as required by the Engineer, on the basis of preliminary reports giving the progress of the work. Such records notwithstanding, any records submitted earlier with bill of supply/progress etc., shall be duly bound and submitted to the Engineer in six copies by the Contractor on his notification of the mechanical completion of erection.

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### **17.3 General Preparations before Completion of the Plant**

#### **17.3.1 Necessary Documents**

- a. Technical Documents
  - i. Operation and Maintenance manual
  - ii. Design documents including the Contractor's design data, drawings and Specifications.
  - iii. Tools and test equipment list
  - iv. Spare parts list
  - v. Lubricant list
- b. Procedures
  - i. Mechanical testing procedure
  - ii. Electrical testing procedure
  - iii. Instrumentation testing procedure
  - iv. Detailed Pre-commissioning and Commissioning procedure
  - v. Detailed Performance Test procedure
- c. General and Coordination Documents.
  - i. Detailed organization charts for Pre-commissioning and Commissioning showing lines of authorities and responsibility, and functions of all key personnel.
  - ii. The job description of the members of the team.
  - iii. The scheduled dates of assignment of each member to Pre-commissioning and Commissioning Organization.
  - iv. A detailed schedule showing the time sequence which the Contractor anticipates to follow for the various steps in Completion of Erection, Pre-commissioning and Commissioning of each unit and equipment.
  - v. The regulations for safety, hygiene and discipline.
  - vi. The practical organization of the relationship (meetings, reports, etc.) between the Contractor and the Employer at the phases of Pre-commissioning and Commissioning.
  - vii. Emergency communication route.

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#### **17.4 Manpower**

Required manpower shall be provided as agreed between the Contractor and the Employer in a Manpower Mobilization Plan which shall include the number and qualifications of the operator and maintenance personnel to be furnished by the Employer for the Plant.

#### **17.5 Completion of Erection**

- a. The completion of Plant under erection by the Contractor shall be deemed to occur, if all the units of the Plant are structurally and mechanically complete and will include among other such responsibilities the following:
  - i. Plant in the Scope of the Contract has been erected, installed and grouted as per specifications.
  - ii. Installation checks are completed and approved by the Engineer.
  - iii. The erected Plants are totally ready for commissioning checks.
- b. At the stage of completion of erection, the Contractor shall ensure that all the physical, aesthetic and workmanship aspects are totally complete and the Plant is fit and sound to undergo tests on completion and subsequent pre-commissioning checks.
- c. Upon achieving the completion as described above, the Contractor shall notify the Engineer by a written notice intimating completion of erection and notify the Engineer for inspection. The Engineer / Engineer's Representative shall proceed with the inspection of such units within 14 days of such a notice.
- d. The Engineer shall certify completion when there are no defaults in the Works.
- e. The Engineer shall inform the Contractor list of deficiencies for rectification hereinafter referred as Punch list and the Contractor shall complete the rectification work within a jointly agreed period before pre-commissioning activities and obtain the Engineer's acceptance or approval of the same before proceeding with the same.
- f. The Engineer may inform the Contractor that the works are accepted with the 'Punch' list (items which do not hamper operability, safety or maintainability) and allow the Contractors to proceed with the pre-commissioning checks when the Contractor under-takes to complete such outstanding works within an agreed time during defects liability period. Taking over shall be based on rectification of all deficiencies as advised by Punch lists.



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- g. The erection period indicated by the Contractor would be deemed to cover all the activities up to Completion as stipulated in previous paragraphs, notice of completion by the Contractor, inspection by the Engineer for Completion, and Contractor rectification of all deficiencies as noticed by the deficiency/Punch list, and acceptance by the Engineer of such rectification's, prior to Tests on Completion.
  - h. Minor defects, which in the opinion of Engineer which do not hamper operability and maintainability will not be taken into account for deciding Mechanical Completion. Such defects shall be rectified concurrent to commissioning checks before Tests on Completion. However, the Engineer's decision in this regard is final.
  - i. The commissioning period as notified by the Contractor shall be deemed to occur beyond the date of Completion and shall include all periods of pre-commissioning, trials and Tests on completion.
  - j. It is in the Contractor's interest to offer the section/units/systems, progressively under identified milestones within overall erection period, duly completed for rectification of any deficiencies pointed out by the Engineer and to achieve Mechanical Completion before undertaking the tests on Completion within the specified erection period. The Engineer also reserves the right to withhold the cost as estimated to be equivalent to the rectification of deficiencies pointed out to the Contractor until such a time such deficiencies are rectified to the satisfaction of the Engineer.

#### **17.6 Pre-commissioning**

- a. After the Completion of erection, Pre-commissioning activities listed below shall be carried out to make the Plant ready for Commissioning. All instruments, materials and provisions necessary for conducting site tests shall be provided by the Contractor at his own cost.
- b. Upon completion of erection of each piece of equipment, facility or discrete part of the plant, mechanical checks and tests shall be carried out according to the Contractor's check list. The mechanical checks and tests shall be to establish that:
  - i. The Plant is erected in accordance with the Contractor's construction drawings, pipe work drawings, instrument diagrams, etc. issued for the Plant.
  - ii. The materials are installed and mechanically function in accordance with the Contract and

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- iii. Applicable codes as listed in the Contract are followed for Materials and Workmanship.
  - c. Items such as painting, thermal insulation and final clean-up which do not materially affect the operation or safety of the Plant will be excluded. All these items shall be listed and completed after Pre-commissioning or Commissioning at the discretion of the Contractor, but before acceptance.
  - d. The Contractor shall prepare and maintain at Site test forms and records which shall include:
    - i. Description of type of test or check,
    - ii. Date and times of test or check,
    - iii. Identification of equipment and facilities,
    - iv. Test pressure, test data and results, including remarks, if any,
    - v. Signature of the Contractor's personnel attesting to data recorded, if any. Checks, tests and records thereof shall be carried out by the Contractor's construction forces.
  - e. Wherever the Employer's witness or attesting of the check or test is required, the Employer's personnel shall attend such check and test. For this purpose, the Contractor shall keep the Employer informed of a day-to-day test plan schedule. The test plan schedule may be revised from time to time to reflect the actual progress of the work and test.
  - f. Any items found incomplete or requiring repair or adjustment shall be marked as such on the test records and then reported by the Contractor to the Employer and the Contractor's personnel in charge of the relevant construction area.
  - g. Checking procedures shall be repeated until all the items on the check list are cleared.
  - h. A complete set of test records shall be handed over to the Employer on completion.
  - i. The tests on the different Mechanical and Electrical equipment shall include but not limited to:

#### **17.7 Pumps, Piping and Valves**

- a. Complete piping installation shall be subjected to hydrostatic test at a pressure of 1.5 times the shut off pressure of pump or twice the working pressure of pump

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whichever is higher to test the soundness of the joints. Provision of the necessary pumps, gauges, blank flanges, tapings etc. for carrying out these tests shall be included in the Contract.

- b. Leakage tests shall be carried out on all erected pipe work, pumps and valves immediately after erection and where possible before being built in.
- c. Operating tests shall be conducted on valves.
- d. The pump set shall be tested for performance. The vibration and noise levels shall be checked to be within the specified.
- e. The pump shall be tested throughout the operating range with all working (excluding stand-by) for all the pumps. No negative tolerance shall be permitted on any parameters visibly head, discharge and efficiency. All the pumps will be tested for efficiency at duty point after installation.

#### **17.8 Pump motors**

- a. Condition of winding insulation be tested and insulation values shall be restored to required level by suitable heating arrangements locally.

#### **17.9 Cranes**

- a. The crane and lifting tackle shall be tested for the safe working load at factory. The Contractor shall arrange the test load. Deflection and speed tests shall also be conducted at site with load in presence of Engineer in- charge.

#### **17.10 Instrumentation**

- a. The tests on the instrumentation equipment shall include but shall not be limited to:
  - i. All cables shall be tested for polarity, continuity and insulation resistance. The common mode D.C. voltage at each signal input terminal shall be measured and recorded.
  - ii. The pre-commissioning tests on the various main categories of plant shall be as listed below:
    - The resistance of each electronic loop shall be measured
    - Electronic equipment shall have been energized for at least 24 hours before testing begins

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- The zero setting of each display instrument including any local indicator on or associated with a transmitter shall be checked
  - The correct calibration of each items in each control or monitoring loop shall be checked by the introduction of appropriate signal at each source, at five cardinals points of the range for increasing and decreasing signals
- b. The following tests methods shall be used:
- i. Pressure operated devices – dead weight testers or portable calibrators
  - ii. Level operated devices – actual level variation or simulation thereof. Instrument zero reading shall be checked against a bench mark:
  - iii. For controlling devices the Contractor shall demonstrate the correct operation of the loop including the regulating devices. Each automatic controller shall be set to the appropriate estimated values of the terms. Which shall be optimized during the plant start-up? Each control valve shall be optimized during the plant start-up. Each control valve shall be checked by operation of the manual control on the associated controller and the correct stroking verified. Valve petitioners, electronpeumatic converters and gauges shall be checked during these tests.
  - iv. All systems shall be checked for “fail-safe” operation.
  - v. Initiating devices not covered by the foregoing e.g. plant stop/start controls shall be checked in conjunction with the testing of the associated switchgear and machine.
- c. The Contractor shall also demonstrate the data transfer as per data transfer schedule between Pumping Stations.

#### **17.11 Commissioning**

- a. After the completion of Pre- commissioning activities the final checks preparations necessary for start-up of the plant shall be carried out. The Contractor shall submit to the Employer a written Notice of Mechanical Completion which shall include :
  - i. Identity of a part of the Plant considered mechanically complete,
  - ii. A copy of all relevant completed test reports,
  - iii. The date on which the completion of the tests was achieved.
  - iv. Check list, and

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- v. A request for issuance of a Mechanical Completion Certificate in respect of that part.
  - b. Within fourteen (14) days from the date of receipt of the Contractor's written Notice, the Employer shall :
    - i. In the case of acceptance, issue a Mechanical Completion Certificate.
    - ii. In the case of Objection, submit a rejection Statement setting forth remaining items to be completed or defects or deficiencies to be corrected before Mechanical Completion status can be accepted. When the Employer rejects the Contractor's Notice the Contractor shall take any necessary action to complete or correct the items marked and give the Employer a second Notice of Mechanical Completion.
  - c. After the issuance by the Employer of a Mechanical Completion Certificate, Commissioning activities listed below shall be carried out to enable the start-up and operation of the Plant. Procedures are described as below :
    - i. Commissioning Procedure shall be carried out in a methodical sequence as follows
      - a) Warming up,
      - b) Start-up,
      - c) Initial running,
      - d) Operability adjustment,
      - e) Stable operation
      - f) Final adjustment
    - ii. At all stages of commissioning sequence, the Plant shall be operated at optimum Plant conditions. To ensure this, the Contractor may make minor adjustment to the conditions indicated in the Operation and Maintenance Manual as necessary.
    - iii. The Contractor shall check the operating conditions of the Plant by constantly monitoring operating data.
    - iv. The Contractor shall specify for each discrete part of the Plant the operational data to be recorded and the manner in which the data is to be taken.
    - v. All the operating data shall be recorded by the Employer on the forms to be mutually agreed. A copy of the operating log and analytical data from initial operation through to the completion of Performance Test shall be made available by the Employer to the Contractor for evaluation.

## 18. DATA SHEETS FOR MECHANICAL WORKS - PUMP HOUSE

### 18.1 Pump

#### 18.1.1 Vertical Turbine Pump (For Each Pumping Station)

Sr.No	DESCRIPTION	PARTICULARS
1.0	Make/Application	Bidder has to furnish (As per approved vendor list)/
1.1	Pump Type	Vertical Turbine Pump
1.2	Number of pumps	As Per Price bid
1.3	Number of normally working pumps(nos.)	As per Price bid
1.4	Design capacity of each pump (m3/hr.)	As per Price bid
1.5	Minimum total head at design capacity(Mtr.)	As per Price Bid
1.6	Pump Efficiency	As per HIS
1.7	Direction of rotation (viewed from Top)	To be furnished by Bidder
1.8	Total duration of operation	Continuous
1.9	Speed(RPM)	980 (Indicative), Bidder to specify as per HIS Design
1.10	Submergence available (Mtr.)	As per IS
1.11	Pump Location	Indoor & On water sump
1.12	WHP,at 50 Hz	Bidder to specify
1.13	Pump Input (BKW),at 50Hz	Bidder to specify
2.0	Feature of Construction	
2.1	Internal element	Mixed Flow impeller
2.2	Type of Lubrication	Force water lubricated
2.3	Type of Sealing	Gland Packing
2.4	Type of Coupling	Shaft Drive
2.5	Number of Stage	To be furnished by Bidders
2.6	Column Size	To be furnished by Bidders
2.7	Discharge level with respect to floor	Above Floor
3.0	Liquid Data	
3.1	Liquid handled	Raw Water
3.2	Temperature	Ambient temp.
3.3	Turbidity	Minimum turbidity: 500 NTU. However, the bidder is advised to carry out physical

Sr.No	DESCRIPTION	PARTICULARS
		and chemical analysis of Raw water, as for the most of the days, it is expected to pump flood water having high turbidity.
<b>4.0</b>	<b>Material of Construction</b>	
4.1	Base Plate	M.S. IS 226
4.2	Discharge Elbow	M.S. IS 226
4.3	Column pipe	ERW, M.S. minimum 12 mm. wall thickness with inside and outside epoxy painted, in, minimum 1.5 Mtr Sections. As per IS 1239
4.4	Suction bell	Cast Steel WCB
4.5	Pump casing / Impeller bowl	Cast Steel WCB
4.6	Impeller	Stainless steel CF8M As per IS 1570
4.7	Line shaft with coupling	Stainless Steel 410 (IS 1570 (part V) Gr. X12Cr12)
4.8	Impeller shaft	Stainless Steel 410 (IS 1570 (part V) Gr. X12Cr12)
4.0	Head shaft	Stainless Steel 410 (IS 1570 (part V) Gr. X12Cr12)
4.10	Shaft coupling	Stainless steel 316 As per IS 1570
4.11	Line bearing	Thordon Type
4.11	Suction strainer	Stainless Steel AISI – 304 (M) As per IS 1570
4.13	Shaft sleeves	S.S ASTMA 351 CF8M As per IS 1570
4.13	Hardware in contact with water	Hot dipped galvanized
4.15	Companion flanges	M.S. as per IS 1538 table IV & VI, off centre drilling.
<b>5.0</b>	<b>Accessories &amp; Services required</b>	
5.1	Base plate	YES
5.2	Foundation bolts	YES
5.3	Suction strainer	YES
5.4	Companion flanges	YES
5.5	Spares parts recommended	YES
5.6	Maintenance tools	YES
5.7	Start-up / essential spares	YES
5.8	Painting	YES ( Epoxy )
<b>6.0</b>	<b>Testing</b>	
6.1	Hydrostatic test	YES to be witnessed
6.2	Pump Performance Testing Standard	IS 5120/IS 9137 ( Latest Amendment)

Sr.No	DESCRIPTION	PARTICULARS
6.3	Pump casing	Ultrasonic test not to be witnessed but certificate for testing during manufacturing is to be produced.
6.4	Performance test	YES to be witnessed
6.5	Standard running test	YES to be witnessed
6.6	Static balancing test	Required
6.7	Dynamic balancing test	YES to be witnessed
6.8	Visual inspection check	Required
6.9	Parallel Operation test at site	Required
<b>7.0</b>	<b>Prime mover</b>	
7.1	Motor for pumps with coupling	Required
7.2	Specifications for the drivers	Class "F" as per motor data sheet and suitable to operate on 6.6 KV AC supply
7.3	Speed	980 (Indicative), Bidder to specify
7.4	Minimum Efficiency @ Rated Speed Duty point a) Full Load b) 0.75 Load c) 0.50 Load	94 % (minimum at full load without negative tolerance) Bidder has to furnish Bidder has to furnish Bidder has to furnish
7.5	Power Factor Duty point  a) Full Load b) 0.75 Load c) 0.50 Load	(To be achieve minimum 0.996 at full load & 0.9 at part load with the help of HV Capacitor bank across motor & APFC Panel)  Bidder has to furnish Bidder has to furnish Bidder has to furnish
7.6	Type of enclosure	Bidder to specify

Note:

- a. Material certificates of components shall be furnished before inspection of components.
- b. Bidder to furnish GA drawing indicating overall dimensions, weight, and height details along with offer.
- c. The capacity range shall be zero flow to maximum flow.
- d. Bidders have to submit performance test report sand, family curves(Head (H)Vs. Discharge (Q), Efficiency Vs. Discharge, and Power (P) Vs. Discharge (Q) and Torque speed curve for similar model of pump.
- e. The difference of 50 BHN hardness shall be between casing ring and impeller ring.
- f. If the guaranteed efficiency of pump quoted by the bidder is less than minimum specified in the tender, then the offer of bidder is liable to be rejected.
- g. Bidder to furnish guaranteed technical particulars duly filled.



- b. The difference of 50 BHN hardness shall be between casing ring and impeller ring.
- c. If the guaranteed efficiency of pump quoted by the bidder is less than minimum specified in the tender, then the offer of bidder is liable to be rejected.
- d. Bidder to furnish guaranteed technical particulars duly filled.

#### 18.1.2 Vertical Turbine Pump (For Palej To WTP)

Sr.No	DESCRIPTION	PARTICULARS
<b>1.0</b>	<b>Make/Application</b>	Bidder has to furnish (As per approved vendor list)/
1.1	Pump Type	Verticle Turbine Pump
1.2	Number of pumps	As Per Price bid
1.3	Number of normally working pumps(nos.)	As per Design
1.4	Design capacity of each pump (m3/hr.)	As per Pricebid
1.5	Minimum total head at design capacity(Mtr.)	As per Price Bid
1.6	Pump Efficiency	As per HIS
1.7	Direction of rotation (viewed from Top)	To be furnished by Bidder
1.8	Total duration of operation	Continuous
1.9	Speed(RPM)	980 (Indicative), Bidder to specify as per HIS Design
1.10	Submergence available (Mtr.)	As per IS
1.11	Pump Location	Indoor & On water sump
1.12	WHP,at 50 Hz	Bidder to specify
<b>1.13</b>	Pump Input (BKW),at 50Hz	Bidder to specify
<b>2.0</b>	<b>Feature of Construction</b>	
2.1	Internal element	Mixed Flow impeller
2.2	Type of Lubrication	Self Water Lubricaton
2.3	Type of Sealing	Gland Packing
2.4	Type of Coupling	Shaft Drive
2.5	Number of Stage	To be furnished by Bidders
2.6	Column Size	To be furnished by Bidders
2.7	Discharge level with respect to floor	Above Floor
3.0	Liquid Data	
3.1	Liquid handled	Raw Water
3.2	Temperature	Ambient temp.

Sr.No	DESCRIPTION	PARTICULARS
3.3	Turbidity	Minimum turbidity: 500 NTU. However, the bidder is advised to carry out physical and chemical analysis of Raw water, as for the most of the days, it is expected to pump flood water having high turbidity.
<b>4.0</b>	<b>Material of Construction</b>	
4.1	Base Plate	M.S. IS 226
4.2	Discharge Elbow	M.S. IS 226
4.3	Column pipe	ERW, M.S. minimum 8 mm. wall thickness with inside and outside epoxy painted, in, minimum 1.5 Mtr Sections. As per IS 1239
4.4	Suction bell	Cast Steel WCB
4.5	Pump casing / Impeller bowl	Cast Steel WCB
4.6	Impeller	Stainless steel CF8M As per IS 1570
4.7	Line shaft with coupling	Stainless Steel 410 (IS 1570 (part V) Gr. X12Cr12)
4.8	Impeller shaft	Stainless Steel 410 (IS 1570 (part V) Gr. X12Cr12)
4.0	Head shaft	Stainless Steel 410 (IS 1570 (part V) Gr. X12Cr12)
4.10	Shaft coupling	Stainless steel 316 As per IS 1570
4.11	Line bearing	Thordon
4.11	Suction strainer	Stainless Steel AISI – 304 (M) As per IS 1570
4.13	Shaft sleeves	S.S ASTM A 351 CF8M As per IS 1570
4.13	Hardware in contact with water	Hot dipped galvanized
4.15	Companion flanges	M.S. as per IS 1538 table IV & VI, off centre drilling.
<b>5.0</b>	<b>Accessories &amp; Services required</b>	
5.1	Base plate	YES
5.2	Foundation bolts	YES
5.3	Suction strainer	YES
5.4	Companion flanges	YES
5.5	Spares parts recommended	YES
5.6	Maintenance tools	YES
5.7	Start-up / essential spares	YES
5.8	Painting	YES ( Epoxy )
<b>6.0</b>	<b>Testing</b>	
6.1	Hydrostatic test	YES to be witnessed

Sr.No	DESCRIPTION	PARTICULARS
6.2	Pump Performance Testing Standard	IS 5120/IS 9137 ( Latest Amendment)
6.3	Pump casing	Ultrasonic test not to be witnessed but certificate for testing during manufacturing is to be produced.
6.4	Performance test	YES to be witnessed
6.5	Standard running test	YES to be witnessed
6.6	Static balancing test	Required
6.7	Dynamic balancing test	YES to be witnessed
6.8	Visual inspection check	Required
6.9	Parallel Operation test at site	Required
<b>7.0</b>	<b>Prime mover</b>	
7.1	Motor for pumps with coupling	Required
7.2	Specifications for the drivers	Class "F" as per motor data sheet and suitable to operate on 0.415 KV AC supply
7.3	Speed	980 (Indicative), Bidder to specify
7.4	Minimum Efficiency @ Rated Speed Duty point a) Full Load b) 0.75 Load c) 0.50 Load	(As Per IS 1180 –latest mendment)  Bidder has to furnish Bidder has to furnish Bidder has to furnish
7.5	Power Factor Duty point  a) Full Load b) 0.75 Load c) 0.50 Load	(To be achieve minimum 0.996 at full load & 0.9 at part load with the help of HV Capacitor bank across motor & APFC Panel)  Bidder has to furnish Bidder has to furnish Bidder has to furnish
7.6	Type of enclosure	Bidder to specify

Note:

- a. Material certificates of components shall be furnished before inspection of components.
- h. Bidder to furnish GA drawing indicating overall dimensions, weight, and height details along with offer.
- i. The capacity range shall be zero flow to maximum flow.
- j. Bidders have to submit performance test report sand, family curves(Head (H)Vs. Discharge (Q), Efficiency Vs. Discharge, and Power (P) Vs. Discharge (Q) and Torque speed curve for similar model of pump.
- k. The difference of 50 BHN hardness shall be between casing ring and impeller ring.
- l. If the guaranteed efficiency of pump quoted by the bidder is less than minimum specified in the tender, then the offer of bidder is liable to be rejected.

- m. Bidder to furnish guaranteed technical particulars duly filled.
- e. The difference of 50 BHN hardness shall be between casing ring and impeller ring.
- f. If the guaranteed efficiency of pump quoted by the bidder is less than minimum specified in the tender, then the offer of bidder is liable to be rejected.
- g. Bidder to furnish guaranteed technical particulars duly filled.

## 18.2 HT Induction Motor

### 18.2.1 HT Induction MOTOR (For Each Pumping Station)

Sr. No	DESCRIPTION	PARTICULARS
1	Make/Application	Bidder has to furnish(As per approved vendor list)/To drive
2	Type of motor	Squirrel cage Induction motor
3	No. of units.(Nos.)	As Per Pricebid
4	Supply system fault level.	Min 25 kA
5	Supply neutral	Resistance earthed
6	Rated voltage / Indicative Rated KW	6.6 KV/As Per Design
7	No. of Phases & frequency	3 Phase & 50 Hz.
8	Supply condition	± 10% voltage variation ± 3% frequency variation ± 10% combined voltage and frequency variation
9	Duty condition as per IS 325 or equivalent	S1 suitable for constant operation
10	Method of starting	FCMA / HFSR
11	Starting torque % of full load torque	Sufficient starting torque to start the pump with delivery valve open and when other pumps are running.
12	Pull out torque % of full load torque	Sufficient to bring the motor to normal speed in minimum time

Sr. No	DESCRIPTION	PARTICULARS
13	Class of insulation & temp. rise by thermometer	Class "F" but Temperature rise restricted to that of class "B" i.e. 65° c. / 75°C (temp. Range indicative)
14	Ambient temperature	50°C.
15	Location	Indoor
16	Hazardous area division	N.A.
17	Atmosphere	Humid, Dusty at a time
18	a) Type of Cooling c) Degree of protection	CACA / CACW/TETV IP – 55
19	Terminal box	Phase segregated terminal box for line and neutral side. And shall be suitable for termination of heat shrinkable termination kit or push on type termination kit.
20	External cable details. a) No. of cores. b) Size	Bidder to furnish
21	Shaft	solid shaft
22	Type of Couplings	Flexible
23	Type of bearings	Ball / Roller / Thrust
24	Colour shade of paint if special	Grey shade 65% as per IS 5
25	Space heater for motors required	240 V, 1 Ph., 50Hz., A.C. for winding heating
26	Thermistors / RTD's / required	For trip, alarming and indicating
27	Bearing temp. Detectors	Required for alarm only
28	Winding connections	6 Terminals
29	Standard to be followed	IS 12615 and other relevant Indian Standard or equivalent BSS.
30	Efficiency @ Rated Speed Duty point a) Full Load b) 0.75 Load c) 0.50 Load	94 % (minimum at full load without negative tolerance)  Bidder has to furnish  Bidder has to furnish

Sr. No	DESCRIPTION	PARTICULARS
		Bidder has to furnish
31	Power Factor Duty point a) Full Load b) 0.75 Load c) 0.50 Load	(To be achieve minimum 0.996 at full load & 0.9 at part load with the help of HV capacitor bank across motor & APFC Panel.)  Bidder has to furnish  Bidder has to furnish  Bidder has to furnish

### 18.3 LT Induction MOTOR

Sr. No	DESCRIPTION	PARTICULARS
1	Make/Application	Bidder has to furnish (As per approved vendor list)/To drive
2	Type of motor	Squirrel cage Induction motor
3	No. of units. (Nos.)	As Per BOQ
4	Motor Energy efficiency class.	IE 3
5	Supply neutral	Resistance earthed
6	Rated voltage / Indicative Rated KW	0.415 KV/As Per Design
7	No. of Phases & frequency	3 Phase & 50 Hz.
8	Supply condition	± 10% voltage variation  ± 3% frequency variation  ± 10% combined voltage and frequency variation
9	Duty condition as per IS 325 or equivalent	S1 suitable for constant operation
10	Method of starting	As Per manufacturer STD
11	Starting torque  % of full load torque	Sufficient starting torque to start the pump with delivery valve open and when other pumps are running.

Sr. No	DESCRIPTION	PARTICULARS
12	Pull out torque % of full load torque	Sufficient to bring the motor to normal speed in minimum time
13	Class of insulation & temp. rise by thermometer	Class "F" but Temperature rise restricted to that of class "B" i.e. 65° c. / 75°C (temp. Range indicative)
14	Ambient temperature	50°C.
15	Location	Indoor
16	Hazardous area division	N.A.
17	Atmosphere	Humid, Dusty at a time
18	Degree of protection	IP – 55
19	Terminal box	Phase segregated terminal box for line and neutral side. And shall be suitable for termination of heat shrinkable termination kit or push on type termination kit.
20	External cable details. a) No. of cores. b) Size	Bidder to furnish
21	Shaft	solid shaft
22	Type of Couplings	Flexible
23	Type of bearings	Ball / Roller / Thrust
24	Colour shade of paint if special	Grey shade 65% as per IS 5
25	Space heater for motors required	240 V, 1 Ph., 50Hz., A.C. for winding heating
26	Thermistors / RTD's / required	For trip, alarming and indicating
27	Bearing temp. Detectors	Required for alarm only
28	Winding connections	6 Terminals
29	Standard to be followed	IS 12615 and other relevant Indian Standard or equivalent BSS.
30	Power Factor	(To be achieve minimum 0.996 at full load & 0.9 at part load with the help of HV capacitor

Sr. No	DESCRIPTION	PARTICULARS
	Duty point	bank across motor & APFC Panel.)
	b) Full Load	Bidder has to furnish
	b) 0.75 Load	Bidder has to furnish
	c) 0.50 Load	Bidder has to furnish

#### 18.4 MS Pipe Work (For Each pumping)

Sr. No.	DESCRIPTION	PARTICULARS
1	Plates / HR coil	IS:2062, Gr.ER 250 BR / IS:10748 Gr.III Fe410
2	Welding & Electrodes	ASME – SECT – IX, IS – 7310, IS – 7307, IS-814, IS – 3613, IS – 6419, IS – 7280, IS – 9595
3	Inside Epoxy	Shot blasting , followed by application of 406 micron Dry film thickness, solvent free, high build, food grade epoxy lining, confirming to AWWA C-210-07/BS 6920 – suitable for potable water application as per specification
4	Fabrication & Manufacturing of Pipe	I.S. 3589 and/ or I.S.5504
5	Field joint coating specials & fittings	Anti corrosion coating by heat shrink wraparound sleeves conforming to EN 12068



## 18.5 ButterFly Valve

### 18.5.1 Butterfly Valves (Electrically Operated) (For Each Pumping)

Sr. No	DESCRIPTION	PARTICULARS
1	Make	Bidder has to furnish (As per approved vendor list)
2	Design Code	IS: 13095-1991 or latest
3	Size (mm)	As Per Design
4	Pressure Rating	PN – 1.6
5	Fluid	Raw water
6	Ends	Flanged Ended, Flat Faced flanged as per IS: 1538 Table IV & VI
7	Disc	Dual Eccentrically Solid Wedge
8	Operation	Electrically Actuator Operated (As described)
9	Seat	Body – Renewable. Disc – Renewable.
10	Body	Ductile Iron
11	Disc	SG Iron IS 1865 GR. 500/7
12	Stem	Stainless Steel AISI 316
13	Drive Shaft	Stainless Steel AISI 316
14	Stub Shaft	Stainless Steel AISI 316
15	Body Seat Ring	Stainless Steel BS 970 Gr. 304 S-16
16	Disc Seal	Nitrile Rubber
17	Bolts, Studs & Nuts	Carbon Steel IS 1367 Class 4.6/4
18	Body Test Pressure	As per Design Code
19	Disc Test Pressure	As per Design Code
20	Seal Leakage Test	As per Design Code
21	Total Weight (kg) of the Complete Assembly	To be furnished by Bidders

Sr. No.	DESCRIPTION	PARTICULARS
22	By-pass Valve and piping arrangement	To be provided with Minimum 4" or As per vendor, whichever is higher

#### 18.6 Non-Return Valve (Dual Plate Check Valve) (For Each Pumping)

Sr.No.	DESCRIPTION	PARTICULARS
1	Make	Bidder has to furnish (As per approved vendor list)
2	Design./Testing Code	API 594/API 598
3	Size(mm)	As per Design
4	Pressure rating	PN – 1.6
5	Type	Non slam, spring action dual plate
6	Ends	Flanged. Flanges shall be flat faced and confirming to IS 1538 part IV & VI having off centre bolt holes
7	Seat	Body - Renewable Plate - Renewable
8	Liquid	Raw Water
9	Body	Ductile Iron (DI)
10	Disc/Plate	Cast Steel
11	Seat rings	S.S AISI 304
12	Spring	S.S. AISI 304
13	Bearings	Teflon
14	Hinge Pin / stop pin	S.S. BS 970 Gr 304 (M)
15	Bolts, Studs & Nuts	Carbon Steel IS :1367 Class 4.6 / 4 hot dipped galvanized
16	Body Test Pressure	As per Design Code
17	Disc Test Pressure	As per Design Code
18	Face to face dimension	As per Design Code

Sr.No.	DESCRIPTION	PARTICULARS
19	Companion flanges and erection hardware	As per Design Code
20	Total Weight (kg) of the Complete Assembly	To be furnished by Bidders
21	Over-all dimensions of the complete assembly – L X B X H (mm)	As per Design Code

#### 18.6.1 Sluice Valves (Gear Operated) (Delivery Side) (For Each Pumping)

Sr. No.	DESCRIPTION	PARTICULARS
1	Make	Bidder has to furnish (As per approved vendor list)
2	Design Code	IS: 14846-2000 PD or latest
3	Size (mm)	As Per Design
4	Pressure Rating	PN – 1.6
5	Fluid	Raw water
6	Ends	Flanged Ended, Flat Faced flanged as per IS: 1538 Table IV & VI
7	Operation	Gear Operated (As described)
8	Seat	Body – Renewable. Disc – Renewable.
9	Body	Ductile Iron
10	Disc	SG Iron IS 1865 GR. 500/7
11	Stem	Stainless Steel AISI 316
12	Drive Shaft	Stainless Steel AISI 316
13	Stub Shaft	Stainless Steel AISI 316
14	Body Seat Ring	Stainless Steel BS 970 Gr. 304 S-16
15	Gland Packing	Jute & Hemp IS 5414 (Latest Amendment)
16	Bolts, Studs & Nuts	Carbon Steel IS 1367 Class 4.6/4

Sr. No.	DESCRIPTION	PARTICULARS
17	Body Test Pressure	As per Design Code
18	Back Seat Test Pressure	As per Design Code
19	Seal Leakage Test	As per Design Code
20	Total Weight (kg) of the Complete Assembly	To be furnished by Bidders

## 18.7 Metallic Expansion Bellow

### 18.7.1 Metallic Expansion Bellow (For Each Pumping)

Sr.No.	DESCRIPTION	PARTICULARS
01	Make	Bidder has to furnish (As per approved vendor list)
02	Item	Corrugation Design Metallic Expansion Bellow
03	Size(mm)	As Per Design
04	Fluid	Raw Water
05	Location	Pump Discharge line And Header Line
06	Pressure Rating	PN - 1.6
07	Temperature	50 deg C
08	End Connection	Suitable end connection or Flanged. Flanges shall be Flat faced,(As per IS 1538)
09	Material of Flange	M.S
10	Material of Bellows	Stainless Steel 304
11	Material of Hardware	Alloy Steel (As per IS 1367)
12	Axial expansion (mm)	15(Min.) to be acquainted with pump installation reqt.
13	Axial compression(mm)	15(Min.) to be acquainted with pump installation reqt.
14	Lateral Movement (mm)	+/-1(Min.) to be acquainted with pump

Sr.No.	DESCRIPTION	PARTICULARS
		installation reqt.
15	Hydrostatic Test Pressure(Kg/cm2)	15 (Min.
16	Mode of Installation	Horizontal
17	No. of Tie rods	As Per manufacturer Standard

### 18.8 Electrically Operated Travelling (E.O.T.) Crane-Overhead (For Each Pumping)

Sr. No.	DESCRIPTION	PARTICULARS
<b>1.0</b>	<b>General</b>	
1.1	Make	Bidder to furnish. (It shall be as per approved vendor list)
1.2	Applicable Standards	IS 13837 M5-Mechanical M7-Electrical
1.3	Capacity (Tones)	As Per Price bid
1.4	Safe working load (Tones)	To be Furnished By Bidders
1.5	Recommended Rail	To be Furnished By Bidders.
1.6	Quantity	1 No For each Pumping
1.7	Class / Duty	To be furnished by Bidders
1.8	Lifting Height(m)	As Per Site condition
1.9	Span (m)	As Per Site Condition
1.10	Length of the runway (m)	As Per Site
1.11	Type	Overhead Double Girder E.O.T Crane (Circular For Circular Intake / Rectangular For Rectangular Intake)
1.12	Method of operation	Floor Operated, Through Down Pendant
1.13	Ladder	Required for servicing Crane & hoist

Sr. No.	DESCRIPTION	PARTICULARS
1.14	Hook Approach(Mtr.)	0.5 (Minimum)
<b>2.0</b>	<b>Operating speed (loaded)</b>	
2.1	Main Hoist (m / min.)	To be Furnished By Bidders
2.2	Cross Travel m / min.	To be Furnished By Bidders
2.3	Long Travel m / min.	To be Furnished By Bidders
<b>3.0</b>	<b>Type of hook</b>	Solid forged steel, IS: 3815
<b>4.0</b>	<b>Hoisting Rope</b>	To be Furnished By Bidders
4.1	Diameter (mm)	
4.2	Construction	
4.3	Core	
4.4	Make	To be Furnished By Bidders
<b>5.0</b>	<b>Factor of safety</b>	To be Furnished By Bidders
<b>6.0</b>	<b>Description of Brakes</b>	To be Furnished By Bidders
6.1	Hoisting	
6.2	Cross travel motion	
6.3	Long travel motion	
<b>7.0</b>	<b>Motor for hoisting</b>	To be Furnished By Bidders
7.1	Make	
7.2	Type	
7.3	Rating	
<b>8.0</b>	<b>Motor for Cross Travel</b>	To be Furnished By Bidders
8.1	Make	
8.2	Type	
8.3	Rating	
<b>9.0</b>	<b>Motor for Long Travel</b>	To be Furnished By Bidders

Sr. No.	DESCRIPTION	PARTICULARS
9.1	Make	
9.2	Type	
9.3	Rating	
9.4	Drive	
<b>10.0</b>	<b>Details of brakes for hoist motion</b>	To be Furnished By Bidders
10.1	Make of electro magnetic brake	
10.2	Make of electro hydraulic	
10.3	thruster Brake	
10.4	Design holding torque	
<b>11.0</b>	<b>Gantry Girder</b>	To be Furnished By Bidders
<b>12.0</b>	<b>Motor</b>	To be Furnished By Bidders
12.1	Rated Voltage, Ph, Freq.	415 V, 3 Phase, 50 Hz
12.2	Supply / Control Voltage	415 / 110 V
<b>13.0</b>	<b>GA drawing indicating overall dimensions weight, height and necessary details</b>	To be Furnished By Bidders
<b>14.0</b>	<b>MOC &amp; Test Certificate</b>	To be Furnished By Bidders

## 18.9 Vertical Non Clog Pump (For Each Pumping)

Sr. No.	DESCRIPTION	PARTICULARS
<b>1.0</b>	<b>General</b>	
1.1	Make	Bidder to furnish (It shall be of approved make)
1.2	Model	To be Furnished By Bidders
1.3	Type	Submersible Non-clog Pump- motor Set
1.4	Standard to which manufactured	Pl. Furnish
1.5	Number of pumps	As per BOQ
1.6	Number of stages	As Per manufacturer standard
1.7	Pump Application	For pumping-out the water collected due to spillage or leakage from the dry-well pit
1.8	Type of operation	Continuous
<b>2.0</b>	<b>Liquid Data</b>	
2.1	Liquid handled	Mud / Sewerage Water
2.2	Temperature	Ambient
<b>3.0</b>	<b>Performance</b>	
3.1	Capacity – Q (m <sup>3</sup> /hr), at 50 Hz	50 m <sup>3</sup> /hr (Minimum)
3.2	Total Head – H (Mt), at 50 Hz	20 meter (Minimum)
3.3	Min. Guaranteed Pump Efficiency, at duty point, at 50 Hz	50 % or more
3.4	BHP, at 50 Hz	Pl. Furnish
3.5	Pump Input (BKW), at 50 Hz	Pl. Furnish
3.6	Shut Off Head	Pl. Furnish
3.7	Required Pump Speed (RPM), at 50 Hz	Bidder to furnish
<b>4.0</b>	<b>Construction</b>	
4.1	Type of Impeller	Non-clog
4.2	Impeller Diameter	Bidder has to furnish
4.3	No. of Impeller Vanes	Bidder has to furnish
4.4	Discharge size	Bidder has to furnish



Sr. No.	DESCRIPTION	PARTICULARS
<b>5.0</b>	<b>Materials of Construction</b>	
5.1	Impeller	SS CF8M
5.2	Casing	Cast Iron (1.5 to 2% Ni)
5.3	Pump Shaft	SS 316 / SS 410
5.4	Casing Wearing Ring	Bronze
5.5	Mechanical Seal	TC
5.6	Motor Body	MS
6.0	Accessories & Services Required	
6.1	Suction strainer with Stand / Skirt-base	Required(SS – 304)
6.2	Companion flanges	Required
6.3	Painting	Required( Epoxy )
6.4	Automatic Coupling device, guide pipe, chain with shackle	Pl. Furnish
7.0	Motor	415 V, 3 Ph, 50 Hz, AC supply, TEFC enclosure with class – F insulation and IP – 68 protection with a suitable cable up to starter panel - Bidder to confirm provision
<b>8.0</b>	<b>Weight / Dimensions</b>	
8.1	Total Weight (kg) of the Complete Assembly	To be Furnished By Bidders
8.2	Over-all dimensions of the complete assembly: [L X B X H (mm)]	To be Furnished By Bidders

**18.10 DOUBLE ORIFICE TAMPER PROOF KINETIC AIR VALVE -(For Each Pumping)**

Sr. No.	Description	Required Specs.
1	General	
(a)	Size	As Per Design
(b)	Type	Flanged, Double Ball, Tamper-proof, Kinetic Air Release Valve with Isolating Valve
(c)	Make	Bidder to furnish (it shall be of approved make)
(d)	Rating	PN 1.6
(e)	Standard to which manufactured	IS 14845 : 2000 / AWWA C 512 (for valve), IS 1538 / 1976, Part IV & VI (for Flange)
(f)	Application / Location	To be fitted on water pipe-line for release of air
2	Materials of Construction	
(a)	Body, Cover, Cowl / Auto Valve etc.	Ductile Iron
(b)	Float - HP Orifice	Stainless Steel (As per IS 3444)
(c)	Float - LP Orifice	Stainless Steel (As per IS 3444)
(d)	Connecting Ends	Flanged flat face ends. Holes (IS 1538)
(e)	Gasket	Rubber, Type B (As per IS -638)
(f)	Bolts, Nuts	Stainless Steel (As per IS 6603)
3	Testing Required	IS 14845 (Latest)
4	Weight / Dimension	
(a)	Total Weight (kg) of the Complete Assembly	Bidder to furnish
(b)	Over-all dimensions of the complete assembly – L X B X H (mm)	Bidder to furnish
	ISOLATION SLUICE VALVE (Size – 200 mm)	As per IS-14846 (Latest)

### 18.12 Manual Chain Pulley Block ((For Each Pumping Station))

Sr. No.	Description	Required Specs.
	<b>GENERAL</b>	
1.0	Item	Hand Operated Trolley Crane with Manual Hoist
1.1	Location	As Per EIC
1.2	Quantity	As per Price Bid / BOQ
1.3	Capacity (Ton)	As per Price Bid
1.4	Applicable Standards	IS 807 & IS 3177 (relevant provisions)
1.5	Operating Floor	Pump House Floor Level
1.6	Test Load	125% of rated load
	<b>CRANE / TROLLEY DATA</b>	
2.0	Make	Approved Make
2.1	Model	To be specified
2.2	Type	Hand Operated / Push-Pull / Chain Operated
2.3	Class of Duty	Medium Duty – Class II as per IS 3177
2.4	Lift (m)	As per site requirement
2.5	Runway / Travel Length (m)	As per Pump House size
2.6	Type of Hoist	Manual Chain Pulley Block
2.7	Number of Falls	2 / 4
2.8	Method of Travel	Hand Push / Hand Chain Operated
2.9	Suspension Type	Hook
2.10	Brakes	Mechanical self-sustaining load brake
	<b>CONSTRUCTION</b>	
3.0	Trolley Frame	Fabricated / Rolled Steel

Sr. No.	Description	Required Specs.
3.1	Bridge / Beam	Standard I-Beam / Box Section
3.2	End Stoppers	Steel end stoppers on both sides of beam
3.3	Wheel Base	To be specified
3.4	Wheels	Forged steel / EN-9, double flanged
3.5	Wheel Bearings	Anti-friction ball / roller bearings
3.6	Shaft	High tensile steel
3.7	Gears (if geared trolley)	EN-24 / EN-9, machined & hardened
3.8	Wire Rope / Load Chain	Alloy steel load chain / steel wire rope as per IS
3.9	Hook	Forged steel hook with safety latch as per IS 15560
3.10	Rope Drum / Chain Wheel	MS, properly machined
3.11	Maintenance Access	Ladder / Safe access arrangement if required
3.12	Painting	Required – details to be furnished
	<b>ACCESSORIES</b>	
4.0	Manual Hoist	Required
4.1	Chain Guide & Guard	Required
4.2	Mechanical Travel Stops	Required
4.3	Load Chain Container	Required
	<b>WEIGHT</b>	
5.0	Weight of Hoist (kg)	To be furnished
5.1	Weight of Trolley (kg)	To be furnished
5.2	Weight of Beam / Girder (kg)	To be furnished
	<b>DRAWINGS</b>	
6.0	GA & Dimensional Drawings	To be furnished

Sr. No.	Description	Required Specs.
6.1	Load Rating & Duty Calculations	To be furnished
6.2	Catalogue of Products	To be furnished
6.3	Quality Assurance Plan (QAP)	To be furnished
	<b>TESTING</b>	
7.0	Visual & Dimensional Inspection	Witnessing
7.1	Load Test	150% of rated capacity – Witnessing
7.2	Functional Test	Witnessing
7.3	Material Test Certificates	Mandatory

### 18.13 SURGE CONTROL DEVICES ((For Each Pumping Station)

#### (Zero Velocity and Vacuum Breaker cum Air Cushion Valves)

Sr. No.	Valve Type	Size & Rating
1	Zero Velocity Valve –1	As Per Design
2	Vaccum Breaker cum Air Cushion Valve - 1	As Per Design
3	Vaccum Breaker cum Air Cushion Valve - 2	As Per Design

**Note:** The successful contractor has to submit detailed design & calculations. Location of Air Vessels & Zero Velocity Valves are to be decided by the successful contractor on the base of detailed design submitted & got approved from the department competent authority before execution.

**Notes:**

- a. Material certificates of components shall be furnished before inspection of components  
Bidder to furnish GA drawing indicating overall dimensions, weight, and height details along with offer
- n. Bidder to furnish Performance curves for Head V/s Capacity, Efficiency V/s Capacity and Power (BKW) V/s Capacity.

- 
- o. The capacity range shall be zero flow to maximum flow.  
Bidders have to submit performance test reports and, family curves (Head(H) Vs Discharge (Q), Efficiency vs. Discharge, and Power (P) Vs. Discharge (Q) for similar model of pump.
  - p. If the guaranteed, efficiency of pump quoted by the bidders is less than minimum specified in the tender than the offer of bidder is liable to be rejected.
  - q. Bidder has to furnish guaranteed technical particulars duly filled.

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# SPECIAL CONDITIONS OF CONTRACT

## Section: Special Technical & Commercial Conditions for Electro-Mechanical Works, SCADA, and Commissioning

### 1. Absolute Turnkey Responsibility and Non-Absoluteness of Schedule-B

- **1.1** The items and descriptions listed under **Schedule-B (Electro-Mechanical Components)** are indicative and **NOT absolute or exhaustive**. The entire contract is on a **Lump-Sum Turnkey / Total Responsibility basis**. The bidder must design, engineer, supply, install, test, and commission the entire pumping machinery, switchyard, and allied components strictly confirming to the latest Indian Standards (IS Codes), IEC standards, CEA safety guidelines, and standard engineering practices.
- **1.2** All items listed in Schedule-B must be supplied. In addition to Schedule-B items, any other electro-mechanical equipment, accessory, internal cabling, structural components, or specialized fittings required for the complete functionality, safety, interlocking, and successful commissioning of the project **must be provided by the bidder within their quoted price**.
- **1.3** No extra payment, variation, or New Item Claim shall be entertained or admissible by the Department on account of any such additional items required for commissioning.
- **1.4** Sizes and ratings of all major equipment's, components and accessories keeping in view the duty parameters that is Q (Flow) And H (Head) of each pumpsets of concern head works are given in estimates. In case of any change in this parameters subsequently, all other dependent associated mechanical, electrical and instruments etc. will also change to suit the actual requirements. Any and all such required/desire changes/modifications/improvements shall have to be incorporated in CDR and implemented without any additional cost to the department. Claim either in the form of excess qty or extra items on account of such changes (if any) shall not be admissible and not payable.
- **1.5** All electro – Mechanical items must be procured from approved vendors as per prevailing GWSSB vendor list of Category A.

### 2. Cloud-Based PLC-SCADA System Requirements

- **2.1 Architecture & Web Portal:** The PLC-SCADA system must be purely **Cloud Server-Based**. The contractor shall design and host a dedicated, secure web portal and provide administrative login credentials to GWSSB. The complete real-time data of the system must be accessible globally via any secure web browser without requiring proprietary software.
- **2.2 Comprehensive Data Integration:** The SCADA dashboard and web interface must continuously log, monitor, and display the following parameters:
  - **Pumping Machinery:** Individual and parallel operational status/conditions of all pumpsets, flow rates, and precise valve positions.

- **Electrical System & Switchyard:** Operational status of transformers, HT/LT breakers, switchyard protection relays, input voltage, current, input kW, power factor, and live DISCOM tariff/power data.
  - **Allied Integration:** All other minor and major Electro-Mechanical components installed in the facility must be fully integrated into the SCADA network.
- **2.3 Analytics & Reporting:** The web portal must feature an in-built automated report generation module. GWSSB users must be able to generate, customize, and download daily, weekly, monthly, and annual operational and consumption reports directly from the web interface.
- **2.4 Cyber Security Guarantee:** The contractor shall bear **sole and absolute responsibility for the cyber security** of the cloud infrastructure, web portal, and data servers. The system must be protected against unauthorized access, data breaches, and cyber threats using industry-standard firewalls, data encryption (SSL/TLS), and secure protocol compliance.

### 3. Separate Energy Metering & Splitting (GIDC vs. GWSSB)

- **3.1** To accurately determine, segregate, and split the electricity billing, the contractor shall design and install a **completely segregated Energy Metering System**.
- **3.2** The system must independently measure, log, and report the exact energy consumption (kWh, kVAh, MD) of the **GIDC pumpsets & components** versus the **GWSSB pumpsets & components**. This segregated data must be cleanly split and displayed on the web SCADA portal for financial auditing and billing reconciliation.

### 4. SCADA Compatibility of Power Components

- **4.1** All electrical components, including but not limited to **HT Panels, LT Panels, Circuit Breakers (VCBs/ACBs), and Soft Starters**, must be strictly **PLC-SCADA compatible**.
- **4.2** They must be equipped with necessary smart communication cards/ports (Modbus TCP/IP, Profibus, or standard IEC protocols) and digital/analog I/O modules to facilitate bidirectional communication, remote operation, and real-time data fetching by the central PLC-SCADA system.

### 5. Deployment of Trained SCADA Engineers

- **5.1** The contractor shall mandatorily deploy **qualified and trained SCADA/Automation Engineers** at the site for the entire duration of the **Trial Run period** as well as the **Operation & Maintenance (O&M) period**.
- **5.2** The deployed engineers shall be responsible for smooth system operation, data logging, troubleshooting, and hands-on training of GWSSB personnel.

### 6. Liaisoning for Electricity Connection & Statutory Formality



- 
- **6.1 Scope of Contractor:** The complete scope of liaisoning with the Electricity Distribution Company (DISCOM / Transmission Utility) for obtaining the permanent high-tension/low-tension power connection rests solely with the contractor.
  - **6.2 Formality & Approvals:** The contractor shall execute all administrative formalities, file applications, prepare drawings, coordinate inspections, and obtain safety clearances from the Electrical Inspectorate.
  - **6.3 Department's Liability:** GWSSB shall only bear the actual official **Registration Charges and official Service Connection Charges (Demand Note amount)** directly payable to the DISCOM. All other expenses, coordination costs, and follow-up overheads shall be borne entirely by the contractor.

**7. To provide the power to the new pumping machinery at the Palej WTP, an arrangement must be made to draw power from the existing PMCC panel at the Palej HW. Any necessary modifications to the existing panel must be carried out to facilitate this. No additional payment will be entertained for this work. Agency has to carried out as free of cost.**

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***Enclosure – Technical Specification for Electrical  
Works***

# Content

Chapter	Title	Page
<b>1.</b>	<b>General</b>	<b>10</b>
1.1	Standards and Codes	10
1.2	Safety & Security	14
1.3	Environmental condition	14
1.4	Electrical switchgear Room Environment	14
1.5	System Voltage	14
1.6	Voltage & frequency variations	15
1.7	Phase Sequence	15
1.8	Voltage drop criterion	15
1.9	Compatibility	16
1.10	Enclosures	16
1.11	Identifications	17
1.12	Harmonics	17
1.13	Surge protection	17
1.14	Earthing Protection	18
1.15	Lightning Protection	18
1.16	Tools & Testing Equipments	19
1.17	Cutting, patching and excavation	20
1.18	Drawings	20
1.19	Personnel	20
<b>2.</b>	<b>Scope of work</b>	<b>21</b>
2.1	Scope of Work	21
2.2	Submittals	22
<b>3.</b>	<b>Technical Specification of Electrical Works</b>	<b>24</b>
3.1	Outdoor Lightning Arrestor	24
3.1.1	Scope	24
3.1.2	Standards	24
3.1.3	Drawings & documents	24
3.1.4	Type	25
3.2	Description	25
3.2.1	Design & Construction	25
3.2.1.1	Porcelain Housing	25
3.2.1.2	Pressure Relief Device	26
3.2.1.3	Terminal Connectors	26
3.2.1.4	Galvanizing	26
3.2.1.5	Name Plate	26
3.2.1.6	Surge Counter	26
3.2.1.7	System voltage	26
3.2.1.8	Rated Arrestors Voltage	26
3.2.1.9	Nominal Discharge Current	26
3.2.1.10	Maximum residual Voltage:	27
3.2.1.11	System Neutral Connection:	27
3.2.1.12	Outdoor Installation:	27
3.2.1.13	Special Condition	27
3.2.1.14	Impulse withstand voltage	27
3.2.1.15	Overhead Earth wire:	27
3.2.1.16	Physical data:	27
3.2.1.17	Creep age Distance	28
3.2.1.18	Type Test:	28

3.2.1.19	Routine Test:	29
3.3	Outdoor Isolator	29
3.3.1	Scope	29
3.3.2	Standards	29
3.3.3	Description	30
3.3.3.1	Contacts	30
3.3.3.2	Insulators	30
3.3.3.3	Operating mechanism	31
3.3.3.4	Earthing switch	31
3.4	Outdoor Bus post insulator	32
3.4.1	Scope	32
3.4.2	Design	32
3.4.3	Testing	32
3.5	Outdoor Current Transformers	33
3.5.1	Scope	33
3.5.2	Standards	33
3.5.3	Description	34
3.5.3.1	Winding & Terminals	35
3.5.3.2	Terminal box of current transformer	36
3.5.3.3	Temperature rise	36
3.5.3.4	Bushing & insulators	36
3.5.3.5	Terminal connectors & earthing terminals	37
3.5.3.6	Galvanising	37
3.5.3.7	Test & test reports	37
3.5.3.8	General points	38
3.5.3.9	Quality Assurance plan	39
3.5.3.10	Completeness of equipments	40
3.6	Outdoor Voltage Transformers	40
3.6.1	Scope	40
3.6.2	Type & rating	40
3.6.3	Standards	40
3.6.4	Description	40
3.6.5	Windings	41
3.6.5.1	Primary & secondary winding	41
3.6.5.2	Insulation	42
3.6.5.3	Temperature rise	42
3.6.5.4	Type of Mounting	42
3.6.5.5	Terminal box of voltage transformer	43
3.6.5.6	Terminal connections	43
3.6.5.7	Tests	44
3.7	Outdoor SF6 circuit breaker	45
3.7.1	Scope	45
3.7.2	Applicable Standards	45
3.7.3	Drawings/documents	45
3.7.4	General Design Features of Circuit Breakers	46
3.7.5	Breaking Capacity	46
3.7.6	Temperature Rise	47
3.7.7	General Features of Circuit Breakers	47
3.7.8	Insulation of the Circuit Breaker	48
3.7.9	Contacts of Circuit Breaker:	48
3.7.10	Operating Mechanism of Circuit Breakers	48
3.7.11	Auxiliary switches	49
3.7.12	Bushing & Insulators	49
3.7.13	Terminal Connectors and Earthing Terminals	49
3.7.14	Tropicalisation	49
3.7.15	Galvanizing	49

3.7.16	Painting _____	50
3.7.17	Test and Test Reports _____	50
3.7.18	Earthquake & wind design load _____	51
3.7.19	General design feature of circuit breaker _____	51
3.8	Switchyard Equipment _____	52
3.8.1	Scope _____	52
3.8.2	Structure _____	52
3.8.3	Gang operated offload disconnectors (GOD) with earth switch: _____	53
3.8.4	Isolator Interlock: _____	53
3.8.5	Insulators: _____	54
3.8.6	ACSR Conductor: _____	54
3.8.7	Drop out (D0) Fuse Unit: _____	54
3.8.8	Drop out (D0) Fuse Unit: _____	55
3.8.9	Chain Link Fencing and Gravel Filling: _____	57
3.9	Power transformers _____	57
3.9.1	Scope _____	57
3.9.2	Standards _____	57
3.9.3	Service condition _____	58
3.9.3.1	Climatic condition _____	58
3.9.3.2	Auxiliary Power supply _____	58
3.9.4	General Technical requirement _____	59
3.9.4.1	Transformer Losses _____	59
3.9.4.2	Construction details _____	60
3.9.4.3	Drawings & documentation _____	80
3.9.4.4	Quality assurance plans _____	80
3.9.4.5	Tests & Inspection _____	81
3.10	Neutral Grounding Resistors _____	86
3.10.1	Scope _____	86
3.10.2	Applicable Standards _____	86
3.10.3	Design Requirements _____	86
3.10.3.1	Resistor elements _____	86
3.10.3.2	Enclosure _____	86
3.10.3.3	Terminal connectors _____	87
3.10.3.4	General _____	87
3.10.3.5	Tests _____	87
3.11	Outdoor substation structure _____	88
3.11.1	Scope _____	88
3.11.2	Standards _____	88
3.11.3	Drawings and Bills of Materials _____	89
3.11.4	Design, Fabrication, Stamping and Galvanising of Materials _____	89
3.11.5	Type of Structures _____	90
3.11.6	Material _____	90
3.11.7	Fabrication Workmanship _____	91
3.11.8	Proto-Model Assembly _____	91
3.11.9	Drilling and Punching _____	91
3.11.10	Erection Mark _____	92
3.11.11	Bending _____	92
3.11.12	Galvanising _____	92
3.11.13	General Guide-Line For Inspection: _____	93
3.11.13.1	Structure Details _____	94
3.12	Overhead conductor _____	94
3.13	Control & Relay Panels-Part I _____	95
3.13.1	Scope _____	95
3.13.2	Standards _____	95
3.13.3	Drawings _____	96
3.13.3.1	Detailed Description: _____	98

3.13.3.2	Semaphore Indicators: _____	99
3.13.3.3	Switches: _____	99
3.13.3.4	Instruments, Meters and Recorders: _____	100
3.13.3.5	Annunciation System: _____	101
3.13.3.6	Relays : _____	101
3.13.3.7	Electrical Equipment and Wiring : _____	101
3.13.3.8	Terminal Blocks: _____	102
3.13.3.9	Space Heaters: _____	102
3.13.3.10	Test Blocks: _____	102
3.13.3.11	Safety Earthing: _____	102
3.13.3.12	Switch Board Lighting: _____	103
3.13.3.13	Supporting Steel: _____	103
3.13.3.14	Accessories: _____	103
3.13.3.15	Tropicalization: _____	103
3.13.3.16	Painting: _____	103
3.13.3.17	Fire Protection: _____	103
3.13.3.18	Protective Scheme Requirement: _____	103
3.13.3.19	Tests: _____	103
3.13.3.20	Co-Ordination with Other Manufacturers: _____	104
3.13.3.21	Specific Requirements: _____	104
3.13.3.22	Annunciation: _____	105
3.13.3.23	Protection (Transformer C & R panel with differential protection) _____	106
3.13.4	Type – II – 66kV Feeder Control & Relay Panel : _____	106
3.13.4.1	Instruments _____	106
3.13.4.2	Annunciation _____	107
3.13.4.3	Protection (66 kV Feeder): _____	107
3.13.4.4	Indicating lamp, instruments and vector group of power transformer, instrument transformer: _____	108
3.13.4.5	Vector Group of Transformer: Dyn – 11 _____	108
3.13.4.6	(Part II) – General Requirements _____	108
3.13.4.7	Scope: _____	108
3.13.4.8	Standard: _____	108
3.13.4.9	General Description: _____	109
3.13.4.10	General Constructions: _____	109
3.13.4.11	Design Details: _____	109
3.13.4.12	Painting: _____	111
3.13.4.13	Wiring: _____	111
3.13.4.14	Tropicalizaton: _____	111
3.13.4.15	Test Facilities: _____	111
3.13.4.16	Grounding: _____	112
3.13.4.17	Instruments: _____	112
3.13.5	Part-III Specification on Protective Relays _____	112
3.13.5.1	Scope: _____	112
3.13.5.2	Standards _____	113
3.13.5.3	Principal Technical Parameters: _____	113
3.13.5.4	General Technical Requirements: _____	113
3.13.5.5	Tests: _____	115
3.13.5.6	Demonstration _____	117
3.13.5.7	Principal Technical parameters of relays _____	118
3.14	Switchyard Equipment _____	124
3.14.1	Scope _____	124
3.14.2	Structure _____	124
3.14.3	Gang operated offload disconnectors (GOD) with earth switch: _____	125
3.14.4	Isolator Interlock: _____	126
3.14.5	Insulators: _____	126
3.14.6	ACSR Conductor: _____	126
3.14.7	Drop out (D0) Fuse Unit: _____	127

3.14.8	Drop out (D0) Fuse Unit:	127
3.14.9	Chain Link Fencing and Gravel Filling:	129
3.15	Battery, Battery charger and DCDB	129
3.15.1	Battery	130
3.15.2	Battery charger and DCDB	132
3.15.3	Performance	133
3.15.4	Tests	134
3.15.5	Technical data	134
3.16	Metal Enclosed HV Switchgear Panel	135
3.16.1	Scope	135
3.16.2	Codes and standards	135
3.16.3	Design criterion	136
3.16.4	Type of Sheet Steel & Cubicle	136
3.16.5	Circuit Breaker	136
3.16.6	Interlocks	137
3.16.7	Safety Shutters	137
3.16.8	Fixed Isolating Contacts	137
3.16.9	Cable Compartment	137
3.16.10	Low Voltage Compartment	138
3.16.11	Auxiliary Switch and Auxiliary Plug & Socket	138
3.16.12	Electrical & Mechanical Position Indication	138
3.16.13	Control and Power Cable Entry	138
3.16.14	Pressure Discharge Flaps	138
3.16.15	Busbars	138
3.16.16	EarthBus	138
3.16.17	Bus & Cable Earthing	139
3.16.18	Current and Potential Transformer	139
3.16.19	Protection Relays	139
3.16.20	Thermal Rating of Switchgear	140
3.16.21	Auxiliary Supply	141
3.16.22	Overall Dimension	141
3.16.23	TypeTest	141
3.16.24	Cabling	141
3.17	HV & LV Cables	142
3.17.1	Scope	142
3.17.2	Codes and standards	142
3.17.3	General construction of cables	143
3.17.4	XLPE Cables	143
3.17.5	PVC cables	144
3.17.6	Cable Accessories	146
3.17.6.1	Installation and Termination of Cables	146
3.17.7	Cable Support Systems	149
3.17.7.1	Trays for Power Cables	149
3.17.7.2	Cables External to Buildings and Structures	149
3.17.7.3	Metallic Conduit:	150
3.17.7.4	Non-Metallic Conduit:	150
3.17.7.5	Corrugated Flexible Conduit:	150
3.17.7.6	Conduit Fittings:	150
3.17.7.7	Conduit Fastenings:	151
3.17.7.8	Expansion Fittings or couplers:	151
3.17.7.9	Outlet and Conduit Boxes:	151
3.17.7.10	Markers:	152
3.17.7.11	Sealing Compound:	152
3.17.7.12	Packing and marking	152
3.17.7.13	Testing and inspection	153
3.17.8	Wires & Cables	153

3.17.8.1	General	153
3.17.8.2	415/240V System	154
3.17.8.3	Buried cables	155
3.18	Lighting system	155
3.18.1	Scope	155
3.18.2	General Requirements	155
3.18.3	Lighting Layout	157
3.18.4	Lighting Fixtures (Luminaires)	157
3.18.5	Decorative Luminaires	158
3.18.6	PANELS/BOARD COMPONENT EQUIPMENT	160
3.18.6.1	Indicating Meters And meters	160
3.18.6.2	Instruments Transformers	160
3.18.6.3	Internal Wiring	161
3.18.6.4	LABELS & DIAGRAM PLATE	162
3.18.6.5	Light Control Switch	162
3.18.6.6	RECEPTACLE UNITS	162
3.18.6.7	Drawings and Data	164
3.18.6.8	Lighting Fixture – LED lamp Set	164
3.18.6.9	Lighting Poles and Flood Light Pole Mounting	165
3.19	Earthing System	167
3.19.1	General	167
3.19.2	240V Equipment	168
3.19.3	415 V Equipment	168
3.19.4	Earth Electrode System	169
3.19.5	Earthing of Power or Motor Control Centre, Distribution Boards	169
3.20	Distribution transformer	170
3.21	LV Switchgear Panel /415V MCC Panel	171
3.21.1	Standards	171
3.21.1	Constructional requirement	172
3.21.1.1	General	172
3.21.1.2	Main Busbar	175
3.21.1.3	Circuit Breaker	175
3.21.1.4	AIR BREAK SWITCHES/ SWITCH DISCONNECTOR FUSE	178
3.21.1.5	FUSES	179
3.21.1.6	MOTOR STARTER	179
3.21.1.7	CONTACTOR	179
3.21.1.8	DIRECT-ON-LINE (DOL) STARTER	180
3.21.1.9	AUTOMATIC STAR-DELTA STARTER	180
3.21.1.10	SOFT STARTER	181
3.21.1.11	APPLICABLE CODES AND STANDARD	181
3.21.1.12	FAULT DETECTION	183
3.21.1.13	REVERSING STARTER	183
3.21.1.14	SINGLE PHASING PREVENTER	183
3.21.1.15	INSTRUMENT TRANSFORMER	183
3.21.1.16	INSTRUMENT	184
3.21.1.17	MICROCOMPUTER MOTOR PROTECTION RELAY	184
3.21.1.18	PROTECTIVE RELAY	184
3.21.1.19	MISCELLANEOUS ACCESSORIES	185
3.21.1.20	INTERNAL WIRING	185
3.21.1.21	TERMINAL BLOCKS	186
3.21.1.22	EARTHING	186
3.22	LV energy efficient Motors	187
3.22.1	Standards	187
3.22.2	Service conditions	187
3.22.3	Constructional requirement	188
3.22.3.1	General	188



3.22.3.2	Enclosures	188
3.22.3.3	Windings	189
3.22.3.4	Terminal boxes	189
3.22.3.5	Rotors and cooling fans	190
3.22.3.6	Bearings	190
3.22.3.7	Anti-condensation heaters	191
3.22.3.8	Earthing	191
3.22.3.9	Lifting facilities	191
3.22.3.10	Rating plates	191
3.22.3.11	Painting and finish	192
3.22.3.12	Noise level	193
3.22.3.13	Motor Starter Feeders	193
3.23	HV Soft Starter	195
3.23.1	Design & Standards	195
3.23.2	HARMONIC FREE SERIES REACTOR (HFSR) SOFT STARTER	197
3.23.3	FLUX COMPENSATED MAGNETIC AMPLIFIER (FCMA) TYPE SOFT STARTER	198
3.23.4	Panel Accessories and Wiring	199
3.23.5	Cable Termination	200
3.23.6	Motor starter protection	200
3.23.7	Statistical Data	201
3.23.8	Metering (Voltage & Current)	201
3.23.9	Enclosure	201
3.23.10	Communications	201
3.23.11	Starting & Stopping	201
3.23.12	Interactive LCD Display	201
3.23.13	Control Circuitry	201
3.23.14	Other Features at Glance	202
3.23.15	Drawings & data	203
3.24	Power Capacitors and Capacitor control panel	203
3.24.1	Scope Of Work	203
3.24.2	LV APFC Panel & capacitor bank	203
3.24.2.1	Busbar / Connection	204
3.24.2.2	Wiring and Terminations	205
3.24.2.3	Anti-condensation heaters	205
3.24.2.4	Auxiliary Supply	205
3.24.2.5	Grounding	206
3.24.2.6	Nameplates	206
3.24.2.7	Cooling Systems	206
3.24.2.8	Lifting Hooks	206
3.24.2.9	Capacitor Banks:	206
3.24.2.10	Performance	207
3.25	6.6 kV HT Capacitor Panel	208
3.25.1	Scope Of Work:	208
3.25.2	General Technical requirements	209
3.25.3	CAPACITOR BANK	210
3.25.4	Reactors	211
3.25.5	Isolators with earth switch	211
3.25.6	Vacuum Contactors	212
3.25.6.1	HRC Fuses	212
3.25.6.2	Protection:	213
3.26	Auxiliary Transformer	214
3.26.1	Scope of Work	214
3.26.2	APPLICABLE IS CODE & STANDARDS:	214
3.26.3	SERVICE CONDITION	215
3.26.4	AMBIENT AIR TEMPERATURE:	216
3.26.5	DESIGN FEATURES	216

3.26.6	ELECTRICAL FEATURES: THE ELECTRICAL FEATURE SHALL ENSURE THE FOLLOWINGS: _____	216
3.26.7	MECHANICAL FEATURES _____	216
3.26.8	CONSTRUCTIONAL DETAILS _____	217
3.26.8.1	CORE _____	217
3.26.8.2	TANKS _____	217
3.26.8.3	TANK COVER _____	218
3.26.9	MOUNTING ARRANGEMENT _____	218
3.26.9.1	CONSERVATOR TANK _____	218
3.26.9.2	EXPLOSION VENT _____	219
3.26.9.3	TEMPERATURE INDICATOR: _____	219
3.26.9.4	WINDINGS _____	219
3.26.10	INSULATION MATERIALS _____	220
3.26.11	EARTHING TERMINALS _____	220
3.26.12	OIL PRESERVATION SYSTEM _____	221
3.26.13	TERMINAL ARRANGEMENT PORCELAIN BUSHING _____	221
3.26.14	CABLE BOXES AND DISCONNECTING CHAMBERS: _____	221
3.26.15	TERMINAL MARKING: _____	222
3.26.16	TERMINATION ARRANGEMENT FOR NEUTRALS _____	222
3.26.17	OFF CIRCUIT TAP CHANGE SWITCH:- _____	222
3.26.18	CLEANING PAINTING _____	223
3.26.19	BOLTS AND NUTS _____	223
3.26.20	FITTINGS _____	223
3.27	Diesel Generating sets _____	224
3.27.1	General & scope _____	224
3.27.2	Standards _____	224
3.27.3	Drawings _____	224
3.27.4	Drawing/Documents submission after completion of work _____	225
3.27.5	Technical requirements _____	225
3.27.5.1	DG set with Acoustic enclosure _____	225
3.27.5.2	Rating _____	225
3.27.5.3	Climatic conditions _____	226
3.27.5.4	Diesel engine _____	226
3.27.5.5	Governor _____	227
3.27.5.6	Frequency variation _____	227
3.27.5.7	Fuel System _____	227
3.27.5.8	Lubricating oil system _____	228
3.27.5.9	Starting system _____	228
3.27.5.10	Battery Charger _____	228
3.27.5.11	Piping Work _____	228
3.27.5.12	Common bed plate _____	228
3.27.5.13	Exhaust Piping _____	228
3.27.5.14	Optimum Silencer Location _____	229
3.27.5.15	Synchronous alternator _____	231
3.27.6	AMF Panel, Batteries & Electrical System _____	233
3.27.6.1	DG Set with acoustic enclosure: _____	233
3.27.6.2	AMF control panel _____	233
3.28	Local Pushbutton Stations _____	239
3.28.1	Construction features _____	239
3.28.2	Push buttons _____	240
3.28.2.1	Type of Push Button Stations _____	240
3.29	Air conditioning system _____	240
3.29.1	General _____	240
3.30	Other accessories _____	241
3.30.1	Water cooler cum Purifier _____	241
3.31	Installation Methods _____	241
3.31.1	General _____	241

3.31.2	Tray _____	241
3.31.3	HDPE Conduits _____	241
3.31.4	Identification _____	242
3.31.5	Electrical Installation Record Drawings _____	243
3.32	Inspection at manufacturer's premises _____	243
3.32.1	Erection & commissioning of Electrical Equipments _____	244
3.32.1.1	Erection and commissioning of tools & tackles _____	244
3.32.1.2	Completion of Erection (General) _____	245
3.32.1.3	Erection of switchyard structures _____	245
3.32.1.4	Erection of Gantry stringing (Busbar stringing) _____	246
3.32.1.5	Erection of secondary equipments _____	247
3.32.1.6	Erection of circuit breaker _____	248
3.32.1.7	Erection of Power transformer _____	249
3.32.1.8	Erection of Isolators _____	250
3.32.1.9	Erection of Control & relay panels ,6.6 kV& 415V switchboards , 6.6 kV & 415V APFC Panel _____	251
3.32.1.10	Erection of battery & Battery charger _____	251
3.32.1.11	General _____	253
3.32.1.12	Painting _____	256
3.33	Inspection & field test of Electrical equipment's _____	256
3.33.1	Scope _____	256
3.33.2	General requirements _____	257
3.33.3	Site Acceptance Test (SAT) _____	258
3.33.3.1	EHV equipments _____	258
3.33.3.2	Power transformer _____	258
3.33.3.3	High voltage switchgear _____	259
3.33.3.4	Medium voltage switchgear _____	261
3.33.3.5	H.V. cable _____	263
3.33.3.6	L.V cable _____	263
3.33.3.7	Wiring _____	263
3.33.3.8	Alarms _____	264
3.33.3.9	Earthing _____	264
3.33.3.10	Batteries _____	265
3.33.3.11	Battery chargers _____	265
3.33.3.12	Insulating liquid dielectric test _____	265
<b>4.</b>	<b>DATA SHEET FOR ELECTRICAL SPECIFICATION</b>	<b>266</b>
4.1	Lighting Arresters _____	266
4.2	Isolators _____	268
4.3	CT PT & BPI unit _____	269
4.4	Circuit Breakers( SF6) _____	274
4.5	Power Transformer _____	277
4.6	Auxiliary Transformer _____	281
4.7	Neutral Grounding Resistor _____	283
4.8	6.6. KV Metal Enclosed Switchgear _____	284
4.9	6.6 KV Soft Starter Panel With Capacitor _____	289
4.10	415V Metal Enclosed Switchgear _____	294
4.11	LT APFC PANEL _____	296
4.12	Maintenance free Lead Acid battery _____	298
4.13	Battery Charger and D.C. Distribution board _____	299
4.14	Power and Control cables (For Each Pumping Station) _____	301
4.15	Earthing and lightning Protection System (For Each Pumping Station) _____	301

## 1. General

- a. This section of the specification sets out the standard for items of electrical system to be executed by the Contractor. This section describes the basic system that has to be adopted for the electrical power distribution. The selection of power distribution system equipment ratings and layout of the electrical equipment shall consider ease of installation, maintenance and modular addition of equipment for future expansion. All the components of the electrical system shall withstand the environmental conditions of the region as described hereafter.
- b. The equipment shall be complete in all respects and device not included in the specifications but essential from code, regulation, statutory requirement, standard practice or operational flexibility point of view shall be included by the Contractor.

### 1.1 Standards and Codes

- a. Applicable standards established by the Indian Standards, International Electro technical commission (IEC) etc. govern the materials and workmanship employed in the manufacture of all equipment/items are:

Codes	Description
IS 191	Copper – Specification
IS 319	Free Cutting Lead Brass Bars, Rods and Section Specification
IS 12615	Three phase induction motors
IS 335	New insulating oils
IS 374	Electric ceiling type fans and regulators
IS 694	PVC Insulated cables for working voltage up to and including 1100 V.
IS 722	Specification for AC Electricity Meters
IS 732	Code of practice for electrical wiring installations
IS 1079	Hot Rolled Carbon Steel Sheet and Strip – Specification
IS1169	Electric pedestal type fans and regulators
IS1248	Direct acting indicating analogue electrical measuring instruments and their accessories
IS 1255	Code of practice for installation and maintenance of power cables up to and including 33kV rating
IS 1271	Thermal evaluation and classification of electrical insulation
IS 1293	Plugs and socket- outlets of rated voltage up to and including 250 volts and rated current up to 16 amperes – Specification
IS 1544	Cotton calico
IS 1554	PVC insulated (heavy duty) electric cables
IS 1868	Anodic Coatings on Aluminium and its Alloys – Specification
IS 1897	Copper strip for electrical purposes – Specification
IS 1944	Code of practice for lighting of public thoroughfare
IS 2026	Power transformers
IS 2099	Bushings for alternating voltages above 1 000 Volts
IS 2190	Selection, Installation and Maintenance of First-aid Fire Extinguishers

Codes	Description
	—code of practice
IS 2253	Designation types of construction and mounting arrangement of rotating electrical machines
IS 2309	Code of practice for protection of buildings and allied structures against lightning
IS 2419	Dimensions for panel mounted indicating and recording electrical instruments
IS 2544	Porcelain post insulators for systems with nominal voltage greater than 1000 V
IS 2546	Specification for galvanized mild steel fire bucket
IS 2551	Danger notice plates
IS 2629	Recommended Practice for Hot-Dip Galvanizing of Iron and Steel
IS 2633	Methods for testing uniformity of coating of zinc coated articles
IS 2667	Fittings for rigid steel conduits for electrical wiring
IS 2705	Current transformers
IS 2925	Specification for Industrial Safety Helmets
IS 2993	A.C. motor capacitors
IS 3043	Code of practice for earthing
IS 3070	Lighting arresters for alternating current systems
IS 3156	Voltage transformers
IS 3231	Electrical relays for power system protection
IS 3347	Dimensions for porcelain transformer bushings for use in lightly polluted atmospheres
IS 3400	Methods of test for vulcanized rubbers
IS 3419	Fittings for rigid non-metallic conduits
IS 3427	A.C. Metal Enclosed Switchgear and Control gear for Rated Voltages Above 1 kV and Up to and Including 52 kV
IS 3480	Flexible steel conduits for electrical wiring
IS 3646	Code of practice for interior illumination
IS 3837	Accessories for rigid steel conduits for electrical wiring
IS 3842	Application guide for electrical relays for ac systems
IS 3854	Switches for domestic and similar purposes.
IS 3975	Mild steel wires, formed wires and tapes for armouring of cables
IS 4759	Hot-dip zinc coatings on structural steel and other allied products
IS 4770	Rubber Gloves - Electrical Purposes – Specification
IS 4795	Holders for Indicator Lamps for Electronic and Telecommunication Equipment
IS 5572	Classification of hazardous areas (other than mines) having flammable gases and vapours for electrical installation
IS 5578	Guide for marking of insulated conductors
IS 5621	Hollow insulators for use in electrical equipment
IS 5819	Recommended short-circuit ratings of high voltage PVC cables
IS 5831	PVC insulation and sheath of electric cables.
IS 6229	Method for Measurement of Real-ear Protection of Hearing Protectors and Physical Attenuation of Earmuffs
IS 6600	Guide for loading of oil immersed transformers
IS 6665	Code of practice for industrial lighting

Codes	Description
IS 7098	Cross linked polyethylene insulated PVC sheathed cables
IS 7752	Guide for improvement of power factor in consumer installation
IS 8130	Conductors for insulated electric cables and flexible cords
IS 8224	Electric lighting fittings for division 2 areas
IS 8468	On-load tap changers
IS 8478	Application guide for on-load tap changers
IS 8752	Towing hook for use between trailers of up to 5 tonnes gross mass and transport tractor
IS 8789	Values of performance characteristics for three phase induction motors
IS 8828	Electrical Accessories - Circuit Breakers for Over Current Protection for Household and Similar Installations
IS 9283	Motors for submersible pump sets
IS 9334	Electric motor operated actuators.
IS 9537	Conduits for electrical installations
IS 9583	Emergency lighting units
IS 9677	Guide for limits of temperature-rise of the windings of electrical equipment when tested by different methods
IS 9678	Methods of measuring temperature rise of electrical equipment
IS 9921	Alternating current disconnectors (isolators) and earthing switches for voltages above 1000 V
IS 9974	High pressure sodium vapour lamps
IS 10118	Code of practice for selection, installation and maintenance of switchgear and control gear
IS 10322	Luminaries
IS 10418	Drums for electric cables
IS 10601	Dimensions of terminals of high voltage switchgear and control gear
IS 10810	Methods of test for cables
IS 11037	Electronic type fan regulators
IS 11353	Guide for uniform system of marking and identification of conductors and apparatus
IS 11171	Specification for Dry-Type Power Transformers.
IS 12065	Permissible limits of noise level for rotating electrical machines
IS 12615	Energy efficient induction motors- three phase squirrel cage.
IS 13585	Power Capacitors of non-Self-healing Type for AC Power Systems having Rated Voltage up to 650 V – Specification
IS 13369	Stationary lead acid batteries (with tubular positive plates) in monobloc containers
IS 13383	Methods of Photometry of Luminaires.
IS 13440	Code of safety for methyl chloride
IS 13703	Low Voltage Fuses for voltages not exceeding 1000V AC or 1500 V DC
IS 13779	AC Static Watt-hour Meters, Class1 & 2
IS 13849	Specification for portable fire extinguisher dry powder type (constant pressure).
IS 13875	Digital measuring instruments for measuring and control.
IS 13925	Shunt capacitors for ac power systems having a rated voltage above 1000 V
IS 13947	Low-voltage switchgear and control gear
IS 14697	AC Static transformer operated Watt hour and VAR Hour Meters

Codes	Description
IS 14981	Live working-Earthing or earthing and short-circuiting equipment using lances as a short-circuiting device-lance working
IS 14927	Cable trunking and ducting systems for electrical installation
IS 14993	Saddles, pole clamps (stick clamps) and accessories for live working
IS 15086	Surge arresters
IS 15652	Insulating mats for electrical purposes – Specification.
IEC 60076	Power transformers
IEC 60335	Household and similar electrical appliances - Safety - Part 1: General requirements.
IEC 60669	Switches for household and similar fixed-electrical installations - Part 1: General requirements.
IEC 60751	Industrial platinum resistance thermometers and platinum temperature sensors
IEC 60789	Medical electrical equipment - Characteristics and test conditions of radionuclide imaging devices – Anger type gamma cameras
IEC 60896	Stationary lead-acid batteries - Part 22: Valve regulated types – Requirements
IEC 60947	Low-voltage switchgear and control gear - Part 1: General rules
IEC 61537	Cable management - Cable tray systems and cable ladder systems
IEC 61643	Low-voltage surge protective devices - Part 12: Surge protective devices connected to low-voltage power distribution systems - Selection and application principles
IEC 61921	Power capacitors - Low-voltage power factor correction banks
IEC 62305	Protection against lightning - Part 4: Electrical and electronic systems within structures
IEC 62271	High-voltage switchgear and control gear - Part 101: Synthetic testing.

- b. Where provisions of the pertinent codes and standards conflict with these Specifications, Drawings and Datasheets or with each other, comply with the more stringent provision.
- c. Use the latest issue of Standards. Make available at least one copy of Standards for reference during construction.
- d. It is essential that the electrical power distribution system will comply in all respects with the relevant statutory and regulatory instruments of state of Gujarat and that of India.
- e. The relevant, state and national, statutory and regulatory instruments for electrical installations are as follows:

- a. The Indian Electricity Rules 1956

- b. The Electricity Act 2003
- c. Gujarat State Electricity Act 2003

## **1.2 Safety & Security**

- a. It is essential at all times to maintain a safe system of working and to comply with all enactments, regulations and working rules relating to safety, security, health and welfare of all persons who may be affected by the work.
- b. In particular, it has to be ensured that only persons who are properly trained for their duties are employed, and that the correct tools and procedures are used.
- c. Nothing which has been written into or omitted from this document shall be taken to relieve the contractor from the obligations under this clause. No clause in this specification shall prevent the executing agency from drawing the attention of the Owner to any feature of the works which is not consistent with normal safety practices nor prevent him putting forward proposals at any time which would increase the safety of the installations.
- d. The design should include all reasonable precautions and provisions for the safety of operating and maintenance personnel.
- e. Electrical works design life shall be 20 years.

## **1.3 Environmental condition**

- a. All equipment shall be designed for operation in tropical humid climate having 50°C ambient temperature and a humidity of 100 percent. Maximum temperature and maximum humidity however are not likely to occur simultaneously. The derating of the equipment shall be done on the basis of the maximum ambient temperature of 50°C.
- b. Continuity of equipment operation is the first consideration and the design shall be such as to provide facilities to simplify inspection, testing, maintenance, and cleaning and general repairs at site.

## **1.4 Electrical switchgear Room Environment**

- a. Electrical switchgear rooms are designed to provide a non-hazardous, clean and dry location for the switchgear/motor control centres/power control centres and associated equipment. Rooms are being ventilated with air taken from non-hazardous and clean areas.
- b. No pipe work is routed in electrical rooms. If this cannot be avoided, precautions taken to ensure that no liquid from a burst pipe or leaking joint can enter the electrical room.
- c. Vehicle access is provided to equipment doors.
- d. Ventilation system shall be provided with minimum three air change in Electrical switchgear room.

## **1.5 System Voltage**

- a. System Voltage/Incoming Power Supply of Pumping station is derived based on Load Demand.



- b. Based on Load requirement, 66 KV Power supply shall be received through GETCO from nearest GETCO Substation.
- c. Fault level has envisaged 25 kA for 3 sec at 66 kV Supply from GETCO, however contractor has to design electrical equipment confirming actual fault level at Project site.
- d. Incoming Power supply & system Voltage for all equipment's is derived in table below:

System Voltage

Sr.No.	System Voltage	Type
1	Incoming Voltage	66 KV based on Load demand of Pumping Station
2	Supply voltage for HV Pump Motors	6.6 KV, 3 phase, 3 wire, 50Hz
3	LV system distribution network	415V 3 phase 4 wire neutral solidly earthed
4	Motors less than 250kW	415 V, 3 phase, 3 wire, 50 Hz

#### 1.6 Voltage & frequency variations

Electrical equipment shall function satisfactorily during voltage fluctuations within +10% and -10% of the stated voltage levels and at frequencies within +/-5% of the stated frequency.

#### 1.7 Phase Sequence

- a. Phase sequence shall be specified in alphabetical order, each phase reaching its maximum in time sequence in this order. Bus bars shall be marked as R.Y.B. and N as seen from the front or operating side of a switchboard or panel.
- b. Cable terminals and apparatus which are to be connected directly or indirectly to supply conductors shall be marked U.V.W. The neutral and earth shall be marked as N, E respectively.

#### 1.8 Voltage drop criterion

- a. The steady-state voltage drop of each circuit shall be calculated on the basis that the total load on the circuit is equal to the sum of the nameplate full load amperes of all connected utilisation devices that will be in operation under normal conditions.
- b. The normal steady-state voltage drops in the distribution system between the secondary terminals of the supply transformer and the utilisation devices shall be limited to values that allow rated voltage to be supplied to each energised and loaded device.
- c. The most suitable setting for the power transformer tap changers shall be established following consideration of the supply configuration and resultant voltage drop conditions.
- d. The actual distribution of the allowable overall steady-state voltage drop across the different parts of the electrical system will depend on the circuit configurations and distances between circuit components.

- e. The voltages at all motors during start up shall be maintained at a value which ensures that there is sufficient accelerating torque developed by the motor to give a safe run up time.
- f. The maximum system transient impedance shall be used in calculating voltage drops relating to motor starting, restarting and re-acceleration requirements.
- g. Vendor requirements for special equipment requiring close voltage regulation shall be taken into account when designing the overall system to ensure that the voltage drops do not exceed those specified.
- h. During starting or re-acceleration of a motor, either individually or in a group, the voltage dip at the motor terminals shall not vary more than 15% from rated voltage when started direct on line under the worst operating scenario i.e. largest motor started with minimum number of power sources and minimum fault level.
- i. The above shall be achieved within the constraints imposed by the electrical system and as feasible with regard to process requirements, safety and economic factors.
- j. Under steady state conditions, the maximum voltage drop in various sections of electrical system shall be limited to the following:
  - a. Cables/bus-bar ducting between transformer and switchboard : 0.5%
  - b. Cables/bus-bar ducting between generator and switchboard : 0.5%
  - c. Cables between LV switchboard and LV motor : 5%
  - d. Cables between LV switchboard and lighting panel : 1%
  - e. Cables between lighting panel and farthest lighting point : 4%

## 1.9 Compatibility

Components used with electrical switchgear, motor control gear and control panels shall be uniform throughout the works in order to reduce spare holdings. Electrical enclosures housing switchgear, motor control gear, control systems, terminations shall each be of similar construction throughout the works in order to achieve a consistent appearance.

## 1.10 Enclosures

- a. Enclosures shall be constructed to provide an adequate level of protection form the environment. The following minimum standards shall be applied unless otherwise specified:
  - a. Switchgear and control panels located in switchgear or control rooms - IP 54
  - b. Switchgear and control panels located in plant rooms - IP 55
  - c. Equipment located externally in sheltered locations - IP 65
  - d. Equipment located externally in exposed locations - IP 65

e. Equipment liable to be periodically submerged

- IP 68.

b. The IP ratings are defined by IEC 529.

### **1.11 Identifications**

- a. Each main and auxiliary item of pumping station shall have permanently attached to it in a conspicuous position a nameplate and rating plate. Upon these shall be engraved, in English, the manufacturer's name, direction of rotation, type and serial number of plant, details of the loading and duty at which the item of pumping station has been designed. All indicating and operating devices shall have securely attached to them or marked upon them designations as to their function and proper manner of use. Provision shall be made to incorporate descriptive numbering codes as indicated on the layout drawings.
- b. Such nameplates, rating plates and labels shall be of a rigid type, at least 3 mm thick, laminated and engraved plastic material, with black block capitals on a white background. The labels shall be fixed by non-ferrous or stainless steel screws.
- c. Warning labels shall be of similar construction with black block capitals on a yellow background.
- d. Weatherproof labels for use outside the buildings shall be rigid type laminated plastic.
- e. All field items shall be tagged with 50 × 25 mm engraved labels. The label shall state the item tag number and hazardous area classification in case it falls under it and shall be attached by a corrosion resistant ring to a fixed portion of the item. The ring shall retain the tag securely but shall allow transfer to a replacement item when necessary.
- f. Warning labels shall be provided where necessary to warn of dangerous circumstances or substances. Inscriptions or graphic symbols shall be black on yellow background and to internationally recognised standards.
- g. Instruction labels shall be provided where safety procedures such as wearing of protective clothing are essential to protect personnel from hazardous or potentially hazardous conditions. These labels shall have inscriptions or graphic symbols in white on a blue background.

### **1.12 Harmonics**

- a. The limits for harmonics in the power system as a result of non-linear loads are to be limited to those standards imposed by the power supply company i.e. GETCO & PGVCL.
- b. No significant non-linear loads are proposed therefore the existing background harmonic content of the supply will be unaffected. There is no evidence of problems at present with harmonic content of the power supply.

### **1.13 Surge protection**

- a. Surge protection shall be provided on power system equipment fed from overhead line systems. Usually this will apply to HV overhead supplies feeding to sites. In this case the surge protection shall be provided by the contractor near to the point of common coupling

- b. Surge protection shall be provided on at each end of long LV cables e.g. such as those feeding the switchboards at longer distance.
- c. Surge protection shall be provided at the main control panel end of instrumentation cabling connecting equipment located external to buildings.

#### **1.14 Earthing Protection**

- a. The electrical installation shall where required be connected to the general mass of the earth by an earthing conductor as per IS 3043.
- b. Where the earth electrode system is not provided by the power supply authority or where a requirement for a standby or base load generator is specified the installation shall comprise one or more earth electrodes, earthing strip network, mesh or a combination of these in order to obtain the required earth electrode resistance.
- c. Earth electrodes where used shall be of galvanized iron. The rod shall penetrate a minimum of three meter below ground level. Where multi-rods are used they shall be separated by a distance of not less than the driven length.
- d. Earth rods shall have hardened tips and caps and be extendable. Bare galvanized iron strip buried at a minimum depth of 600 mm shall be used for interconnection of rods.
- e. Where soil conditions make the use of rod type electrodes impracticable a grid configuration may be used comprising horizontally buried bare galvanized iron strips as per IS 3043. Strip shall be buried at a minimum depth of 600 mm.
- f. Each earth electrode rod if used shall be provided with an approved non-ferrous clamp for the connection of the earthing conductor or tape as required. These connections shall each be housed in individual concrete inspection chamber set flush to the finished ground level and shall allow disconnection for testing of individual electrodes.
- g. All materials used for the earth electrode installation shall be purpose made for the application and shall be suitable for the site and soil conditions.
- h. Unless otherwise stated all excavation of trenches for the installation of the earth electrodes and the inspection pit shall be carried out by the Contractor.
- i. The Contractor shall demonstrate that the resistance of the electrodes to earth and the continuity of the earth network are within the limits specified. Any additional earth electrodes and test instruments required for the tests shall be provided by the Contractor.
- j. Marker posts and plates shall be provided to mark the route of buried strip electrodes. The markers shall be similar to those provided for cable routes.

#### **1.15 Lightning Protection**

- a. Lightning Protection system shall be provided for protection against atmospheric discharges on the all new buildings. This shall consist of an air termination network of horizontal and/or vertical

conductors. The air termination network shall be connected to earth electrodes by an adequate number of down conductors. The earth electrodes shall be connected to the pumping station earthing system.

- b. The lightning protection system shall be designed and installed in accordance with IS 2309 and IEC 62305 Standards. The normal air termination shall be GI strip. All metallic ducts, antennae, hand railing, etc. shall be bonded to the air termination.
- c. The earth electrode resistance of the lightning protection earth electrode system alone shall not be more than ten ohms. Each lightning protection system should be bonded locally to the power earth at not less than two points.

#### **1.16 Tools & Testing Equipments**

- a. The work shall be performed using tools and testing equipment designed and approved for the purpose.
- b. The following tools and testing equipment's are recommended for carrying out the electrical installation work. The contractor shall bring tools and equipment which may be necessary to carry out / complete the work, in addition to the tools and equipment suggested hereunder, if asked for by Owner.
  - a. 5000 volts constant pressure type motorised insulation tester (megger)
  - b. 1000 volts constant pressure type insulation tester (megger)
  - c. 500 volts constant pressure type insulation tester (megger)
  - d. Relay testing kit
  - e. High voltage test kit
  - f. Universal Earth Tester
  - g. Welding Sets
  - h. Cutting Tools
  - i. Derricks, if required
  - j. Jacks
  - k. Electric Blower
  - l. Drilling Machines (different sizes)
  - m. Grinding Machine
  - n. Cable Crimping Tool
  - o. H.V. and L.V. Cable termination and jointing kits.
  - p. Tong Tester
  - q. Portable Voltmeter
  - r. Pipe bending machine
  - s. Phase sequence indicator
  - t. Portable test lamps with prongs
  - u. Tachometer (0-1500 r.p.m.)
  - v. Constant pressure type continuity tester
  - w. Wiremen kits
  - x. Fitter's tools
  - y. Vices

- z. Die sets with difference dies
- aa. Ladders (different sizes)
- bb. Cable laying tools

#### **1.17 Cutting, patching and excavation**

The Contractor shall do all excavation and cutting required for the installation work and shall be responsible for any damage that may be caused to the work of others. He shall, where possible, keep the excavation, cutting and patching to a minimum. If the contractor fails to perform his work in the proper manner or at proper time and due to this, additional excavation, cutting and patching is required, the Contractor shall do such additional cutting and patching without any extra cost.

#### **1.18 Drawings**

- a. The Contractor shall submit four prints of the each drawing after award of contract for approval.
- b. One set of drawings shall be kept as record drawings. All deviations of the actual proposed installations as shown on the drawings should be marked in red on these drawings. On completion of the project, as-built drawings shall be prepared by the contractor incorporating these changes and four sets of such drawings shall be handed over to the Owner at the time of final handing over.
- c. The contractor shall also submit one set of CD each to Owner containing all drawings. Sketches etc. in AutoCAD 2009/2010 and data in MS Office/WINDOWS 2010 or latest.

#### **1.19 Personnel**

All work shall be performed by contractor under the direct supervision of a qualified person appointed by him and regularly engaged in the installation of electrical equipment. The contractor shall place in charge of the work at all the times during the construction. A qualified and experienced Contractor's Electrical Engineer who shall be responsible for keeping liaison and co-ordination between Owner's personnel and his own men at site. he shall also submit progress reports every fifteen days. Anyone not deemed capable shall be replaced immediately upon such advice.

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## 2.Scope of work

### 2.1 Scope of Work

- a. The Electrical scope for pumping station is briefly described below, but not limited to it,
- b. Design, supply, installation, testing(Factory Acceptance Test(FAT) and Site Acceptance Test(SAT)), Pre-commissioning, Commissioning and Operation & Maintenance of 66 kV outdoor type Air Insulated Switchyard (AIS)comprising of equipment i.e. Substation structure, Lightning arrestor, circuit breaker, Current and potential transformer, Isolator, Bus bar assembly, Power and Auxiliary transformer with tap changer, NGR, Marshalling box, Cable containment & necessary fire protection/ fighting system arrangement.
- c. Outdoor switchyard illumination, lightning and earthing protection system for outdoor switchyard and electrical panel building and pumping station.
- d. All Architectural and Civil work comprising equipment and substation structure foundation, soil treatment, fencing, gates, Gravels, cable trenches, Storm water drain system, Oil drainage system, approach road, buffer wall, rail track HDPE,RCC pipe etc.
- e. Design, supply, installation, testing Factory Acceptance Test (FAT) and Site Acceptance Test (SAT), pre-commissioning, commissioning and operation and maintenance of 66kV Control and Relay panel, RTCC, Battery and battery charger, PDB,MLDB etc.
- f. Design, supply, installation, testing Factory Acceptance Test (FAT) and Site Acceptance Test (SAT), pre-commissioning, commissioning and operation and maintenance of 6.6kV Switchboard,6.6Kv Capacitor bank and APFC panel, 6.6 kV Digital soft starter, 6.6 kV XLPE insulated power cable battery charger, LDB etc.
- g. Design, supply, installation, testing Factory Acceptance Test (FAT) and Site Acceptance Test (SAT) pre-commissioning, commissioning and operation and maintenance of 415 V Switchboard, 415 V Capacitor bank and APFC panel,415V XLPE insulated power and control cable etc.
- h. Indoor illumination and electrification for Electrical panel room and pumping station;
- i. Outdoor street illumination using lamps.
- j. Reactive power compensation, Harmonic mitigation, switching surge protection in line with utility norms, OEM recommendation and confirming to Indian Standards and latest IE Rules.
- k. Supply and delivery of Personal Protective Equipment (PPE) in line with utility norms and confirming to Indian Standards and latest IE Rules.
- l. 66Kv control and relay panel room and SCADA room; ventilation of electrical panel building and Pumping station as per OEM recommendation.

- m. All work to be performed and supplies to be effected as a part of contract shall require specific review and approval of Client or his authorized representative as per vendor data requirement.
- n. Design, supply, installation, testing (Factory Acceptance Test (FAT) and Site Acceptance Test (SAT), pre-commissioning, commissioning and operation and maintenance of DG set of 415V, Min. 50 KVA capacity complete with AMF panel.
- o. To obtain clearance for energizing the complete electrical facilities covered under this tender and approval of installation / drawings and documents from Central Electrical Authority / Gujarat state electricity Inspectorate and any other concerned approving authority and follow up with Electricity board for getting power approved by Client. Any other requirements as necessary by the statutory regulations which are not shown in typical installation shall be complied by the contractor.
- p. To supply and deliver commissioning spares
- q. To make the provision of all testing instruments / kits for testing and commissioning of the system
- r. The contractor shall arrange technical experts of equipment from OEM as and when necessary until the commissioning and guaranteed run of the plant is completed.
- s. The Contractor shall also include in the project any other work/activity which is not specifically listed but is necessary for completeness of electrical system.

## **2.2 Submittals**

- a. Following submittals shall be part of scope of work but not limited to following list.
  - a. Design Calculations
  - b. Equipment Lists covering list of Bearings and Seals
  - c. Equipment Data Sheet
  - d. Electrical Single Line Diagrams
  - e. Schematic and Control Diagrams
  - f. General Arrangement Drawings of electrical equipments
  - g. Earthing Layout
  - h. Illumination layout
  - i. Lightning Protection layout
  - j. Equipment Dimensional Drawings.
  - k. Electrical Equipment Weights.
  - l. Cable Schedules and Cable Routing Drawings.
  - m. Transformer, Motor, switchgear etc. Performance Curves
  - n. Noise and Vibration Test Certificates.
  - o. Factory Test Reports and Performance Test Certificates.
  - p. Construction Power Supply Requirements
  - q. Protection co-ordination Settings
  - r. Interface or Inter-Connection Diagrams / Lists
  - s. Quality control document
  - t. Firefighting system layout & test reports



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- b. Submit to Inspection Authority and the Power Supply Authority the required copies of relevant drawings and specifications for examination and approval prior to commencement of work.
  - c. Neatly assemble and submit operating and maintenance data containing booklets, "AS BUILT" drawings, instruction sheets, etc., issued by the suppliers and relating to the equipment intended to be installed under this section and necessary or desirable for the maintenance, repair or operation of the equipment along with "AS BUILT" drawing.
  - d. The contractor shall submit to the department such as QAP / data sheets / drawings / catalogues etc. and any other supporting documents (each 3 sets) of equipment / items of electrical system before start of manufacturing and approval of Engineer-in-charge to be obtained. Before shipping of such items, the contractor shall obtain inspection release note / dispatch clearance from the Engineer-in-charge.

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## 3. Technical Specification of Electrical Works

### 3.1 Outdoor Lightning Arrestor

#### 3.1.1 Scope

This specification covers the design, manufacture, assembly, testing at manufacture's works, delivery & commissioning of outdoor type, heavy duty station class lightning arrestors, complete in all respects, conforming to modern design and practice for protection of transformers, sub-station equipment's and overhead lines.

#### 3.1.2 Standards

The lightning arrestors covered by this specification shall comply with the requirements of latest, edition of IEC publication No. 60099 – 4, except specified, otherwise in the specification.

#### 3.1.3 Drawings & documents

- a. The contractor shall furnish one set of following drawings after award of work:
- b. General outline drawings of the complete arrester with technical parameters.
- c. Drawing showing clearance from grounded and other live objects and between adjacent poles of surge Arresters, required at various heights of surge Arresters.
- d. Drawing showing details of pressure relief devices.
- e. Detailed drawing of discharge counters along with the writing and schematic drawing of discharge counter and meter.
- f. Outline drawing of insulating base.
- g. Details of grading rings, if used.
- h. Mounting details of Surge Arresters.
- i. Details of line terminal and ground terminals.
- j. Details and dimensions of ZnO block.
- k. Volt-time characteristics of Surge Arresters.
- l. Details of galvanizing being provided on different ferrous parts.
- m. Details of Master name plate and individual unit name plate.
- n. The detailed dimensional drawing of porcelain housing such as ID, OD thickness and insulator details such as height, profile of petticoats, angle of inclination and gap between successive petticoats, total minimum creep age distance etc.

- o. Contractor shall submit above drawings for owner's approval.
- p. The contractor shall submit the routine test certificates of bought out items and raw materials at the time of routine testing of the fully assembled arrester.

#### **3.1.4 Type**

The metal oxide type lightning arrestors shall be designed to provide maximum possible protection against lightning and switching surges. Supporting insulators, terminal connectors and other components as specified hereafter, shall be provided with arrestors. The metal oxide type lightning arrestors shall be of class 'A' pressure relief device and long duration Class-II.

### **3.2 Description**

#### **3.2.1 Design & Construction**

- a. Arrestors shall be without series gaps as per the requirement along with characteristic of elements.
- b. The non-linear resistor blocks shall have non-ageing characteristic and stable thermal properties.
- c. The blocks shall preferably be metallised on the flat surface for ensuring good electrical contact.
- d. The arrestors shall be complete with suitable grading devices, wherever necessary and shall be provided with an insulating base at the bottom. The clamps required to fix the surge counter shall have to be provided with the surge counter. Braided flexible copper jumper shall be provided for bypassing surge counter, whenever required.
- e. Each individual component unit of the arrester stack shall have its arrester elements hermetically sealed under dry inert air and fully protected against ingress of moisture into the arrester. The details like material, cross section/thickness etc. shall be indicated in cross sectional drawing.
- f. The arrester, when energized at rated operating voltage, shall not exhibit any visible corona, when viewed in complete darkness.
- g. All arrester units shall be provided with pressure relief class 'A' devices, to limit the internal arrester pressure to obviate explosion or violent shattering of porcelain housing.

##### **3.2.1.1 Porcelain Housing**

All porcelain used in or with each arrester shall be manufactured by the wet process, be free from lamination, cavities or other flaws, affecting mechanical & dielectric strength and shall be vitrified property and non-porous. The creep age distance along with external surface shall be large enough to ensure that surface contamination which is possible under site condition will not adversely affect the performance of arrestors.

#### **3.2.1.2 Pressure Relief Device**

The arrestors shall be provided with efficient pressure relief device so as to check bursting of lightning arrestors, in case, excessive gas pressure is built up and in case, it losses its ability to effectively dissipate the energy due to any operation. The contractor shall submit detailed information and literature on pressure relief class 'A' device of lightning arrestors.

#### **3.2.1.3 Terminal Connectors**

Each lightning arrestor shall be supplied with compression joint type terminal connector suitable for ACSR 'PANTHER' Conductor. The bolt and nuts shall be of stainless steel 2 SS washer and 2 SS nuts (including lock nut) for each bolt shall be supplied. Each terminal connector shall be suitable for vertical / horizontal take-off.

#### **3.2.1.4 Galvanizing**

All metal parts exposed to weather and likely to be subjected to corrosion, shall be hot dip galvanized as per IS: 2629 (latest edition). Bolts, Nuts and Washers shall be electro zinc plated.

#### **3.2.1.5 Name Plate**

Each arrestor shall have non-corrosive nameplate, legibly and indelibly marked and securely fixed to it. They shall be provided with the information as required by relevant standard. The words 'BIPC' shall, also, be punched on it after inspection of lightning arrestor is over.

#### **3.2.1.6 Surge Counter**

Each lightening arrestors shall be provided with a recording type surge counter with vertical mounting. The installation of surge counter shall have practically no effect on the operation. The number of discharges recorded by the counter shall be visible through inspection window. The connection of LA to Surge Monitor shall be made from bottom of surge monitor and there shall not be any opening on top of surge monitor.

#### **3.2.1.7 System voltage**

- i. Nominal system voltage-66 kV
- ii. Highest System Voltage-72.5 kV

#### **3.2.1.8 Rated Arrestors Voltage**

- i. Normal System Voltage-66 kV
- ii. Arrestor Voltage -60 KV

#### **3.2.1.9 Nominal Discharge Current**

The arrestor shall have a nominal discharge current of 10 kA (8/20 micro- sec) and shall be of heavy-duty station class type with long duration Class 3.

#### **3.2.1.10 Maximum residual Voltage:**

The maximum residual voltage at nominal discharge current of 10 kA with 8/20 micro-second current wave shall not exceed 190 kV (Peak).

Maximum Continuous Operating Voltages:

The maximum continuous operating voltages shall be as per IEC60099-4.

Energy absorption capability shall be 5 in kJ/ kV.

#### **3.2.1.11 System Neutral Connection:**

The system is an effectively earthed neutral system.

#### **3.2.1.12 Outdoor Installation:**

All the lightning arrestors shall be suitable for outdoor installation.

#### **3.2.1.13 Special Condition**

- a. Maximum temperature for a few days, in a year, is likely to go to 45 °C and humidity during monsoon is likely to reach the value of 95%. The arrestors offered must withstand these climatic conditions without deteriorating effects.
- b. The lightning arrestors shall be suitable for 1.2/50 micro-sec lightning impales voltage of 350 kV peak and one minute's power frequency withstand voltage of 140 kV rms.

#### **3.2.1.14 Impulse withstand voltage**

The BIL of transformer and circuit breakers is 350 kV (Peak).

#### **3.2.1.15 Overhead Earth wire:**

Solidly grounded overhead Earth wire/s shall be provided for the sub- station and Transmission Lines.

#### **3.2.1.16 Physical data:**

- a. Technical and guaranteed particulars shall be furnished in datasheet. Drawings showing, dimensions, (actual figures), arrangement and clearances (actual figure) required shall, also be furnished after award of work.
- b. All fittings and accessories which may not be specifically mentioned in this specification but which are useful or necessary for lightning arrestors shall be deemed to be included in the specifications and shall be furnished by the contractor without extra charges.

### 3.2.1.17 Creep age Distance

- a. In case the lightning arrestors are installed in highly polluted atmosphere i.e. near the industrial area or near the sea shore. The total minimum creepage distance shall be 1810 mm that commensurate with the highly polluted atmosphere.
- b. All necessary accessories and earthing connection leads between the bottom of the arrester and the discharge counter shall be in the contractor's scope. The discharge counter shall be so designed that the readings of discharges recorded by the counter and the readings of milliamp meter shall be clearly visible through an inspection window to a person standing on ground. The minimum height of support shall be 2.5 M. The live part to plinth level clearance shall be maintained as – 4000 mm. mounting bolt, Nut, washers etc. shall be supplied with each LA.
- c. The mounting of LA shall be suitable to structure on which it is to be mounted. If required necessary MS, HDG 8 mm thick adaptor plate with both PCD drilled in, shall be supplied as a part of supply.

### 3.2.1.18 Type Test:

- a. All the Lightning Arrestors shall be fully type tested from accredited laboratory (accredited based on ISO/IEC Guide 25 /17025 or EN 45001 by the National accreditation body of the country where laboratory is located), as per IEC / IS / technical specification. The Contractor shall furnish two sets of type test reports for the complete Lightning Arrestors along with the test reports of porcelain housing of the type and Design offered by him after award of work.
- b. The Type test reports shall not be older than FIVE years and shall be submitted for owner's approval.
- c. The following type test reports shall be submitted after award of work.
- d. In case of non-submission of some of the type test reports, the contractor shall confirm the submission of same before commencement of supply, without affecting delivery schedule, from NABL accredited laboratory, at his own cost.

#### List of type test reports

Sr.No	List of type test Reports
1	Tests on metal oxide blocks
2	Steep Current Impulse Residual Voltage test
3	Lightning impulse Residual voltage test
4	Switching impulse Residual voltage test
5	Long duration current impulse withstand test
6	Operating duty test - High Current Impulse operating duty test - Switching Surge Operating Duty test
7	P. F. voltage v/s time characteristic
8	Reference voltage test
9	Accelerated ageing test

Sr.No	List of type test Reports
10	Tests on Arrester Housing
11	Impulse voltage withstand test on insulator
12	P.F. (Dry) voltage withstand test on insulator
13	P.F. (Wet) voltage withstand test on insulator
14	Bending test on assembly
15	Tests on Arrester
16	Artificial pollution test
17	Seismic test
18	High current pressure relief test (High current short circuit test)
19	Low current pressure relief test General
20	STC on Terminal connector (25 kA for 3 sec)
21	Degree of Protection test on counter/surge monitor
22	Uniformity of Zinc coating

#### 3.2.1.19 Routine Test:

Routine tests shall be carried out by the contractor on all complete arrestors and also on proportionate prorated sections as per IEC recommendations. Certified copies of routine test reports shall be submitted to the Owner for approval along with the acceptance test reports.

Sr.No	List of routine test Reports
1	Measurement of reference voltage
2	Lightning Impulse Residual voltage test
3	Seal Leakage check test
4	Partial discharge test
5	Tests on discharge counter
6	Visual / Dimensional check
7	Special Seal leakage test for a duration of 24 hrs to check the water penetration, on any one randomly selected sample from every 50 (Fifty) or below nos. of LA offered for inspection, shall be carried out and report shall be submitted.

### 3.3 Outdoor Isolator

#### 3.3.1 Scope

This specification covers design, manufacture, assembly, testing, Supply, installation & commissioning of high voltage isolators and earthing switches suitable for outdoor installation.

#### 3.3.2 Standards

Unless otherwise specified, equipment shall conform to the latest applicable Indian Standards in particular to following:

Sr.No	Codes	Description
1	IS : 1818 (1972)	Specification for alternating current isolators (Disconnectors) and earthing switches
2	IS : 2544 (1973)	Specification for porcelain post insulators (3.3 KV and above)
3	IS : 2099 (1986)	High voltage bushing
4	IS : 9921 (1981)	Alternating current isolator (Disconnector) and earthing switches for voltage above 1000V

### **3.3.3 Description**

- a. Isolators shall be off load type but shall be able to make and break the magnetizing on line/bus charging currents.
- b. Isolators shall be suitable for horizontal mounting or vertical mounting as specified in the data sheet.
- c. Isolators shall be designed for a normal current rating and the system voltage indicated on the data sheet.
- d. All similar parts shall be interchangeable.
- e. Base channels and all other structural steel members manual operating rod, bolts – nuts etc. shall be hot dip galvanized or metallised. All castings, except current carrying parts shall be made of malleable cast iron or cast steel. Grey iron shall not be used in the manufacture of any part.
- f. Each pole of the isolator shall be provided with two earthing pads at opposite ends.
- g. The isolators and earth switches shall be designed to withstand stresses corresponding to short circuit duties specified in the data sheet and shall withstand seismic forces.

#### **3.3.3.1 Contacts**

- a. The construction shall be such that it ensures permanent pressure and liberal contact area.
- b. Contacts shall be fully self-aligning and floating type with self-cleaning and wiping action with central blade rotating type.
- c. Contacts, current carrying parts, shall be of non-ferrous material such as copper or copper alloy and all contact surfaces shall be silver faced.

#### **3.3.3.2 Insulators**

- a. Insulators shall conform to IS: 2544 & IS: 2099.
- b. Insulators shall be post type, glazed vitreous porcelain.
- c. Insulators of the same rating and type shall be interchangeable.
- d. Insulator shall be suitable for heavily polluted atmosphere.



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#### **3.3.3.3 Operating mechanism**

- a. The operating mechanism shall be such that isolators cannot be dislodged from their open or closed position by gravity, vibration, wind pressure etc.
- b. The operating mechanism shall provide a quick, simple and effective operation. One man shall be able to operate the isolator/earthing switches without undue effort.
- c. The operating mechanism shall be so designed that all the three phases are opened or closed simultaneously.
- d. The length of the operating handle for vertical mounting type of isolators shall be 18 feet and the length of the operating handle for horizontal mounting type isolators shall be with respect to mounting height specified in the data sheet.
- e. The operating handle shall have provision for padlocking in both, open and closed position.
- f. A weatherproof (IP 55) galvanised sheet cabinet with gasketed hinged door and padlocking facility shall be provided to house driving mechanism auxiliary switches for electrical interlocks, if specified in the data sheet.
- g. Suitable means for mechanical 'Castle' type or electromagnetic type interlocking shall be provided. Details of type of interlocking shall be as specified in the data sheet.
- h. A position indicating device shall be provided for each isolator/earthing switch, irrespective of whether the isolating distance is visible or not.
- i. Adjustable stops shall be provided to prevent over travel of isolator blades in either direction.

#### **3.3.3.4 Earthing switch**

- a. When specified, earthing switch shall form an integral part of each pole of the isolator.
- b. Two independent earth terminations with flexible braids and switches connectors shall be provided.
- c. Isolator and earthing switch shall be mechanically interlocked such that it will not be possible to close the earthing switch when the isolator is closed or vice versa.
- d. Suitable name plate shall be provided for isolators and earthing switches.
- e. Clamps and connectors shall be supplied as part of the isolator, wherever called for in the data sheet. The direct delivery of insulators from insulator manufacturer's works will not be accepted. Isolators shall be completely assembled at the works to ascertain that all parts fit correctly.
- f. Contractor shall furnish supporting structures for isolators and earthing switches, detailed dimensioned drawings indicating weights and all fixing details and relative locations of chassis,

operating mechanism box and operating handles. The mounting will be confirmed at the time of drawing approval.

- g. Routine tests shall be carried out as per IS: 1818 in the presence of the Owner's representatives.
- h. Four copies of type and routing tests certificates of insulators isolators shall be submitted for the Owner's record and approval before despatch.

### **3.4 Outdoor Bus post insulator**

#### **3.4.1 Scope**

This specification covers design, manufacture, assembly, testing at manufacturer's works, supply, delivery, Installation & commissioning of & 66 kV solid core post insulators required for 66 kV sub-station.

#### **3.4.2 Design**

- a. The post insulator required for sub-station shall be of outdoor type suitable for operation under tropical conditions with high temperature, humidity and rainfall.
- b. The insulation level should be as under:
  - a. Power frequency withstand value-1 min(dry)/wet in kV(rms)-165/140 kV
  - b. Impulse withstand strength-kV(peak)-350 kV Peak
- c. All malleable iron steel work, steel bolts and nuts and flanges shall be hot dip galvanized in accordance with IS: 2629/1966 with the latest amendment thereof.
- d. Insulators shall be of "Post Type" and the metal fitting cemented by insulator manufacturers.

#### **3.4.3 Testing**

- a. All the acceptance tests shall be carried out as IS 2544-1973 (latest amendments). Power Frequency (dry) withstand test shall be carried out on selected samples at the time of Acceptance Test.
- b. List of Type Tests:
  - a. Visual Examination
  - b. Verification of dimensions
  - c. Visible discharge (Corona extinction) test
  - d. Lightning Impulse Voltage withstand test
  - e. Lightning Impulse 50% flashover Voltage test
  - f. Dry Power frequency voltage withstand test
  - g. Wet Power frequency voltage withstand test

- h. Dry Power frequency flashover voltage test
  - i. Wet Power frequency flashover voltage test
  - j. Temperature Cycle test
  - k. RIV test
  - l. Corona inception & extinction
  - m. Switching Impulse voltage test
  - n. Mechanical Strength test
  - o. Compression Test
  - p. Tensile Test
  - q. Torsion Test
  - r. Cantilever Strength test and Bending test
  - s. Porosity Test
  - t. Puncture Test (for Insulators type B only) and,
  - u. Galvanizing test
- c. The contractor shall furnish documents & drawings for owner's approval after award of work

### 3.5 Outdoor Current Transformers

#### 3.5.1 Scope

This section covers this design, manufacture, assembly, testing at manufacturer's works, supply, delivery, Installation & commissioning of outdoor, dead tank type, oil impregnated paper, single phase, 50 Hz, oil immersed, self-cooled, current transformer. The current transformers shall be complete in all respects.

#### 3.5.2 Standards

- a. Unless otherwise specified, equipment shall conform to the following latest applicable Indian Standards:

Sr. No	CODES	DESCRIPTION
1	IS:2165	Insulation co-ordination for equipment of 100 KV and above
2	IS:2705 (I to IV)	Instrument Transformers
3	IS:2099	High voltage porcelain bushings
4	IS:3347	Dimensions of porcelain transformer bushings
5	IS:2071	Method of high voltage testing
6	IS:335	Insulating oil for transformers and switchgears
7	IS:2147	Degree of protection provided by enclosures for low voltage switchgear and control.
8	IEC-60044-1	Instrument Transformers
9	IEC-270	Partial discharge measurement
10	IEC-44(4)	Instrument transformer measurement of PDs
11	IEC-171	Insulation co-ordination
12	IEC-60	High voltage testing techniques
13	IEC-8263	Method for RIV test on high voltage insulators
14	--	Indian Electricity Rules 1956

- b. The Instrument Transformers covered by this specification shall comply with the requirement of the latest edition of IEC Publication No. 60044-1 &/ or Indian Standard No. 2705 Parts – I to III (as amended up to date) but the Instrument Transformers for the accuracy class 'PS' shall conform to Part - IV of IS : 2705 except where specified otherwise in the specification.
- c. The core shall be high grade, non – ageing, silicon laminated steel of low hysteresis loss and high permeability. The core material used in case of metering core shall be stated in the datasheet.

### **3.5.3 Description**

- a. The core shall be high grade, non – ageing, silicon laminated steel of low hysteresis loss and high permeability. The core material used in case of metering core shall be stated.
- b. The current transformers shall be hermitically sealed to eliminate breathing and entering of air and moisture in the tank. Provision of pressure releasing device is not permitted.
- c. For compensation of variation in volume of oil due to temperature variation, stainless steel bellows shall be provided. The contractor shall have to submit calculations of volumetric expansion and contraction.
- d. These calculations shall be submitted along with the basic parameters of SS bellow used in CT.
- e. Rubber bellow or Nitrogen gas cushioning for above purpose shall not be permitted.
- f. The current Transformers provided with stainless steel bellows for compensation of oil volume variation shall be provided with a suitable oil level indicator at suitable location to enable an observer to see the oil level of the C.T. from the ground level. Oil level indicator shall be provided with fluorescent green coloured floating ball of non-oil reacting material. All parts of bellow shall be of stainless steel only.
- g. The core of current transformers to be used for metering and instrumentations shall have saturation factor, low enough to avoid damage to the instruments, in the event of maximum short circuit current.
- h. The C.T. core, to be used for protective relays shall be of accuracy class, specified or appropriate class suitable for back up, over current and earth fault, differential and bus-bar protection.
- i. The contractor shall ensure that sealing of current transformer is properly achieved. In this connection, the arrangement provided by the contractor at various locations including the following ones shall be described supported by sectional drawings.
  - a. Location of emergence of primary and secondary terminals.
  - b. Interface between porcelain housing and metal tank.
  - c. Cover of the secondary terminal box.

- d. G.A. drawing complete with details of primary and secondary windings overall dimensions, weight, nameplate, porcelain insulator, primary & secondary terminals, terminal connectors, etc.
- j. Nuts and bolts (or screws used for fixation of interfacing porcelain bushings for taking out terminals) shall be provided on flanges, cemented to the bushing and not on the porcelain i.e. Flange type 66 KV bushing for CT, shall be provided.
- k. For gasket joints, wherever used, Nitrile Butyl rubber NBR or Viton shall be used. No CORK gasket shall be used. All gaskets or O rings shall be fixed in a machine groove. The gaskets shall be securely fitted for perfect sealing.
- l. The bolts required for fitting the dome shall be of stainless steel of minimum 6 mm dia.
- m. The outer surface of metal tank shall be Hot Dip Galvanized, whereas, the inner portion shall be painted with oil resistive, insoluble paint. The Owner reserves right for stage inspection during manufacturing process of tank or CT. The galvanizing shall be as per applicable standard IS: 2629 and minimum thickness of zinc coating shall be 610 gm/sqmt.
- n. The tank of CT shall be provided with pressboard of 2 mm thickness inside and at bottom.
- o. Provision of drain valve for sampling / draining of oil purpose at the bottom of tank is not permitted.
- p. The minimum thickness of flange & gasket provided on tank shall be as follow:
  - a. Flange thickness of tank - 8 mm
  - b. Top plate thickness - 5 mm
  - c. Gasket thickness - 6 mm
- q. The current transformers shall be suitable for mounting on steel structures or concrete pedestals.

#### **3.5.3.1 Winding & Terminals**

- a. The rating of the secondary winding shall be suitable as per transformer rating. Ratio changing arrangement shall be provided on secondary winding for multi-ratio design, either a number of identical secondary winding may be provided to achieve desired ratios by series / parallel connection for the secondary winding or the secondary winding may be tapped. However, identical secondary's for tapped secondary winding shall meet requirement as specified.
- b. Primary and secondary windings shall be of electrolytic grade copper and shall have continuous thermal rating as specified for all ratios. The primary winding is to be designed for continuous extended primary current at 120 % of rated primary current. The secondary winding wherever tapped, shall be adequately reinforced to withstand normal handling without damage.
- c. The primary terminals shall be of standard size of 30 mm dia x 80 mm length for all CTs rated up to 1200 Amps. For higher values of primary current, each primary terminal shall be made out of

two such rods of 30mm dia x 80 mm length in parallel. The primary terminals shall be of heavily tinned electrolytic copper. The maximum thickness of tinning shall be 15 microns.

- d. The secondary terminals shall be brought out in a compartment for easy access.
- e. Secondary terminal studs shall be provided with at least three nuts and adequate plain and spring washers for fixing the leads. The studs, nuts and washers shall be of brass, duly nickel-plated. The minimum outside diameter of the studs shall be 6mm. The length of at least 15mm shall be available on the studs for inserting the leads. The horizontal spacing between centres of the adjacent studs shall be at least 1.5 times the outside circum dia. of the units.
- f. The current transformer shall be provided with suitable test tap for measurement of capacitance, tan delta as well as partial discharges, in factory as well as at site. Provision shall be made of a screw on cap for solid and secured earthing of the test tap connection, when not in use. A suitable caution plate shall be provided duly fixed on the cover of the secondary terminal box, indicating the purpose of the test tap and necessity of its solid earthing as per prescribed method, before energizing the CT.

#### **3.5.3.2 Terminal box of current transformer**

The exterior of the secondary terminal box shall be hot dip galvanized. A cable box along with necessary glands for receiving control cables suitable for mounting on bottom plate of the terminal box shall be included in the scope of supply. A door with locking arrangement shall be provided on the front of the terminal box. The secondary terminals shall be taken out through composite epoxy or FRP mould having single gasket packing & shall be provided by suitable link with dummy secondary leads. For control cable connections, separate terminal connector blocks to be provided. Secondary jumpers shall be terminated at one side of this terminal connector block. The secondary terminal box shall comply with Degree of Protection (IP-55) standards and type test report shall be furnished with for owner's approval.

#### **3.5.3.3 Temperature rise**

The maximum temperature rises of the current transformer and its oil, winding and external surface of the core and other parts shall be as specified in Table I of IS: 2705 (Part I).

#### **3.5.3.4 Bushing & insulators**

- a. The porcelain hollow insulator used shall be homogenous, free from lamination cavities and other flaws or imperfection that might affect the mechanical or dielectric qualities. The hollow insulator shall conform to the latest edition of IS: 5621. The puncture strengths of the hollow insulator shall be entirely free from external and internal corona. The total creepage distance of the hollow insulator shall be suitable for heavily polluted atmosphere i.e. The total creepage distance shall be 1810 mm (minimum).
- b. Suitable means shall be provided to accommodate conductor expansion and there should not be any undue stress on any part of the equipment due to temperature changes.

- c. The contractor may provide packing between insulator and tank. This packing shall be preferably Nylon Bush of minimum 3 mm thickness.
- d. The exterior, upper and lower joints of insulator bushing shall be sealed with suitable sealant.
- e. The hollow porcelain bushings confirming to the latest edition of IS: 5621 shall be used for current transformers. The insulation of bushings shall be coordinated with that of the instrument transformer such that the flashover, if any, will occur only external to the current transformers. The bushings should not cause radio interference, when operating at rated voltage.
- f. The oil shall confirm to the requirements of latest edition of IS: 335.

#### **3.5.3.5 Terminal connectors & earthing terminals**

- a. Compression joint type bimetallic terminal connectors suitable for ACSR 'PANTHER' conductors (with 510 amps.) shall be supplied for CTs having ratio from 150-300 / 1-1-1 Amp up to 600-300 / 1-1-1 Amp.
- b. The terminal connectors shall be suitable for 25 kA for 3 sec. They shall be suitable for vertical & horizontal connections of the transmission line conductors or station bus bar. The bolt and nuts shall be of stainless steel and one SS washer and two SS nuts (including lock nut) for each bolt shall be supplied. Two grounding terminals suitable for receiving connections for grounding shall be provided for the current transformers.

#### **3.5.3.6 Galvanising**

All ferrous parts of current transformers including bolts, nuts etc. Shall be hot dip galvanized as per IS: 2629 with (latest edition) and the minimum thickness of zinc coating shall be 610 gr/sqmt.

#### **3.5.3.7 Test & test reports**

- a. Equipment offered shall have Type Test Certificates from accredited laboratory (accredited based on ISO/IEC Guide 25 /17025 or EN 45001 by the National accreditation body of the country where laboratory is located), as per IEC / IS / technical specification. The type test reports shall not be older than FIVE years.
- b. The type test reports for the type tests carried out as per IS: 2705 (latest edition) & IEC 60044-1 for specified CTs and those for offered insulator shall be submitted.
- c. Following test reports shall be submitted for owner's approval.
  - a. Lightning chopped Impulse voltage withstand test on Primary winding
  - b. High voltage power frequency wet withstand test on Primary winding
  - c. High voltage power frequency dry withstand test on primary winding
  - d. Temperature rise test
  - e. Short Time Current withstand test
  - f. Determination of Errors & other characteristics

- g. Measurement of dielectric dissipation factor
  - h. Degree of protection IP55 for secondary terminal box
  - i. STC test on primary terminal connector
  - j. Mechanical Load test on primary terminal
  - k. Thermal stability test
  - l. Thermal coefficient test
- d. The type test reports for offered terminal connectors (confirming to IS: 5561 (latest edition), but not older than five years and those for offered insulators confirming to the applicable standard shall, also, be submitted after award of work.
- e. Routine tests as per the latest edition of IS: 2705 for current transformers shall be carried out on each current transformer (in presence of Owner's representative, if desired by the Owner).
- f. Following tests shall be performed:
  - a. Verification of terminal marking and polarity
  - b. High voltage power frequency dry withstand test on primary winding
  - c. High voltage power frequency dry withstand test on secondary winding
  - d. Over Voltage inter turn test
  - e. Measurement of Partial Discharge test
  - f. Determination of Errors & other characteristics
  - g. Measurement of dielectric dissipation factor (0.3%max) & Capacitance at 10 kV and at  $U_m/\sqrt{3}$ .
- g. In case of non-submission of some of the type test reports, the contractor shall confirm the submission of same before commencement of supply, without affecting delivery schedule, from NABL accredited laboratory, at his own cost
- h. If contractor has submitted all valid type / special / additional test reports as per requirement of technical specifications, then the same are not required to be repeated. However, those tests which are covered under acceptance/ additional/ routine tests will be required to be carried out during the inspection, which is not a repetition.

#### **3.5.3.8 General points**

- a. The manufacturer shall use 5 kV motorized megger for measuring IR values of CTs.
- b. The manufacturer shall carry out Partial Discharge test and tan delta test as per relevant IS, and shall keep record of the same.
- c. The manufacturer shall offer CTs for routine tests / inspection in line with the requirement as per delivery schedule.



- d. Record of each manufacturing process shall be maintained by the manufacturers, and shall be shown to the inspector, on demand at the time of inspection.

#### **3.5.3.9 Quality Assurance plan**

- a. The contractor shall invariably furnish following information after award of work; Information shall be separately given for individual type of instrument transformer.
- b. Statement giving list of important raw materials, including but not limited to:
  - a. Primary Conductor
  - b. Insulator Bushing
  - c. Core
  - d. Oil
  - e. Sealing material
  - f. Secondary wire
- c. Names of sub-suppliers for the raw materials, list of standards; according to which the raw materials are tested, list of tests normally carried out on raw materials in presence of contractor's representative, copies of test certificates.
- d. Information and copies of test certificates as in (i) above, in respect of, bought out accessories
- e. List of manufacturing facilities available. In this list the contractor shall specifically mention whether lapping machine, vacuum drying plant, air conditioned dust free room with positive air pressure for provision of insulation, oil leakage testing facility, facility for testing tan delta of insulation at rated voltage etc. are available.
- f. Levels of automation achieved and list of areas where manual processing still exists.
- g. List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.
- h. Special features provided in the equipment to make it maintenance free.
- i. List of testing equipment available with the contractor for final testing of instrument transformer and test plant limitation, if any for the type, special acceptance and routine tests specified in the relevant standards. These limitations shall be very clearly brought out in schedule of deviations.
- j. The following testing equipment's shall be available for testing at OEM/Third party NABL accredited laboratory works.
  - a. Partial Discharge test set up

- b. Tan delta and capacitance test set up
  - c. Minimum Sensitivity of high voltage laboratory- 2.5pC for PD measurement.
  - d. All test set up shall be calibrated at NABL accredited laboratory and report shall be submitted with inspection report.
- k. OEM (Original equipment manufacturer) shall have ISO certification.

#### **3.5.3.10 Completeness of equipments**

Any fittings, accessories or apparatus which may not have been specifically mentioned in these specifications, but which are usual or necessary for the equipment of similar plant shall be deemed to be included in the contract and shall be supplied by the contractor without extra charges. All plant and equipment shall be complete in all details whether such details are mentioned in the specification or not.

### **3.6 Outdoor Voltage Transformers**

#### **3.6.1 Scope**

This specification is intended to cover the design, manufacturing, assembly, testing at manufacturer's works, supply, delivery, Testing & commissioning of outdoor voltage transformers.

#### **3.6.2 Type & rating**

The voltage transformers shall be of outdoor, dead tank type, oil impregnated paper, single phase, oil immersed, self-cooled suitable for operation in 3 phase, 66 kV solidly grounded system.

#### **3.6.3 Standards**

- a. The voltage transformers shall conform in all respects to the latest issue of IEC, recommendations publication No. 60044 or British Standards No. 81 & 2046, and IS: 3156 (latest issue) except wherein specified otherwise, where the equipment conforms to any other standard, the salient points, differences between the standards adopted and the British Standards shall be clearly brought out datasheet.
- b. Equipment meeting any other authoritative standard, which ensures an equal or better quality than the standard mentioned above, is also acceptable.

#### **3.6.4 Description**

- a. The voltage transformers shall be outdoor, oil immersed and self-cooled type suitable for the services indicated confirming to the modern practice of design and manufacture.
- b. The core shall be of high grade, non-ageing, electrical silicon laminated steel of low hysteresis loss and high permeability to ensure high accuracy at both normal and over voltage.

- c. The voltage transformers shall be hermitically sealed to eliminate breathing and entering of air and moisture in the tank. Provision of pressure releasing device is not permitted.
- d. For compensation of variation in volume of oil due to temperature variation, stainless steel bellows shall be provided. The contractor shall have to submit calculations of volumetric expansion and contraction. These calculations shall be submitted along with the basic parameters of SS bellow used in PT.
- e. Rubber bellow or Nitrogen gas cushioning for above purpose shall not be permitted.
- f. The Voltage Transformers provided with stainless steel bellows for compensation of oil volume variation shall be provided with a suitable oil level indicator at suitable location to enable an observer to see the oil level of the C.T. from the ground level. Oil level indicator shall be provided with fluorescent green coloured floating ball.
- g. All parts of bellow shall be of stainless steel only.
- h. The bolts required for fitting the dome shall be stainless steel of minimum 6 mm diameter.
- i. The outer surface of metal tank shall be Hot Dip Galvanized, whereas, the inner portion shall be painted with oil resistive paint. The OWNER reserves right for inspection during manufacturing process of metal tank.
- j. The tank of PT shall be provided with pressboard of 2 mm thickness inside and at bottom.
- k. The contractor shall provide packing between insulator and tank. This packing shall be preferably Nylon Bush of minimum 3 mm thickness.
- l. The exterior, upper and lower joints of insulator bushing shall be sealed with suitable sealant.
- m. The provision of drain valve for sampling / draining of oil purpose at the bottom of the tank is not permitted.
- n. The minimum thickness of flange & gasket provided on tank shall be as follow:
  - i. Flange thickness of tank-8mm
  - ii. Top plate thickness-5 mm
  - iii. Gasket thickness-5 mm

### **3.6.5 Windings**

#### **3.6.5.1 Primary & secondary winding**

- a. The primary winding shall be of electrolytic grade copper. All primaries of potential transformers will be connected in phase to neutral with the neutral point solidly earthed. The neutral of the system is also solidly earthed.

- b. The primary terminal shall be of heavily tinned electrolytic grade copper and shall be of standard size 30 mm dia. x 80 mm long and tinning shall be adequate.
- c. The secondary winding shall be of electrolytic grade copper. Secondary terminal shall be nickel-plated brass.
- d. The secondary terminals shall be taken out through composite epoxy or FRP mould having single gasket packing & shall be provided by suitable link with dummy secondary leads. For control cable connections, separate terminal connector block to be provided. Secondary jumpers shall be terminated at one side of this terminal connector block.
- e. All potential transformers for phase to ground connection shall be provided with two separate windings rated for 110 V and 63.5 V for connection in star and delta winding respectively. The star winding, to be used for metering and relaying (distance relays) shall be of accuracy class specified or appropriate class. The rated burden of this winding shall not be less than that specified above.
- f. The delta winding to be used for synchronizing and relaying (directional relays) shall be of accuracy class specified or appropriate class and its rated burden shall not be less than that specified above.

#### **3.6.5.2 Insulation**

- a. The potential transformer shall withstand 1.2/50 microsecond lightning impulse withstand voltage of 350 kV peak.
- b. They shall withstand power frequency withstand voltage of 140 kV (rms) (dry & wet) for one minute.

#### **3.6.5.3 Temperature rise**

- a. The potential transformers shall be designed to limit the temperature of windings and other parts as specified in the IEC Standards / relevant standards when corrected or the differences between the temperature prevailing at site and temperature specified by the standards. The temperature rise, at 1.2 times rated primary voltage when applied continuously at rated frequency and at rated burden, shall not exceed the limits specified above and the temperature rise at 1.5 times rated primary voltage when applied for 30 seconds, starting from previous stable operating condition at rated frequency and rated burden shall not exceed the above temperature limits by more than 10 °C.
- b. The insulating oil shall confirm to the requirements of latest edition of IS: 335.
- c. The manufacturer of PT shall measure the PPM value of oil before filling inside the PT and shall keep record of the same.

#### **3.6.5.4 Type of Mounting**

The voltage transformers shall be suitable for mounting on steel structures or concrete pedestals. The necessary flanges, bolts etc. For the base of the voltage transformer shall be

supplied and these shall be galvanized. Nuts and bolts shall be provided on flanges, cemented to the bushing and not on the porcelain. i.e. flange type bushing to be provided.

#### **3.6.5.5 Terminal box of voltage transformer**

- a. The exterior of the secondary terminal box shall be hot dip galvanized.
- b. A cable box along with necessary glands for receiving control cables suitable for mounting on bottom plate of the terminal box shall be included in the scope of supply. A door with locking arrangement shall be provided on the front of the terminal box. The secondary terminals shall be taken out through composite epoxy or FRP mould having single gasket packing & shall be provided by suitable link with dummy secondary leads. For control cable connections, separate terminal connector blocks to be provided. Secondary jumpers shall be terminated at one side of this terminal connector block. The secondary terminal box shall comply with Degree of Protection (IP-55) standards and type test report shall be submitted for owner's approval.
- c. The porcelain hollow insulator used shall be homogenous, free from lamination cavities and other flaws or imperfection that might affect the mechanical or dielectric qualities. The hollow insulator shall conform to the latest edition of IS: 5621. The puncture strengths of the hollow insulator shall be entirely free from external and internal corona. The total creepage distance of the hollow insulator shall be suitable for heavily polluted atmosphere i.e. the total creepage distance shall be 1810 mm (minimum).
- d. Suitable means shall be provided to accommodate conductor expansion and there should not be any undue stress on any part of the equipment due to temperature changes.
- e. The contractor may provide packing between insulator and tank. This packing shall be preferably Nylon Bush of minimum 3 mm thickness.
- f. The exterior, upper and lower joints of insulator bushing shall be sealed with suitable sealant.
- g. The hollow porcelain bushings conforming to the latest edition of IS: 5621 shall be used for current transformers. The insulation of bushings shall be coordinated with that of the instrument transformer such that the flashover, if any, will occur only external to the current transformers. The bushings should not cause radio interference, when operating at rated voltage.
- h. For gasket joints, wherever used, Nitrile Butyl rubber NBR/Viton gaskets shall be used. No CORK gaskets shall be used. All gaskets/O rings shall be fixed in a machine groove. The gaskets shall be securely fitted for perfect sealing.

#### **3.6.5.6 Terminal connections**

- a. The compression joint type terminal connector suitable for ACSR 'PANTHER' conductor shall be supplied. Suitable terminal earth connector for connections for earthing shall also be supplied.
- b. The terminal connectors shall be suitable for 25 KA for 3 seconds. They shall be suitable for vertical & horizontal connections of the transmission line conductors or station bus bar. The bolt and nuts shall be of stainless steel and one SS washer and two SS nuts (including lock nut)

for each bolt shall be supplied. Two grounding terminals suitable for receiving connections for grounding shall be provided for the voltage transformers.

#### **3.6.5.7 Tests**

##### **a. Type tests**

The type test report for all the type tests as stipulated in IS: 3156 (Part – I – latest edition) but not older than FIVE years and shall be submitted for owner's approval. The type test reports for offered terminal connectors (confirming to IS: 5561 (latest edition), but not older than five years.

- a. Lightning chopped Impulse voltage withstand test on Primary winding
- b. High voltage power frequency wet withstand test on primary winding
- c. High voltage power frequency dry withstand test on secondary winding
- d. Temperature rise test
- e. Determination of Errors & other characteristics
- f. Degree of protection IP55 for secondary terminal box
- g. STC test on primary terminal connector
- h. Mechanical load test on primary terminal

##### **b. Routine tests**

- a. Each voltage transformer shall be subject to routine tests as stipulated in IS: 3156 (latest edition) in presence of Owner's representative. All the type test reports shall be submitted and got approved from the Owner before the dispatch of potential transformer.
- b. Following tests shall be performed:
- c. Verification of terminal marking & polarity test
- d. High voltage power frequency dry withstand test on primary winding
- e. High voltage power frequency dry withstand test on secondary winding
- f. Measurement of Partial Discharge test
- g. Determination of Errors & other characteristics
- h. Measurement of dielectric dissipation factor (0.3% max) & Capacitance at 10 kV and at  $U_m/\sqrt{3}$ .

### 3.7 Outdoor SF6 circuit breaker

#### 3.7.1 Scope

This section covers the design, manufacture, testing, inspection, supply, delivery, testing & commissioning of 66 kV SF6 gas Circuit Breakers SPRING operated, along with associated accessories and complete in all respects.

#### 3.7.2 Applicable Standards

- a. The equipment to be supplied under this specification shall confirm to the latest issue of standards, rules and codes some of which are mentioned below.

Sr.N o.	IS/IEC code	Description
1.	IEC-62271/ IS 13118	Specification for alternating current Circuit breaker
2.	IEC-60376	Specification and acceptance of new Supply of sulphur Hexafluoride
3.	IS: 2147	Degree of protection provided for Enclosures for low voltage switchgear and control gear.
4.	IS: 375	Marking and arrangement for switchgear bus- bar, main connections and auxiliary wiring.
5.	IS: 325	Specification for 3ph induction motor.
6.	IS: 2516	Specification for circuit breaker.
7.	IS: 2099	High voltage porcelain bushing.
9.	IS: 2629	Recommended practice for hot dip galvanizing of iron and steel.

- b. The components & accessories to be used in the manufacture of circuit breaker shall confirm to relevant Indian Standards/the standard specified under respective clause in this specification.
- c. However, in the event the offered breakers confirming to any other standard, salient points of differences between the standard adopted and the specified standards shall be clearly indicated in the offer

#### 3.7.3 Drawings/documents

- a. The contractor shall furnish the drawings in triplicate incorporating the following particulars.
- Drawing showing the general outlines dimensions of circuit breakers, with clear identification of parts / items.
  - Drawing showing control cabinets and circuit diagrams for operating mechanism of circuit breakers.
  - Drawing showing the complete operation cycle of the circuit breaker with description.
  - Compression type terminal connectors for the breakers.

- b. The contractor shall submit the following drawings after award of work.
  - a. Outline dimensional drawings showing all parts / items, transport weight etc. of circuit breaker & its support structure.
  - b. Detailed drawings of operating mechanism of circuit breakers.
  - c. Wiring and control diagram.
  - d. Drawings of foundation details, mounting structures, spacing of bolts etc.
  - e. Compression type terminal connectors, with STC rating, bill of materials, etc., complete with all dimensions.
  - f. Erection, operation & maintenance manuals.

#### **3.7.4 General Design Features of Circuit Breakers**

- a. The circuit breakers shall be capable of rapid and smooth interruption of currents under all conditions completely suppressing all undesirable phenomena even under the most severe and persistent short circuit conditions or when interrupting small currents or leading or lagging reactive currents. The circuit breakers shall be 'Restrike-Free' under all operating conditions. The details of any device incorporated to limit or control the rate of rise of restricting voltage across, the circuit breaker contacts shall be stated. The over voltages caused by circuit breaker while switching inductive or capacitive loads shall not exceed 2.5 times the highest phase to neutral voltage. The actual makes and break times for the circuit breakers throughout the ranges of their operating duties shall be stated and guaranteed.
- b. The arc quenching chambers shall have devices to ensure almost uniform distribution of voltage across the interrupters.

#### **3.7.5 Breaking Capacity**

- a. The interrupting capacity of the breaker for kilometric faults (short line faults) shall be equal to its interrupting capacity as per IS: 13118 / IEC 62271. The details of tests conducted for confirming the capability of the breakers under kilometric fault conditions shall be furnished.
- b. The circuit breakers shall be designed for interrupting line charging currents without undue rise in the voltage on supply side and without any restrike and without showing signs of undue strain. The guaranteed over voltage which shall not be exceeded while interrupting the line charging currents.
- c. The circuit breakers shall be capable of interrupting small inductive currents (occurring while switching off unloaded transformer) without giving rise to undue over voltage and without restrikes.

##### **a. Restriking Voltage:**



- i. The circuit breakers shall be capable of interrupting the rated power when the restriking voltage has a frequency of not less than 400 Hz and with a restriking voltage having frequency of 2000 Hz. The circuit breakers shall be capable of interrupting at least 50% of nominal breaking capacity
  - ii. The measures adopted for ensuring proper operation at high rate of rise of restriking voltage and for limiting the actual voltage values across the breaks shall be described. The type characteristics and rating of the resistor used, if any, to shunt the breaker contacts and of the auxiliary switching devices used for interrupting the resistor current shall be clearly stated.
- b. Recovery voltage and power Factor:
  - i. The circuit breaker shall be capable of interrupting the rated power with recovery voltage equal to the rated maximum line to line service voltage at rated frequency and at a power factor not exceeding 0.15.
- d. The circuit breakers shall also be capable of satisfactory operation even under conditions of phase opposition that may arise due to faulty synchronizing. The maximum power which the breaker can satisfactorily interrupt under phase opposition shall be stated in the datasheet.
- e. The operating duty of the circuit breaker shall be as specified in the specific technical requirement for breakers.

#### **3.7.6 Temperature Rise**

The temperature rises and the maximum temperature on any part of the breaker when in service under continuous full load conditions and exposed continuously to the direct sun-rays shall not exceed the permissible limits as per relevant IS. When the standard specifies the limits of temperature rise, this shall not be exceeded when corrected for the difference between ambient temperature at site and the ambient temperature specified in the relevant specification. The correction proposed shall be stated in datasheet and shall be subject to the approval of the Owner

#### **3.7.7 General Features of Circuit Breakers**

- a. The circuit breakers shall be suitable for outdoor operation under the climatic conditions specified in this specification.
- b. The circuit breakers operating mechanism shall have two nos. of tripping coils and one no. of closing coil for both 66 kV SF6 Gas CB for better reliability. There shall be separate contactor for each coil.
- c. Exposed live parts shall be placed high enough above ground to meet the requirements of local safety codes.
- d. All similar parts, particularly removable one and shall be interchangeable with one another.

### **3.7.8 Insulation of the Circuit Breaker**

- a. The insulation to ground, the insulation between open contacts and the insulation between phases of the completely assembled circuit breaker shall be capable of withstanding satisfactorily dielectric test voltages corresponding to BIL specified in this specification.
- b. The minimum clearances in open air shall be as under in case of SF-6 Breakers:
  - a. Minimum clearance between phase : As per relevant IS.
  - b. Minimum clearance between live parts : As per relevant IS. and grounded objects.
- c. Adequate clearance in air shall be provided between phase and from phase to ground. The clearance shall be such that the breaker shall withstand the BIL specified in the specification. The minimum clearance from live parts to ground level shall not be less than 4000 mm – including plinth height as 300 mm

### **3.7.9 Contacts of Circuit Breaker:**

The main contacts shall have adequate area and contact pressure for carrying the rated currents and the short time rated breaking currents of the breaker without excessive temperature rise. Contacts shall be easily replaceable and shall have a minimum of movable parts and adjustments. The main contacts shall be first to open and last to close so that burning of the contact may be negligible

### **3.7.10 Operating Mechanism of Circuit Breakers**

- a. Circuit breakers shall be power operated by a motor compressed spring charging mechanism; the mechanism will be trip-free electrically and mechanically. The mechanism shall be strong, quick in action and shall be removable without disturbing other parts of the circuit breakers. All the working parts in the mechanism shall be of corrosion resistant materials and all bearings which require greasing, shall be equipped with pressure grease fittings. The mechanism and breaker shall be such that the failure of any spring will not prevent tripping and will not cause tripping or closing.
- b. The circuit breakers shall be designed for remote control from the control room and there shall be provision for manual operation of circuit breakers during maintenance and for local tripping and closing by normal means.
- c. The circuit breaker shall have a mechanical 'ON-OFF' indicator in addition to facilities for remote electrical indicator.
- d. The operating mechanism along with its accessories shall be suitable for electrical operation and shall be mounted in a weather proof cabinet with hinged doors located near the breakers. The cabinet shall be suitable for IP 55 degree of protection. The operation shall be possible from ground or necessary HDG stand/platform of suitable height maintaining all safety clearance with live parts shall be supplied as a part of breaker. The local control switch and the breaker position indicator shall be provided in this cabinet, which shall be free standing and supported by suitable

arrangement. The control circuit shall be designed to operate on D.C. as specified in section-II of this specification. The closing and opening coils shall be designed to operate satisfactorily at any control voltage from 85% to 110% & 70% to 110% of the normal voltage, respectively. A heater of adequate capacity with thermostat shall be provided in the cabinet to avoid moisture condensation

The terminal block shall of 1.1 kV voltage grade & shall be with stud type connections instead of with screw types connections

#### **3.7.11 Auxiliary switches**

A minimum number of 6 NC + 6 NO Auxiliary switches contacts shall be provided on each circuit breaker for use in remote indication control scheme of the circular breakers and for safety interlocking. Special contacts for use with trip coils and auto reclosing operation shall also be provided. Provision shall be made for adding more auxiliary switches, if required. Auxiliary switches shall be placed in weatherproof galvanized casing & current rating of switches shall be furnished.

#### **3.7.12 Bushing & Insulators**

The porcelain insulator used in manufacturing the bushings shall be homogeneous, free from laminations, cavities and other flaws or imperfection that might affect the mechanical or dielectric qualities. All bushings of identical ratings shall be interchangeable. The insulators shall confirm to the latest edition of IS: 3447 or other equivalent standard. The puncture strengths of the bushings shall be greater than their flashover values. The bushings shall be entirely free from external and internal corona. The protected and total creepage distance of the bushings shall be suitable for heavily polluted atmosphere. The minimum creepage distance of the insulator shall be 1810 mm suitable for heaving polluted atmosphere. The compressive and cantilever strength shall confirm to the relevant IS.

#### **3.7.13 Terminal Connectors and Earthing Terminals**

Compression joint type terminal connectors suitable for single or twin ACSR panther/zebra/Moose shall be supplied and they shall be suitable for both vertical and horizontal connections of the Transmission line conductor or station bus bar. Suitable terminal earth connectors (two Nos.) for earthing connections shall also be supplied. The drawings for these connectors shall be submitted. SS bolt for connector shall be provided with two Nos. of SS nuts (including lock nut & one SS washer.)

#### **3.7.14 Tropicalisation**

All control wiring, electric motors and accessories shall be protected against fungus growth and other harmful effects due to tropical environments

#### **3.7.15 Galvanizing**

All ferrous parts of breakers and bolts, nuts etc. shall be hot-dip galvanized as per latest edition of IS: 2629. Support structure's galvanizing shall be done as per IS 4843 (latest edition). Electro galvanized bolts nuts, & washers are also acceptable.

### **3.7.16      Painting**

Interior and exteriors of tanks, mechanisms, enclosures, cabinets and other metal parts shall be thoroughly cleaned to remove all rust scales, corrosion and other adhering foreign matter, steel surfaces in contacts with insulation oil, as far as possible shall be painting with not less than two coats of heat resistant, oil insoluble, insulating varnish light-grey paint shade 631 as per IS:5 shall be selected to withstand tropical heat and extremes of weather

### **3.7.17      Test and Test Reports**

- a. Reports of following type tests carried out in NABL / Govt. approved laboratory&as per IS: 13118 / IEC 62271-100 for A C circuit breaker shall be submitted for owner's approval:
  - a. Lightning impulse withstand voltage test
  - b. Power frequency voltage withstand voltage test. (Dry as well as Wet)
  - c. Temperature rise test.
  - d. Measurement of resistance of main circuit
  - e. Short time current withstand and peak current withstand Test
  - f. Mechanical endurance test
  - g. Duty cycle & Single phase short circuit test.
  - h. Out of phase making and breaking current test.
  - i. Capacitor current switching test for isolated neutral capacitor banks.
  - j. Line charging current switching test
  - k. Cable charging current switching test
  - l. Short line fault duty test
  - m. Degree of protection test on cubicles
- b. Equipment offered shall have Type Test Certificates from accredited laboratory (accredited based on ISO/IEC Guide 25 / 17025 or EN 45001 by the National accreditation body of the country where laboratory is located), as per IEC / IS / technical specification. The type test reports shall not be older than FIVE years.
- c. In case of non-submission of some of the type test reports, the contractor shall confirm the submission of same before commencement of supply, without affecting delivery schedule, from NABL accredited laboratory at his own cost.
- d. Routine tests as per the latest edition of IS: 13118/IEC 62271 for circuit breakers shall be carried out on each circuit breaker. All the acceptance tests in presence of Owner representative shall be carried out on circuit breakers selected from offered lot.
- e. In addition to above, speed curves for each breaker shall be obtained with the help of a suitable operation analyser to determine the breaker contact movement during opening, closing, auto-re-closing and trip free operations under normal as well as limiting operating conditions (of control voltage) The tests shall show the speed of contacts directly at various stages of operation, travel of contacts, opening time, closing time, shortest time between separation and meeting of contacts at make-break operation and dynamic contact resistance measurement (DCRM) etc.

- f. The test reports for type tests and routine tests in respect of associated items such as spring charging motors, instruments, pressure switches, relays, terminal connectors, etc. as per the latest edition of the relevant IS shall be supplied by the contractor. All the routine test reports for all the breakers and for all the insulators utilized shall be submitted with inspection report.
- g. All tests report for acceptance / routine tests shall be submitted in spiral bound volume and got approved from the Owner before dispatching the breaker

### **3.7.18 Earthquake & wind design load**

Each circuit breaker including its supporting structure shall be designed to withstand required earthquake acceleration of  $0.08 \times 2 \text{ g}$  and with wind loads of  $150 \text{ Kg/m}^2$  on the projected area (non- simultaneous) without damage to component parts and without impairment of operation

### **3.7.19 General design feature of circuit breaker**

- a. SF6 Gas Circuit breaker shall consist of three identical single phase units with common spring operating mechanism suitable for specified duty. Separate SF6 Gas Cylinder along with suitable gas system, incorporating required gas stop valves, copper piping of suitable size shall be provided. Required pressure switches as stated shall be provided. Gas pressure gauge shall be fitted on the common feed pipe to monitor the pressure of SF6 gas in the interrupter.
- b. Absorbent shall also be provided in each interrupting unit to keep the SF6 gas dry & absorb the decomposed product of SF6 gas, formed during arcing.
- c. Contractor shall give complete constructional details for SF6 gas circuit breaker offered by them. The insulation level of porcelain of the circuit breaker shall be so coordinated with that of the breaker that flashover shall occur externally to the breaker.
- d. In case of SF6 circuit breaker, it shall be possible to arrange for either automatic tripping of the circuit breaker or tripping of circuit breaker on fault and will be automatically locked when the pressure in the individual interrupter reaches below the limit value. Arrangements shall be made to prevent closing of the breaker due to leakage of gas passing through the closing valve without a positive impulse from the closing coil.
- e. The SF6 gas used in the circuit Breaker shall comply in all respect with the provisions of the latest edition of relevant standard.
- f. Inter Locks:
  - a. Pressure switches with the required pressure fitting must be incorporated to ensure safety of breaker operation when SF6 gas pressure goes below the specified pressure range due to leakage, the trip coil circuit & closing coil circuit must be cut-off. The pressure switch shall generally be temperature compensated gas pressure switch having two micro-switches, operating at different pressures one for low pressure alarm and other for low pressure cut-out.
  - b. Additional dedicated pressures switch with 4 poles for Normal, Low gas, Lockout, etc shall be provided for SCADA remote operations. L/R switch shall have spare contacts.

- c. Limit switch for motors shall be provided with 4 NO and 4 NC contacts

### **3.8 Switchyard Equipment**

#### **3.8.1 Scope**

The design, material, construction, manufacture and testing of substation equipment shall comply with all currently applicable standards/ statutes, regulations and safety codes in the locality where the equipment will be installed. In case of conflict between the standards and this specification, this specification shall govern. The following equipment shall be provided in the switchyard.

#### **3.8.2 Structure**

Two/ four pole structures in switchyard to receive 11KV power supply from electric supply authority shall conform to the latest applicable standards specified as under.

- a. A two / four pole structure shall be of a rolled steel joist if minimum ISMB 150 (150mm x 75mm) for 9 meter pole with 400 mm x 400 mm x 8 mm thick base plate weld at bottom end of all poles of structure.
- b. Mild steel cross members of minimum ISMC . 100 mm x 50 mm x 6 mm size channels of 3.5 mtr in length, 8 Nos. shall be provided with cross bracing angles of minimum ISA 50 m x 50 mm x 6 mm size of 4.5 meter in length.
- c. Side clamps, stay clamps, cleats etc. shall be fabricated from minimum 50 mm x 6 mm size MS flats as per actual requirements. All bolts, nuts, washers, etc. shall be of minimum 15 mm size.
- d. All the members of two/ four pole structure should be galvanized.
- e. Excavation of pits even in hard soil shall be done up to a depth of about 1/ 6 the length of pole and refilling the same after erection of structure and concreting work. Compacting the bottom of pits, providing cement concrete to suit at bottom ad side of poles up to at-least 150 mm above FGL curing and making it hard as per requirement.
- f. Erection of TSJ poles and fixing of all structural members as per requirement shall be in line, level and properly facing the incoming and outgoing lines. Cross members shall be firmly tightened.
- g. All members shall be fabricated to suit mounting / fixing of gang operated disconnectors / isolators, lighting arrestors, pin / post insulators, cable end termination kit / box etc.
- h. All MS parts shall be painted with two coats of red oxide and two coats of aluminium paints.
- i. Earthing terminals shall be provided by welding 15 mm size bolts or cleats of 50 mm x 6 mm size MS flat shall be welded in each joist with a hole of 15 m size and galvanized nuts, bolts, washers shall be provided as earthing terminals.
- j. Necessary stay sets & hardware as required for completeness shall be supplied and erected.
- k. All drawings/ documents such as GA drawing of two/ four pole structure showing all equipment mounted on the structure, technical particulars & bill of material etc shall be prepared nd

submitted to purchaser/ purchaser's representative for approval. Obtaining the approval from CEIG / IMPD (GOG) and getting power released from supply authority are also included in the scope of work.

### **3.8.3 Gang operated offload disconnectors (GOD) with earth switch:**

- a) The double break type isolator (GOD) shall be manually operated and suitable for specified site conditions and shall be able to –
  - i. Carry rated current without excessive temperature rise.
  - ii. Withstand the short circuit forces developed during fault.
  - iii. Carry the inrush current of the transformer.
  - iv. Interrupt small inductive and capacitive currents.
- b) The operating rod shall be extended up to the operating level and shall have a handle with 'lock and key' arrangement. The operating handle shall be at level of 1.0 meter from finished ground level.
- c) The operating handles shall be mounted on the base of supporting structure. Guide bearings shall be provided if necessary at appropriate height above ground level. Necessary accessories viz. brackets, angles, guides, guide bearings for attaching the operating mechanism and operating handles to the structure and part of the isolator, rust proof pins, ball or roller type bearings shall be provided and installed. All bearings shall be protected by means of covers and grease retainers. Bearings pressure shall be kept low to ensure long life and ease of operation.
- d) The operating mechanism design shall be such that, as soon as the moving blades reach the sparking distance during operation of isolator, springs shall take over to give a quick snap action closing so that the isolator closing is independent of manual effort. Similarly the springs must assist during opening operation to give quick breaking feature.
- e) All copper parts shall be Silver or Tin plated. All ferrous parts shall be hot dipped galvanized to assure long protection against tropicalised weather.
- f) The contacts shall be of silver faced copper ensuring sufficient contact pressure. The male and female contacts shall be of self-aligning type to ensure trouble free operation during opening and closing of isolator. Mild steel arcing horn capable of breaking the magnetizing current shall be provided. Earth mesh below GOD to be provided

### **3.8.4 Isolator Interlock:**

- l. Electrical interlock arrangement shall be provided among double break isolator (GOD) and respective 11 KV indoor type breakers.
- m. Interlocking arrangement shall be robust, heavy-duty type and sturdy in construction.
- n. Mechanical interlock between Isolator & Earth Switch shall be provided

### **3.8.5 Insulators:**

- o. Insulator shall be properly glazed with smooth surface without cracks etc. and dielectric property shall be properly coordinated with isolator voltage class. Porcelain used for the manufacturer of insulator shall be uniform, brown color, free from blisters, burns and other similar defects. Insulators of the same rating and type shall be interchangeable.
- p. Porcelain and metal parts shall be assembled in such a manner that any thermal expansion differential between the metal and porcelain parts throughout the range of the temperature variation shall not loosen the parts or create undue internal stresses which may affect the electrical or mechanical strength and rigidity. Each cap and base shall be of high grade cast steel or malleable steel casting and they shall be machinefaced and smoothly galvanized. The cap and base of the insulators shall be interchangeable with each other.

### **3.8.6 ACSR Conductor:**

- q. Aluminium conductor steel reinforced shall be hard drawn from 99.5% pure electrolytic aluminium rods. The Contractor shall specify the conductivity.
- r. Chemical composition of the material shall comply with the requirements of relevant standards.
- s. The surface of conductor shall be clean and dry and free from any excess grease that may be used in its fabrication. The surface strands shall be smooth and free from burrs and other projections which may be a cause for increasing corona losses.
- t. The Contractor shall provide necessary treatment for the bus conductor to make it free from corrosion.
- u. The steel wire strand of conductor and steel conductor shall be hot dip galvanized. Zinc coating shall be evenly and uniformly for heavily coated wires.
- v. The steel core and inner layer of aluminum wires where more than one aluminum layer exist shall be protected with special grease in order to provide additional protection against corrosion due to salinity. The grease shall fill the whole space between wires within circumscribed cylinder at inner aluminum layer or at steel core if the conductor has only one aluminum layer.
- w. The grease shall be chemically neutral with respect to aluminum, zinc and steel. It shall withstand weather conditions given elsewhere and temperature of 85 degree centigrade without alternation of its properties.
- x. Bare conductor shall be covered in Alkathene pipes of suitable insulation to avoid accidental contact.

### **3.8.7 Drop out (D0) Fuse Unit:**

- y. Drop Out Fuse shall be of approved make suitable for 11 kV supply and shall be mounted on two pole structure complete with 3 fuse elements of required ampere suitable for continuous current rating and shall offer protection against fault level of suitable ampere at 11 kV.



- z. The fuse link shall consists of iron channel base to stack insulators per phase, fuse carrier Bakelite tube, heavy duty non-ferrous metal parts and spring loaded phosphor bronze contacts.
- aa. The insulator shall comply with impulse voltage in accordance with relevant IS.

#### **3.8.8 Drop out (D0) Fuse Unit:**

- bb. The design, material, construction, manufacture, inspection and testing of lightning arresters shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed.
- cc. In case of conflict between the standards and this specification, this specification shall govern.
- dd. The equipment covered in this specification shall conform to the latest edition of the following standards.

IS: 3070 (Part-3) : Lightning arresters for AC system – Specification(Metal Oxide Lightning Arrester without Gaps)

IEC: 60099-4 : Metal Oxide surge arresters without gaps for AC system

#### **ee. Constructional Features:**

- a. Lightning arrester shall be station class heavy duty and non- linear resistance type. The elements shall be in hollow cylindrical form, stacked together. Lightning arrestor shall be of class II, having non – linear voltage – current characteristic and having high discharge capability.
  - b. The entire arrester unit shall be housed in a porcelain insulating casing of high strength, made from brown glazed wet process porcelain, with metallic cover plates and terminal assemblies. The end castings shall be hermetically sealed and leak tested to protect the unit from moisture or breathing.
  - c. Pressure relief diaphragm, vent pipe, etc. shall be provided on the LA for the escape of gases formed. In the event of failure of L.A., the pressure relief directional aperture should be directed away from adjacent apparatus to prevent damage, due to arc transfer.
  - d. All hardware such as clamps, screws, bolts, nuts, washers etc. shall be electro galvanized.
- ff. Insulators:
- a. The porcelain insulators used shall be made from wet process, and shall be homogenous, free from lamination, cavities and other flaws, which may impair its mechanical or dielectric strength. They shall be thoroughly vitrified, tough and impervious to moisture.

- b. The glazing of porcelain shall be uniform brown colour, free from blisters, burns, cracks and other defects. The glazing shall cover all the porcelain part of the insulators except that area which serves as support during firing or are unglazed for the purpose of assembly.
  - c. The minimum creepage distance shall be as stipulated in data sheets. The petticoats shall be spaced for natural cleaning action by wind and rain and avoid concentrated hot spots where local stress can precipitate flashover.
  - d. All live metallic parts shall be suitably painted. All joints shall be fluid – tight and air tight. The design of insulators shall be such, as to produce uniform compression pressure joints.
  - e. All insulators of identical rating shall be interchangeable.
  - f. Each bushing shall be provided with aluminium / bimetallic terminal connectors suitable as specified in data sheet.
- gg. Accessories: Each lightning arrester shall be furnished complete with the accessories as listed below:
- a. Anti-contamination and pressure relief diaphragm complete with vent pipe.
  - b. Two (2) grounding pads.
  - c. Base plate suitable for mounting on GI/ steel structure or concrete structure.
  - d. Line side terminal suitable for specified conductor.
  - e. Other standard accessories which are not specifically mentioned but are usually and provided with lightning arrester of similar type and rating for efficient and trouble free operation.
  - f. Name plates fixed on lightning arresters giving full technical details.
  - g. The clamps and connectors on arrester terminals for connection to purchaser's line conductor and the connection between incoming transmission line and LA will be in the contractors scope.
- hh. Drawings/ documents to be furnished for Purchaser's approval:
- a. Technical particulars
  - b. GA drawing of LA indicating weight and overall dimensions
  - c. GA drawing of insulating base, discharge counter, terminal assembly
  - d. Bill of material
  - e. Mounting arrangement (base plate details) on the structure

f. QAP for lightning arrester

### 3.8.9 Chain Link Fencing and Gravel Filling:

ii. The work of erecting chain link fencing includes excavation, brick wall construction, erection of angle/ channel supports, providing chain link mesh on angle / pipe frame barbed wire fencing at top, concreting of support members, painting the complete structure and white washing the walls. All materials, hard wares, labours etc. are in the scope of contractor.

jj. Fencing height shall be minimum 2.0 meter & shall be complying with CEA guide.

kk. Gate for entry in fenced compound shall be got approved from the engineer in charge before starting the fabrication work. All necessary hard wares, fittings, stoppers, locking arrangements with brass pad locks of 100 mm size are in the scope of gate works.

Gates shall be self-supporting type.

ll. Gravel filling

## 3.9 Power transformers

### 3.9.1 Scope

This specification covers the design, construction, manufacture, assembly, testing of performance of transformers packing, supply delivery & commissioning of 66 kV class power Transformers complete with all fittings, accessories and associated equipments which are required for efficient & trouble free operation.

### 3.9.2 Standards

Unless otherwise specified equipment shall confirm to the following latest applicable Standards

Sr.No.	Description
IS 2026 Part I	Specification of Power Transformers
IS 2026 Part 2	Temperature Rise
IS 2026 Part 3	Insulation levels and Dielectric Tests
IS 2026 Part 4	Terminal Markings, Tapping and connections
IS 2026 Part 5	Transformer / Reactor Bushings - Minimum External clearance in Air Specification
IS 6600	Guide for Loading of Oil Immersed Transformer
IS 335	Specification for New Insulating Oil for Transformers and Switchgears.
IS 3639	Specification for Fittings and Accessories for Power Transformers.
IS 2099	Bushings for alternating voltages above 1000 Volts.
IS 3637	Specification for gas operated relays.

Sr.No.	Description
IS 1666	Copper conductors for transformer Windings.
IS 3347	Dimensions for Porcelain and transformer bushing.
IS 1271	Thermal evaluation and classification of electrical insulation.
IS 2026 Part I	Specification of Power Transformers
IS 2026 Part 2	Temperature Rise
IS 2026 Part 3	Insulation levels and Dielectric Tests

### 3.9.3 Service condition

#### 3.9.3.1 Climatic condition

##### Climatic conditions

Sr.No	Description	Parameters
(i)	Maximum Altitude above sea	level less than 1000M
(ii)	Service conditions	
(a)	Maximum ambient air temperature (°C)	50
(b)	Average daily air temperature.(°C)	35
(c)	Maximum yearly air temperature(°C)	50
(d)	Minimum ambient air temperature (°C)	3.5
(iii)	Maximum relative humidity (%)	95
(iv)	Average annual rainfall (mm)	1000
(v)	Maximum wind pressure kg/m2	150
(vi)	Seismic level (Horizontal acceleration)	0.3 g

#### 3.9.3.2 Auxiliary Power supply

a Auxiliarelectrical equipmentsshallbesuitableforoperationonthe following supply system.

##### a. Power Devices

- i. 415V, 3 Phase; four wire 50 Hz, neutral grounded AC supply.
- ii. 240V, single phase, 2 wire 50 Hz, AC supply.
- iii. Alarm, Control 220 / 110 DC supply,

##### b. Protective device.

- i. Variation in AC supply Voltage  $\pm 10\%$
- ii. Frequency:  $\pm 5\%$
- iii. Variation in DC supply voltage: -15 % to + 10 %

### **3.9.4 General Technical requirement**

- a. The transformer and OLTC should be suitable for unidirectional flow of rated power HV to LV.
- b. The transformers and all its accessories shall be designed to withstand without injury the thermal & mechanical effects of any external short circuit to earth & of short circuits at the terminals. The short circuit duration for confirming thermal limit shall be three seconds. The short circuit apparent power of the HV System to which the HV of transformer will be connected is 25 kA. The thermal ability to withstand short circuit for duration of 3 seconds shall be demonstrated by calculation. The calculation of dynamic ability to withstand short circuit shall also be submitted after award of work.
- c. The transformer shall be capable of being loaded continuously in accordance with IS: 6600 up to loads of 110%. There shall be no limitation imposed by bushings, tap changer or any other accessory.
- d. The Transformer shall be capable of being operated without danger on any tapping, at the rated MVA, with voltage variation of  $\pm 10\%$  corresponding to the assigned voltage of tapping.
- e. The transformer shall be of oil and natural cooling.
- f. Transformer shall be capable of withstanding thermal & mechanical stress caused by symmetrical and asymmetrical faults due to external short circuits, on any winding.
- g. All materials used shall be new and is of best quality & of the best class, most suitable for working under the conditions specified and shall withstand variation of temperature & atmospheric condition without distortion or deterioration, or setting up of undue stress in any part and also, without affecting the strength and stability of the various parts for the work which they have to perform.
- h. Exposed parts shall not leave pockets where water can collect.
- i. Internal design of the transformer shall ensure that air is not trapped in any location.
- j. Materials in contact with oil shall be such as not to contribute to the formation of acid in oil. Surface in oil shall not be galvanised or cadmium plated.
- k. Labels indelibly marked shall be provided for identifiable accessories / parts.
- l. Centre line of transformer shall be marked on top plate.
- m. The GM valves shall confirm to IS: 778.

#### **3.9.4.1 Transformer Losses**

- a. The transformers are to be designed with maximum permissible losses as per IS.
- b. The above losses are maximum, without any positive tolerance.

- c. The measurement of losses shall be carried out with 3 (Three) Watt meter method only and CTs, PTs and meters used for these measurements shall be of class of accuracy of 0.2.

#### **3.9.4.2 Construction details**

The feature & construction details of power transformer shall be in accordance with the requirement stated hereunder.

##### **a. Transformer Tank**

- a. The tanks shall be made from good commercial grade steel & shall be of welded construction. The structural steel material used for fabrication of tank shall be as per IS:2062 (latest edition). All joints shall be hot oil tight & no bulging shall take place while in service. All the oil tight joints shall be made with suitable flanges, treated cork or other approved type of packing. The tanks shall be so designed that the core and winding can be lifted freely from the case with as little dismantling as possible.
- b. Suitable guide may, also, be provided for positioning of cores. External lugs or eyes for lifting the core with windings, as also, the complete transformer with oil shall be fitted with as substantial under carriage and mounted on four bi-directional flanged, wheels for rail track gauge of 1436mm. The main tank body excluding tap changer compartment and radiators shall be capable of with standing vacuum of 500 mm of hg. The tank shall be designed to withstand mechanical shock during transportation, vacuum filling of oil. It shall also with stand the pressure for one hour corresponding to twice the normal head of oil or to the normal pressure plus  $35\text{KN/m}^2$  ( $5\text{Lbs/Inch}^2$ ) whichever is lower, measure at the base of the tank.
- c. Dimensions of turret for provision of bushing shall be such that required clearances are maintained and there will not be any discharge or high field stress developed.

##### **b. Axle & Wheels**

- a. The transformer shall be provided with flanged bi-directional wheels & axle.
- b. These shall be designed not to deflect excessively to interfere with the movement of the transformer.
- c. The wheels are required to swivel and they shall be arranged so that they can be turned through 90°, when the tank is jacked up to clear of rail, Means shall, also, be provided for locking the swivel movements in positions parallel & right angle to the longitudinal axis of tank. The anti earth quake clamps should be provided for protection against earth quake.
- d. The rail track gauge shall be 1436mm along longer axis as well as shorter axis.

##### **c. Core**

- 
- a. The transformer shall be of three legged core type with interleaved/step lap, core joints. On no account, interleaved step down butt joints shall be offered. The core shall be bolt less & built of non – ageing prime grade CRGO laminations having high permeability and low hysteresis loss and with hot oil proof insulation. The core material shall be prime CRGO, shall be procured directly from manufacturer or through accredited marketing organization of reputation. It shall be properly clamped to gether to the frame & bonded by application of araldite tightly to prevent undue vibration or noise. The complete design of the core must ensure per manency of the core losses with continuous working of the transformer.
  - b. The thickness of lamination shall be 0.27 mm or less. Surface insulation of laminations shall be rust resistant and have high interred laminar resistance. Insulation shall withstand annealing temperature as high as 850 °C. Insulation shall be resistant to hot cooling medium. Laminations are not to be punched.
  - c. Contractor should have in house core cutting facility for proper monitoring & control on quality & also to avoid any possibility of mixing of prime material with defective/second grade material. This should be indicated invariably in the QAP. The Owner may witness the core-cutting process. In case the in-house core cutting facility is not available, then the same shall be carried out in the presence of the representative of Owner.
  - d. Contractor will offer the core for stage inspection and get approval from Owner during manufacturing stage. The Contractor has to produce following documents at the time of stage inspection for confirmation of use of prime core materials.
    - i. Invoice of supplier
    - ii. Mills approved test certificates
    - iii. Packing list
    - iv. Bill of lading
    - v. Bill of entry certificate by custom.
  - e. To avoid any possibility of mixing of 'Prime material' with any other second grade/ defective material, the imported packed slit coils of CRGO materials shall be opened in the presence of the Owner's representative. Only after the inspection and approval from Owner, the core material will be cut in-house OR sent to external agency for cutting individual laminations. In case the core is sent to external agency for cutting, the Owner's representative will have full access to visit such agency for the inspection of the cutting of core.
  - f. After having sheared, the laminations shall be treated to remove all burrs and shall be re annealed in a non- oxidizing atmosphere to remove all residual stresses and restore the original magnetic properties of CRGO sheets. The insulation of the lamination shall be inert to the action of hot transformer oil. Paper and varnish insulation will be not accepted.

- g. The core shall be rigidly clamped to ensure adequate mechanical strength and to prevent vibration during operation. The clamping structure shall be so constructed that eddy currents will be minimum. The insulation of bolt less core to clamp plates shall be such as to withstand 2000 V A.C. for one minute.
- h. The design of magnetic circuit shall be such as to avoid static discharges, development of short circuit paths within itself or to the earthed clamping structure and production of flux components at right angles to the plane of the laminations which may cause local heating.
- i. The core shall be provided with lugs suitable for lifting the complete core and coil assembly of the transformer.
- j. The core and the coil assembly shall be so fixed in the tank that shifting will not occur and cause any damage when the transformer is moved shifted, or during a short circuit.
- k. The core shall not be earthed at multiple locations. Terminal shall be brought on top of tank and earthed through link. Core and Frame terminals should be brought out on transformer top so as to enable megger.

**d. CRGO used shall be strictly as per below detail:-**

To avoid any possibility of mixing of 'Prime material' with any other second grade/ defective material, the imported packed slit coils of CRGO materials shall be opened in the presence of the TPI / Engineer-In-Charge representative. Only after the inspection and approval from Owner, the core material shall be cut in-house OR sent to external agency for cutting individual lamination. In case the core is sent to external agency for cutting, the Owner's representative shall have full access to visit such agency for the inspection of the cutting of core.

- a. After having sheared, the laminations shall be treated to remove all burrs and shall be re annealed in a non- oxidizing atmosphere to remove all residual stresses and restore the original magnetic properties of CRGO sheets. The insulation of the lamination shall be inert to the action of hot transformer oil. Paper and varnish insulation shall is not accepted.
- b. Every care shall be exercised in the selection treatment and handling of core steel to ensure that the laminations are flat and that finally assembled core is free from distortions. Oil ducts where necessary should be formed across the plane of the lamination and be given a suitable slope to assist oil circulation. The overall design of core and winding should be such that free flow of oil is not obstructed.
- c. The core shall be rigidly clamped to ensure adequate mechanical strength and to prevent vibration during operation. The clamping structure shall be so constructed



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that eddy Currents shall be minimum. The insulation of bolt less core to clamp plates shall be such as to withstand 2000 V, AC for one minute.

- d. The design of magnetic circuit shall be such as to avoid static discharges, development of short circuit paths within itself or to the earthed clamping structure and production of flux components at right angles to the plane of the laminations which shall cause local heating.
- e. The core shall be provided with lugs suitable for lifting the complete core and coil assembly of the transformer.
- f. The core and the coil assembly shall be so fixed in the tank that shifting shall not occur and cause any damage when the transformer is moved shifted, or during a short circuit.
- g. The core shall not be earthed at multiple locations. Terminal shall be brought on top of tank and earthed through link. Core and Frame terminals should be brought out on transformer top so as to enable megger.
- h. The insulation of core to bolts and core to clamp plates shall be able to withstand a voltage of 2 KV RMS for one minute.
- i. The tenderer should indicate the maximum flux density allowable continuously as well as for time intervals of 1 minute and 5 second and the limit of flux density at which core material used by them saturates.
- j. The name of the core material must be mentioned in the tender. The successful tenderer shall be required to furnish magnetization curves of the core material/design calculations and such other data/documents deemed fit by the Purchaser for being satisfied that flux density is as desired.
- k. Purchaser shall inspect the built-up core for verification of flux density for which all facilities shall be provided. The purchaser shall inspect/test the core material for various tests as per relevant IEC/IS to ensure quality. Core shall also be inspected during horizontal assembly, built-up assembly.

#### **e. Winding**

- a. The winding shall be of electrolytic grade copper conductors. The arrangement of windings must be such that there is good electrical and magnetic balance under all loading & short circuit conditions. Oil ducts shall be provided to ensure uniform temperature gradients and absence of hot spots. All similar coils shall be interchangeable.

- b. It is essential that the windings shall be subjected to thorough shrinking & seasoning process, so that no further shrinkage of winding occurs, even during service. However adjustable devices shall be provided for taking up any possible shrinkage of coils, while in service. The general design and construction of the transformer and the bracing of the windings shall be such that no mechanical movement of the coils is possible with dead short circuit on either side.
- c. The insulation paper shall be of high quality and the value of degree of polymerization shall not be less than 1200 Pv and the necessary test certificate shall be submitted along with the stage inspection report. Provision shall be made for taking sample of paper for testing purpose and location shall be easily accessible and indicated on the transformer tank by affixing special caution plate.
- d. The material used in the insulation and assembly windings shall be insoluble, non-crystallite and chemically inactive in the hot transformer oil and shall not soften or otherwise, be affected under the operating conditions.
- e. Transformers shall be capable of withstanding dynamic & thermal forces, due to three phase symmetrical faults at the terminals, without considering any system impedance. The short circuit duration for conformity of thermal limit shall be three seconds. Current density of windings shall be stated. The calculations of Thermal stability and dynamic ability to withstand short circuit shall also be submitted after award of work. Ampere turns shall be balanced at various heights of windings for HV, LV and tapping winding. Contractor shall justify for the same by submitting details.
- f. Special attention shall be given for the provision of adequate insulation and clearance between HV & LV windings. All clearance of widening & other live parts must be adequate, for the maximum voltage of operation, plus 10 %. The minimum required clearance of windings in oil shall be stated.
- g. The HV winding shall be interleaved / disc type. Disc winding shall be with the static end rings at both ends. The winding shall be suitable for chopped wave & full wave impulse voltage. The wave shape of the impulse voltage shall be in accordance with IS 2026 (Part III) & relevant IEC standard for high voltage Tests. LV winding shall be continuous disc type / Layer type.
- h. The impulse strength of HV and LV winding for 1.2 / 50 micro sec., wave Full description of the windings for the transformer, offered, shall be furnished in datasheet.
- i. Contractor shall indicate in the DATASHEET, the cross sectional area of all windings with respect to the current density adopted.
- j. All threaded connections shall be provided with locking facilities. All leads from the winding shall be duly brazed for proper contact to the terminal board and bushings shall be rigidly supported to prevent injury from vibration.

- k. The guaranteed minimum IR value should be indicated in DATASHEET. The measured IR value with 5 kV motorized megger during acceptance test shall not be less than guaranteed minimum value.

**f. Fittings & Accessories**

- a. Standard fitting as described in IS: 2026 (latest issue) and stated below shall be provided for each transformer.
- b. Main conservator shall have air cell type constant oil preservation system to prevent oxidation and contamination of oil due to contact with moisture. Conservator for main tank shall fitted with oil filling flange & cap, isolating valve, drain valve, 150mm magnetic oil level gauge with low level alarm potential free contacts. Conservator shall be at right angle to the axis of HV bushing. The conservator shall be provided with separate compartment for OLTC. No separate conservator tank shall be provided for OLTC.
- c. Prismatic oil level gauge shall, also, be provided on conservator tank. The background shall be so painted that the oil level can be seen from ground level also. The three positions of oil level shall be indicated viz.
- Minimum
  - Normal
  - Maximum.
- d. Silica gel dehydrating breather of acrylic seamless body with clear view design. The capacity of breather for main conservator tank should be such that it can contain minimum 5 kgs. Silica gel and minimum 1 kg. for OLTC conservator compartment. The GI pipe connecting breather with conservator should be seam less and no joint is permitted. It will be located below conservator tank opposite to HV side of transformer.
- e. Pressure Relief valves should be provided one each for main tank and OLTC of minimum size of T6 and T3 respectively. Necessary pressure operation test will have to shown during acceptance testing of transformer. It shall operate before reaching the test pressure specified in transformer tank pressure test. The operating pressure shall be recorded. The device shall seal off after excess pressure has been released. The terminal box of PRV should confirm to degree of protection as per IP – 55 of IS: 13947.
- f. One drain valve (gate) of 75mm diameter, with flange. Two Nos. Oil sampling valves, of 25mm size-each at top & bottom of main tank with the provision for fixing PVC pipe. All the necessary flanges with adopter suitable to connect piping for oil tanking and filtration process. Necessary guiding cover must be provided to these valves.
- g. Two Nos. Oil filter valves (gate) of 50mm size, on diagonally opposite corners of the transformer tank with flange and adopter for connection of (30mm) hose pipe for filtration of oil.

- h. Rating and diagram plate of Brass / stainless steel with details engraved.
- i. Jacking lugs.
- j. Minimum Two Nos. of inspection covers on tank cover. No inspection cover shall be provided on any of the sides, of transformer.
- k. Four nos. of earthing pads each with four nos. of tapped holes (M 12 Bolts,) with M12 bolts, plain & spring washers suitable for connection of 50 x 6 mm GS earthing flats. These earthing pads should be provided one each on each side of transformer at centre.
- l. All the gaskets to be provided shall be of RC7 °C or RC8 °C grade. It shall not be older than one year. Necessary tests certificates from manufacturer shall be submitted along with acceptance test report. Flat gasket material will be SRBC (Synthetic rubber bonded cork) with minimum joints. When chords are used it shall be provided in fabricated groove. It shall be of Nitrile rubber. In fabricated groove the inner strip shall be welded for its full length.
- m. Four nos. of anti-earth quake clamps should be provided along with the required sized foundation bolts.
- n. HV and LV terminal connectors shall be supplied along with the transformer
- o. 150mm dial temperature indicator of mercury switch contacts with pointer reading 'Maximum', suitable resetting device, set of electrical contacts for 'alarm' and 'trip' along with necessary length of capillary tubing to be provided one each for Oil & Winding temperature monitoring. The contact rating shall be at least 2 Amp continuous at 250 V AC or DC. The range shall be from 0°C to 150°C.
- p. Double float buchholz relay with 'alarm' & 'trip' contacts. The oil connection from transformer tank to conservator vessel shall be arranged at rising angle of 6 to 9 degrees to horizontal up to the Buchholz relay and shall consist of suitable pipe of inside diameter (heavy gauge) as per IS: 3639.
- q. Marshalling Box, housing the temperature indicators and auxiliary contacts.
- r. Air release plugs
- i. Detachable pressed steel radiators shall be provided with two butterfly valves, one for inlet & the other for outlet connection. The nos. of radiator to be provided shall be arrived from the cooling calculation submitted after award of work.
- s. Two isolating GM valves of 50mm dia shall be provided for Buchholz relay on either side.
- t. Skids.
- u. Additional thermometer pockets to be provided other than for Oil and winding temperature measurement. The capillary so provided for both pockets shall be only of Brass and having same diameter and threads suitable to interchange.

- v. Flanged bi-directional rollers suitable for 1436mm rail track gauge with anti-earth quake clamps.
- w. Terminal marking plates of Brass/ Stainless steel should be provided and it should be legible from ground level also.
- x. Lifting lugs.
- y. Oil surge relay with trip contacts for OLTC, with 25mm GM gate valve on either side should be provided.
- z. Bushing with metal parts & gaskets as specified
- aa. Neutral earthing GI bar of size 50 x 6 mm thick along with 22 kV class Epoxy support insulators shall be provided.

**g. Cooling arrangement**

- a. All the transformers covered by this specification shall have 'ONAN' cooling. The cooling shall be effected by pressed steel radiators conforming to IEEMA. The radiators fins provided shall have sufficient surface to limit temperature rise. The tubes shall be so arranged as to admit scrubbing without trouble when necessary. It will be so designed that any scale forming inside will flake off and pass to the bottom of the tank by gravity. Oil leak proof butterfly valves (positive operated) shall be provided to facilitate taking out any of the radiators without disturbing the transformer. Necessary gaskets in required nos. for fixing radiators and butterfly valve operating keys shall be provided. The space between the bottom of tank and mounting rail shall be maintained to minimum of 350 mm, for free air circulation.

**h. Oil**

- a. The insulating oil for transformer shall, generally confirm to IS: 335 (latest edition). Sufficient quantity of oil for the first filling of complete transformer (with accessories) plus 10% extra oil shall be supplied by the vendor in non-returnable 210 litre capacity drums. The quantity of oil for transformer (including accessories) and OLTC should be indicated separately in the rating plate.

**i. Terminal Arrangement**

**a. Bushing**

- i. The electrical & mechanical characteristic of bushing shall be in accordance with IS: 2099 & (IS 3347 (Part – III / Section I) respectively, and bushings shall be suitable for heavily polluted atmosphere.
- ii. 72.5 kV bushing shall be oil filled condenser type & hermetically sealed. 24 kV bushing to be used for LV side shall be solid porcelain.
- iii. Condenser type bushing shall be provided with Oil level glass

- iv. Tap for capacitance / tan delta test.
- v. Bushing of identical ratings shall be interchangeable.
- vi. Porcelain used in the manufacture shall be homogeneous, free from lamination, cavities & other flows or imperfection that might affect the mechanical or dielectric quality and shall be thoroughly vitrified tough and impervious to moisture.
- vii. Glaze of porcelain and bushing shall be of uniform brown colour, free from blisters burrs & other defects.
- viii. Clamps & fittings shall be hot dip galvanised steel.
- ix. For neutral, the bushing of the same rating shall be used as those to be used for LV terminals.
- b. Special Adjustable co-ordinating gaps shall be provided as per relevant IS, on all bushing terminals and the gap setting shall be fixed with reference to the impulse strength of the windings. The contractor shall state the impulse flash over values of the bushings & the calibration with settings for coordinating gap shall be given for the arrangement of the terminals. All the required type test reports as per relevant IS stated above for the bushings to be used shall be submitted after award of work. The height of live part shall be so arranged that minimum clearance up to plinth shall be maintained as follow:

**66 kV - 4500 mm, 6.6 kV - 3600 mm.**

**j. Foundation**

- a. The transformers shall be erected on concrete foundations, which shall be laid by contractor in time to have the foundations ready before the Transformers arrive at site. The foundation shall be of concrete masonry with reinforced steel as per requirement. The OEM/supplier shall furnish complete information regarding loading and maximum stress in the foundations etc. and the Contractor will design the foundations as per site conditions.

**k. Completeness of contract**

- a. All fittings, accessories, or apparatus, which may not have been specifically mentioned but which are useful or necessary for the efficient working of the transformer shall be deemed to be included in the contract and shall be provided by the supplier without any extra charge. The transformer with accessories shall be complete with all details whether such details are stated in the specification or not.

**l. Tools**

- a. The contractor shall also, quote the prices for one set of special tools, if any. The Owner reserves the right to order for any quantity of tools, as may be deemed fit.

**m. Interchangeability**

- a. All similar parts of the various transformers shall be inter-changeable as far as possible.

**a. Flexible separator (Air cell)**

- b. This section covers the design, manufacture, assembly, testing at manufacturer's works, supply and delivery of the Flexible Separator (Aircell), complete with all accessories required for satisfactory and trouble free operation of the equipment.

**a. Construction**

- i. The construction of Flexible Separator (Air cell) shall be of Polyamide/nylon fabric coated on both side with synthetic rubber and meeting the complete requirement of this specification.
- ii. Adhesives used shall be compatible with air and transformer oil at 1000°C. All the joints shall be properly designed & suitably vulcanized. Further, Flexible Separator (Air cell) shall be reinforced at bottom face to avoid damage due to contact with magnetic oil gauge float. There shall not be any patch work in Flexible Separator (Air cell). Adaptor used shall be made from structural steel conforming to Fe-410-S to IS: 226. Adaptor and bolts shall be cadmium plated and passivated (CD-8 of IS: 1572) or Zinc plated and passivated. (Fe Zn 12.5 of IS: 1573). The width of the overlap at the joints shall be such that there is no possibility of joint opening and leakage. Minimum width shall be 75 mm.

**b. Functional requirements**

- i. The function of Flexible Separator (Air cell) is to line the inside of the conservator tank in transformer, allowing for changes in volume, while protecting the oil from any type of contamination or external corrosive agents like ozone, nitrogen, humidity etc.
- ii. Flexible Separator (Air cell) shall be suitable for continuous use in transformer oil at -20°C to 100° C.
- iii. Inside coating shall be very good enough to resist weather and ozone.
- iv. Outside coating shall be transformer oil resistant. Compounds used for coating shall not deteriorate during service.
- v. Flexible Separator (Air cell) shall be suitable for inflation and deflation due to change in oil volume in the conservator. Further, Flexible Separator (Air cell) shall be designed to collapse slowly as oil level rises in the conservator.
- vi. Flexible Separator (Air cell) shall not develop cracks even at -20°C.
- vii. Fixation lugs and adaptor shall be provided on the Flexible Separator (Air cell).
- viii. Flexible Separator (Air cell) shall have excellent permeability to oil, gases and water vapour.

- ix. Flexible Separator (Air cell) shall have high mechanical resistance. ix) Flanges provided shall meet any of our requirements indicated.

**c. General**

- i. The Flexible Separator (Air cell) shall be suitable for conservator of diameter, length & shape in the datasheet. The suitability & size of Flexible Separator (Air cell) to be provided shall be supported by necessary calculation for given size and shape of conservator.
- ii. The Flexible Separator (Air cell) confirm to relevant IS or international standards shall be indicated in the datasheet. The type tests and routine/acceptance tests shall be carried out accordingly and report shall be submitted after award of work for owner's approval
- iii. The work of providing and fixing shall be carried out as per availability of shut down of particular transformer at site. Necessary tools tackle, accessories, manpower, etc. required shall be managed by Contractor.

**c. On load tap changing gear**

**a. General requirements**

- i. The details of the method of diversion of the load current during tap changing; the mechanical construction of the gear and the control features for OLTC gear shall be submitted with the datasheet. Information regarding the service, experience on the gear and a list of important users shall be furnished. The tap changer shall change the effective transformation ratio without producing phase displacement.
- ii. The current diverting contacts shall be housed in a separate oil chamber not communicating with the oil in main tank of the transformer.
- iii. The contacts shall be accessible for inspection without lowering oil level in the main tank and the contact tips shall be replaceable.
- iv. The Contractor shall indicate the safeguards in order to avoid harmful arcing at the current diverting contacts in the event of operation of the OLTC gear under over-load conditions of the transformer. Necessary tools and tackles shall be furnished for maintenance of OLTC gear.
- v. The OLTC oil chamber shall have oil filling and drain plug, oil sampling valve, relief vent and level glass. It shall also be fitted with oil surge relay; with the trip contacts. The outlet of which shall be connected to a separate conservator tank.
- vi. The diverter switch or arcing switch shall be so designed as to ensure that its operation once commenced shall be completed independently of the control relays or switches, failure of auxiliary supplies etc. To meet any contingency



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which may result in incomplete operation of the diverter switch, adequate means shall be provided to safeguard the transformer and its ancillary equipment.

- vii. Tap changer shall be so mounted that TOP cover or transformer can be lifted without removing connections between windings and tap changer.
- viii. Drive mechanism chamber shall be mounted on the tank in accessible position. It should be adequately ventilated and provide with anti condensation metal clad heaters. All contactors, relay coils and other parts shall be protected against corrosion, deterioration due to condensation, fungi etc.
- ix. The control feature shall provide the following:
- x. Local / remote selector switch mounted in the local control shall switch control of OLTC in the following manner:
  - (1) When the selector switch is in LOCAL position, it shall be possible to operate the RAISE / LOWER control switches specified under sr. NO. (ii) below. Remote control of RAISE / LOWER functions shall be prevented
  - (2) When the selector switches in REMOTE position the local control cubicle mounted RAISE / LOWER switches specified under Sr. No (ii) shall be inoperative. Remote control of the raise lower function shall be possible from the control panel.
- xi. The LOCAL / REMOTE selector switch shall have at least two spare contacts per position which are closed in that position but open in the other position.
- xii. A RAISE / LOWER CONTROL SWITCH shall be provided in the Local Control Cubicle. The switch shall be spring loaded to return to the centre 'OFF' position and shall require movement to the RIGHT to raise the voltage of the transformer. Movement to the left shall lower the voltage. This switch shall be operative only when 'local / remote, selector switch is in "local" position. As an alternative to the raise / lower Control switch, push button shall be provided for the said purpose.
- xiii. An OFF-ON tap changer control switch shall be provided in the OLTC local control cabinet for transformer. The tap changer shall be inoperative in the OFF positioning. Also the OFF-ON switch shall have at least one spare contact per position which is closed in that position but open in the other position.
- xiv. Operating mechanism for on load tap changer shall be designed to go through one step or tap change per command. Subsequent tap changes shall be initiated only by a new 'ON' repeat command.
- xv. On load tap changer shall be equipped with a time delay incomplete STEP alarm consisting of a normally open contact which closes, if the tap changer fails to

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make a complete tap change. The alarm shall not operate for momentary loss of auxiliary power.

- xvi. Limit switches shall be provided to prevent overrunning of the mechanism and shall be directly connected in the circuit of the operating motor. In addition, a mechanical stop shall be provided to prevent over running of the mechanism under any condition.
- xvii. Limit switches may be connected in the control circuit of the operating motor provided that a mechanical declutching mechanism is incorporated.
- xviii. Thermal device or other means shall be provided to protect the motor and control circuit. All relays, switches, fuses etc. Shall be mounted in the drive mechanism chamber and shall be clearly marked for the purpose of identification.
- xix. A permanently legible lubrication chart shall be fitted within the driving mechanism chamber.
- xx. A five-digit counter shall be fitted to the tap changing equipment to indicate the number of operations completed.
- xxi. All relays and operating devices shall operate correctly at any voltage between the limits specified.
- xxii. It shall not be possible to operate the electric drive when the manual operating gear is in use.
- xxiii. It shall not be possible for any two controls to be in operation at the same time.
- xxiv. The equipment shall be suitable for supervisory control and indication with make before break multi-way switch, having one potential free contact for each tap position. This switch shall be provided in addition to any other switch / switch which may be required for remote tap position.
- xxv. Operation from the local or remote control switch shall cause one tap movement only until position between successive operations.
- xxvi. All electrical control switches and the local operating gear shall be clearly labelled in a suitable manner to indicate the direction of tap changing.
- xxvii. Transfer of source failure of one AC supply shall not affect tap changing operation.
- xxviii. One number each of Oil Surge Relay and Pressure Relief Valve should be provided.

**d. Manual control**

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The cranking device for manual operation of the OLTC gear shall be removable and shall be suitable for operation by a man standing on ground level. The mechanism shall be complete with the following:

- i. Mechanical tap position indicator which shall be clearly visible from near the transformer.
- ii. A mechanical operation counter.
- iii. Mechanical stops to prevent over-cranking of the mechanism beyond the extreme tap positions.
- iv. The manual control considered as back up to the motor operated load tap changer control shall be interlocked with the motor to block motor start-up during manual operation. The manual operating mechanism shall be labelled to show the direction of operation for raising the secondary voltage and vice-versa.

**e. Electric control**

- a. This includes the followings:
  - i. Local Electrical control
  - ii. Electrical remote control from remote control panel.
- b. The control circuits shall have the followings features:
  - i. An interlock to cut off electrical control automatically upon recourse being taken to the manual control in emergency.
  - ii. Reinforcement of the initiating impulse for a tap change, ensuring a positive completion once initiated to the next (higher or lower) tap.
  - iii. Step-by-step operation ensuring only one tap change from each tap changing impulse and a lock-out of the mechanism if the control switch (or push button) remains in the "operate" position.
  - iv. An interlock to cut-out electrical control when it tends to operate the gear beyond either of the extreme tap positions.
  - v. An electrical interlock to cut-off a counter impulse for reverse step change being initiated during a progressing tap change and until the mechanism comes to rest and resets circuits for a fresh position.
  - vi. Tap change in progress by means of an indicating lamp at the Owner's control panel & necessary contacts for this and for remote tap position indicator at Owner's control panel shall be provided by the Contractor.

- vii. Protection apparatus, considered essential by the Contractor according to specialties.

**f. Remote Electrical group control**

- a. The OLTC control scheme offered shall have provision of remote electrical group control during parallel operation of transformers. This is in addition to independent control of OLTC.
- b. A four position selector switch having MASTER, Follower, Independent and OFF position shall be provided in the remote OLTC control panel for each transformer. This shall be wired to enable operator to select operation of OLTC in Master, Follower or Independent mode.
- c. Out of step relays with timer contacts shall also be provided to give alarm and indication in case of tap positions in all the transformers under group control being not in same position.
- d. MASTER Position

If the selector switch is in MASTER position, it shall be possible to control the OLTC units in the FOLLOWER mode by operating the controls of the MASTER unit. Independent operation of the units under FOLLOWER mode shall have to be prevented. However, the units under independent mode will be controlled independently.

**i. FOLLOWER Position**

- If the selector switch is in FOLLOWER mode, control of OLTC shall be possible only from MASTER panel.

**ii. INDEPENDENT Position**

- In this position of selector switch, control of OLTC of individual unit only shall be possible.

**g. Type test**

Following test reports, as per IEC – 60214, should be submitted for owner's approval.

- i. Short Circuit current test
- ii. Dielectric test
- iii. Temperature Rise test
- iv. Mechanical test
- v. Degree of Protection IP55 test on driving mechanism box.

#### **h. Control cabinet**

##### **a. Local OLTC control cabinet, and remote OLTC panel.**

- i. Each three phase transformer unit shall be provided with Local OLTC control cabinet, and remote OLTC panel.
- ii. The cabinet and remote OLTC Panel shall be provided with non-disconnecting stud type terminal blocks. Each of the terminal blocks in the above panels should have 20 % spare terminals exclusively for Owner's use. Necessary shorting of terminals shall be done at the local OLTC cabinet and remote OLTC panel.
- iii. The Local OLTC control cabinet shall house all necessary devices meant for OLTC control and indication.
- iv. Following cabling are specifically excluded from the scope of the Contractor. However, interconnection drawings for the same are to be submitted by the Contractor.
  - (1) Cabling between Remote OLTC panels to Local OLTC cabinet.
  - (2) Cabling between Remote OLTC to Owner's Panel.
  - (3) Cabling between Local OLTC Cabinet to Owner's panel.
- v. The sheet steel used shall be at least 2.6mm thick for indoor and 3mm thick for outdoor use. The degree of protection shall be IP 55 (FOR OLTC cabinet & Marshalling Box) & IP 54 (OLTC Remote control panel) in accordance with IS 13947. All the separately mounted cabinets and panels shall be free standing floor mounted type and have domed or sloping roof. Test reports of degree of protection for the panels & MK Box shall be submitted after award of work, in which the size and material of enclosures and gasket should be indicated.
- vi. The temperature indicators shall be so mounted that the dials are not at height more than 1600 mm from ground level. Glass door of suitable size shall be provided for convenience of reading.
- vii. A space heater and cubicle lighting with ON-OFF switch shall be provided.
- viii. Applicable standards

#### **Control cabinet Applicable Standards**

Particulars	IS/IEC Standards
SWITCHGEAR GENERAL REQUIREMENTS	IS-4237
AIR BREAK SWITCHES	IS-4047, IEC-408
FUSES	IS-2208, IEC-259-1
CONTACTORS	IS-2959, IEC-158-1

Particulars	IS/IEC Standards
STARTERS	IS-1822, IEC-292
INDICATING INSTRUMENTS	IS-1248, IEC-51
PANEL WIRING	IS-375
DEGREE OF PROTECTION	IS-13947

**i. Terminal blocks**

- a. The terminal blocks to be provided shall be fully enclosed with removable covers and made of moulded, non-inflammable plastic material with block and barriers moulded integrally. Such block shall have washer and nut bolts for external circuit wire connections, a white marking strip for circuit identification and moulded plastic cover.
- b. All terminals shall be clearly marked with identification numbers or letters to facilitate connection to external wiring.
- c. All internal wiring to be connected to the external equipment shall terminate on terminal blocks, preferably vertically mounted on the side of each panel. The terminal blocks shall be 1100 V grade and have 10 amps continuous rating, moulded piece, complete with insulated barriers, non-disconnecting stud type terminals, washers, nuts and lock nuts. Terminal block design shall include a white fibre marking strip with clear plastic, slip on / clip on terminal cover. Markings on the terminal strips shall correspond to wire number and terminal numbers on the wiring diagrams.
- d. At least 20% spare terminals shall be provided on each panel and these spare terminals shall be uniformly distributed on all terminal blocks.
- e. Unless otherwise specified, terminal blocks shall be suitable for connecting the minimum of one no. 2.5mm<sup>2</sup> copper conductors on each side.
- f. There shall be a minimum edge to edge clearance of 250mm between the first row of terminal blocks and the associated cable gland plate. Also the clearance between two rows of terminal blocks shall be a minimum of 150mm.
- g. Arrangement of the terminal block assemblies and the wiring channel within the enclosure shall be such that a row of terminal blocks is run parallel and in close proximity along each side of the wiring duct to provide for convenient attachment of internal panel wiring. The side of the terminal block opposite the wiring duct shall be reserved for external cable connection. All adjacent terminal blocks shall also share this field wiring corridor. A steel strip shall be connected between adjacent terminal block rows at 450mm intervals for support of incoming cables.
- h. The number and sizes of the multicore incoming cable will be furnished by the Contractor after award of contract.
- j. The gaskets shall be of neoprene rubber.
- k. Bolts & Nuts

- a. All bolts and nuts exposed to weather shall be hot dip galvanised / cadmium plated.

**l. Wiring & cabling**

- a. All external cabling will be carried out based on wiring diagram & interconnection schedule to be supplied by the contractor. Cable box / sealing end shall be suitable for following types of cables :-
  - i. 415 Volt power: 1100 Volt grade PVC insulated stranded copper conductor cable with Armour.
  - ii. Control:1100 Volt grade PVC insulated 7/0.737mm stranded copper conductor cable with armour.
- b. Compression type cable connector shall be provided for termination of power and control cables.
- c. Not more than 2 wires shall be connected to one terminal. Each terminal shall be suitable for connecting two 7/0.737mm stranded copper conductors from each side.
- d. All internal wiring shall be securely supported neatly arranged, readily accessible and connected to equipment terminals and terminal blocks.
- e. Engraved code identification plastic ferrules marked to correspond with schematic diagrams shall be fitted at both ends of wires. Ferrules shall fit tightly on wires and shall not fall off when the wire is disconnected from terminal block.

**m. Local OLTC Control Cabinet**

- a. The auxiliary devices for electrical control of the OLTC shall be housed in a weather proof cabinet. It shall be complete with the following:
  - i. A contractor with thermal overload devices for controlling the AC auxiliary supply to the OLTC motor.
  - ii. Cubicle light with door switch.
  - iii. Space heaters to prevent condensation of moisture.
  - iv. Padlocking arrangement for hinged door of cabinet.
  - v. Cable terminal glands for power and control cables to the OLTC gear.

**n. Remote OLTC Control Equipment**

- a. Equipment to be mounted in RTCC: Control and signal devices required to be mounted as follow:
  - i. Actuating switch for electrical raise / lower control

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- ii. Remote tap position indicator.
  - iii. Signal lamps for
    - (1) Tap changer in progress
    - (2) Tap changer out of step
    - (3) Tap changer motor trip
    - (4) Tap changer Supply ON
    - (5) Tap changer Supply OFF
  - iv. Annunciator: A 6 window microprocessor based Annunciator shall be provided for following fascia:
    - (1) AC SUPPLY FAIL
    - (2) OUT OF STEP RELAY OPERATED
    - (3) TAP CHANGER MOTOR TRIP
    - (4) TAP CHANGE INCOMPLETE
    - (5) SPARE
    - (6) SPARE
- b. Remote OLTC Control panel (to be supplied by the Contractor): The auxiliary devices for remote electrical control of the OLTC except those mentioned above shall be housed in a separate panel to be placed in the control room. The size shall be 2312 x 600 x 600 mm and colour will be of shade 631 of IS: 5.
- i. Following Data to be furnished by Contractor after award of work
    - (1) Bill of material for all the equipment
    - (2) Control cabinet drawing showing outline dimensions, floor openings, floor / wall / pedestal fixing arrangements, weights, and Front view, inside view showing the mounting arrangement of various equipment.
    - (3) Schematic diagram of control cabinet.
    - (4) Interconnecting drawing showing the external cable connections to the control cabinet.
    - (5) MANUFACTURER'S descriptive literature on various equipment mounted on control cabinet.



- (6) Cabinet internal wiring diagram (This drawing shall be submitted only for information and records and shall be based on a approved schematic drawing. The correctness of the drawing shall be the responsibility of vendor
- (7) Test certificates for the control cabinet and the various equipment mounted therein.

**o. Clamps & Connectors**

**a. General Requirements**

**i. Terminal connectors**

- (1) Bushing terminal shall be provided with bimetallic terminal connectors for HV & LV, of approved type and size, for connection of external parts. The terminal connectors offered must have been type tested as per IS: 5561. HV terminal connector shall be bimetallic with STC rating of 25 kA for 3 sec. Copper threaded Terminal Connectors suitable for connecting 2/3/4 nos. 6.6 kV suitable XLPE cable and the rated current of LV winding terminal. Neutral bushing to earthing strip connection shall be through copper flexible strip of size 50 x 10 mm.
- (2) All castings of the terminal connector shall be free from holes, surface blisters, cracks & cavities. All sharp edges and corners shall conform to design as per IS: 617.
- (3) No part of a clamp shall be with less than 10 mm thickness.
- (4) All the bolts and nuts shall not be provided of size less than 12 mm. Check nuts shall be provided for all the bolts.
- (5) All ferrous parts shall be hot dip galvanised, as per IS: 2633.
- (6) For, bimetallic terminal connector, copper alloy liner of minimum thickness of 2 mm, shall be cast integral with aluminium body.
- (7) All current carrying parts shall be designed & manufactured to have minimum resistance.
- ii. The short time rating of terminal connectors shall be 25 kA for 3 sec.
- iii. The type test report of accredited laboratory shall be submitted.

**iv. APPLICABLE STANDARDS:**

**Clamp & connectors**

Particulars	IS/IEC Standards
FITTINGS FOR ALUMINIUM AND STEEL CORED ALUMINIUM CONDUCTORS FOR OVERHEAD LINES	IS 2121 BS 3288

Particulars	IS/IEC Standards
ELECTRIC POWER CONNECTORS	IS 5561 BS 159
HOT DIP GALVANISED PROCESS	IS 2629 BS 729
ACSR CONDUCTORS	IS 398

#### 3.9.4.3 Drawings & documentation

##### a. Documentation

- a. The Contractor shall furnish the typical dimensional drawings of transformer & all other accessories after award of work.
- b. The drawings shall include the following information
  - i. Dimensions
  - ii. Tolerances on dimensions
  - iii. Material designation used for different components with reference to standards.
  - iv. Fabrication details, such as welds, finishes and coatings.
  - v. Catalogue or part numbers for each component & total assembly with bill of materials.
  - vi. Identification marking
  - vii. Weight of individual components and total assembled weight.
- c. All dimensions in drawings shall be in metric units unless, other wise specified All drawings shall indicate the following:
  - Name of the Owner
  - Purchase order No/Contract No.
  - Title of the drawing
  - Date of drawing
  - Scale

#### 3.9.4.4 Quality assurance plans

The contractor shall in variably furnish following in formation 'safter award of work.

- a. QAP for incoming material, in process and final checks and testing.
- b. Statement giving list of important raw materials, names of sub suppliers for the raw materials, list of standard according to which the raw materials are tested. List of tests

normally carried out on raw materials in presence of contractor's representatives, copies of test certificates.

- c. Information and copies of test certificates as in (i) above in respect of bought out accessories.
- d. List of manufacturing facilities available.
- e. Level of automation achieved and list of areas where manual processing exists.
- f. List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.
- g. Special features provided in the equipment to make it maintenance free List of testing equipments available with the supplier for final testing of Field Quality Plan shall be submitted. Type test certificates of the raw material and bought out accessories.
- h. The contractor shall present on demand the routine test certificate of bought out accessories and central excise passes for raw material viz. Oil, copper, aluminium, conductors, insulating material & core material at the time of routine testing of the fully assembled equipment.
- i. The performance test should be carried out by the manufacturer on all the accessories (100% inspection). This verification should be carried out on receipt of accessories at store.
- j. The physical verification of bought out items viz. CRGO sheet, press pan, tank, all bought out items, windings, etc. should be carried out by the manufacturer of the power transformer and test them either internally or at other laboratory to correlate the results with those of test certificate received from the original manufactures. This will be useful for design as well as analysis in the event of the failure of transformer.
- k. The contractor shall guarantee for the following
  - a. Quality & strength of material to be used.
  - b. Satisfactory & trouble free operation of transformer.
  - c. The contractor shall fill in the required details against each parameter described under Guaranteed Technical particulars.

#### **3.9.4.5 Tests & Inspection**

- a. Type tests & special tests
  - a. The equipment offered shall be fully type tested and tested for special tests as per relevant standards. In case the equipment of type and design offered is similar to type and design of higher rating/capacity of same voltage class and same voltage ratio as of the transformer offered, already type tested, the contractor shall furnish the type test report s accordingly. Equipment offered shall have all Type Test Certificates from

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accredited laboratory (accredited based on ISO / IECGuide25 / 17025 or EN45001 by the National accrediting body of the country where laboratory is located), as per IEC/IS / technical specification, The type test reports shall not be older than FIVE years.

- b. The above said test report submitted for owner's approval.
- c. No load losses & percentage impedance of one of the transformers of each rating shall be measured by Government approved laboratory, if so desired by Owner, at Manufacturer's works in the presence of Owner's representative.

b. Acceptance & routing tests:

All acceptance tests, as stipulated in the relevant standards, shall be carried out by the supplier in the presence of Owners. All the routine / acceptance tests shall be carried out on transformer filled with oil to be supplied and fitted with all accessories to be supplied with transformer.

c. Additional tests:

All required Additional tests shall be carried out in the presence of Owner's representative at no extra cost to the Owner. Also HV bushings shall be tested for measurement of Tan Delta value and capacitance (both C1 and C2) at 10 kV and recorded.

- d. The contractor shall submit the type test reports for the type tests carried out as per IS 5561 (latest edition) on terminal connectors of HV side and LV side.

e. Tests for oil:

- a. Sample shall be taken from each lot of oil to be used, in presence of Owner representative and shall be tested from NABL accredited laboratory for following tests:

- i. Specific Resistivity
- ii. Kinematic Viscosity
- iii. Total acidity
- iv. Tan delta
- v. Water content in ppm.
- vi. Dissolved Gas Analysis

- b. Before commissioning the transformer at site 2 Nos. joint sample as per relevant IS may be collected and sealed. One sample will be sent for testing as per relevant IS including all above 6 tests at NABL accredited laboratory to confirm the quality of transformer oil and second sample will be preserved. In case of disputes about results of first sample, 2nd sealed sample should be got tested at any other approved test house by Owner and result shall be binding to vendor.

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- f. Contractor shall have to offer transformer tank of each rating of transformer for vacuum and pressure test as per CBIP Manual (latest edition).
  - g. Test reports
    - a. Four sets of certified type tests reports shall be submitted for approval prior to dispatch of the equipment. The equipment shall be dispatched only when all the required acceptance & routine tests have been carried out & the test reports have been approved by the Owner.
  - 2. Four copies of the test reports for the tests carried out on ancillary apparatus/shall be furnished to the Owner for approval prior to dispatch.
  - h. Inspection
    - a. The Owner shall have access at all times to the works and all other places of manufacturer / vendor where the transformers are being manufactured and vendor shall provide all facilities for unrestricted inspection at his works, raw materials, manufacture of all accessories and for conducting necessary tests.
    - b. The contractor shall intimate the Owner, In advance, of the time of starting and progress of manufacture of the equipment in its various stages, so that arrangements can be made for inspection.
    - c. The acceptance of any quantity of equipment shall in no way relieve the vendor of his responsibility for meeting all the requirements at this specification & shall not prevent subsequent rejection, if such equipment's are later, found to be defective.
    - d. The contractor shall submit the following during commencement period.
      - i. Name of raw material as well as bought out accessories and then names of sub-suppliers selected from those furnished after award of work.
      - ii. Type test certificate of the raw material bought out accessories.
      - iii. Quality assurance plan with hold points for Owner's inspection.
    - e. The contractor shall submit the routine test certificate of bought out items & raw materials at the time of routine testing of the fully assembled equipment.
    - f. The contractor shall have to offer stage inspection, during manufacturing process of each offered power transformer. The proposed date of stage inspection shall be informed to Owner TEN days in advance. Owner reserves the right to inspect at any stage of manufacturing of offered transformer.
    - g. The first stage inspection will be carried out by Owner representative for offered lot of CRGO material (before slitting) and one sample will be collected from the same. Also inspection will be carried out when the core formation and all the windings are ready for insertion in core. At this time contractor will have to demonstrate for guaranteed core

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losses. Owner will collect the sample from the built up core laminations of offered transformer and will get it checked at any Government approved laboratory if required at risk and cost of the Transformer manufacturer, for the particulars guaranteed by the contractor

- h. Similarly, the winding shall also be inspected for its guaranteed particulars like cross sectional area, material etc., and if required, the Owner will collect the sample of paper and conductor used and get it checked at any Government approved laboratory if required at risk and cost of the Transformer manufacturer, for the particulars guaranteed by the contractor. Contractor shall make necessary provision during winding so as to take sample of conductor of required length.
- i. During stage inspection the contractor shall have to keep ready following documents and the same shall be verified by the inspector.

Following tests shall be carried out on selected sample of CRGO and winding material.

- i. CRGO material:
  - (1) Specific Core loss measurement
  - (2) B-H curve
  - (3) Lamination thickness
- ii. WINDING Material
  - (1) Dimensions:
    - (a) Size of bare and covered conductor
    - (b) Size of insulation on conductor
    - (c) Nos. of layers of insulating paper
    - (d) Overlap
    - (e) Conductor finish
  - (2) Mechanical Properties:
    - (a) Corner radius
    - (b) Tensile strength
    - (c) Hardness
  - (3) Electrical properties:
    - (a) Conductivity

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(b) Resistivity

i. Testing during manufacturing stage

- a. The manufacturer of the power transformer should keep records of the tests carried out during manufacturing stage, in detail for the checks / test carried out during assembling / manufacturing of the transformers. The manufacturer should keep the systematic record for complete drying out process, covering various parameters for the power transformer.

b. Instruments/Equipments

- i. The manufacturer should keep the precise and accurate measuring instruments /equipments. The periodical calibration should be carried out of all the instruments / equipments used for the measurement during tests and for assessing the various properties of the material and accessories. The proper record of the same should be maintained during manufacturing stage and shall be shown to the inspecting officer on demand.

j. Painting

- a. The transformer will be applied with one coat of epoxy red oxide paint as per IS :104 and one each finishing coats of epoxy & enamel paint confirming to shade 631 of IS 5, after due sand blasting treatment on tank. An additional coat of synthetic paint will also, be given to minimize the chance of decomposition of epoxy in the outside atmosphere. The minimum total thickness of paint shall not be less than 60 microns. The same paint shall also be applied to main equipment & accessories. Transformer tank inner surface shall also be painted with one coat of epoxy red oxide paint as per IS: 104 and one each finishing coats of oil resistive paint confirming to glossy white shade of IS 5.

k. Packing

- a. The equipment shall be packed in crates, suitable for vertical / horizontal transport as the case may be, and suitable to withstand handling during transport & storage during transit. The contractor shall be responsible for any damage to the equipment during transit, due to improper and inadequate packing. The easily damageable material shall be carefully packed and marked with the appropriate caution symbol. Wherever necessary, proper arrangement for lifting, such as lifting hooks etc shall be provided. Any material / item found short inside the packing cases shall be supplied by the contractor at his own cost. Each consignment shall be accompanied by a detailed packing list, containing the following information

- i. Name of consignee.
- ii. Details of consignment
- iii. Destination
- iv. Total weight of consignment

- v. Sign showing upper/lower side of the crate
- vi. Handing & unpacking Instruction
- vii. Bill of material indicating Contents of each package

### **3.10 Neutral Grounding Resistors**

#### **3.10.1 Scope**

- a. This specification covers design, supply, testing, commissioning of neutral grounding resistor with all accessories for trouble free operation.
- b. Each transformer shall have independent neutral grounding resistor of required rating.

#### **3.10.2 Applicable Standards**

- a. The design, manufacture and performance of the equipment shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed.
- b. Unless otherwise specified, equipment shall conform to the latest applicable Standards IEEE 32.

#### **3.10.3 Design Requirements**

##### **3.10.3.1 Resistor elements**

- a. The resistors shall be non-inductive, stainless steel type.
- b. The grids shall be securely supported at sufficient number of points so that no damage is caused to the grids due to vibrations and no mechanical stresses are developed. The resistor elements shall be insulated from supporting bars by mica tubes. The grid elements shall be given a protective coat of a suitable heat resistant paint.
- c. The insulating material used in the construction shall be heat resistant such as mica.
- d. The temperature rise shall be 350 °C.
- e. All the resistor elements comprising one stack shall be internally connected and end terminals shall be brought out of tank enclosure in the form of bushings. If resistor taps are specified all taps shall also be brought out of the tank enclosure in the form of bushings.

##### **3.10.3.2 Enclosure**

- a. The grid resistor elements shall be enclosed in a tank type enclosure. The enclosure shall be made of one piece welded construction rigid frame fabricated from steel angles. The frame shall be adequately protected from antitrust and deterioration due to exposed conditions by antitrust coating and a final aluminium paint. The frame shall be fitted with removable louvered aluminium covers on all sides, top and bottom. The enclosure shall



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be completely weatherproof for outdoor operation. The louvered openings shall be provided with fine galvanised wire mesh.

- b. Cap and pin type, stand insulators shall be provided for supporting the enclosure and isolating it from ground. Insulators shall be complete with the required hardware for supporting resistor enclosure and fixing to the mounting structure.
- c. The resistor tank will normally be mounted at a minimum height of 2.44 meters.
- d. Each neutral grounding resistor shall be housed in weather-proof enclosure having DOP of IP: 65. Enclosure shall be cold rolled sheet steel having a minimum thickness of 2 mm.
- e. A cast resin, ring type CT having an accuracy class 5P20 shall be provided for earth fault protection and shall be suitably mounted with the NGR cubicle in such a way as to ensure easy removal and replacement. The secondary leads of CT shall have polarity markings as per IS. The secondary leads shall be brought out to the terminals at a terminal box provided at a suitable location inside the NGR cubicle.

#### **3.10.3.3 Terminal connectors**

- a. Terminal connections arrangement shall be provided on the enclosure for the incoming and outgoing conductors. All terminals shall be insulated from ground as well as the body of the resistor.
- b. For resistor incoming neutral and earthing terminal connections; bushing type stud connections shall be provided complete with cable lugs, non-ferrous lock nuts and lock washers.
- c. For the outgoing connections from resistor, all taps of resistors shall be brought out through bushings into a terminal box mounted on the side of the enclosure.
- d. For connection of other end of NGR to ground, 2 nos. earthing terminal/pad tapped holes and bolts for connection of 50X6 or 75X10 mm copper strip/aluminium strip or copper ground wire shall be provided.

#### **3.10.3.4 General**

- a. The contractor shall submit with his proposal a general outline drawing showing all accessories, total dimensions and weight.

#### **3.10.3.5 Tests**

- a. The following tests on resistors shall be performed and test certificates shall be furnished prior to dispatch:
- b. High voltage withstands for insulation.
- c. Ohm value test on off-load on complete resistor.
- d. Heat run test on part of the resistor.

- e. Test certificates of the manufacturers of bushings, insulators, mica tubes, etc., shall be submitted for approval prior to dispatch of the resistors.

### **3.11 Outdoor substation structure**

Technical Specifications for Design, Fabrication, Galvanising, Fabricated Structure Materials, Bolts – Nuts, Anchor bolts and Accessories & Attachments.

#### **3.11.1 Scope**

- a. The scope for supply work covered under this section consists of:
  - b. Preparation of fabrication sketches and get their approvals,
    - a. Procurement of raw-materials like steel, zinc, etc. required for fabrication and galvanizing,
    - b. Procurement of bolts-nuts, accessories and attachments for insulator string, earth wire clamp etc., (for gantry structures)
    - c. Preparation of 'PROTO-MODEL' assembly based on its approved structural drawings, bills of materials and fabrication sketches.
    - d. Inspection of finished structure materials.
    - e. Inspection of bolts-nuts, accessories and attachments at manufacturer's works.
    - f. Dispatch of all materials to destination, including transit insurance.
    - g. Guarantee of all above activities carried out from (i) to (viii).
- c. The steel shall confirm to IS 2062 grade-A.
- d. All the work shall be carried out in accordance with the revised and latest provisions under respective Indian Standard.
- e. The Contractor shall be fully responsible for supply of complete structure inclusive of bolts-nuts, accessories and attachments for the final quantities ordered.
- f. The contractor shall make his own arrangement for procurement of required Bolt-Nuts, accessories, attachments like 'D' shackles. 'U' bolts, anchor bolts, step bolts etc. well in advance and supply as per scheduled completion period along with the inspection at sub vender's premises.

#### **3.11.2 Standards**

The design, fabrication, galvanising and testing of material used for manufacture of structures shall confirm to the latest edition of the following standards (as mentioned up-to-date) except where otherwise specified in the Specification

### Standards for substation structure

Sr.No.	IS Codes	Description
1.	IS : 209	Specification for zinc
2.	IS : 800	Code of practice for use of structural steel in general Building Construction.
3.	IS : 802	Code of practice for use of structural steel in overhead Transmission line towers.
4.	IS : 1363	Hexagon head bolts, screws and nuts of product grade 'C'.
5.	IS : 1367	Technical supply conditions for threaded fasteners (First Revision)
6.	IS : 2016	Plain washers
7.	IS : 2062	Steel for general structural purposes Specification.
8.	IS : 2629	Recommended practice for hot-dip galvanising of iron and steel.
9.	IS : 2633	Methods of testing weight thickness and uniformity of coating on hot-dip galvanised articles.
10.	IS : 2063 Part-1	Single Coil Rectangular Section spring washers for bolts, nuts, screws.
11.	IS : 4759	Specification for hot-dip zinc containing on structural steel and other allied products.
12.	IS : 5358	Specification for hot-dip galvanised coating on fasteners.
13.	IS : 5613	Code of practice for design, installation and maintenance of overhead power lines.
14.	IS : 6610	Heavy washers for steel structures.
15.	IS : 6639	Hexagonal bolts for steel structures.
16.	IS : 6745	Methods for determination of weight of zinc coating of zinc coated iron and steel articles.
17.	IS : 12427	Transmission Tower bolts.

#### 3.11.3 Drawings and Bills of Materials

- The contractor has to submit copies of drawings and documents as stated for Owner's approval before commencing the production.
- Proto-Model shall be prepared and got inspected for the approval along with fabrication sketches, structural drawings and bills of material.

#### 3.11.4 Design, Fabrication, Stamping and Galvanising of Materials

- Two sets of anchor bolt setting templates should be designed, fabricated, and supplied for each type of column and equipment support structure.
- Any extension or other type of structure, if required, to be supplied by the contractor shall design and prepare Proto - Model at no extra cost to the Owner.

- c. All the activities like straightening, cutting, drilling punching, bending, notching, stamping galvanising etc. Shall be carried out according to technical part of this Specification.

#### **3.11.5 Type of Structures**

- a. All the structures shall be fully galvanised using only structural mild steel sections for members. The use of high tensile steel is not permitted. Hexagonal head bolts with nuts and spring washers shall be used for connections.
- b. The 66kV structures are required for the switch yard of substation.
- c. Weights: The unit weights of each type of structure, including bolt-nuts, accessories, attachments and anchor bolts shall be furnished and / or to be approved by the Owner. The weight of structure shall mean the weight calculated by using the black sectional (i.e. ungalvanised) weights of a steel members of the sizes indicated in the fabrication drawings and bills of materials without taking into consideration the reduction in weight due to drilling of bolts, holes, skew cuts, chambering etc. or increase in weight due to galvanising, but taking into consideration the weight of the special fitting, bolts, nuts, washers and other accessories.

#### **3.11.6 Material**

- a. The steel required for fabrication of structure member shall confirm to IS:2062 - Grade A.
- b. The zinc required for galvanising shall be of Zn-99.95% and shall confirm to IS: 209.
- c. The bolts and nuts shall confirm to IS: 6639 or IS: 12427. The bolts and nuts shall be of minimum class 5.6.
- d. The plain washers shall confirm to IS: 2016. Heavy washers shall confirm to IS: 6610spring washers for bolts and nuts shall confirm to IS: 3063
- e. All bolts and nuts shall have hexagonal heads. The heads, being forged out of the solid, truly concentric and square with the shanks, must be perfectly straight.
- f. Fully threaded bolts shall not be used. The length of bolts shall be such that the threaded portion will not extend into the place of contact of the member.
- g. All bolts shall be threaded as per IS: 1363 to take full depth of the nut and be threaded enough to permit firm gripping of the member, but no further threaded portion of each bolt shall project through the nut at least 6mm. when fully tightened. All nuts shall fit hand tight to the point where the shank, of the bolt connects to the head. Flat and tapered washers shall be provided where necessary
- h. The diameter of bolts shall be 12 mm, 16mm and 20mm. The thickness of spring washers shall be 2.5 mm, 3.5 mm and 4 mm respectively. Spring washers shall be provided under all nuts. These washers shall be positive lock type electro-galvanised.

- i. Each structure shall be provided with step-bolt of not less than 16mm diameter. The step-bolt shall be fixed on one leg up to top of structure as indicated in approved drawing. Each step-bolt shall be provided with two nuts and one washer.
- j. The attachments like 'U' bolt, 'D' shackle, strain plate etc. shall be as per approved drawings

#### **3.11.7 Fabrication Workmanship**

- a. The details of fabrication shall confirm to IS: 802.
- b. All the structure members shall be accurately fabricated to bolt together easily at site without any undue strain on the bolts.
- c. The diameter of the bolt-hole shall be equal to the diameter of bolt plus 1.5 mm.
- d. All similar parts of structure shall be made strictly inter-changeable.
- e. All steel sections before any work is done on them, shall be carefully, levelled, straightened and made true to detailed drawings by methods which will not injure the materials so that when assembled the adjacent matching surfaces are in close contact throughout. No rough edges shall be permitted in the entire structure.

#### **3.11.8 Proto-Model Assembly**

Before proceeding with mass fabrication the contractor shall fabricate one structure of each type (i.e. superstructure) for the purpose of checking accuracy and workmanship. This structure should be strictly according to the respective structural drawing and bills of material provided and approved by the Owner. The contractor shall be solely responsible for preparation and inspection of such PROTO-MODEL assembly.

#### **3.11.9 Drilling and Punching**

- a. Holes for bolts shall be drilled or punched with a jig but drilled holes shall be preferred. The following maximum tolerance of accuracy of punched holes is permissible.
  - a. Holes must be perfectly circular and no tolerance in this respect is permissible
  - b. The maximum allowable difference in diameter of the holes on the two sides of plates or angle is
  - c. 0.8 mm i.e. the allowable taper in punched holes should not exceed 0.8mm of diameter.
  - d. Holes must be square with the plates or angles and have their walls parallel.
- b. All burs left by drills or punch shall be removed completely. When the structure members are in positions, the holes shall be truly opposite to each other. Drilling or ramming to enlarge defective holes shall not be permitted.

### **3.11.10 Erection Mark**

- a. Each individual structure member shall carry a code number confirming to the component number given to it in the bills of material and fabrication drawing. This code number shall be marked with marking dies, having 16 mm size-letter before galvanizing and shall be legible after galvanizing. The letters indicated for different types of structure shall only be used.

Erection mark shall be "AAA - BB-CCCC-DDD" where,

AAA = Contractor's own code-Numerical/Alphanumeric

BB = '06' for 66kV -Numerical

CCCC = Structure type (as per respective table of weights) -Alphanumeric

DDD = Member number -Numerical.

This mark shall be got approved from the OWNER.

- b. Each structure member shall also be marked with indelible ink through stencil of 16 mm size alphabet /numerical.

### **3.11.11 Bending**

- a. Mild steel angle sections up to 75 x 75 mm (up to 6 mm thick) shall be bent cold up to and including bend angle of 10 Deg. angles above 75x75 mm (thickness up to 6 mm) and up to and including 100 x 100 mm (thickness up to 8 mm) may also be bent cold up to the bend angle of 5 Degree. All other angle sections and bend angles not covered above shall be bent hot.
- b. All plates up to 12 mm thickness shall be bent cold up to a maximum bend angle of 15 Degree. Greater bends and other thicknesses shall be bent hot.
- c. All hot bent material shall be air cooled. The bends shall be of even profile and free from any surface damages.

### **3.11.12 Galvanising**

- a. The galvanising shall be done to all the structure members after the fabrication work is completed. The nuts may be tapped or re-run after galvanising. Threads of bolts and nuts shall have neat fit and can be turned with finger throughout the length of the threads of bolts and they shall be capable of developing full strength of bolts.
- b. The zinc deposition should not be less than specified per galvanised surface area of the fabricated structure member.
- c. The galvanising of the structure members shall confirm to IS: 2629& IS: 4759 Allgalvanised members shall withstand tests as per IS: 2633. The weight of zinc coating shall be

determined as per the method stipulated in IS: 2633. Spring washers shall be electro galvanised as per IS:1573

- d. Unless otherwise specified the fabricated structures shall have a minimum overall Zinc coating of 610 gm per sq. m of surface except for plates & sections below 5mm which shall have Zinc coating of 460 gm per sq. m of surface. The average zinc coating for all sections & plates 5mm & above shall be maintained minimum 87 microns and that for sections below 5mm shall be maintained minimum 65 microns.
- e. Under marine environment, the fabricated structures shall have a minimum overall Zinc coating of 900 gm/sq. m of surface are except for plates and sections below 5 mm which shall have a minimum overall Zinc coating 610 gm/sq. m of surface area. The average Zinc coating for all sections and plates 5 mm and above shall be maintained minimum 127 microns and that for plates and sections below 5 mm shall be maintained minimum 87 microns.
- f. The foundation bolt shall be galvanized as per IS 1367(Part-XIII) i.e. 375gms/sqMtr (54Microns). The weight of zinc coating shall be determined as per the method stipulated in IS: 2633.
- g. All the stubs, cleats and stub-setting templates shall be fully galvanised.

### **3.11.13 General Guide-Line For Inspection:**

- a. Fabricated Structure Members:
  - a. Visual examination and quantity verification of offered lot.
  - b. Sample selection from the offered lot at an appropriate ratio of MT (or part thereof) 1 no. for all tests.
  - c. Dimension, fabrication and triunes verification of structure member from fabrication sketch.
  - d. Galvanizing test of each sample i.e. dip test, hammer test and mass of zinc test.
  - e. Random verification Zinc coating over galvanized surface by Elcometer.
  - f. Tensile test and bend test of each sample.
  - g. Chemical composition test of at least one sample per lot offered for inspection.
  - h. Verification of manufacturer's test certificate for mild steel used in structure members.
- b. Bolts-Nuts, Washers, Accessories, and Attachments etc.: (To be carried out at manufacture's works.)
  - a. Visual examination and quantity verification of offered lot.

- b. Sample selection from the offered lot as per relevant IS for each item.
- c. Dimension, fabrication and trueness verification from fabrication sketch.
- d. Galvanizing test of each sample.
- e. Other acceptance tests for respective item as per relevant Indian Standard.

### 3.11.13.1 Structure Details

- a. 66 kV Gantry structure

Sr.No.	STRUCTURE	STEEL KG	B/N KG	A/B KG	TOTAL KG
1	66 CPA3	636.982	37.931	57.330	732.24
2	66 CPB3	526.210	27.877	57.330	611.42
3	66 BA3	327.690	25.023	0	352.71
4	66 FB1	397.108	34.014	0	431.12
5	66 FB2	420.833	30.733	0	451.57
6	66 FC	566.544	27.526	68.538	662.61
7	66 'S'	680.640	19.130	35.408	735.18

- b. 66 kV Equipment Structure

Sr.No.	STRUCTURE	STEEL KG	B/N KG	A/B KG	TOTAL KG
1	66 KV LA	133.16	4.32	9.23	146.71
2	66 KVCT	147.68	7.98	9.23	164.89
3	66 KV ISO with E/S	391.12	8.2	9.23	408.55
4	66 KV ISO without E/S	381.08	8.2	9.23	398.51
5	66 KV PT	146.48	7.98	9.23	163.69
6	66 KV PI	137.93	4.32	9.23	151.48

- c. Matching base plan

After award of work the contractor shall ensure that the supply of equipment structure & base plan shall got approved

### 3.12 Overhead conductor

- a. Installation should be carried out as per relevant IS. While running out conductors from drums care should be taken that conductors should not rub or touch against ground / any objects. Conductors should be run out of drum from top in order to avoid damage. Running blocks with pulleys should be provided wherever required. Drums should be provided with suitable breaking device to avoid loose running out and prevent kinking of conductors. Conductors should continuously be observed for loose or broken strands or any other damage. Proper tensioning, sagging & clamping of conductors should be carried out as per relevant IS specification.



b. Conductor & Earth wire parameters:

Sr.No	Description	Conductor	Earth wire
1	Materials	ACSR Panther"/Dog	Galvanised steel wire
2	Size & stranding	30/3.0-AL 7/3.0-ST	7/3.15
3	Ultimate Tensile strength	89.19 KN	56.017 KN
4	Weight	976 Kg. / Km	434 Kg. / Km
5	Overall diameter	21.00 mm	9.45 mm
6	Area of cross-section	261.2 mm <sup>2</sup>	54.57 mm <sup>2</sup>
7	Maximum sag under maximum temperature and no wind condition.	7.95 Mtr. At 67 deg.C	7.300 Mtr. At 67 deg.C.
8	Modules of elasticity	8000 Kg / mm <sup>2</sup>	1.933x106 Kg/ mm <sup>2</sup>
9	Co-efficient of linear expansion.	19.3x10-6/Deg.C.	11.5x10-6/Deg.C.
10	Maximum working Tension at : 32 Deg. C with full wind	1223 Kg.	1285 Kg.
11	Maximum working Tension at : 0 Deg. C with 2/3rd full wind	3050 Kg.	1315 Kg.

### 3.13 Control & Relay Panels-Part I

#### 3.13.1 Scope

This specification covers the design, manufacture, assembly, testing at manufacturer's works, supply and delivery of control and relay panels complete with wiring, meters, relays, control switches and other miscellaneous equipments specified herein-after, in this Specification.

#### 3.13.2 Standards

- a. The 66 kV control & relay panel and materials covered by this Specification shall comply with the requirements of the latest edition of the following standards as amended up to date except where specified otherwise in the specifications.
  - a. A.C. Electricity meter : IS: 722 (Part –I & IV) (Latest edition)
  - b. Indicating instruments : IS: 1248 (Latest edition)
  - c. Recording instruments : IS: 6236 (Latest edition)
  - d. Protective relays : IS: 3231 & IEC 60255 (Latest edition)

- b. However, in the event of offered 66 kV control & relay panels, confirming to standard other than above Standards, the salient points of differences between the standards adopted and the specified standards shall be stated.

### **3.13.3 Drawings**

- a. Contractor shall submit following drawings, after award of work.
  - a. Principal dimensional details of each control and relay panel.
  - b. Front and rear views of the panels with instrument, devices and relay positions marked.
  - c. Details of protection schemes for lines, transformers etc. and annunciation system offered with its leaflet
  - d. General arrangement drawings of control and relay panels, showing all parts / items mounted on them with height of each along with complete panel wise list of equipment and list of nameplates.
  - e. Schematic internal wiring diagram of each panel, showing termination of external wiring.
  - f. Schematic drawing shall follow TB Nos. as under.
    - i. CT Circuits,
    - ii. PT Circuits,
    - iii. Aux. AC & DC supply
    - iv. Control Circuits,
    - v. Indication Circuits,
    - vi. Annunciation Circuits,
    - vii. RTU / Spare, B – Bus wires
    - viii. M - Energy meter RS485 communication wires
- b. Details of all switches.
- c. Outline drawings and internal wiring diagrams of all instruments, relays and other parts / items.
- d. Outline drawings, mounting details, internal wiring diagram and item wise bill of material for all devices not located in contractor's panels, but supplied by him with the panels.
- e. Complete three-phase diagram (A.C. Schematic), covering all elements controlled from the control panels. They shall show all A.C. Power connections, and secondary connections for relays, meters etc. with vector representation.

- 
- f. Complete schematic control diagrams of all parts / items controlled from the panels, including synchronizing circuits, if required. These diagrams shall show complete internal circuits of the controlled parts / items and clearly indicate the terminal markings for extra connections.
  - g. Complete schematic drawing for annunciation system with various purposes for which it is suitable.
  - h. Foundation drawings including Cable Cutouts and floor plans of control and relay panels.
  - i. Locations of cable slot for Bus wires and weights shall also be given on these drawings
    - a. They may submit any other drawing found necessary in addition to the drawings stated above
    - b. The sequence of drawing sheets shall be as follows.
      - i. Title Sheet
      - ii. Brief Product specifications
      - iii. GA drawings – Front view , Rear View, Side View, Internal views, Foundation Drawing including Cable Cutouts
      - iv. Bill Of Materials
      - v. Station Single Line Diagram (if applicable)
      - vi. Single line Diagram
      - vii. Protection Single Line Diagram
      - viii. AC & DC distribution
      - ix. Metering Circuit
      - x. Main Protection Relay Circuit
      - xi. Back up Protection Relay circuit
      - xii. Circuit Breaker Closing & Tripping circuit
      - xiii. Indication Circuit
      - xiv. Annunciation Circuit
      - xv. TB details
      - xvi. Wiring Table (with 'as built' drawings only)

### 3.13.3.1 Detailed Description:

#### Construction of panel and detailed description:

- a. The control and relay panel shall be of simplex type and comprise of one vertical stationary front panel, provided with single door (fitted and lockable with latches at three points) on the rear.
- b. The control relay panels shall be fabricated out of structure levelled, finished sheet steel of minimum thickness 3mm for front side and 2.5mm for all other sides and necessary stiffening members. They shall form rigid, unyielding freestanding, completely assembled enclosures, neat in appearance. All structural members shall be bolted or welded together. All joints shall be made flush and all edges shall be bent at right angles and rounded. Necessary arrangements shall be made for bolting the adjacent panels together as well as for fastening them to the floor. Suitable vibration absorption devices and kick- plates along the base shall be bent at right angles and rounded. The opening required for mounting the parts / items shall be punched or cut and filed smooth.
- c. Panel shall be painted first with anti-rusting paint and then by two coats of synthetic enamel grey paint of shade 631 of IS: 5 for exterior and white for interior respectively.
- d. Dimensions:
  - a. The dimension of the panels shall be as nearer as those stated below.
    - i. Height - 2300 mm including M.S. frame of 50 x 50 x 4mm
    - ii. Size for base, Depth- 610mm
    - iii. Width - 610 mm
- e. Controls, relays and instruments shall be mounted on the front of the panel and not on any moving parts of panel. The panels shall be vermin proof and suitable for IP54 protection. They will be suitable for tropical climate. The panels shall be supplied complete with wiring, through wiring supports, interior lighting device, wiring, terminal blocks, space heaters, channels, base grounding M.S. bolts, nuts, washers etc.
- f. Mimic Diagram and Symbols:
  - a. Coloured mimic diagrams of metal or plastic, with symbols to facilitate exact representation of the system shall be fixed on the front of control panel. Control switches and semaphore indicators shall be incorporated in the mimic diagram to represent the respective circuit breaker and isolators. Scheme of mimic diagram shall be subject to the approval of the Owner
- g. Name plates and Marking:

- a. Name plates shall be with black background with white engraved letters. Each part / item on the panels shall, also, have an appropriate nameplate. Nameplates for relays shall be marked with their function standard code number.

h. Indicating Lamps:

- a. Indicating lamps shall be of "LED" type, the supply for which shall be 110V/220V D.C. unless stated otherwise. Lamp covers shall be preferably of screwed type, unbreakable and moulded from heat resisting material. They shall be translucent to diffuse light and shall be of following unless otherwise stated. The overall diameter of lamp shall be 30 mm while that of cut out shall be 22.5 mm.
  - i. 'RED' for indicating "CLOSED" position of breakers.
  - ii. 'GREEN' for indicating "OPEN" position of breakers.
  - iii. 'BLUE' for indicating Spring charged position
  - iv. 'MILKY WHITE' for SF6 Gas Pressure Normal
  - v. 'WHITE' for 'TRIP CIRCUIT HEALTHY' indication (2 Nos with Push buttons).
  - vi. 'AMBER' FOR 'AUTO TRIP' indication.

**3.13.3.2 Semaphore Indicators:**

- a. Semaphore indicators shall be provided on the front side of the panel on Mimic diagram for indicating position of circuit breakers, isolators and earthing switches. They shall be of two coil type and their operating voltage shall be 110V / 220V D.C., unless otherwise stated.

**3.13.3.3 Switches:**

- a. All switches shall be of rotary operated type with silver to silver contacts of adequate making, carrying and breaking current ratings and shall be provided with easily removable protective terminal covers. The contacts of all switches shall preferably open and close with snap action to minimize arcing. Switches shall be suitable for accommodating spare / additional contacts. The contractor shall clearly state the continuous current ratings and interrupting current rating for D.C. and A.C. inductive and non-inductive circuits. The type of switches used shall be subject to approval of the Owner
- b. Voltmeter switches for A.C. shall be suitable for reading all line to line voltages for effectively earthed systems. The switch shall be 4-way stay put type with minimum 10A continuous rating.
- c. Circuit breaker and isolator control switches shall be of "THREE POSITION SPRING RETURN" type with pistol grip handles. The spring return type switch shall have spring return from close and trip position to 'After Close' and 'After Trip' positions respectively. The control springs shall be strong and robust enough to prevent inadvertent operation due to light touch. The

continuous rating of the switches shall not be less than 25 Amps. and that for one second shall be 150 Amps. Breaker control switches shall be provided with adequate nos. of spare contacts for control, interlocking, annunciation and discrepancy indication. Breaker control switches shall be with lost motion device for indicating auto trip indication

#### **3.13.3.4 Instruments, Meters and Recorders:**

- a. All instruments, meters and recorders shall be enclosed in dust-proof, moisture resistant, black finished cases and shall be suitable for tropical atmosphere. All accessories, including test switches and test plugs, wherever required, shall be furnished. They shall be capable of withstanding over currents due to faults in primary circuits. Their elements shall be shock-resistant and shielded from external magnetic fields. The instruments shall be of 144mm x 144mm size with 240 degree scale. These shall be mounted semi-flush on the panel with only flange projecting. Dials shall be white with black numbers.
- b. Ammeters:
  - a. All ammeters shall be provided with direct reading, double range scale, one on each side of the dial or alternatively two scales for two ranges. The scale value of A.C. ammeters shall be equal to 1 to 1.3 times the rated primary current of the current transformers feeding it. The rated current of the ammeter element shall be 1.0 Amp. D.C. ammeter shall have shunt and shunt leads. Class of accuracy shall be 0.5 or better.
- c. Voltmeter:
  - a. All voltmeters shall be provided with direct reading scales. The maximum value of the voltage scale shall be 115 % of the normal circuit voltage. The rated voltage of the voltmeters shall be  $110/\sqrt{3}$  volts. The voltmeters shall preferably be supplied with suppressed scales with initial suppression, wherever necessary. Class of accuracy shall be 0.5 or better.
- d. Multi Function Meter:
  - a. Multifunction meter shall be measure Active power (Kw/Mw) , reactive power (Kvar/Mvar), Power factor can be measure in multifunction meter wherever necessary. Class of accuracy shall be 0.5 or better.
- e. Energy Meter:
  - a. The Energy Meter shall be 3-Phase, 4 Wire type with accuracy class 0.5S. It shall be as per attached technical specifications and it shall be compatible to the existing DAS (Data Acquisition System) working in GETCO network.
  - b. Energy meters shall be as per the list of approved make and it shall be in line with the standard requirement of GETCO.

#### **3.13.3.5 Annunciation System:**

- a. General:
  - a. Alarm annunciation system shall be provided for the control board in order to draw the attention of the operator to the abnormal operating conditions or the operation of any protective device. The annunciation equipment shall be suitable for operation on 220/110V DC in normal conditions and on 240V AC in case the DC supply to Annunciation is failed i.e. it shall work on both AC & DC supply with AC supply as standby.
  - b. Annunciation scheme shall have provision of AC fail and DC fail alarm internally without any external relays or wiring. Trip and Non-Trip alarms shall be distinguished by separate Hooter while DC fail alarm shall be through AC Buzzer.
- c. Annunciation:
  - i. This annunciation is used to draw the attention of the operator, when the circuit breaker / relay trips due to fault or abnormality. The audible annunciation shall be provided by means of a "Bell". The visual annunciation shall be by flickering of a facia window.
- d. Warning / Non Trip Annunciation:
  - i. This is used during occurrence of an abnormal operating condition, other than the tripping of the circuit breaker / relay. The audible annunciation shall be provided by means of 'Hooter'. The visual annunciation shall be obtained by flickering of the respective facia window.
- e. DC Fail Annunciation :
  - i. This shall be used for indicating DC fail condition. The audible annunciation shall be provided by means of 'Buzzer'. The visual annunciation shall be obtained by flickering of the respective facia window

#### **3.13.3.6 Relays :**

Shall be as per PART-III – Requirement of protective relays for 66kV C&R Panels

#### **3.13.3.7 Electrical Equipment and Wiring :**

- a. Electrical equipment furnished by the contractor shall be designed for use under the climatic conditions, prevailing at site. Metal parts shall be protected against corrosion by plating and / or painting. Power & control wiring, shall have insulation of non-hygroscopic type unless specifically stated otherwise.
- b. Control wiring shall be securely supported, neatly arranged, readily accessible and connected to equipment terminals and terminal blocks voltage grade 1.1 kV. Each wire shall be provided with identifying ferrule at each end or connecting point. Colour coding of control wiring shall be as per standard modern practice. All wires shall be flexible, multi strand copper wires with P.V.C. insulation of 1100 volts grade and shall be suitable for specified control &

relay panel and shall be of adequate cross section not less than 2.5mm<sup>2</sup> stranded copper wire. The wire shall be flame-retardant and vermin proof, type, suitable for the tropical climate.

#### **3.13.3.8 Terminal Blocks:**

- a. One piece moulded, barrier type, terminal block of non-inflammable plastic, having voltage grade of 800 V shall be used complete with washers, and heads strips etc. and stud type terminals. Continuous current ratings for the terminal blocks shall not be less than 45 Amps. At least twenty percent spare terminals shall be provided in each panel and evenly distributed in all TBs. The terminal blocks shall be located, on both sides of the panel.
- b. Control cable shall be of 2.5, 4.0, mm<sup>2</sup> size copper. The terminals shall be suitable for connection of copper conductors. In case of 2.5 sq.mm size, the number of cables to be taken inside the terminal may be four. Accordingly, the terminal size shall be suitable.
- c. The control schemes shall incorporate necessary arrangements for isolation purpose, while testing and checking faults in control and signaling circuits.

#### **3.13.3.9 Space Heaters:**

Tubular space heaters of 60 watts with thermostat control of suitable rating for connection to single phase, 240 Volts, A.C. Supply complete with switches conveniently located, shall be provided at the bottom of the cubicle to prevent condensation of moisture. The loss of power shall be low enough to keep the temperature of surface well below permissible limits.

#### **3.13.3.10 Test Blocks:**

- a. Switch board type, back connected, semi-flush mounting type test blocks having Voltage rating 1100 V and Current rating 45A shall be provided with links or other devices to enable insertion of a device into the circuit without causing open circuit secondary of Current Transformer (C.T.) or to enable short circuiting of secondary of the C.T.
- b. Test Terminal Blocks shall be used to facilitate complete isolation of meters, instruments and relays, so that power for testing can be supplied either from the instrument transformers or from an external source.
- c. Loose Test Plugs / handles required for online testing of the relays through Test Blocks shall be in the scope of the work and shall be supplied with the panels. However its quantity shall be 5% of the panel quantity.

#### **3.13.3.11 Safety Earthing:**

Control panels shall be provided with earthing bus of copper having a minimum cross sectional area of 50 sq.mm. Earthing bus shall be securely mounted across the inside base of the panels. Earthing bus shall run throughout the width of panel. It shall be provided with M4 holes and Nuts & Bolts at a distance of 100mm. Provisions shall be made for extending the grounding bus bar to future adjoining panels. Earthing wires shall be connected by using suitable terminals and clamp connections. Solder connections shall not be employed



#### **3.13.3.12 Switch Board Lighting:**

The switchboard shall be illuminated by 11 W, CFL with fixture including reflector, front cover, etc. The voltage rating shall be 240 Volts, 1 $\phi$ , 50 Hz, AC supply. This light shall be operated by door operated switch.

#### **3.13.3.13 Supporting Steel:**

All necessary embedded leveling steel, steel, anchor bolts, channels and other parts for supporting and fastening the panels shall be supplied by the contractor.

#### **3.13.3.14 Accessories:**

The contractor shall supply necessary accessories like test blocks, test links, special terminal boards etc. for testing, operation and maintenance of all relays and meters, as specified.

#### **3.13.3.15 Tropicalization:**

Wiring, terminal blocks, relays, instruments, meters and control devices shall be suitable for installation in a tropical monsoon area, having a hot humid climate and dry and dusty season with ambient conditions specified Section-II. All equipment and accessories shall be painted by means of spray or dip coating and shall be protected against fungus growth condensation, vermin and other harmful effects due to tropical environment.

#### **3.13.3.16 Painting:**

A suitable rust resisting primer paint shall be applied on the interior and exterior steel surfaces of control panel after removing rust by sand blasting, foreign adhering matter of grease, scale etc. An under coat to serve a base and binder for the finishing coat shall be applied. The finishing coat on the exterior of the panels shall be of shade No. 631 (Light grey) of IS 5. Polished cellulose enamel of light grey evenly sprayed on the outside and egg shell white paint evenly sprayed on the inside shall be applied as finishing coat. Sufficient quantity of finishing paint shall be supplied for minor touching up required at site.

#### **3.13.3.17 Fire Protection:**

All equipment connections and cabling shall be designed and arranged to minimize the risk of fire and damage, which may be caused by fire.

#### **3.13.3.18 Protective Scheme Requirement:**

Shall be as per PART-III – Requirement of protective relays for 66 kV C&R Panels

#### **3.13.3.19 Tests:**

- a. Type Test:
  - a. The contractor shall submit the reports of the type tests as stated hereunder for the offered item after award of work, These tests must have been conducted in the NABL accredited laboratory.

b. Degree of Protection – IP 54

- i. It shall be certified by the contractor that the type tests in accordance with the relevant standards have been successfully carried out on all type of relays, meters, switches and other devices being supplied by him. Certified copies of all type tests shall be submitted to the Owner (four sets) for his approval.
- ii. Relay / C&R panel offered shall have type test certificates from accredited laboratory (accreditation based on ISO/IEC/Guide 25/17025 or EN 45001 by the national accreditation body of the country where the lab is located.) as per IS/IEC/Technical specification, not older than FIVE (5) years.

c. Routine & Acceptance Tests: -

- i. All control & relay panels shall be subjected to routine tests according to the relevant standards and to such other tests as may be required to ensure that each panel is satisfactory and in accordance with this specification. The Owner reserves the right to witness all the tests and advance intimation shall be given regarding these tests. Test reports of all such tests shall be submitted to the Owner for approval before inspection. Any modification required in the testing procedure shall be made at no additional cost to the owner. No panel shall be dispatched from the manufacturer's work before the relevant tests reports have been approved by the Owner. The contractor shall send four copies of the certified final test reports to each consignee of all factory tests carried out on each panel, relay, meter, switch, instrument, transformer and other devices, which shall furnish complete information including the method of application and duration of test. List of routine tests to be performed on the panel shall, also, be furnished for owner's approval.

**3.13.3.20 Co-Ordination with Other Manufacturers:**

The control panel manufacturer shall also co-operate and co-ordinate in every respect with the suppliers of the switchgear, equipment and other associated equipment and shall provide complete technical data, schematic drawings of control, indication, protection etc.

**3.13.3.21 Specific Requirements:**

- a. Type – I – 66 kV Transformer C & R Panel: with differential protection Instruments:
  - a. Moving iron Ammeters, 144mm x 144mm size, flush pattern, having scale range of 0-150-300 Amp. connected to secondary of 150-300/1-1-1 Amps.. 66 kV CTs as per approved SLD
  - b. Voltmeter, 144mm x 144mm size, flush pattern, with selector switch having scale range of 0-75 KV connected to secondary of 66000/V3kV / 110/V3V PTs.
  - c. Static KWh meter, flush pattern, connected to above CT and PTs.
  - d. MW meter, 144mm x 144mm size, flush pattern connected to above CT and PTs. (Suitable for unbalanced load).

- e. MVAR meter, 144mm x 144mm, size flush pattern connected to above CT and PTs. (Suitable for unbalanced load.)
- f. Mimic diagram to represent bus bars, Isolators, circuit breaker, etc.
- g. Pistol Grip, spring return type, 3 position control switch with lost motion device for 66kV circuit breakers with one spare contact in each position.
- h. Automatic semaphore indicators for position indication of the breaker and the isolator. (size of semaphore for breaker shall be 63 mm while that for isolator shall be 36 mm)
- i. One 'RED' and one 'GREEN' - 'ON' and 'OFF' indicating lamps, suitable for 110/220V DC, for the circuit breaker.
- j. 'WHITE' Indicating lamp, for 'Trip Circuit' healthy' indication with push button.
- k. 'Blue' indicating lamp for 'spring charged' position of the breaker.
- l. 'AMBER' indicating lamp for 'Auto Trip' indication of breaker. 'Milky White' indicating lamp for 'SF6 Gas Pressure Normal' indication Breaker.

#### **3.13.3.22 Annunciation:**

- a. 1 No. 18 Way illuminated facia window type alarm annunciation for indication of individual types of faults as under:-
  - a. Differential Protection Operated
  - b. Over Current Protection Operated
  - c. Earth Fault Protection Operated
  - d. Buchholz Trip
  - e. Winding / Oil Temp. High Trip
  - f. PRV Trip
  - g. OLTC Surge Relay Trip
  - h. Buchholz Alarm
  - i. Winding / Oil Temp. High Alarm
  - j. Low oil level Alarm
  - k. DC Fail
  - l. AC Fail
  - m. CB Lockout

- n. SF6 Gas Pressure Low
  - o. Differential Relay Faulty
  - p. Trip Circuit -1 / 2 Faulty
  - q. Over Current & Earth fault Relay Faulty
  - r. Trip Relay Operated
- b. The unit shall be complete with necessary, bell, hooter lamps, push key units for alarm reset, alarm acknowledgment and lamp test. It shall be mounted on the front of the panel
  - c. 1 set of alarm accept, reset and lamp test push buttons, if required separately.:-

#### **3.13.3.23 Protection (Transformer C & R panel with differential protection)**

- a. Transformer Differential Relay
- b. Non directional O/C & E/F Relay
- c. Transformer Trouble Relays
- d. Trip Circuit Supervision Relays
- e. Master Trip Relay
- f. It shall be as per PART-III – Requirement of protective relays for 66kV C&R panels

#### **3.13.4 Type – II – 66kV Feeder Control & Relay Panel :**

##### **3.13.4.1 Instruments**

- a. Moving iron ammeters as stated above.
- b. Voltmeter as stated above.
- c. static KWH meter as stated above
- d. MW meter as stated above.
- e. Mimic diagram as stated above.
- f. Pistol grip, spring return type, 3 position control switch as stated above.
- g. Automatic semaphore indicators as stated above for breaker and isolator & earth switch position indication.
- h. One 'RED' and one 'GREEN' indicating lamps, working on 110V/220V D.C. to show circuit breaker 'ON' and 'OFF' position.

- i. White' trip circuit healthy indicating lamps with push button.
- j. 'Blue' indicating lamp for 'spring charged' position of breaker as stated above.
- k. 'Amber' indicating lamp for "Auto trip" of breaker as stated above.

'Milky White' indicating lamp for 'SF6 Gas Pressure Normal indication of the breaker.

#### **3.13.4.2 Annunciation**

- a. 12 window annunciator for annunciation-1 No..
  - a. Over Current Protection Operated
  - b. Earth Fault Protection Operated
  - c. Trip Relay Operated
  - d. Trip Circuit -1 Faulty
  - e. Trip Circuit -2 Faulty
  - f. O/C & E/F Relay Faulty
  - g. CB SF6 Gas Pressure Low
  - h. CB Lockout
  - i. Spare
  - j. Spare
  - k. DC Fail
  - l. AC Fail
- b. 1 - Set of alarm accept reset and lamp test push buttons, if required separately.

#### **3.13.4.3 Protection (66 kV Feeder):**

- a. Directional O/C & E/F Relay
- b. Trip Circuit Supervision Relays
- c. Master Trip Relay

It shall be as per PART-III – Requirement of protective relays for 66 kV C & R Panels

#### **3.13.4.4 Indicating lamp, instruments and vector group of power transformer, instrument transformer:**

- a. Indicating instruments shall be of flush type and shall have 2400C scale and 144mm x 144mm size. Instruments shall be of the taut band suspension type.
- b. Colored mimic diagram of 10mm width shall be for main bus and that of 5mm for remaining. Colour shade shall be as under:

Earth - Green.

66 KV - Golden brown shade 414 of IS: 5.

#### **3.13.4.5 Vector Group of Transformer: Dyn – 11**

#### **3.13.4.6 (Part II) – General Requirements**

#### **3.13.4.7 Scope:**

- a. This part covers design, manufacture, inspection, dispatch and delivery of electric control and relay panels and accessories. 'Control Panel' shall be suitable for inter changeability. This covers simplex panels as well as control desks. Both parts of this specification are mutually dependent and are essential for correct and complete interpretation. Part I covers specific requirements and part II covers general requirements. When requirements of two parts conflict, those of part one shall prevail.
- a. The following works have been included within the scope of this specification:
  - i. Design and fabrication of complete panel including provision for all parts / items and wiring.
  - ii. Painting of all panels specified in part one of this specifications, together with such auxiliary items as may be incidental or complementary to those specified.
  - iii. All internal wiring to equipment and terminals and inter panel wiring.
  - iv. Furnishing of all necessary material and parts / items required for the control panel/desk to perform as specified in part I.
  - v. Electrical detailing as outlined in this specification.
  - vi. Preparation and furnishing of all drawing as required.

#### **3.13.4.8 Standard:**

All materials and parts / items offered shall confirm to the requirements of the latest editions of the relevant Indian Standards and Codes of Practices.

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#### **3.13.4.9 General Description:**

- a. Simplex Control Board shall comprise of single vertical standing control or relay panels sections bolted together at their sides to form a single control or relay panel or control relay board. Each panel shall have a hinged rear access door provided with locks.

#### **3.13.4.10 General Constructions:**

- a. Control Board shall be completely closed, constructed from specially selected smooth finished sheet steel, not less than 3mm for front and 2.5 mm for all other sides and top, in thickness, bent and formed into a rigid unit and suitable for mounting auxiliary apparatus. There shall be sufficient reinforcement to provide flat level surfaces, resistance to vibration and rigidity during transportation and installation. Support and enclosure of cables and wiring shall be safe, neat and shall provide sufficient accessibility.
- b. Design, material selection and workmanship shall be such as to result in a neat appearance outside and inside, with no welds, rivets or bolt heads apparent from outside and with all exterior surfaces true and smooth.
- c. Cut outs and small wiring for items / parts shall be according to items / parts manufacturer's drawings and diagrams.
- d. Items / parts shall be mounted such that removal and replacement can be accomplished individually without interruption of service to adjacent parts / items. Parts / items mounted inside the panel shall be so located that terminals and adjacent devices are readily accessible without the use of special tools. Terminal markings shall be clearly visible
- e. Relays and devices mounted on or inside the control board shall have identification markings clearly visible from the insider, of control board enclosure. Devices mounted on the control board shall also be labeled on the outside of the control board.
- f. Control Board base shall be designed with a flat bearing surface for mounting on two strips each of 10mm thick of approved type of shock absorbing materials which shall be supplied by the contractor. Foundation pamphlets describing by details in regard to method of mounting and cable trench, to be provided in the foundation platform shall be furnished by the contractor well in advance of the dispatch of the panels.

#### **3.13.4.11 Design Details:**

- a. Panels and openings shall have edges and corners slightly rounded for safe handling.
- b. Supports shall be provided for incoming and outgoing cables.
- c. Terminal blocks shall be provided for connections between these cable and control board wiring, wiring gutter shall be provided for vertical panel wiring and for interconnecting wiring.
- d. Auxiliary parts / items shall be mounted inside the panels in a manner that will not interfere with the inspection or maintenance of the wiring and the terminal connections. Wiring

through, gutters, cable supports and mountings for terminal blocks shall be provided for future circuits, whenever these are specified in part I.

- e. One piece moulded, barrier type, 800 Volt grade terminal blocks complete with washers heads, terminal screws and identification strips shall be used. Continuous current ratings for the terminal blocks shall not be less than 45 Amps. At least twenty percent spare terminal blocks shall be provided on each panels.
- f. Terminal blocks shall be suitable for connection up to three conductors of Owner's cables which will be of following sizes:
  - a. PT and control Circuit - 2.5 – 4mm<sup>2</sup> Copper.
  - b. C.T. circuits. - 4 mm<sup>2</sup> Copper.
- g. The contractor shall be solely responsible for correctness of the internal wiring and for the proper functioning of the panels furnished by him
- h. Designation for the panel sections, relay instruments and meters, control devices circuit breakers, test blocks, fuses etc. shall be clearly marked close to the equipment. Laminated plastic name plate shall be provided for small relays, meters, test facilities and control devices.
- i. A mimic bus shall be mounted on the face of the panels in the general location indicated on the switch board layout drawings accompanying this specification. This mimic bus shall be of screwed on type, anodized aluminum or plastic.
- j. Terminal Blocks for bus wires i.e. (A.C. and D.C.) supply, PTs, and other common services shall be provided near the top of the panels, running throughout the length of the Board.
- k. Adequate illumination shall be provided for the access to interior of the switch board.
- l. Illumination for simplex panels shall be through provision of a 240V, 1 phase 50 Hz. A.C. CFL mounted in each panel controlled through rear door operated 'ON/OFF' switched.
- m. Tubular space heaters with thermostat suitable for operation at 240V, 1 phase 50 Hz, A.C. supply complete with switches located at convenient positions shall be provided at the bottom of the cubicle to prevent condensation of moisture. The watt loss per unit surface of the heaters shall be low enough to keep surface temperature well below visible heat.
- n. Auxiliary parts / items which to be mounted adjacent or complementary to the parts / items has specified in part one shall be mounted inside the enclosure on inner surface of panels or on supplementary structures.
- o. Clamping devices shall be provided for fixing incoming multicore control cables. These clamps shall be of robust construction, capable of clamping the cable firmly without injury to insulation. Cable type and sizes will be specified later.



#### **3.13.4.12 Painting:**

A suitable rust resisting primer shall be applied on the interior and exterior surfaces of the steel after removing rusts, greases, scale etc. An under coat to serve as base and binder for the finishing coat shall be provided. Polished cellulose enamel of light grey colour specified in part one, evenly spread on the exterior of the panel & egg shall colour on the inside of panel shall be applied as finishing coat. A small quantity of finishing paint shall be supplied for minor touching up required at site

#### **3.13.4.13 Wiring:**

- a. Control Board panels shall be furnished completely wired, ready for connections at the terminal blocks. All inter panel wiring and connections shall be furnished by the contractor.
- b. Control wiring shall be securely supported, neatly arranged, readily accessible and connected to equipment terminal and terminal blocks. Terminals on the terminal blocks shall be marked and numbered by the contractor to show wiring designation. Terminal marking shall correspond to the designations on the wiring diagrams.
- c. Wiring shall be carried out with 1100V grade cable of minimum 2.5mm<sup>2</sup> copper wire. Wiring shall comprise of switchboard type, single core, multi-conductor (Minimum three strands), and annealed copper wire with PVC insulation and shall be fire retardant and vermin proof type suitable for the climatic conditions outlined in part I.
- d. Wire terminals shall be made with compression type tinned copper lugs which firmly grip the conductor and the insulation. Wire terminations shall be provided with insulated sleeves to reduce the possibility of short circuits.
- e. Numbered sleeves shall be used in the control panel wiring. Sleeves bearing identical numbers shall be placed at both, ends of the wire, the sleeve number being shown in the panel wiring diagram. This is to facilitate checking of panel wiring and to permit easy replacement of components during maintenance.

#### **3.13.4.14 Tropicalization:**

Wiring, terminal blocks, relays instruments, meters and control devices shall be suitable for application in tropical and shall be with suitable treatments to protect them against tropical conditions which are conducive to rust and fungus growth.

#### **3.13.4.15 Test Facilities:**

- a. Protective relays and electric meters shall have built in test blocks. Devices which are not available with built in test blocks or which have been specified to have separate auxiliary devices in their test circuits, shall be supplied with external test facilities. Test blocks in such case, shall be mounted near the auxiliary device.
- b. Test blocks shall provide complete isolation of energy meters, instruments and relays, so that testing power can be supplied either from the instrument transformers or from an out external source.

- c. Terminal blocks with disconnecting facilities shall be used for C.T, P.T. secondary circuits and Auxiliary AC & DC supply.

#### **3.13.4.16 Grounding:**

Control panels shall be equipped with a ground bus bar of copper having a minimum cross sectional area of 150 Sq.mm. Ground bus shall be securely mounted across the inside base of the panels. Provisions shall be made for extending the grounding bus bar to future adjoining panels. Earthing wires shall be inter connected by using suitable terminals and clamp connections. Solder connections shall not be employed.

#### **3.13.4.17 Instruments:**

- a. Indicating instruments shall be of flush type and shall have scale of 240 degrees and of 144mm x 144mm size and shall be of taught band suspension type. These shall be mounted semi-flush on the panel with only flange projection. Dials shall be white with black numbers and letters free dial, in parallel, is preferred.

### **3.13.5 Part-III Specification on Protective Relays**

#### **3.13.5.1 Scope:**

- a. The overall scope of work proposed to be assigned to the contractor according to this specification covers the following aspects.
- b. The design, manufacture, testing at manufacturer's works, supply and demonstration of the Protective Relays as detailed in the Protective Relays schedule, supply thereof, testing and commissioning at site.
- c. Design and manufacture of Protective Relays to meet the requirements of Protection of power equipment's viz.
  - a. 66 kV feeders
  - b. 66/6.6kV two winding transformers
    - Design and fabrication of Protective Relays along with all necessary accessories like switches, indicating LED etc. to provide self-contained and ready to use Protective Relays as per this specification.
- d. Complete testing at manufacturer's works.
- e. F.O.R. destination supply of completely assembled Protective Relays.
- f. Testing and commissioning of these Protective Relays at site.
- g. It is not the intent to specify completely all the details of the design and construction of Protective Relays. However, the Protective Relays shall conform in all respects to high standards of Engineering, design and workmanship. The offered Protective Relays shall be complete with all components necessary for their effective trouble free operation.

### **3.13.5.2 Standards**

Unless otherwise specified elsewhere, in this specification, the rating, performance and testing of Protective Relays shall confirm to the latest revisions, available at the time of placement of order of all relevant standards. However, the contractor shall submit the copies of English version of the relevant standards applicable to the Protective Relays.

### **3.13.5.3 Principal Technical Parameters:**

The Protective Relays covered in these specifications shall have the technical requirements listed in Annexure.

### **3.13.5.4 General Technical Requirements:**

- a. Scope of Work.
  - a. Supply of Protective Relays as specified in guaranteed technical particular.
  - b. Preparation and furnishing of all the required drawings.
  - c. Testing of Protective Relays and associated equipment and furnishing of test certificates
  - d. Preparation and furnishing of commissioning instructions, operation and maintenance manuals with all operational features/optional features.
- b. General requirement for the protective relays:
  - a. Design, material selection and workmanship shall be such as to result in neat appearance inside and outside with no weld, rivets or bolt heads apparent from outside and with all exterior surface true and smooth Relays:
  - b. All relays shall confirm to the requirements of IS: 3231/IEC-60255. Relays shall be suitable for flush or semi-flush mounting on the front with connections from the rear.
  - c. All AC operated relays shall be suitable for operation at 50 Hz. AC voltage operated relays shall be suitable for 110V VT secondary and current operated relays for 1 or 5 ampere CT secondary. All DC operated relays and timers shall be designed for the DC voltage specified, and shall operate satisfactorily between 80% and 110% of rated voltage. Voltage operated relays shall have adequate thermal capacity for continuous operation.
  - d. The protective relays shall be suitable for efficient and reliable operation of the protection scheme described in the specification. Necessary auxiliary relays and timers required for interlocking schemes for multiplying of contacts suiting contact duties of protective relays and monitoring of control supplies and circuits etc. also required for the complete protection schemes described in the specification shall be provided. All protective relays shall be provided with at least two pairs of potential free isolated output contacts. Auxiliary relays and timers shall have pairs of contacts as required to complete the scheme contacts shall be silver faced with spring action. Relay case

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shall have adequate number of terminals for making potential free external connections to the relays coils and contacts, including spare contacts.

- e. All protective relays, auxiliary relays and timers except the lockout relays and interlocking relays specified shall be provided with self-reset type contacts. All protective relay and timers shall be provided with externally hand reset positive action operation indicators with inscription. All protective relays which do not have built-in hand-reset operation indicators shall have additional auxiliary relays with operating indicators (flag relays) for this purpose.
- f. Timers shall be of continuous rating. Time delay in terms of millisecond obtained by the external capacitor resistor combination is not acceptable. The variable pot type timer is not acceptable.
- g. No control relay which shall trip the power circuit breaker when the relay is de-energized shall be employed in the circuits.
- h. Provision shall be made for easy isolation of trip / CT / PT circuits of each relay for the purpose of on line testing and maintenance. Test Block and Test plugs/test handles, necessary for this, shall be included in contractor's scope of supply without any additional cost
  - Auxiliary seal-in-units if provided on the protective relays shall preferably be of shunt reinforcement type. If series, relays are used the following shall be strictly ensured.
- i. The operating time of the series seal-in-unit shall be sufficiently shorter than that of the trip relay in series with which it operates to ensure definite operation of the flag indicator of the relay.
- j. Seal – in – unit shall have obtained adequate current for operation when one or more relays operate simultaneously.
- k. Impedance of the seal – in- unit shall be small enough to permit satisfactory operation of the trip coil on trip relays when the D.C supply voltage is minimum.
  - All protective relays shall be provided with one extra isolated pair of contacts wired to terminals exclusively for future use.
  - The setting ranges of the relays offered, if different from the ones specified shall also be acceptable if they meet the functional requirements.
- c. For numerical relays, the scope shall include the following.
  - a. Necessary licensed software and hardware to up/down load the data to/from the relay from/to the personal computer installed in the substation. The supply of laptop having latest version and licensed software is covered under this clause.

- b. The software shall be suitable for operations like switching, retrieval of information or changing of setting groups, retrieve oscillography fault data from the relay memory and to store fault record data as oscillography records in standard COMTRADE format. The software shall be suitable to provide oscillography data into several different graphical representations that can be used to analyze the fault or event captured by the relay. It shall also be possible to calculate additional values from the captured signals and displaying analog curve with time base phasor diagram locus diagrams, harmonic graphs etc. Automatic upload of DR files should be possible. The software shall be suitable for creating / modifying logics of the protective relay.
- c. The relay shall have communication facility, if specified in the technical requirements listed in Annexure, with suitable port for local communication with Laptop/PC and preferably also for connectivity to SCADA. In such case the relay shall be capable of supporting IEC-60870-5-103 / IEC 61850-8-1 protocols, as specified.
- d. The relay shall be provided with all the software mentioned in the catalogue.
  - The contractor shall include in his datasheet a list of installations where the relays quoted have been in satisfactory operation.
  - All relays and their drawings shall have phase indications as R-Red, Y- Yellow, B-Blue

#### **3.13.5.5 Tests:**

- a. The contractor shall submit the complete type test reports as stated hereunder for the offered relay for owner's approval. These tests must have been conducted in the NABL accredited laboratory as per IEC 60255, IEC 60068, IEC 61000, IEC 60529, IEC 61010-1 within last 5 years.
- b. Performance tests:
  - a. Accuracy requirements
  - b. Limits of operating range of auxiliary energizing inputs and auxiliary Voltage dependence.
  - c. Limits of frequency range and frequency dependence iv. Rated burden
  - d. Mechanical Endurance test
  - e. Characteristic and Functional test
- c. Thermal requirements:
  - a. Maximum allowable temperature
  - b. Limits of shorttime thermal withstand value of input energizing quantities.
  - c. Limiting dynamic value -
- d. Insulation Tests:

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- a. Dielectric Tests
  - b. Impulse Voltage withstand Test
  - c. Insulation resistance measurement
  - e. Influencing Quantities
    - a. Permissible ripples
    - b. Interruption of input voltage
  - f. Electromagnetic Compatibility Test:
    - a. 1 MHZ burst disturbance test
    - b. Electrostatic Discharge Test
    - c. Radiated Electromagnetic Field Disturbance Test
    - d. Electrical Fast transient Disturbance Test
    - e. Conducted Disturbances Tests induced by Radio Frequency Field
    - f. Magnetic Field Test
    - g. Emission (Conducted and Radiated) Test.
    - h. Surge Immunity Test
  - g. Contact performance Test
    - a. Contact making/Breaking capacity test
    - b. Continuous capacity test
  - h. Environmental tests:
    - a. Dry Cold Test
    - b. Dry Heat test
    - c. Storage temperature test
    - d. Damp heat Cyclic test
  - i. Mechanical Tests:
    - a. Vibration response & Vibration endurance test
    - b. Bump test

- c. Shock response test
- d. Seismic test
- j. Enclosure Test:
  - a. Degree of Protection test – IP51
- k. Safety Test:
  - a. Single fault condition assessment
  - b. Earth bonding impedance test
  - c. Mechanical resistance to shock and impact
  - d. Protection against electrical shock
  - e. Protection against the spread of fire
- l. Acceptance and routine tests.
  - a. All acceptance and routine test as stipulated in the relevant standards shall be carried out by the contractor in presence of Owner's representative without any extra cost.
  - b. Immediately after finalization of the programme of type / acceptance/ routine / testing the contractor shall give two weeks advance intimation to the Owner to enable him to depute his representative for witnessing the tests
- m. Quality Assurance Plan:
  - a. The contractor shall invariably furnish, the quality assurance plan adopted by him/his sub-suppliers in the process of manufacturing all major equipment/component.
  - b. Precaution taken for ensuring usage of quality raw materials and sub- components shall be stated in the quality assurance plan.
  - c. The contractor should specifically express their consent to accept additions, revisions to their quality assurance plan to meet the Owner's requirements if needed.

#### **3.13.5.6 Demonstration**

After award of work during technical scrutiny of the technical document submitted by the contractor, Owner may ask to give demonstration of the offered Protective Relays at Owner's site. The contractor shall demonstrate the Protective Relays within one week of intimation from Owner.

### 3.13.5.7 Principal Technical parameters of relays

Sr.N o.	Item	Specification
1.	<b>DIRECTIONAL O/CANDE/F PROTECTION RELAYS.</b>	<p><b>(A)Features:</b></p> <ul style="list-style-type: none"> <li>d. Shall be Numerical type.</li> <li>e. Shall have 3 over current and 1 Earth Fault element.</li> <li>f. TRUERMS Measurement.</li> <li>g. Have selectable and front panel programmable normal, inverse, very inverse, extremely inverse &amp; long inverse IEC/ANSI Characteristic.</li> <li>h. Selectable CTSecondary.i.e.1A&amp;5A</li> <li>i. High set over current with selectable time delay.</li> <li>j. High set Earth fault with selectable time delay</li> <li>k. Have adjustable characteristic angle, lead/ lag, for Directional over current / Earth Fault respectively.</li> <li>l. Shall decide directionality through zero sequence quantity, derived internally.</li> <li>m. Shall have Breaker Failure Protection as inbuilt feature.</li> <li>n. Include hand reset Flag/LED indicators for phase identification for all faults.</li> <li>o. Readable Human Machine Interface with LED/ LCD display.</li> <li>p. Should be able to store at least last 3 events with fault data viz. Fault current, Faulty Phase etc. with time stamp</li> <li>q. Shall have inbuilt Disturbance Recorder with total time minimum 3sec.</li> <li>r. Shall have continuous self-hardware &amp; software monitoring and diagnostic features</li> <li>s. Relay offered shall be communi cable type.</li> <li>t. Relay shall have online testing facility</li> </ul> <p><b>(B)Technical Parameters:</b></p> <p>1. Analogue input:</p> <ul style="list-style-type: none"> <li>Rated Current : 1A &amp; 5A(site selectable),50 Hz <math>\pm</math> 2.5Hz</li> <li>Rated Burden : &lt;0.05 VA/0.3 VA for 1/5 Amp</li> <li>Over load capability : 4xIn continuous 100xIn1Sec. 25 x In 3Sec.</li> <li>250 x In Dynamic</li> <li>Rated Voltage : 110/63.5V, 50Hz <math>\pm</math> 2.5Hz Rated</li> <li>Burden : &lt;0.3VAperphase</li> <li>Overload Capability : 2XV continuous</li> </ul> <p>2. Auxiliary Supply : 110/220 V DC <math>\pm</math>15 %</p> <ul style="list-style-type: none"> <li>Power consumption : &lt; 15W</li> <li>Ripple (peak to peak) : &lt; 12%</li> </ul>



Sr.N o.	Item	Specification
		<p><b>(C) Relay settings:</b></p> <p>a. Over Current : 50% - 200% (In steps of 5%)</p> <p>b. Earth Fault : 5% - 80% (In steps of 5%)</p> <p>c. High set O/C : 0.5 – 15 times In or more.</p> <p>d. High set E/F : 0.5 – 12 times In or more.</p> <p>e. Time multiplier for IDMT : 0.05 – 1.0 (In steps of 0.025) (Independent for O/C &amp; E/F)</p> <p>f. Time delay for high set Element : 0.02 to 2 sec (in steps of 0.01 sec)</p> <p>g. Pick up : Within 1.1 times of set current value.</p> <p>h. Reset current : 95% to 90% of pick-up current.</p> <p>i. Operating Time : As per selectable characteristic. For Inst. Element ≤ 50ms for 2xIn.</p> <p>j. LBB feature : Current setting range – 0.1 to 2 X In</p> <p>k. Time delay - 0.1 to 2 sec (In steps of 0.010 Sec)</p> <p><b>(D) Other Features:</b></p> <p>1. Binary Inputs : Minimum 5 Nos.</p> <p>2. Outputs :</p> <p>Provide sufficient number of potential free contacts to cater the needs of connection to alarm annunciation.</p> <ul style="list-style-type: none"> <li>• Trip contacts : Minimum 2 N/O contacts with <ul style="list-style-type: none"> <li>- Continuous carry 5 A</li> <li>- Make &amp; Carry for 0.5 s 30 A</li> <li>- Make &amp; Carry for 3.0 s 15 A</li> </ul> </li> </ul> <p>Signalling contact : Minimum 4 Nos. (Programmable at site)</p> <p>3. Local PC Communication:</p> <ul style="list-style-type: none"> <li>• Ports - Front RS232 and Rear RS485</li> <li>• Protocol - IEC-60870-5-103</li> </ul> <p>4. Housing</p> <ul style="list-style-type: none"> <li>• Flush Mounting</li> <li>• Screw Terminals ('O' Lug for CT Connection)</li> <li>• Degree of Protection IP51</li> </ul> <p>5. Temperature and humidity</p> <p>(a) Ambient temp - 10 to 55 °C</p> <p>(b) Relative humidity 10% to 90% Non-Condensing</p> <p>(c) Operate range 0-95%</p> <p>(d) Storage temp. - 40 to 70 °C</p>

Sr.N o.	Item	Specification
2	<b>NON-DIRECTIONAL O/CANDE/F PROTECTION RELAYS.</b>	<p><b>(A)Features:</b></p> <ol style="list-style-type: none"> <li>Shall be Numerical type.</li> <li>Shall have 3 over current and 1 Earth Fault element.</li> <li>TRUE RMS Measurement.</li> <li>Have selectable and front panel programmable normal, inverse, very inverse, extremely inverse &amp; long inverse IEC / ANSI Characteristic.</li> <li>Selectable CT Secondary i.e. 1A &amp; 5A</li> <li>High set over current with selectable time delay.</li> <li>High set Earth fault with selectable time delay</li> <li>Shall have Breaker Failure Protection as in built feature.</li> <li>Include hand reset Flag/LED indicators for phase identification for all faults.</li> <li>Readable Human Machine Interface with LED/LCD display.</li> <li>Should be able to store at least last 3 events with fault data viz. Fault current, Faulty Phase etc. with time stamp.</li> <li>Shall have Disturbance Recording facility with total time minimum 3 sec.</li> <li>Shall have continuous self-hardware&amp; software monitoring and diagnostic feature.</li> <li>Relay offered shall be communicable type.</li> <li>Relay shall have on line testing facility</li> </ol> <p><b>(B)Technical Parameters:</b></p> <ol style="list-style-type: none"> <li>Analogue input: <ul style="list-style-type: none"> <li>Rated Current : 1A &amp; 5A (site selectable),50Hz <math>\pm</math>2.5Hz</li> <li>Rated Burden : &lt;0.05 VA/0.3 VA for 1/5 Amp</li> <li>Over load capability : 4xIn continuous 100 x In 1Sec. , 25 x In 3Sec., 250 x In Dynamic</li> </ul> </li> <li>Auxiliary Supply : 110/220V DC <math>\pm</math> 15% Power consumption: &lt;15W Ripple (peak to peak) : &lt;12%</li> </ol> <p><b>(C) Relay settings:</b></p> <ol style="list-style-type: none"> <li>Over Current : 50% - 200% (In steps of 5%)</li> <li>Earth Fault : 5% - 80% (In steps of 5%)</li> <li>High set O/C : 0.5 – 15 times In or more.</li> <li>High set E/F : 0.5–12 times In or more.</li> <li>Time multiplier for : 0.05–1.0 (In steps of 0.025) (Independent for O/C &amp; E/F)</li> <li>Time delay for high set element : 0.02 to 2 sec (in steps of 0.01 sec)</li> <li>Pickup : Within 1.1 times of set current value.</li> <li>Reset current : 95% to 90% of pick-up current.</li> <li>Operating Time : As per selectable characteristic.</li> </ol>

Sr.N o.	Item	Specification
3	<b>DIFFERENTIAL RELAYWITH HIGHSET</b>	<p><b>(D) Other Features:</b></p> <ol style="list-style-type: none"> <li>1. Binary inputs : Min 5nos.</li> <li>2. Outputs : <ul style="list-style-type: none"> <li>• Trip contacts : Minimum 2N/O contacts with <ul style="list-style-type: none"> <li>- Continuous carry 5A</li> <li>- Make &amp; Carry for 0.5s 30A</li> <li>- Make &amp; Carry for 3.0s 15A</li> </ul> </li> <li>• Signalling contacts : Minimum 4Nos. (Programmable at site)</li> </ul> </li> <li>3. <b>Communication:</b> <ul style="list-style-type: none"> <li>• Ports-FrontRS232andRearRS485</li> <li>• Protocol- IEC-60870-5-103</li> </ul> </li> <li>4. <b>Housing</b> <ul style="list-style-type: none"> <li>• Flush Mounting</li> <li>• Screw Terminals ('O' Lug for CT Connection)</li> <li>• Degree of Protection IP 51</li> </ul> </li> <li>5. <b>Temperature and humidity</b> <ol style="list-style-type: none"> <li>1. Ambient temp -10 to 55<sup>0</sup>C</li> <li>2. Relative humidity 10% to 90% Non-Condensing</li> <li>3. Operate range 0 - 95%</li> <li>4. Storage temp. - 40 to 70<sup>0</sup>C</li> </ol> </li> </ol> <p><b>A) A) Differential % BIASED protection</b></p> <ol style="list-style-type: none"> <li>ii. Be high speed with an operating time of less than 30ms at 5 times the rated current.</li> <li>iii. Shall have principle of biased differential type with highest feature and adjustable slope characteristic.</li> <li>iv. Shall be numerical type.</li> <li>v. Shall have true RMS measurement.</li> <li>vi. Shall have ratio and phase angle matching through software.</li> <li>vii. ShallhavesiteselectableCTsecondary1&amp;5A</li> <li>viii. Be suitable for three phase two winding transformer.</li> <li>ix. Be stable on heavy through faults.</li> <li>x. Be immune to magnetizing inrush current.</li> <li>xi. Have features to provide stability under over excited conditions and have 2nd harmonic restraint features.</li> <li>xii. Be triple pole type with faulty phase identification/ indication.</li> <li>xiii. Provide sufficient number of potential free contacts to cater the needs of connection to alarm annunciation.</li> <li>xiv. Shall have readable human machine interface with LED/LCD display.</li> <li>xv. The relay shall have on line testing facility</li> </ol> <p><b>Technical Parameters:</b></p> <ol style="list-style-type: none"> <li>1. Analogue input: <ul style="list-style-type: none"> <li>Rated Current : 1A &amp; 5A (site selectable), 50 Hz ±2.5 Hz</li> <li>Rated Burden : &lt;0.05VA/0.3 VA for 1/5 Amp</li> </ul> </li> </ol>

Sr.N o.	Item	Specification
		<p>Over load capability : 4xIn continuous 100xIn 1 Sec. 25xIn 3 Sec. 250xIn Dynamic</p> <p>2. Auxiliary Supply : 110/220 V DC <math>\pm</math>15 %</p> <p>Power consumption : &lt; 15W</p> <p>Ripple (peak to peak) : &lt; 12%</p> <p>Differential protection settings:</p> <p>1. Diff. Current : 10% - 50% In</p> <p>2. Bias Diff Current : 10% - 50% In</p> <p>3. 2nd Harmonic Restraint ratio: 10 to 80%</p> <p>4. Highest current : 400 to 2000% In</p> <p>Other Features:</p> <p>5. Output contacts</p> <ul style="list-style-type: none"> <li>• Trip contacts : Minimum 2 N/O contacts with</li> <li>- Continuous carry 5 A</li> <li>- Make &amp; Carry for 0.5 s 30 A</li> <li>- Make &amp; Carry for 3.0 s 15 A</li> </ul> <p>Signalling contacts : Minimum 3 Nos. (Programmable at site)</p>
4	<b>UNBALANCE CURRENT RELAY</b>	<p>The relay shall be suitable for rated current of 1 amp &amp; have suitable D.C/D.C converter suitable for 110/220 V D.C. (Preferably 88V TO 300V D.C.). DC voltage range of -15% to + 25% harmonic level is max, 0.2% at rated value. It shall</p> <ol style="list-style-type: none"> <li>a. Be Single pole <b>OR</b> two pole type (in case of controlling 2 Banks)</li> <li>b. Be of numerical type</li> <li>c. Be <b>two</b> Stage relay so that alarm &amp; tripping can be set at different values of current</li> <li>d. Have current setting of 10-50% of rated current.</li> <li>e. Have alarm and trip out put contacts.</li> <li>f. Have a local user interface (MMI) comprising of a 2-3 line alphanumeric LCD display and as of touch keypad to access the settings, events and records in the relay.</li> <li>g. Include hand reset flag / LED</li> <li>h. Indicator be high speed with typical operating time of less than 25 ms.</li> <li>i. Be provided with sufficient number of potential free contacts to cater the needs of connection to alarm annunciation.</li> <li>j. Data acquisition and optional trip facility to be connected whenever needed.</li> <li>k. Store minimum 3 Nose of fault data.</li> </ol>

Sr.No.	Item	Specification
5	<b>OVER VOLTAGE RELAY</b>	<p>The relay shall</p> <ol style="list-style-type: none"> <li>be electromagnetic / static type</li> <li>monitor all three phases</li> <li>Have adjustable voltage setting range of 100 – 150% of rated voltage &amp; adjustable time setting range of 0 to 10 seconds continuously or in step of 1 Sec.</li> <li>Have independent alarm &amp; trip out put contacts.</li> <li>Have drop off to pick up ratio equal to or greater than 95%.</li> <li>Be provided with Hand reset flag/LED type operation indicator.</li> <li>have sufficient potential free contacts to cater for local LED indicator &amp; for DR &amp; SER.</li> </ol>
6	<b>UNDER VOLTAGE RELAY</b>	<p>The Relay shall</p> <ol style="list-style-type: none"> <li>be electromagnetic / static type</li> <li>Be triple pole type.</li> <li>Have adjustable voltage setting range of 40 – 90% of rated voltage &amp; adjustable time setting range of 0 to 10 seconds continuously or in step of 1 Sec.</li> <li>Be provided with Hand reset flag / LED type operation indicator.</li> <li>Have minimum two potential free NC contact .Self reset type.</li> </ol>
7	<b>AUXILIARY RELAYS FOR TRANSFORMER TROUBLES</b>	<p>Buchholz trip.--1No.          Buchholz alarm ---1No.          OLTC Buchholz trip. ---1No.          Oil temperature trip. ---1No.          Oil temperature alarm.--1No.          Winding temperature trip.--- 1No.          Winding temperature alarm.--- 1No          P.R.V. trip.---2No.          Low oil level alarm --1No.          Provide sufficient number of potential free contacts to cater the needs of connection to alarm annunciation, Data acquisition and optional trip facility</p>
8	<b>HIGHSPEED TRIP RELAY</b>	<p>As per the system design sufficient relays having potential free contacts for trip circuit 1 &amp; 2 of main/coupler breaker shall be provided. The relay shall</p> <ol style="list-style-type: none"> <li>Have Heavy Duty Contacts for trip circuit.</li> <li>Provide sufficient number of potential free contacts to cater the needs of connection to alarm annunciation, Optional trip facility to be connected where needed.</li> <li>It shall be instantaneous within herent operating time less than 10ms.It shall have 8 NO &amp; 2 NC hand resetting type contacts. It shall be 220 / 110V DC operating and preferably provided with single coil.</li> <li>Be provided with operation indicators Be provided with operation indicators.</li> </ol>

Sr.N o.	Item	Specification
9	<b>TRIPCIRCUIT SUPERVISION RELAY</b>	<p>Trip circuit supervision relay shall be provided for each trip coil of the breaker. The relay shall</p> <ol style="list-style-type: none"> <li>Monitor the complete trip circuit with circuit breaker in pre-close &amp; post – close condition.</li> <li>Monitor loss of battery supply . c) Have a delay on drop off</li> <li>Provide alarm output.</li> <li>Include hand reset flag indicator.</li> <li>Provide sufficient number of potential free contacts to meet the scheme &amp; future requirement.</li> </ol>
10	<b>PTSELECTION RELAY</b>	<p>The necessary PT selection relay shall be provided for bus Voltage selection. It shall be provided with sufficient contacts for selected P.T. to protection and metering circuits and D.C permissive to protection. The relay should be latched type with operating and resetting coils. The relay shall have clear visible indication flag/LED.</p>

### 3.14 Switchyard Equipment

#### 3.14.1 Scope

The design, material, construction, manufacture and testing of substation equipment shall comply with all currently applicable standards/ statutes, regulations and safety codes in the locality where the equipment will be installed. In case of conflict between the standards and this specification, this specification shall govern. The following equipment shall be provided in the switchyard.

#### 3.14.2 Structure

Two/ four pole structures in switchyard to receive 11KV power supply from electric supply authority shall conform to the latest applicable standards specified as under.

1. A two / four pole structure shall be of a rolled steel joist if minimum ISMB 150 (150mm x 75mm) for 9 meter pole with 400 mm x 400 mm x 8 mm thick base plate weld at bottom end of all poles of structure.
2. Mild steel cross members of minimum ISMC . 100 mm x 50 mm x 6 mm size channels of 3.5 mtr in length, 8 Nos. shall be provided with cross bracing angles of minimum ISA 50 m x 50 mm x 6 mm size of 4.5 meter in length.
3. Side clamps, stay clamps, cleats etc. shall be fabricated from minimum 50 mm x 6 mm size MS flats as per actual requirements. All bolts, nuts, washers, etc. shall be of minimum 15 mm size.
4. All the members of two/ four pole structure should be galvanized.

5. Excavation of pits even in hard soil shall be done up to a depth of about  $\frac{1}{6}$  the length of pole and refilling the same after erection of structure and concreting work. Compacting the bottom of pits, providing cement concrete to suit at bottom and side of poles up to at-least 150 mm above FGL curing and making it hard as per requirement.
6. Erection of TSJ poles and fixing of all structural members as per requirement shall be in line, level and properly facing the incoming and outgoing lines. Cross members shall be firmly tightened.
7. All members shall be fabricated to suit mounting / fixing of gang operated disconnectors / isolators, lighting arrestors, pin / post insulators, cable end termination kit / box etc.
8. All MS parts shall be painted with two coats of red oxide and two coats of aluminium paints.
9. Earthing terminals shall be provided by welding 15 mm size bolts or cleats of 50 mm x 6 mm size MS flat shall be welded in each joist with a hole of 15 mm size and galvanized nuts, bolts, washers shall be provided as earthing terminals.
10. Necessary stay sets & hardware as required for completeness shall be supplied and erected.
11. All drawings/ documents such as GA drawing of two/ four pole structure showing all equipment mounted on the structure, technical particulars & bill of material etc shall be prepared and submitted to purchaser/ purchaser's representative for approval. Obtaining the approval from CEIG / IMPD (GOG) and getting power released from supply authority are also included in the scope of work.

#### **3.14.3 Gang operated offload disconnectors (GOD) with earth switch:**

The double break type isolator (GOD) shall be manually operated and suitable for specified site conditions and shall be able to –

- I. Carry rated current without excessive temperature rise.
  - i. Withstand the short circuit forces developed during fault.
  - ii. Carry the inrush current of the transformer.
  - iii. Interrupt small inductive and capacitive currents.

The operating rod shall be extended up to the operating level and shall have a handle with 'lock and key' arrangement. The operating handle shall be at level of 1.0 meter from finished ground level.

The operating handles shall be mounted on the base of supporting structure. Guide bearings shall be provided if necessary at appropriate height above ground level. Necessary accessories viz. brackets, angles, guides, guide bearings for attaching the operating mechanism and operating handles to the structure and part of the isolator, rust proof pins, ball or roller type bearings shall be provided and installed. All bearings shall be protected by means of covers and grease retainers. Bearings pressure shall be kept low to ensure long life and ease of operation.

The operating mechanism design shall be such that, as soon as the moving blades reach the sparking distance during operation of isolator, springs shall take over to give a quick snap action closing so that the isolator closing is independent of manual effort. Similarly the springs must assist during opening operation to give quick breaking feature.

All copper parts shall be Silver or Tin plated. All ferrous parts shall be hot dipped galvanized to assure long protection against tropicalised weather.

The contacts shall be of silver faced copper ensuring sufficient contact pressure. The male and female contacts shall be of self-aligning type to ensure trouble free operation during opening and closing of isolator. Mild steel arcing horn capable of breaking the magnetizing current shall be provided. Earth mesh below GOD to be provided

#### **3.14.4 Isolator Interlock:**

Electrical interlock arrangement shall be provided among double break isolator (GOD) and respective 11 KV indoor type breakers.

Interlocking arrangement shall be robust, heavy-duty type and sturdy in construction.

Mechanical interlock between Isolator & Earth Switch shall be provided

#### **3.14.5 Insulators:**

Insulator shall be properly glazed with smooth surface without cracks etc. and dielectric property shall be properly coordinated with isolator voltage class. Porcelain used for the manufacturer of insulator shall be uniform, brown color, free from blisters, burns and other similar defects. Insulators of the same rating and type shall be interchangeable.

Porcelain and metal parts shall be assembled in such a manner that any thermal expansion differential between the metal and porcelain parts throughout the range of the temperature variation shall not loosen the parts or create undue internal stresses which may affect the electrical or mechanical strength and rigidity. Each cap and base shall be of high grade cast steel or malleable steel casting and they shall be machinefaced and smoothly galvanized. The cap and base of the insulators shall be interchangeable with each other.

#### **3.14.6 ACSR Conductor:**

Aluminium conductor steel reinforced shall be hard drawn from 99.5% pure electrolytic aluminium rods. The Contractor shall specify the conductivity.

Chemical composition of the material shall comply with the requirements of relevant standards.

The surface of conductor shall be clean and dry and free from any excess grease that may be used in its fabrication. The surface strands shall be smooth and free from burrs and other projections which may be a cause for increasing corona losses.

The Contractor shall provide necessary treatment for the bus conductor to make it free from corrosion.



The steel wire strand of conductor and steel conductor shall be hot dip galvanized. Zinc coating shall be evenly and uniformly for heavily coated wires.

The steel core and inner layer of aluminum wires where more than one aluminum layer exist shall be protected with special grease in order to provide additional protection against corrosion due to salinity. The grease shall fill the whole space between wires within circumscribed cylinder at inner aluminum layer or at steel core if the conductor has only one aluminum layer.

The grease shall be chemically neutral with respect to aluminum, zinc and steel. It shall withstand weather conditions given elsewhere and temperature of 85 degree centigrade without alternation of its properties.

Bare conductor shall be covered in Alkathene pipes of suitable insulation to avoid accidental contact.

#### **3.14.7 Drop out (D0) Fuse Unit:**

Drop Out Fuse shall be of approved make suitable for 11 kV supply and shall be mounted on two pole structure complete with 3 fuse elements of required ampere suitable for continuous current rating and shall offer protection against fault level of suitable ampere at 11 kV.

The fuse link shall consists of iron channel base to stack insulators per phase, fuse carrier Bakelite tube, heavy duty non-ferrous metal parts and spring loaded phosphor bronze contacts.

The insulator shall comply with impulse voltage in accordance with relevant IS.

#### **3.14.8 Drop out (D0) Fuse Unit:**

The design, material, construction, manufacture, inspection and testing of lightning arresters shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed.

In case of conflict between the standards and this specification, this specification shall govern.

The equipment covered in this specification shall conform to the latest edition of the following standards.

- g. IS: 3070 (Part-3) : Lightning arresters for AC system – Specification(Metal Oxide Lightning Arrester without Gaps)
- h. IEC: 60099-4 : Metal Oxide surge arresters without gaps for AC system

#### **Constructional Features:**

- i.
  - i. Lightning arrester shall be station class heavy duty and non- linear resistance type. The elements shall be in hollow cylindrical form, stacked together. Lightning arrestor shall be of class II, having non – linear voltage – current characteristic and having high discharge capability.

- ii. The entire arrester unit shall be housed in a porcelain insulating casing of high strength, made from brown glazed wet process porcelain, with metallic cover plates and terminal assemblies. The end castings shall be hermetically sealed and leak tested to protect the unit from moisture or breathing.
- iii. Pressure relief diaphragm, vent pipe, etc. shall be provided on the LA for the escape of gases formed. In the event of failure of L.A., the pressure relief directional aperture should be directed away from adjacent apparatus to prevent damage, due to arc transfer.
- iv. All hardware such as clamps, screws, bolts, nuts, washers etc. shall be electro galvanized.

**Insulators:**

- i. The porcelain insulators used shall be made from wet process, and shall be homogenous, free from lamination, cavities and other flaws, which may impair its mechanical or dielectric strength. They shall be thoroughly vitrified, tough and impervious to moisture.
- ii. The glazing of porcelain shall be uniform brown colour, free from blisters, burns, cracks and other defects. The glazing shall cover all the porcelain part of the insulators except that area which serves as support during firing or are unglazed for the purpose of assembly.
- iii. The minimum creepage distance shall be as stipulated in data sheets. The petticoats shall be spaced for natural cleaning action by wind and rain and avoid concentrated hot spots where local stress can precipitate flashover.
- iv. All live metallic parts shall be suitably painted. All joints shall be fluid – tight and air tight. The design of insulators shall be such, as to produce uniform compression pressure joints.
- v. All insulators of identical rating shall be interchangeable.
- vi. Each bushing shall be provided with aluminium / bimetallic terminal connectors suitable as specified in data sheet.

j. **Accessories:**

- k. Each lightning arrester shall be furnished complete with the accessories as listed below:
  - a. Anti-contamination and pressure relief diaphragm complete with vent pipe.
  - b. Two (2) grounding pads.
  - c. Base plate suitable for mounting on GI/ steel structure or concrete structure.
  - d. Line side terminal suitable for specified conductor.

- i. Other standard accessories which are not specifically mentioned but are usually and provided with lightning arrester of similar type and rating for efficient and trouble free operation.
- ii. Name plates fixed on lightning arresters giving full technical details.
- iii. The clamps and connectors on arrester terminals for connection to purchaser's line conductor and the connection between incoming transmission line and LA will be in the contractors scope.

**I. Drawings/ documents to be furnished for Purchaser's approval:**

- i. Technical particulars
- ii. GA drawing of LA indicating weight and overall dimensions
- iii. GA drawing of insulating base, discharge counter, terminal assembly
- iv. Bill of material
- v. Mounting arrangement (base plate details) on the structure
- vi. QAP for lightning arrester

**3.14.9 Chain Link Fencing and Gravel Filling:**

1. The work of erecting chain link fencing includes excavation, brick wall construction, erection of angle/ channel supports, providing chain link mesh on angle / pipe frame barbed wire fencing at top, concreting of support members, painting the complete structure and white washing the walls. All materials, hard wares, labours etc. are in the scope of contractor.
2. Fencing height shall be minimum 2.0 meter & shall be complying with CEA guide.
3. Gate for entry in fenced compound shall be got approved from the engineer in charge before starting the fabrication work. All necessary hard wares, fittings, stoppers, locking arrangements with brass pad locks of 100 mm size are in the scope of gate works.
4. Gates shall be self-supporting type.
5. Gravel filling

**3.15 Battery, Battery charger and DCDB**

- a. This specification covers the requirements of stationary lead-acid storage battery and suitable battery charger required for the operation and control of circuit breakers/emergency lighting system.
- b. The design, manufacture and performance of the equipment shall confirm to the following Standards

CODICES	DESCRIPTION
DIN 40736	Lead Acid Batteries-Part-I Stationary vented cells with plastic tubular plates in plastic containers
IS : 8320	General requirements and methods of tests for lead-acid storage batteries.
IS : 1146	Rubber and plastic containers for lead-acid storage batteries.
IS : 6619	Safety code for semiconductor rectifier equipment.
IS : 6071	Synthetic separators for lead acid batteries.
IS : 2147	Degrees of protection provided by enclosures for low voltage switchgear and control gear.
IS : 4237	General requirements for switchgear for voltages not exceeding 1000 V AC
IS : 8623	Specification for factory built assemblies of switchgear and control gear (up to 1000 volts).
IS : 9224(II)	Fuses with breaking capacity for industrial application.
IS : 4064	Specification for air break switches, disconnectors and fuse combination units.
IS : 266	Battery Grade Sulphuric Acid.
IS : 266	Water for Storage Batteries.
IS : 6071	Synthetic Separator for Lead-Acid Batteries

### 3.15.1 Battery

- a. Capacity - The ampere-hour capacity at ten-hour rate of discharge shall be based on the requirements of loads. It may be assumed that the battery is fully charged to 2.15 volts at the start of the cycle and is discharged to a voltage of 1.75V/cell at the end of the cycle.
- b. The battery offered shall preferably be lead-acid (VRLA) in transparent SAN container type. The batteries shall be suitable for indoor installation.
- c. The cell containers shall be of hard rubber / glass or plastic. Suitable acid level indicators shall be provided.
- d. The cells shall be sealed and filter vent plugs shall be provided to avoid spillage, spray and emission of acid vapours.
- e. Inter-cell and inter-tier connectors shall be of lead or lead-plated copper depending on the discharge rate to which the battery will be subjected.
- f. Terminal posts shall be designed to accommodate external bolted connection. Each terminal post shall have two bolt-holes of the same diameter, preferably at right angle to each other. All metal parts of the terminals shall be of lead or lead-coated type. The junction between terminal posts and cover and between cover and container shall be so sealed as to prevent any seepage of the electrolyte.

- g. The electrolyte shall be battery grade sulphuric acid confirming to relevant standards. Required quantity of electrolyte for first filling with 10% extra shall be supplied in non-returnable containers.
- h. Battery shall be complete with battery racks preferably in single tier arrangement. For smaller units, utilising sealed-in type of batteries, mounting of the battery in sheet metal cubicle will be acceptable.
- i. Battery racks shall be constructed from good quality teak wood and painted with two coats of approved acid-resisting paint. The construction of the racks, unless otherwise specified in the data sheet, shall be suitable for fixing on a flat concrete floor. The racks shall be rigid, free-standing type and free from warps and twists. The complete rack shall be suitable for being bolted end to end to form a continuous row.
- j. The battery shall be complete with accessories and devices including the following:-
- Battery racks
  - Porcelain insulators, rubber pads, etc.
  - Set of intercell and interior connectors as required for the complete installation.
  - Accessories for testing and maintenance:
    - One - -3 to +3 volts DC voltmeter with suitable leads for measuring cell voltage.
    - One - Hydrometer for measuring specific gravity of electrolyte in steps of 0.005.
    - One - Filler hole thermometer fitted with plug and cap and having specific gravity correction scale.
    - One - Pocket thermometer
    - One - Acid-resisting funnel
    - Two - Rubber aprons
    - Four - Rubber gloves
    - Two - Cell lifting straps
    - One set - Terminals and cable boxes with glands for connecting cables as required.
    - Spare Connectors
    - Spare vent plugs
    - Spare nuts and bolts
    - Suitable set of spanner
    - PVC spill trays under the battery cells.
- k. Each cell shall be marked in a permanent manner to indicate the following information: -
- a. Cell number
  - b. Type of positive plate
  - c. Ampere-hour capacity at 10 hour rate
  - d. Type of container
  - e. Manufacturer's name

- f. Month and year of manufacture.
- l. The battery shall be transported in dry and uncharged condition. The acid shall be supplied separately in non-returnable sealed containers. Adequate quantity of distilled water shall also be supplied in a sealed container.

### **3.15.2 Battery charger and DCDB**

The battery charger shall be indoor, cubicle type floor/wall mounted, dust and vermin proof and front attended.

- a. The control panels shall comprise rigid structural frame enclosed by 2 mm thick cold rolled (CRCA) sheet steel. Doors and covers shall be from 1.6 mm thick CRCA sheet steel. Structural frame-work with foundation bolts/fixing bolts, etc. at the bottom / back side shall be provided to mount the battery charger panels directly on concrete floor/steel channel base or directly on wall as required.
- b. The charger and control equipment shall be arranged in the panels such that the components related to boost-charging, float-changing, common equipment and D.C. distribution are physically segregated in order to avoid haphazard placement and mix-up of the components. Location of the various equipment and components in the panels shall be as per proper logic and sequence.
- c. All doors and removable covers shall be gasketed all around preferably with neoprene gaskets.
- d. The battery charger and control panels shall be complete with the following:
- e. Removable cable gland plate, brass cable glands and as specified in datasheet.
- f. 650 V grade terminal blocks. 10% additional terminal blocks shall also be provided as spare.
- g. Earth bus bar of size and material as specified in data sheet.
- h. The battery charger shall be static type with silicon controlled rectifiers (SCRs) connected in three phase full wave bridge circuit or single phase circuit with ripple filtering device.
- i. The rectifier transformer shall be indoor dry type, double wound, with adequate number of primary/secondary taps.
- j. The composite (float/boost) charger, or separate float and boost chargers, shall be designed for supplying the DC loads as specified in the data sheet in addition to float charging /boost charging the battery.
- k. The battery charger shall consist of:
  - a. One (1) - TPN/DP incoming switch on a.c. side of the charger along with HRC fuses as required depending on three/single phase supply (one for boost charger and one for float charger) along with two nos. voltmeters with selector switches.

- b. Three (3)/one (1) - Multiple LED type potential indicating lamp(s) on a.c. supply side depending on three/single phase supply.
- c. One (1) set - Automatic voltage regulator unit (for float charger) with auto/manual selector switch and Constant current controller for boost charger with auto/manual selector switch.
- d. One (1) set - Coarse and fine control knobs for manual control.
- e. One (1) - Selector switch for mode for charging i.e. float charging/boost charging.
- f. One (1) set - Double wound dry type main transformer of suitable rating with adequate primary and secondary windings.
- g. One (1) set - Taps for the charger output voltage control with off load tap changing switch for changing the taps on the transformer.
- h. One (1) set - Booster transformer, as required.
- i. One (1) set - Silicon rectifiers connected in three phase full wave bridge circuit/single phase circuit, as per requirement indicated in data sheet, with ripple filtering device
- j. Two (2) - D.C. Volt-meter
- k. Two (2) - D.C. Ammeter with Shunts
- l. One (1) - Switch fuse unit in D.C. output side of each charger, with HRC fuses.
- m. Two (2) - Silicon diodes in series in the boost charger circuit.
- n. Two (2) - A.C. contactors (or auxiliary relays) connected across the incoming supply to give alarm on Annunciator.
- o. One (1) - Cubicle space heater suitable for 240V A.C., 50 Hz single phase supply with switch.
- p. One (1) - 240V A.C. Lamp for cubicle internal lighting with switch.

### **3.15.3 Performance**

- a. The automatic constant voltage regulator shall regulate the DC voltage within +1% of the set value from no load to full load under fluctuations in supply voltage and frequency by + 10% and +5% respectively of their normal values.
- b. The float charger shall have built-in current limiting feature to drop the output voltage for currents more than 110% of the rated current.
- c. Suitable ripple filtering circuits shall be provided to give a smooth D.C. output. The ripple content shall be limited to less than +5% on resistive load.

#### 3.15.4 Tests

- a. Routine tests (acceptance tests) such as visual inspection, dimensional check, etc. shall be conducted as per relevant I.S.
- b. Type test certificates for retention of charge, etc. shall be submitted. Type tests shall be carried out if specified in Data Sheet.
- c. Seven copies of the routine and type test certificates shall be submitted for the Owner's approval before despatch of the equipment.

#### 3.15.5 Technical data

a. **Battery:**

- a. Ambient temperature : 50<sup>0</sup> C max.
- b. Humidity : 95% Max.
- c. Battery capacity : lead-acid (tubular) in transparent SAN container type, High discharge performance
- d. Total effective voltage required : 110V D.C.
- e. Voltage per cell : 2.2V
- f. Voltage per cell at the end of discharge: 1.75V
- g. No. of identical batteries required : 2X100% One set of 23 Cells – 110V DC
- h. Proposed application : Alarm, Closing and tripping ckts. of Breakers,
- i. Indicating lamps, Tripping of Protective Relays, Annunciators, Hooters
- j. Accessories and spares : As required
- k. Approved makes : As per Approved vendor list

b. **Battery charger and DCDB**

- a. Rating : As required
- b. Input voltage : 415V, + 10%, 3Phase, 50Hz, + 3% A.C.
- c. Output voltage : 110V D.C.
- d. TYPE : Float & float cum boost with trickle Charging Facility and automatic battery over drain protection.



### 3.16 Metal Enclosed HV Switchgear Panel

#### 3.16.1 Scope

- a. This specification covers the design, manufacture, testing & supply of 6.6 kV indoor switchboards to operate 6.6kV 3 phase Induction motors at pumping station.
- b. For indicative power distribution scheme Electrical single diagram shall be referred. All the rating shown in the referred drawing represents the minimum requirement only; exact rating, number and type of feeder etc. shall be decided by the contractor.

#### 3.16.2 Codes and standards

- a. The equipment shall comply with all currently applicable electricity rules, approval of fire insurance, association, statutory regulations and safety codes in the locality where the equipment will be installed.
- b. Unless otherwise specified equipment shall confirm to the following latest applicable IS Standards. Equivalent IEC standards shall be used as applicable.

CODES	DESCRIPTION
IS: 5	Columns for ready mixed paints and enamels.
IS: 1248 (Part-1)	Direct acting indicating analogue electrical measuring instruments and their accessories: General requirements.
IS:1777	Specification for industrial luminaries with metal reflector
IS: 2099	Bushings for alternating Voltages above 1000 Volts.
IS: 2147	Degrees of protection provided by enclosures for low voltage switchgears & control gear.
IS: 2705 (Part-1)	Current transformers: General requirements.
IS:2834	Specification for Shunt capacitors for power system
IS:3043	Code of practice for earthing
IS: 3156 (Part-1)	Voltage transformers: General requirements.
IS: 3231	Specification for electrical relays for power system protection.
IS: 3427	A.C. metal enclosed switchgear and control gear for rated voltages above 1 KV & up to & including 52 KV.
IS:9385	High voltage fuses
IS: 12729	General requirements for switchgear & control gear for voltages exceeding 1000 V.
IS: 13118	Specification for High Voltage A.C. Circuit breaker.
IS:13703	Specification for low voltage for voltages not exceeding 1000V.
IS:13947	Specification for low voltage switchgear and control gear assemblies

### **3.16.3 Design criterion**

- a. The switchgear shall be used to supply power to HV motors, transformers and other loads of pumping station.
- b. Duty involves starting of large induction motors through Fully electronic type soft starter. The motor starting current varies from 2 to 4 times the full load current.
- c. For continuous operation at specified ratings, temperature of the various switchgear components shall be limited to the permissible values stipulated in the relevant IS/IEC standards.
- d. The switchgear and components thereof shall be capable of withstanding the mechanical forces and thermal stresses of short circuit listed in the data sheet and SLD without any damage or deterioration of material.
- e. Circuit breaker shall not produce any harmful over voltage during switching off induction motors, unloaded lines and unloaded transformers. If required surge protective devices shall be provided in the scope of supply to limit over-voltage.

### **3.16.4 Type of Sheet Steel & Cubicle**

The cubicle shall be of bolted construction with minimum thickness of 2.0mm and for other non-load bearing members such as inter compartment partition etc. can be of 1.5 mm. Sheet steel used for fabrication shall be cold rolled carbon annealed only and fabrication shall be done through CNC turret punch press and CNC bending machine. Sheet steel shall be of Aluzinc material without painting however the front sheet and rear sheet covers can be of CRCA powder coated painted. Width of cubicle shall be max 600mm/800mm up to 1250A. All covers & doors shall be of folded design type with viewing window at rear cover (box type) of polycarbonate.

### **3.16.5 Circuit Breaker**

- a. The circuit breaker shall be mounted on a with drawable truck which shall roll out horizontally from service position to isolated position with ease and it shall also be possible to take out the breaker truck from cubicle smoothly on to the floor. It is preferable to provide with guides for withdrawal and insertion of truck into the cubicle with ball bearing arrangement on the top of the truck. Circuit breaker shall be of vacuum only and the truck shall have distinct 'SERVICE' and 'TEST' position. Special multi point hinged locking arrangement shall be provided to prevent opening of door in the event of internal arc in breaker compartment. Isolation shall be horizontal.
- b. All the three interrupters of individual phases shall be mounted on a common phase segregated epoxy/BMC body mounted on a truck for better insulation and avoidance of non- simultaneity of poles. Circuit breaker shall be vacuum type only. Interrupter mounted on the conventional individual insulators will not be accepted. No separate fiber glass sheet barrier to be used.
- c. It shall be operated through a common motor wound spring charged mechanism with electrical release coil for closing and shunt trip coil for tripping. Operating mechanism must have manual

charging, closing and tripping facility with the provision locking facility in push to close & push to trip mechanical push button.

- d. The mechanism shall be such that motor will automatically recharge the mechanism springs after a closing operation enabling breaker to perform OCO operation. The charging time of motor shall be less than 15 secs making it suitable for rapid auto reclosing duty. Mechanical push to trip button shall be provided for manual tripping with front door closed. All the 'MS' components of circuit breaker mechanism shall be treated with zinc plating with passivation for longer life even in adverse climatic condition. Yellow passivation shall not be acceptable. All mechanism springs shall be powder coated. Plating on mechanism spring is not acceptable. The normal current rating of circuit breaker shall be in panel rating.

#### **3.16.6 Interlocks**

- a. Circuit breaker can be inserted only in open position. Likewise circuit breaker in closed position cannot be withdrawn. Attempt to draw out closed breaker shall not trip the breaker.
- b. The circuit breaker shall operate only in one of the three defined positions i.e. service, test and isolated. The breaker shall not close in any of the intermediate positions.
- c. The circuit breaker cannot be inserted into service position till auxiliary contacts are made. Similarly interlock shall prevent auxiliary contacts from being disconnected, if circuit breaker is in service position.

#### **3.16.7 Safety Shutters**

Safety shutters shall be metallic and shall be provided to cover up the fixed High voltage contacts on bus bar and cable sides when the truck is moved to Test / isolated position. The shutters shall move automatically, through a Linkage with the movement of the truck and shall be of gravity fall type only. It shall be possible to padlock shutters individually.

#### **3.16.8 Fixed Isolating Contacts**

Switch gear cubicle shall have seal off bushing arrangement between the circuit breaker compartment and bus bar / C.T. cum cable compartment, i.e. the fixed isolating contacts shall be embedded in epoxy cast bushing so the these act as seal off bushing to prevent transfer of arc from one compartment to the other in the event of internal arc within the cubicle & must be tested for internal arc in all three HV compartments as per new IEC 62271-200.

#### **3.16.9 Cable Compartment**

- a. It shall be at the rear side with rear bolted box type back covers. There shall be an inspection window at the rear back cover enabling operator to have visual inspection without opening back cover in live condition. Viewing window at the rear side shall be of poly carbonate only and shall be tested for internal arc. The gland plate of cable chamber shall be of minimum 3mm thickness MS sheet in two halves section.
- b. Sufficient head room shall be provided for cable termination. The distance between gland plate and terminal shall be minimum 600mm.

#### **3.16.10 Low Voltage Compartment**

Low voltage compartment shall be mounted at the front on the top of breaker compartment and shall also have hinged type of door. All wiring shall be routed through PVC ducts and shall be terminated on to stud type terminal with plastic cover. For current transformer terminal shall be disconnecting link type only. The wire shall be of 1.1KV grade and suitable for 2KVrms for 1 minute power frequency high voltage.

#### **3.16.11 Auxiliary Switch and Auxiliary Plug & Socket**

There shall be minimum 4NO and 4NC contacts in breaker auxiliary switch. In case of Additional contacts the same can be multiplied through contact multiplication relay type VAJC11 type electrically latched relay. Auxiliary plug and socket shall be of minimum 24 pin plug type and shall have scrapping earth feature. Auxiliary contacts shall be suitable for continuous thermal current rating of 10A.

#### **3.16.12 Electrical & Mechanical Position Indication**

In addition to mechanical position indication in breaker for test and service position, electrical indication shall also be provided through limit switch. There shall be minimum 2NO +2 NC contacts available in each position for electrical indication and for any other interlocking purpose.

#### **3.16.13 Control and Power Cable Entry**

Control cable entry shall be from front and there should be a possibility of terminating to LV chamber from both right hand and left hand side. Power cable entry shall be from rear bottom. Provision shall be available for entry of power cable from rear bottom. Control cable entry in LV compartment shall be through earthed metallic compartment segregated from HV compartments.

#### **3.16.14 Pressure Discharge Flaps**

Pressure discharge flaps shall be provided at the top in all high voltage compartments for the exit of hot gases in the event of internal arc in any of the HV compartments.

#### **3.16.15 Busbars**

Bus bar material shall be of high conductivity electrolytic aluminium and accessibility of the same shall be from top only. All bus bars shall be insulated with heat shrinkable PVC sleeves and joints shall have sufficient clearances in order to meet the BIL of 28kV RMS and 75 kVp withstand. Phase identification shall be made at the end by coloured tape. Bus bars shall be mounted on integral seal off bushings.

#### **3.16.16 EarthBus**

There shall be a continuous copper/GI earth bus at the bottom of the panel. Earth bus shall be robust and shall be capable of carrying full short circuit current for 1 second. Doors, covers and all non-current carrying metallic parts shall be earthed through flexible copper wires. This also includes instrument casing and cable armour which are also connected to the earth bus. Earth bus must be tested for minimum of 25KA for 1 sec.

### **3.16.17 Bus & Cable Earthing**

Separate earthing truck shall be provided for bus earthing and cable earthing. The earthing truck shall be so designed that it is impossible to earth a live. It shall be supplied with potential indicator and audio visual alarm .Incase of circuit being live. Earthing circuit shall be suitable of carrying full fault current for 1 second. Special electrical interlocking shall be provided for incomer earthing at cable side with secondary plug and socket arrangement.

### **3.16.18 Current and Potential Transformer**

- a. Current transformers shall be double core window/bar primary for higher rating or wound primary for lower rating. Maximum VA burden shall be of 15 VA and shall be rated for full short circuit current for 1 second.
- a. Potential transformer shall be 3nos single phase with 100VA per phase of class 1.0 accuracy. Line P.T. shall be mounted in a separate drawout carriage. In case of truck mounted breaker, line P.T. shall be provided in a separate panel. For bus connected P.T. it shall be provided in a separate panel.

### **3.16.19 Protection Relays**

- a. Incomer & Outgoings (50, 50N, 51, 51N)
  - a. Non – Directional Over current and Earth Fault Protection
    - i. The relay should have 3 independent time delayed O/C stages.
    - ii. The first stage should be programmable to have either a DT characteristics or IDMT characteristics described as follows and shall have a current setting range of 0.1 IN to 5 IN and time setting range of 0 ms to 150 sec. The second and third stage should have a current setting range of 0.1 IN to 40 IN.
    - iii. The relay should have 3 independent time delayed E/F stages.
    - iv. Should have a current setting range of 0.005 IN to 8 IN and time setting range of 0 ms to 100 sec. The lower setting is critical to take care of systems, which have low earth fault currents.
    - v. The relay should have front USB port for local communication with Laptop and rear RJ45 ports to communicate on native IEC61850 protocol for future integration. No protocol convertors shall be acceptable.
    - vi. Should be able to record at least 5 oscillographic disturbance records each of minimum 3 seconds.
    - vii. Should have minimum of 8 programmable LEDs.
    - viii. Should be able to record 5 fault records and 75 event records.
    - ix. Current input should be rated for both 1A & 5A.

- x. Should have two independent setting groups.
  - xi. Should have in built MIMIC display.
  - xii. Should be provided with free software for programming and analysing the disturbance records supporting comtrade format.
  - xiii. Should be able to measure and record harmonics apart from Current and frequency.
  - xiv. In built trip circuit supervision is mandatory apart from CT supervision feature.
  - xv. All CT & VT Connections should be with ring terminals.
- b. Incomer (Backup Earthfault Protection)
- i. The relay should have 3 independent time delayed E/F stages.
  - ii. Should have a current setting range of 0.005 IN to 8 IN and time setting range of 0 ms to 100 sec. The lower setting is critical to take care of systems, which have low earth fault currents.
  - iii. The relay should have front USB port for local communication with Laptop and rear RJ45 ports to communicate on native IEC61850 protocol for future integration. No protocol convertors shall be acceptable.
  - iv. Should be able to record atleast 5 oscillographic disturbance records each of minimum 3 seconds.
  - v. Should have minimum of 8 programmable LEDs.
  - vi. Should be able to record 5 fault records and 75 event records.
  - vii. Current input should be rated for both 1A & 5A.
  - viii. Should have two independent setting groups.
  - ix. Should have in built MIMIC display.
  - x. Should be provided with free software for programming and analysing the disturbance records supporting comtrade format.
  - xi. Should be able to measure and record harmonics apart from Current and frequency.
  - xii. In built trip circuit supervision is mandatory apart from CT supervision feature.
  - xiii. All CT & VT Connections should be with ring terminals.

### **3.16.20 Thermal Rating of Switchgear**

End temperature of all current carrying parts including breaker Relay shall be governed by IEC62271-1. All isolating contacts shall be silver plated. All rating shall be in panel only.

### **3.16.21 Auxiliary Supply**

Control supply for closing and tripping shall be 220 or 110Volts D.C. through external battery source. 230 Volts single phase A.C. supply shall also be available for the operation of spring charging motor and cubicle space heater. Wattage of closing and tripping coils shall be within 250 watts.

### **3.16.22 Overall Dimension**

Width of the switch gear cubicle shall be maximum 600mm upto 1250A panels and maximum width must not exceed 800mm for higher rating. Depth without extension chamber for more no. of cables shall be restricted to 2000mm.

### **3.16.23 TypeTest**

Following minimum type test reports shall be submitted for the evaluation of offers.

- a. All short circuit duties from test duty 1 to test duty 5 including single phase and double line to ground as per IEC62271-100
- b. Short time rating of minimum 25kA for 3 seconds as per IEC 62271-100,62271-200
- c. Temperature rise test as per IEC 62271-200
- d. Capacitor bank switching for 400A minimum & cable charging 25 A test as per IEC 62271-100 For test duties 1 to 4
- e. Degree of protection test as per IEC 62271-200
- f. Upto 600 mm cubicle and upto 1250A tested for IP-54
- g. Lightning impulse voltage test as per IEC 62271-100, 62271-200
- h. Intern alarc test in all the three high voltage compartments 25kA 0.1sec as per IEC62271-200

### **3.16.24 Cabling**

- a. All cables shall be so connected between main switchboards, distribution boards, plant and accessories so that the correct sequence or phase colours are preserved throughout the system. Tinned copper lugs of appropriate size shall be used for termination of power cables.
- b. All cable cores shall be identified with phase colours for three and four wire circuits and red and black for single-phase circuits. Cables shall confirm to relevant Indian Standards and shall be of the heavy-duty type.
- c. Cable shall be capable of satisfactory performance when laid on trays, in trenches/ conduits/ ducts and directly buried in the ground.
- d. All types of power Cables shall confirm to IS 1255.

- e. Cable network should be so designed that cables are not loaded for more than 50% of rated capacity arrived after applying all the applicable derations.
- f. All cables shall be delivered on robust cable drums with cable ends treated to form an effective seal. When a cable is cut from a drum, the cable end and the left on the drum shall be immediately sealed in an approved manner to prevent the ingress of moisture. Prior approval of the Engineer shall be taken to deliver the cable/s in a coil form, where the same cannot be delivered on a drum.
- g. The Contractor shall ensure that the current rating of each cable is adequate for its duty under both normal and possible fault conditions. In assessing the rating and cross section required for each cable the following should be taken into account.
  - a. Fault level and duration as governed by circuit protection relays/ fuse;
  - b. Conditions of ambient temperature and method of installation and grouping;
  - c. Voltage drop
  - d. Loading under steady state and transient conditions;
  - e. Disposition of cables, whether in air or laid in the ground in groups or otherwise

### 3.17 HV & LV Cables

#### 3.17.1 Scope

This specification covers requirement of XLPE Cables for High Voltage Systems and XLPE/PVC Cables for Medium Voltage systems.

#### 3.17.2 Codes and standards

Unless otherwise specified cables shall confirm to the following Indian Standards (as amended latest)

CODES	DESCRIPTION
IS : 1554 (Part I)	PVC insulated (heavy duty) electric cables - Part-I for working voltages upto and including 1100 V.
IS : 7098 (Part I)	Cross-linked Polyethylene insulated PVC sheathed cables: Part I for working voltages up to and including 1100kV.
IS : 7098 (Part II)	Cross-linked Polyethylene insulated PVC sheathed cables: Part II for working voltages from 3.3 KV upto and including 66 KV.
IS : 8130	Conductors for insulated electric cables and flexible cords.
IS : 5831	PVC insulation and sheath of electric cables.
IS : 3975	Mild steel wires, strips and tapes for armouring of cables.
IS : 3961 (Part II)	Recommended current ratings for cables: Part II PVC insulated and PVC sheathed heavy duty cables.
IEC : 502	Extruded solid dielectric insulated power cables for rated voltages from 1



CODES	DESCRIPTION
	KV upto 30 KV.
IS : 10810 (Part 61)	Flame Retardant Test
IS : 10810 (Part 62)	Flame retardant test for bunched cables.
IS : 10418	Drums for electric cables.

### 3.17.3 General construction of cables

- The cables shall be suitable for laying in trays, trenches, ducts or for underground buried installations with uncontrolled backfill and possibility of flooding by water and chemicals.
- Outer sheath of the cables shall be black in colour and the minimum value of oxygen index shall be 29 at  $27 \pm 2$  degree Celsius. In addition, suitable chemicals shall be added into the PVC compound of the outer sheath to protect the cable against rodent and termite attack.
- Sequential marking of the length of the cable in metres shall be provided on the outer sheath at every one mtr. The embossing shall be legible and indelible. The size of the cable also shall be indicated on the outer sheath of the cable at regular intervals.
- The overall diameter of the cables shall be strictly as per the values declared in the technical information to be furnished along with datasheet subject to a maximum tolerance of  $\pm 2\text{mm}$ .
- PVC / Rubber end caps shall be supplied at his own cost for each drum with a minimum of ten nos. per five hundred metres length. In addition, the ends of the cables shall be properly sealed with these caps to avoid ingress of water during transportation and storage.

### 3.17.4 XLPE Cables

- Power cables for 3.3 KV up to and including 66 KV system shall be Aluminium Conductor; XLPE insulated screened, sheathed, armoured and overall PVC sheathed XLPE type as detailed below.
- Power cables for up to and including 1100 V system shall be Aluminium Conductor, XLPE insulated screened, sheathed, armoured and overall PVC sheathed, XLPE type as detailed below. The conductors shall be stranded and compacted circular for all cables.
- All cables rated 3.3/6.6kV and above shall be provided with both conductor screening and insulation screening. The conductors shall be provided with non-metallic extruded semi conducting shielding.
- The core insulation shall be with cross-linked polyethylene insulating compound applied by extrusion. It shall be free from voids and shall withstand all mechanical and thermal stresses under steady state and transient operating conditions. It shall confirm to the properties given in Table-1 of IS: 7098 (part II).
- The insulation shielding shall consist of non-metallic extruded semi-conducting compound in combination with a non-magnetic metallic screening of copper..

- f. The conductor screen, XLPE insulation and insulation screen shall all be extruded in one operation by “Triple Extrusion” process to ensure perfect bonding between the layers. The core identification shall be by coloured strips or by printed numerals.
- g. The inner sheath shall be applied over the laid up cores by extrusion and shall confirm to the requirements of type ST2 compound of IS: 5831. The extruded inner sheath shall be of uniform thickness.
- h. For multi-core cables, the armouring shall be by galvanised steel strips. If armouring is specified for single core cables in the data sheet, the same shall be with H4 grade hard drawn aluminium round wire of 2.5 mm diameter.
- i. The outer sheath of the cables shall be applied by extrusion over the armouring and shall be of PVC compound confirming to the requirement of type ST2 compound of IS: 5831. . The minimum and average thickness of outer sheath for unarmoured cables and the thickness of outer sheath shall be as per IS: 7098 - Part 2.
- j. The thickness of the insulation, inner sheath shall be governed by values given in IS : 7098 (Part-1).
- k. Where specified, 1100 V grade shall also be XLPE insulated and shall meet the requirement specified in IS-7098(Part-1). power cables

### **3.17.5      PVC cables**

- a. All control cables shall be heavy-duty type, 650/1100 V grade with minimum 1.5 sq mm copper conductor, PVC insulated, inner-sheathed, armoured and overall PVC sheathed unless specified otherwise.
- b. The core insulation shall be with PVC compound applied over the conductor by extrusion and shall confirm to the requirements of type ‘A’ compound as per IS: 5831. The thickness of insulation and the tolerance on thickness of insulation shall be as per Table 2 of IS: 1554 (Part-1). Control cables having 6 cores and above shall be identified with prominent and indelible English numerals on the outer surface of the insulation. Colour of the numbers shall contrast with colour of insulation with a spacing of maximum 50 mm between two consecutive numbers. Colour coding for cables up to 5 cores shall be as per Indian standard.
- c. The inner sheath shall be applied over the laid-up cores by extrusion and shall be of PVC confirming to the requirements of Type ST-1 PVC compound as per IS: 5831. The minimum thickness of inner sheath shall be as per IS: 1554 (Part-1). Single core cables shall have no inner sheath.
- d. If armouring is specified for multicore cables in the cable schedule, the same shall be by single round galvanized steel wires where the calculated diameter below armouring does not exceed 13 mm and by galvanized steel strips where this dimension is greater than 13 mm. Requirements and methods of tests for armour material and uniformity of galvanization shall be as per IS-3975 and IS-10810 (Part 41). The dimensions of Armour shall be as per method (b) of IS-1554 (Part -1).

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If armouring is specified for single core cables in the cable schedule, the same shall be with H4 grade hard drawn aluminium round wire of 2.5 mm diameter.

- e. The outer sheath for the cables shall be applied by extrusion and shall be of PVC compound confirming to the requirements of type ST-1 compound as per IS: 5831. The minimum and average thickness of outer sheath for unarmoured cables and minimum thickness of outer sheath for armoured cables shall be as per IS:1554 (Part-1)
- f. If heat resisting PVC cables are specified in the cable schedule, the following shall be the requirements:
- g. It shall be possible to continuously operate the cable at a maximum conductor temperature of 85°C.

PVC compounds used for heat resistant PVC cables shall be as follows:

Conductor insulation	-	Type C
Inner sheath		-Type ST 2
Outer sheath	-	Type ST 2

- h. All cable conductors shall be of electrolyte grade high conductivity annealed copper as per IS 191 and shall have a cross-sectional area of not less than:
- i. 10 mm<sup>2</sup> for cable in between feeder pillar/main lighting distribution board and street lighting poles junction boxes.
- j. 2.5 mm<sup>2</sup> for power circuits such as to supply power to motor windings.
- k. 2.5 mm<sup>2</sup> for motor , valve actuator(in case provided) and auxiliary circuits such as for anti-condensation heaters, thermistors, pushbutton stations, etc
- l. 1.5 mm<sup>2</sup> for indoor lighting circuits.
- m. 1.5 mm<sup>2</sup> for instrumentation circuits.
- n. Each neutral conductor shall be of the same cross-sectional area as the associated phase conductors.
- o. Use of Armoured Cables:  
  
Cables which are laid external to the electrical panels shall be armoured as per IS 3975.
- p. Use of Unarmoured Cables

Unarmoured cables shall be used inside each electrical panel for wiring of control circuit.

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### **3.17.6 Cable Accessories**

- a. The termination kits for use on the systems shall be suitable for the type of cables offered as per this specification.
- b. The accessories shall be supplied in kit form. Each component of the kit shall carry the manufacturer's mark of origin.
- c. The kit shall include all stress grading, insulating and sealing materials apart from conductor fittings and consumable items. An installation instruction sheet shall also be included in each kit.
- d. The contents of the accessories kit including all consumable shall be suitable for storage without deterioration at a temperature of 50° C with shelf life shall be 5 years.
- e. The terminating kits shall be suitable for termination of the cables to indoor switchgear or to a weatherproof cable box of an outdoor mounted transformer / motor. For outdoor terminations, weather shields / sealing ends and any other accessories required shall also form part of the kit. The termination kits shall be from one of the makes / types mentioned in the approved vendor list.

#### **3.17.6.1 Installation and Termination of Cables**

- a. The contractor shall install, test and commission the cables specified in the specification in accordance with drawings and instructions issued by the Owner or Owner's Representative. Cables shall be laid directly buried in earth, on cable racks, in built up trenches, on cable trays and supports, in conduit and ducts or bare on walls, ceiling etc. as per drawings. contractor's scope of work includes unloading, laying, fixing, jointing, bending and termination of the cables. The Contractor shall also supply the necessary materials and equipment required for jointing and termination of the cables.
- b. All apparatus, connections and cable work shall be designed and arranged to minimise risk of fire and any damage which might be caused in the event of fire. Wherever cables pass through floor or wall openings or other partitions, suitable bushes of an approved type shall be supplied and put into position by the Contractor. If required by the Owner or Owner's Representative the Contractor shall seal the cables into the bushes using fire resisting materials to prevent the spreading of fire through each partition.
- c. Inspection on receipt, unloading, storage and handling of cables shall be in accordance with the IS: 1255 and other Indian Standard Codes of Practice.
- d. Standard cable grips and reels shall be utilized for cable pulling. If unduly difficult pulling occurs, the Contractor shall check the pull required and suspend pulling until further procedure has been approved by the Owner's Representative. The maximum pull tension shall not exceed the recommended value for the cable measured by the tension dynamometer. In general, any lubricant that does not injure the overall covering & does not set up undesirable conditions of electrostatic stress or electrostatic charge may be used to assist in the pulling of insulated cables in conduits and ducts.

- e. After pulling the cable, the Contractor shall record cable identification with date pulled neatly with waterproof ink in linen tags and shall securely attach such identification tags. Identification tags shall be attached to each end of each cable with non-corrosive wire. The said wire must be non-ferrous material on single conductor power cable. Tags may further be required at intervals on long runs of cables on cable trays and in pull boxes. Cable and joint markers and RCC warning covers shall be provided wherever required.
- f. Sharp bending and kinking of cables shall be avoided. The bending radii for various types of cables shall not be less than those specified below
- g. 6.6KVXLPE multicore : 15 times the overall diameter of the cable armoured cables
- h. 650-1100 V XLPE/PVC insulated : 10 times the overall diameter of the cable
- i. If shorter radius appears necessary, no bend shall be made until clearance and instructions have been received from the Owner's Representative.
- j. Power and control cables shall be laid in separate cable racks/trays.
- k. Where groups of HV, LV and control cables are to be laid along the same route, suitable barriers to segregate them physically shall be employed.
- l. When power cables are laid in the proximity of communication cables, minimum horizontal and vertical separation between instrumentation and control cables carrying analogue and digital signals shall be separated from LV power cables by at least 300 mm and HV power cables by at least 600 mm. Telecommunication cables shall be segregated from all other cables by at least 600 mm. Power and communication cables shall as far as possible, cross at right angles to each other.
- m. Where cables cross roads and water, oil, gas pipes, the cables shall be laid in reinforced spun concrete or uPVC conduits. For road crossings the pipe for the cables shall be buried at not less than one metre depth.
- n. Cables laid in ground shall be laid on a 75 mm riddled earth bed. The cables shall then be covered on top and at their sides with riddled earth of depth of about 150 mm. This is then gently filled up to a depth of about 100 mm above the top of uppermost cable to provide bedding for the protective cable covers for LV cables may be of earthenware. The RCC covers shall have one hole at each end, to tie them to each other with GI wires to prevent displacement. The trench is then backfilled with the excavated soil and well-rammed in successive layer of not more than 300 mm in depth, with the trenches being watered to improve consolidation wherever necessary. To allow for subsidence, it is advisable to allow a crown of earth not less than 50 mm in the centre and tapering towards the sides of the trench.
- o. Each cable shall be pulled into the particular conduit and shall be taken from the particular reel designated for the run. All cables shall be neatly trained without interlocking. In hand holes, pull boxes or junction boxes having any dimension over 1000 mm, all conductors shall be cabled and/or racked in an approved manner. Care shall be taken to avoid sharp bending or kinking conductors, damaging insulation or stressing cable beyond manufacturer's recommendations in

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pulling. Cable shall be protected at all times from mechanical injury and from absorption of moisture at unprotected ends.

- p. In each cable run some extra length shall be kept at a suitable point to enable one or two straight through joints to be made, should the cable develop a fault at a later date.
- q. Cables on cable racks, on cable trays and conduits shall be formed to avoid bearing against edges or trays, racks, conduits or their supports upon entering or leaving trays, racks or conduits. Cables shall be racked or laid directly into cantilevered cable trays where practicable, but in some cases it may be necessary that cables are pulled or threaded into trays. To facilitate visual tracing, cables in trays shall be laid only in single layers and unnecessary crossing of cables shall be avoided. Cables on trays shall finally be clamped in an approved manner.
- r. Splices shall be made by contractor for each type of wire or cable in accordance with the instructions issued by cable manufacturers and the Owner's Representative. Before splicing insulated cables shall have conductor insulation stepped and bound or pencilled for recommended distance back from splices to provide a long leakage path. After splicing, insulation equal to that on the spliced conductors shall be applied at each splice.
- s. At cable terminal points where the conductor and cable insulation will be terminated, terminations shall be made in a neat, workmanlike and approved manner by men specialized in this class of work. Terminations shall be made by the contractor for each type of wire or cable in accordance with instructions issued by cable manufacturer's and the Owner's Representative.
- t. Control cable termination shall be made in accordance with wiring diagrams using colour codes established by the Owner's Representative for the various control circuit, by code marked wiring diagram.
- u. When control cables are to be fanned out and cabled together with cord, the Contractor shall make connections to terminal blocks and test the equipment for proper operation before cables are corded together. If there is any question as to the proper connection, the Contractor shall make a temporary connection with sufficient length of cable so that the cable can be switched to another terminal without splicing. After correct connections are established through operating the equipment, cables shall be cut to their correct lengths, connected to terminals in the specified manner, and corded together .
- v. Cable seals shall be examined to ascertain if they are intact and that cable ends are not damaged. If the seals are found to be broken the cable ends shall not be jointed until after due examination and testing by the Owner's Representative.
- w. After installation and alignment of motors, the Contractor shall complete the conduit installation, including a section of flexible conduit between motor terminal box and trench/tray. The Contractor shall install and connect the power, control and heater supply cables as per equipment manufacturer's drawings, if any. The Contractor shall be responsible for correct phasing of the motor power connection and shall interchange connections at the motor terminal box if necessary, after each motor is test run.

- x. Connections to recording instruments, float switches, level electrodes, limit switches, pressure switches, thermocouples, thermostats and other miscellaneous equipment shall be done as per manufacturer's drawings and instructions.
- y. Metal sheath and armour of the cable shall be bonded to the earthing system of the station. The size of conductor for bonding shall be appropriate with the system fault current.
- z. All new cables shall be megger tested before termination. After termination, all L.V. cables shall be megger tested. 1100/650 volt grade cables shall be tested by 1000 volt megger.
- aa. Cable shall be tested in accordance with IS 7098. Contractor shall furnish all testing kit and instrument required for field-testing
- bb. Contractor shall ensure to use calibrated test equipment having valid calibration test certificates from standard laboratories traceable to National Standards.
- cc. Every cable shall be installed in a single length without joints.
- dd. Double compression cable gland shall be used to terminate each end of every armoured cable confirming to IS 4218. The cable gland for every cable rated up to 1100 V shall be constructed from brass.
- ee. Every cable shall be identified at each end, in line with the cable schedule.
- ff. Cable laying shall be initiated only after approval of entire cable route.

### **3.17.7 Cable Support Systems**

#### **3.17.7.1 Trays for Power Cables**

Ladder type cable trays shall be used for power cables & perforated type cable shall be used for control cables. Cable trays shall be as per relevant IS standards. Material of construction shall be of hot dip galvanized steel.

#### **3.17.7.2 Cables External to Buildings and Structures**

- a. Cables external to buildings and structures shall be installed underground through suitable sized uPVC conduits, concrete ducts or shall be directly buried.
- b. Where cables pass below internal or external roads or areas of hard standing, cables shall be laid through concrete ducts. Cable concrete duct systems shall incorporate suitably located draw-pits/inspection chambers/pull boxes whenever there is change in direction of route of the cable. Cables crossing below the walls or structures shall be laid through uPVC conduits.
- c. Minimum 30% space inside uPVC conduits and concrete ducts shall be kept for future expansion. The minimum depth LV cable installation shall be 700 mm.
- d. Cable trays and supports shall be in accordance with IEC 61537.

- e. Cable tray supports shall provide adequate strength with minimum rigid support to the fully laden cable tray along its entire length.
- f. All cable trays inside the control room and out of the trench shall be closed.
- g. A maximum of two layers of cable shall be installed on any tray.
- h. All cable trays shall be supported to prevent sagging.

#### **3.17.7.3 Metallic Conduit:**

All outdoor black stove conduits shall be of rigid galvanized steel, unless otherwise specified. Galvanization process shall go from three stages: Surface Preparation, Galvanizing and Inspection. All metallic conduits shall be as per IS 9537(Part –II)

#### **3.17.7.4 Non-Metallic Conduit:**

- a. All exposed indoor conduits, underground, concealed or concrete embedded conduits shall be uPVC unless otherwise specified on drawing. Conduits in classified areas shall be of uPVC material as per latest Indian Standard.
- b. Conduits shall be round in shape with different mechanical strength as per area requirement i.e. low mechanical strength for indoor conduit installation and high mechanical strength for outdoor and buried application.
- c. Conduit shall be durable and impact resistant as per IS 9537 and IS 14927.
- d. Conduit shall be fire retardant and corrosion resistant as per IS 9537.
- e. Conduit shall have negligible water absorption.

#### **3.17.7.5 Corrugated Flexible Conduit:**

- a. uPVC corrugated flexible conduits shall be manufactured as per IS 9537 ideally suited for electrical wiring and cable protection.
- b. Use liquid tight flexible uPVC conduit for termination at Junction boxes, Local control stations (LCS), termination to motors, field instrumentation and process equipment unless otherwise specified.

#### **3.17.7.6 Conduit Fittings:**

- a. Fittings, as required, for use with conduit specified, with coating and colour same as conduit shall be provided.
- b. All conduit fittings and covers shall be weatherproof and watertight as per Indian standard 3419, unless otherwise noted.



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#### **3.17.7.7 Conduit Fastenings:**

- a. Use uPVC straps for uPVC conduits and steel straps for galvanized steel / galvanized iron conduits.
- b. Channel type supports shall be provided for two or more conduits.
- c. All surface installation horizontal runs of conduits should be secured at maximum distance of 0.9 meters and vertical runs of conduits should be secured at maximum distance of 1.2 meters.
- d. Fastening should be properly tightened to restrict thermal movement of conduit.

#### **3.17.7.8 Expansion Fittings or couplers:**

- a. Appropriate water tight expansion sleeves with bonding where conduit crosses a structural expansion joint or to accommodate for thermal movement due to temperature change on surface installations, complete with grounding strap and clamps shall be provided.
- b. Expansion couplers shall be installed with a short side coated with solvent cement and coupler pushed firmly over the conduit down the nib. The slip side coated with silicon grease receives the conduit to a midpoint to the nib. This will then permit for expansion or contraction providing the conduit is free to move in the saddle.

#### **3.17.7.9 Outlet and Conduit Boxes:**

- a. Outlet boxes shall be sized in accordance with IS 3419.
- b. Appropriate Switch boxes shall be provided where wiring devices such as switches, fan regulators etc. are grouped.
- c. Blank cover plates shall be provided for boxes without wiring devices.
- d. Where outlet boxes are used for more than one system appropriate combination of barriers shall be provided.
- e. Outlet boxes made from uPVC or galvanized steel and shall be suitable for mounting/fixing on masonry and/or concrete construction and shall be flush mounted or surface mounted as per site requirement.
- f. All fittings, boxes and covers, in below grade areas, shall be weatherproof confirming to relevant IS unless otherwise noted.
- g. Outlet boxes, conduit boxes and fittings for hazardous locations shall be as per IS 5571.
- h. uPVC and galvanized steel boxes with fittings (bends elbows, tees crosses etc) for surface wiring of switches and receptacles.

#### **3.17.7.10 Markers:**

- a. 300 mm wide polyethylene Cable Marker Tape, Red in colour with the following imprinted continuously over its entire length: "DANGER- "sign of Skull & Bones" BURIED ELECTRIC CABLE BELOW".
- b. The Cable route marker post in circular in shape made up of hot dip galvanized steel of approximate diameter 100 mm and thickness not less than 4 mm. shall be used for cable route indication. The inscription shall indicate the presence of a cable below, the depth and voltage rating.

#### **3.17.7.11 Sealing Compound:**

- a. Conduit fitting shall be installed in the system using solvent cement for restriction of water in it and silicon grease where installation is subject to frequent changes.
- b. PVC solvent cement shall be used as a method of joining uPVC conduit into fitting like couplings, adaptors, bends and boxes, especially formulated for watertight joint.

#### **3.17.7.12 Packing and marking**

- a. Cables shall be despatched in non-returnable wooden drums of suitable barrel diameter, securely battened, with the take-off end fully protected against mechanical damage. The wood used for the construction of drum shall be properly seasoned, sound and free from defects. Wood preservatives shall be applied to the entire drum. Ferrous parts used shall be treated with a suitable rust preventive finish or coating to avoid rusting during transit or storage.
- b. On the flange of the drum, necessary information such as Project Title, Manufacturer's name, Type, Size, Voltage Grade of cable, length of cable in metres, drum no., cable code, BIS certification mark, gross weight, etc. shall be printed, with also suitable markings showing the direction of rotation of the drum.
- c. Cables shall be supplied in drum lengths as follows: -
  - Medium voltage power cables up to and including 16 sq. mm -1000M.
  - Medium voltage power cables from 16 sq. mm up to and including 300 sq.mm - 500M – 750M
  - Control cables up to and including 27 cores -1000M.
  - HV Cables - 500M
- d. A tolerance of plus or minus 5% shall be permissible for each drum. However, overall tolerance on the total length of each size of cable shall be limited, to  $\pm 2\%$ . If non-standard drum lengths are specified in the data sheet, the same shall be supplied.
- e. Final confirmations shall be taken from the Owner, regarding the drum lengths for various sizes of cables at the time of order.

### **3.17.7.13 Testing and inspection**

- a. The cables shall be examined and tested at the manufacturer's works. The Owner representative shall have free access to the manufacturer's works for the purpose of inspecting the process at manufacturer's works in all stages and he will have the power to reject any material, which appears to him to be unsuitable.
- b. After completion of manufacture of cables and prior to despatch, the cables shall be subjected to type, routine, acceptance and special tests as detailed below. The Owner reserves the right to witness all tests with sufficient advance notice from the Contractor. The test reports for all cables shall be got approved from the Owner before despatch of the cables.
- c. All routine tests, acceptance tests, type tests for improved fire performance shall be carried out on cables as listed in IS : 1554 Part-I and IS : 7098 Part I and II.
- d. Following are the special tests to be performed on the cables. Copies of test reports for similar type of cables shall be provided for owner's approval.
  - Flammability Test: The test shall be carried out on finished cable as per IS: 10810 (Parts 61 and 62).
  - Test for rodent and termite repulsion property.

### **3.17.8 Wires & Cables**

#### **3.17.8.1 General**

- a. Installation of wires and cables shall be in accordance with I.S. 732. All wires shall run from box to box without splices. Sharp bends shall be avoided. They shall be pulled in or laid in such a manner that the insulation is not damaged at the time of installation or in service. Care shall be exercised to ensure avoidance of any moisture in terminations. The wire / cable being laid shall be in one length, and straight joints shall be avoided as far as possible.
- b. Insulation shall be removed for making terminations in such a manner that the conductor is not damaged. Conductors shall be clean and free from burrs.
- c. The current carrying ability of the terminations shall be equal to or greater than the wire / cable being terminated, without dependence on the solder. The termination shall be mechanically secure, without dependence on the crimping. Solder and soldering flux, if used, shall be non-corrosive and of a make approved by the cable or wire manufacturer.
- d. Minimum wire size shall be 2.5 sq. mm. copper. Above 10 sq. mm. size, all wires shall be stranded. All wire and cable runs under (i) poured concrete or road beds and (ii) passing through walls shall be in (i) RCC pipes and (ii) conduit sleeves respectively.
- e. No wire or cable shall be run through any equipment foundation unless specifically indicated in the drawings, or directed in writing by Owner. Cables shall be kept at least 300 mm away from steam or other hot lines. Where closer than this, hylem or fibre glass barrier shall be used between pipe and cables. The armouring of all armoured cables shall be electrically continuous

from Switchgear to equipment and shall be terminated by an appropriate gland fitting and grounded at both ends. Minimum bending radius shall be 12 to 15 times the outside diameter of the cables as recommended by the cable manufacturer.

- f. The colour code of wires shall be same throughout the installations and shall be approved by the Owner. (Where more than one neutral is carried in the same conduit, the neutral conductors shall be identified.)
- g. Where colour coding is not practicable or possible, the above scheme shall be achieved by the use of colour bands provided by the electrical contractor.
- h. No oil, grease or compound other than powdered soap stone shall be used to facilitate the pulling of wires. Buried cable shall be installed with sufficient slack in the trench along the cable length.
- i. The electrical contractor shall arrange all cables and wires in neat formations along the wall or in suitable cable, including supply and installation of all supporting steel work like angles, channels, etc. and painting of the same.

#### **3.17.8.2 415/240V System**

- j. Wires drawn in conduit will be unarmoured. Cables laid in trays or buried in the ground shall be armoured.
- k. The number of wires and conduit sizes indicated for the various circuits (control, alarm and signal) were decided for a general scheme of wiring. The actual number of wires installed for each circuit and the required size of conduit shall, however, be as required to accomplish the specified results as required by the manufacturer of the said control equipment.
- l. Wires connected to the same phase and for the required neutral only can be grouped in one conduit, for lighting installation.
- m. No single core wire alone shall run in any conduit unless clearly shown in the drawings.
- n. This part of the specifications cover the responsibility of selecting the proper branch circuit designation in the panel boards and to install the branch circuit wiring in accordance with the phasing sequence as shown on the drawings, so that the loads are balanced across all the phases as closely as possible and to cause minimum unbalance in the panel board neutral wires. If any changes are to be made, approval of the Owner is essential.
- o. No wire shall be pulled until the complete conduit is installed. No splices or joints shall be permitted in either feeders or branches except at the outlet of accessible junction boxes.
- p. Termination of wires and cables at main boards, MCCs, lighting /power panels, fixtures, etc. is to be done preferably with solderless tinned copper terminal lugs duly crimped and using petroleum jelly at all connections. Special permission shall be taken from the Owner for termination with soldering method.

### **3.17.8.3 Buried cables**

- a. Only armoured / cables shall be buried directly in the ground. Trench for H.T. cables shall be 900 mm deep and for L.T. and other lower voltage cables shall be 600 mm deep or as specified in the drawings. Where both H.T. and L.T. cables follow the same route, one trench may be used. In that case, the higher voltage cables shall be installed at 900 mm and then the trench shall be filled to 600 mm with sand and pebbles and the low voltage cables shall be then installed. High voltage cables shall be spaced minimum 75 mm on centres.
- b. When it is necessary to pull the cable into the trench, rollers or a greased wooden trough should be used to reduce friction. A series of sleeves may be necessary to guide the cable around corners. Care should be exercised to avoid contact with sharp stones and other heavy objects in the trench. A two-inch layer of sand or clean earth shall be placed at the bottom of trench to avoid sharp objects coming in contact with the cables.
- c. After the cables are installed, cover the cables with 150 mm of rock-free earth or sand, place a layer of bricks or concrete tiles over that and backfill to grade. Concrete markers shall be placed at each bend and at a approximately 15 meters' intervals along straight runs to show the location of the cables. These markers shall extend above the grade by 25 mm.
- d. Cables shall be laid with slight slack in the trench to allow for the settlement of earth.
- e. After confirming with the Owner, necessary loops shall be made at the locations indicated by him.
- f. Concrete-lined cable trenches for cables inside buildings, if shown on the drawings, shall be provided by others.

## **3.18 Lighting system**

### **3.18.1 Scope**

- a. The scope covers supply and installation of LED Light in Indoor & Outdoor lights. The system shall cover all interior and exterior lighting such as area lighting, high bay fittings, Flood Lighting, Transformer yard, Street lighting etc. The constructional features of lighting distribution boards are given in item LT Switch-gear.
- b. Emergency lighting shall be from DC Battery system and shall be provided at important locations. Portable emergency lights shall be provided where DC Battery System is not used.
- c. The type of lighting fixtures and receptacles, illumination level and approximate quantity required shall be generally as per design criteria

### **3.18.2 General Requirements**

- a. comprehensive illumination system shall be provided.
- b. It shall be the responsibility of the contractor to work out a detailed layout with detailed requirement of lighting and receptacle system for the whole pumping station, area lighting,

MCC building, outdoor switchyard, street light and staff quarters including area lighting as per specification and accordingly procure and install them.

- c. The system shall include, lighting fixtures complete with Lamps and accessories distribution boards, lighting panels, lighting fixtures, junction boxes, receptacles switch boards, lighting pole/masts, conduits, cables and wires, etc
- d. The system shall cover all interior and exterior lighting such as area lighting, High bay fitting, Flood Lighting, including Transformer yard etc. The constructional features of lighting distribution boards are given in item LT Switch-gear.
- e. Energy efficient LED lights with aluminium body fitting can be used at suitable locations.
- f. Street Lighting shall be automatically controlled by synchronous timer. Provision to bypass the timer shall be provided in the panel for manual control.
- g. ELCB, MCB to be used for human safety
- h. Light control switches, receptacle units with control switch units, lighting wires, conduits and other similar items necessary to complete lighting system
- i. In all types of cabling, due consideration shall be given to neatness and good appearance
- j. The illumination system shall be designed on the basis of best engineering practice and shall ensure uniform reusable, aesthetically and glare free illumination. The lighting fixtures shall be designed for minimum glare.
- k. The Contractor shall measure the lux levels after installation and be responsible to maintain lux level as per tender requirement. If required additional lighting shall be provided without extra cost
- l. The Illumination levels to be adopted for various areas are indicated in Table Below.

**ILLUMINATION LEVEL:**

<b>Pump House, Indoor, outdoor Area</b>	<b>Average Illumination Level in Horizontal plane (in Lux)</b>	<b>Type of fitting</b>
Main Pump house area	200	LED Tube light
Main Pump house area	200	Hi bay LED light
Service Bay	200	LED Tube light
Control Room	300	LED Tube light
Switchgear Room	250	LED Tube light
Cable floors & other areas (each)	100	LED Tube light
W.C; galleries & Staircase	100	LED Down light
Galleries	70	LED Down light

Battery Room	150	LED Tube light
Switch Yard equipments	50	LED Flood light
Switchyard, road light & outside Pump house	30	ED street light

- j. Lighting fixtures rating and quantity shall be provide to achieve above mention lux level in different area.
- k. Lighting design shall be performed using DiaLux Software with its latest version/ Original Equipment Manufacturer (OEM) validated software.

### **3.18.3 Lighting Layout**

It shall be the responsibility of the contractor to work out a detailed layout for the complete plant in order to provide the levels of illumination as indicated in the design criteria. The type of fixtures to be used in various areas are also indicated in the above mentioned drawing. The Contractor shall be responsible for measuring the levels of illumination after installation and establish compliance with the specification.

### **3.18.4 Lighting Fixtures (Luminaires)**

- a. Luminaires shall be designed for continuous trouble-free operation without reduction in lamp life or without deterioration of materials and internal wiring. Outdoor fittings shall be weather-proof and rain-proof type.
- b. The Luminaires shall be designed so as to facilitate easy maintenance, including cleaning, replacement of lamps/starters etc.
- c. Connections between different components shall be made in such a way that they will not work loose by small vibration.
- d. For each type of Luminaires the Contractor shall furnish the utilisation factor tables to indicate the proportion of the light emitted by the bare lamps which falls on the working plane.
- e. All Luminaires shall be supplied complete with lamps suitable for operation on a supply voltage and the variation in supply voltage, frequency and combined voltage and frequency of  $\pm 10\%$ ,  $\pm 5\%$  and  $\pm 10\%$  respectively.
- f. The Luminaires and accessories shall be designed to have low temperature rise.
- g. The temperature rise above the ambient temperature shall be as indicated in the relevant Standards.
- h. Luminary shall be mounted as far as possible in the luminaries housing only. Outdoor type fixtures shall be provided with outdoor type weather-proof box.

- i. Terminal blocks: Each indoor luminaries shall have a terminal block suitable for loop-in, loop-out and T-off connection by 240 V, 1 core, PVC insulated copper conductor wires up to 4 mm<sup>2</sup> in size. Outdoor areas the termination at the luminaries shall be suitable for voltage grade of 1100 V, 6 mm<sup>2</sup> copper conductor, PVC insulated armored cables. Terminals shall be of stud or clamp type. Terminal blocks shall be mounted with minimum two fixing screws.

- j. Mounting facility and conduit knock-outs for the luminaires shall be provided.

**a. Earthing**

- i. Each luminaire shall be provided with an earthing terminal suitable for connection to the earthing conductor of 12 SWG GI wire.
- ii. Where separate control gear box is provided for housing the accessories the same shall be provided with an earthing terminal suitable for connecting earthing conductor of 12 SWG GI wire.
- iii. All metal or metal enclosed parts of the luminaire shall be bonded and connected to the earthing terminal so as to ensure satisfactory earthing continuity.

**b. Painting/Finish**

- i. All surfaces of the Luminaire/Control gear box housing accessories shall be thoroughly cleaned and degreased. It shall be free from scale, rust, sharp edges and burrs.
- ii. When enamel finish is specified, it shall have a minimum thickness of 2 mils for outside surface and 1.5 mils for inside surface. The finish shall be non-porous and free from blemishes, blisters and fading.
- iii. The luminaire housing shall be stove-enamelled/epoxy stove-enamelled- vitreous enamelled or anodised as indicated under various types of fittings.
- iv. The surface shall be scratch resistant and shall show no sign of cracking or flaking when bent through 90 deg. over 1/2" dia. mandrel.
- v. The finish of the luminaire shall be such that no bright spots are produced either by direct light source or by reflection.

**3.18.5 Decorative Luminaires**

**c. LED SURFACE PANEL LIGHTS**

- 1. These luminaries shall be generally indoor type shall operate from 90 to 300V AC, be of long life @ above 30000 Hrs, instant start shall house provided with aluminum body housing ceiling mounted complete with all require electrical control accessories mounted on it.



2. Luminaries shall be suitable for the number of led lamps of specified wattage, direct mounting on ceiling/wall/column pendant mounting or for recess mounting in false ceiling in control rooms and computer rooms.

d. LED TUBE LIGHT LUMINARY

LED Tubes lights shall have more than 25000 working hours, suitable to operate for 90 to 300V, AC Supply, surface mounted, The luminaries shall be provided with PC+ Aluminium body mounting.

e. LED FLOOD LIGHT LUMINARIES

- a. Flood light luminaries shall be of long life, instant start shall house in weather proof construction with robust aluminum housing, wall/ pole recessed/ ceiling fitted, heat resistant, toughened glass cover and necessary neoprene gaskets to prevent ingress of dust.
- b. The housing shall be supported suitably and capable of being swilled in both horizontal and vertical directions and locked in any desired position.
- c. For focusing purposes, knobs shall be provided along with sector plate indicating the beam angle in degrees more than 110 degree in vertical direction.
- d. The Luminaries shall be suitable for LED lamps, operating from 90 to 300 VAC, Life above 50000 working hours, IC based LED driver, short circuit proof, over voltage & under voltage protected. It shall be mounted in a separate cast aluminum weather proof with preferably IP 65
- e. The luminaire shall be provided with cable gland on the canopy in down ward direction for cable connection.
- f. It shall be possible to replace the lamp from the canopy without opening the front glass.

F. PORTABLE EMERGENCY LIGHT LUMINAIRE

- a. Emergency light of Installed luminaries shall be indoor type for providing emergency light during failure of normal AC supply.
- b. The luminaries shall be with CRCA sheet steel enclosure, complete with metalized mirror reflector, leak proof re-chargeable battery rated for two hour discharge, battery charger, charger-on lamp, push button switches, automatic changeover switch/relay, two meter length cord with plug, mounting pads and other accessories required for satisfactory operation of the luminaries.

- c. The luminaries shall be suitable for connection to 240 V, 50 Hz single phase supply. On failure of normal A.C. supply the luminaries shall pick-up automatically and on restoration of A.C. supply the luminaries shall switch off automatically
- d. The luminaries shall be suitable for LED Lamps

### **3.18.6 PANELS/BOARD COMPONENT EQUIPMENT**

#### **A. SWITCHES/MINIATURE CIRCUIT BREAKERS (MCB) & HRC FUSE**

- a. Switches/ MCB's shall be conforming to applicable standards.
- b. The switch shall be protected by fuse and the MCB shall be provided with overload/short-circuit protective device.
- c. The minimum breaking capacity of MCBs shall be 6 kA, 415 V A.C.
- d. The connections between switch and fuse shall be insulated and all live connections shall be shrouded. Switch boxes decorative cover shall be 1.6 mm thick and switch box shall be hot dip galvanized MS sheet with 2 mm thick.
- e. HRC cartridge type Fuses of suitable Amperes having rupturing capacity of 50 kA at 415 V shall be provided for light distribution system. Fuses shall be provided with visible indication to show that they have operated. Cartridge fuses shall be mounted in moulded plastic carriers. If fuse carriers are not provided, insulated fuse pulling handle shall be provided for each size of fuse for each switchboard.

#### **3.18.6.1 Indicating Meters And meters**

- f. Instruments and meters shall be of the flush mounting type, suitably mounted so as to provide for easy access to CTs and wiring.
- b. Instruments shall be of minimum 96 mm square size, shall have provision for zero adjustment outside the cover and black numerals on white dial.
- c. Ammeter/Voltmeter selector switches having 3 positions and off, with stay-put contacts rated 10A shall be provided when specified.
- d. Fuses shall be provided at the tap-off point from the busbars for the voltmeters.

#### **3.18.6.2 Instruments Transformers**

- a. Current and voltage transformers shall be of the dry type, of metering accuracy class 1.0. Unless otherwise specified, it shall be the responsibility of the Contractor to ensure that the VA burden of the instrument transformer is adequate for the meters connected to it.

b. Test links shall be provided in both secondary leads of the CTs to easily carry out current and phase angle measurement tests. Facilities shall be provided for short circuiting and grounding the CTs at the terminal blocks.

c. Voltage transformers shall be provided with suitably rated primary and secondary fuses.

#### **3.18.6.3 Internal Wiring**

d. Panels/boards shall be supplied completely wired, ready for the external connections at the terminal blocks. Wiring shall be carried out with

b. Lighting wires shall be 650/1100V grade, PVC insulated, stranded aluminum/copper conductors. Conductors of adequate sizes shall be used to suit the rated circuit current.

c. Colour of the PVC insulation of wires shall be Red, Yellow, Blue and Black for R, Y, B phases & neutral, respectively and white & grey for DC positive & DC negative circuits, respectively.

d. Minimum size of wire shall not be less than 1.5 sq. mm for copper and above 6 sq. mm for aluminum. The size of the lighting wires/ cables shall be selected such that the total voltage drop from the LDB to the lighting fixture receptacle does not exceed 3%.

e. Wiring shall run throughout in separate conduits. Wires of different phases shall run in different conduits.

f. Wiring for lighting circuits and receptacle circuits shall be carried out in separate conduits and from separate feeders.

g. Engraved identification ferrules, marked to correspond with the wiring diagram shall be fitted at both ends of each wire.

h. All wiring shall be terminated on terminal blocks. Terminal blocks shall be one piece moulded rated 500 V, of reputed make, preferably stud type for higher current ratings such that wires are connected by cable-lugs and complete with nuts and washers. Terminals shall be adequately rated for the circuit current; the minimum rating shall be 20 A.

i. Terminals shall be numbered and provided with identification strip for identification of the circuit.

j. Terminal blocks for C.T. secondary lead wires shall be provided with shorting and disconnecting/earthing facilities.

k. Lighting panels etc. shall be earthed by two separate and distinct connections with earthing system.

l. Switch boxes, junction boxes, lighting fixtures, fans, single-phase receptacles etc. Shall be earthed by means of separate earth continuity conductor.

- m. The earth continuity conductor 14 SWG GI wire shall be run along with each conduit run. Cable armours shall be connected to earthing system at both the end.

#### **3.18.6.4 LABELS & DIAGRAM PLATE**

- a. All door mounted equipment as well as equipment mounted inside the switchboard/panels shall be provided with individual labels with equipment designation/rating. Also the boards/panels shall be provided on the front with a label engraved with the designation of the board/panel.
- b. Labels shall be made of non-rusting metal, 3-ply Lamicoid or engraved PVC
- c. Inside the door of the 1 phase ways lighting panels a circuit diagram description shall be fixed for reference and identification.

#### **3.18.6.5 Light Control Switch**

- a. Light control switches of ratings and types, i.e. decorative/industrial shall be supplied as required. The switches shall be suitable for use on 240 V, 1 Ph, 50 Hz supply.
- b. Switches shall be of flush type for mounting behind an insulated plate or incorporated with a switch plate for mounting flush with the surface of wall or switch box/suitable enclosure. The switch box/enclosure shall be recessed into or mounted on a wall as per the requirement of project layouts.
- c. The size of enclosure boxes shall be chosen to accommodate the number of switches to be installed at the particular location. The enclosures shall be 14 gauge sheet steel galvanized. The enclosure box shall be covered with Perspex / insulating cover. An enclosure intended for surface mounting shall not have holes or gaps in its sides other than those expressly provided for cable entry.

#### **3.18.6.6 RECEPTACLE UNITS**

- a. Receptacle units shall consist of socket outlet with associated switch and plug. The socket outlet and switch or MCB shall be flush mounted within galvanized 14 gauge steel enclosure with insulation cover. The box shall be recessed into or mounted on a wall as per requirements of project layouts.
- b. The receptacle units shall be suitable for 240 V, 1 ph - N, 50 Hz/415 V, 3 Ph - N, 50 Hz supply as required.
- c. Single phase receptacles shall be associated with a switch/MCB of same current rating and the receptacle shall become live only when the associated switch/MCB is in "ON" positions.
- d. Three phase receptacles shall be associated with a TPN switch housed in the same enclosure. The receptacle shall become live only when the associated switch is in "ON" position.

- e. The plugs shall be provided with cord grips to prevent strain and damage to conductors/wires at connection and entry points.

### **LIGHTING WIRES**

- a. The wires for wiring in lighting system shall be 250/415 V, 1/C, PVC insulated, Unarmored with stranded copper conductors.
- b. The minimum area of conductors shall be 1.5 sq.mm. for light fittings and 5A Receptacles and 2.5 sq.mm for receptacles rated 15 A and above.
- c. The wires shall be coded white for phase/positive of D.C. and black for neutral/negative of D.C.

### **CONDUITS**

- a. Rigid PVC conduits and their associated fittings as required shall confirm to applicable standards. The minimum size of conduit shall be 20 mm for surface installation and 25 mm for concealed installation. They shall be supplied in standard lengths of 5 m.
- b. Supply of conduits shall include all associated fittings like couplers, bends, C Clamp and tees as required for lighting system installation work. Conduits and fitting shall be cleaned to remove sludge, dirt or trash from the inside, prior to installation.
- c. In no case shall conduits be fastened to other pipes or installed in such a manner as to obstruct the ready removal of pipes for repair or replacement.
- d. All conduit openings shall be capped PVC caps (conduit plugs) during or immediately after installation. Before wires are drawn into conduits, the conduits shall be thoroughly cleaned by use of a swab or blown out with compressed air.
- e. Suitable inspection boxes shall be provided to permit periodical inspection and to facilitate removal of wires when necessary.
- f. Positions of lighting panels, switches, sockets etc. shown in drawings shall be adhered to. If desired by the Owner, the positions of these shall be changed without any extra cost.
- g. The heights for switches and receptacles are as indicated on the respective drawings /standard notes.
- h. All conduit drops from ceiling to the wall must be nearly in the centre of the wall. Conduit drops going out of the wall shall have to be made good by the Contractor at his cost without damaging/ weakening the building structure.

### **JUNCTION BOX**

- a. Junction boxes with terminals shall be supplied for branching and terminating lighting cables when required for outdoor areas, 3 phase receptacles etc. It shall be deep drawn or fabricated type made of 2.0 mm thick CRCA Sheet. The box shall be hot dip galvanized.
- b. The junction boxes shall be dust and vermin proof and shall be fabricated from 14 gauge sheet steel and shall be complete with removable cover plate with gaskets, two earthing terminals each with nut, bolt and washer. Boxes shall be additionally weather proof.
- c. The boxes shall have provision for wall, column, pole or structure mounting and shall be provided with cable/conduit entry knock outs, terminal blocks, HRC fuses as required.
- d. Insulation barriers, galvanized nuts, bolts and washers and provided with identification strips of PVC. The terminals shall be made of copper alloy and shall be of box clamp type.
- e. The boxes shall be painted with one shop coat of red oxide zinc chromate primer followed by a finishing coat of paint.

#### **PULL OUT BOXES**

- a. Pull out boxes shall be provided at approximately 4-meter interval in a conduit run. Boxes shall be suitable for mounting on Walls, Columns, Structures, etc. Pull out boxes shall have cover with screw and shall be provided with good quality gasket lining.
- b. Pull out boxes shall be weather proof type suitable for IP: 55 degree of protection. Pull out box & its cover shall be hot dip galvanized.

#### **FAN AND REGULATORS**

Ceiling Fans shall be suitable for operation on 240 V, 50 Hz, AC supply comprising of class F insulated copper wound single phase motor, 1200mm sweep, aerodynamically designed well balanced MS blades (3 Nos.), down rod, die cast aluminum housing, capacitor, suspension hook, canopies etc. finished in stove enameled white. Power factor of fans shall not be less than 0.9.

#### **3.18.6.7 Drawings and Data**

- i. As part of proposal, the Contractor shall furnish relevant descriptive and illustrative literature on lighting fixtures and accessories dimensioned drawings/data for the respective lighting fixtures with manufacturer's catalogue numbers.
- ii. It shall be the responsibility of the Contractor on award of contract to work out a detailed layout for the complete plant in order to provide the levels of installation as indicated under Design Criteria and shall be furnished for the approval of the Owner's representative before commencement of installation.

#### **3.18.6.8 Lighting Fixture – LED lamp Set**

Supplying and erecting LED outdoor as a street light fittings with LEDs with wattage 1watt and above assembled on single MCPCB, efficiency more than 130 lm/w and corrosion free High

pressure die cast aluminium housing with smooth finish powder coated and heat sink extruded aluminium with diffuser and Polycarbonate optics/ lenses with company mark/name engraved or embossed with housing used as a heat sink shall be made of thick sheet steel conforming to IS513/CRCA and high U.V. and corrosion resistance with diffuser 90 to 300 V, power factor more than 0.95 ,THD < 10%,CCT 5000K to 5700 K, uniformity ratio > 0.45 ,Luminaire efficiency > 85 % lumens/watt, LED driver efficiency > 85 %. Each fittings required LM-79 and LM-80 certificate. Index of Protection Level Minimum IP 66. Surge Protection –10KV.(1 No. of Luminaire equivalent to 70W HPSV (3120 Lumens) fitting per street light pole.

The working life of the lamp at junction temperature of 85° C (max) at operating current shall be more than 50,000 working hours of accumulative operation and shall be suitable for continuous operation of 24 hours per day. These features shall be supported with data sheet.

**MARKING:**

The following information shall be distinctly and indelibly marked on the housing:

Year of manufacture/ Batch Number/ Serial Number

Name of Manufacturer (Engraving only, stickers not allowed)

Rated watt and voltage & Input frequency

**3.18.6.9 Lighting Poles and Flood Light Pole Mounting**

- i. Providing and fixing approved make Swaged steel tubular pole made from CR Sheet steel. The tubular steel poles shall conform to the latest edition of Indian Standard specification IS: 2713 (Part – I, III): 1980 or any other authoritative standards (as amended up-to- date).
- ii. Tubular Steel Poles shall be swaged type. Swaged poles shall be made of seamless or welded tubes of suitable lengths swaged and jointed together. No circumferential joints shall be permitted in the individual tube lengths of the poles. If welded tubes are used they shall have one longitudinal weld seam only and the longitudinal welds shall be staggered at each swaged joint. The pole shall be suitable for wind loadings as per IS 875 part 3 1987.
- iii. The length of joints on swaged poles shall be in accordance with clause No. 5.4 of IS: 2713 (Par-I): 1980. Poles shall be well-finished, clean and free from harmful surface defects. Ends of the poles shall be cut square. Poles shall be straight, smooth and cylindrical. The weld joints, if any, shall be of good quality, free from scale, surface defects, cracks, etc.
- iv. Number of poles selected for conducting different tests shall be in accordance to clause No. 10.1.1 and No. 10.1.12: of IS: 2713 (Part-I) 1980.
- v. The poles may also be marked with the ISI certification mark if applicable. The poles shall be marked with manufacturer's identification, year of manufacture.
- vi. The installation of pole shall be done as per direction of Engineer –In- charge at distance of approx. 25 Mtr or as per site requirement between two poles. Special care shall be taken while erection of poles so that these are not strained or damaged during erection and are firmly stayed till the foundation are secured, as per instruction of Engineer- in-charge and as per

drawing . Foundation of each pole shall be provide as per manufacturer recommendation or as per Engineer in charge.

- vii. The alignment of all the poles and the height shall be in one line so that from the distance it looks in one line. The material shall not be dispatched without prior inspection by the inspecting authority appointed by the department Pole drawing from manufacturer must be get approved from concerned department.

- i. Drawings and Data

The following shall be furnished as part of the datasheet.

- i. General arrangement of panels showing plan, elevation and typical section views.
- ii. Technical literature on the equipment offered.

### **"J" type Foundation Nut-Bolt**

Supply and Installation of M 20 x 750 long 'J' type EN 8 grade foundation bolts along with template for the above poles.

### **Cable Gland**

Providing & Fixing of Heavy Duty ISI Marked Flanged, Double Compression type Brass Cable Gland with rubber ring suitable for required XLPE Insulated Alu. Armoured cable complete with outgoing tails, insulating taps etc. - (2 Nos. Glands Per Syntax Box on St. Light Pole).

### **Lugs**

Providing & Fixing of Solder less Crimping Type Aluminium Lugs (4 Nos. per termination) conforming to IS suitable for required XLPE Insulated Aluminium Armoured cable tail complete erected with insulating materials for each termination. - (2 Nos. Termination Per St. Light Pole).

### **12mm Thick Backlite Sheet**

Supplying and erecting bake lite sheet 12mm thick on existing angle iron frame or in the pole suitable size complete with bakelite connector strip with stud type terminals suitable for cable with ,single pole 6 A to 32 A, MCB with mounting clamp with nuts, bolts & washers suitable for erection on pole with cable clamps & earth bolt. - (1 No. Per St. Light Pole)

### **Single Arm bracket**

Provide & Installation of Single Arm Bracket consisting of Light Class M. S. pipe of suitable outside dia. Complete with require size pole top having sufficient fasteners for fixing the brackets and having suitable rise as per site condition as directed and spread of 2 mtr. with suitable welded stiffener reducer and lock nut complete painted with one coat of PU base primer and two coats of PU paint suitable for side entry fitting brackets, as per site condition and as per drawing / directed by Engineer In-charge. - (1 No. Per St. Light Pole) The bracket



shall be hot dip galvanized as per IS 2629/IS 2633/IS 4759 standards with minimum coating thickness of 85 micron.

### **DWC Pipe**

Providing & laying of approved make Doubled Walled Corrugated Pipes (DWC) of polyethylene (conforming to IS 14930 - II) with necessary connecting accessories like coupler, Tee, L - Bow, etc. of same material at required depth (90 cms) including excavation for laying of cable below ground/ road surface for enclosing cable and back filling the same to make ground as per original & as per instruction of Engineer In-charge - for Street light Cable

### **3.19 Earthing System**

The main earth grid conductor shall be hot dip galvanised GI flat unless otherwise specified. Sizes for main conductors shall be as per IS 3043. Amount of galvanizing shall be 610gm per sq. Metre.

#### **3.19.1 General**

- a. All metal vessels, process pipe lines, tanks, buildings and other metal structures that may receive lightning stroke or develop a static charge shall be earthed, as per details on applicable drawings.
- b. All equipment to be earthed shall be cleaned down to bare metal before attaching the ground wire.
- c. Neutral conductor shall not be used for equipment earthing.
- d. All earthing connections shall be carried out in an approved manner and with specified materials. Typical methods of earthing as per standard drawings will be adopted for the earthing, as indicated in the applicable drawings.
- e. The entire plant shall be earthed by a series of ground loops. The loops will be effectively earthed by means of earthed electrodes.
- f. All earth connections shall be applied bitumen compound if welded with the system earthing grid / equipment. However, welding should be avoided as far as possible.
- g. Sizes of the earth wires shall be as shown in the applicable standard drawings.
- h. Copper strip if used shall be tinned at the joints.
- i. Armouring of cables shall be earthed at both ends through suitable cable glands.
- j. Earthing wires and cables shall be terminated on the earth bus with solderless cable sockets with silicon bronze / G.I. bolts.
- k. Each earthing wire shall be in one length from the equipment to the earth bus.

- l. Pipe electrodes in earth pit as per standard drawing shall be provided unless otherwise indicated in the relevant drawings. The earthing electrode and pits shall be in accordance with IS: 3043.
- m. The earth pit centre shall be at a minimum of 2 metres distance from the nearest building. Distance of not less than 3 meters shall be maintained between centres of two earth pits.
- n. The neutrals of transformers shall be connected to separate earth electrodes through NGR.
- o. Specialised Earthing shall be provided to the sensitive equipment by means of dedicated Cu. earthing pits, Cu. earthing conductor and Cu. earth bus bar mounted on the insulators.

### **3.19.2 240V Equipment**

- a. All 240 V equipment shall be earthed with minimum one number of 12 SWG cu. wire unless stated otherwise on the relevant drawing.
- b. For lighting circuits in conduits, one number 12 SWG. copper wire shall run inside the conduit for earthing.
- c. Fluorescent fixtures and all other fixtures provided with earthing terminals shall be earthed by 12 SWG copper wire.
- d. Switch and single phase lighting receptacle housings shall be earthed with 12 SWG copper wire. The earthing wire shall be connected to the earthing screw on the switch or receptacles by a solder less cable socket duly crimped.
- e. All street lighting poles shall be earthed as indicated in the drawings

### **3.19.3 415 V Equipment**

- a. All 415 V equipment shall be earthed by 2 independent paths to earth through earth wires. The earthing conductors shall be of the sizes as specified on the drawings and be of G.I., aluminium or bare copper where buried. Outside the building, a minimum of 300 mm of cover shall be provided.
- b. All motor frames, hoist rails, pipe racks, etc. shall be effectively earthed, as shown on the applicable drawing.
- c. Earth strip extending above the floor shall be protected from mechanical injury by running it through GI pipe sleeve to at least 300 mm height.
- d. The entire conduit system, supports, cabinets, transformers, motor control centres and equipments shall be effectively earthed as shown on the drawings and in accordance with the latest Indian Codes.
- e. All three phase receptacles shall be earthed with 8 SWG G.I. wire or as specified in the drawing.

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#### **3.19.4 Earth Electrode System**

- a. Earthing pit shall comprise of G.I. earthing plate or G.I. earthing rod. The plate/rod shall penetrate a minimum of three meter below ground level as per IS 3043. Where multiple rods are used, distance between them shall not be less than as specified in IS 3043.
- b. Marker posts and plates shall be provided to mark the route of buried electrodes. The markers shall be similar to those provided for cable routes.

#### **3.19.5 Earthing of Power or Motor Control Centre, Distribution Boards**

- a. Each switchgear, control panel and distribution boards shall be provided with an earth busbar running along its entire length. The earth busbar shall be located at the bottom of the Switchgear, Control Panel and Distribution Board.
- b. The sizes of conductors for earthing various equipments shall be referred in technical datasheets.
- c. Lightning protection shall be provided for the equipment, structures and buildings as per relevant IS standards. An independent earthing network shall be provided for lightning protection and this shall be bonded at least at two points with the main earthing network below ground. Lightning down conductor shall be brought to earth electrode in shortest straight path as feasible to minimize surge impedance
- d. The main earthing network shall be used for earthing of equipment to protect against static electricity.
- e. All medium and high voltage equipment (above 240V) shall be earthed by two separate and distinct connections with earth.
- f. Plant instrument system clean earthing, UPS system clean/safety earth, etc shall be separate from the electrical earthing system.
- g. All paint, scale and enamel shall be removed from the contact surface before the earthing connections are made.
- h. All earthing connections for equipment earthing shall be preferably from the earth plate mounted above ground wherever provided.
- i. Equipment foundation bolts shall not be used for earthing connection.
- j. Earth connections shall be made through compression type cable lugs/by welded lugs.
- k. All hardware used for earthing installation shall be hot dip galvanised or zinc passivated.
- l. Spring washers shall be used for all earthing connections and all connections adequately locked against loosening.

- m. Lighting fixtures and receptacles shall be earthed through the extra core provided in the lighting circuit/cable for this purpose.

### **3.20 Distribution transformer**

- a. Distribution transformers shall comply with IS 1180 and Latest and as per IEC 60076.
- b. The kVA and current ratings of every transformer shall be sufficient to enable it to continuously feed the maximum electrical load which shall be connected to it. For this purpose, it shall be assumed that all 'duty' drives are running and all lighting loads etc are in operation. Where two identical transformers are used in parallel, it shall possible to continue operation of total plant with one transformer out of service. The calculation shall be carried out for the system with one such transformer out of service. i.e. No. of operating transformer shall be equal to no. of standby transformer.
- c. When the kVA maximum demand from the transformer has been established, it shall be used to establish the maximum current which is to be drawn from the transformer secondary. For this calculation the nominal 'system voltage' shall be used.
- d. The following factors shall also be taken into account when selecting the kVA rating of a transformer:
  - a. Any need to derate the nominal kVA rating to allow for arduous operating conditions such as a high level of harmonic current
  - b. The need to avoid excessive voltage regulation, due to high starting current, at the time of starting the drive which is fed from the transformer
  - c. The need to limit the prospective fault level for the system fed by the transformer
  - d. Every distribution transformer shall be of the oil-filled type.
  - e. The following fittings shall be provided:
    - i. lifting lugs
    - ii. earthing terminal
    - iii. Jacking or Lifting lugs
    - iv. skid mounted
    - v. 'winding temperature high' thermostat,
    - vi. 'winding temperature high-high' thermostat,
    - vii. Thermostat to start and stop the possible future cooling fan,
- e. HV cable terminations shall be fully-insulated.

- f. LV cable terminations or bus duct shall be fully insulated and when the transformer is de-energised, it shall be possible to easily disconnect and reconnect the LV cables or bus duct without damaging any insulation or shrouding.
- g. Each oil filled transformer shall comply with IS 1180 and cooled by means of natural circulation of air and windings shall be cooled with help of oil within the transformer (ONAN).
- h. The vector group of each transformer shall be Dyn11 unless otherwise specified.
- i. The primary winding of each transformer shall be provided with an off-Circuit tap-changer with tappings of  $\pm 5\%$  in addition to the nominal tapping. Facilities shall be provided for padlocking the tap-changer in each position.
- j. The impedance of the transformer shall be as per Indian standard
- k. Unless otherwise specified, the transformer shall be of the conservator type with a silica gel breather.
- l. Every transformer shall be either skid mounted or provided with wheels. It shall be provided with lifting lugs or jacking points as per rating of the transformer.
- m. Every transformer shall be provided with a liquid temperature gauge. This gauge shall be provided with two volt-free changeover contacts, the first of which is to generate a 'Liquid temperature high' signal and the other to generate a 'Liquid temperature high-high' signal.

### **3.21 LV Switchgear Panel /415V MCC Panel**

1. The specification covers the design, manufacture, testing at manufactures works, supply, delivery, storage at site; erection, testing and commissioning of 0.415 kV Switchgear, Motor Control Center (MCC) and Power distribution Board (PDB) complete with instrumentation controls and safety devices.
2. The scope of supply shall include spares for 10 years of operation & maintenance of the pumping station, special tools and testing devices, all parts accessories etc. which are essential for construction, operation and maintenance of the switchgear. Components of the Switchgear and associated equipment and spares shall be of the same material, dimensions and finish and shall be interchangeable.
3. LV Switchgear Panel shall be Partially/Total type tested as per latest IEC 61439-1 & 2.

#### **3.21.1 Standards**

- n. The design, manufacture and performance of the equipment shall comply with all Indian Standards, I.E. Rules, Statutory Regulations and Safety Codes currently applicable in the locality where the equipment will be installed.

- o. Unless otherwise specified, the equipment shall confirm to the latest applicable Indian Standards and, in particular, the following:

**LV switchgear panel IS codes**

Sr.No.	IS codes	Description
1	IS 2147	Degree of Protection provided by enclosure for low voltage switchgear and control gear.
2	IS 13947	Specification for low voltage switchgear and control gear.
3	IS 2705	Specification for current Transformers.
4	IS 3156	Specification for voltage transformer.
5	IS 1248	Specification for direct acting indicating analogue electrical measuring instrument and their accessories
6	IS 8623	Specification for low voltage switchgear and control gear assemblies.
7	IS 3231	Specification for electrical relays for power system protection.
8	IS 5578	Guide for marking of insulated conductors.
9	IS 11353	Guide for uniform system of marking and identification of conductors and apparatus terminals.
10	IS 13703	Specification for Low-voltage fuses not exceeding 1000V AC or 1500V DC.

**3.21.1 Constructional requirement**

**3.21.1.1 General**

1. L.T. panel Board shall be design verified assembly conforming to IEC 61439 — 1 & 2 and suitable for operation on 415V 3 Phase, 50 Hz. A.C. System completely, assembled wired, tested and painted with rust proof paint for controlling L.T. supply to different auxiliaries of pump house.
2. All identical equipment and parts shall be interchangeable.
3. The ACB/ MCCB are to be installed in the panel as per system requirement.
4. The main incomer from the transformer shall be through 3 1/2 core XLPE.
5. The switchgear shall consist of indoor, floor-mounted, metal enclosed compartmentalized (if not indicated specifically in data sheet), modular type, totally front side operated vertical sections.
6. It shall be dust and vermin proof and shall be easily extensible on both sides Panel

assemblies shall be minimum IP54.

7. The Panel assembly shall comply to Seismic Zone 5 as per IS 1893.
8. All doors and removable covers shall be gasketed all around with neoprene gaskets.
9. Each vertical section shall comprise the following:
  - a) Metal-enclosed bus bar compartment, running horizontally throughout the length of the switchgear.
  - b) Individual feeder modules in multi-tier formation.
  - c) Shrouded main and vertical bus bars and individual feeder connection.
  - d) Vertical cable alley and bus bar alley with doors or covers covering the entire height of the feeder module panel.
  - e) Horizontal wire way for control wiring.
  - f) Space heater with thermostat and MCB in each vertical panel.
  - g) Sheet steel barrier between two adjacent vertical sections except for horizontal bus bar compartments.
  - h) Separate door for each feeder module. For ease in maintenance, etc. each door shall be open able by at least 95 deg.
  - i) 20% additional space in the panel (in terms of vacant feeder compartments of Various sizes), to accommodate the future requirement, if any.
  - j) Totally front operated panel, i.e. cable and bus bar alleys of suitable sizes (minimum 300 mm width) shall be on the panel front side only.
  - k) Each vertical panel should be divided into the distinct zones for bus bars; Feeders power cabling, control cabling and power & control terminals and shall comply to form of separation as 4B.
  - l) Feeder control and motor control equipment not incorporating Air circuit breaker shall be fixed type execution.
  - m) In the case of fully draw out ACB withdraw-able chassis all electrical power and control connections shall be of plug-in type.
  - n) 300 mm clearance shall be provided between the finished floor and the bottom of the lower most feeder compartment.
  - o) Panel lifting lugs shall be of removable type and to be fixed with panel using bolts and nuts.
  - p) Fixed type-both power and control connections shall be of bolted/screwed type.
  - q) The MCCs shall be divided into convenient shipping sections not exceeding 2.5 Meters.
  - r) Complete panel shall be mounted on a base frame made out of ISMC 100 x50

sections.

- s) Every panel shall have independent vertical bus bar chamber / alley or shared vertical busbar alley to increase feeder density.
  - t) The panel shall be divided into following compartment:-
    - i. Bus bar Chamber
    - ii. Connector Chamber
    - iii. Main Incomer feeder
    - iv. Individual MCCB/ SFU Feeder
    - v. MPCB/MCCB shall be used for motor starters etc.
  - u) The cable alley shall be provided with concealed hinged doors for easy access to cables inside the cable alley. The compartment door shall be with cam-locks for easy opening and closing.
  - v) Each vertical panel shall be provided with maximum six modules. Minimum height of motor feeder shall be 300 mm and SFU / MPCB/ MCCB feeder shall be 250 mm.
8. The switchgear assembly unit shall consist of rigid structural frame enclosed by 2mm thick cold rolled (CRCA) sheet steel. Doors and covers shall be of 1.6 mm thick cold rolled (CRCA) sheet steel. Structural framework with foundation bolts, etc. at the bottom shall be provided to mount the switchgear directly on concrete/steel channel base.
- All doors shall be provided with concealed hinge design for better security against unauthorized access to feeders.
9. Switchgear assembly shall be provided with removable minimum 3 mm thick cable gland plate with pack hole for cable entry. Brass cable glands and crimping type copper cable lugs for cables shall be provided if specified in data sheet.
10. Control switches, push buttons, indicating lamps, meters and relays shall be mounted on the front door. Current Transformers (CT) and Voltage Transformers (VT) shall be mounted on the fixed portion. For fully draw out / semi draw out execution, all other equipment shall be mounted on withdrawable chassis with suitable guides for easy withdrawal.
11. Name plate shall be provided on all switchgear modules, relays, instruments, switches, etc with white letter with Black background & rear engraving. Name plate shall have following details:
- i. Feeder rating with type of feeders.



- ii. Feeder description.
  - iii. Feeder Module No.
12. Painting shall be done by surface coating comprising pre-treatment, electrostatic Powder spraying and curing. The colour of the shade shall be 631 of IS 5.

#### **3.21.1.2 Main Busbar**

- a. Main bus bars shall be of uniform cross section in aluminum or copper as specified in the drawing / data sheet.
- b. The horizontal bus bar chamber shall be on the top whereas vertical bus bars shall be provided in bus alley at the front.
- c. Wherever aluminum to copper connections is required, suitable bimetallic connections/clamps shall be provided .
- d. Maximum temperature of the bus bars and the bus connections shall not exceed 85oC.
- e. The bus bars shall be provided with heat shrinkable sleeves and colour coded for identification.
- f. Separate supports shall be provided for each bus bar. If common support is provided for all bus bars, anti-tracking barriers shall be incorporated.  
  
Minimum clearances between Ph. to Ph. shall be 25 mm. and 19 mm. for Ph. To N. or Ph. to E for better safety.
- g. In order to avoid any accidental hazards, bus bar compartments shall be protected with 3 mm thick hylem / bakelite sheets.
- h. The size of the neutral bus bar shall be similar to that of phase bus bars in the case of Main L.V. panels, PCCs, PMCCs, PDBs, main and sub lighting DBs. However, the neutral bus bar shall be of half size that of phase bus bars in the case of Motor control centers.

#### **3.21.1.3 Circuit Breaker**

##### **A. AIR CIRCUIT BREAKER**

Air-break, fully draw-out type circuit breakers shall consist of the following:

- 1. Breaker shall confirm to IEC 60947
- 2. ACB shall be suitable for pollution category – 4 and shall be RoHS Compliant
- 3. Breaking Capacities shall be as indicated in SLD.  $I_{cs}=I_{cu}=I_{cw}$  (1 Sec).

4. Shunt trip, Operation Counter,
5. Mechanical OPEN/CLOSE position indicator, visible with door closed.
6. Emergency trip push button.
7. Red', 'Green', 'Blue' and 'Amber' indicating lamps for Breaker ON, Breaker OFF and Breaker trip on fault.
8. There shall be 'Service', 'Test' and 'Fully withdrawn/ Isolated' positions for the breakers along with their indications on the breaker front fascia.
9. In-built Electrical & Mechanical Anti-pumping and over & under voltage trip facility should be provided.
10. It shall be possible to with-draw the breaker only in open position.
11. Compartment door of the breaker shall not open unless the breaker is in open position.
12. Automatic safety shutters shall be provided to cover live contacts when carriage is withdrawn. These safety shutters shall be with locking facility.
13. Release shall have potential-free contacts/ Micro-switch for common fault tripping indication and shall have variable time settings and pre-trip alarm facility.
14. It shall be possible to accommodate 02 sets of protection settings in ACB release.
15. Facility shall be provided for blocking under-voltage releases.
16. Manual operating mechanism shall be of spring charged stored energy type.
17. Power-operated mechanism shall be of motor-wound spring-charging stored energy type. Emergency manual charging facility shall also be provided.
18. Indicators shall be provided to show 'charged' and 'discharged' conditions of the spring.
19. The operating mechanism shall be trip-free.
20. ACB terminals for all 3- Phase & Neutral shall be of same size.
21. The breaker shall be provided with the microprocessor based release with breaker control through RS 485 port and communication with PC through universally used protocol if asked for in the drawing.
22. For 3 Pole ACBs, matching NCT from ACB manufacturer shall be provided.
23. The Microprocessor release should have Phase & Neutral over current, short circuit and earth fault protections along with their indications due to which the breaker has tripped. The release shall be able to record minimum 20 trip data. Before tripping, pre-alarm facility shall be an integral feature. All ACBs shall have Directional and Double

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Short Circuit Selectivity and the same shall be with Adjustable Time Delay.

All Main Incomer ACBs shall have inbuilt Temperature rise protection for protection against abnormal temperature rise at ACB terminals.

24. It shall be ensured that circuit breaker body is grounded while it is racked-in into the panel.
25. Trip circuit healthy indicating lamp with integral push button shall be provided.
26. FRP Barrier plate between Incoming and Outgoing terminals of ACB shall be provided.
27. Interlock shall be provided between breaker operating mechanism & the arc chutes to prevent closing of ACB in case the arc chutes are not properly secured.
28. Racking handle in case of draw-out ACB shall be accessible from front without opening the panel door. Racking shutter shall not be possible to open unless ACB is in OFF condition.
29. ACB releases shall have O-LED Display showing Current, Energy, Power Parameters & Harmonic Metering up to 27th order.
30. Breaker shall have three different positions in the cradle with proper function interlock. (Service/Test/Isolated).

**B. MOULDED CASE CIRCUIT BREAKER (MCCB)**

1. MCCB shall be suitable for isolation and shall comply with the requirement of IEC 60947, IEC 60947-2, High voltage withstand should be as per switchboard standards- IEC 61439
2. MCCB shall be air break type and having quick make quick break with trip free operating mechanism.
3. MCCB shall be designed for both vertical and horizontal mounting, as per recommendation of manufacturer, without any adverse effect on electrical performance.
4. The design & operating principal of MCCB should be of current limiting design with extremely low trip times under short circuit conditions and low thermal stress with compact size and independent manual operation.
5. MCCB shall provide double insulation between the live power parts and the front part of MCCB. It shall have the feature of finger proof terminals to avoid direct contact with the live parts from front fascia.
6. MCCB shall be made of halogen free high strength heat resisting and flame retardant thermosetting insulating material.
7. Extended Rotary type operating handle of MCCB shall be provided in front and

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should clearly indicate ON/OFF/TRIP positions and should have padlocking facility. It should be possible to ON/OFF MCCB without opening the panel.

8. MCCB shall be equipped with a “push to trip” button in front to test operation and opening of the poles.
9. The electrical contact of the MCCB shall be of high conducting non deteriorating silver alloy contacts.
10. MCCB should have shunt trip release, earth fault release with adjustable current setting facility and mechanical interlock facility.
11. MCCBs upto 250 A shall be Thermal – Magnetic type and above 250 A MCCBs shall be with inbuilt Microprocessor based trip units for O/L, S/C and inbuilt earth fault protection.
12. MCCB shall be provided with adjustable type thermal overload release and adjustable type short circuit protection device. All the release shall operate on common trip bus bar so that in case of operation of any one of the releases in any of the three phases, it shall cut off all the three phases and thereby single phasing of the system is avoided.
13. MCCB wherever called for in the appended drawings shall provide an earth fault relay/release.
14. MCCB shall provide required sets of extra auxiliary contacts for the indication circuit, control circuit and for remote signaling purpose and should have inbuilt indications for tripping due to over current, short circuit or earth fault.
15. Neutral Overload protection shall be provided for 3 pole Microprocessor MCCB with provision for external neutral CT (from MCCB manufacturer) sensing. For Thermal Magnetic MCCB with Earth Fault, CBCT Shunt from MCCB manufacturer shall be provided.
16. In case of 4 poles MCCB neutral shall be defined and capable of offering protection up to full current rating with possibility of adjustment at site in the neutral setting.
17. MCCB shall be communicable type RS 485, MODBUS, changing of settings (with password protection) should be possible from display of Panel as safety practices.
18. The electrical parameters of the MCCB shall be as per the description given in the appended drawings.

#### **3.21.1.4 AIR BREAK SWITCHES/ SWITCH DISCONNECTOR FUSE**

1. Switches shall be quad-break type and shall withstand a short circuit current of value equal to the let-through current of the associated fuse for 1 second and  
  
peak short circuit current equal to cut-off current of the fuse.

2. Switches of motor feeders shall be of motor duty (AC23A), group-operated, fault- make, load break type. All other switches shall be of heavy-duty type. All the switches shall be provided with phase barriers and auxiliary contacts.
3. Switch handle shall have padlocking facility in 'OFF' position.
4. It shall be possible to open the door only when switch is in 'OFF' position and it shall not be possible to close the switch when the door is open. However, defeat mechanism shall be provided for inspection purpose.

#### **3.21.1.5 FUSES**

1. Fuses shall be of link type with visible indication of operation and shall have
2. rupturing capacity of more than the fault level specified.
3. Fuse make shall be same as that of Switch disconnector fuse (SDF) make.
4. Fuses of smaller capacity rating for control circuit shall be of cartridge type.
5. 1 no. fuse pulling handle shall be provided for each Switch-board / Power Control Center / Motor Control Center.

#### **3.21.1.6 MOTOR STARTER**

Wherever the main pump motors are of 0.415 kV, the adequate starters with protection are to be provided. The starter to be selected as follows

- 1.Up to 5 kW - DOL Starter
- 2.Up to 50 kW - Star Delta Starter
- 3.Above 50 kW - Soft Starter

#### **3.21.1.7 CONTACTOR**

1. Contactors shall be air break, double break, single throw, electromagnetic type.
2. Main contacts shall be of silver faced copper.
3. Minimum Two 'N.O.' and two 'N.C.' auxiliary contacts shall be provided for each power contactor. However, additional nos. of auxiliary contactors should be added in the control scheme as per the requirement.
4. The auxiliary contacts shall be wired to the terminals.

### **3.21.1.8 DIRECT-ON-LINE (DOL) STARTER**

DOL starters shall be suitable for AC3 utilization category as per IS: 13947 (Part-4 /Sec-

1). It shall be comprised of: -

- i. FSU
- ii. Power contactor
- iii. Auxiliary contactor(s)
- iv. O/L relay with built-in SPPR.
- v. Separate SPPR.
- vi. Mushroom headed stay put type. Red Stop PB.
- vii. Start push button.
- viii. O/L Relay reset push button on door
- ix. Red, Green & Amber indicating Lamps (LED) for ON, OFF & trip indications respectively.
- x. . Set of selector switches as per various control requirements.

### **3.21.1.9 AUTOMATIC STAR-DELTA STARTER**

These starters shall comprise of following: -

- xi. FSU
- xii. Set of power contactors (3 nos.).
- xiii. Auxiliary contactor(s)
- xiv. O/L relay with built-in SPPR.
- xv. Separate SPPR.
- xvi. Timer.
- xvii. Mushroom headed stay put type. Red Stop PB.
- xviii. Start push button.
- xix. O/L Relay reset push button on door
- xx. Red, Green & Amber indicating lamps (LED) for ON, OFF & Trip indications respectively.
- xxi. Set of selector switches as per various control requirements.

xxii. Starters shall be suitable for AC3 utilization category as per IS: 13947  
(Part-4 /Sec-1).

#### **3.21.1.10 SOFT STARTER**

This specification defines the technical requirements governing the design, construction and testing of factory assembled Low Voltage FCMA/ Electronic Soft starter Stand alone panel. The Soft starter panel & its switchgear/ components, auxiliary equipment shall be fully designed & tested in accordance with IS / IEC codes as stated above, necessary certificates shall be made available at the time of inspection, Panel shall consist of Semi-conductor fuse.

#### **3.21.1.11 APPLICABLE CODES AND STANDARD**

Sr No	Standard	Description
1	IS 8623	Verification of Short circuit withstand strength 50KA RMS 1 sec.
2	IS 8623	Temperature rise test , IEC61439-1 Impulse withstand voltage.
3	IEC60529	IP for Enclosures
4	IEC60947-4-1	Contactors, IEC60947-2 & Circuit Breakers.
5	IEC60947-4-2	AC semiconductor motor controllers and starters (Soft starters)

#### **Salient features:**

1. Soft starter panel shall be fully automatic contactor operated and confirm to the accepted standard specification. The panel shall be totally enclosed free standing sheet steel clad, cubicle pattern.
2. The Soft Starter shall be suitable for operation on 415 Voltage at 3 Ph, 50 Hz  
A.C. supply with supply voltage variation of 415 Volts +/- 10%, 50hz +/-5%.
3. The soft starter shall work on the principle of full sine wave control and shall not lead to generation of harmonics.
4. The Soft Starter shall be so rated as to allow to start motor as per motor design
5. The winding of the Soft Starter shall be with insulation class F and Max. Temperature of winding shall be limited to that of class B.

6. The Soft Starter unit shall have anti condensation heater, complete with switch and thermostat
7. The Soft Starters should be suitable for indoor mounting
8. Soft starter shall be connected on line side for LT Motors.
9. The soft starter shall be equipped with Analog output 0-10V, 0-20mA, 4-20mA
10. Soft starter shall be provided for LT Motor above 50 KW Starting current shall be between 2.5 to 3.0 times Full load current of the motor. Pump data and characteristic curve to be submitted to soft starter manufacturer and they shall have to confirm value of starting current, all the equipments shall be sized accordingly.
11. The Soft Starter shall reduce the starting current of the motor at least to 50 % to 60% of the direct online (DOL) starting current of the motor. In other word, If DOL provides starting current 6-7 times full load line current then soft starter would provide starting current 2.5 to 3 times line current.
12. The soft starter shall be rated corresponding to the motor power & shall be capable of Operating satisfactorily with the Motor under the various loading & starting condition of the motor over the entire operating Range. The Soft Starter rating offered shall not be less than the rated kW of the Motor
13. The Soft starter shall control the starting torque. Acceleration Control with built- in “Torque Control” in such a manner so as to effect smooth starting of the motor drive is achieved option. Voltage control option shall also be available.
14. Soft Starter shall have a built in facility for run mode bypass so that the incoming voltage to the motor is equal to the supply voltage.
15. Since it comes in to service during starting of motor and then it is remains out of the service, it reduces motor starting load on the transformer and accordingly transformer capacity requirement reduces.
16. All main component like, Main Controller, MCCB, Contactors shall be of same make
17. Motor and Load Protection shall be integrated with the soft starter and all the protection functions shall under no circumstances be disconnected or disabled when a by-pass contactor is used
18. Motor Protections shall be numeric. Phase Imbalance, Phase Reversal, High Current, Locked Rotor, Under Load, Soft starter Overload, Phase loss ,load loss, shorted Thyristors, Frequency fault, connection fault, etc. shall be provided.



#### **3.21.1.12 FAULT DETECTION**

- a. In order to protect both starting equipment and the load, the soft starter shall be provided with the fault detections below & with Warning indications

Internal soft starter fault,

- i. Soft starter Over Temperature Fault,
- ii. Phase-Loss detection,
- iii. Shorted Thyristors (SCR) ,
- iv. Detection Non conducting Thyristors,
- v. Frequency out of range detection,
- vi. Main Voltage on line side detection,
- vii. Open circuit on motor side,

- b. The Fault Message on Display shall be in plain test English. Fault display in coding language not acceptable
- c. Inputs / Output - Minimum Two programmable input signals shall be available.
- d. The soft starter unit shall have a minimum of three signal output relays. Run Status, end of Start & Fault Soft starter shall store 20 past events (trip logs) with Date.

#### **3.21.1.13 REVERSING STARTER**

- a. Forward and reverse contactors shall be mechanically and electrically interlocked.
- b. Reversing starters shall be suitable for AC4 utilization category as per IS: 13947 (Part-4/Sec-)

#### **3.21.1.14 SINGLE PHASING PREVENTER**

Separate single phasing preventer shall be provided in the starters along with inbuilt SPP provided with over load relay. The relay shall be current operated and hand reset type with separate hand reset push button.

#### **3.21.1.15 INSTRUMENT TRANSFORMER**

- 1. CT and VT shall conform to the requirement of IS:2705 and IS:3156 respectively. The

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ratings specified are indicative only and it shall be Vendor's responsibility to ensure that the ratings offered are adequate for the relays/meters provided considering lead resistance, etc.

2. CT and VT shall be of dry air insulated type.
3. Facility shall be provided in the terminal blocks for shorting and earthing the CTs and terminal blocks.
4. VT shall be provided with adequately rated primary and secondary fuses.

#### **3.21.1.16 INSTRUMENT**

1. Indicating meters shall be of digital type, 96 x 96 mm size, suitable for flush mounting with constant accuracy for entire range of respective parameter with an inbuilt provision for calibration verification.
2. Watt-hour and Var-hour meters shall be suitable for 3 phase, 4 wire system, and balanced as well as unbalanced load and suitable for semi-flush mounting.
3. All KWH meter shall have computer interface facility through RS 485 port.

#### **3.21.1.17 MICROCOMPUTER MOTOR PROTECTION RELAY**

- a. Starters shall be complete with Microcomputer based Motor protection relay with OLED display facility for the motors of 15KW and above rating and without display for motors below 15KW rating.
- b. The relay PCB shall be with conformal coating and shall have over current protection (with medium tripping characteristics), Under current protection, Instantaneous short circuit protection, Single phasing protection, Current unbalance protection - for all the ratings of motors and for motors above 55 KW ratings, in addition to the above standard protections, the relay should be provided with Stator Ground Fault Protection, over temperature protection, locked rotor protection, Voltage unbalance and Under & Over Frequency protections.  
Relay shall have the facility to record minimum 05 trip data.
- c. The relay shall be Auto/ hand reset type. A hand reset push button separate from the stop push button shall be brought out on the front of the compartment door for all starter feeders of all ratings.

#### **3.21.1.18 PROTECTIVE RELAY**

- a. Relays shall be microprocessor based / static type and suitable for flush or semi flush mounting with connections from rear. Protective relays shall be in draw out cases.

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Load analyzer / load manager shall have communication port to interface with the / control room.

- b. Relay operation / trip indication shall be provided on door.
- c. All protective and tripping relays and timers shall be provided with fault display LEDs.

#### **3.21.1.19 MISCELLANEOUS ACCESSORIES**

- a. Breaker control switch shall be :
  - b. Spring return-to-neutral type with pistol grip handle
  - c. Lockable in neutral position.
  - d. Indicating lamps shall be multiple LED type made from FR type polycarbonate material with Low voltage glow protection (up to 50V) and translucent lamp covers. Lamps shall be replaceable from front. The power consumption of each indicating lamp should not exceed 0.5 Watts. The lamps shall have translucent covers. Lamps shall have diameter of 22.5.
  - e. Push buttons shall be momentary contact type rated for 10A at 500 V AC. The colour of push buttons shall be as follows:
    - a. Start - Green
    - b. Stop - Red
    - c. Trip - Amber
    - d. Spring Charger - Blue
    - e. Trip Circuit Healthy – White

All push buttons are required to have functional labels.

- f. Alarm Annunciator shall be provided, if specified in drawing/data sheet. Alarm Annunciator shall comprise flush mounted facia units with two lamps and Series resistor and ground glass plate in front for inscriptions. Alarm annunciation scheme shall include facia units with relay for each fault, a Common alarm bell and Accept / Reset / Test Push buttons.

#### **3.21.1.20 INTERNAL WIRING**

- a. All wiring inside the switchgear shall be carried out with 650V grade FRLS PVC Insulated flexible stranded copper wires. Minimum size of conductor for control wiring shall be 2.5 mm<sup>2</sup> Copper.

- b. Control circuits shall be provided with HRC fuses.
- c. Ferrules shall be provided on each wire.
- d. All wiring shall be terminated on terminal blocks with crimping type Copper cable lugs.
- e. Power connections for 63A and above shall be carried out with PVC insulated copper links.
- f. Vertical / horizontal Al. wire ways shall be provided to run the control wires within the same vertical panel and / or between different vertical panels.
- g. The control power supply shall be tapped from R phase and Neutral before / after the main fuses of each feeder. Control circuit shall have protection fuses. Wiring shall be carried out to facilitate testing of control circuit, without energizing the power circuit.

#### **3.21.1.21 TERMINAL BLOCKS**

- a. All terminal blocks for power and control circuits shall be of 650V grade stud type and shall be properly separated from each other.
- b. Terminal blocks of different voltage groups shall be segregated and suitably labeled.
- c. Terminals shall be numbered as per wiring diagrams.
- d. Minimum 20% spare terminals shall be provided.
- e. Shorting links shall be provided for all C.T. terminals.
- f. All spare contacts of contactor shall be wired up to terminal blocks.

#### **3.21.1.22 EARTHING**

- 1. An earth bus extending throughout the length of the Switch-board / PCC / MCC/ PMCC / DBs /APFCR Panel shall be provided.
- 2. The earth bus shall be of sufficient cross section to carry safely momentary short circuit current for 1 sec.
- 3. All non-current carrying metal parts shall be effectively bonded to the earth bus.
- 4. All doors shall be bonded to earth, wherever electrical switchgear are mounted on door.

### 3.22 LV energy efficient Motors

#### 3.22.1 Standards

Motors shall confirm in design, materials and performance, except where otherwise specified, with the current issue and amendments of the following codes and standards.

Codes and standards

CODES	DESCRIPTION
IS : 325	Three-phase Induction Motors
IS : 900	Code of practice for installation and maintenance of induction motors.
IS : 1231	Dimensions of three phase foot-mounted induction motors.
IS : 2148	Flameproof enclosures for electrical apparatus.
IS : 2223	Dimensions of flange mounted AC induction motors.
IS : 4029	Guide for testing three phase induction motors.
IS : 4691	Degrees of protection provided by enclosures for rotating electrical machinery.
IS : 4728	Terminal making and direction of rotation for rotating electrical machinery.
IS : 12615	Energy efficient three phase squirrel cage induction motors.

Compliance with this specification shall not relieve the vendor of its responsibility to supply equipment suited to meet the specified service conditions and applicable regulations.

Where conflicts exist between this specification and other Drawings, standards, codes and specifications, the most stringent shall be applied.

Motors may comply with other National Standards subject to receipt of prior written approval from the Owner.

#### 3.22.2 Service conditions

- a. The induction motors shall be suitable for continuous operation at a site location under ambient temperatures, altitude, humidity, atmosphere etc.
- b. The motors shall be high efficiency motors. Vendor to furnish motor efficiency chart for each rating of the motor.
- c. Motors shall be suitable for indoor/outdoor installation.
- d. The Electrical System requirements for the motor shall be as follows :-
  - a. 415 V, 3 phase, 50 Hz. neutral solidly earthed.
  - b. 240 V, 1 phase and neutral, 50 Hz, neutral solidly earthed.

- e. Unless otherwise stated, motors shall be suitable for continuous operation, without any deteriorating effect on the motor performance with variations of voltage and frequency as follows :
  - a. Voltage :  $\pm 10\%$
  - b. Frequency :  $\pm 5\%$
- f. The phase sequence shall be standard, i.e., red-yellow-blue.

### **3.22.3 Constructional requirement**

#### **3.22.3.1 General**

- a. Three- phase motors shall be of the squirrel-cage type unless otherwise specified standard types and sizes shall be used wherever possible.
- b. Single-phase motors shall be either capacitor-start type or split-phase type with centrifugal switch.
- c. Motor frames and end shields shall be constructed of ferrous metals.
- d. Protection shall be provided against galvanic action between dissimilar metals.
- e. Motors shall be suitable for full voltage direct-on-line starting or Star-Delta or soft starter or VFD or any other method of starting as specified.
- f. Unless otherwise stated, motors shall be duty type S1 continuous running duty with maximum continuous rating.
- g. Motors shall be capable of starting and accelerating the load with the applicable method of starting, without exceeding acceptable winding temperatures, when the supply voltage is 85% of the rated motor voltage.
- h. The locked rotor current of the motor shall not exceed 600% (maximum 720% with I.S. tolerance unless otherwise approved.)
- i. The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in hot, humid and tropical climate.
- j. Motors weighing more than 25 Kg. shall be provided with eyebolts, lugs or other means to facilitate safe lifting.
- k. Except as noted, horizontal motors shall be foot mounted type and vertical motors shall be base mounted type.

#### **3.22.3.2 Enclosures**

- a. Motor enclosures and all terminal boxes shall have a minimum degree of protection of IP55.

- b. Motors and their associated terminal boxes located in hazardous areas shall have the appropriate type of certified enclosure for the area classification.
- c. Motors shall be treated for operation in tropical conditions.
- d. Where a drain hole is provided, it shall be at the lowest point on the stator, subject to accessibility for the removal of the threaded plug when the motor is mounted in the service position. Online greasing arrangement shall be provided for motor ratings as specifically asked for.

#### **3.22.3.3 Windings**

- a. Three phase motors shall be delta with all six (6) leads brought out to terminal box.
- b. Windings shall be of copper.
- c. Motors shall be suitable for switching by all normal switching devices.
- d. Stator winding insulation shall be applied by vacuum impregnation. Winding insulation shall be class F. The motor temperature rise shall be class B.
- e. The method of measurement of temperature rise of windings shall be by resistance method.

#### **3.22.3.4 Terminal boxes**

- a. Particular attention shall be paid to the cable sizes required due to a voltage drop and derating factors, cable sizes can be larger, requiring a larger terminal box than is standard. Cable size shall be indicated during drawing approval.
- b. Terminal boxes shall be designed such that no parts can be dropped into the motor frame.
- c. An internal stud of the same size as the line terminals shall be fitted. This stud shall be in addition to the earthing bolt specified in the section entitled 'Earthing' and shall be complete with washers and lock nuts.
- d. Unless otherwise stated, the motor main terminal box shall be located on the left-hand side when looking from the non-drive end and be suitable for accepting cables from below. However, a top-mounted main terminal box is acceptable, if specifically required.
- e. The terminal box shall be adjustable for cable entry at four 90° positions.
- f. Terminal boxes shall be phase insulated.
- g. Terminal boxes shall have IP55 degree of protection.
- h. Terminal boxes shall be capable of withstanding full internal short circuit conditions without danger to plant or personnel. Motors shall be assumed to be protected by HRC fuses.

- i. When a motor is provided with a heater, current transformers or temperature detectors, the connections for each such device shall be brought out to separate terminal boxes. Each of these terminal boxes shall be provided with an internal earth terminal.
- j. Cable terminal boxes for the incoming cables shall be suitable for isometric threads which shall be provided to allow compression-type glands to be fitted.
- k. Cable connection shall allow for the removal of motors without breaking or stressing the cable sealing.
- l. The terminals shall be of the stud type with necessary plain washers, spring washers and check-nuts. They shall be substantially designed for the current carrying capacity and shall ensure ample phase to phase and phase to earth clearances.

#### **3.22.3.5 Rotors and cooling fans**

- a. Fans shall be constructed of metal / FRP and shall be of non-corroding material or be treated with a corrosion-resistant material and shall be non-sparking and anti-static.
- b. The flow of cooling air shall be in the direction of the driven equipment.
- c. The direction of rotation of the motor shall be clearly indicated on the motor by raised or embossed markings.
- d. Shaft ends shall be provided with suitably threaded holes to facilitate the assembly or removal of couplings and bearings, etc.
- e. The rotor and internal fan(s), if fitted, shall be dynamically balanced with the key way(s) fully filled with half key(s).
- f. The coupling half and external fan shall be independently balanced, also with the key way fully fitted with a half key.
- g. If additional weight is required for balancing, this material shall not be of lead or similar soft material.
- h. Unless stated otherwise, the method of motor cooling shall be:
  - i. Totally enclosed fan-cooled (TEFC).

#### **3.22.3.6 Bearings**

- a. The motor shall have two end shield housing ball or roller or thrust bearings.
- b. Type, size and make for driving and non driving end shall be clearly specified.
- c. Adequate number of bearing chart, co-relating motor frame sizes, bearing number and type shall be provided.



- d. It shall have grease packed and sealed for life to prevent ingress of foreign matter and the loss of grease.
- e. Motors shall be able to operate for 25,000 hours without any attention apart from lubrication.
- f. Non-sealed lubricated bearings shall be so constructed that they can be greased without stopping the motor.

#### **3.22.3.7 Anti-condensation heaters**

Motors shall be provided with a suitably rated anti-condensation heater if specifically asked for. Anti-condensation heaters shall be suitable for operation on a 240V, AC supply.

#### **3.22.3.8 Earthing**

- a. Motors shall be provided with a minimum-size-M10 earthing bolt external to the terminal box tapped into the frame, complete with locknuts and washers. This shall be in addition to the earthing bolt specified in the section entitled "Terminal Boxes".
- b. Precautionary measures shall be taken to ensure that no sparking can occur between adjacent parts on all motors, particularly those which are located in hazardous areas.
- c. Where it is considered advisable, each enclosure part shall be bonded. The bonding terminations shall be of a design to prevent loosening caused by mechanical shock or vibration and precautions shall be taken against corrosion.
- d. Two independent earthing points of bolted type shall be provided on opposite sides of the motor.

#### **3.22.3.9 Lifting facilities**

Motors above 25 Kg weight shall be provided with eye bolts, lugs or extension pieces for lifting.

#### **3.22.3.10 Rating plates**

- a. Rating plates shall be made of stainless steel and be screw fixed to a non-removable part of the motor frame and shall be stamped with data in accordance with IS: 325. Values given shall be those measured during tests. The following information shall also be given.
  - a. Enclosure degree of protection IP Number.
  - b. Hazardous area certification data, wherever applicable.
  - c. Locked rotor current: percentage of rated current.
  - d. Locked rotor torque : percentage of rated torque
  - e. Allowable run-up time: seconds.
  - f. Bearing type, size, fit, greasing period and type of grease.

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- g. Net weight.
  - h. Date of Manufacture.
  - i. Equipment Number
  - j. Vendor's Name
  - k. Serial Number.
  - l. Motor KW rating.
  - m. Motor rated volt / phase / frequency (Hz).
  - n. Full load Amps.
  - o. Full load power factor.
  - p. Frame size
- b. The serial number shall be stamped permanently on a non-removable part of the motor frame.
  - c. Following additional information shall also be submitted in data sheet after award of work.
    - a. Torque full load.
    - b. Locked rotor torque as a percentage of full load torque (FLT).
    - c. Pull up torque as a percentage of full load torque (FLT).
    - d. Breakdown torque as a percentage of full load torque (FLT).
    - e. Amperes at no load and 1/4, 1/2, 3/4 of full load (FL).
    - f. Power factor at no load and 1/4, 1/2, 3/4 of full load (FL).
    - g. Bearing (Number and manufacture).
    - h. Noise level - dB at 1m.
    - i. Motor vendor drawing numbers.

#### **3.22.3.11 Painting and finish**

- a. Motor external parts shall be finished and painted to produce a neat and durable surface, which would prevent corrosion.
- b. The motor shall be thoroughly degreased all rust, sharp edges shall be removed and treated with one coat of primer and finished with two coats of light grey enamel paint.
- c. Requirement for type of coating shall be Epoxy or powder coated.

### **3.22.3.12 Noise level**

Noise level shall not exceed 75 dB (A) at 1 m from any part of the motor when operating at full load.

### **3.22.3.13 Motor Starter Feeders**

- a. Each motor starter shall incorporate the following features in addition to complying with the requirements specified elsewhere in the specification.
- b. A suitably rated 3-phase & neutral (four pole) MCCB as a means of isolating the starter from the busbars and to provide short-circuit protection. A facility shall be provided to enable the MCCB to be padlocked in the 'Off' position only.
- c. Where any control or monitoring circuit inside the starter compartment operates at a voltage in excess of 24 V d.c. and is energised from outside the starter compartment, both poles of the circuit shall enter the starter compartment via miniature circuit breaker (MCB) so that the circuit inside the starter is isolated when the MCB is open.
- d. An isolating transformer shall be provided to feed the control and monitoring circuit. The primary of the transformer shall be fed from one phase and the neutral; the phase connection shall be protected by fuse. The output from the secondary shall be 110V/ 240 V. One pole of the transformer secondary shall be earthed and a fuse shall be fitted in the other pole. An earthed metallic screen shall be provided between the transformer primary and secondary windings.
- e. A 'test' switch to enable the control and monitoring circuit to be tested while the main circuit feeding the motor is isolated. The 'test' switch shall only be accessible when the starter compartment door is open. The switch shall take the form of a pushbutton which has to be pulled out to select the 'test' position and pressed in to select the 'normal' position. The 'test' button shall be located in the compartment so that the starter cannot remain in the 'test' mode when the compartment door is shut.
- f. An ammeter shall be provided to measure the line current drawn by the motor. The ammeter shall be connected on the compartment door with help of Ammeter selector switch. The ammeter shall have an extended range to suit the motor locked rotor current and an adjustable red pointer which can be used to indicate the motor full load current.
- g. Following Relay Protection shall be provided
  - a. A 'Run' relay, the coil of which shall be rated at energised from the relevant control and instrumentation compartment
  - b. An 'Available' relay
  - c. An 'Inhibit' relay, where appropriate
  - d. One or more 'Trip' relays, where appropriate

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- e. A 'Local switch-disconnector closed' relay, where appropriate. This relay shall only be energised when the switch-disconnector local to the pump is closed.
  - h. An overload and single phasing protection device
  - i. A motor over-temperature protection device to suit the thermistors or thermostat fitted in the motor
  - j. Other drive protection relays, as appropriate
  - k. The following control devices mounted on the starter door:
    - a. A Red 'Start' pushbutton
    - b. A Green 'Stop' pushbutton
    - c. A Yellow 'Lamp test' button
  - l. The following indicator lamps mounted on the starter door:
    - a. A Red lamp for pump 'Stopped'
    - b. A green lamp for pump 'Running'
    - c. An amber lamp for 'Fault'
    - d. Motor Starting
  - m. In selecting the appropriate type of fixed speed starter for a motor, account shall be taken of the following factors:
    - a. The torque/speed curves of the driven equipment and of the motor
    - b. The calculated frequency of starting each motor and the starts/hour for which the motor is suitable
    - c. Voltage regulation
  - n. The motor starter shall be one of the following types:
    - a. Direct-on-line
    - b. Star-delta
    - c. Soft start
  - o. Of these, direct-on-line starters shall be provided wherever the voltage regulation which results is within the specified limits. DOL starter shall be used for the motor rating up to 7.5kW
  - p. For the motor rating above 7.5 kW, star delta starter shall be utilized

- q. Soft-starter units shall be provided for motor rating above 55 kW, the appropriate characteristics (e.g. 'voltage ramp', 'pump start' and possibly 'soft stop') shall be determined.

### **3.23 HV Soft Starter**

#### **3.23.1 Design & Standards**

- a. The Soft Starter shall work on the principles of unsaturated Series Reactor Technology. It should follow the [IS standard 5553[part 3] year 1990/ IEC 60289/076 year 1988] for the design of the current limiting reactors which is the prime and key component of the soft starter.
- b. The soft starter shall comply with the requirements of IS 13947 Part-4 for Low voltage switchgear and control gear as well as guidelines of IS 12661(Part-1). Any material and component not specifically stated in this specification but necessary for trouble free smooth operation of the equipment and the accessories.
- c. The soft starter shall be designed for supply voltage variation of +/- 10% and frequency variation +/- 5%.
- d. Connection Neutral Side / Line Side As per Manufacturers recommendations for HT Motors and line side for LT Motors.
- e. The Soft Starter shall be so rated as to allow at least two consecutive starts from cold or three equal Starts equally spaced per hour or two hot starts per hour.
- f. The soft starter shall be rated corresponding to the motor power & shall be capable of Operating satisfactorily with the Motor under the various loading & starting condition of the motor over the entire operating Range. The Soft Starter rating offered shall not be less than the rated kW of the Motor.
- g. The Soft Starter shall reduce the starting current of the motor at least to 50 % to 60% of the direct online (DOL) starting current of the motor. In other word, If DOL provides starting current 6 times line current then soft starter would provide starting current 2.4 times line current. The soft starter shall have a facility to further reduce the starting current if motor / load torque curve permit so.
- h. The Soft starter shall control the starting torque in such a manner so as to effect smooth starting of the motor drive is achieved.
- i. Soft starter manufacturer shall submit impedance sizing calculation to achieve starting current 2.5 to 3 times. This shall be measured during the inspection.

- j. Soft Starter shall have a built in facility for run mode bypass so that the incoming voltage to the motor is equal to the supply voltage.
- k. The Soft Starter should be suitable for up to 50 °C ambient temperature. All the equipments used in the soft starter panel must meet appropriate IS/IEC standards and it should follow the standard practices and specifications.
- l. The Soft Starter shall be housed in a sheet steel enclosure of thickness not less than 2 mm & internal frame 3 mm. The enclosure should be only CNC fabricated. The enclosure shall be painted with powder coating corrosion resistive paint as per IS-5 such as Epoxy or Polyurethane. The degree of Protection shall be IP 5X

The Soft Starter shall be indoor, metal clad with separate metal enclosed compartments for

- a. Control, metering & push buttons with indicating lamps
  - b. Power Switchgear
  - c. Reactor and capacitor Compartment
  - d. Power Cable Terminations.
- m. Each cubicle of Soft Starter shall be fitted with a label in the front & rear of the cubicle, indicating the panel designation, rating & duty. Each relay, instrument, switch, fuse & other devices should be provided with separate labels.
  - n. The control supply to the Soft Starter shall be 110 V.D.C
  - o. The soft starter shall be provided with suitably rated digital ammeter to indicate the motor current during starting.
  - p. The Soft Starter shall have suitable hour meter and operation counter for counting motor running hours & counting no. of start–stop operations of the motor.
  - q. The Soft Starter shall have suitable rated control switch gear like contactors, 4-20mA transducers & indication lamps (Indication: Control supply ON, Auxiliary supply ON, Soft starter ready, Soft starter bypass, Soft starter fault, emergency PB operated)
  - r. Power Terminals, Cable termination shall be suitable for required cable size.
  - s. Busbar shall be of Copper, Insulated by heat shrinkable sleeves. Maximum temperature of busbar 40 deg C above ambient.
  - t. Earthing bus bar shall be of aluminum and 30x6 mm size.

- u. Cable entry shall be from bottom, Power and control cable Gland plate shall be 3 mm thick, separate removable and nonmagnetic type.
- v. The Soft Starter shall have anti condensation heater with switch & thermostat. The Heater shall have interlocking in such a way that it is switched OFF when Motor is in run mode.

### **3.23.2 HARMONIC FREE SERIES REACTOR (HFSR) SOFT STARTER**

- a. Series reactor coils shall be air cored coils held in rigid steel frame, duly insulated with insulation, vacuum impregnated to withstand the rated voltage and shall be provided with suitable taps for finer adjustment at site to provide optimum starting solution.
- b. Reactor coil shall be built from copper section to circulate current involved during starting duty without overheating.
- c. The winding of the soft starters shall be with Insulation class H, maximum temperature of winding shall be limited to that of Class B.
- d. Three reactors for three phases must be independent in construction for easy maintenance and cooling, any reactor should be easily removable from the panel without disturbing the remaining two. The reactors should be clearly visible for inspection as well as ventilation.
- e. The reactor modules must be all weather and vermin proof epoxy coated.
- f. The reactors of Soft Starter shall be of standard design for smooth linear acceleration and high efficiency, Natural Air Cooled [meeting all the specification of standard IS 5553[part3] IEC60289/076] & shall be maintenance free and shall generate any Harmonics
- g. The series reactor should be designed such as to avoid the eddy currents, noise/ vibrations/ humming noise and heat generation as well as to avoid core saturation & power losses.
- h. For further line current reduction up to 1.5 X FLC, dynamic compensator shall be used (as per IS 13925).
- i. The Soft starter shall be provided with specially programmed and calibrated PLC to control the starting process of motor through soft starter.

- j. PLC should monitor the complete starting process for errors, healthiness and Operational sequence of soft starter. PLC should provide current based close loop starting process and should not work on timer based open loop control.
- k. PLC should be equipped with enough digital and analogue ports to control the Complete soft starting process and continues monitoring.
- l. The minimum but not limited to parameters to be monitored by PLC are:
  - 1) Interlock fail with external device
  - 2) Door open
  - 3) Over temperature
  - 4) Number of starts and consecutive start limit
  - 5) Bypass device fail
  - 6) Long starting time
  - 7) Premature current fault
  - 8) Number of starts and time for life cycle of soft starter
- a. The interface for soft starter should be through capacitive touch screen HMI, 5.7" or higher size with at least 16 shade colour display and IP 65 protection.
- b. The HMI should be capable of displaying all errors, warnings, status messages, with Accept and reset facility, plotting the starting performance curves along with energy saving calculations with previous start histories.
- O) Complete PLC configuration should be possible through HMI.

### **3.23.3 FLUX COMPENSATED MAGNETIC AMPLIFIER (FCMA) TYPE SOFT STARTER**

- 1. The high Voltage Soft Starter for HV induction motor shall be based on Flux Compensated magnetic amplifier principle.
- 2. The applicable standards are IEC60071-2, IEC60060-1, IEC 62271-1, IEC60529, IEC 60076-6 clause 3.1.5, IEC 60289.
- 3. FCMA shall not lead to generation of harmonics.
- 4. The Soft Starter shall have silicon steel core, VPI for reactor coils shall be used.
- 5. The winding of the soft starters shall be with Insulation class H, maximum temperature of winding shall be limited to that of Class B.
- 6. The FCMA unit should be air cooled, and dust & vermin proof.



7. The FCMA Soft Starters should be suitable for indoor mounting.
8. FCMA Soft Starter shall not contain any active electronic components.

#### **3.23.4 Panel Accessories and Wiring**

- a. Panel shall be supplied completely wired internally upto equipment and terminal blocks and ready for the external cable connections at the terminal blocks. Interpanel wiring between compartments of the same panel shall be provided.
- b. All auxiliary wiring shall be carried out with 650 volts grade, single core, stranded copper conductor with PVC insulation. The sizes of wire shall be not less than 1.5 mm<sup>2</sup>.
- c. Terminal blocks shall be of stud type, 650 volts grade 10 amps rated, complete with insulated barriers. Terminal blocks for CTs shall be provided with test links and isolating facilities.
- d. All spare contacts and terminals of cubicle mounted equipment and devices shall be wired to terminal blocks.
- e. Accuracy class for indicating instruments shall be 0.5. Instruments shall be 110 mm square, 240mm scale for flush mounting with only flanges projecting.
- f. Relays shall be suitable for flush mounting with only flanges projecting.
- g. All protective relays shall be in draw-out cases with built-in test facilities.
- h. Necessary test plugs shall be supplied loose and shall be included. All auxiliary relays and timers shall be supplied in non-draw-out cases. Externally operated hand reset flow indicators shall be provided on all relays and timers. Timers shall be of electromagnetic or electronic type only.
- i. Push buttons shall be provided with inscription plates engraved with their functions.
- j. Indicating lamps shall be panel mounting type with series resistors. The wattage of lamps shall be 5 to 10 watts.
- k. Space heaters of adequate capacity shall be provided inside each panel. They shall be suitable for 240 V, 1 ph, 50 Hz supply. They shall be complete with HRC fuses, isolating switches and thermostat.
- l. Each panel shall be provided with 240 Volts, 1 phase, 50 Hz, 5 amps, 3 pin receptacle with switch located in a convenient position. An interior illuminating lamp together with the operating door switch and protective fuses shall be provided.
- m. Provision shall be made for receiving, distributing, isolating and fusing of auxiliary D.C. and A.C. supplies for controls, space heating etc. The fuse ratings shall be so chosen as to ensure selective clearance of sub circuit faults.
- n. Fuses shall be HRC cartridge type mounted on plug in type fuse base.

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- o. The D.C. and A.C. auxiliary supply shall be distributed inside the panel with necessary isolating arrangements at the point of entry and with sub-circuit fuses as required.

#### **3.23.5 Cable Termination**

- a. Necessary number of cable glands shall be supplied for terminating auxiliary power and control cables. Glands shall be of double compression nickel plated and complete with check nut, washers, neoprene compression ring etc.
- b. Cable lugs for all power and control cable connections shall be supplied. The lugs shall be tinned copper/aluminium depending on cable conductor and of solder less crimping type
- c. All necessary materials required for terminating the power cables such as tapes, fillers, binding wires, amour clamps, brass glands etc. shall be supplied.

#### **3.23.6 Motor starter protection**

- a. Too many starts & start inhibit time
  - a. Long start time (Stall protection)
  - b. Electronic overload with selectable curves
  - c. Electronic shear-pin
  - d. Electronic motor overcurrent protection
  - e. Electronic starter overcurrent protection
  - f. Undercurrent & Over Current
  - g. Unbalanced current
  - h. Ground fault current
  - i. Phase loss & Phase Imbalance.
  - j. Phase sequence and under/over frequency
  - k. Under voltage & Over voltage
  - l. External faults (2 separate inputs)
  - m. Shorted SCR & Wrong Connection
  - n. Starter Over temperature
  - o. Power on without start signal
  - p. Open Bypass contactor

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#### **3.23.7 Statistical Data**

- a. Elapsed run time, last Start time.
- b. Average starting current,
- c. Storage of history of upto 20 events (data including date & time, phase & ground fault current etc.
- d. Display of time to trip, remaining inhibit time and start/hour values.

#### **3.23.8 Metering (Voltage & Current)**

- a. Current : Phase A, B, C & average current, start current etc.
- b. Thermal data : Thermal capacity of motor,
- c. Time since last start, frequency, phase order etc.

#### **3.23.9 Enclosure**

- a. NEMA 12, top & bottom entrance plates, 11-gauge steel
- b. ASA#61 Powder coated paint with lifting eyes.

#### **3.23.10 Communications**

- a. RS485 with Modbus RTU protocol or RS232 with windows interface.

#### **3.23.11 Starting & Stopping**

- a. Soft start and soft stop
- b. Current limit
- c. Pump Control characteristics
- d. Torque and Current Control for optimized Starting & Stopping processes.
- e. Pulse start for high break-away torque
- f. Linear acceleration needing Tacho/encoder feedback.

#### **3.23.12 Interactive LCD Display**

In English language

#### **3.23.13 Control Circuitry**

- a. Multi-function programmable I/Os.

- b. Opto-isolated control inputs.
- c. Analogue output 0/4-20mA, 0-10VDC
- d. Tacho incremental encoder feedback

#### **3.23.14 Other Features at Glance**

- a. Heavy duty design at 50°C ambient temperature.
- b. Reduced inrush current and mechanical shock.
- c. Latest generation microprocessor circuitry.
- d. Soft, Stepless acceleration & deceleration.
- e. Advanced Starting & stopping characteristics.
- f. Advanced motor protection package and ramp features programmable via the keypad or a laptop computer.
- g. User friendly, easy setup and operation.
- h. Suitable Thermistor /RTD should be embedded in to all 3 windings with digital temperature scanner for protection. There should be audio-visual alarm in case of the temperature of soft starter coils are higher or any such soft starter failure.
- i. Soft Starter manufacture must measure impedance XL value at the shop floor and calculate and confirm the starting current. Starting current should be fully established at 'manufacturer's shop floor' calculation method. Further manufacturer must prove starting current at the pumping station.
- j. Induction motor starting, utilizing unique module
- k. -Innovative low voltage test modes - full testing with a small L.V motor using standard built in features and "dry" cabinet automation test.
- l. Advanced Electronic Potential Transformer utilizing Patent Pending "wireless" voltage measurement system.
- m. Complete isolation between MV and LV compartments for safety and reliability.
- n. Fault indication down to the individual thyristor level.
- o. Each starter tested for Partial Discharge (Korona) improving safety and ensuring
- p. long term reliability.
- q. Power factor capacitors can be connected directly to the upstream contactor.

- r. Coordinated motor fuses with blown fuse indicators.
- s. Heavy duty SCR stack assemblies with ring transformer isolation for reliable SCR gate firing.
- t. Fully rated bypass contactor for increased thermal capacity and optional across the- line starting.
- u. RS485 Communication with MODBUS, PROFIBUS or MODBUS/TCP protocols or RS232 with windows interface

#### **3.23.15 Drawings & data**

- a. The following shall be furnished as part of tender :
  - a. General arrangement showing plan, elevation and typical sectional views
  - b. Technical literature on the Soft starter offered.
- b. The following shall be furnished after award of contract for Owner's approval:
  - a. General arrangement showing plan, elevation and typical section views.
  - b. Foundation plan showing location of fixing channels, floor openings etc.
  - c. Schematic wiring drawings for each panel.
  - d. Terminal block details.

### **3.24 Power Capacitors and Capacitor control panel**

#### **3.24.1 Scope Of Work**

The specification covers the design, manufacture, testing at manufactures works, supply, delivery, storage at site; erection, testing and commissioning of LT APFC panel complete with instrumentation controls and safety devices.

The scope of supply shall include spares for 10 years of operation of the pumping station, special tools and testing devices, all parts accessories etc. which are essential for construction, operation and maintenance of the capacitor even though these are nor individually or specifically stated or enumerated. Corresponding components of the capacitors and associated equipment and spares shall be of the same material, dimensions and finish and shall be interchangeable. Voltage level of the equipment shall be as per price bid and technical data sheet.

#### **3.24.2 LV APFC Panel & capacitor bank**

- a. The panels shall be dead front, totally enclosed types with rear cable alleys for capacitor mounting. They shall be free standing, to be mounted on floor and suitable for indoor applications.
- b. The switchboards shall have suitable lifting arrangements in the form of lifting angles.

- c. The panels shall be of the cubicle type and extendable to both sides.
- d. The enclosure shall have protection IP 42.
- e. Separate segregated compartments shall be provided for circuit breakers, bus bars, cable boxes, voltage transformers, wire ways, relays and instrument and control devices.
- f. The shade of the paint for inside and outside surface shall be pebble grey as per RAL 7032.
- g. Panel cubicles shall be provided with hinged doors in front and back with facility for padlocking doors. All doors, panels and removable covers shall be provided with non-deteriorating (neoprene) gaskets around the perimeters.
- h. Adequate sized cable compartments shall be provided for easy clamping of all the incoming and outgoing cables, irrespective of whether they enter at the top or bottom.
- i. Floor mounted cubicles shall be provided with a 75mm high channel base frame. The total height of the cubicle shall not exceed 2400mm and the operating height of the highest switches shall not exceed 1750mm from floor level.
- j. The APFC shall be rigid and robust in design and construction fabricated out of cold rolled closed annealed sheet steel. Cubicles shall be made with rigid welded structural frames made of structural steel sections or of sheet steel of not less than 3mm thickness.
- k. The frames shall be enclosed by sheet steel of at least 2mm thickness, smoothly finished, levelled and free from flaws. Stiffeners shall be provided where necessary.
- l. After fabrication of the panels, the entire structure shall undergo a seven tank treatment for removing dust, grease, rust etc. The panels shall then be powder coated with approved shade.
- m. One name plate giving the designation of the panel shall be affixed prominently on the top or bottom of the switchboard describing the panel designation. These labels shall be of non-corrosive material. All the feeders shall be labelled with similar name plates indicating feeder number, name, rating etc.

#### **3.24.2.1 Busbar / Connection**

- a. The main bus bar systems shall be horizontal, three phase, three wire systems.
- b. The bus bars shall be made from aluminium. Rated short circuit withstand times for main and vertical bus bars shall be 25 kA for 1 second unless otherwise stated.
- c. The fault level analysis shall be submitted to the Owner for approval.
- d. Power feeder connections shall be of aluminium with PVC sleeve insulation. The size of the feeder connections shall be based on rating and permissible temperature rise.

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#### **3.24.2.2 Wiring and Terminations**

- a. Power and auxiliary circuits shall be provided with 1100V grade XLPE insulated flexible, copper stranded conductors, colour in accordance with Owner's specifications / requirements.
- b. Coloured sleeves shall be provided on the termination for identification purposes.
- c. Crimping type copper lugs shall be used for terminations.
- d. CT circuits shall be provided with 2.5 mm<sup>2</sup> wires whereas power terminals, control, annunciation and auxiliary circuits shall be provided with 1.5 mm<sup>2</sup> wires.
- e. Power terminals shall be bus bar type.
- f. Fixed terminals of control circuit shall be of 'polyamide' belonging to group of thermosetting compound.
- g. The material of control terminals shall have excellent resistance to deformations, optimum dimensional stability and strong resistance to surface discharge.
- h. Normal clip-on type fixed terminals shall be provided for Current transformer shorting.
- i. Power and control cable entry shall be from the bottom of the panel.

#### **3.24.2.3 Anti-condensation heaters**

- a. Anti-condensation heaters shall be supplied to maintain the interior of the APFC enclosure. Heaters shall be sized and located so as to prevent condensation of moisture during shutdown periods. The heaters shall permanently remain ON when the APFC is not in service and as such shall not cause damage to the components.
- b. Heaters shall be unaffected by the accumulation of moisture and shall have terminals adequately protected against moisture under severe weather conditions. Heaters shall be mounted on non-combustible material and shall operate without thermal damage to the components or themselves. Heaters shall be rated 240 volts single phase.
- c. Heaters shall be controlled and protected through two pole MCBs and thermostats.
- d. Warning nameplates shall be provided and installed in a prominent location. They shall have a red background with white letters and shall read: "CAUTION - CONTAINS AN EXTERNAL VOLTAGE SOURCE."

#### **3.24.2.4 Auxiliary Supply**

- a. The motors of circuit breakers shall operate on 240 V ac supplies received external PDBs.
- b. The closing and tripping operation of circuit breaker would be on 110V DC supply received from external battery bank or DCDB.

- c. The auxiliary supplies for the capacitor feeders shall be 240 V ac received from the control transformers installed in each APFC.
- d. Five ampere sockets shall be provided for lamps; receiving power from external power distribution boards and operated through two pole MCBs.

#### **3.24.2.5 Grounding**

- a. Rated short circuit current withstand time for earth bus bars shall be 50 kA for 1 second for 415 V. The earth bus shall be bare galvanized iron.
- b. Earth bus bars shall be extendable on either side of the switchboard.
- c. Earth bus shall be provided with coloured tape ring at suitable locations.
- d. Earthing of all panel doors shall be with minimum 4 mm<sup>2</sup> copper flexible braided wire.
- e. At least one hole of diameter 10 mm with bolt and nut shall be provided on earth bus bar at each end for connection to external earthing grid.
- f. All meters and relays mounted on panel doors shall be connected to the doors with mounting screws.

#### **3.24.2.6 Nameplates**

- a. Each APFC and capacitor bank shall have a corrosive-resistant nameplate containing information in accordance with relevant IS.
- b. Additional information as stipulated in applicable standards shall be included in the nameplate for APFC and capacitor banks meant for use in hazardous atmospheres.
- c. The lettering shall be white in colour on black background and attached to panel surfaces with adhesive.

#### **3.24.2.7 Cooling Systems**

All APFC panels and capacitor banks shall be provided with proper ventilation louvers as required.

#### **3.24.2.8 Lifting Hooks**

All APFCs shall be provided with lifting hooks of adequate capacity.

#### **3.24.2.9 Capacitor Banks:**

- a. Capacitor banks shall comprise of three identical single phase capacitors kept inside the aluminium enclosure. The capacitors shall be cylindrical/ box type in design.
- b. The individual capacitor units shall be connected in a delta configuration. The capacitor technology shall have All polypropylene film as core component. The unit shall be impregnated in the vacuum environment with non-PCB (Poly Chlorinated Biphenol) Oil as the impregnate.



- c. For safety purposes, capacitor units shall be factory fitted with discharge resistors, with a standard discharge time to 50 volts or less in 60 seconds. The capacitor units shall have a non-self-healing feature. For external protection, they shall be provided with PSDs (pressure sensitive disconnectors) as per IS 12672.
- d. The capacitor shall have bushing terminals designed for large cable termination and direct bus bar mounting for banking.
- e. The capacitors shall be provided with fuses. It shall be possible to identify the blown fuse from outside. The tolerance and degree of unbalances shall be as per the relevant Indian or international standard.
- f. The capacitors shall be designed with APP (industrial, high performance, high longevity, low power loss, good harmonic capabilities capacitors) technology as per IS 13585. The APP technology is capable of giving the longest life, highest over load limits and the highest operating ambient temperature. It is also suitable to use in a moderately high harmonic environment, up to 20 % non-linear content. Above 20 % detuned capacitors with reactors are to be considered.
- g. The capacitor shall comply with acceptance tests, type test and routine tests classified under IS 13585.

#### **3.24.2.10 Performance**

- a. Rated Output:
  - a. The required KVAR requirement shall be calculated and design calculations shall be submitted to the Owner for approval.
- b. Power Loss:
  - a. The dielectric loss of the material shall not be greater than 0.2 Watts/kvar. The total losses of the capacitor bank shall not be greater than 0.5 Watts/ kvar.
- c. Permissible Overload:
  - a. The units shall be able to withstand an over-current up to  $2.5 \times I_s$ . The capacitors shall offer a mean expected life of 160,000 hours. The maximum permissible overloads with regard to voltage, current and reactive output shall confirm to relevant IS.
- d. Transient Free Switching:
  - a. The capacitors shall withstand a peak inrush current up to  $400 \times I_n$ .
  - b. The Contractor shall ensure that all the capacitors installed are switched in a transient free manner to ensure reliable performance of the installations.
- e. Resonance:

- a. The contractor shall ensure the risk of resonance is avoided and a safe combination of capacitor + filter reactor shall be selected for high voltage application to ensure reliable power factor improvement. The Contractor shall submit the design calculations for approval by the Owner.
- f. Voltage Stress:
  - a. The voltage stress shall be less than 40 and 60 Volts per micron for low and high voltage capacitor applications respectively.
- g. Design Voltage of the Capacitors
  - a. The capacitor should be designed at 480 V or higher due to the presence of 7% reactor in the system.
- h. Detuned Reactor:
  - a. Capacitor units shall be supplied with 7% detuned aluminium wound reactors for the smooth functioning of the capacitors in a harmonic environment. The reactors shall offer linearity up to 1.73 times rated current.

### **3.25 6.6 kV HT Capacitor Panel**

#### **3.25.1 Scope Of Work:**

The specification covers the design, manufacture, testing at manufactures works, supply, delivery, storage at site; erection, testing and commissioning of HT capacitors complete with instrumentation controls and safety devices.

The scope of supply shall include spares for 10 years of operation of the pumping station, special tools and testing devices, all parts accessories etc. which are essential for construction, operation and maintenance of the capacitor even though these are nor individually or specifically stated or enumerated. Corresponding components of the capacitors and associated equipment and spares shall be of the same material, dimensions and finish and shall be interchangeable. Voltage level of the equipment shall be as per price bid and technical data sheet.

#### **Operating conditions**

Sr.No.	Particulars	Specified value
1	Nominal System Voltage	6.6 kV
2	Highest system voltage	7.2 kV
3	Frequency	50Hz $\pm$ 3%
4	Number of Phases	3
5	Neutral Earthing	Solidly grounded
6	Fault level	25 kA for 3 sec
7	Auxiliary AC supply	240 Volts $\pm$ 10%

Sr.No.	Particulars	Specified value
8	Auxiliary DC supply	30 Volts +10% – 15%

### 3.25.2 General Technical requirements

- a. The capacitor bank and control panel shall be suitable for being installed indoor
- b. The equipment shall remain functional during and subsequent to the application of seismic loading. The exact value of seismic level (Horizontal acceleration) may be considered as per data available with IMD.
- c. The shunt capacitor should be designed for satisfactory operation even with presence of harmonics in the system. Suitable devices of required ratings should be included in the scope of supply. The general arrangement drawing along with the detailed lay out plan of the capacitor bank shall be submitted for necessary approval.
- d. To improve the power factor of motors and in tern of the system. The capacitor value shall be worked such that the power factor shall improve to 0.98 from no load to full load condition of the transformer and also with motor and other load on the bus.
- e. The capacitor across each motor shall be selected to improve the power factor up to 0.99 however care shall be taken that kVAR of capacitor shall not exceed magnetizing kVAR of the motor even if corrected power factor is less than 0.99. Provision Capacitor on 6.6 KV bus and/or at individual 6.6 KV motor end shall be decided during detailed engineering.
- f. The HV capacitors connected on HV bus shall discharge through directly connected discharge device from the residual voltage value to 50 volts or less within 5 minutes after the capacitor is disconnected from the source of supply.
- g. The contractor shall provide timer for capacitor feeder so that the circuit breaker does not re-close prior to 5 minutes after it is switched off.
- h. The HT capacitor shall be suitable for voltage factor of 1.3 (multiple of rated voltage) for maximum duration of 1 minute.
- i. The HT capacitor units shall be suitable for continuous operation at a current (rms value) of 1.3 times the current that occurs at rated sinusoidal voltage and rated power frequency excluding transients.
- j. HT Capacitors for transformers, if provided shall be protected against over current by means of suitable breaker with adjustable over current relays, which are adjusted to interrupt the circuit, when the current exceeds the permissible limit as specified in 5.3 of IS: 2834-1964.
- k. Maximum over voltage the unit capacitor shall be capable to withstand 110% continuously.
- l. Suitable discharge device to be provided.

- m. The size and method of connection of capacitors shall be checked with the motor manufacturers.
- n. Contractor shall check with manufacturer regarding the provision of inductor coil.
- o. The circuit breaker for capacitor feeder shall be restrike free.
- p. The capacitors shall be provided in separate expanded metal housing with top completely covered with M.S. sheets. The capacitors shall be mounted on rigid framed structure. The bushings required for supporting IS.2834 but shall also meet the requirement as per B.S.S. 1950 wherever these are applicable.
- q. The capacitors shall be provided with earth terminals. The earth fault relay is included under HT panel.
- r. The one no. of CBCT to detect the earth fault required for earth fault relay shall be provided.

### **3.25.3 CAPACITOR BANK**

- a. The capacitors shall be arranged in double star. Neutral current transformer provided shall detect any unbalance due to capacitor unit failure. Neutral current transformer shall be provided between two star points of the capacitors bank. The star point shall be ungrounded. The capacitor unit should be made up of all polypropylene film dielectric with NON PCB impregnate liquid and provided with internal fuse element. The containers shall be made from CRCA sheet of thickness not less than 2mm (14 SWG). The capacitor unit should be arranged in galvanized steel rack with copper tinned conductors for their interconnections and aluminum bus bar for interconnections between capacitor bank, lightning arrestor, series reactor and neutral current transformer.
- b. The container shall be hermetically sealed by controlled arc welding/tig welding process. The metal flanges of the bushing should be soldered /welded to the container and covered with epoxy compound providing a strong hermetical seal to the container. Suitable mounting shall be provided for the container. The container of each capacitor unit shall be provided with suitable earthing terminal clearly marked.
- c. The capacitor bank shall be designed, manufactured and tested as Per IS- 13925 (Part-I). Unless otherwise specified, the capacitors shall be suitable for upper limit of temperature category 50° C as per IS-13925 (Part-I).
- d. The capacitors shall be designed with APP/ MPP/ PPMO technology as per IS.
- e. Each unit shall be rated for appropriate kV phase to earth voltage with series parallel combination connected in double star with neutrals interconnected through NCT. The maximum permissible overloads with regard to voltage, current and reactive output shall conform to IS: 13925 (part I) with latest amendments.

- f. The power loss in capacitors shall not exceed 0.2 Watt/ kVAr. Suitable discharge device shall be connected across the capacitor units in accordance with the provision of IS: 13925 (part I) with latest amendments.
- g. The outside of the container should be coated with weather-proof and corrosion-resistant paint with colour shade 631 as per IS: 5.
- h. The capacitor shall be provided with a rating plate and terminal markings as stipulated in IS:13925 (part I).

#### 3.25.4 Reactors

- a. The reactor should be air cooled dry type aluminum wound. The reactor shall be suitable for Indoor duty having bushings as terminal arrangements and the Inrush Current Limit coil shall be connected on Line end of star section. The reactors shall be suitable to carry 130% of the rated current of the capacitor bank.

#### Reactors

Sr.No.	Particulars	Specified value
1	Rated voltage	6.6
2	Rated capacity / Inductance	Based on the capacitor bank rating
3	Rated frequency	50 Hz
4	Number of phases	Single phase
5	Terminal arrangement	Suitable for bus bar connections on IC & OG side
7	Confirming to IS	IS 5553 ( part-3)
8	Class of Insulation	Class F
9	Type Of Connection	Line Side Of capacitor
10	Max operating temperature	90 degree Celsius ( Over Ambient)

#### 3.25.5 Isolators with earth switch

- a. The Main Incomer Panel shall comprise of 1 No. of 6.6 KV suitable rating 25 kA / 1 Sec 3-Pole Off - Load type Manually Operated panel mounted Isolator with Earth Switch mechanism.
- b. The Isolators shall confirm to the latest version of IS 9922 (Part I to IV) and IS 9921 (part I to IV) or any other International standards.
- c. The isolators with earth switch shall have the following ratings:
  - a. Rated voltage : 12 KV
  - b. Rated impulse withstand voltage : 75 KV
  - c. Rated current : As required
  - d. Rated frequency : 50 Hz

- e. Rated short time current : 25 KA
- f. Rated max. duration of short circuit : 1 sec
- d. The Isolator shall be provided with Earth Blade with suitable mechanical interlocking arrangement.

### **3.25.6 Vacuum Contactors**

- 1. Vacuum contactors shall follow IEC 60470.
- 2. Operating Characteristics of Vacuum contactors are
  - a. Rated Voltage- 6.6 kV/ 3.3 KV
  - b. Rated service current - as per requirement
  - c. Fixed construction
  - d. Frequency -50 HZ
  - e. Operating duty Hourly operations
    - (i) Electrical latching-900 operations /hour
    - (ii) Mechanical latching - 300 operations /hour
  - f. Ultimate performance for: (at a voltage of) 7.2 KV/ 3.6 KV
  - g. capacitor bank KVAR – As per design
  - h. Capacitor current switching rating-As per design requirement
  - i. Mechanical operations (i.e. Electric Life of VCU)-Total 1, 00,000 operations
  - j. Electrical operations (i.e. Electric Life of VCU) at rated current- Total 1, 00,000 Operations vacuum contactor shall have back to back switching

#### **3.25.6.1 HRC Fuses**

- a. Nominal System Voltage : Suitable For capacitor Application
- b. For suitable capacitor Application.
- c. Applicable standard IEC 60282-1 (IEC 282-1).
- d. HRC fuse links should have the following properties:
  - a. Low minimum breaking current
  - b. Low power losses
  - c. Low arc-voltage
  - d. High current limitation
- e. Low power losses permit installation of these fuses links in compact switchgear.
- f. HRC should have a zone between the minimum melting current and the minimum breaking current where the fuse links may fail to interrupt.

### 3.25.6.2 Protection:

#### a. Fuses:

- a. The fuses shall withstand repeated application of transient conditions associated with normal duty of capacitor unit.
- b. Fuses shall be capable of limiting arc energy within the case of faulty capacitor to such small proportions that the danger of case rupture is eliminated.
- c. It shall have adequate rupturing capacity for the fault levels at the terminals of the capacitor.
- d. It shall have adequate thermal capacity to cater for increased heating which may occur due to harmonics.
- e. It shall have an ampere rating which will provide proper co-ordination between its total clearing time current curve and capacitor unit's case rupturing capacity.

#### b. The capacitor banks shall be provided with the following others protections:

- a. Over current and earth fault protection to cover bus faults between the capacitor banks and its controlling circuit breaker.
- b. Over voltage protection.
- c. Unbalance protection.
- d. No volt protection.
- e. Leading Power factor Protection.

#### f. Requirement of each of the above protection are described below:-

##### i. Over-current & Earth fault protection:

- (1) Combination of two IDMT relays having 50-200% settings and one EIF relay of IDMT characteristic with 20-80% setting shall be used with suitable current transformer.

##### ii. Over-voltage Protection:

- (1) Over-voltage shall have an inverse time characteristics and shall be energized through VT connected to the main bus bars on the source side of the circuit breaker controlling the capacitor banks. Relay shall have variable settings from 100% to 130% in steps of at least 1% to 2%.

##### iii. Unbalance Protection:

- (1) Unbalance protection shall be provided with current operated relay with separate one no. NCT for each group capacitor bank. The relays used shall be provided with a

time delay device to prevent operation under transients and to allow individual fuses to isolate the faulty units. Inverse time delay relay may be used.

iv. No volt Protection:

- (1) Under voltage protection shall be provided to disconnect the bank under low voltage conditions. A time delay relay must be provided with adjustable setting of 0 to 10 minutes to provide a time lag before which the bank shall not be again switched on (to avoid closing of the circuit breaker on a trapped charge).
- (2) The under-voltage protection shall not operate in the event of fault on 6.6 kV which may dip the bus bar voltage to 50%. There should be provision for adjustments in settings of voltage and time to coordinate the 6.6 kV line protections with the under-voltage protection to avoid malfunctioning of under-voltage relay under bus fault conditions.

g. The power factor meter should be provided.

h. The associated equipments shall be supplied along with the capacitor banks.

### **3.26 Auxiliary Transformer**

#### **3.26.1 Scope of Work**

This specification provides for the engineering, manufacturing, testing and supply of 11/0.433 KV or 6.6 /0.433 kV or 3.3/0.433 KV (as per system requirement) Distribution Transformer , oil immersed, naturally cooled suitable or outdoor application Transformer should be Energy Efficiency level-2. The offered equipment shall be complete with all components necessary for their effective and trouble free operation. Such, components shall be deemed to be within the scope of contractor supply irrespective of whether those are specifically brought out in this specification and / or the commercial order or not. Voltage level of the equipment shall be as per price bid and technical data sheet.

#### **3.26.2 APPLICABLE IS CODE & STANDARDS:**

The equipment covered under this specification shall comply with all the latest applicable statutory rules, regulations, acts and safety codes in force.

The transformer shall comply with the latest revision and with the relevant parts of standards mentioned below:

Sr No	IS Standard no	Description
1	IS: 1180(Part-I):2014	Specification for auxiliary Transformer
	IS;2026	Specification of Power Transformer



2	IS 12444, ASTM B-49	Specification for Copper wire rod
3	IS: 10561	Application guide for auxiliary transformers
4	IS: 10028	Code of practice for selection, installation and maintenance of transformers
5	IS : 1866	Code of practice for maintenance and supervision of mineral insulating oil.
6	ISS -3347/1967	Specification for porcelain Transformer bushing
7	ISS - 2099/1973	Specification for High Voltage Porcelain bushings
8	ISS - 7421/1974	Specification for Low Voltage bushings
9	ISS - 5484	Specification for Al Wire rods
10	ISS-9335, IEC-554	Specification for Insulating Kraft Paper
11	ISS-1576, IEC 641	Specification for Insulating Press Board
12	IS: 335	New insulating oil for transformers.
13	IS : 6600	Guide for loading of oil immersed transformers
14	IS : 3639	Fittings and accessories for power transformers
15	IS: 3637	Gas operated relays
16	IS: 1271	insulating materials
17	IS: 2147	Cable boxes degree of protection
18	IS-649	Testing of Steel Sheets & Strips For Magnetic circuits
19	IS-3401	Silica gel
20	IS-1866	Code of practice for maintenance & supervision of Mineral insulating oil in equipment
21	IS-6262	Method of test for Power factor and dielectric constant of electrical insulating liquid
22	CBI&P Publication	Manual on Transformer

Nothing in this specification shall be construed as to relieve the supplier of the responsibility for correctness of the design and construction of the equipment.

### 3.26.3 SERVICE CONDITION

The Distribution Transformers to be supplied against this Specification shall be suitable for satisfactory continuous operation under the following climatic conditions as per IS 1180 (Part - I) Latest Revision

#### **3.26.4 AMBIENT AIR TEMPERATURE:**

Daily average ambient air temperature of 44deg.C, Maximum temperature 50 deg.C

Altitude: Maximum up to 1000 meters above MSL.

Humidity: Relative humidity maximum up to 100% during rainy season.

Location: outdoor.

#### **3.26.5 DESIGN FEATURES**

The design of the transformers and accessories shall be in accordance with the latest standard practice and shall be such as to facilitate inspection, cleaning, repairs, maintenance and operation. Transformer shall be able to sustain starting impact of Induction motor used for the project.

#### **3.26.6 ELECTRICAL FEATURES: THE ELECTRICAL FEATURE SHALL ENSURE THE FOLLOWINGS:**

1. Continuous operation at rated kVA provided service conditions does not exceed the values given.
2. Continuous operation at rated kVA within +/- 10 % Voltage variation, +/- 5 % Frequency variation and +/- 10 % variation of voltage and frequency (combined) corresponding to the voltage of the tapping.
3. It shall ensure safety operations under situation of sudden variations of loads and voltages up to +12.5% to – 12.5%.
4. The transformer shall be suitable for Continuous operation for flux densities specified in the technical requirement
5. The transformer shall be capable of being loaded in accordance with IS: 6600 up to load of 150%. There shall be no limitation imposed by bushings, tap changer etc

#### **3.26.7 MECHANICAL FEATURES**

1. The transformer shall be able to withstand the electro dynamic stress due to terminal short circuit of the LV side assuming the HV side fed from an infinite bus. All leads windings in cores shall be properly supported, clamped and tightened after vacuum drying to ensure the short circuit withstand ratings. The short circuit withstand duration shall be minimum 3 sec.
2. The transformer shall be so designed as to minimize any undue noise and vibration.

### **3.26.8 CONSTRUCTIONAL DETAILS**

#### **3.26.8.1 CORE**

- a) The core shall be of NEW high grade, non aging, grain oriented, cold rolled silicon steel lamination having low hysteresis loss and high permeability properties, with heat resistant & hot oil proof insulating coating. Lamination thickness should not be more than 0.23 to 0.27 mm.
- b) The flux density in any part of core and yoke at normal voltage and frequency shall not be more than 1.5 Tesla.
- c) Preferably no bolt shall be used in the cores. Clamping shall be done externally to the limb. Core structure shall be securely grounded to prevent electrostatic potential. Lifting eyes and lugs shall be provided on the limbs and core assembly.
- d) The design of magnetic circuit shall be such as to avoid static discharges, development of short circuit paths within itself or the earthed clamping structure and the production of flux component at right angles to the plane of lamination which may cause local heating.
- e) The transformers core shall be suitable for over fluxing (due to combined effect of voltage and frequency) up to 12.5% without injurious heating at full load conditions and shall not get saturated. The Bidder shall furnish necessary design data in support of this situation.
- f) The manufacturer shall furnish the exact type of core material, its BH Curve, design flux density at normal tap and source of procurement.
- g) Cores and winding shall be capable of withstanding shocks during transportation, installation & service. Adequate provision shall be made to prevent movement of core and winding relative to tank during these conditions.

#### **3.26.8.2 TANKS**

- a. Tanks shall be of welded construction and fabricated from boiler steel plates of adequate thickness.
- b. All seams and joints those are not required to be opened at site shall be factory welded and wherever possible they shall be double welded.
- c. All joints of tank and fittings shall be oil tight and no bulging should occur during service. Inside tank shall be painted with varnish/ hot oil resistant paint.
- d. Tanks stiffeners shall be provided for general rigidity and these shall be designed to prevent retention of water.
- e. The tanks shall be designed to withstand and without permanent distortion:
  - i. Mechanical shocks during transportation
  - ii. Vacuum filling of oil with 760 mm of mercury.

- iii. Continuous internal gas pressure above atmosphere.
- iv. Short circuit force
- f. The transformer tank and its accessories shall be designed without pockets where in gas shall collect.
- g. Adequate space shall be provided at the bottom of the tank for settlements of sediments.
- h. Suitable guides shall be provided in the tank for positioning the core and coil assembly.
- i. The tank shall be suitable for movement in both directions during shipment. Each tank shall be provided with two Lifting lugs suitable for lifting the complete transformer and minimum of four jacking pads to be raised or lowered using hydraulic or screw jacks.
- j. All bolted connections shall be fitted with oil tight gaskets of nitrile rubber or equivalent, which shall give satisfactory service under operating conditions. Special attention shall be given to method of making the hot tight joints between tank and cover, with bushing and all other outlets

#### **3.26.8.3 TANK COVER**

1. The tank cover shall be sloped to prevent retention of rain water and shall not distort when lifted.
2. At least two adequately sized inspection covers one at each end of the tank shall be provided for easy access to bushings and earth connection. The inspection covers shall have suitable lifting arrangement.
3. Bushings, inspection covers etc. shall be designed to prevent ingress of water into or leakage of oil from the tank.
4. All bolted connections shall be fitted with weather proof hot oil resistance for complete oil tightness. If gasket is compressible metallic stop shall be provided to prevent over compression.

#### **3.26.9 MOUNTING ARRANGEMENT**

1. The transformers shall be provided with two nos. bi-directional skids and pulling eyes integral with the tank body for fixing the transformer tank on foundation.
2. These skids shall be such that the bottom of the tank is at a sufficient height above foundation for cleaning purposes. Each transformer shall be provided with unidirectional, flat rollers of 1000 mm length.

##### **3.26.9.1 CONSERVATOR TANK**

1. The conservator tank shall have adequate capacity to accommodate oil preservation system and volumetric expansion of the total cold oil volume in the transformer and

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radiators for a change in temperature from minimum ambient air temperature of 50 deg C to 110 deg C.

2. The conservator shall be bolted into position so that it can be removed for cleaning purposes.
3. The conservator tank shall be fitted with a silica gel filter breather.
4. The conservator shall be fitted with plain oil level gauge. The oil level at 30 deg C shall be marked on the gauge. The conservator which shall also be provided with a drain plug and filling hole with cover.

#### **3.26.9.2 EXPLOSION VENT**

1. The transformers shall be provided with the single type of explosion vent
2. An equalizer pipe shall be connected to explosion vent from the conservator.

#### **3.26.9.3 TEMPERATURE INDICATOR:**

The transformers shall be provided OTI and WTI inside Marshaling box. OTI/ WTI temperature high alarm shall be provided on Panel.

#### **3.26.9.4 WINDINGS**

1. The conductors shall be of electrolytic grade copper free from scales and burns.
2. Current density for HV and LV shall not be more than 2.5 A/ sq. mm for copper or current density for HV and LV shall not be more than 1.60 A/sq. mm for aluminum conductor. (However, +5% tolerance for LV winding is permissible)
3. All winding shall be fully insulated. No graded insulation shall be accepted. Use of enamel as a sole conductor insulation is prohibited.
4. The insulation of transformer winding and connections shall be free from insulating compounds which are liable to soften, ooze out, shrink or collapse and be non-catalytic and chemically inert in transformer oil during service.
5. Coil assembly shall and insulating spacers shall be so arranged as to ensure free circulation of oil and to reduce the hot spot of the winding.
6. Tapping shall be so arranged as to preserve the magnetic balance of transformers at all voltage ratios.
7. Transformer shall be design for 25 KA for 1 Sec for through fault withstands capability.

8. All bus bars and leads shall be adequately supported in insulated cleats or frames from the clamping structure.
9. Studs, set screws or bolts provided for securing cleats or frames shall be effectively locked.
10. Bus bars and leads shall be supported throughout their length to ensure they shall not move under normal service or transport or be forced from the prescribed position during any short circuit.
11. The impedance values shall be as per Latest IS-1180.
12. The winding shall be connected to achieve a vector group of DY11.
13. Temperature rise: The temperature rises over ambient shall not exceed the limits

#### **3.26.10 INSULATION MATERIALS**

1. Class 'A' insulating materials specified in IS: 1271 or latest version shall be used. Wood insulation, press board, wooden block where used, shall be well -seasoned and treated. Materials Electrical grade insulating craft paper shall be used.
2. INSULATING OIL :
  - i) The new insulating oil supplied with the transformer shall conform to the requirements of IS: 335 tested at bidder's premises. No inhibitors shall be used in the oil.
  - ii) Prior to filling the oil in the main tank suitable number of samples shall be tested for BDV moisture content, resistivity at 90 deg C tan delta at 90 deg C and interfacial tension. The oil samples taken from the transformer at site shall conform to the requirements of IS: 1866.
  - iii) The manufacturer shall dispatch the transformer filled with oil. The manufacturer shall take care of the weight limitation on transport and handling facility at site. Ten percent (10%) extra oil shall be supplied for topping up, in non returnable sealed containers suitable for outdoor storage.

#### **3.26.11 EARTHING TERMINALS**

Two earthing terminals suitable for connecting 50 x 8 mm mild steel flat shall be provided at positions close to the two diagonally opposite bottom corners of tank. These grounding terminals shall be suitable for bolted connection.

### **3.26.12 OIL PRESERVATION SYSTEM**

The transformers shall be provided with the conventional conservator preservation system with a single compartment with dry air filling of space above the oil. The top of the conservator shall be connected to the atmosphere through a silica gel filter breather. It shall be so designed that:

- i) Passage of air is through dust filter and silica gel.
- ii) Moisture absorption indicated by a change in colour of the tinted crystal can easily observed from a distance.
- iii) Breather shall be mounted not less than 1400 mm above rail top level.

### **3.26.13 TERMINAL ARRANGEMENT PORCELAIN BUSHING**

- 1. The minimum clearances in air between the phases and between the phase and earth potential of the porcelain bushings shall be in accordance with IS: 2026- part V, 1994, IS 1180.
- 2. Bushing terminals shall be provided with suitable terminal connectors of approved type and size for ACSR conductor.
- 3. All transformer bushings shall be of solid porcelain with plain sheds conforming to IS: 8603.
- 4. The removal of bushing shall be possible without disturbing the current transformers, secondary terminals and connectors or pipe work.
- 5. Bushing of the same voltage class shall be interchangeable bushing with plain shed as per IS

### **3.26.14 CABLE BOXES AND DISCONNECTING CHAMBERS:**

- 1. Wherever cable connections are specified, suitable air insulated type cable boxes of sufficient sizes shall be provided to accommodate cable termination. Cable boxes shall be designed and installed such that it shall be possible to move away the transformer without disturbing the cable termination leaving the cable box on external supports. The support for the cable box shall be of galvanized iron.
- 2. Cable boxes shall have terminal connectors of adequate size and bolt holes to receive cable lugs.
- 3. The contractor shall provide earthing terminals on the cable box to suit 50 x 8 mm GI flat.

4. All necessary cable terminating accessories such as supporting brackets, power cable lugs, hard ware etc. shall be provided by the bidder.
5. Cable boxes shall have removable top cover and ample clearance shall be provided to enable either transformer or each cable to be subjected separately to high voltage test.
6. Cable boxes shall have degree of protection of IP-52 as per IS: 2147.

#### **3.26.15 TERMINAL MARKING:**

The terminal marking and their physical position shall be in accordance with IS:2026 .

#### **3.26.16 TERMINATION ARRANGEMENT FOR NEUTRALS**

The transformer shall be solidly earthed at the secondary neutral. The neutral terminal brought on to a separate neutral bushing shall be connected to associated neutral grounding pit by a copper flat, which shall be supplied and installed by the bidder.

#### **3.26.17 OFF CIRCUIT TAP CHANGE SWITCH:-**

1. The tap change switch shall be three phase, hand operated, for simultaneous switching of similar taps on the three phases by operating an external handle.
2. Arrangement shall be made for securing and pad locking the tap changer in each of the working positions, and it shall not be possible for setting or padlocking in any intermediate position. An indicating device shall be provided to show tap in use.
3. The cranking device for manual operation shall be removable and suitable for operation by a man standing on ground level. The mechanism shall be complete with the following
  - i. Mechanical operation indicator.
  - ii. Mechanical tap position indicator which shall be clearly visible from the transformer.
  - iii. Mechanical stops to prevent over cranking of the mechanism beyond extreme tap position.
  - iv. The manual operating mechanism shall be labeled to show the direction of operation for raising the secondary voltage and vice versa.
  - v. A warning plate indicating "The switch shall be operated only when the transformer has been de-energized" shall be fitted.



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### **3.26.18 CLEANING PAINTING**

1. The internal and external surfaces including oil filled chambers and structural work to be painted shall be sand blasted to remove all rust and scale or foreign adhering matter.
2. All steel surfaces in contact shall be painted with hot oil resisting insulating varnish or paints.
3. All steel surface exposed to weather shall be given a primary coat of zinc chromate, second coat of oil and weather resistant varnish of a colour distinct from primary and last two coats of glossy oil and weather resisting non fading paint of light gray colour conforming to IS: 632.

### **3.26.19 BOLTS AND NUTS**

All bolts and nuts exposed to weather shall be of hot dip galvanized or cadmium plate or zinc passivated steel. All bolts, nuts and washers in contact with nonferrous part which carry current shall be of phosphor bronze.

### **3.26.20 FITTINGS**

The following fittings shall be provided with all the transformers:

- a) Rating and diagram plate.
- b) Terminal marking plate
- c) Two earthing terminals
- d) Lifting lugs
- e) Jacking lugs
  - f) Drain valve with plug, 50mm size.
- g) Dehydrating breather
- h) Plain oil level indicator with minimum marking.
- i) Off load tap changing switch
- j) Oil filling hole with cover
- k) Conservator
- l) Explosion vent
- m) Skids and pulling eyes on both sides
- n) Rollers, Flat unidirectional limited to 1000 mm
- o) H.V. porcelain bushings with metal parts or L.V.cable box.
- p) Filter valve.
- q) Inspection cover
- r) L.V. Cable box

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### **3.27 Diesel Generating sets**

#### **3.27.1 General & scope**

- a Work shall include design, manufacture, supply, transportation, delivery, installation, testing and commissioning of Diesel Generator Sets and auxiliaries.
- b The generator set shall consist of a diesel engine directly coupled to an electric generator, together with the necessary control panel, battery, diesel tank etc and accessories to provide prime electric power for the duration of any failure of the normal AC source
- c Foundations for equipments including vibration isolation springs/ pads,
- d Making good all damages caused to the structure during installation and restoring the same to their original finish.
- e Minor building works necessary for installation of equipments, foundation trench for fuel line & cable, making of opening in walls or in floors and restoring them to their original condition/ finish and necessary grouting. as required.
- f All supports for exhaust & water pipes, chimney, cables, anti- vibration pads etc. as are necessary.
- g All electrical work and neutral earthing, body earthing, required for engine& alternator, main board/ control panels, and control wiring including loop earthing.
- h All pipes, bus trunking and/ or cable connections.
- i Painting of all exposed metal surfaces of equipments and components with appropriate colour.
- j Contractor shall take necessary clearance/approval of the complete installation from CPCB/state pollution control board, central electricity authority/Local bodies and other licensing authorities, wherever required.

#### **3.27.2 Standards**

- a The equipment offered shall confirm to the latest revision of relevant Indian or British Standard (BSS) as indicated below and Codes together with the requirements of the Local Supply Authority.
- b Engine shall confirm to BS 5514/IS: 10000 and the alternator shall be in accordance with IS: 4722/BS: 2613/IEC-34(Part-1).

#### **3.27.3 Drawings**

- a The Contractor shall prepare & submit four sets of following drawings and get them approved from the Owner before the start of the work. The approval of drawings however does not absolve the contractor not to supply the equipments/materials as per agreement, if there is any contradiction between the approved drawings and agreement.
- b Lay out drawings of the equipments to be installed including control cables, fuel/ lube oil pipes and supports/ structure for exhaust piping, Chimney and bus ducts/ cable trays.
  - a. Drawings including section, showing the details of erection of entire equipments.

- c Electrical wiring diagrams from engine-alternator set to Electrical control panel, Electrical control panel to essential LT board including the sizes and capacities of the various electrical/ control cables and equipment.
- d Dimensioned drawings of Acoustic enclosure/ Engine- Alternator set and Electrical control panel.
- e Drawings showing details of supports for pipes, chimney cable trays, ducts etc.
- f Any other drawings relevant to the work.

#### **3.27.4 Drawing/Documents submission after completion of work**

Four sets of the following laminated drawings shall be submitted by the contractor while handing over the installation to the Department. Out of these three, one set shall be laminated on a hard base for display in the DG set room/room where AMF panel is installed. One set shall be displayed in Owner Engineer's room. In addition, drawings will be given on Compact Disc(CD):

- a. DG set installation drawings giving complete details of all the equipments, including their foundations.
- b. Line diagram and layout of all electrical control/AMF panels giving switchgear ratings and their disposition, cable feeder sizes and their layout.
- c. Control wiring drawings with all control components and sequence of operations to explain the operation of control circuits in AMF panel/PCC
- d. Manufacturer's technical catalogues of all equipments and accessories.
- e. Key plan/line diagram showing outgoing feeder feeding from DG set.
- f. Operation and maintenance manual of all major equipments, detailing all adjustments, operation and maintenance procedure.

#### **3.27.5 Technical requirements**

##### **3.27.5.1 DG set with Acoustic enclosure**

DG sets up to 1000 KVA capacity are required to be supplied with acoustic enclosures per CPCB norms. DG Set with acoustic enclosure shall preferably be installed in DG room near to MCC building & location should be finalized in consultation with the Owner. However, DG set should be as near to the. as near to Essential LT Panel as possible. Associated AMF panel/ Electrical panel of the DG Set can be located inside the acoustic enclosure or outside the acoustic enclosure as per manufacturer standard. In case, AMF/ Electrical panel has to be installed outside the acoustic enclosure, location of room to house AMF/ Electrical panel should be decided in consultation with the owner so that it shall be as near to the acoustic enclosure as possible. Specially, in case of connection through bus trunking, care should be taken for aesthetics.

##### **3.27.5.2 Rating**

Capacity output of DG Set shall be depending upon the particular, 'Standby' load. Minimum rating shall be 50 kVA or specified as per requirement of standby load.

### 3.27.5.3 Climatic conditions

- a The output of DG Set shall be specified under actual site conditions. The contractor has to certify that the engine & alternator meets the capacity requirement after de-rating as per IS/ BIS.
- b. DG Set upto 500KVA capacity should be type tested for Noise and Emission norms/standards as per CPCB norms.

### 3.27.5.4 Diesel engine

- a The engine shall be of standard design of the original manufacturers. It should be 4stroke cycles, water cooled, naturally aspirated/ turbo charged (as per manufacturer standard), diesel engine developing suitable BHP for giving a power rating as per ISO 8528- Part-1 in KVA at the load terminals of alternator at 1500 rpm at actual site conditions.
- b The engine shall be capable for delivering specified Prime Power rating at variable loads for PF of 0.8 lag with 10% overload available in excess of specified output for one hour in every 12 hours. The average load factor of the engine over period of 24 hours shall be 0.85 (85%) for prime power output.
- c The engine shall conform to IS;10000/ ISO 3046/ BS;649 /BS 5514 amended up to date.
- d Necessary certificate indicating the compliance of the above capacity requirement for the engine model so selected along with compliance of Noise and Emission norms as per latest CPCB guidelines for DG set capacity up to 1000KVA, should be furnished from the manufacturers after award of work.
- e The engine shall be fitted with following accessories subject to the design of the manufacturer:
  - i. Dynamically balanced Fly wheel
  - ii. Necessary flexible coupling and guard for alternator and engine (applicable only for double bearing alternator)
  - iii. Air cleaner( dry/ oil bath type) as per manufacturer standard,
  - iv. A mechanical/ electronic governor to maintain engine speed at all conditions of load
  - v. Daily fuel service tank of minimum capacity as per Table below, fabricated from M.S. sheet with inlet, outlet connections air vent tap, drain plug and level indicator (gauge) M.S. fuel piping from tank to engine with valves, unions, reducers, flexible hose connection and floor mounting pedestals, twin fuel filters and fuel injectors. The location of the tank shall depend on standard manufacturers design.

#### Recommended minimum capacity of daily fuel service tank

Sr.No	Capacity of DG set	Minimum Capacity	Fuel Tank
(i)	Up to 25 KVA	100 Litres	
(ii)	Above 25 to 62.5 KVA	120 Litres	
(iii)	Above 62.5 KVA to 125	225 Litres	

Sr.No	Capacity of DG set	Minimum Capacity	Fuel Tank
	KVA		
(iv)	Above 125 KVA to 200 KVA	285 Litres	
(v)	Above 200 KVA to 380 KVA	500 Litres	
(vi)	Above 380 KVA to 500 KVA	700 Litres	
(vii)	Above 500 KVA to 750 KVA	900 Litres	

- vi. Dry exhaust manifold with suitable exhaust residential grade silencer to reduce the noise level.
- vii. Suitable self-starter for 12 V/ 24 V DC.
- viii. Battery charging alternator unit and voltage regulator, suitable for starting batteries, battery racks with interconnecting leads and terminals.
- ix. Necessary gear driven oil pump for lubricating oil, priming of engine bearing as well as fuel systems as per manufacturer recommendations.
- x. Naturally aspirated/ turbo charger (as per manufacturer standard)
- xi. Lubrication oil cooler
- xii. Lubrication oil filters with replaceable elements.
- xiii. Crank case heater as per manufacturer recommendations.

#### 3.27.5.5 Governor

Mechanical governor of class A2 for up to and including 200 KVA capacity and Electronic governor of class A1 for capacity above 200KVA, as per ISO 3046/BS5514 with actuator shall be provided as per standard design of manufacturer. Governor shall be a self-contained unit capable of monitoring speed.

#### 3.27.5.6 Frequency variation

The engine speed shall be so maintained that frequency variation at constant load including no load shall remain within a band of 1% of rated.

#### 3.27.5.7 Fuel System

It shall be fed through engine driven fuel pump. A replaceable element of fuel filter shall be suitably located to permit easy servicing. The daily service tank shall be complete with necessary supports, gauges, connecting pipe work etc. In case of Top Mounted tanks, non return valves are must in fuel supply and return line of specified value. Pipe sealant should be used for sealing for all connections. No Teflon tape to be used. If piping length is more than 10 meters, detail engineering is required in consultation with OEM/ Manufacture.

#### **3.27.5.8 Lubricating oil system**

It shall be so designed that when the engine starts after a long shut down lubrication failure does not occur. Necessary priming pump for the lub. oil circuit as per recommendation of manufacturer shall be installed, to keep bearings primed. This pump shall be normally automatically operative on AC/ DC supply available with the set.

#### **3.27.5.9 Starting system**

This shall comprise of necessary set of heavy duty batteries 12V/ 24V DC (as per manufacturer standard), and suitable starter motors, axial type gear to match with the toothed ring on the fly wheel. A timer in the control panel to protect the starter motor from excessively long cranking runs shall be suitably integrated with the engine protection system and shall be included within the scope of the work. Battery capacity shall be suitable for meeting the needs of starting system (as three attempt starting), as well as the requirements of control panel, indications and auxiliaries such as priming pump as applicable etc. The scope shall cover all cabling, terminals, including initial charging etc. The system shall be capable of starting the DG set within 20-30 sec. even in winter condition with an ambient temperature down to 0°C.

#### **3.27.5.10 Battery Charger**

The battery charger shall be suitable to charge required numbers of batteries at 12V/ 24 volts complete with, transformer, rectifier, charge rate selector switch, indicating ammeter & voltmeter etc. Connections between the battery charger & batteries shall be provided with suitable copper leads with lugs etc.

#### **3.27.5.11 Piping Work**

All pipe lines and fittings and accessories requirement inside the room/ enclosure and outside for exhaust piping shall be provided by the contractor. This shall include necessary flexible pieces in the exhaust, fuel, lub. oil and water lines as are necessary in view of the vibration isolation requirement in the installation. Piping of adequate size shall be used for lub. oil of the material as per manufacturer standard. However, only M.S. pipes for the exhaust shall be used. For fuel lines within the acoustic enclosure, PVC braided pipe as per manufacturer recommendations can be used. However, for fuel lines outside the acoustics enclosure only MS pipe be used. The pipe work shall be inclusive of all fittings and accessories required such as bends, reducers, elbows, flanges, flexible connections, necessary hardware etc. The installation shall cover clamps, supports, hangers etc. as are necessary for completing the work. However, the work shall be sectionalized with flanged connections as are necessary for easy isolation for purposes for maintenance of unit as approved by Engineer-in-charge.

#### **3.27.5.12 Common bed plate**

Engine and alternator shall be directly coupled or coupled by means of flexoplate/flexible coupling as per manufacturer standard design and both units shall be mounted on a common bed plate together with all auxiliaries to ensure perfect alignment of engine and alternator with minimum vibrations. The bed plate shall be suitable for installation on suitable anti-vibration mounting system.

#### **3.27.5.13 Exhaust Piping**

- a All M.S. Pipes for exhaust lines shall be confirming to relevant IS. The runs forming part of factory assembly on the engine flexible connections up to exhaust silencer shall be exclusive of exhaust piping item. The work include necessary cladding of exhaust pipe work using 50mm thick Loosely bound resin(LBR)mattress / mineral wool/ Rockwool, density not less than

120kg/m<sup>3</sup> and aluminum cladding ( 0.6mm thick) for the complete portion. The exhaust pipe work includes necessary supports, foundation etc. to avoid any load & stress on turbo charger / exhaust piping. . The exhaust pipe shall be \*run along the existing wall of the building duly clamped/\*supported on independent structure for which, the design and Drawing for such structure shall be got approved from the Engineer in charge.

- b Exhaust system should create minimum back pressure.
- c Number of bends should be kept minimum and smooth bends should be used to minimize back pressure.
- d Pipe sleeve of larger dia. should be used while passing the pipe through concrete wall & gap should be filled with felt lining.
- e Exhaust piping inside the Acoustic Enclosure/ Genset room should be lagged with asbestos rope along with aluminium sheet cladding / insulated to avoid heat input to the room.
- f Exhaust flexible shall have it's free length when it is installed. For bigger engines, 2 flexible bellows can be used.
- g For engines up to 500KVA, only one bellow is required. However, if exhaust pipe length is more than 7 m then additional bellow/ provision for expansion should be provided.
- h 'Schedule B' MS pipes and long bend/elbows should be used.
- i The exhaust outlet should be in the direction of prevailing winds and should not allow exhaust gases to enter air inlet/ windows etc.
- j When tail end is horizontal, 45 Degree downward cut should be given at the end of the pipe to avoid rain water entry into exhaust piping.
- k When tail end is vertical, there should be rain trap to avoid rain water entry.
- l If rain cap is used, the distance between exhaust pipe and rain cap should be higher than diameter of pipe. Horizontal run of exhaust piping should slope downwards away from engine to the condensate trap. Silencer should be installed with drain plug at bottom.

#### 3.27.5.14 Optimum Silencer Location

Location of the silencer in exhaust system has very definite influence on both reduction of noise and back pressure imposed on the system. The preferred silencer locations are given in the Table below, where L is length of the total exhaust system measured from exhaust manifold in meters. Please note that locating the silencer as per optimum silencer location is not mandatory

##### optimum location of silencer

Table Heading Left	Inline Engine	V Engine
Best	2L/5	(4L – 1.5) / 5
Second best	4L/5	(2L – 4.5) / 5
Worst Location of Silencer	L/5 or 3L/5 or at tail end of Exhaust piping	(3L - 10)/ 5 or at the tail end of Exhaust piping

#### Exhaust stack height

In order to dispose exhaust above building height, minimum exhaust stack height should be as follows:-

For DG set up to 1000KVA :-

$$H = h + 0.2 \times KVA$$

Where H = height of exhaust stack

h = height of building

Care should be taken to ensure that no carbon particles emitted due to exhaust leakage enters and deposits on alternator windings and on open connections.

#### **Support to Exhaust Piping:**

Exhaust piping should be supported in such manner that load of exhaust piping is not exerted to turbocharger.

#### **Air System**

- a It is preferable to provide vacuum indicator with all engines to indicate choked filter.
- b Maximum air intake restrictions with clean and choked filters should be within prescribed limit as per OEM/ manufacturer recommendation for the particular model of the engine. Gensets should be supplied with medium duty/ heavy duty air cleaners (specify one only). (Heavy duty air cleaner should be used for installations in dusty or polluted surroundings.)

#### **Cooling System**

- a System should be designed for ambient temperature of 50 Deg.C.
- b Water softening/ demineralizing plants should be used, if raw water quality is not acceptable.
- c Coolant should be used mixed with additive (in suitable proportion) as per recommendation of OEM /Manufacturer for various engine models.
- d Radiator fan flow should be free from any obstruction.
- e For radiator cooled DG Set, proper room ventilation should be planned at the time of construction of DG room.
- f The horizontal distance of remote radiator from engine should not exceed 10 Meter.
- g Optional items as under may be included as per site requirement at the discretion of Technical Sanctioning authority;

#### **xiv. Cooling System**

- Remote Radiator
- Jacket Water Heater
- Crankcase Oil Heater
- After cooler jacket turbo charger electrical pre heat systems.



xv. Fuel System

- Fuel Water Separator
- Auxiliary Fuel Pump

xvi. Exhaust System

- Industrial Grade Muffler
- Residential Grade Muffler
- Critical Grade Muffler
- Super Critical Grade Muffler

xvii. Start System

- Battery Warmer Plate
- Battery Charger
- Automatic Float Equalizing
- Trickle

**3.27.5.15 Synchronous alternator**

- a Self-excited, screen protected, self-regulated, brush less alternator, Horizontal foot mounted in Single/Double bearing construction(specify one only) suitable for the following:

- Rated PF. : 0.8 (lag)
- Rated voltage : 415 volts
- Rated frequency : 50 Hz
- No. of Phases : 3
- Enclosure : SPDP
- Degree of protection : IP-23
- Ventilation : Self ventilated air cooled
- Ambient Temperature : 40 ° C Maximum
- Insulation Class : F/H
- Temperature Rise : Within class F/H limits at rated load
- Voltage Regulation : +/- 1%
- Voltage variation : +/-5%
- Overload duration/capacity: 10% for one hour in every 12 hours of continuous use.

- Frequency variation: As defined by the Engine Governor (+/- 1%)
- Excitation : Self / separately excited (Self excitation upto 750KVA )
- Type of AVR : Electronic
- Type of Bearing and : Anti-friction bearings with Grease lubrication arrangement
- Standard: IS-4722 & IEC:34 as amended upto date.

b Alternator should be able to deliver output rating at actual Site conditions.

c Excitation: The alternator shall be brushless type and shall be self/ separately excited, self-regulated having static excitation facility. The exciter unit be mounted on the control panel or on the alternator assembly. The rectifier shall be suitable for operation at high ambient temperature at site.

d Automatic Voltage Regulators (AVR): In order to maintain output terminal voltage constant within the regulation limits i.e. +/- 1%, Automatic voltage regulator unit shall be provided as per standard practice of manufacturer.

e Fault tripping: In the event of any fault e.g. over voltage/ high bearing temperature/high winding temperature or an external fault, the AVR shall remove the excitation voltage to the alternator. An emergency trip shall also be provided.

f Standards: The alternator shall be in accordance with the following standards as are applicable.

xviii. IS: 4722/BS : 2613/1970. The performance of rotating electrical machine.

xix. IS: 4889/BS: 269 rules for method of declaring efficiency of electrical machine.

g Performance: Voltage dip shall not exceed 20% of the rated voltage for any step load or transient load as per ISO: 8528 (Part-1). The winding shall not develop hotspots exceeding safe limits due to imbalance of 20% between any two phases from no load to full load.

h The generator shall preferably be capable of withstanding a current equal to 1.5 times the rated current for a period of not more than 15 seconds as required vide clause 14.1.1 of IS 4722:1992.

i The performance characteristics of the alternator shall be as below:

j Efficiency at full load 0.8 P.F.

xx. Upto 25 KVA – not less than 82%

xxi. above 25 KVA and upto 62.5 KVA not less than 86%

xxii. above 62.5 KVA & upto 250 KVA – not less than 90%

xxiii. above 250 KVA – not less than 93.5%

k Total distortion factor Less than 3 %

xxiv. 10% overload One hour in every 12 hrs of continuous use.

xxv. 50% overload 15 seconds.

**l Terminal Boxes:**

Terminal boxes shall be suitable for U.G. cables/ Bus Trunking. The terminal box shall be suitable to withstand the mechanical and thermal stresses developed due to any short circuit at the terminals.

**m Earth Terminals :**

2 Nos. earth terminals on opposite side with vibration proof connections, non-ferrous hardware etc. with galvanized plate and passivated washer of minimum size 12mm dia. hole shall be provided.

**Space Heaters:**

Alternators of capacity more than 500KVA shall be provided with suitable space heaters to maintain the winding temperature automatically such that it does not absorb moisture during long idle periods. The heater terminals shall be brought to a separate terminal box suitable for 230 VAC supply and a permanent caution notice shall be displayed.

### **3.27.6 AMF Panel, Batteries & Electrical System**

#### **3.27.6.1 DG Set with acoustic enclosure:**

Associated AMF panel of the DG Set can be located inside the acoustic as per manufacturer's standard. In case, AMF/ Manual panel has to be installed outside the acoustic panel, location of room to house AMF/ Manual panel should be decided in consultation with the Architect as near to the acoustic enclosure as possible. In case of connection through bus trunking, care should be taken for aesthetics vis-à-vis surrounding.

#### **3.27.6.2 AMF control panel**

**General Features:**

The control panel shall be fabricated out of 1.6mm thick sheet steel, totally enclosed, dust, damp and vermin proof free standing floor mounted type & front operated. It shall be made into sections such that as far as feasible, there is no mixing of control, power, DC & AC functions in the same section and they are sufficiently segregated except where their bunching is necessary. Hinged doors shall be provided preferably double leaf for access for routine inspection from the rear. There is no objection to have single leaf hinged door in the front, all indication lamps, instruments meter etc. shall be flushed in the front. The degree of protection required will be IP-42 confirming to IS:2147.

**Terminal blocks and wiring:**

Terminal blocks of robust type and generally not less than 15 Amps capacity, 250/500 V grade for DC up to 100V and 660/ 1100 volts grade for AC and rest of the junction shall be employed in such a manner so that they are freely accessible for maintenance. All control and small wiring from unit to unit inside the panel shall also be done with not less than 2.5 sqmm copper conductors PVC insulated and 660/ 1100 volts grade. Suitable colour coding can be adopted. Wiring system shall be neatly formed and run preferably, function wise and as far as feasible segregated voltage wise. All ends shall be identified with ferrules at the ends.

**Labelling:**

All internal components shall be provided with suitable identification labels suitably engraved. Labels shall be fixed on buttons, indication lamps etc.

**Painting:**

The entire panel shall be given primer coat after proper treatment and powder coating with 7 tanks process before assembly of various items.

**Equipment requirements:**

The control cubical shall incorporate into assembly general equipment and systems as under:

- Control system equipments and components such as relays, contactors, timers, etc. both for automatic operation on main failure and as well as for manual operation.
- Equipment and components necessary for testing generating set's healthiness with test mode and with load on mains.
- Necessary instruments and accessories such as voltmeter, power factor meter, KW meter, KWH meter, Ammeter, Frequency meter etc. in one energy analyzer unit with selector switch to obtain the reading of desired parameters.
- Necessary indication lamps, fuses, terminal blocks, push buttons, control switches etc. as required.
- Necessary engine/ generating set shut down devices due to faults / abnormalities.
- Necessary visual audio alarm indication and annunciation facility as specified.
- Necessary battery charger.
- Necessary excitation control and voltage regulating equipment. (Alternatively provided on the Alternator itself).
- Necessary over head bus trunking terminations all internal wiring, connections etc. as required.
- Breakers as specified in the schedule of work.

**System Operation:**

- The above mentioned facilities provided shall afford the following operational requirements.

**Auto Mode:**

- A line voltage monitor shall monitor supply voltage on each phase. When the mains supply voltage fails completely or falls below set value (variable between 80 to 95% of the normal value) on any phase, the monitor module shall initiate start-up of diesel engine. To avoid initiation due to momentary disturbance, a time delay adjustment between 0 to 5 second shall be incorporated in start-up initiation.

- A three attempt starting facility shall be provided 6 seconds ON, 5 seconds OFF, 6 seconds ON, 5 seconds OFF, 6 seconds ON, if at the end of the third attempt, the engine does not start, it shall be locked out of start, a master timer shall be provided for this function. Suitable adjustment timers be incorporated which will make it feasible to vary independently ON/OFF setting periods from 1-10 seconds. If alternator does not build up voltage after the first or second start as may be, further starting attempt will not be made until the starting facility is reset.
- Once the alternator has built up voltage, the alternator circuit breaker shall close connecting the load to the alternator. The load is now supplied by the alternator.
- When the main supply is restored and is healthy as sensed by the line voltage monitor setting, both for under voltage and unbalance, the system shall be monitored by a suitable timer which can be set between 1 minute to 10 minutes for the load to be transferred automatically to main supply.

#### **Manual mode:**

- In a manual mode, it shall be feasible to start-up the generator set by the operator on pressing the start push button.
- Three attempt starting facility shall be operative for the start-up function.
- Alternator circuit breakers close and trip operations shall also be through operator only by pressing the appropriate button on the panel and closure shall be feasible only after alternator has built up full voltage. If the load is already on 'mains', pressure on 'close' button shall be ineffective.
- Engine shut down, otherwise due to faults, shall be manual by pressing a 'stop' button.

#### **Test mode:**

- When under 'test' mode pressing of 'test' button shall complete the start up sequence simulation and start the engine. The simulation will be that of mains failure. sequence of manual mode shall be completed. Engine shall build up voltage but the set shall not take load by closing of alternator circuit breaker. When the load is on the mains, monitoring of performance for voltage/ frequency etc. shall be feasible without supply to load.
- If during test mode, the power supply has failed, the load shall automatically get transferred to alternator.
- Bringing the mode selector to auto position shall shut down the set as per sequence of Manual mode provided main supply is ON. If the mains supply is not available at that time, the alternator shall take load as above.

Engine shut down and alternator protection equipment: Following shut down and protection system shall be integrated in the control panel.

#### **Engine:**

- Low lubricating oil pressure shut down. This shall be inoperative during start up and acceleration period.
- High coolant (water) temp. shut down.

- Engine over speed shut down.

**Alternator Protection:**

Following protection arrangement shall be made:

- Over load
- Short circuit
- Earth fault
- Over voltage

**Monitoring and metering facilities:**

- Necessary energy analyzer unit for visual monitoring of mains, alternator and load voltage, current, frequency, KWH, power factor, etc.
- A set of visual monitoring lamp indication for:
  - Load on set
  - Load on mains
  - Set on test (Alternator on operation duty, Alternator on standby duty).
- Set of lamp for engine shut down for over speed, low lub. Oil pressure and high coolant water temperature; overload trip of alternator, earth fault trip of alternator, engine lock out and failure to start etc. All these indications shall have an audio and visual alarm. When operator accepts the alarm, the hooter will be silenced and the fault indication will become steady until reset by operating a reset button

**Operating devices:**

- A set of operation devices shall be incorporated in the front of panel as under:
  - Master Engine Control Switch: This shall cut off in 'OFF' position DC control to the entire panel, thus preventing start-up of engine due to any cause. However, battery charger, lamp test button for testing the healthiness of indication lamps, DC volt meter / ammeter etc. shall be operative. It
  - shall be feasible to lock the switch in OFF position for maintenance and shut down purposes.
  - Operation selector switches OFF/AUTO/MANUAL/TEST position.
  - Energy analyzer unit for display of various electrical parameters like voltage, current, frequency, KW, power factor, etc.
  - A set of push button as specified.
  - Relays, contactors, timers, circuit breakers as required.
  - (Necessary battery charger with boost/ trickle selector, DC voltmeter and DC ammeter

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**Compatibility with 'Building Management System'(BMS):**

- PLC compatibility and required nos. of Input/ Output terminals points should be provided in the AMF control panel.

**Battery/ Electrical System**

- Batteries supplied with Genset are generally dry and uncharged. First charging of uncharged batteries is very important and should be done from authorized battery charging centre. Initial charging should be done for 72-80 hours.
- Batteries should be placed on stands and relatively at cool place.
- Battery capacity and copper cable sizes for various engine capacity are recommended as indicated in the table below. Cable sizes shown are for maximum length of 2m. If length is more, cable size should be selected in such a way that voltage drop does not exceed 2V. However capacity as recommended by manufacturer may be taken.
- For AMF applications, a static battery charger working on mains supply is recommended to keep the batteries charged at all times.
- 1.5 Sq.mm copper wire should be used for wiring between junction box and Control Panel.

**Foundation**

- For DG Sets installed inside the DG Set Room - A PCC foundation (1:2:4,M-20 grade) of approximate depth 150mm above the finished Genset Room
- Floor level is required so as to provide leveled surface for placement of the acoustics enclosure. The length and breadth of foundation should be at least 250 mm more on all sides than the size of the enclosure. Genset should be mounted on AVM's inside the enclosure.
- Foundation level should be checked diagonally as well as across the length for even flatness. The foundation should be within  $\pm 0.5$  Degree(angle) of any horizontal plane

**Acoustics Enclosure**

- The acoustic enclosure shall be designed and manufactured confirming to relevant standards suitable for outdoor installation exposed to weather conditions, and to limit overall noise level to 75 dB (A) at a distance of 1 mtr. from the enclosure as per CPCB norms under free field conditions.
- The construction should be such that it prevents entry of rain water splashing into the enclosure and allows free & quick flow of rain water to the ground in the event of heavy rain. The detailed construction shall confirm to the details as under:
- The enclosure shall be fabricated out of the CRCA sheet of thickness not less than 1.6mm on the outside cover with inside cover having not less than 0.6mm thick perforated powder coated CRCA sheet.
- The hinged doors shall be made from not less than 16 SWG (1.6mm) thick CRCA sheet and will be made air tight with neoprene rubber gasket and heavy duty locks.

- All sheet metal parts should be processed through 7-tank process.
- The enclosure should be powder coated.
- The enclosure should accommodate the daily service fuel tank of the D.G.Set to make the system compact. There should be provision of fuel gauge, which should show the level of the fuel even when the DG Set is not running.
- The gauge should be calibrated. The fuel tank should be filled from the out side as in automobiles and should be with a lockable cap.
- The batteries should be accommodated in the enclosure in battery rack.
- The canopy should be provided with high enclosure temperature safety device.
- The acoustic lining should be made up of high quality insulation material
- i.e. Rockwool/ glass/ mineral wool/ PU foam of appropriate thickness & density for sound absorption as per standard design of manufacturer's to reduce the sound level as per CPCB norms. The insulation material shall be covered with fine glass fiber cloth and would be supported by perforated
- M. S. Sheet duly powder coated / GI sheet/ aluminium sheet.
- The enclosure shall be provided with suitable size & No. of hinged type doors along the length of the enclosure on each side for easy access inside the acoustic enclosure for inspection, operation and maintenance purpose.
- Sufficient space will be provided inside the enclosure on all sides of the
- D.G. set for inspection, easy maintenance & repairs.
- The canopy should be as compact as possible with good aesthetic look.
- The complete enclosure shall be of modular construction.
- The forced ventilation shall be as per manufacturer design using either engine radiator fan or additional blower fan(s). If the acoustic enclosure is to be provided with forced ventilation then suitable size of axial flow fan (with motor and auto-start arrangement) and suitable size axial flow exhaust fan to take the hot air from the enclosure complete with necessary motors and auto start arrangement should be provided. The forced ventilation arrangement should be provided with auto stop arrangement to stop after 5 minutes of the stopping of D.G sets.
- The acoustic enclosure should be suitable for cable connection/connection through bus-trunking. Such arrangements on acoustic enclosure should be water proof & dust-proof confirming to IP-65 protection.
- The inside of enclosure should be provided with at least two nos. 28W- T5 fluorescent tube light luminaire controlled by a 5A switch for adequate lighting during servicing etc. of the DG Set. The power supply to this luminaire should be from the load side of the AMF Panel so that it can remain energized under all conditions.

## Earthing



- This section covers the earthing requirement of DG Set installations. G.I. plate earthing (Neutral Grounding) shall be provided for DG Sets below 500KVA capacity. The body earthing shall generally be of G.I.
- The generating set and all associated equipments control and switch gear and switch gear panels must be earthed before the set is put into operation.
- Four numbers earth sets for each DG Sets are required as under:
- 2 earthing sets for Genset/ control panel body.
- 2 earthing sets for neutral.
- In case there are more than one DG Set in one location, independent two nos. neutral earthing shall be provided for each DG set. However, two nos. earthing sets shall be common for the body earthing of DG Sets, Control Panel, AMF Panel and Essential LT Panel.
- Copper or GI strips of suitable size shall be used for earthing as detailed here under for interconnection:
- DG Set below 500 KVA capacity:- GI strip
- For Gensets with AVM's between engine/ alternator and base rail, the body
- Earthing must be done at the engine/ alternator and not at base-rail.
- Genset should be earthed at two distinct points through a conductor strip having cross-section suitable to carry the short circuit (three phase dead
- Earth Bus: For body earthing, an earth-bus shall be provided.
- In case, DG Set is being installed inside the substation building or near to the substation, for body-earthing of DG set, AMF Panel and Essential Panel, earth bus provided for sub-station shall be used.
- Test joints should be provided for testing the earthing as and when required.

### **3.28 Local Pushbutton Stations**

#### **3.28.1 Construction features**

The constructional features of the local push button stations shall be as follows:

- a. Metal enclosed, weather proof, suitable for mounting on wall or steel structures. The enclosure shall be die cast aluminium or sheet metal of 2 mm thickness.
- b. Outdoor type push buttons shall be completely weather, dust and vermin proof and shall be provided with canopy. Degree of protection shall be IP:55.
- c. Metal parts shall be given tropicalising treatment as per standards and painted with one coat of epoxy primer and two coats of light grey epoxy paint.

- d. Provided with inscription plates of rear engraved with white letters on black background. The letter size shall be 6 mm.
- e. Provided with two earthing terminals suitable for 14 SWG G.I. wire.
- f. Provided with removable undrilled gland plate and cable glands for appropriate sizes of cable. The cable entry shall be from the bottom.
- g. Push button contacts shall be designed for extra robust both mechanical and electrical operation. High quality material shall be used in their construction to ensure mechanical life exceeding 10 million switching operations. The contact shall be of silver alloy of 10 A continuous current rating.

### **3.28.2 Push buttons**

- a. All push buttons shall be :
- b. Fitted with two (2) normally open and two (2) normally closed contacts rated to carry and break 6 Amps at 415 Volts (10 A at 240 V AC)
- c. Provide integral escutcheon plates marked with its function.
- d. The open/close/start push buttons shall be of the momentary contact push to actuate type and shall be green in colour.
- e. The stop push buttons shall be stay put type with mushroom knob and shall be red in colour.

#### **3.28.2.1 Type of Push Button Stations**

The following types of push button stations shall be supplied;

- a. Push button station type A - Each P.B. station suitable for indoor installation and shall comprise two push buttons viz. 'START' and 'STOP' for control of non-reversible motors.
- b. Push button station type B - Each P.B. station for indoor installation and shall comprise of three push buttons viz. 'OPEN' 'CLOSE' and 'STOP' for control of reversible motor.

### **3.29 Air conditioning system**

#### **3.29.1 General**

The areas to be ventilated by mechanical ventilation process shall be as follows:

- a. Battery Room
- b. Toilets
- c. 6.6 KV switchgear LT switchgear/MCC room
- d. Auxiliary building

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### **3.30 Other accessories**

#### **3.30.1 Water cooler cum Purifier**

- a. The contractor shall provide watercooler cum purifier having appropriate storage capacity. The water cooler should comprise of Compressor, Fan Motor, Condensing unit, Water tank surrounded by evaporating coil, thermostats, relays, etc complete with necessary inlet & outlet connections. The body of Water cooler shall be stainless steel.

### **3.31 Installation Methods**

#### **3.31.1 General**

- a. All cables where required to be run on walls, ceilings or other building structures shall unless otherwise agreed by the Engineer be secured on tray or enclosed in HDPE conduit or trunking.
- b. Every cable whether in or out of sight shall be neatly run vertically, horizontally or parallel to adjacent walls, beams or other structural members. Where the building structure incorporates purpose built covered cable duct/ trench systems for cables, power cables, control, protection and instrumentation cables shall be segregated and installed on tray-work or otherwise secured to the walls of the trenches.
- c. Where the structure incorporates general service ducts/ trenches containing pipe work, chemical lines and other services all cabling shall be segregated from other services and run on the trench walls.
- d. Throughout the installation due regard shall be paid to prevent interference between power and signal cables and to avoid unnecessary crossovers. All cabling throughout the installation shall be fixed with purpose designed clamps, cleat or saddles. Saddles for power and control cables shall be fabricated from PVC covered metal strapping. Self-locking plastic buckle clips and strapping shall not be used. Cabling installation shall be tested as per relevant Standards.

#### **3.31.2 Tray**

- a. All cable trays and accessories shall be of GI. Tray sizes shall be limited to 150, 300, 450 & 600 mm. Supports as required shall be supplied and installed. Supporting structure for trays shall be MS and duly painted. Any damage caused by the Contractor to surfaces of buildings/ structures etc. during installation of trays shall be made good by the Contractor to the satisfaction of the Employer's Engineer.
- b. Type of paint and its shade for supporting structures for use in normal/ corrosive atmosphere proposed by the Contractor shall be subject to Employer's Engineer approval.

#### **3.31.3 HDPE Conduits**

- a. Conduits shall be run on the surface or embedded and shall be neatly arranged. When one or more cables are laid through a conduit, conduit size shall be that the total cross sectional area of the cables does not exceed 40 % of the internal cross-sectional area of the conduit.

- b. The conduits shall be screwed into spout of conduit boxes or where fixed to boxes with properly sized clearance holes. They shall be secured by means of sockets and hexagonal bushes. All threads shall be cut clean and all burrs shall be removed with a reamer.
- c. Particular care must be taken to ensure that no water is allowed to enter the conduit at any time and all conduits shall be arranged with adequate ventilation and drainage points, where necessary, as directed by the Employer's Engineer. Inaccessible junction boxes shall not be allowed.
- d. Only continuous lengths of buried conduit shall be installed between boxes, no joint boxes being allowed in the floor screeds. Conduits crossing expansion joints shall be fitted with coupling of approved manufacture with an earthing clip at each side of the coupling, connected by the correct size of tinned copper stranded wire. The ends of the conduit laid or set in form work prior to concreting shall be temporarily sealed off with a coupler and solid brass plug.
- e. Fixing to surfaces off walls shall be by means of spacers and saddles securely fixed by screws. Where conduits are concealed or laid constructional floors, they shall be held in position with substantial fixings. All conduit fittings shall be supplied with rubber gaskets/ covers/ plugs as applicable. Adaptors/ junction boxes shall be constructed using minimum 2 mm thick GI sheet sized to prevent the undue packing of cable in them.
- f. Weather proof boxes and accessories shall be used outdoors. Adequate number of inspection boxes shall be provided where wiring is to be carried out in concealed conduit above false ceiling/ civil works. Junction and adaptor boxes shall be provided with gasketed flat covers secured with brass or plated screws.

#### **3.31.4 Identification**

- a. Each and every cable shall be permanently identified at each and by its cable number as per the cable schedule. Cable markers shall comprise semi-rigid black PVC carrier strip and shall be fixed axially by means of two PVC covered aluminum strips with buckles. Cable markers shall also be installed at entry and exit points of buried ducts, road and drain crossings, and exits from building and in such other positions as are necessary to identify and trace the route of any cable. The marker shall be projected 150 mm above ground and shall be spaced at an interval of 30 meters and at every change in direction. Cable marker of other types shall be subject to approval by the Engineer.
- b. In addition, control cables shall have individual cores identified by means of suitable permanent ferrules bearing the same numbers at both ends. Core identification shall occur at every point of termination using an approved system of ferrule markers. At those points of interconnection between wiring where a change of number cannot be avoided, double ferrules shall be provided on each wire. The change of numbering shall be shown on the wiring diagrams of the equipment at which the change is made.
- c. Cables to be installed outside buildings shall be laid in RCC trenches with removable concrete covers.

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### **3.31.5 Electrical Installation Record Drawings**

- a. All approved drawings shall where necessary be modified or uploaded during the progress of the installation and shall form the basis of the record drawing for the complete installation.
- b. Record drawings for cabling and earthing installation shall include route drawings, block diagram and cable schedules. Within buildings, record cable route drawings shall show the location of all items of electrical plant, the route method of installation of all cables e.g. on trays, in trenches, on hangers, in ducts, conduits etc.
- c. External cable route drawings shall show:
  - a. the route of the buried cable/ conductor, laid otherwise;
  - b. the depths of laying including any deviations to avoid local obstruction;
  - c. position of joints (for cables only) located from marker posts or other agreed key points;
  - d. distances of cable runs from pipe runs or other buried services;
  - e. position of earth electrodes, earth rods disconnecting chamber and interconnecting earthstrips;
  - f. cable type, number as per cable schedule, number of cores and cross-section and purpose such as power/ control etc.;
  - g. Typical details for cabling and earthing system.

### **3.32 Inspection at manufacturer's premises**

- d. Testing of the critical items (Transformer, HV Switchgear, LV Switchgear, HV and LV cables etc in case of electrical discipline) at the manufacturer's premises will be required in accordance with the conditions of contract. All inspection, examination and testing shall be carried out in accordance with appropriate national and or international standards.
- e. All instruments used for such tests shall be calibrated and certified by an approved independent testing authority not more than 12 months prior the test in which they are used. The Owner's Representative reserves the right to impound any instrument immediately after test for independent testing. A certificate shall be produced by the contractor prior to carrying out every test showing the reading obtained, calculations and full details of the calibration certificates referred to.
- f. If the Owner's Representative witnesses a test he shall be given a copy of the test results and certificates immediately. Whether he witnesses a test or not, copies of test certificate shall be sent to the Owner's Representative. No item of the plant shall be forwarded to the site until its test certificate has been approved in writing by the Owner's Representative. Six copies of the test certificates shall be supplied in suitable folders with proper index.

- g. Certificates shall be clearly identified by serial or reference number where possible to the material being certified and shall include information required by the relevant reference standard or specification clause.
- h. The inspection of all critical equipment (required to be supplied to complete the works) shall be done as detailed in this specification. Only defect free and sound material meeting the technical requirements of this specification and in accordance with a high standard of engineering will be acceptable to the Owner's Representative.
- i. To meet the requirements of inspection, testing (including testing for chemical analysis and physical properties) arrangement shall be made by the contractor and test certificates shall be submitted to the Owner's Representative. Owner's Representative will have the right to witness or inspect the above mentioned testing/inspection at final stage as desired by him. Calibration certificates or test instruments shall be produced for the Owner's consent in advance of testing and if necessary instruments shall be recalibrated or substituted before the commencement of the test. Items of plant or control systems not covered by standards shall be tested in accordance with the details and programme agreed between the Owner and Contractor.
- j. If during or after testing, any item of the plant fails to achieve its intended duty or otherwise prove defective it shall be modified or altered or replaced as necessary, retested and re-inspected as required by the Owner.
- k. At least 21 days advance notice shall be given to the Owner before the specified tests are to be carried out.
- l. No material is to be delivered to site without the above described inspection having been carried out and clearance is given for dispatch or officially waived off in writing by the Owner's Representative

### **3.32.1 Erection & commissioning of Electrical Equipments**

The works shall be carried out strictly as per the erection manuals and shall fully comply with the relevant Indian Standard. The IE rules and Acts in force from time to time shall also be applicable during pendency of the contract

#### **3.32.1.1 Erection and commissioning of tools & tackles**

- a. The contractor shall provide all tools/tackles jigs and fixtures winches, alignment tools, welding sets, breaker handling devices all consumable items and construction equipment as required to install the equipments and to complete the work in all respects and shall necessarily include (but not limited to) bolts, nuts, rivets, welding rods, shims, wedges, packing sheets, packing compounds, oil installation and protection of individual equipment in storage and during erection.
- b. This shall also cover proper alignment, tack welding tagging, laying marking of and connection of cables, fabrication supply and installation of all support structures for installation of various electrical equipment and cables

- c. Provision of cable glands, ferrules, and cable lugs tags sealing kit (for HT cables) shall also be arranged by the contractor.
- d. Erection of various equipment shall be done strictly as per manufacturer's instructions
- e. All additional iron framework erected to put the equipment in operational condition shall be provided with two coats of primer and two topcoats of finish paint.
- f. Special care shall be taken to make the enclosed equipment protected against entry of rats, lizard, and creeping reptiles, which may create electrical short circuits.

#### **3.32.1.2 Completion of Erection (General)**

- a. Equipment shall be considered to have been completely erected when the following activities have been completed.
- b. Moving of all equipments to the respective foundations
- c. Fixing of anchor bolts or tack welding as required.
- d. Leveling and alignment of equipment.
- e. Assembling of all accessories such as relays, CTs, PTs, meters instruments etc. as described in the job specifications.
- f. Drying of equipment as required and testing of oil for dielectric strength.
- g. Filtration and filling of oil as required.
- h. Cable laying, termination with continuity checks.
- i. Applying of finishing coat of paint wherever required.
- j. Mounting of lighting fixtures & connections.
- k. Testing of all system with operation of all protection system.

#### **3.32.1.3 Erection of switchyard structures**

- a. Erection of switchyard structure shall mean erection of gantry column, beams, equipment support structure and lighting mast, watch and ward observation posts if any.
- b. Before commencement of the erection work, the contractor shall check cast foundations and anchor bolts for their individual and mutual distances and also for the correctness of concreted bolts in terms of number and verticality. In case of any disagreement with the layout drawing, the matter may be referred to Engineer in charge for remedial measures who in turn will arrange such remedial measures. However, the contractor shall also render necessary assistance in the matter.

- c. The erection of structure shall be done strictly as per the approved set of structural drawings. The erected column for bringing the structure in alignment or bringing the structure in plumb shall be allowed.
- d. The erection of column/beams shall be done in phased manner on already erected column. The elevation faces of the beam should be first fastened to the column one by one and thereafter plan bracings should provide one by one to complete the beam geocentric Pre-stressing of beam member for alignment should be avoided. In case of difficulty in fabricated material or otherwise, the Engineer in charge should be contacted for remedial measures who in turn will take necessary action. However the contractor shall also render necessary assistance in this work to Engineer in charge for speedy completion of work. The load points rings bracing shall also be provided as per drawings.
- e. The Cross-connected beams should be perfectly at right angle and matching with respective faces of the column. No column or beam shall be erected with missing members.
- f. The method of erection is not being dealt with in detail here. However, while making the rigging arrangement, it should be ensured that no column beam or part thereof is damaged due to misjudgment. All the members, plates, cleats, bolts, buts and other accessories should be fitted to the column, beam support structure as per the approved drawing.
- g. After the erection of beam and column, the bolt nuts should be properly tightened and center punched. The thread protruding bolt should be dented in the contact surface of nut at 3 point 120 degrees apart to eliminate loosening of bolt due to vibration. The stringing of bus bar conductor be done only after getting
- h. Certificate from Engr. in charge that all bolts & nuts are provided as per approved drawings and tightened.
- i. The equipment support structure should also be erected like gantry column. They should well be in plumb with all members fitted as per approved drawings and bolt nuts properly tightened. The contractor shall also take care to see that the alignment of foundation of equipment support structure is well done. The equipment support structures shall be erected as per the approved drawings.

#### **3.32.1.4 Erection of Gantry stringing (Busbar stringing)**

- a. After the erection of gantry structure and equipment support structure is over, the contractor shall take up bus bar and line gantry structure stringing.
- b. The sag and tension of the bus bar conductor and line conductor shall be coordinated with the help of Engr in charge so that mutual distances of the strung conductor and the ground clearance of the strung conductor do not cross the limit set out in the electricity rules and acts.
- c. The method of handling the conductor accessories is not dealt in details, however, contractor can himself get informed about the same and sees that conductor and other material is handed over properly and is string scratch free to the extent possible. No joint or use of



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repair sleeve will be permitted in the busbar and line gantry stringing. While stringing between twin and quadruple bundle conductor, care shall be taken to keep tension in all sub conductors equally. Adjustment in the sag shall be carried out by sag adjustment plate if provided in the tension insulator strings.

- d. All the insulator strings to be used on the structure shall be properly cleaned with the cloth. Compression dead end joints of the conductor shall be made after proper marking. There should not be any difference in the position of dead end compression joints amongst the sub conductors of a twin or quadruple bundle conductors. All the tension insulator string shall be double tension type. The pilot insulator string or a guide insulator string shall be single suspension type. The corona control ring space clamp and other accessories if any on insulator stringing shall also erected as per the drawing.
- e. The earth wire to shield the conductors from lighting stroke shall be provided along the column in each bay of the switchyard and across, as per the switchyard lay out and sectional view drawing and as per the instruction of Engineer in charge. The earth wire shall be fitted with all accessories like suspension clamp, tension clamp cross by clips, copper earth bold etc. completed. No mid span joint shall be permitted in the switchyard earth wire stringing.
- f. After the bus bar and line gantry stringing work is over, the contractor shall provide droppers for the equipment connection to bus bar or line conductors by using prescribed clamps and connectors. The dropper is to be provided with ACSR Panther conductor.

#### **3.32.1.5 Erection of secondary equipments**

- a. The secondary equipments like PI, CT, PT, LA (Surge arrestors) etc. shall be procured by the contractor and transported to the site at the cost of contractor. The contractor shall also do loading and unloading of the equipment.
- b. After the arrival of equipment at site, packing shall be gently removed without causing any damage to the equipment. The equipment shall be checked for its correctness of dimension, make etc. as per the approved drawing. The equipment then shall be cleaned by a piece of cloth and made ready for erection.
- c. The equipment shall be mounted on the ready pedestal (of masonry) or steel structure as the case may be and checked the same for its verticality.
- d. In case of CT, PT, the junction box or terminal box of the equipment shall be opened, cleaned and all their connections should be checked.
- e. The arcing horns or corona control rings shall be provided as per the approved drawing. Similarly all fittings etc. shall also be provided as per the approved drawings.
- f. The electrical connection of the equipments through jumpers or through 4"aluminum pipe shall be carried out along with the cable connection of respective equipment to the marshalling kiosk or to the control relay panels. The connection of high voltage terminal of equipment shall not be resorted to, unless secondary connection or cabling work to control

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equipment is over. Testing of equipment shall also be done to ensure the correct wiring sequence of the equipment and continuity before energizing equipment by EHV

- g. Polarity of the equipment to be connected on HV side should be checked prior to erection. The oil level (if any) of the equipment should be checked for its totality.
- h. If level is found to be inadequate, topping filling of oil should be resorted.
- i. Fuse, links, etc provided in the secondary box of the equipment shall be checked for their position and continuity and any lacuna observed will be set right before taking the equipment for commercial use.

#### **3.32.1.6 Erection of circuit breaker**

- a. The circuit breaker shall transported to the work place well in time on loading/unloading. The crates containing the insulators and important parts and accessories shall be opened carefully keeping them in their proper position. Insulator parts and other accessories shall be thoroughly cleaned for any deposits of dust or other particles.
- b. The breaker shall be brought on the pedestal of masonry or steel frame as the
- c. case may be) in up right position without any inclination.
- d. The main parts of the equipments shall be assembled as per approved drawing..
- e. After the placement of circuit breaker in position the kiosk of the breaker shall be thoroughly inspected and any lacuna found shall be reported to the Engineer in charge of the work. The HT terminal connection shall be done only after the terminals of the equipment kiosk are made to the marshalling kiosk and or to the control/relay panels. Polarity of the equipments shall also be ensured before physical erection.
- f. The method of erection of breaker is not dealt with in details; however, it is recommended that breaker poles shall be erected only by using telescopic crane or other suitable mechanical arrangement. The rigging should be tool proof.
- g. The operating mechanism in the breaker Kiosk and contacts as well as the power supply circuits (AC/DC) shall be properly checked for its operation worthiness.
- h. All piping for gas/air shall be laid as per the approved drawing. The air receive or compressor shall be positioned as per the relevant drawing. Minor fittings and fabrication or grouting work required to place these articles or accessories shall be done by the contractor without any extra cost to the purchaser. In case of breakers with spring mechanism the trials of the mechanism by actuating should be done to ensure its' line worthiness.
- i. EHV side of the breaker should be aligned to a incoming and outgoing bus conductor. While erecting the breaker, the operating mechanism without the porcelain insulator should be laid perfectly to avoid any mal functioning of the breaker.

- j. Earthing points of the breaker as well as attached Kiosk shall be connected to earth grid by means of risers already available nearby the equipment. Any other erection checks and precautions indicated in the Manual furnished by the respective supplier of the equipment shall be studied well by the contractor and the provisions there of shall be implemented as far as possible.

#### **3.32.1.7 Erection of Power transformer**

- a. The contractor laid readily on the rails and plinth shall make a power transformer of appropriate capacity available. However, using proper tools shall do adjustment or shifting requirement for proper alignment of the equipment and tackles jacks taking due care.
- b. Bushing of HV, LV, and IV side shall be made open by removing the casing/covers and packing whatsoever may be. The bushing shall be cleaned by the cloth. The bushing shall be handled very carefully and preferably should be opened and erected in presence of the Engineer In charge or his authorized representative. Before taking up the erection work of bushing and accessories, conservator tank and the transformer tank should be thoroughly cleaned from outside to remove all dust and other material deposited on it.
- c. For fixing the bushing, the opening provided on the transformer tank/turret shall be removed and bushing should be connected to it. The current transformer and other accessories in the turret should be carefully handled while erecting bushings.
- d. The radiators should be mounted on the pedestals already available at site. The proper leveling and alignment of the radiator should be done. Any minor nature of civil or foundation work, if required should be done by the contractor at his cost. However, if already provided pedestal are totally misaligned and it is not possible to erect radiators upon it with slight modifications, the matter should be brought to the notice of Engineer in charge who will take appropriate action to remove the anomaly. As a matter of fact, the contractor may, before taking up the erection work on hand, satisfy himself that the alignments of pedestal provided for various radiator and piping headers are as per the approved drawing from the respective supplier of transformer and remedial measures should be taken much ahead of actual erection work.
- e. The Kiosk of the equipment shall be inspected for its internal wiring fuse, link temperature indicator, de-humid fire power connection, control circuits etc. If any deviation compared to the approved drawing is observed, the matter should be brought to the notice of Engineer in charge and if it is of trivial nature, corrective measures should be taken by the contractor himself. All the piping or wiring from various measuring points to the Kiosk should be checked for its trueness and continuity.
- f. Buchholz relay will be erected on the transformer tank as per the standard practice.
- g. After the erection of various accessories indicated above, filling of oil under vacuum should be started. If required random sampling and testing of oil being filled in should be carried out. The oil level in the conservator tank, condenser bushing etc. should be checked for its desired mark. After the oil filling work is over, final filtration of oil to obtain desirable low

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PPM should be done. Filter machine of 1000 GPH capacity having one pass facility of reputed make approved by Engineer in charge for filling and filtration work shall be brought by the contractor himself.

- h. Internal testing on the transformer and its accessories for operation worthiness shall be done following oil filtration work. However, the commissioning of the transformer either from LV or HV side should be done only after the installation of control panels in the control room, its connections to the transformer and complete unit testing of transformer. The commissioning work should be done as per the instruction of Engineer in charge or his authorized representative.

#### **3.32.1.8 Erection of Isolators**

- a. Isolators of the switchyard shall be with or without earth blade type centre breaks type etc. The isolators shall be procured by the contractor and transported to the work site. All the spare parts shall be properly unpacked cleaned and made ready for erection.
- b. Before erection, the contractor shall obtained copies of approved drawing of respective equipments. The isolators shall be erected on the ready galvanized structures. However, foundation for them will be available readily the respective points in the switchyard.
- c. The contractor shall check the erected support structure for their alignment vertically and tightness of fasteners before mounting the isolators parts on them. The contractor shall also verify the mounting arrangement for the operating mechanism on this structure and suitable for the same. Incase of any shortcoming the matter may be reported to engineer in charge. Any modification of trivial nature for the structure of fixtures shall be carried out at his own cost.
- d. The parts of the isolators, fixed and moving contacts earthing rode etc. shall be handled very carefully to avoid breakage or distortions. The erection shall be carried out using mechanized erection tools. The polarity of the isolator polls shall be properly identified and also the direction of the opening should be pre-determined. It should be ensured that in the entire switchyard the isolator open and close uniformly (direction point)
- e. The operating mechanism for the line contacts shall be thoroughly checked for their accessories as per approved drawing and it should be ensured that all the connection fuses links dehumidifiers lighting sockets electric motors are in their proper position. Any deviation form the approved drawing should be got sat right with the help of engineer in charge. Position. Any deviation from the approved drawing should be got set right with the help of Engineer-in-Charge.
- f. While erecting the isolator, it should be ensured that it should be properly aligned with respect to bus conductors or line conductors bus provided In the switchyard: The erected Isolator shall be within the plumb. The operating mechanism rods, pole and rotating insulators shall be checked for their proper function. The testing of the wiring to the kiosk should also be done to ensure its operation worthiness. The final commissioning of the isolator should be done only after connection to control panel is affected. However, prior to

that it should be ensured that the physical movement of the fixed and moving contacts and reach of them is within the prescribed limit.

#### **3.32.1.9 Erection of Control & relay panels ,6.6 kV& 415V switchboards , 6.6 kV & 415V APFC Panel**

- a. The contractor shall procure the All panel and transport the same to the erection site. The cases containing the panel shall be unpacked carefully and shall be nicely cleaned. In case any of external damage is observed, same shall be brought to the notice of Engineer In-charge. The panel shall be unpacked in up side up position. After an external visual inspection, the panel door shall be opened and checked for the circuit connection, terminal connector, dehumidifier, power connection etc.
- b. A front side of the panel shall be checked for any damage to the meter indicator, hooter, semaphore indicators Any lacuna in the equipments, circuits, fittings, dimensions etc. observed shall be brought to the notice of Engineer in charge who will try to impose remedial measures
- c. The All panel should also be checked for type, of schemes adopted for protection, internal connection, fascia indicator etc. Any difference observed should be brought to the notice of Engineer in charge who will take necessary action.
- d. The panel shall be erected along cut outs provided in the slab concrete, in the order, it is decided, by Engineer in charge or which is approved by authorized drawing.
- e. The size and number of cores of cables be brought from the equipment to control panel, control panel to relay panel and back to equipment shall be pre-determined by study.
- f. After the erection of panel, all the equipments, accessories indicators etc.along with the internal wiring and other accessories provided with the kiosk of the panels.

#### **3.32.1.10 Erection of battery & Battery charger**

- a. The contractor shall procure the material required for installation of batteries sets and battery charger from transport this material to the work site.
- b. All the container/packing of the battery and battery charger shall be opened carefully to prevent any damage to the equipment. The equipment than shall be cleaned to remove any dust or other un-warranted deposition. The battery rack shall be placed in such a fashion that rows of battery cell can be conveniently connected to each other. The contractor shall obtain the drawing of arrangement of battery racks and its connection to floats charger and boost charger with reference to the floor space. The battery cells shall be filled with requisite amount of electrolyte with proper specific gravity and up to the mark of maximum-level indicated on the battery cells. All the cells shall be connected in the series to obtain total voltage of the 224V AC. However. Individual cell shall also be checked for their voltage across terminal before series connection.

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- c. The battery rack shall be provided with bottom insulating material to prevent any leakage of current to the earth. Similarly individual battery cell shall be provided with insulation supports to wooden rack to prevent any body leakage. The purchaser shall supply wooden racks and acid distilled water etc.
  - d. The connection. of the battery shall be done through a cable. and same shall be terminated in the LV room (AC/DC) before commissioning of the battery and battery charger. The entire battery room shall be completely cleaned. Similarly racks and. battery cells shall also be cleaned for any deposits of electrolyte and other particles.
  - e. A connection of boost charger shall be secured from the AC supply provided in the switchgear room.
  - f. All the accessories supplied for measuring the specific gravity and testing etc. provided by the supplier shall be return to the Engineer in charge or shall be placed at proper place in the battery room under intimation to Engineer in charge.
  - g. Load test on the commissioned battery sets shall be taken as per the instruction of the Engineer in charge and performance of the battery cells float boost charger shall be observed for few hours. Test load then shall be removed and battery shall be ultimately connected to the LV room for its onwards utilization in control indication and protection circuits.
  - h. The following checks are recommended for battery
    - a. Checking of completion of civil/ventilation requirement of battery room.
    - b. Checking of adequacy of charger output/requirement with respect to current required for battery charging as per the manual.
    - c. Checking for availability of safety devices, water and first aid box.
    - d. Checking the polarity of connections between battery and charger.
    - e. Visual inspection test for level and leakages.
    - f. Checking of layout as per approved drawing.
    - g. Checking of IR value from positive to earth and negative to earth. .
    - h. Checking of voltage per cell and total voltage between positive negative and earth to positive/negative,
    - i. Checking of tightness of connectors on each cell. .
    - j. Checking of capacity test and hourly measurement of specific gravity and voltage for each cell.
    - k. Charging-discharging cycle as per standard practice, and as per instruction of Engineer-in-charge

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- i. The following checks are recommended for battery charger.
    - a. IR test
    - b. Checking for charging mode of batteries, constant current and constant voltage mode.
    - c. Load test on charges by running of DC drives (if there and by liquid resistance system).
    - d. Checking of thickness of earthing connections.
    - e. Check for functional operation of charger, auto manual change over from float to boost to float etc.
    - f. Check for AC ripple in boost and float mode after charging.
    - g. Check and polarity of cables connected to battery

#### **3.32.1.11 General**

- a. In accordance with the specific installation instructions, as shown in manufacturer's drawings or as directed by the Owner or Owner's Representative the Contractor shall unload, erect, install, wire, test and place into commercial use all electrical equipment included in the contract. Equipment shall be installed in a neat manner so that it is level, plumb, square, and properly aligned and oriented.
- b. The Contractor shall furnish all supervision, labour, tools, equipment, rigging materials and incidental materials such as bolts, wedges, anchors, concrete inserts etc. required to completely install, test and adjust the equipment.
- c. Manufacturer's drawings, instructions and recommendations shall be correctly followed in handling, setting, testing and commissioning of all equipment and care shall be exercised in handling to avoid distortion to stationary structures, the marring of finish, or damaging of delicate instruments or other electrical parts.
- d. The contractor shall erect and commission the equipment as per the instructions of the erection Owner(s) and shall extend full co-operation to him.
- e. In case of any doubt/misunderstanding as to correct interpretation of a manufacturer's drawings or instruction, necessary clarification shall be obtained from the Owner or the Owner's Representative. The Contractor shall be held responsible for any damage to the equipment consequent to not following a manufacturer's instructions correctly.
- f. The Contractor shall move all equipment into the respective buildings through regular doors or floor openings provided specifically for the equipment. Wherever possible the crane or cranes will be made available for lifting heavy equipment and materials. The Contractor shall make his own arrangement for lifting of equipment .
- g. Where assemblies are supplied in more than one section, the Contractor shall make all necessary mechanical and electrical connections between sections including the connections

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between bus bars/wires. The Contractor shall also carry out the adjustment/alignments necessary for proper operation of the circuit breakers. All insulators and bushings shall be protected against damage during installation. Insulators or bushings chipped, cracked or damaged due to negligence or carelessness shall be replaced by the Contractor at his own expense.

- h. The Contractor shall take utmost care in handling instruments, relays and other delicate mechanisms. Wherever the instruments or relays are supplied separately, they shall be mounted only after the associated control panels have been erected and aligned. The blocking material/mechanism employed for the safe transit of the instruments and relays shall be removed after ensuring that the panels have been completely installed and no further movement of the same would be necessary. Any damage to relays and instruments shall be immediately reported to the Owner or Owner's Representative.
- i. Switchgear and motor control centre shall be installed in accordance with the latest Indian Standard Code of Practice 10118 and manufacturer's instructions. The switchgear and motor control centre panels shall be installed on finished surface or concrete or steel sills. The Contractor shall be required to install and align any channel sills which form part of the foundations. Tape or compound shall be applied where called for by manufacturer's drawings. The base of outdoor type units shall be sealed in an approved manner to prevent ingress of moisture.
- j. Care shall be taken during handling of insulating oil to prevent ingress of moisture or foreign matter. In the testing, circulation, filtering, or other wise handling of oil, rubber hose shall not be used. Circulation and filtering of oil, the heating of oil by regulated short-circuit current during drying runs and sampling and testing of oil shall be in accordance with manufacturer's and the latest Code of Practice IS : 10028.
- k. After installation of all power and control wiring, the Contractor shall perform operating tests on all switchgear and power control centre / motor control centre to verify the proper operation of switchgear/panels and the correctness of the interconnections between various items of equipment. This shall be done by applying normal a-c or d-c voltage to the circuits and operating the equipment. Megger tests for insulation, polarity checks on the instrument transformer, operation tests on equipment, and manufacturer's installation tests shall be carried out by the Contractor who shall also make all necessary adjustments as specified by the manufacturer for proper functioning of the equipment.
- l. Installation and testing of the battery and battery chargers shall be done in strict compliance with the manufacturer's indications.
- m. Equipment furnished with finished coats of paint shall be touched up by the Contractor if their surface is spoiled or marred while handling.
- n. Foundation work and grounding - in of fixing bolts or channels for all switchgear, motors, motor control centre will be carried out by the Contractor.



- o. All commissioning tests shall be carried out at site after completion of installation. Contractor shall ensure to use calibrated test equipment having valid calibrations test certificates from standard laboratories traceable to National Standards.
- p. All the electrical equipment will be run on a trial basis for a minimum period of 30 days.
- q. Guarantee period shall be mentioned for all such equipment.
- r. Following safety equipment and accessories and its procedure and practice shall be implemented by electrical contractor in switchgear room and transformer yard/substation as per latest edition of IS: 5216.
  - a. 'CO2 ,portable Fire extinguishers, of size 5kg each ,manufactured from CRCA sheets in all welded construction, body coated with glossy corrosion resistant epoxy powder coating ,with inbuilt water proof pressure gauge ,with wall bracket ,as per IS 2190 and IS 13849 with latest amendments-8Numbers.
  - b. 11000 V ,A' class, non-skid ,high voltage insulation synthetic mat made from electrometric polymer material ,1000 mm wide , 2.0 mm thick, Dielectric strength 3300V for 1 minute ,fire retardant ,no adverse effect of transformer oil ,diesel, acid ,alkali, High Tensile & Elongation properties, good mechanical strength to withstand load and movement of breaker trolley ,as per IS 15652 with latest amendments -50 sqmtr.
  - c. 415 V ,A' class, non-skid ,high voltage insulation synthetic mat made from electrometric polymer material ,1000 mm wide , 2.0 mm thick, Dielectric strength 3300V for 1 minute ,fire retardant ,no adverse effect of transformer oil ,diesel, acid ,alkali, High Tensile & Elongation properties, good mechanical strength to withstand load and movement of breaker trolley ,as per IS 15652 with latest amendments -10 sqmtr.
  - d. Shock treatment chart , duly laminated in Gujarati(Local) and English languages.-4 Nos.
  - e. First aid box with all essential medicines including wall mounted bracket – 4 Nos.
  - f. 66000V, Aluminium, anodised Danger caution plate in Gujarati (local) and English languages with the sign of skull and bones in signal red colour on front side, as per IS 2551 with latest amendments-6Nos.
  - g. 11000 V, Aluminium, anodised Danger caution plate in Gujarati (local) and English languages with the sign of skull and bones in signal red colour on front side, as per IS 2551 with latest amendments-6Nos
  - h. 415 V, Aluminium, anodised Danger caution plate in Gujarati (local) and English languages with the sign of skull and bones in signal red colour on front side, as per IS 2551 with latest amendments-6Nos.
  - i. Galvanised mild steel sand Fire bucket with lid and handle, 9 Litres capacity. Buckets to be provided with suitable strand with 4 No. hooks to hang sand filled buckets, as per IS 2546 with latest amendments-4 No.(3 Sets)

- j. Fire Safety: The requirement of portable fire extinguisher and fire bucket with sand in electrical equipment room and transformer yard shall be provided as per Fire Protection Manual by Regional Tariff Committee.
- s. The contractor shall obtain the necessary valid license or authorization from the state licensing authority to do the installation work. The technicians deputed by the contractor shall hold valid permits issued by the Licensing authority.
- t. The electrical installation work shall be carried out by licensed electricians only and approved by appropriate authorities. It is the responsibility of contractor to get approval of complete system from the electrical inspectorate.

#### **3.32.1.12 Painting**

- a. All sheet steel work shall be phosphated in accordance with relevant standards for phosphating iron and steel.
- b. Oil, grease, dirt and shall be thoroughly removed by emulsion cleaning Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.
- c. After phosphating, thorough rinsing shall be carried out with clean water, followed by final rinsing with dilute dichromate solution and oven drying.
- d. The phosphate coating shall be sealed by the application of two coats of ready mixed, stoving type zinc chromate primer. The first coat may be flash dried while the second coat shall be stoved.
- e. After application of the primer, two coats of finishing synthetic enamel paint shall be applied, with each coat followed by stoving. The second finishing coat shall be applied after completion of tests. The colour for the finishing paint shall be as specified.
- f. Each coat of primer and finishing paint shall be of a slightly different shade to enable inspection of the painting.
- g. The final finished thickness of paint film on steel shall not be less than 100 microns, and shall not be more than 150 microns.
- h. Finished painted appearance of equipment shall present an aesthetically pleasing appearance, free from dents and uneven surfaces.
- i. Material not complying with the foregoing requirements are liable to be rejected.

### **3.33 Inspection & field test of Electrical equipment's**

#### **3.33.1 Scope**

The work to be performed under these guidelines cover the quality assurance plan for the inspection and testing of electrical installations at site.

### 3.33.2 General requirements

- a. The contractor shall furnish necessary meters, instruments, temporary wiring and labour to perform all required tests, adjustments and wiring of all equipment installed and/ or connected under the contract including electrical equipment supplied by others, if any, to determine proper polarity, phasing, freedom from grounds and shorts and the proper operation of the equipment, meters, relays, etc. All testing instruments shall be calibrated and certified for accuracy by competent authority.
- b. Inspection and testing shall be carried out to ensure that all equipment and materials have been installed as required and as per the relevant International Standard Specifications and Codes, Local Rules and Regulations, requirements of Fire Insurance, Chief Electrical Inspector and any other authorities having jurisdiction. The installation must pass all inspection and will be subject to the approval of the Owner and the concerned local authorities.
- c. Before the electrical facilities are placed in operation, the Contractor shall make suitable tests to establish to the satisfaction of the Owner that all equipment, devices and wiring have been correctly installed, are in satisfactory condition and will operate as intended.
- d. All tests shall be performed by or under the direct supervision of men qualified for carrying out inspection and testing.
- e. Owner reserves the right to witness all tests, and he shall be informed in this regard two weeks before the tests are to take place. Owner reserves the right to approve the test results before circuits or equipment will be energised for the first time.
- f. If motors record low insulation resistance, then they must be dried to obtain the required insulation resistance values. Approval of the drying methods shall be obtained from Owner before applying heat.
- g. All results of the tests shall be recorded on prescribed test data sheets. All tests described herein shall be recorded on forms provided or agreed upon by Owner. Test reports shall include, for each test, the date of performance and name of the person in charge of the test.
- h. Before starting the tests, a visual inspection of the material / equipment is to be made to determine that all components are installed as per drawings and in a neat and workman-like manner and that, in general, the equipment is ready for testing.
- i. In case of fault, the Contractor shall isolate the fault and shall take necessary steps to eliminate the fault to the satisfaction of Owner. All defects through faulty workmanship of contractor or of equipment and material supplied by him shall be corrected or replaced at his own expense.
- j. Before commencement of any test, all equipment shall be thoroughly cleaned by blower and checked for proper and rigid connection of termination, fixing of foundation bolts, etc.
- k. Contractor shall submit all formats for tests to be conducted on each equipment/system in accordance with these specifications for approval to the Owner before entering the test readings.

### **3.33.3 Site Acceptance Test (SAT)**

Check all units for proper rating and size. Inspect earth connections, terminations on EHV, HV & LV sides. Checks for oil leaks at all fittings and connections. Check for thermometer, breather and other safety devices. Check oil level and colour of silica gel.

#### **3.33.3.1 EHV equipments**

Lightning Arrester, CTs, VTs, isolators, circuit breakers, insulators

- a. Insulation resistance test with 5KV/1KV megger as applicable for each equipment and for system.
- b. Physical checking of equipment - visual examination.
- c. Operational tests for Circuit breakers, isolators and associated relays, motors.
- d. Ratio tests, polarity tests, secondary injection, primary injection tests for CTs/VTs.
- e. Interlocks checking / testing.
- f. Earth continuity test.
- g. Phasing checks on system energisation.
- h. All other tests as per equipment supplier's recommendations.

#### **3.33.3.2 Power transformer**

- a. Tests
  - a. Winding insulation resistance shall be measured from primary and secondary windings to earth and from primary to secondary winding. The winding, which is not under test, shall be earthed during the test.
  - b. The insulation resistance should be measured by at least 1000 Volts megger. Every time the voltage should be applied for 1 minute. While taking the insulation resistance measurements, the value of insulation resistance shall not be less than 400 Mega ohms at 30 Degree Celsius and 200 Mega ohms at 40 Degree Celsius for HV winding and 50 Mega ohms at 30 Degree C and 25 Mega ohms at 40 Degree Celsius for LV winding. If the values obtained are less than the above figures, drying out process shall be necessary.
  - c. Measure the dielectric strength of transformer oil in accordance with IS: 335. The oil should withstand at least 40KV for 1 minute when tested.
  - d. Test operation of buchholz relay in accordance with Manufacturer's instructions
- b. On-load tap changer (OLTC)
  - a. General

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Check for oil leakage, at all fittings and connections. Check for selector switch, tap changing contacts, motor and manual driving mechanism and all indicating and control instruments.

b. Tests

- i. Test the automatic operation of the on-load tap changer connected to the transformer. Measure the primary and secondary voltage with tap changer in each position and verify that the voltage ratios are in accordance with the specified data on the nameplate.
- ii. Test the gear for correct operation of tap position indicator, step-correcting switches, limit switch, over travel torque limiter, counter, sequence switches and similar devices.
- iii. Dielectric strength of oil shall be in accordance with Indian Standard 335. Minimum acceptable value shall be 40 KV for 1 minute.
- iv. Prior to placing the transformer with OLTC in regular service, tap changer shall be set to provide rated secondary voltage at no load for the value of primary voltage expected at start-up, and OLTC will be set for automatic operation.
- v. Before energising the OLTC, the insulation resistance of electrical control circuits shall be measured from phase to earth. Minimum acceptable value will be 1 Mega ohms.

c. Off-circuit tap changer (OCTC)

- i. Check for oil leakage, at all fittings and connections. Check for tap changing contacts, manual driving mechanism and all indicating instruments.
- ii. Tests
  - (1) Test the operation of the off-load tap changer connected to the transformer. Measure the primary and secondary voltage with tap changer in each position and verify that the voltage ratios are in accordance with the specified data on the nameplate.
  - (2) Test the gear for correct operation of tap position indicator.
  - (3) Prior to placing the transformer with off-circuit tap changer in regular service, tap changer shall be set to provide rated secondary voltage at no load for the value of primary voltage expected at start-up.

**3.33.3.3 High voltage switchgear**

- a. Before switchgear is energised, the insulation resistance of each bus shall be measured from phase to phase and from phase to earth. Measurements shall be repeated with circuit breakers in operating position and contacts open. Each test shall be held until constant reading is obtained. Minimum time shall be ten seconds. Minimum megger reading shall be 10 Mega ohms.

- b. Before switchgear is energised, the insulation resistance of all D.C. control circuits shall be measured from phase to earth. Minimum acceptable value shall be 1 Mega ohm.
- c. Each adjustable protective relay shall be set, calibrated and tested by using a cycle counter, load box, ammeter, and voltmeter as required or by using a suitable relay test set having good wave form. Settings, calibration points, and test points shall be in accordance with values given by the approved relay settings for the job.
- d. Test all current transformer secondary circuits by applying current (thro secondary injection test) to transformer secondary windings and verifying that relay(s) and/or meter(s) operate properly.
- e. Test all potential transformer secondary circuits by applying voltage to potential transformer secondary winding and verifying that relay(s) and/or meter(s) operate properly.
- f. Test all the circuit breakers for proper interlocking operation. The sequence of interlocking shall be as indicated on single line diagram.
- g. Test the operation of tie breakers / bus couplers.
- h. The following tests shall be performed on all circuit breakers before they are operated:-
  - a. Contact alignment shall be checked and adjusted where necessary in accordance with manufacturer's instructions.
  - b. Each circuit breaker shall be drawn out of its cubicle and shall be closed manually, and then its insulation resistance shall be measured from phase to phase and from phase to earth.
  - c. All adjustable direct acting trip devices shall be set using values given in the approved relay settings for the job.
- i. Before switchgear is energised, the following tests shall be performed on each circuit breaker in its 'test' position:-
  - a. Close and trip circuit breaker from its control switch, push button, or operating handle.
  - b. Test operation of circuit breaker latch and check switch, where provided.
  - c. Test proper operation of lockout device in the closing circuit, where provided, by simulating conditions, which would cause a lockout to occur.
  - d. Trip breaker by manual operation or by applying current or voltage to each of its associated protective relays.
  - e. All automatic control operations and interlocks shall be tested for correct operation.
- j. After completion of tests, all test results shall be recorded in standard format approved by Owner, witnessing site Owner and contractor's representative.

- k. All test reports shall indicate the details of the instruments used for test with date and time of test.
- l. After commissioning of the equipment, all measuring and indicating instruments to be checked properly for operation. Any improper operation of these indicating lamps / instruments shall be corrected by checking fuse / connections, polarity, etc. If still these are found to be not in working condition, the supplier should report the same to the Owner for suitable action for replacement.

#### **3.33.3.4 Medium voltage switchgear**

##### **a. Main LT switchboard**

- a. Before switchgear is energised, the insulation resistance of each bus shall be measured from phase to phase and from phase to earth. Measurements shall be repeated with circuit breakers in operating position and contacts open. Each test shall be held until constant reading is obtained. Minimum time shall be ten seconds. Minimum megger reading shall be 10 Mega ohms.
- b. Before switchgear is energised, the insulation resistance of all D.C. control circuits shall be measured from phase to earth. Minimum acceptable value shall be 1 Mega ohm.
- c. Each adjustable protective relay shall be set, calibrated and tested by using a cycle counter, load box, ammeter and voltmeter as required or by using a suitable relay test set having good wave form. Settings, calibration points and test points shall be in accordance with values given for the approved relay settings for the job.
- d. Test all current transformer secondary circuit by applying current (thro secondary injection test) to transformer secondary windings and verifying that relay(s) and/or meter(s) operate properly.
- e. Test all the relevant circuit breakers for proper interlocking operation. The sequence of interlocking is as indicated on single line diagram.
- f. Test the operation of tie breakers / bus couplers.
- g. The following tests shall be performed on all circuit breakers before they are operated:-
  - i. Contact alignment shall be checked and adjusted where necessary in accordance with manufacturer's instructions.
  - ii. Each circuit breaker shall be drawn out of its cubicle and shall be closed manually, and then its insulation resistance shall be measured from phase to phase and from phase to earth.
  - iii. All adjustable direct acting trip devices shall be set using values given in the approved relay settings for the job.

- 
- h. Before switchgear is energised, the following tests shall be performed on each circuit breaker in its 'test' position:-
    - i. Close and trip circuit breaker from its control switch, push button or operating handle.
    - ii. Test operation of circuit breaker latch and check switch, where provided.
    - iii. Test proper operation of lockout device in the closing circuit, where provided, by simulating conditions, which would cause a lockout to occur.
    - iv. Trip breaker by manual operation or by applying current or voltage to each of its associated protective relays.
  - i. All automatic control operations and interlocks shall be tested for correct operation.
  - j. After completion of tests, all test results shall be recorded in standard format approved by Owner, witnessing site Owner and contractor's representative.
  - k. All test reports shall indicate the details of the instruments used for test with date and time of test.
  - l. After commissioning of the equipments, all measuring and indicating instruments to be checked properly for operation. Any improper operation of these indicating lamps / instruments shall be corrected by checking fuse / connections, polarity, etc. If still these are found to be not in working condition, the supplier should report the same to the Owner for suitable action for replacement.

**b. RTCC, motor control centre (MCC), DCDB, APFC Panels**

- a. Before energising, the insulation resistance of each bus shall be measured from phase to phase and from phase to earth with disconnecting devices. Repeat measurements with devices closed but with contactors open. Minimum acceptable value shall be 10 Mega ohms.
- b. Contact alignment of each contactor shall be checked and adjusted where necessary in accordance with manufacturer's instructions.
- c. Before energising, the insulation resistance on both the "line side" and "load side" of each contactor shall be measured separately from phase to phase and from phase to earth. Minimum acceptable value shall be 10 Mega ohms.
- d. Set each adjustable relay and direct acting trip device in accordance with values given in the approved relay setting record.
- e. Each contactor shall be closed and tripped from its control switch and/or push button station to test proper operation.

**c. Other distribution boards**



- a. Before energising, the insulation resistance of each bus shall be measured from phase to phase and from phase to earth with circuit breakers/isolating switch open. Measurements shall be repeated with circuit breakers/isolating switch closed.
- b. The distribution boards shall be checked for rigid mounting, earthing connections, proper rating and size of components, interlocking and overload settings.

#### **3.33.3.5 H.V. cable**

- a. A D.C. high voltage test shall be made, after installation, on HV XLPE cables.
- b. Test data shall be noted for record purposes. Measure values of leakage current versus time.
- c. The D.C. high voltage tests shall be performed in accordance with following: -
  - a. Cables shall be installed in final position, with all through splices complete. Terminations shall be kept unfinished so that motors, switchgear, transformers, etc. are not subjected to the test voltage. However, insulation shall be pencilled and otherwise prepared for completion of the termination of the cable, including making up & grounding of stress cone for shielded cable.
  - b. Where potheads are employed, all internal work in making up the pothead shall be completed including filling. Pothead insulators shall be clean and dry.
- d. The test voltage, duration of test, and test procedure shall be in accordance with IS: 1255.

#### **3.33.3.6 L.V cable**

- a. A megger test shall be made for continuity and proper end-to-end connection and correct termination after installation, on all feeder cables including motor feeder cables.
- b. Record test data between phase to phase and phase to earth.
- c. The test voltage, duration of test and test procedure shall be in accordance with IS: 4288.

#### **3.33.3.7 Wiring**

- a. Before energising, the insulation resistance of every circuit shall be measured from phase to phase, from phase to neutral and phase to earth.
- b. The insulation resistance of the circuits noted below shall be measured as follows: -
  - a. Motor feeders: with motors disconnected, measure insulation resistance from load side of circuit breakers or contactors.
  - b. Motor control circuits: With push buttons and over current devices connected, measure insulation resistance from phase to earth.
  - c. Lighting feeders: Measure insulation resistance with circuit breakers or switch-fuse units on panel boards connected but with lighting branch circuit breakers or switches open.

- d. Lighting branch circuits: Measure insulation resistance after all lamp holders, receptacles, fixtures, etc. are connected but before fixing of lamps.
- c. Where splices or terminations are required in circuits rated above 600 Volts, measure insulation resistance of each length of cable before splicing and/or terminating. Repeat measurements, after splices and/or terminations are complete.
- d. Measure the insulation resistance of buried cable circuits before cable trenches are backfilled. Repeat measurements after backfilling.
- e. Test light intensity of each room by light intensity meter at working height and record the same.
- f. All receptacles shall be tested for correct phase sequence and by test lamp for operation of switch and continuity of earthing.

#### **3.33.3.8 Alarms**

All electrical alarms shall be tested for proper operation by causing alarm to sound under simulated abnormal conditions.

#### **3.33.3.9 Earthing**

- a. Specifications
  - a. Earthing shall be carried out as per IS Code of Practice: 3043 and as shown in the relevant drawings.
- b. General inspection
  - a. Check that earthing system is installed as per drawings.
  - b. Check that all connections are tight and connections are protected from mechanical injury.
- c. Testing
  - a. The resistance to ground shall be measured at the following locations:
    - i. The resistance of the system/neutral earthing should be maintained preferably at less than 1 Ohm.
    - ii. At each earthing point provided for lightning protection, the earth resistance shall preferably not exceed 1 Ohm.
    - iii. At any one point of each system used to provide earthing to electrical equipment enclosures, resistance shall not preferably exceed 1 Ohm.
  - d. Measurements shall be done before connection is made between the earth and the object to be earthed.

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#### **3.33.3.10 Batteries**

All substation batteries shall be given a booster charge in accordance with manufacturers' instructions and adjusted for float operation before being placed in regular service.

#### **3.33.3.11 Battery chargers**

Battery charger shall be tested for proper operation and to verify that chargers deliver their maximum rated output.

#### **3.33.3.12 Insulating liquid dielectric test**

For test of the dielectric strength of insulating liquid or oil in transformer or reactor, test sample of liquid shall be drawn from equipment after filling. In some cases, a test also shall be made with samples drawn from the liquid container before the equipment is filled. Tests shall be carried as per IS: 335.

## 4. DATA SHEET FOR ELECTRICAL SPECIFICATION

### 4.1 Lighting Arresters

Sr. No.	Description	Unit	Particulars
	General		
1	Designation		Lightning Arrester
2	Make/Manufacturer		As per approved Vendor list
3	Applicable Standards		IS 3070 and IEC 60099
4	Type and model		Metal oxide Gapless type
5	Quantity	Nos.	9Nos(Min.) (3 Sets)
6	Installation		Outdoor
7	System voltage	kV	66 Nominal 72.5 Highest
8	No. of units per phase		Bidder to specify
9	No. of ZnO blocks per unit		Bidder to specify
10	Ratings		
A	Maximum continuous operating voltage		Bidder to specify
B	Rated frequency		50
C	Nominal discharge current in kA of 8/20 micro second shape		10 kA
D	Basic Insulation level of equipments to be protected		Bidder to specify
E	Impulse withstand (1.2/50 microsecond)	kV(P)	350
F	1 min. Power frequency withstand voltage	kV	140
G	Resistive and capacitive currents of arrester at continuous operating voltage.		Bidder to specify
H	Performance Data		
11	Virtual steepness of front		
A	Rate of rise	kV/micro sec.	Bidder to specify
B	Time of spark over	Micro sec.	Bidder to specify
12	Maximum residual voltage at (8/20 microsecond wave) rated nominal discharge current(10kA)	kV (peak)	< 190
A	(5kA)	kV(peak)	Bidder to specify

Sr. No.	Description	Unit	Particulars
B	(10kA)	kV(peak)	Bidder to specify
C	(20kA)	kV(peak)	Bidder to specify
13	Steep current impulse withstand voltage at 10 kA with one microsecond front time		
A		kV(peak)	Bidder to specify
14	Arrestor housing		
A	Minimum creepage distance Total	mm	25 mm / kV or 1810mm
15	Minimum cantilever strength of arrester assembly	Kg	Bidder to specify
A	1 min. Power frequency wet flash-over voltage	kV	> 140
B	Pressure relief class (as per IEC:60099)		Class A
C	Accessories required		Bidder to specify
D	Conductor size		Bidder to specify
E	Line side terminal		ACSR Panther
F	Earth side terminal		50 x 10 CU
16	Energy absorption in kJ/kV(2 SHOTS)	Kj/kV	5
17	Over voltage withstand capacity	kV	Bidder to specify
	100 Second		
	10 Second		
	1 Second		
	0.1 Second		

## 4.2 Isolators

Sr. No.	Description	Unit	Particulars
	Rating		
1	Application		Isolator
2.	Make		As per approved vendor list
3	Applicable Standards		IS 9921, IEC 60865
4	Quantity		3 Nos with Earth switch 3 Nos without Earth switch
5	System Voltage	kV	66 Nominal
		kV	72.5 Highest
6	Frequency	Hz	50
7	No of Phases		3 phase
8	Rated current for site conditions	A	Bidder to specify
9	Short time current		
	a. Rating	kA	Min.25
	b. Duration	Sec	3
10	Design Requirements		
	Temperature	° C	Ambient
	Insulation level	Full/ Reduced	Full
11	Phase spacing	mm	As per IS/CBIP
12	Earthing switch required		To be provided and interlocked with main switch
13	Type of break		Double break central rotating
14	Type of mounting		Horizontal
15	Height of mounting above GL	mm	As per IS/CBIP
16	Operating device For isolator For earthing switch		Manual with Operating handle with reduction gear and Suitable electro-mechanical interlock
17	Orientation of operating mechanism box W.R.T isolator		Suitable
18	Auxiliary contacts NO NC		6 6
19	Make before break		
20	Insulator Data		
	Rated voltage	kV	66/72.5
	Power frequency dry flash-over	kV	165

Sr. No.	Description	Unit	Particulars
	voltage		
22	1 min. Power frequency wet flash-over voltage	kV	140
23	Impulse flash-over : Positive wave(1.2*50 micros)	kV(peak)	375
24	Impulse withstand (1.2*50 micros)	kV(peak)	350
25	Creepage distance Total	mm	25 mm per kV
26	Minimum strength Torsional Cantilever	Kg-m Kg	Bidder to specify

### 4.3 CT PT & BPI unit

#### (A) Potential transformers(PT)

Sr. No.	Description	Unit	Particulars
3.1	General		
1	Designation		Potential transformer
2	Type		Oil immersed
3	Make		As per approved vendor list
4	Applicable Standards		IS 3156, IEC 60044
5	Quantity		Min. 9 Nos.
6	Nominal system voltage	kV	66
7	Highest system voltage	kV	72.5
8	Frequency	Hz	50
9	System neutral earthing		Effectively earthed
3.2	Design Equipments		
1	PT data for Incomer GETCO Metering Core 1 (metering) Core 2 ( Spare)		EPC Agency to collect details from GETCO & to provide as per GETCO specification
2	PT Data For Incomer Core 1 (Metering) Core 2 (Protection) Core 3 (Spare)		66KV/√3/110V/√3,100VA,CL :3P 66KV/√3/110V/√3,100VA,CL : 3P 66KV/√3/110V/√3,100VA,CL : 3P
3	PT Data For Incomer Core 1 (Metering) Core 2 (Protection) Core 3 (Spare)		66KV/√3/110V/√3,100VA,CL : 3P 66KV/√3/110V/√3,100VA,CL : 3P 66KV/√3/110V/√3,100VA,CL : 3P
	Method of connection 1. Primary winding		Star, Earthed

Sr. No.	Description	Unit	Particulars
	2. Secondary winding		Star, Earthed
	Rated power factor		0.8
	Insulation withstand level		
	a) Impulse withstand (1.2*50 microsecond)	kV peak	350
	b) 1 min. Power frequency withstand voltage (dry) primary	kV rms.	Bidder to specify
	c) 1 min. Power frequency withstand voltage (wet) primary	kV rms.	Bidder to specify
	d) 1 min. Power frequency withstand voltage secondary	kV rms.	3 kV for 1 minute
14	Rated /Over voltage factor and time		1.2 Continuous
15	Class of insulation of winding		Oil immersed
16	Max. Wdg. temp. at 110% excitation rated burden	°C	As per IS
17	Total minimum creepage distance	mm	25 mm per kV/1810 mm
18	Temperature rise at 1.2 times rated voltage with rated burden	°C	Bidder to specify
19	Temperature rise at 1.5 times rated primary voltage for 30 second	°C	Bidder to specify
20	Seismic coefficient		Bidder to specify
3.3	GA drawing indicating overall dimensions weight, height and fixing details		Bidder to specify



**(B) Current Transformers (CT)**

Sr. No.	Description	Unit	Particulars
	General		
1	Designation		Current transformer
2	Type		Oil immersed
3	Make		As per approved vendor list
4	Applicable Standards		IS: 2705-1981, IEC 60044
5	Quantity		12 Nos. Min
6	Nominal system voltage & Frequency	kV	66 & 50 Hz
7	Highest system voltage	kV	72.5
8	System neutral earthing Type		Effectively earthed
9	66 kV INCOMER METERING, PROTECTION & SPARE) Core 1/2 / 3/ 4		
A	Primary current	A	150 A
B	Secondary current	A	1-1-1-1
C	Rated output and accuracy Core 1 (metering) Core 2 ( protection) Core 3 ( protection) Core 4 (Spare)	VA %	5 VA Cl. 0.2S 15 VA Cl. 5 P 10 15 VA Cl. 5 P 10 15 VA Cl. 5 P 10
E	Minimum Knee point voltage(at highest ratio)		Specify during detail engineering for each CT
F	Resistance of the Secondary winding		Specify during detail engineering
G	Instrument Security factor (ISF)		5 or less at minimum ratio
10	66 kV Transformer, Metering, Relaying, Differential Core 1/2 / 3		
A	Primary current	A	EPC Agency to collect details from GETCO & to provide as per GETCO a CT Ratio specification
B	Secondary current	A	
C	VA Burden		
D	Extended primary current rating(As per IS 2705 )	A	120 %
E	Short time current Rating Duration	KA Sec	Minimum 25 3.0
G	Dynamic rating	kA(peak)	132
12	Temp rise at rated		

	Continuous thermal current over ambient temp at site Oil Winding at the top Exposed current carrying parts Reference ambient temp	°C °C °C °C	Bidder to specify
13	Variation in ratio and Phase angle error due to Variation in Voltage by 1% Frequency by 1Hz		Bidder to specify
14	Current density in Primary winding for Each ratio to be stated clearly	Amp/sqmtr	Bidder to specify
15	Insulation		
A	Class of insulation		Class A
B	Maximum temp. rise of winding Ambient Temp rise	°C °C	50 50/55
C	1.2/50 micro sec lightning impulse withstand	kV(peak)	350
D	One minute power frequency withstand	kV(rms)	140
16	Make		
	Insulator		Bidder to specify
	Insulating oil		Bidder to specify
17	GA drawing indicating overall dimensions weight, height and fixing details		Bidder to provide

**(c) Bus post insulators (BPI)**

Sr. No.	Description	Unit	Particulars
	General		
1	Designation		Bus post insulator
2	Type		Solid core type
3	Make		As per approved vendor list
4	Applicable Standards		Relevant IEC,IS& ANSI Standards
5	Quantity		As per Requirements
6	Nominal system voltage & Frequency	kV	66 & 50 Hz
7	GA drawing indicating overall dimensions weight, height and fixing details		Bidder to provide
8	Height of unit	mm	770 ±1
9	Bending strength (approx. failing load): i) Upright	kgf	400
10	Tensile strength (Approx.)	kgf	3500
11	Torsional strength (Approx.)	kgfM.	200
12	a) Power frequency flashover voltage (Dry) b) Power frequency flashover voltage (Wet)	kV kV	180 150
13	a) Impulse flashover voltage (Positive) b) Impulse flashover voltage (Negative)	kVp kVp	355 405
14	a) 1 min. power frequency withstand voltage (Dry) b) 1 min. power frequency withstand voltage (Wet)	kV (rms) kV (rms)	165 140
15	Lightning Impulse positive / negative withstand voltage.	kVp	350
16	Power frequency puncture voltage.	kV	Puncture proof
17	Visible discharge voltage	kV	53
18	Radio Interference Voltage	Micro volts	Bidder to specify
19	Creepage distance (Minimum) a) Total b) Protected	mm mm	1815 910
20	Dry Arcing distance (Minimum)	mm	Bidder to specify
21	Top metal fitting PCD	mm	127±0.2
22	Bottom metal fitting PCD	mm	127±0.2

23	All ferrous parts should be hot dip galvanized to IS:No.2629/1966.	YES / NO	Yes
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#### 4.4 Circuit Breakers( SF6)

Sr. No.	Description	Unit	Particulars
1	General		
A	Application		Power distribution
B	Quantity		Min. 3 Nos.
C	No of Pole Per Circuit Breaker		3
D	Make		As per approved vendor list
E	Applicable Standards		IS:13118,IEC:62271
F	Type of circuit breaker		SF6
G	Reference Ambient temperature	° C	50
H	Phase System Voltage Nominal Highest	kV kV	66 72.5
2	Ratings		
A	Voltage and frequency	kV, Hz	66 kV,50 Hz
B	Normal current at site Conditions	A	1250 Amps.
C	Short Circuit breaking current	KA	Bidder to specify
D	Rate short circuit breaking capacity Rating Duration	kA Sec	25 3 Sec.
E	Rated Short circuit Making capacity	kA peak	78.75
F	Operating duty		O - 0.3sec. – CO - 3min - CO
G	Clearance : (a) phase to phase (b) phase to earth	mm mm	As per IS As per IS
H	Maximum temperature rise above ambient temperature due to rated current in main contacts measured after breaking test	° C	Bidder to specify
3	Additional Breaking Current Ratings		Bidder to specify
A			
B	Maximum Line charging current breaking capacity Without over	Amp	10

Sr. No.	Description	Unit	Particulars
	voltage Exceeding 2.5 phase neutral voltage		
C	Maximum Cable charging current breaking capacity And corresponding overvoltage recorded i)on supply side ii)on line side.		Bidder to specify
D	Maximum shunt Capacitor bank switching capacity	MVA	Bidder to specify
4	Withstand Test voltage		
A	1.2/50 micros lightning impulse withstand voltage i)Between line terminal and ground ii)Between terminals with circuit breaker contacts open	kV(peak)  kV(peak)	Bidder to specify
B	Dry 1 Minute power frequency test withstand voltage,for complete circuit breaker. i)Between line and grounded parts ii)Between terminals with circuit breaker contacts open	kV(rms)	Bidder to specify
5	Total interrupting time For interruption of 10% of the rated capacity. For interruption of 30% of the rated capacity. For interruption of 60% of the rated capacity. For interruption of full rated capacity.	(milli-second)	Bidder to specify
6	Arcing time	Milli-sec.	Bidder to specify
7	Making time		Bidder to specify
A	Rated Closing time	Milli sec.	
B	Rated opening time	Milli-sec.	
8	No. of breaks in series / pole		One Preferred
9	No. of spare auxiliary contacts		6 NO + 6 NC
10	Operating Mechanism		
A	Electro Pneumatic Motor Compressed Spring		Motor spring charged mechanism
B	Compressed air system required		Bidder to specify

Sr. No.	Description	Unit	Particulars
C	Receiver pressure of Purchaser's Compressed air system if applicable kg/cm <sup>2</sup>		Not Applicable
D	1 pole / 3 pole operation		3 pole operation
E	Control Voltage		110V DC
11	Spring charging motor rating		Bidder to specify
	Power requirement of closing and tripping coil		Bidder to specify
12	breaker offered (Outdoor/Indoor)		Bidder to specify
13	Maximum interrupting capacity under phase opposition condition		Bidder to specify
14	Insulation Class		Bidder to specify
15	Type of main contacts		Bidder to specify
16	Material of main contacts		Bidder to specify
17	Whether main contacts silver plates		Bidder to specify
18	Contact pressure on main and arcing contacts	Kg.sqmtr	Bidder to specify
19	Details of spring charging motor		Bidder to specify
	Type		
	Rated supply voltage		
	wattage		
	Maximum time for charging spring		
	Tripping and closing circuit voltage		
	Power required for trip coil(in watts)		
	Power required for closing coil(in watts)		
20	SF6 gas details		Bidder to specify
	Rated SF6 Gas pressure (20 degree Celsius)		
	IS/equivalent standard		
	Applicable for SF6 gas.		
	Quantity in each pole		
	Total quantity		
	Spare gas quantity	%	
21	Seismic level	g	Bidder to specify
22	GA drawing indicating overall dimensions weight, height and mounting details		Bidder to specify

#### 4.5 Power Transformer

Sr. No.	Description	Unit	Particulars
	General		
1	Application /Designation		Power Distribution
2	Quantity		As per BOQ
3	Make		As per approved vendor list
4	Applicable Standards		IS:2026,IEC:60076 or latest
5	Installation (Indoor/Outdoor)		Outdoor
6	Type (Auto/2-wdg/3-wdg/other)		2 winding
7	3 phase unit/single phase unit		3 phase unit
8	Full Load Rating		Minimum 15 MVA
9	Cooling		ONAN
	Ratings		
10	No load voltage H.V. Winding L.V. Winding	kV kV	66 6.9
11	Frequency	Hz	50
12	Rating for each type of cooling HV MV LV	MVA MVA MVA	Bidder to specify
13	Percentage Impedance HV - MV HV - LV MV - LV	% % %	As per CBIP Manual
14	Guaranteed (subject to tolerance) impedance voltage at rated current for the principal tapping. HV – LV HV – MV MV – LV	 % % %	Bidder to specify
15	Efficiency at 25 Deg. Cent., at unity power factor. At full load At 3/4 full load At 1/2 full load	 % % %	Bidder to specify
16	Guaranteed Load losses at rated current at 75°C winding	kW (Max.)	As per CBIP Norms

Sr. No.	Description	Unit	Particulars
	temperature (Without IS tolerance)		
17	Estimated maximum cooler losses at full load	kW	Bidder to specify
18	Guaranteed No load losses (core loss and dielectric loss) at 100% rated voltage and frequency (Without IS tolerance)	KW (Max.)	As per CBIP Norms
19	Guaranteed no-load current When excited from LV side at 100% rated voltage	A	Bidder to specify
a	When excited from LV side at 110% rated voltage	A	
20	a) Maximum flux density 1. At rated voltage 2. At 110% rated voltage Over fluxing capability b) Current density HV MV LV	Wb/m <sup>2</sup> Wb/m <sup>2</sup>  A/cm <sup>2</sup> A/cm <sup>2</sup> A/cm <sup>2</sup>	Bidder to specify   Bidder to specify
21	Regulation at full load, 0.8 P.F. at 75 Degree Centigrade winding temperature	%	Bidder to specify
22	External short circuit withstand Capacity	MVA	Bidder to specify
23	Core Whether over fluxing	Yes/No	No
24	Winding connections		
A	Winding connection (Vector group)	HV MV LV	Delta (Dyn11) - Star
B	Application / Direction of power Flow	HV MV LV	From HV to LV
25	System Data		
A	System Voltage HV : Nominal / Highest LV : Nominal / Highest	kV kV	66/72 6.6/7.2
B	Fault level HV System LV System	kA kA	25 kA 25 kA
C	System Neutral earthing	HV	Bidder to specify



Sr. No.	Description	Unit	Particulars
	Effectively Resonant	MV	
	Non effectively Isolated	LV	NGR
26	Transformer Neutral		Bidder to specify
A	Type of earthing Directed Isolated	HV LV	
B	Method of earthing stabilising Winding		
27	Winding Insulation Test Voltages		Bidder to specify
A	Impulse voltage withstand + ve & - ve (1.2/50 micro wave) HV LV	kV (peak) kV (peak)	325 60
B	Power frequency voltage withstand (separate source induced voltage) HV HV Neutral LV	kV kV kV	140 Bidder to furnish 20
28	Temperature Rise		Bidder to specify
A	Ambient temp.Max.  Max. ambient air Max. daily average air Max. yearly average air Cooling water (max.)	°C °C °C °C	50 40 50 Pl. Furnish
B	Temp. rise of top oil by Thermometer	°C	50/55
C	Max temp. rise of windings by Resistance Oil nature and air nature	°C	50
29	Tappings		
A	Tappings on windings		HV
B	Whether on load/off circuit		On-load
C	Tapping range	%	+10 % to -10 %
D	Tapping step	%	1.25%
E	Category voltage variation		

Sr. No.	Description	Unit	Particulars
	clauses 3.2, 3.3, 3.4, of IS:2026 part IV)		
F	Capacity full / reduced		Full capacity
30	On Load Tap Changer (OLTC)		
A	Manual/automatic control		Automatic control
b	Remote/local control If remote control, whether the remote control cubicle included in BIDDER'S scope of supply		Remote/local Control
C	Voltage class of OLTC	kV	66/72.5
D	Current rating of OLTC	A	Suitable rating
31	Transformer With Which Parallel Operation is Required		Not applicable
A	Manufactured by		
B	Output	MVA	
C	No load voltages at principal Tapping HV LV	KVA KVA	
D	Turns ratio for each tapping		Bidder to specify
E	Percentage impedance		Bidder to specify
F	Vector Group HV LV		Dyn11
G	Diagram for connections ref. dwg. No		Bidder to specify
32	Surge diverter Details of surge diverter		Bidder to specify
A	Make		
B	Type		
C	kV class		
D	kV rating		
33	Cooling arrangement If unit cooler arrangement offered for cooling advise		Bidder to specify
A	Total no. of unit coolers provided		
B	No. of unit coolers which would be in service for full load operation of transformer		
C	No. of 'spare' unit coolers		
D	No. of fans in each unit cooler		

Sr. No.	Description	Unit	Particulars
E	No. of pumps in each unit		
F	cooler Rating of each fan motor		
G	Rating of each oil pump motor		
34	Terminal Bushings		Bidder to Specify (As per IS )
35	Bushings Current Transformers		Bidder to Specify (As per IS )
36	GA drawing indicating overall dimensions weight, height and mounting details		Bidder to specify
37	NIFPS System		Provided

#### 4.6 Auxiliary Transformer

Sr. No.	Description	Unit	Particulars	
1	Make		As per approved vendor list	
2	Applicable Standards		As mentioned in tender	
3	Rated output	kVA	Minimum 250 KVA – Level-2	
4	Quantity required	Nos.	2 Nos. (For Each Pumping)	
5	Transformer location		Outdoor	
6	No load transformer Ratio	kV/kV	6.6 / 0.433	
7	Number of phases		Three	
8	Rated frequency	Hz	50	
9	Impedance at all taps	%	As per IS	
10	Number of winding / material of conductor		Two/Copper	
11	Method of connection			
(a)	HV winding		Delta	
(b)	LV winding		Star	
12	Vector group		Dyn 11	
13	LV Neutral		Solidly earthed	
14	Type of cooling		ONAN	
15	Tap changer		Full capacity off circuit type on HV side with pad locking facility	
16	Tap range	%	+5 % to – 10%	
17	Tap step	%	2.5%	
18	Terminal connection			
(a)	HV terminals		Cable box suitable to 6.6 kV XLPE, unearthed.	
(b)	LV terminals		Cable box suitable to 1100 V AYFY cable,	
19	Current Transformer		Bidder to specify	
(a)	On LV Neutral			
20	LV Neutral earthing		LV Neutral shall be brought out through a 1.1 kV rated bushing, both inside the cable box for forming the 3 Ph, 4-wire system and outside the cable box for direct connections to earth by means of 25 x 3mm, CU earthing conductor	
21	Insulation of Windings		H.V.	L.V.
(a)	One minute power Frequency withstand voltage (dry and wet)	kV (r.m.s)	20	3.0

(b)	1.2/50 micro second full wave impulse withstand voltage	kV (peak)	60	
22	Insulation of bushings		H.V.	L.V Line and Neutral)
(a)	Rated Voltage of bushing	kV	6.6	0.433
(b)	One minute power frequency withstand voltage	kV (r.m.s)	20	3.0
	1.2/50 microsecond full wave impulse withstand voltage	kV (peak)	60	Bidder to specify
(d)	Minimum creepage Distance	mm	276	25
23	Guaranteed impedance voltage at rated current for all taps	%	Bidder to specify	
24	Guaranteed efficiency at 75 °C at unity P.F at full load		Bidder to specify	
25	Guaranteed Load losses at rated current at 75°C winding temperature (Without IS tolerance)	KW (Max)	As per IS	
26	Guaranteed No load losses (core loss and dielectric loss) at 100% rated voltage and frequency (Without IS tolerance)	KW (Max)	As per IS	
27	Guaranteed no-load current: a. When excited from LV side at 100% rated voltage b. When excited from LV side at 110% rated voltage	A A	Bidder to specify	

#### 4.7 Neutral Grounding Resistor

Sr. No.	Description	Unit	Particulars
1	Make		As per approved vendor list
2	Applicable Standards		As per approved vendor list
3	Rated voltage	kV	6.6 / 1.73
4	Rated continuous current & Qty	Amps. & Nos.	Bidder to Furnish / 2 Nos.
5	Rated ohmic value	Ohms.	As per Design
6	Duration	Secs.	10
7	Neutral CT details		Bidder to furnish
8	Temperature rise	°C	Bidder to furnish

Sr. No.	Description	Unit	Particulars
	(not exceeding safe temperature of insulation) when carrying :- Maximum current for 60 seconds Continuous rated current		
9	Change in resistance with temperature	% increase	Bidder to furnish
10	Dimensions / Weight a) Size of the panel b) Weight	mm Kg.	Bidder to furnish

#### 4.8 6.6. KV Metal Enclosed Switchgear

Sr. No.	Description	Unit	Particulars
1	Quantity	No.	One
2	Make		As per approved vendor list
3	Applicable Standards		As mentioned in tender
4	Reference Drawings		Bidder to furnish
5	Overall dimensions of each SWBD (Length x Depth x Height)	mm	Bidder to furnish
6	Switchgear cubicles and Busbar ratings		
a)	Rated voltage, phases and frequency		6.6 KV, 3 Ph 50 Hz
b)	System Neutral Earthing Effectively earthed / Non effectively earthed		Earthed through resistor.
c)	Maximum system voltage	kV	7.2
d)	One minute power frequency withstand voltage	kV (rms)	20
e)	1.2/50 microsec impulse withstand voltage	kV (peak)	60
f)	Short circuit withstand		
i)	Short time (1 sec) at rated voltage	kA (rms)	25
ii)	Dynamic rating	KA (peak)	62
g)	Reference ambient temperature		50° C
h)	Maximum temperature of bus bars droppers connectors and contacts at continuous current rating under site reference ambient temperature		Joints, Silver faced - 60°C Other cases – 50 ° C

Sr. No.	Description	Unit	Particulars
i)	Continuous current rating of bus bar(min.)	Amp	1250
j)	Bus bar material		Alluminium
k)	Bus bar Insulation		Fully insulated by encapsulation in epoxy resin with mould caps protecting all joints or heat shrinkable PVC sleeves and tapes
l)	Cable entry		Bottom
m)	Cable type 6.6 kV XLPE unearthed Aluminium conductor		Bidder to specify
	(i) Incoming feeders		
	(ii) Outgoing feeders		
7	Switchgear constructional requirements		
a)	Thickness of sheet steel Frame, Frame enclosures, doors, covers and partitions	mm	Cold Rolled – 2.0
b)	Degree of protection		IP54
c)	Colour finish shade		Interior - Glossy white
d)			Exterior - Light grey semi-glossy epoxy based shade 631 of IS:5
e)	Earthing Bus		
f)	Material		Cu
ii)	Size(min.)	mmxmm	25x6
g)	Earthing conductor (main grid)		
i)	Material		Cu flat (Bimetallic connector required for connecting to main grid)
ii)	size	mmxmm	Bidder to furnish
h)	Clearances in Air of live parts		
	(i) Phase to Phase	mm	As per IS
	(ii) Phase to Earth	mm	As per IS
8	Breaker Particulars		
a)	Make		As per approved vendor list
b)	Applicable Standards		As furnished in tender
c)	Circuit breaker type		Vacuum
d)	Voltage, phases and frequency		6.6 kV, 50 Hz, 3 Ph
e)	Rated operating duty		O – 3 min – CO – 3 min –CO
f)	Rated current at reference	A	1250

Sr. No.	Description	Unit	Particulars
	ambient temperature Incoming breakers(min.)		
g)	Rated breaking capacity	kA (rms)	25
h)	Rated making current	kA(peak)	62
i)	Short time current withstand for 1 Sec duration	kA (rms)	25
j)	Total break time		Less than 3 cycles
k)	Operating mechanism type		Motor Charged spring manual trip & close facility to be provided
l)	Minimum no. of auxiliary contacts		Bidder to furnish
m)	Withstand test voltage		
i)	One minute power frequency	kV (rms)	20
ii)	1.2/50 $\mu$ sec impulse	kV (peak)	60
n)	Auxiliary control voltage		
i)	For closing / tripping coil		110 V DC
ii)	For spring charging motor		240 V AC
ii)	For space heaters and lighting		240 V AC
o)	Anti pumping feature		Bidder to furnish
p)	Latching requirement		Trip free
q)	Trip coil circuits of all breakers shall be provided with trip circuit supervision relays, to supervise the circuit in both open and closed conditions of circuit breakers		Yes
9	Vacuum Circuit Breaker For Motor Feeders		
a)	Make		As per approved vendor
b)	Applicable Standards		As furnish in tender
c)	Type		Mechanically latched Electrical horizontally Draw out type
d)	Type of operating mechanism		Solenoid
e)	Method of closing		Solenoid
f)	Voltage, phases and frequency		6.6 kV, 3 Ph, 50 Hz
g)	One sec current withstand capacity	kA (rms)	8
h)	Momentary withstand capacity	kA (peak)	40



Sr. No.	Description	Unit	Particulars
i)	Rated current(min.)	A	800
j)	Duty		AC3
k)	Minimum no. of auxiliary contacts		Bidder to specify
l)	Withstand test voltage		20
m)	(i) One minute power frequency	kV (rms)	Bidder to specify
	(ii) 1.2/50 $\mu$ sec impulse	kV (peak)	60
n)	Auxiliary control voltage		110V DC
	(i) For closing / tripping coil		
	(ii) For space heaters and lighting		240V AC
o)	Surge suppressor		Bidder to specify
10	Load Break Switches		
a)	Make		As per approved vendor list
b)	Applicable Standards		As given in technical Specification
c)	Application		Bidder to specify
d)	Type		Indoor, metal enclosed
e)	Voltage frequency & No of phase		6.6 kV, 50 Hz, 3 ph
f)	Rated current at reference Ambient Temp.(min.)	A	800
g)	Rated making current	kA (peak)	40
h)	Withstand currents		
	(i) 1 Sec. Current	kA (rms)	16
	(ii) Momentary	kA (Peak)	40
i)	Withstand Test Voltage		
	(i) One minute power freq.	kV (rms)	20
	(ii) 1.2/50 micro Impulse	kV (peak)	60
j)	Breaking capacity for capacitive currents Amps		Bidder to specify
k)	Type of switching		Manual with shunt trip coil for tripping
11	Core Balance CTs		
a)	Make		As per approved vendor list
b)	Applicable Standards		As furnish in tender
c)	Ratio		Bidder to specify
d)	Maximum magnetization current at proposed setting		Bidder to specify

Sr. No.	Description	Unit	Particulars
e)	CT secondary resistance		Bidder to specify
12	Current Transformers		
a)	Make		As per approved vendor list
b)	Applicable Standards		As per tender
c)	Type		Cast resin
d)	Class of insulation		Class E or better
e)	Rated current ratio and burden (i) Incomers and bus coupler		Bidder to specify
	(ii) Outgoing feeders – Motor feeders – Protection		Bidder to specify
	(iii) Motor feeders – Metering		Bidder to specify
	(iv) Auxiliary TR feeder (CBCT)- Protection		Bidder to specify
	(v) Auxiliary TR feeder Metering		Bidder to specify
f)	Accuracy class (i) Metering		Bidder to specify
	(ii) Protection		Bidder to specify
g)	Short time 1 sec current rating	kA (rms)	25
h)	Dynamic rating	kA (peak)	62
13	Voltage Transformers		
a)	Make		As per approved vendor list
b)	Applicable Standards		As per tender document
c)	Type		Cast resin
d)	Rated Voltage (i) Primary	V	6600/V <sub>3</sub>
	(ii) Secondary – S1 – S2	V	110/V <sub>3</sub> -110/V <sub>3</sub>
e)	Method of connection (i) Primary – P		Star, earthed
	(ii) Secondary – S1 – S2		Star, earthed
f)	Application – S1 – S2		Metering and protection
g)	Rated burden	VA	100 Dual
h)	Accuracy class		Metering 0.5
			Protection 3P
i)	Rated voltage factor (i) Continuous		1.1
	(ii) Short time		1.5
j)	Insulation class		Class E or better

Sr. No.	Description	Unit	Particulars
14	Meters		Class 0.5
a)	Accuracy Class		
	(i) Indicating Meters		Bidder to specify
	ii) Electronic Trivector Meter		Bidder to specify
15	Relays(Type make)		
a)	Inverse time over current relay		Bidder to specify
b)	Instantaneous over current relay		
c)	Motor protection relay		
d)	Instantaneous Earth Fault Relay		
e)	Inverse Time Earth Fault Relay		
f)	Under voltage relay		
g)	Lockout relay		
h)	Fuse failure relay		
i)	Auxiliary relays		
16	Indicating Meters (Ammeter, Voltmeter)		Bidder to specify (As per approved vendor list)
17	Kilowatt Meter / Kilowatt Hours Meter / Power Factor Meter		Bidder to specify (As per approved vendor list)
18	Annunciations		Bidder to specify (Pls refer Tech. Specification)

#### 4.9 6.6 KV Soft Starter Panel With Capacitor

Sr. No.	Description	Unit	Particulars
1	Make		As per approved vendor list
2	Applicable Standards		As per tender document
3	Quantity	Nos	1 No. for each motor
4	Reference drawing		Bidder to furnish
5	Overall dimensions of 6.6 KV Soft Start Panel (Length x Depth x Height)	mm	Bidder to furnish
6	Soft Start Panel and Busbar Rating		Bidder to furnish
7	Type		FCMA/HFSR
(a)	Rated voltage phases and frequency		6.6 kV, 3 ph, 50 Hz
(b)	Indicative Motor rating	KW	As Per Design
(c)	System neutral earthing		Bidder to furnish
(d)	Maximum system voltage	KV	7.2
(e)	One minute power frequency	KV (rms)	20

Sr. No.	Description	Unit	Particulars
	withstand voltage		
(f)	1.2/50 micro sec. Impulse withstand voltage	KV (peak)	40
(g)	Short circuit withstand		
(i)	Short time (1 sec) at rated voltage	KA (rms)	25
(h)	Reference ambient temperature	° C	50
(i)	Maximum temperature of busbars droppers connectors & contacts at continuous current rating under site reference ambient temperature	° C	Joints silver faced 60° C  Other cases 60° C
8	Soft Start Panel Particulars		
(a)	Busbar rating and type	A	Bidder to furnish
(b)	Bus bar insulation		Fully insulated by encapsulation in epoxy resin with moulded caps protecting all joints or heat shrinkable pvc sleeves and tapes
(c)	Minimum Clearance		As per IS
9	Soft Start Panel Constructional Requirements		
(a)	Thickness of sheet steel		Bidder to furnish
(b)	(i) Frame, Frame enclosures, doors, covers and partition	Mm	Cold rolled 2.0
(c)	Degree of protection		IP54
(d)	Colour finish shade		Interior : Glossy white
(e)	Colour finish shade		Exterior : Light grey semi glossy shade 631 of IS-5
(f)	Earthing bus		
	Material		Copper
	Size-Min.	mmxmm	25x6
(g)	Earthing conductor		
	Material		Copper
	Size-Min.	mmxmm	50x10
(h)	Type of cooling for winding	-	Air Cooled
10	Auxiliary Supply		
(a)	Control		110 V DC
(b)	Space heater & lighting		240 V, 1 ph, 50 Hz
11	Current Transformer		
(a)	Make		As per approved vendor list
(b)	Applicable Standards		As per tender document
(c)	Type		Cast resin, bar
(d)	System voltage & freq.		6.6 kV, 50 Hz

Sr. No.	Description	Unit	Particulars
(e)	Class of insulation		Class H
(f)	Rated current ratio and burden		Bidder to furnish
(g)	Accuracy class Metering		0.5
(h)	Short time 1 sec. Current rating	KA (rms)	21.92
12	Following requirements shall be provided in panel Starting interlock with incomer 6.6 kV vacuum contactor		Bidder to furnish
(j)	Trip circuit		
(ii)	Running mode signal		
	<b>Capacitor Bank</b>		
1	Make		As per approved vendor list
2	Applicable Standards		As per tender document
3	Quantity	Nos.	1 for each motor
4	Reference drawing		Bidder to furnish
5	Overall dimensions of 6.6 KV Capacitor Bank With Panel (Length x Depth x Height)	mm	Bidder to specify
6	6.6 kV Capacitor Bank Panel		
(a)	Rated voltage, phases and frequency		6.6 kV, 3ph, 50 Hz
(b)	System neutral earthing		Earthed through Resistor
(c)	Maximum system voltage	KV	7.2
(d)	One minute power Frequency withstand voltage	kV (rms)	20
(e)	1.2/50 micro sec. Impulse withstand voltage	kV (peak)	60
(f)	Short circuit withstand Short time (1 sec) at rated voltage	kA (rms)	25
(g)	Dynamic rating	kA (peak)	62
(h)	Reference ambient temperature	°C	50
(i)	Maximum temperature of busbars droppers connectors and contacts at continuous current rating under site reference ambient temperature		Joints silver faced 60°C Other cases 50°C
7	Capacitor Banks		
(a)	Make		As per approved vendor list
(b)	Applicable Standards		As per tender document
(c)	Application		Power factor improvement of 6.6 kV motor
(d)	Quantity	Nos.	1 No. for each motor

Sr. No.	Description	Unit	Particulars
(e)	Rated capacity	kVAR	As Per Design
(f)	Rated voltage	KV	6.6
(h)	No. of phases		Three
(k)	Size of cable	mm <sup>2</sup>	Bidder to furnish
(l)	Capacitor bank		To be installed in metal enclosed cubicle
(m)	Type of capacitor bank connection		Star
(n)	If star connected, mode of neutral connection		Earthed
(o)	Hot spot temperature at rated current	°C	Bidder to furnish
(p)	Maximum operating temperature	°C	Bidder to furnish
(q)	Capacitance	Micro- farads	Bidder to furnish
(r)	Rated line current	A	Bidder to furnish
(s)	Maximum permissible overload current	A	Bidder to furnish
(t)	Capacitor Losses		
	(i) For complete bank	Watts	Bidder to furnish
	(ii) For individual units	Watts	Bidder to furnish
8	Capacitor Bank Panel Particulars		
(a)	Bus bar rating & Material	A	Aluminium
(b)	Busbar insulation		Fully insulated by encapsulation in epoxy resin, with moulded caps protecting all joints or heat shrinkable PVC sleeves and tapes.
(d)	Minimum Clearance		As per IS
9	Capacitor Bank Panel constructional requirement		
(a)	Thickness of sheet steel (i) Frame, Frame enclosure, doors, covers and partition	mm	Bidder to furnish
(b)	Degree of protection		IP54
(c)	Colour finish shade		Interior: Glossy White
			Exterior: Light grey semi - glossy shade 631 of IS-5
(d)	Earthing bus		
(i)	Material		Copper
(ii)	Size(min.)	mm x mm	25 x 6
(e)	Earthing Conductor		
(i)	Material		Copper

Sr. No.	Description	Unit	Particulars
(ii)	Size(min.)	mm x mm	50 x 10
10	Load Break Switches		
(a)	Make		As per approved vendor list
(b)	Applicable Standards		As per tender document
(C)	Application		Capacitor Bank Switching
(d)	Type		Indoor, metal enclosed
(e)	Voltage frequency & No of phase		6.6 kV, 50 Hz, 3ph
(f)	Rated current at reference Ambient Temp.	A	Bidder to furnish
(g)	Rated making current	kA (peak)	40
(h)	Withstand currents	kA (rms)	16
(i)	1 Sec. Current		
(ii)	Momentary	kA (Peak)	40
(i)	Withstand Test Voltage		
(i)	One minute power freq.	kV (rms)	20
(ii)	1.2/50 micro Impulse	kV (peak)	60
(j)	Breaking capacity for capacitive currents Amps		Bidder to specify
(k)	Type of switching		Manual closing and provided with P.B. for tripping
11	Core Balance Current Transformer (CBCT) Type		
(a)	Make		As per approved vendor list
(b)	Applicable Standards		As per tender document
(c)	Type		Cast resin
(d)	System voltage and freq.		6.6 kV, 50 Hz
(e)	Class of insulation		Class E or better
(f)	Rated current ratio and burden		Bidder to specify
(g)	Accuracy Class protection		5P10
(h)	Short time		Bidder to specify
(i)	1 second current rating	kA(rms)	
(ii)	Dynamic rating	KA (Peak)	Bidder to specify
12	H.V. Fuses		
(a)	Make		As per approved vendor list
(b)	Rated current	A	Bidder to specify
(c)	Voltage class	kV	6.6
(d)	Symmetrical interrupting rating	kA (rms)	25
13	Discharge Device Resistor		Bidder to specify
(i)	Rated voltage	V	

Sr. No.	Description	Unit	Particulars
	(ii) Rated resistance	Ohm	
	(iii) Rated continuous wattage Type and material	W	

#### 4.10 415V Metal Enclosed Switchgear

Sr. No.	Description	Unit	Particulars
1	Make		As per approved vendor list
2	Applicable Standards		As per tender document
3	Overall dimensions of 415V Metal Enclosed Switchgear panel (Length x Depth x Height)	Mm	Bidder to furnish
4	Quantity	Nos	As per BOQ
5	415 V Switchgear and Busbar Ratings		
(a)	Rated voltage phase and frequency		415 V, 3 Ph 50 Hz
(b)	Type of Construction		Bidder to furnish
(c)	Maximum system voltage	V	456.5 + 10%
(d)	One minute power frequency voltage		
	i) Power circuits	V	2500
	ii) Control circuits	V	1500
	iii) Aux. Circuits connected to Sec of CTS	V	1500
(e)	Continuous current rating of Busbars under site reference Ambient Temperature and type(Min.)	A	Bidder to Specify (As per Deign)
(f)	Busbar insulation		Fully insulated Encapsulation in epoxy resin with moulded caps protecting all joints or heat shrinkable PVC sleeves and tapes.
(g)	Reference Ambient Temperature	° C	50° C
(h)	Maximum Temperature of Busbars, Droppers and Contacts at Continuous current rating under site ambient temperature	° C	50° C for non silver plated joints 60 ° C silver plated joints
(i)	Short Circuit current withstand for Busbars and droppers		
	(i) Short time 1 sec	kA (rms)	50
6	Switchgear constructional Requirements		
(a)	Type of Construction		Bidder to furnish



(b)	Thickness of sheet steel (i) Frame, Frame enclosures, doors, covers and partitions	Mm	Cold Rolled – 2.0
(c)	Degree of protection		IP54
(d)	Colour finish shade		Interior : Glossy white Exterior : Light grey semi glossy Shade 631 of IS-5
(e)	Earthing bus		
	Material		Copper
	Size(Min.)	Mmxmm	25x6
(f)	Earthing conductor (Main grid)		
	Material		GI
	Size(Min.)	Mmxmm	50 x 10
(g)	Minimum clearances in air of live parts	mm	As per IS Standard
7	Instrumentation Transformers		
(a)	Current transformer		
	(i) Make		As per approved vendor list
	(ii) Ratio		Bidder to furnish
	(iii) Burden	VA	10
	(iv) Accuracy class	VA	0.5
(b)	Voltage Transformer		
	(i) Make		As per approved vendor list
	(ii) Ratio		As per Requirements
	(iii) Burden	VA	Bidder to furnish
	(iv) Accuracy class	VA	Bidder to furnish
8	Capacitor Bank Panel Particulars		
(a)	Make		As per approved vendor list
(b)	Applicable Standards		As per tender document
(c)	Quantity		
(d)	Rated capacity	KVAR	Bidder to furnish
(e)	Capacitor Losses (i) For complete bank (ii) For individual units	Watts Watts	Bidder to furnish
(f)	Rate Voltage	V	415
(g)	Rated frequency and phases		50 Hz,3 Phase
(h)	Ambient Temperature	° C	50
9	Unit capacitors		

(a)	Rated Voltage	V	Bidder to furnish
(b)	Rated Output	KVAR	Bidder to furnish
10	Constructional Requirement		
(a)	Overall dimensions of Capacitor control panel(LXDXH)	Mm	Bidder to furnish
(b)	Thickness of sheet steel i) Frame, Frame enclosures, doors covers and partition	Mm	Cold rolled 2.0
(c)	Degree of protection		IP 54
(d)	Colour finish shade		Interior : Glossy white Exterior : Light Grey Semi Glossy, Shade 631 of IS:5
11	Design Requirements		
(a)	Insulation level	kV (rms)	2.5
(b)	Capacitor bank connection		Delta
(c)	Short circuit withstand for busbars (i) Short time (1 sec) (ii) Dynamic	kA (rms) kA(Peak)	20 50
(d)	Type of switching		Automatic switching responsive to power factor through power factor sensing relay
(e)	Switching steps		Bidder to furnish
(f)	Rating of contactor		To suit KVAR Unit

#### 4.11 LT APFC PANEL

Sr. No.	Description	Unit	Particulars
10.1	Make		As per approved vendor list
10.2	Reference Drawing No		Specify during detail engineering
10.3	Applicable Standards		As per IS 13925 or latest
10.4	Overall dimensions of Capacitor control panel(LXDXH)		Specify during detail engineering
10.5	Quantity		As per BOQ
10.6	Rated System Voltage		415V +/- 10%
10.7	Highest system voltage		456 V
10.8	Frequency		50Hz +/- 5%
10.9	Number of Phases		3
10.10	Neutral Earthing		Solidly grounded
10.11	One min power frequency with stand voltage		20 KV

10.12	1.2/ 50 micro sec impulse with stand voltage		60 KV peak
10.13	Short circuit with stand time at rated voltage		50 KA, 1sec
10.14	Dynamic rating		50 KA
10.15	Reference ambient. temp		50 ° C.
10.16	Busbar current rating		Specify during detail engineering
10.17	Bus bar size		Specify during detail engineering
10.18	Busbar Insulation		Fully insulated by encapsulation in epoxy resin with moulded caps on all joints or heatshrinkable PVC sleeve and taps.
10.19	Maximum temp of bus bar, droppers and contacts at continuous current rating under sitereference ambient temp		As per IS
10.20	Earthing Bus		Copper
10.21	Earth bus size		Specify during detail engineering
10.22	Panel		CRCA 14 gauge
10.23	Size of Cable		Specify during detail engineering
10.24	Cable entry		Bottom
10.25	Degree of protection		IP42
10.26	Colour & shed		631 of IS-5
	<b>LT Capacitor</b>		
1	Application		Power factor improvement
2	Quantity		On each sectional Bus bar, Specify during detail engineering
3	Manufacturer		As per approved vendor list
4	Rated capacity KVAR		42.5 KVAR on each sectional Bus bar,
5	Rated current of Capacitor bank		Specify during detail engineering.
6	Rated System Voltage		415V +/- 10%
7	Frequency		50Hz +/- 5%
8	Number of Phases		3
9	Reference Standard		IS 13925-1998 Part-1
10	Capacitor Type		APP
11	Insulation level		2.5 KV
12	Capacitor bank connection		Delta

13	Ambient Temperature		50 ° C
14	One min power frequency with stand voltage		20 KV
15	1.2/ 50 micro sec impulse with stand voltage		60 KV peak
16	Short circuit with stand time at rated voltage		50 KA, 1sec
17	Dynamic rating		50 KA
18	Maximum over voltage the unit capacitor is capable of withstanding continuously		Specify during detail engineering
19	Capacitor Losses For complete bank (Watts)		Specify during detail engineering
20	Capacitor Losses For individual units (Watts)		Specify during detail engineering
21	Insulation strength to earth		Specify during detail engineering
22	No. of capacitor elements per capacitor		Specify during detail engineering
23	Discharge Device		Specify during detail engineering
24	Type of switching		Automatic switching in response to PF through PF sensing relay
25	Switching steps		Specify during detail engineering
26	Discharge time		< 50 Volts within 5 min
27	Permissible over load		
A	110% of rated Voltage		To confirm
B	150% of rated current		To confirm
C	150 % of rated KVAR		To confirm
28	Capacitor Fuses Rating of the Element		Specify during detail engineering
A	Rated voltage		Specify during detail engineering
B	Rated Current		Specify during detail engineering

#### 4.12 Maintenance free Lead Acid battery

Sr. No.	Description	Unit	Particulars
1	Make		As per approved vendor list
2	Applicable Standards		As per tender document
3	Overall dimensions (i) Each cell (L x W x H)	mm	Bidder to furnish

Sr. No.	Description	Unit	Particulars
	(ii) Complete battery with rack L x W x H		
4	Application		Control, annunciation and emergency lights
5	Type of battery		Maintenance free sealed lead acid
6	Number of battery banks required		Bidder to Furnish
7	Ambient conditions		Min.Temp.25° C Max.Temp.50° C
8	D.C. system voltage	V	110
9	Ampere hour capacity of battery at 27 Deg. C at 10 hour rate to give final cell voltage of 1.75 volts/cell	Ah	Bidder to furnish
10	No. of cells required to give rated D.C. voltage		Bidder to furnish
11	No. of spare cells		Bidder to furnish
12	Type of cell		Bidder to furnish
13	Momentary load/duration	A	Amps for one minute
14	Emergency load/duration	A	Amps for two hours
15	Continuous load/duration	A	Amps for ten hours
16	Cell voltage – initial/final	V	2.15/1.75 V
17	Mounting arrangement		Multi tier inside panel/battery room
18	Charging method proposed		Float cum boost charging

#### 4.13 Battery Charger and D.C. Distribution board

Sr. No.	Description	Unit	Particulars
1	General		
(a)	Make		As per approved vendor list
(b)	Applicable Standards		As per tender document
(c)	Dimensions of battery charger Length x Depth x Height	mm x mmx mm	Bidder to furnish
(d)	Number required		
	(i) Battery charger	Nos	One
	(ii) D.C. Distribution board	Nos	One
(e)	DC System Voltage (Nominal)	V	110
(f)	DC System Earthing		Unearthed
(g)	Ambient Design Temperature	°C	50
(h)	Busbars		Copper
(i)	Rating	Amp	Bidder to furnish

Sr. No.	Description	Unit	Particulars
2	Battery Details		
(a)	Float/Trickle charging current of battery	mA	Bidder to furnish
(b)	Boost Charging Current of Battery (Maximum)	A	Bidder to furnish
(c)	Boost Charging Voltage of Battery (maximum)	V	Bidder to furnish
(d)	Maximum Time for Boost charging of Battery	hr	Bidder to furnish
(e)	Battery capacity & no. of cells	Ah	Bidder to furnish
3	AC System Data		
(a)	Supply		
	Voltage	V	415 $\pm$ 10%
	Phase		3
	Frequency	Hz	50 $\pm$ 3%
4	Performance		
(a)	Maximum permissible variation in DC voltage (no load to full load)		$\pm$ 1%
(b)	D.C. voltage setting adjustment for boost charging		70% to 100% of max. boost charging voltage
(c)	D.C. current adjustment for boost Charging		30% to 100% of max. boost charging current
(d)	Current stabilization for constant current regulator for boost charger		$\pm$ 2%
(e)	Minimum permissible power Factor to rated continuous load		0.8
(f)	Permissible ripple content at rated continuous load		3% (maximum)
5	General		Bidder to furnish
	Constructional Features for Battery Charger & D.C. Distribution Board		
(a)	Overall dimensions of D.C.D.B(LXDXH)	mmxmmxmm	Bidder to furnish
(b)	Thickness of sheet steel i) Frame, Frame enclosures, doors covers and partition	mm	Cold rolled 2.0
(c)	Degree of protection		IP 54
(d)	Colour finish shade		Interior : Glossy white Exterior : Light Grey Semi Glossy,

Sr. No.	Description	Unit	Particulars
			Shade 631 of IS:5
(e)	Earthing bus		
	Material		Copper
	Size-Min.	mm xmm	25x6

#### 4.14 Power and Control cables (For Each Pumping Station)

Sr. No.	Description	Unit	Particulars
1	6.6 kV Unearthed Aluminium Conductor XLPE, armoured power cable		As per IS 7098
	a) Make		As per approved vendor list
	b) Applicable Standards		As per tender document
2	650/1100 V grade XLPE insulated Aluminium conductor armoured power cable (AYWY or AYFY)		As per IS 7098
	c) Make		As per approved vendor list
	d) Applicable Standards		As per tender document
3	650/1100 V grade PVC insulated copper conductor armoured control cable (CYWY or CYFY)		As per IS 1554
	e) Make		As per approved vendor list
	f) Applicable Standards		As per tender document

#### 4.15 Earthing and lightning Protection System (For Each Pumping Station)

Sr. No.	Description	Unit	Particulars
1	Main Earthing Grid		As per IS 3043
A	Buried in Earth	Lot	GI, 50x10 mm (min.)
B	Buried in floor slab in buildings	Lot	GI, Size 50x10 mm (min.)
2	Conductor Leads To Equipment (above ground)		Bidder to furnish
a.	Switchyard Equipments and structures		
(i)	Circuit Breaker,	Lot	GI, 50x6 mm (min.)
(ii)	Isolator,	Lot	GI, 50x6 mm (min.)
(iii)	Transformer Transformer neutral to bottom of tank, From bottom of tank to earth grid,	Lot	GI, 50x6 mm (min.)
(iv)	Lightning arrester,	Lot	GI, 50x6 mm (min.)

Sr. No.	Description	Unit	Particulars
(v)	C.T. and P.T. body,	Lot	GI,50x6 mm (min.)
(vi)	C.T. and P. T. secondary terminal box,	Lot	GI,50x6 mm (min.)
(vii)	Transformer tanks and radiator bank,	Lot	GI,50x6 mm (min.)
(viii)	Marshalling boxes,	Lot	GI,50x6 mm (min.)
(ix)	Towers and structures,	Lot	GI,50x6 mm (min.)
(x)	Fence posts and gates (Flex. braid)	Lot	GI,50x6 mm (min.)
3	6.6 kV Switchgear, 415V switchgear, 6.6 KV capacitor panel, Soft Starter panel,	Lot	GI. 50x10 mm (min.)
4	Motors		
(a)	6.6 kV Motors and cable boxes ,	Lot	GI, 50x10 mm (min.)
(b)	415V Motors up to 10 kW	Lot	GI wire, 8SWG (min.)
5	Other Items		
(a)	Capacitor panel, Battery charger panel, Main lighting D.B, Control panels and sub-lighting distribution boards	Lot	GI, 50x6mm (min.)
(b)	Hand Rails	Lot	GI, 25x3(min.)
(c)	Cable trays	Lot	GI, 25x3(min.)
(d)	Tanks,	Lot	GI, 25x3(min.)
(e)	Junction boxes,	Lot	GI wire, 8SWG(min.)
(f)	Lighting fixtures, single phase receptacles, lighting conduits,	Lot	GI wire, 12SWG(min.)
(g)	Push button stations, limit switches,	Lot	GI wire, 12SWG(min.)
6	Crane rail,	Lot	GI, 25x3 mm(min.)
7	Street lighting, flood lighting poles and junctions boxes,	Lot	GI, 25x3mm(min.)
8	Metallic non current carrying structures,	Lot	GS, 25x3 mm(min.)
9	Lightning Conductors		
(a)	Lightning protection down comers for building,	Lot	GI, 50x6 mm(min.)
(b)	Lightning protection horizontal roof conductor for building	Lot	GI, 50x6 mm(min.)
10	Electrodes		
(a)	Pipe electrode	Lot	Bidder to specify





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***Enclosure – Technical Specification for  
Instrumentation Works***

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## LIST OF CONTENT

### Chapters and Annexure

1. GENERAL.....	6
1.1 General .....	6
1.2 TECHNICAL REQUIREMENT FOR INSTRUMENTATION AND AUTOMATION SYSTEM INTEGRATOR (SI).....	8
1.3 DRAWINGS, DOCUMENTS AND SCHEDULES: .....	8
1.4 LIST OF APPLICABLE INDIAN STANDARD AND CODE OF PRACTICE .....	10
1.5 Operation Control Philosophy of pump, motor and its auxiliaries: .....	11
1.6 PIPE AND INSTRUMENT DIAGRAM (P&ID): .....	14
2. FLOW MEASURING SYSTEM.....	16
3. FULL BORE ELECTROMAGNETIC TYPE FLOW METER .....	19
3.1 Digital flow indicator and integrator for Electromagnetic .....	21
3.2 Routine Test.....	21
4. LEVEL MEASURING SYSTEM.....	22
4.1 ULTRASONIC TYPE LEVEL MEASURING SYSTEM .....	22
4.2 CONDUCTIVITY TYPE LEVEL SWITCH .....	22
4.3 Float and Board type Level Measuring System .....	23
5. PRESSURE MEASURING SYSTEM .....	24
5.1 Pressure Gauges .....	24
5.2 PRESSURE TRANSMITTER .....	24
5.3 Pressure switch.....	25
6. TEMPERATURE MONITORING FOR PUMP MOTOR: .....	26
7. PUMP MOTOR RUNNING HOUR METER:.....	27
8. Lightning Protection Unit (LPU) .....	28
9. UNINTERRUPTIBLE POWER SUPPLY .....	29
10. CABINETS FOR FIELD INSTRUMENTS .....	31
11. MICROPROCESSOR BASED ALARM ANNUNCIATORS .....	33
11.1 ALARM SCHEDULE .....	34
12. INSTRUMENT POWER SUPPLY CABLES AND INSTRUMENTATION SIGNAL CABLES .....	35
13. LAYING OF CABLES .....	37
14. SCADA System.....	38
14.1 Cabinet General Design .....	38
14.2 Scada Display .....	38
14.2.2 Invalid Entries from SCADA System .....	39
14.2.3 Windows Structure of Displays .....	40

---

14.2.4	Alarm and Event Management.....	40
14.2.5	Priority station of Alarms .....	41
14.2.6	Alarm Banner .....	41
14.2.7	Alarm Display.....	42
14.2.8	Alarm Pages.....	42
14.2.9	Colours for Alarm Display .....	42
14.2.10	Alarm Inhibit .....	42
14.2.11	Event Schedules .....	42
14.2.12	Event Display Format.....	43
14.2.13	Trends.....	43
14.2.14	Trend Facilities.....	44
14.2.15	Reports .....	44
14.2.16	Access Security.....	45
14.2.17	Archiving .....	45
14.2.18	Scada Hardware and System components.....	45
14.2.19	Scada (Historian, Trending and Report generation) Server Cum Engineering And Operating work station .....	46
14.2.20	Managed Ethernet Switches: .....	47
14.2.21	System Software .....	47
15.	POGRAMMABLE LOGIC CONTROLLERS .....	49
15.1	GENERAL:.....	49
15.2	CODES AND STANDARDS .....	49
15.3	DESIGN AND CONSTRUCTION REQUIREMENTS .....	49
15.4	CENTRAL PROCESSING UNITS.....	51
15.5	MEMORY UNIT.....	53
15.6	INPUT / OUTPUT MODULES .....	53
15.7	SOFTWARE.....	53
15.8	ENGINEERING STATION .....	54
15.9	DATA TRANSFER .....	54
15.10	PLC Hardware and Software.....	54
15.11	PLC SYSTEM CABINET / CONTROL DESK .....	56
15.11.1	GENERAL TECHNICAL REQUIREMENTS .....	56
15.11.2	MOUNTING .....	57
15.11.3	EARTHING FOR INSTRUMENTS .....	57
15.11.4	FRAME EARTHING.....	57
15.11.5	SPACE HEATER .....	57
15.11.6	INTERIOR LIGHTING AND RECEPTACLES .....	58
15.11.7	VOLTAGE LEVEL AND POWER SUPPLY UNITS .....	58

---

15.11.8	LABELS .....	58
15.11.9	SWITCHES AND MINIATURE CIRCUIT BREAKERS (MCBS) .....	58
15.11.10	PANEL INTERNAL WIRING .....	59
15.11.11	TERMINAL BLOCKS .....	59
15.11.12	CABLE SUPPORTS .....	60
15.11.13	TERMINAL / IDENTIFICATION .....	60
15.11.14	PAINTING OF SYSTEM CABINET/ CONTROL DESK .....	60
<b>16.</b>	<b>CCTV SYSTEM .....</b>	<b>61</b>
16.1	GENERAL .....	61
16.2	GENERAL REQUIREMENT .....	61
16.3	MATERIAL SPECIFICATIONS .....	62
16.4	Video Management System Software .....	65
16.4.1	General Requirements .....	65
16.4.2	Operator Console Features .....	68
16.5	TRAINING AND HANDING OVER OF DOCUMENTS .....	69
<b>17.</b>	<b>DATASHEET FOR INSTRUMENTATION .....</b>	<b>70</b>
17.1	Electromagnetic Flowmeter (Each Pumping Station) .....	70
17.2	Ultrasonic Type Level Measuring System (Each Pumping Station) .....	72
17.3	Float And Board Type Level Indicator (Each Pumping Station) .....	72
17.4	Conductivity Type Level Switch (Each Pumping Station) .....	73
17.5	Pressure Gauges with Electrical Contact (Each Pumping Station) .....	74
17.6	Pressure Transmitter (Each Pumping Station) .....	75
17.7	Instrumentation cable (Each Pumping Station) .....	75
17.8	Power Supply cables To Instruments (Each Pumping Station) .....	77
17.9	Cables For Analog Signals (Each Pumping Station) .....	77
17.10	Instrumentation Panel along with PLC, annunciator & associated hardware (Each Pumping Station) .....	78
17.11	SCADA Server cum Operator workstation (Each Pumping Station) .....	78
17.12	Managed Ethernet Switches (Each Pumping Station) .....	80
17.13	Uninterrupted Power Supply (UPS) .....	81
17.14	Fixed day/night Camera (Each Pumping Station) .....	81
17.15	Digital Video Manager .....	82

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## LIST OF ABBREVIATION

Acronym	Description
GWSSB	Gujarat Water Supply and Sewerage Board
HDPE	High Density Polythene Pipe
HP	Horse Power
KW	Kilo Watt
MS	Mild Steel
RCC	Reinforced Cement Concrete
ROU	Right Of Use
SoR	Schedule of Rates

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## 1. GENERAL

### 1.1 General

- a. A complete instrumentation, control and automation system shall be provided to ensure the fully automatic control of the Pumping Station.
- b. Pumping Station instrumentation providing information relating to Pump operation and performance.
- c. SCADA based control system providing local area automatic control and monitoring including generating alarms requiring operator response.
- d. The SCADA controller communication is based on an open system concept. Vnet/IP network has open standards architecture using Ethernet interface 1 GBPS.
- e. All network hardware requirements (cable, switches, hubs etc.) are based on common off the shelf standard equipment.
- f. SCADA system, providing central monitoring of the Pumping System, gathering of information to enable the handling of alarms, historical information and the processing of performance related information for the Pumps. The SCADA system shall also provide operator intervention facilities for the changing of settings and remote intervention in operating sequences. The Human Interface Station shall run under the current version of Microsoft Windows Operating System prevailing at the time of installation and commissioning. The MS Windows operating system offers a familiar look and feel to the operator.
- g. Access to control and information data is proposed to be available in both the SCADA operation Room and at the local equipment areas (Remote Electrical switch rooms). Data is presented to the operator using graphical displays developed to reflect the plant design and geographical layout. Control functions and motor stop/start functions are access via the graphical displays, events such as alarms, starting and stopping of equipment is logged and presented to the operator in a chronological event list. Each event is logged with date; time, event description and event type e.g. event notification, event alarm accepted, event cleared.
- h. Instrument & control system shall be designed, manufactured, installed and tested by the approved system integrator with proven Track Record to ensure the high standards of operational reliability. Instruments mounted in field and on panels shall be suitable for continuous operation. All electronic components shall be adequately rated, and circuits shall be designed so that change of component characteristics shall not affect plant operation.

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- i. All Instrument & control equipment shall be new, of proven design, reputed make, as per approved Vendor List and shall be suitable for continuous operation. Unless otherwise specified, all instruments shall be tropica-lised. The outdoor equipments shall be designed to withstand tropical rain. Wherever necessary space heaters, dust and water - proof cabinets shall be provided. Instruments offered shall be complete with all the necessary mounting accessories.
  - j. Electronic instruments shall utilize solid state electronic components, integrated circuits, microprocessors, etc., and shall be of proven design.
  - k. Unless otherwise stated, overall accuracy of all measurement systems shall be  $\pm 1\%$  of measured value, and repeat-ability shall be  $\pm 0.5\%$ .
  - l. Unless otherwise specified, the normal working range of all indicating instruments shall be between 20% and 80% of the full scale range.
  - m. After a power failure, when power supply resumes, the instruments and associated equipment shall start working automatically.
  - n. The instruments shall be designed to permit maximum interchange ability of parts and ease of access during inspection and maintenance.
  - o. The field instruments i.e. the instruments mounted outside the control panel shall be mounted at a convenient height of approximately 1.2 m above grade platform.
  - p. Unless otherwise stated, field mounted electrical and electronic instruments shall be weather proof to IP-65.
  - q. The instruments shall be designed to work at the ambient conditions of temperature, humidity, and chlorine contamination that may prevail. The instruments shall be given enough protection against corrosion.
  - r. Lockable enclosure shall be provided for the field-mounted instruments wherever required.
  - s. All field instruments and cabinets / panel-mounted instruments shall have tag plates/name plates permanently attached to them.
  - t. The performance of all instruments shall be unaffected for the  $\pm 10\%$  variation in supply voltage and  $\pm 5\%$  variation in frequency simultaneously.
  - u. All wetted parts of sensors shall be made out of non corrosive material capable of working with chlorine content of 5 ppm.
  - v. For all instruments (transmitting analogue signals) installed in the field (outside pump house), lightning protection units (LPU) shall be provided at both ends of the connecting cable for the protection against static discharges / lightning and electromagnetic interference.



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- w. Unless otherwise specified, double compression glands shall be used for glanding the cable in field instruments and instrument control panel.
  - x. Two wire transmitters shall be provided with on-line test terminals.
  - y. This document does not fully describe all the components of control and instrumentation works for project components in scope but yet Contractor is responsible to build fully complete and functional system in end to end manner matching to the requirements of Fully Automatic operation.
  - z. Modem which used for wireless connectivity among all packages shall be GPRS/3G/4G based with 100% redundant or hot back up as per system required and network provider as per required by client.
  - aa. PLC-SCADA of all PS of Link shall display data of Flow, level, KWh, pump status and alarms on SCADA at Pumping station. P.H PLC-SCADA data shall be collected at P.H as per process requirement.
  - bb. Web based monitoring of data of all Packages pertaining to their respective Link shall be provided at client office.

#### **1.2 TECHNICAL REQUIREMENT FOR INSTRUMENTATION AND AUTOMATION SYSTEM INTEGRATOR (SI)**

- a. Instrumentation and Automation system integrator called system integrator (SI) shall be in possession of minimum ISO 9001, 'Quality Management System' certification, conferred by an accredited agency.
- b. The SI must be an authorized system integrator for the PLC hardware and SCADA and Operational Database Management Software (ODMS) manufacturer.
- c. Valid authorization certificates shall be submitted for verification.
- d. The SI shall have similar kind of work experience of Instrumentation Control and Automation projects execution within India or outside India. It shall demonstrate capability and resources for integrating/interfacing control systems for different Original Equipment manufacturers products/system as well as coordination with multiple agencies for contract execution.
- e. All hardware and software proposed shall have been successfully in operation in a water application for a period of at least five (5) years and be from established and reputed OEM.
- f. The contractor shall provide and install all Instrumentation and Automation system required for proper operation of the Pumping station.

#### **1.3 DRAWINGS, DOCUMENTS AND SCHEDULES:**

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Contractor shall furnish following drawings / documents after award of the contract for review & approval.

- a. Process and instrumentation diagram shall comply with BS1646 and BS 1553.
- b. General arrangement drawings of field-mounted instruments showing installation details.
- c. Instrument list & Instrument data sheets including Instrumentation range.
- d. Annunciators arrangement and engraving details.
- e. Internal circuit and wiring diagrams for instrument and control panels.
- f. Schematic control diagrams & System architecture diagram.
- g. Instrument loop diagrams & Instrument Hook up drawings
- h. Instrument test and calibration report
- i. Instrument catalogue& operation and maintenance manual

#### 1.4 LIST OF APPLICABLE INDIAN STANDARD AND CODE OF PRACTICE

Sr.No	Standard no.	Title
1	API RP 551	Process measurement instrumentation
2	ISA 5.1 & ISA S5.4	Instrumentation symbols & identification & instrument loop diagrams
3	IS – 694 ,IS – 6346, , IS – 1554 (Part I & II), IS – 5831 s.	PVC insulated cables IS standards for Instrument power & signal cables
4	IS – 732 (part I)	Code of practice for electrical wiring installations
5	IS – 1651	Stationary cells and batteries, lead acid type (with tubular positive plates)
6	IS – 2147 , IS13947 Part-I:	Degrees of protection provided by panel enclosures
7	IS – 3043	Code of practice for Earthing
8	IS – 4064	Switch fuse unit
9	IS – 5216.	Guide for safety procedures and practices in electrical work
10	IS – 8130	Conductors for insulated electric cables and Flexible cords.
11	IS – 8197	Terminal marking for electrical measuring instruments and their accessories
12	IS – 8309	Compression type tubular terminal ends for aluminum conductors of insulated cables
13	IS – 10418	Specification for drums of electric cables
14	IS – 10810 s	Methods for test for cable
15	IEEE 472-1974	Surge Protection
16	IEC 61158-2	Communication Protocols
17	IEC 60381-1 & 2	Analog signal standards for voltage and current signals

Sr.No	Standard no.	Title
18	IEC 60801-1,& IEC 61326	Electromagnetic compatibility for measuring instruments
19	IEC 60870 – 1 to 5	For Remote terminal unit(RTU),PLC & SCADA
20	ISO 6817	Flow measurement standard
21	ISO/IEC 17025	Flow meter calibration standard

### 1.5 Operation Control Philosophy of pump, motor and its auxiliaries:

(This is given for reference and proper design of control system)

- a) The automation system shall be designed with geographical & functional distribution of hardware in a multi-level hierarchy, viz. Level-0, Level-1 etc as applicable, to meet specific site requirements for monitoring, control, visualization & optimization of all major drives in the scheme unit.
- b) Level of down stream sumps shall be controlled by regulating incoming water flow through inlet pipe using PLC-SCADA of
- c) The automation system shall be structured in general, considering the following hierarchical levels:

Level-0: This level is also called field level. It is functionally responsible for generation, transmission & conversion of signal for input to the higher-level equipment's as well as signal-based activation for the final control/ operation. Primary sensing elements, proximity switches, converters, microprocessors based intelligent system etc., are in domain of this level.

Level-1: This level, also called supervisory level, is functionally responsible for supervision of the individual process equipment & function, control, visualization and regulation, guidance & optimization and control of process parameters to the desired level of perfection based on signals generated from field level. This level is also responsible for processing of signals for generating compatible control commands to control the process parameters by activation of the final control elements. This level is realized based on controllers & systems, input systems, data based units, data communication, visualization system (HMI stations) and interface units for connectivity to the other levels of automation system. In addition to routine MIS functions, advanced process optimization functions comprising special control algorithms, mathematical computations etc. will be able to permit distribution of control and data acquisition functions throughout the entire pumping stations (Scheme).

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The Level-1 automation shall basically comprise:

A programmable Logic Controller (PLC) based automation system. Modes of operation shall be:

A. Local mode: Local control Station (LCS) shall be provided for all motors/ drives & shall have required numbers of push buttons for operation of drives. HV motors shall be provided with hard-wired interlocking in MCC with fail safe operation..

B. Remote: In remote mode, the equipment can be started from control room only. Once the remote mode of operation is selected, then from HIM with the help of Key board/ mouse/soft keys above three modes of operation can be selected. This mode is further divided into following three modes: • Operator mode. • Auto mode. • Computer mode.

d) Pump starting/ closing logic and interlocks for Operating conditions, interlock protections mentioned below are indicative only however same can be modified as per OEM & client requirement

e) Provide Local/ Remote, Automatic/ Semi auto/ manual operation of pumping station equipment including drives, actuator sequentially as predefined.

I. On, Off, control shall be from local Push button station, switchgear/ PMCC, PLC & SCADA with start permissive, trips, safety interlocks to optimize the operation.

II. Operator shall select the pumps to run/standby depending on availability of pump/motor. Pump running hours shall be displayed in HMI for respective pumps to guide operator about which pump to run.

III. Flow meters continuously monitors flow rate, cumulative flow which communicate with PLC/SCADA, pump operation can be controlled on water requirement.

f) Logic for pump starting:

After single push button command following operation will take place in sequence.

I. Lubrication, cooling system shall start in case it is provided as per main pump, motor OEM recommendation.

II. Once start command given to main pump motors it will start through soft starter and capacitor cubicle circuit will be 'ON'. Soft starter shall get bypassed once the pump comes to normal speed.

III. Corresponding pump discharge valve will get open.

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IV.The pumps will be started in sequence, at an interval such that the subsequent Pump starts after the previous pump has attained full speed.

g) Logic for pump closing:

After single push button command following operation will take place in sequence.

I.Main pump motors it will stop and capacitor cubical circuit will switch off.

II.Corresponding pump discharge valve will get closed.

III.Lubrication, cooling system shall stop in case it is provided as per main pump motor OEM recommendation.

h) Control & Interlocks

I.A minimum water level has to be maintained in the sump

II.Start permissive for VT pumps will be obtained when sump level is not low, which is derived from the level transmitter.

III.Low-Low sump level set point activation will trip all the running pump.

IV.When motor winding temperature or pump/ motor bearing goes very high – the corresponding pump will tripped and winding temperature/ bearing temperature very high alarm will get generated. Set values shall be as per OEM recommendation.

V.The Pressure transmitter is provided at the discharge of each pump will enable alarm at high pressure.

i) Start Permissive Interlock for VT pumps:

I.Sump level is not low

II.Main header valve open.

III.Motor winding temperature/ Bearing temperature not High.

IV.Electrical protection relay /Motor protection relay not operated.

V.Pump selection feedback available.

VI.Stop feedback from pump available

VII.VT Pump discharge motorized valve is closed. Supply is available to the valve.

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VIII. Corresponding Lubrication, cooling system is in service and require parameters for starting of the pump are available, in case it is provided as per main pump, motor OEM recommendation.

j) VT PUMP shall trip in any of the following condition.

- I. Sump level very low
- II. Motor winding / pump motor bearing temperature very high.
- III. Pump discharge motorized valve closed.
- IV. Electrical protection relay / Motor protection relay operated.
- V. Corresponding Lubrication, cooling system trips or is in service and require parameters for the pump are not available, in case it is provided as per main pump, motor OEM recommendation.

k) Alarm / Indication

I. Following audio visual alarm shall be provided local panel/ Switch gear control panel/ PLC/ SCADA Monitoring

II. Sump level low , very low and low very High.

III. Discharge header pressure high.

IV. Motor winding temperature High and very High

V. Pump/ Motor bearing temperature High and very High.

VI. Pump discharge valve Jam/ Trip.

VII. Vibration monitors shall be provided at motor, should any abnormality occur; there will be audio visual alarm.

#### **1.6 PIPE AND INSTRUMENT DIAGRAM (P&ID):**

Agency has to submit complete P & ID of the pump house and water supply scheme, its system architectures. It should include following:

- a. Individual Pump, motor, discharge pipes, bellows, Non return Valves, butterfly valve, sluice valve & kinetic air valve etc & actuator where ever used. Common discharge header & valves with actuator on it. All these Should be shown with exact location including technical details of each Component Pump & motor lubrication system, water cooling system, where used in the pump house.
- b. Sump De-watering / De-silting system

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- c. Instruments to be use for measuring pressure, temperature, level, flow (Gauges, switches, transmitters, monitoring system including high/ very high, low/ very low alarm & trip With hooter & annunciators.



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## 2. FLOW MEASURING SYSTEM

- a. Flow measuring system shall consist of flow sensor/ transducers, flow computer & flow transmitter, digital flow indicator & integrator and any other item required to complete the system. The flow sensor and Transmitter should be separated by a corrosion resistant material.
- b. Flow sensors / transducers shall be rugged in construction and shall be suitable for continuous operation. Flow transducers shall have waterproof construction and shall be suitable for installation on underground /above ground pipelines. In line type/removal of flow sensors shall be possible when pipelines are pressurized and should be Leak-proof at 1.5 times the working pressure at that location. This is not applicable if electromagnetic in line flow meter is considered.
- c. To avoid the effects of disturbances in the velocity profile, a straight and uninterrupted run, upstream as well as downstream from the location of the flow sensor shall be provided, as required by the flow meter manufacturer.
- d. The exact location of flow transducers shall be finalized in consultation with Engineer-in-charge Representative.
- e. The flow transmitter shall be suitable for field mounting and shall accept input from the flow transducer. It shall process the input signal and provide 4-20mA DC output proportional to flow rate. Flow transmitters shall have LCD display to indicate instantaneous flow rate. The flow range shall be adjustable. The flow meters shall be suitable for measuring flow at velocities of water from 0 to 4 m/sec.
- f. Flow measurement shall not be affected by physical properties of water viz., temperature, pressure, viscosity, density etc., within given limits. Contractor shall provide compensating electronic circuits, if required.
- g. Contractor shall construct a suitable concrete chamber for enclosing flow transducer to be mounted on underground pipelines. A concrete cabin shall be constructed above the chamber for housing the flow transmitter. A concrete cabin shall be constructed for housing the flow transducer and the flow transmitter to be mounted on surface pipelines.
- h. The flow transmitter shall be microprocessor based and shall have self diagnosis facility.
- i. Measurement of flow at site will be by full bore Electromagnetic type flow meter.
- j. Electromagnetic Flow Meter shall be installed on discharge header pipeline and tail end for flow measurement.
- k. Flow meters shall be suitable for the water turbidity at site during various seasons.

l. A lockable enclosure shall be provided for the flow transmitter cum computing unit.

m. The technical details are as under.

Sr.No.	Description	Particulars
A	Process Liquid	
1	Liquid Type	Raw water
2	Type of solid	To be ascertained
3	Size	As Per Design
B	Operating Condition	
1	Operating pressure	PN – 1.6
2	Operating temperature	0°C to 50°C.
C	Flow Sensor	
1	Type	Pulsed DC excitation
2	End Connections	Flanges of carbon steel
3	Electrode Material	SS 316 (Stainless steel) /Platinum /Tantalum
4	Meter Tube	SS 304 (Stainless steel)
5	Electrode type	Round Head electrodes ( Bullet Nose )
6	Lining Material	Hard Rubber(SBR/EPDM)/Neoprene
7	Coil Housing	SS 304 with fully welded construction/CS/Diecast with anticorrosive Painting.
D	Flow transmitter cum computer	
1	Type	Multi-channel microprocessor based with facility to input pipe size, Engineering units, measuring span etc.
2	Power supply	240 V AC, 50 Hz, Zero and span adjustment, battery backup for totalized flow.
3	Communication	RS-485/Modbus
4	Protection category	IP 68
5	Measuring accuracy	Measuring accuracy +/-0.5% of Measured Value inclusive of Linearity, repeatability.
E	Digital Flow Indicator	
1	Type	Microprocessor based combined unit, 12.5mm or higher digit height, Input: from level transmitter trough RS-485/Modbus, Accuracy : $\pm 0.25\%$ of span or better
2	Display	Min. 2 line back lit LCD for indication of actual flow rate, forward, reverse, sum totalizes
3	Protection Category	IP67
4	Enclosure	Die Cast Aluminium with polyurethane finish

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Sr.No.	Description	Particulars
		with glass window
5	Power Supply	240 V AC, 50 Hz
6	Mounting	Panel mounted

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### 3. FULL BORE ELECTROMAGNETIC TYPE FLOW METER

Inline electromagnetic flow meter shall be as per following specs:

- a) Electromagnetic Flow Meter shall be a velocity sensing electromagnetic type, microprocessor based signal converter, sealed housing, flanged tube meter for 1.6 Mpa working pressure.
- b) EM type flow meter shall be manufactured as per BS EN ISO 20456 Standard measurement of conductive liquid flow in closed conduits.
- c) Full bore electromagnetic flow meters shall be calibrated according to ISO standard.
- d) The flow meter shall be capable of measuring bi-directional flow.
- e) Electromagnetic Flow meters shall withstand maximum working temperature of about 50 d C and working pressure of 16 kg/cm<sup>2</sup> (1.6 Mpa), unless specified otherwise.
- f) Full bore electromagnetic flow meter shall consist of flow sensor (i.e. flow tube), flow transmitter, flow computing unit and flow indicator and integrator and any other item required to complete the system.
- g) Flow meter shall have waterproof construction and shall be suitable for installation on underground pipe lines with the protection of IP 68 and submerged condition.
- h) To avoid the effect of disturbances in the velocity profile a straight and uninterrupted run, upstream as well as downstream from the location of the flow meter shall be provided as required by the flow meter manufacturer. Its installation shall be such to ensure flow meter & pipe remains filled with water.
- i) Taper pieces required for installation of flow meter shall not exceed an angle of 8° in order to avoid disturbance in flow profile.
- j) Flow tube flanges and transmitter housing shall be properly earthed. Earthing Ring/ Electrode shall be provided.
- k) Accuracy of electro magnetic flow meter shall be within  $\pm 0.5\%$  at site including instrument accuracy and installation & other errors. This is to be measured and verified by OEM after installation at site. The accuracy should be inclusive of linearity, hysteresis, repeat-ability, temperature and pressure effects. In case of overall accuracy error more than  $\pm 0.5\%$  after installation then necessary changes in installation and recalibration shall be done to achieve above accuracy.
- l) Flow meter shall have empty pipe line alarm facility.

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- m) Zero span adjustment facilities shall be providing in flow meter.
  - n) Flow tube shall be rugged in construction and shall be suitable for continuous operation.
  - o) Flow tube shall have waterproof construction and shall be suitable for installation on underground /above ground pipe lines.
  - p) The distance between transmitter and flow tube shall be maximum 250 meters.
  - q) The flow transmitter shall be mounted separate from the flow tube, connected by a cable. The flow transmitter and flow computation/ evaluation unit shall be mounted in field mounted enclosure/ Cabinet with open/ close monitoring device
  - r) The flow computer shall be microprocessor based signal converter with self - diagnostic feature, high speed signal processing communication protocol like HART, mod bus RS-485, RS-232 and transmitter shall be a single unit suitable for panel mounting.
  - s) It shall accept inputs from flow tube process the signals and shall provide an output proportional to the flow rate.
  - t) The flow meter shall be suitable for measuring flow at velocities of water from 0.25 m/sec to 5 m/sec (10 m/sec maximum).
  - u) Electromagnetic flow meter shall be compatible to GSM/GPRS connectivity.
  - v) Power supply to the electromagnetic flow meter and transmitter shall be 240v Ac, 50Hz. It shall have UPS battery back up at pump house and solar operated panel with rechargeable battery back up for remote location.
  - w) The flow transmitter shall be suitable for field mounting and shall accept input from the flow meter. It shall process the input signal and provide 4-20 mA DC output proportional to flow rate.
  - x) Flow transmitters shall have LCD display to indicate instantaneous flow rate. The flow range shall be adjustable. Control and power cable from flow measuring unit to transmitter panel and any other item required to complete the system cabinets & hardware shall be provided.
  - y) Contractor shall construct a suitable concrete chamber for enclosing flow transducer to be mounted on underground pipelines. A concrete cabin shall be constructed for housing the flow transducer and the flow transmitter to be mounted on surface pipelines.
  - z) Concrete chamber size shall be to provide housing of flow meter, possibility to carry out maintenance & accuracy checking of flow meter with ladder for approach to flow meter, provide

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proper sealing to prevent water accumulation and theft proof panel enclosure with necessary mounting arrangements for Flow transmitter ,battery ,GSM modem and all required accessories shall be provided as per client requirement.

Note: Digital Flow indicator and flow integrator shall be a combined unit mounted on panel.

### **3.1 Digital flow indicator and integrator for Electromagnetic**

- a) Digital flow indicator & integrator shall be Microprocessor based combined unit, 12.5mm or higher digit height, Input: 4-20 mA DC (isolated) from flow transmitter, Accuracy:  $\pm 0.25\%$  of span or better and Min. 2 line back lit LCD for indication of actual flow rate, forward, reverse, sum totalizes, etc.
- b) It shall have facility for retaining flow totalizer data even if the power supply fails.
- c) Digital flow indicator & integrator for flow meter shall be installed immediate after Header and panel mounted with IP 52 protection or better as per application.
- d) Power supply to the digital indicator shall be 240v ac,50Hz.

Inspection shall be witness at manufacturer premises.

### **3.2 Routine Test**

- a) Flow measuring devices wet calibration ( at 60,70, 90 & 100% of total flow)
- b) Pressure, range, accuracy & repeatability shall be check.
- c) testing for various alarm like empty line etc
- d) Communication test for RS-485, GSM/GPRS modem and other soft signal compatibility.

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## 4. LEVEL MEASURING SYSTEM

### 4.1 ULTRASONIC TYPE LEVEL MEASURING SYSTEM

- a) Ultrasonic type level measuring devices shall comprise a transducer, a transmitter, remote level indicator and all other items required to complete the control system.
- b) The level sensor and the field-mounted transmitter shall be separate and interconnected by integral cable of sufficient length.
- c) The transducer shall be suitable for flange or bracket mounting as required and shall be environmentally protected as per IP 65. It shall have ambient temperature compensation and adjustable datum setting facilities.
- d) The design and application of this ultrasonic level meters shall take into account the vessel or channel construction, the material size, shape, environment, process fluid or material, the presence of foam, granules, size etc.
- e) The installation shall avoid any degradation of performance from spurious reflections, absorption, sound velocity variations, sensor detection area, temperature fluctuations, specific gravity changes and Condensation. For application where spurious reflections are unavoidable the control unit shall be provided with facilities for spurious reflection rejection.
- f) The transmitter will provide an isolated 4-20mA 2 wire o/p and compatible to GSM/GPRS modem connectivity for sending data to PLC-SCADA or MPS.
- g) To remove the effect of water turbulence in reservoirs averaging facility should be provided in the transmitter unit.
- h) Level transmitter is also required on the sump for sump level High / Low alarm & Very high/ Very low trip and sequential operation purpose.

### 4.2 CONDUCTIVITY TYPE LEVEL SWITCH

- a) The electrodes used for conductivity level switches shall be of stainless steel (SS316).
- b) The electrodes shall be insulated such that only the tip of each electrode is exposed to the liquid at the operating level.
- c) Control unit (IP 65) operating with level electrodes shall have adjustable sensitivity. Separate potential free contacts shall be provided in the control unit for each level of detection.

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- d) Level switches are required for level High / Low alarm & Very high/ Very low trip and sequential operation purpose.

#### **4.3 Float and Board type Level Measuring System**

- a) Float board type Level measuring system shall be provided for Sump/ Fore-bay.
- b) Float and board type level measuring system shall be provided with all necessary accessories like anchor plate, bracket, fasteners, etc for complete the system.
- c) MOC of float, guide wire rope and float wire rope shall be SS316 and calibrated board shall be AL white powder coating with black graduations and numerical.



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## 5. PRESSURE MEASURING SYSTEM

- a) Pressure measuring system shall consist of pressure transmitter and digital Pressure indicator and any other items required to complete the pressure measuring system.
- b) It shall be diaphragm type and provided with impulse tubing, fittings, two valve manifolds with drain cock and calibration valve.
- c) Local & remote unit shall be provided.

### 5.1 Pressure Gauges

- a) Pressure gauges shall comply with IS 3624/ BS 1780. Glycerin filled dial shall be provided where the gauge is subjected to pressure pulsation and / or vibrations. The internal parts of pressure gauge shall be stainless steel.
- b) The minimum diameter for round pressure gauges shall be 150 mm unless specified otherwise or where the gauge forms part of a standard item of equipment.
- c) Accuracy of pressure gauge  $\pm 0.1\%$  of the full scale. The zero and span of pressure gauge shall not change by more than 0.1 % of the span per  $^{\circ}\text{C}$  changes in ambient temperature.
- d) The internal parts of pressure gauge shall be stainless steel.
- e) Weather protection shall be IP65 or better as per application.
- f) Vented part shall be of SS 316.
- g) Pressure gauge shall be provided on discharge of each pump, discharge header & compound pressure gauge shall be provided on suction side of pump.
- h) All pressure gauges to be provided with isolation valve.

### 5.2 PRESSURE TRANSMITTER

- a) Pressure transmitter shall be rugged in construction and shall be suitable for continuous operation.
- b) Pressure gauge & transmitters shall be designed for operation over 130% of full range.
- c) Pressure transmitters shall be suitable for field mounting. They shall provide 4-20 mA DC output proportional to pressure and compatible to GSM/GPRS modem connectivity for sending data to PLC-SCADA or MPS.

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- d) Transmitter output shall be isolated and shall be suitable for transmitting over long distance.
  - e) Pressure transmitters shall have high degree of weatherproof protection (IP 67) as specified in technical particular.
  - f) Transmitter will be mounted on a 2" pipe stand installed near the process tapping with first isolation valve to provide operator convenient height from floor level of 1.2 meters from floor level.
  - g) Required SS valve manifold and SS impulse to be provided.
  - h) FRP enclosures shall be provided for the transmitters mounted outside the pump house.

### **5.3 Pressure switch**

- a) Electro mechanical pressure switch shall be provided to detect high pressure in the surge vessel & discharge header of the pumping station.
- b) Pressure switch shall have manually adjustable set point and differential pressure switching level.
- c) Pressure switch shall be complete with impulse tubing, fittings, two valve manifolds with drain cock and calibration valve.
- d) Pressure switch are required on discharge line pressure High alarm.

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## **6. TEMPERATURE MONITORING FOR PUMP MOTOR:**

- a. Temperature sensor/ scanner shall be provided to detect motor winding and pump & motor bearing temperature.
- b. It will be used to monitor temperature and generate temperature high alarm and very high trip signal.
- c. The Input signals to temperature signals shall be derived from industrial type PT-100 resistance temperature detector provided in windings and RTS on bearings
- d. The temperature scanner shall be provided on panel & communicable with PLC / SCADA and also compatible for GSM/GPRS modem connectivity for transferring data and commands to PLC-SCADA.

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## **7. PUMP MOTOR RUNNING HOUR METER:**

- a. Pump motor running meter shall be provided on each pump to monitor the operating hours.
- b. This can guide to equalized running hours for operating staff and carry out time based maintenance by the maintenance staff
- c. It shall be microprocessor based panel mounted and communicable with PLC/SCADA.

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## 8. Lightning Protection Unit (LPU)

Surge protection devices shall be provided for all field devices, data Communication lines and buried signal cabling.

- a. Surge protection devices (SPDs) shall be suitable for withstanding the surge arising from high energy static discharges and lightning strikes and protect the instruments to which it is connected.
- b. SPDs shall be passive and shall require negligible power for operation.
- c. SPDs shall be provided to protect devices transmitting and receiving analogue and Digital signals from outdoor field devices.
- d. The surge protection devices shall comply with IEC 61643.
- e. Two numbers of lightening protection units shall be provided for each signal loop.
- f. LPU shall provide three stages of protection through a gas discharge tube, quick acting semiconductor like tranzorb, zener diodes, transistor and an automatic disconnect and reset circuit.
- g. LPU shall be a passive unit and shall require no power for its operation.
- h. During a lightning strike it shall clamp on the allowable voltage and pass the excess voltage to the ground.
- i. LPU shall be of self resetting type to minimize the down time of the measurement loop.
- j. LPU shall have a weather proof casing and shall be suitable for field/back of panel mounting.
- k. LPU provided shall be suitable for connecting in 24 V / 48 V, 4-20 mA DC signal lines.
- l. There should be total isolation between input, output and ground terminals. The LPU shall have a minimum surge rating of 10 KA.

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## 9. UNINTERRUPTIBLE POWER SUPPLY

- a) UPS with 60 min back up time shall be provided for power supply of instrumentation, control and automation system.
- b) The UPS shall be floor mounted; self contained and metal clad and shall be suitable for supplying a non linear load.
- c) It shall be possible to open the enclosure front door when the unit is in use without exposing any live contact touch.
- d) It shall be confirming IEC 62040-3 or equivalent.
- e) Degree of Protection shall be IP 41 or better as per the application.
- f) It shall be of SNMP & MODBUS communicable.
- g) The UPS shall be on-line type incorporating a six-pulse rectifier and pulse width modulation inverter technology with microprocessor control. It shall incorporate a static bypass switch that shall operate in event of UPS failure, overload or manual initiation in order to transfer the output supply to mains without disturbance to the output supply.
- h) The UPS shall incorporate a DC under voltage trip circuit to Electro- mechanically trip the UPS output in order to protect the batteries.
- i) The noise level of the unit shall not exceed 60 dB (A) at 1 m from the UPS cabinet.
- j) The output of the inverter shall be a sine wave having less than 2% THD for linear loads and less than 4% for 50% non linear loads. It shall be suitable for load power factors 0.7 lag to 0.9 lead.
- k) The unit shall have a dynamic response such that 100 % step load causes an output voltage transient of less than  $\pm 4\%$  with a recovery of less than 4ms. The load crest factor shall not be less than 3:1.
- l) The UPS shall provide volt free contact outputs for the following purpose for Indicators and warning shall be provided for the following:
  - UPS status
  - PS alarm conditions
  - Rectifier trip
  - Inverter trip
  - Load on battery

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- Load on static bypass.

- m) The UPS shall have an overloaded capacity of 150% for 30 seconds and shall be protected in the event of a short circuit of the output.
- n) The batteries shall be housed, within a separate matching battery cubicle suitable for location adjacent to the UPS. The batteries shall be of the rechargeable, sealed maintenance free Li-Cd type. The battery supply to the UPS shall be via a fused load break switch disconnectors circuit breaker. The battery recharge time to 90% of full charge shall be approximately ten times the discharge time at full load.
- o) Terminals shall be shrouded to prevent accidental contact
- p) Contractor shall furnish UPS & Battery sizing calculation for review and approval.

## 10.CABINETS FOR FIELD INSTRUMENTS

- a) A Cabinet shall be provided for enclosing instruments and associated accessories such as transmitter, SPDS, terminal blocks, Flow transmitter, Batteries, GPRS modem etc. mounted at all FM locations.
- b) It shall be fabricated from Glass fiber plastics (GRP) as per CSA Standard C22.2 and shall be suitable for wall mounting or pedestal mounting as required.
- c) 304 stainless steel shall be used on all external hardware and Bosses utilize threaded brass inserts accepting 10-32 screws.
- d) It shall be light weight, Water-tight, dust-tight, Non-conductive, impact resistant, UV resistant type.
- e) Size of panel shall be as per requirement and installation layout and location shall be decided by Engineer in Charge.
- f) The cabinet shall conform to IP-65 protection and shall have built in locking facility. The cabinet shall be earthed properly. Rain shield protection against incidental water ingress for NEMA 3R enclosures and temperature range shall be (-76°F to +250°F) (-60°C to +120°C) with Non-flame propagating.
- g) Material cuts, drills, punches, and saws on panel shall be easy and accurately..
- h) A GRP plate/pipe, as per the requirement, shall be provided in the cabinet for mounting and connecting cables etc. Entire arrangement shall be corrosion proof.
- i) Unauthorized opening panel door detection or theft proof system shall be provided.

Technical specifications	
Material	GRP (Glass Fiber Reinforced Plastic)
Raw Material	Sheet Molding Compound (SMC)
Base Color	RAL7035(other colors available on request)
Cover Color	RAL7035(other colors available on request)
Gasket Material	Neoprene / PU
Lock (If Applicable)	Cast Aluminum / SS
Cover Fixing Hardware	MS / SS
Toxicity	Halogen Free
Water Absorbance	Max. 0.7 % , ASTM D 570



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Insulation Resistance	>100 M ohm
<b>Protection Classification</b>	
Thermal Ageing (70.c / 96 hrs)	Withstood
Ingress Protection	IP 65
Impact Resistance	≥IK 07
<b>Rating</b>	
Flammability Rating	Low Flammability (UL-94)
Glow Wire Test @ 960°C	Withstood
Impact Resistance	> 7 Nm, EN 50014

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## 11.MICROPROCESSOR BASED ALARM ANNUNCIATORS

- a. Microprocessor based annunciators shall be provided for generating audio-visual alarms for each abnormal condition.
- b. Alarms shall be initiated by the opening and closing of volt-free contacts.
- c. Alarm functions shall be indicated on internally illuminated annunciators units bearing appropriate legends and arranged on the panel in groups to the approval of the Owner.
- d. Each alarm shall initiate the operation of both visual and audible devices.
- e. The bulbs in the alarm annunciators shall be of the cluster LED type.
- f. A common audible alarm of an approved type and intensity shall be mounted within the panel with a muting switch for use during commissioning and testing
- g. Alarm circuitry shall be arranged so that spurious or transient alarm states persisting for less than 0.5 seconds do not initiate any action.
- h. Isolation facilities shall be provided for the audible alarm.
- i. Each Annunciator shall have provision for a number of spare windows for future alarms.
- j. The circuitry shall be compact without unnecessary decorative trim.
- k. The alarm indications on each Annunciator shall be logically arranged in a format to the approval of the Owner.
- l. The legend area of each indication shall not be more than 40 mm high and 75 mm wide.
- m. The wording of all legends shall be subject to the approval of the Owner before manufacture.
- n. Alarm Accept, Lamp Test and Alarm Reset push buttons shall be provided on each annunciators panel.
- o. On pressing the Alarm Accept push button, the audible alarm shall be silenced and the flashing light shall become steady
- p. The alarm indication shall remain illuminated whether or not the alarm condition has returned to normal until the Alarm Reset push button has been operated, whereupon the light shall be extinguished if the fault condition no longer exists.
- q. Operation of the Lamp Test push button shall cause all the alarm lamps to be illuminated simultaneously and the audible alarm to be sounded.

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- r. The alarm system shall respond to any new condition arises, even while an existing condition is being indicated.
  - s. The alarm system shall be designed on a fail-safe principle so that a fault in any circuit component causes an alarm to be given and shall operate on a power supply not greater than 110 volts.
  - t. Alarm annunciators shall be provided on instrument control panel for annunciation of alarms in control room.
  - u. Annunciators shall available on PLC / SCADA also.

### **11.1 ALARM SCHEDULE**

The following alarms shall be enunciated on the control panel associated with each drive:

1. Pump tripped on overload
2. Motor winding High
3. Bearing temperature High
4. High level in sump
5. Low level in sump
6. Pump discharge pressure high
7. Pump discharge pressure low
8. Pump discharge header pressure high
9. Water flow measuring system failure
10. Water flow measuring system started
11. Level measuring system failure
12. Level measuring system Started.
13. Pump failed to start
14. Pump failed to stop
15. Motorized valve Trouble
16. Any other process trip
17. Electrical tripping condition
18. Battery on load.
19. Instrument mounting box open/ close
20. Power supply to instrument failed.
21. Faulty sensor
22. Reverse water flow
23. Empty Pipe

## 12. INSTRUMENT POWER SUPPLY CABLES AND INSTRUMENTATION SIGNAL CABLES

- a) Cables for power supply to instruments and Digital signals: shall be 660 V/1100 V grade Multi-core cables, multi-stranded high conductivity, annealed 1 sq.mm stranded tinned copper conductor, extruded PVC insulated with aluminum Tap. ATC drain wire run continuously in contact with aluminum Mylar tap, inner sheathed with extruded PVC, armored with galvanized steel wire, over all sheathed with extruded PVC, confirming to IS:1554 & IEC-189 part II.
- b) Cables for Analog signals and signals from temperature sensors: 660 V/1100 V grade multicore cables, multi-stranded high conductivity, annealed 1 sq.mm stranded copper conductor, extruded PVC insulated two/three cores twisted in to pair/triad laid up collectively, individual in pair/triad shielded and overall shielded with aluminum Mylar tap. ATC drain wire run continuously in contact with aluminum side of tap, inner sheathed with extruded PVC, armored with galvanized steel wire, over all sheathed with extruded PVC, confirming to IS:1554 & IEC-189 part II.
- c) Instrumentation cable in between conventional measuring transmitters and analogue process controllers, such as digital or 4mA to 20mA DC output from a constant-current source.
- d) Cables from indicating devices to alarm or tripping circuits shall be as specified above for high level signals but shall use cables, cable trays, ducts and conduit separate from those for other high-level circuits.
- e) Cables for high-level signals, low-level signals, resistance thermometers and thermocouples shall be segregated from each other and each shall be separated from cables for power, communications and other electrical services.
- f) Other cables running in the vicinity of instrumentation cables shall be twisted at the rate of one twist per 50mm approximately and shall be separated from instrumentation cables by a distance of not less than 300mm.
- g) Initiating devices for plant protection and personnel safety shall be connected by individual cables directly to the tripping or safety device and shall not be routed via any intermediate junction, Marshaling box, cabinet, relay etc. The outer sheaths of such cables shall be orange colored.
- h) Cables shall be capable of satisfactorily withstanding without damage, transportation to site, installation at site, and operation under normal and short circuit conditions of the various

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systems to which the respective cables are Connected when operating under the climatic conditions prevailing at the site as indicated in this specification.

- i) Cable joints in instrument signals and power supply cables shall not be permitted.
- j) Cables shall be capable of satisfactory performance when laid on trays, in trenches, conduits, ducts and when directly buried in the ground.
- k) Cables shall be capable of operating satisfactorily under a power supply system voltage variation of  $\pm 15\%$ , a frequency variation of  $\pm 5.0\%$ .

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### 13.LAYING OF CABLES

- a. A distance of minimum 300mm shall be maintained between the cables carrying low voltage AC and DC signals and a distance of minimum 600mm shall be maintained between cables carrying HT and LT signals. In outdoor areas, the cables shall be directly buried. Each instrumentation and power supply cable shall be terminated to individual panel / terminal box. Identification of each cable shall be by proper ferrules at each junction as per cable schedule to be prepared by the contractor.
- b. Cable shall be laid in accordance with layout drawing and cable schedule which shall be prepared by contractor and submitted for engineers representatives approval.
- c. All cable routes shall be carefully measured and cable cut to the required lengths, leaving sufficient amount for the final connection of the cable to the terminals on either end. Various cable length cut from the cable reels shall be carefully selected to prevent undue wastage of cables. A loop 1 meters shall be left near each field instruments before terminating the cable.
- d. Cables shall be complete uncut lengths from one termination to the other.
- e. All cables shall be identified close to their termination point by cable numbers as per cable interconnection schedules. Identification tags shall be securely fastened to the cables at both the ends.
- f. Cable shall be rigidly supported on structural steel and masonry, using individually cast or malleable iron galvanized clips, multiple cable supports or cable trays.

## 14. SCADA System

### 14.1 Cabinet General Design

- a. The SCADA systems provided at each P.S and it shall be monitoring and controlling of all parameters, commands & feedback of whole pump house.
- b. The SCADA will have number of HDMI graphical Screen in computer to display all plant and process related information/ data in clear real time of process through different information pages in the screen of HMI Server Computer, such that the operator can go virtually to the individual houses/ section of the pumping station visualize the pumping station operation. The SCADA should log all relevant processed data and store up to 12 years.
- c. The SCADA software must have sufficient expansion capability such that future expansion of monitoring and control can be accommodated.

### 14.2 Scada Display

- a. SCADA displays will be based on a hierarchical structure with a menu at its head. The displays will fall into a number of categories, including the following:
  - Menus
  - Tables of other operator-selectable parameters
  - alarm banner
  - alarms pages
  - trends
  - I/O status pages
  - Hours run pages.
  - Power distribution layout page for various breakers like
  - SF6/VCB/ACB/MCCB of I/C, O/G, B/C with annunciators, feedback of Isolators & earth swatches, data of power import meter & MFM, status of MPR-Numeric relays, etc as per requirements.
  - Equipment Specification Page for all equipments like Pump, motor, valves, switch yard equipments, instrumentation items etc as per requirements.

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- b. The menus will, where possible, not simply be a list of displays which can be viewed but be presented in a diagrammatic form that relates to the Pumping Station system. It is anticipated that these displays will not show any process information but that they will facilitate movement to the appropriate display for this purpose.
  - c. When viewing the relevant copy for a drive, valve, etc. for which there is to be a 'SCADA hand' control facility, it will be possible to open a small 'SCADA hand' control window for the item so that the item can be manually controlled and its status viewed at the same time with administrator password protections.
  - d. Tables of operator-selectable parameters will be provided to enable the operator to view current set-point values held in the PLCs and to adjust these parameters with administrator password protections.
  - e. The alarm banner will be permanently on view at the bottom of each screen and will show the most recent unacknowledged alarms.
  - f. Alarms pages will be provided and will display alarms according to alarm group and state.
  - g. Trends will be provided as appropriate and will show, in graphical form, the variation with time of process values or the status of a drive, etc.
  - h. The PLC I/O status tables are intended as an aid to fault-finding and will show the site, PLC reference, card reference, the number of the I/O point on the card and the tag name or other identifier of the physical I/O point. For digital I/O the current value (0 or 1) will be shown, while for analogues the value of the physical input. (E.g. a value in the range 4-20 mA or 1 to 5V) will be shown.
  - i. The hours run schedule will record the running hours of all Pumps, drives except small infrequently run drives, sump pumps, actuated valves, etc. The running hours for each drive will be stored in registers within the appropriate PLCs and read periodically (say once every 24 hours) by the SCADA system. The hours run will be displayed on one or more pages.
  - j. It will be manually reset any register from the PLC. The date of the last reset will be displayed alongside the appropriate running hour display. The PLC register for each drive will be capable of storing at least 5 years' running hours.

#### **14.2.2 Invalid Entries from SCADA System**

- a. A screen-based warning window will be displayed and the action prevented if the SCADA operator tries to enter a process control instruction that is not valid. For example, the operator may try to select ultrasonic level sensor 'A' in a reservoir as the 'duty' sensor when the control system is aware
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that this sensor is not functioning correctly or to attempt to adjust a set point outside of its limit. Wherever possible, the logic for these features is to reside in the PLCs.

#### **14.2.3 Windows Structure of Displays**

- a. The SCADA package is to operate on a 'Windows' type operating system.
- b. It is suggested that the alarm banner should be a window of fixed size and located at the bottom of each SCADA system screen.
- c. In general, all other displays will be of fixed size and location so that they appear above the alarm banner and cannot be moved or relocated to obscure the alarm banner.
- d. The only possible exception is the 'SCADA hand' control window, where it might be necessary to provide a 'click and drag' facility so that the window can be positioned clear of the item being controlled and so that, if necessary, more than one 'SCADA hand' control window can be open at any one time.
- e. Special attention will be paid to the closure of each 'SCADA hand' control window to ensure that it cannot be used.

#### **14.2.4 Alarm and Event Management**

- a. An 'alarm' is to be an occurrence that will be treated as follows by the SCADA system:
    - ❖ It will appear on the alarm banner until it has been acknowledged.
    - ❖ It will cause each SCADA system workstation to emit a short audible alarm tone to attract the attention of any operator in the vicinity.
    - ❖ It will be recorded by the alarm and event printer at the time it happens but will not be retained as archived data unless it is also an 'event'.
    - ❖ The time and date of acknowledging and resetting of each alarm will also be recorded.
    - ❖ It will be allocated to one or more 'alarm groups' so that an operator may easily determine what alarms are current for a particular physical or logical part of the operation.
  - b. In general, an alarm will correspond to an abnormal operating condition, an unusually high or low level, or to a plant failure.
  - c. There will be three possible states for each alarm, as follows:
    - ❖ An 'unacknowledged activity' alarm is one which represents a current alarm condition on the plant and which has yet to be acknowledged by the SCADA system operator.
    - ❖ An 'acknowledged active' alarm is one which represents a current alarm condition on the plant but which has been acknowledged by the SCADA system operation.
    - ❖ An 'event' is to be an occurrence which is to be treated as follows by the SCADA system:
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- d. It will be recorded by the alarm and event printer (at the time that it happens).
  - e. It will be allocated to an 'events schedule'.
  - f. Typically, the following occurrences will be treated as events.
  - g. A change between 'duty' and 'standby' devices initiated by the operator.
  - h. The starting and stopping of each of the main pumps and of other selected major drives. The operation of certain important valves.

#### **14.2.5 Priority station of Alarms**

- a. Level 1: This alarm requiring immediate attention.
- b. Level 2: This alarm which requires attention within a given period of time.
- c. Level 3: This alarm which requires no particular action other than acknowledgement by the Operator

#### **14.2.6 Alarm Banner**

- a. The following requirements will apply as far as is practicable: The display of each new alarm on the alarm banner will comprise:
    - ❖ Date (DD MM YYYY)
    - ❖ Time (HH MM)
    - ❖ Description
    - ❖ State (active/inactive)
    - ❖ Alarm level.
  - b. It is not essential that the whole of the display for each alarm be visible at once provided that it can all be read by horizontal scrolling of the banner
  - c. There will be a means of accepting alarms using the alarm banner.
  - d. The alarm banner will display at all times at least the three most recent unacknowledged alarms for the whole system.
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#### 14.2.7 Alarm Display

This will comprise:

- ❖ Alarm Date (DD MM YYYY)
- ❖ Alarm Time (HH MM)
- ❖ Alarm Description
- ❖ Alarm Tag name
- ❖ Alarm level
- ❖ State (active/inactive)
- ❖ Acknowledge/unacknowledged

#### 14.2.8 Alarm Pages

The alarms pages will enable current and inactive (i.e. potential) alarms to be viewed according to alarm group, level and state (i.e. active, inactive, unacknowledged and acknowledged).

#### 14.2.9 Colours for Alarm Display

- a. The following background colours will be used for the display of alarms at the SCADA system workstations:
  - ❖ 'Unacknowledged active' – red
  - ❖ 'Acknowledged active' – black
  - ❖ 'Unacknowledged inactive' - blue

#### 14.2.10 Alarm Inhibit

- a. The SCADA system operator will be able to inhibit the operation of any alarm. Such action will be recorded on the alarm and will be shown in an easily recognizable way on the alarms pages displayed by the SCADA system.
- b. Consideration will be given to automatically inhibiting certain alarms if other alarms are raised. For example, a power failure at a site is likely to give rise to a number of 'drive failed' alarms which do not in practice reflect a true failure. Hence it may be appropriate to suppress these alarms in the event of a power failure.

#### 14.2.11 Event Schedules

There will be schedules of events arranged in a similar manner to the alarms pages. Additionally, there will be 'events history' pages so that the history of opening and closing of important valves, the starting and stopping major drives, etc. can be seen.

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#### 14.2.12 Event Display Format

For both the printer and the events schedule, this will comprise:

- ❖ Event date (DD MM YYYY)
- ❖ Event time (HH MM)
- ❖ Event description
- ❖ Event tag name
- ❖ Event state (e.g. drive 'running'/'not running' or valve 'open'/'not open').

#### 14.2.13 Trends

- a. Parameters of trend will be provided for every analogue value monitored by the PLCs and for every analogue value derived in the PLCs from this data. Trends will also be provided for certain events where these trends, in conjunction other analogue trends, provide the operator with a more meaningful picture of part of the operation.
- b. Trends will be displayed in groups of inter-related parameters. Some specific examples of groups which are provisionally suggested are:

I. For each For bay:

- Level of water in For bay.
- Flow out of Forbay.

II. For each point of possible discharge of treated water:

- 'discharge in progress' (an event)
- 'discharge flow rate'

III. For each pump:

- Flow rate of water discharged
- Pressure of discharged water

IV. Number of pumps 'running'.

V. Discharge header pressure

VI. Monthly water loss trend can be known.

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#### 14.2.14 Trend Facilities

- a. Both 'real time' and 'historical' trends will be provided.
- b. A 'real time' trend shows the variation of the relevant parameter with time, the last point shown always being the current value of the parameter. It is anticipated that 'real time' trends will be entirely pre-formatted as regards the time span being viewed, the parameters shown, the scales used, etc.
- c. A 'historical' trend shows the variation of the relevant parameter with time during a time window, the end of which can be in the past or can be the present. In this case the operator will be able to adjust the time span of the trend graph, typically between one hour and one month, and to select the start time of the graph.
- d. It will, however, be pre-formatted in all other respects.
- e. The operator will also be able to configure 'historical' and, 'real time' trends, with traces from a range of parameters shown together, and to adjust the vertical axis calibration Search for data in or out of a specified range.

#### 14.2.15 Reports

The following reports will be automatically produced on the report printer.

- I. A daily report.
  - II. The following information will be provided in the daily report:
    - III. Day of week, date and time of generation.
    - IV. Water levels in each reservoir at the start of the day.
    - V. Discharge water pressure at each pump.
    - VI. Total volume of water discharged.
    - VII. Monthly water loss. trend can be known.
    - VIII. Power consumption in kWh at Pumping station plant.
    - IX. Total pump running hours for the last 24 hours.
    - X. List of alarms for the last 24 hours.
    - XI. Number and total duration of power interruptions for the last 24 hours.
    - XII. SCADA will be primary used to generate reports daily and calculation of the specific power consumption, daily water balance, water loss & power factor, deviation in guaranteed parameters over and above reports required by the clients. The daily report will be produced automatically at the same operator-selectable time each day.
    - XIII. The SCADA system may be linked with a proprietary database software product such as Access in order to improve the functionality of report preparation.
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#### **14.2.16 Access Security**

- a. Other features of the SCADA system which enable a user to acknowledge alarms, control plant, alter parameters; etc. will require the user to log-in and to enter a valid password.
- b. It will be possible to provide different users with access to the system at any of the following levels:
  - I. Level-1 (Operator): View all display, acknowledge alarms and facility to control drives, valves, alter set points, change control modes etc. and to inhibit alarms in SCADA.
  - II. Level-2 (Engineer): Level-1 access plus the facility to copy archived data to diskette for processing offline and to carry out any operator actions relevant to changing the CD / Hard disk for data archives and change the process logic or programming in SCADA.
  - III. Level-3 (Administrator): Level 2 access plus the facility to perform SCADA system administrative tasks such as allocating or removing passwords, etc.
- c. The system will automatically revert from any of Levels 2 or 3 to Level 1 if no key stroke is entered for an operator-selectable period. A warning prompt should be provided first.

#### **14.2.17 Archiving**

- a. The Contractor will provide facilities to enable the archiving of all the data. Alarms will be configured to advise the operator that the archive disk space is nearing full. Failure of the operator to off-load archive data will result in old data being overwritten by new.
- b. The Contractor will provide facilities for the data to be transferred to a removal separate hard disk by the Administrator / Engineer and for the data to be recoverable and displayed in a comprehensible format on an off-line PC running industry-standard spread sheet or database software or the SCADA software.
- c. It will also be possible to reload the software into the operator workstation and display the data using the trending facility.

#### **14.2.18 Scada Hardware and System components**

- a. Supply, installation, testing and commissioning all SCADA hardware and system components specified in this Section.
  - b. It is the intent of this section to provide a fully operating SCADA system to be connected to the plant PLC based control system and the remote I/O panel.
  - c. SCADA hardware and system components generally consist of SCADA (Historian, Trending and Report generation) Server Software cum Operator workstation and Engineering workstation, GSM/Web modem, printers, and all other associated equipment's.
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#### 14.2.19 Scada (Historian, Trending and Report generation) Server Cum Engineering And Operating work station

1. SCADA Servers to have following minimum features and shall be latest one:

- a) Processor: Industrial server board with 2x Intel Xeon Eight –core E5 2620V4 or better
- b) 64GB (16 GB x 4) DDR4 ECC registered RAM
- c) Internal Storage: 2 x1 TB enterprise SATA HDD Hot swap RAID-1
- d) External storage: 2 x 4 TB Enterprise HDD RAID -1 hot swap for data back-up.
- e) DVD Drive for read & write
- f) Extended keyboard, USB, 8 hot keys
- g) 32" Flat LED Monitor (TFT),
- h) Mouse USB, 2 buttons and scroll (optical type), Sound card and speakers
- i) Integrated dual 10 GBPS sever Ethernet
- j) Wireless network adapter card.
- k) Communication port: 4 nos. (min.) with serial port & 4 nos. (min.) with parallel port (USB) & Graphic accelerator
- l) Architecture: 32 bit minimum
- m) Video Card: 32 bit minimum
- n) One (1) spare PCI slot Compatible with specified SCADA software
- o) Antivirus software (Quick heal, Trend micro, Norton)
- p) 2 x 1100 W Hot-Plug SMPS
- q) Chassis with cable and HS cage, HW Remote management module with rail KIT complete having 3 year On-Site warranty.
- r) Database Management Software
- s) Required Drivers to suit running application as required
- t) Factory system recovery CD
- u) Microsoft Windows 10 or latest.
- v) Microsoft Office 2010 Standard Edition or latest edition
- w) SCADA server hardware configuration shall be compatible to Web connectivity. All the software's for servers, workstation etc (Minimum 1 copy) shall be licensed copies and not pre-loaded software's.

2. Monitor

- a) Type : TFT colour monitor
  - b) Screen diagonal : 32"
  - c) Display : XGA or better
  - d) External controls: Brightness, Contrast, etc.
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- e) Power Supply : 240V AC, 50Hz, 1 Phase
  - f) Ambient temperature: 0-50 Deg. C
  - g) Humidity: 95 % non-condensing
  - h) To Suit Industrial Application

3. Printer

- a) A3 size: Black & White dot matrix printer
- b) A4 size: laser colour printer
- c) Memory : minimum 128MB
- d) 1 port USB compatible with USB 2.0 specification
- e) Ethernet 10/100 base
- f) 250 paper input capacity
- g) Printer configuration from control panel.
- h) Separate power ON/OFF.

**14.2.20 Managed Ethernet Switches:**

Managed Ethernet switch with rack that connects PLC system with SCADA Server. Minimum Specifications are given below.

- I. Type :- Managed, Rack mountable
- II. Flash Memory: - 16 MB
- III. DRAM: - 32 MB
- IV. Communication mode: - Full Duplex, Half Duplex and Auto Negotiation
- V. Interfaces: - 10/100 Mbps RJ45 ports – 8 Nos,
- VI. Features: - Should support DHCP support, VLAN, QoS features, IGMP, STP, SNMP
- VII. Security: - Shall support Port Access Authentication, Link Aggregation Control Protocol (LACP), SSL
- VIII. Remote Management: - Telnet, SNMP, HTTP
- IX. Power Rating: - 180Volts – 230Volts AC
- X. Operating frequency: - 50Hz
- XI. Operating temperature: - Ambient to 50°C
- XII. Accessories: - All required accessories based on site and actual requirement

**14.2.21 System Software**

Provide software licenses in Owner's name. Software shall have following minimum features:

- a) Compatible with OPC or open database
  - b) Compatible with MS Windows XP Professional Edition or latest OS Version.
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- c) Development tool: A Professional SCADA Unlimited Development software tool. Install it on The Programming Workstation (Development Node).
  - d) Run time package: A Professional SCADA Unlimited Runtime. Install it on the Run time.
  - e) Work stations (Run time Node).
  - f) System shall be compatible to connect Web server with Web client software package (in future) for monitoring and report generating from remote places through internet connectivity.
  - g) Historian Enterprise Edition (unlimited)
  - h) Suitable XL Reporter Professional Tool
  - i) Communications and report interface tool to be supported for all RTU/PLC manufacturer.
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## 15. PROGRAMMABLE LOGIC CONTROLLERS

### 15.1 GENERAL:

The Programmable Logic Controller (PLCs) shall be Standard of the shelf available hardware, must be expandable in future and have enhanced features instead of tailored made / custom made.

PLC shall have full control over pumping and it shall be capture all data of pumping PLC through GSM/GPRS modem as per operation philosophy.

### 15.2 CODES AND STANDARDS

PLC shall comply with NEMA, IEC, ANSI, ISA, IEEE, DIN and VDE.

### 15.3 DESIGN AND CONSTRUCTION REQUIREMENTS

- a) Programmable-device functional design shall include hardware details, logic flow charts, ladder diagrams and program listings.
  - b) All component of PLC and system house shall be from the reputed makes and approved vendor list having established installed base in water application.
  - c) PLC shall be provided as a stand-alone controller to perform combinational and sequential logic functions, status monitoring and reporting functions with counter and timer facilities.
  - d) PLC shall comprise of necessary processors shall be designed with 1:1 redundant Mode CPU with Dual Ethernet Port, USB port for programming, local & remote Input /Output (I/O) modules, and communication interface mod bus modules and man-machine interface required to perform the desired functions. Communication processors, memory modules, rack power supply units, bulk I/O power supply units shall be redundant. communication between CPU to I/O modules shall be redundant and communication between scada PC shall be redundant . PLC controller shall have 100 % redundancy with Hot Standby back up facility running in synchronism such that in the event of failure of on PLC, standby PLC shall take over seamlessly.
  - e) PLC shall have the following attributes as a stand-alone controller:
    - ❖ It shall carry out sequential start/stop logic implementation for operation of the pumps. Continuous checking of changes in input & Output parameters.
    - ❖ It shall accept downloaded program from a programmer.
    - ❖ It shall have different functional modules to perform the desire functions.
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- ❖ It shall scan the inputs in time cycles and update the status of inputs / Outputs.
  - ❖ It shall have relays, counter/timer functions, internal registers/ flags, watch dog timer, set/reset facilities, up-down counter etc.
  - ❖ It shall have a provision for spare input and output modules.
  - ❖ Built-in Lightning Surge Protection IEC category-II, 40KA, arrester rated voltage 335 V AC
  - ❖ Flash Read Only Memory for storing operational Logic and variables for long duration without power.
  - ❖ for local control of Inlet /Outlet control valve,
  - ❖ A separate LCD Display , built in touch control colour TFT QVGA 5.5" HMI (Human Machine Interface) shall be provide on PLC panel in order to observe important system parameters like discharge pressure, total water flow, motor winding & bearing temperature, pump running hours etc and Alarm parameter setup, Time parameter setup, displaying.
  - ❖ It shall carry out sequential logic implementation for operations of plant and carry out computation and interfacing for data acquisition, data storage and retrieval;
  - ❖ It shall accept downloaded program from a programmer without interrupting the operation of the pumping station. Any changes in the program shall be pass word protected.
  - ❖ Two 24 V DC supply source shall be provided with automatic change over scheme.
  - ❖ Contractor shall provide 20% spare channels in each configured card/module and minimum 20% spare module for each type of I/O modules shall also to be provide. The spare channel shall be fully wired and terminated.
  - ❖ PLC shall be with state of the art technology with self-diagnostic feature.
  - ❖ System components shall be carefully chosen so that the reliability shall be high.
  - ❖ PLC shall use standard bus protocols and structures for communication within and outside the system.

f) The PLC system shall be expandable and shall be modular in construction so as to carry out the future expansion without any hardware modifications.

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- g) PLC shall have enhanced features Instead of tailored made / custom made.
  - h) PLC shall be microprocessor-based semi-conductor ICs and solid state components with state of the art technology. System components shall be carefully chosen so that the reliability of the PLC shall be high. PLC shall use standard bus protocols and structures for communication within and outside the system.
  - i) In case of system failure or power supply failure all the outputs shall attain pre-determined fail safe condition. Spurious signals shall not cause equipment operation. To avoid spurious output because of output module failure, all commands shall be associated with release signals. Release signals shall include information on healthiness of the hardware, software and power supply modules.
  - j) Communication Interface module shall be provide at Raw water Pump House along with associated i/o modules and power supply. to facilitate hook-up between the i/o racks at RWPH with the main PLC system at CWPH, required interface hardware and communication cable shall be provided. Approximate distance is 500mtrs.
  - k) The Controller shall be from among the reputed makes listed in the make List.
  - l) The Controller should be capable of installation of communication modules that can facilitate communication over the network selected from among Options such as Ethernet, Device Net, Control Net, etc. with the ability to access, monitor and program from the factory floor to anywhere in the plant setup within scope.
  - m) The controller should be redundancy enabled and capable of handling a minimum of 100 I/Os (analog or digital or combination of both)
  - n) The data transfer speed over Ethernet should be a minimum of 10/100 Mbps. there should also have an isolated RS 485 port inbuilt or separately for providing a host of different point-to-point and network protocols.
  - o) This port should support minimum following protocols: DF1 Full Duplex / DF1 half Duplex master & Slave / DF1 232 GSM / Radio modem Modbus RTU Master and RTU Slave ASCII .Separate Electronic earthing shall be provided

#### **15.4 CENTRAL PROCESSING UNITS**

- a. The Central Processing Unit (CPU) shall be high performance processors with modular configuration suitable for real time process application. High inherent reliability, self-checking, error-recovery and trouble-shooting features shall be source of the features of CPU.
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- b. Automatic restart of the system on re connection of power shall be provided.
  - c. A Real Time Clock embedded in it.
  - d. Approximate capability to cater to 100% expansion based on the I/O count required in this tender.
  - e. Processor / Controller shall have minimum 32 bit processors with a minimum of 1000 K user memory, non volatile memory for firmware/program storage & Secure Digital Memory Card of 1GB and have a minimum 2 inbuilt communication ports and facility for installation of minimum two communication modules, thus enabling communication over various networks as well as I/O communication.
  - f. The PLC applications programs and firmware shall be remotely downloaded able via the communications network. Applications programs (site database and logic Program/s) shall be able to be uploaded from the PLCs.
  - g. The PLC shall support a range of communications options that includes:
    - 1. Serial ports to be user configurable as RS232 / RS422 / RS485 for data rates from 300bps to 115kbps.
    - 2. PSTN Modem (RS 232)
    - 3. Ethernet: (10/100 mbps)
    - 4. Device Net
    - 5. Control Net
  - h. PLC shall have the following attributes as a stand-alone controller:
    - 1. It shall carry out sequential start/stop logic implementation for operation of the pumps.
    - 2. It shall accept downloaded program from a programmer.
    - 3. It shall have different functional modules to perform the desired functions.
    - 4. It shall scan the inputs in time cycles and update the status of inputs/outputs.
    - 5. It shall have relays, counter/timer functions, internal registers/flags, watch dog timer, set/reset facilities, up- down counter etc.
    - 6. It shall have a provision for spare input and output modules.
  - i. The PLC system shall be expandable and shall be modular in construction so as to carry out future expansion without any hardware modifications. PLC shall be microprocessor based semi conductor ICs and solid state components with state of the art technology. System components shall be carefully chosen so that the reliability of the PLC shall be high. PLC shall use standard bus protocols and structure for communication within and outside the system.

In case of system failure or power supply failure all the outputs shall attain pre-determined fail safe condition. Spurious signals shall not cause equipment mal-operation.
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### **15.5 MEMORY UNIT**

- a. Memory unit shall comprise of highly reliable memory chips which are industry standard, proven design with fast random access and suitable for operation in process environments. Main memory shall be modular and facility shall be provided for up-gradation and expansion of memory to meet future demands.
- b. Sufficient program memory and data memory space shall be provided. System initialization and application software shall be stored in EEPROM or EPROM with necessary hardware. Running data shall be stored in a RAM with internal battery back-up
- c. At least 25% extra memory space shall be provided over the actual requirements.
- d. Processor / Controller shall have a minimum 32 bit processors with a minimum of 1000 K user memory, non volatile memory for firmware/program storage and 1 No. 1GB SD Card for Future Storage.

### **15.6 INPUT / OUTPUT MODULES**

- a. Standard rack mounted I /O modules with plug incards shall be provided.
- b. Field wiring shall be terminated in screwed terminal blocks and inter connected to the processor I/O system with pre-fabricated cables and plug in card type connectors.
- c. 20% extra I/O's of installed capacity for each type shall be provided as spares and shall be wired to the terminal block of the control panel. Provision shall be made for future expansion of extra I/O modules of the installed capacity.
- d. Some of the common features of the I/O modules shall be as follows:
  - 1. All inputs shall be terminated with input protective network and necessary isolating barriers.
  - 2. Filters for noise rejection.
  - 3. Provision for isolation of faulty channels.
  - 4. Test points and fault indication LEDs shall be provided to carry out module testing.
  - 5. Surge withstand facility as per IEEE STD All the modules shall be of addressable type
  - 6. Protection for continuous overload up to 200 % of all input ranges.
  - 7. Fuse protection and fuse failure detection. ix. Internal battery back-up.

### **15.7 SOFTWARE**

The on line real time operating system supplied shall be proven for similar application and shall be able to support all the equipment /peripherals. All software's should be with Unlimited tags.

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## **15.8 ENGINEERING STATION**

- a. The computer shall be provided complete with propriety PLC programming and documentation software. The software shall have facilities for :
1. Carrying out program revision management.
  2. Facility for comprehensive program subroutine and run comments
  3. Search and find and search and replace 'contacts' and coils'
  4. Simulation functions and testing of the program by changing the status of contacts and monitoring the outputs
  5. Preparation of coil and contact list and their location and memory maps.
  6. Make system backup copies while the system is online
  7. Upload and down load programs to the PLC
  8. Carry out on line monitoring
  9. The station will also have required development Programming S/W for editing / modifying / adding new Screens
  10. The Software should be able to furnish the formation of tasks, programs and routines. This should include formation capability of a minimum of 30 tasks, each including a minimum of 75 programs with unlimited subroutine formulation provision.
  11. Online editing of the application programs should be possible to carry out required edits without interruption of plant process.

## **15.9 DATA TRANSFER**

The PLCs proposed must support a number of data transfer philosophies that include, Standard polling – where the master station continuously requests some/all real-time data values.

- a. Exception reporting – where the PLC initiates messages.
- b. Peer to peer communications – allowing PLCs to communicate with each other rather with a master station.
- c. Store and forward communications allowing PLCs to pass on messages for other PLCs. The PLC must be capable of being programmed to execute specific operations on occurrence of specific events of significance. The PLC should be capable of communicating with remote I/Os over a minimum distance of 500 Mtrs.
- d. In case of any kind of communication failure or when PLC in off state (program mode), the controller should be capable of holding on to its outputs. Online Editing of the program application should be possible to facilitate any required edits without any interruption in the plant operation.

## **15.10 PLC Hardware and Software**

- a. The PLC programming shall be prepared using the PLC manufacturers recommended windows-based PLC coding and documentation software. The PLC code shall be structured in the
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manner of the best industry standard and have comprehensive sub routine and rung annotation. Ladder program will be preferred.

- b. The PLC shall be commissioned using RAM memory storage modules, which shall be replaced with an EPROM or EEPROM when testing is complete.

Sr. No.	DESCRIPTION	PARTICULARS	TO FURNISHED BY BIDDER	BE BY
A	Operating Temperature	-05 <sup>0</sup> ...65 °C		
B	Storage Temperature	-20 <sup>0</sup> ...85 °C		
C	Relatively Humidity	5...95% non condensing		
D	Vibration	Operating 10...500Hz, 5 g. 0.015 in max peak to peak (relay operation 1.5 g)		
E	Shock, Operating	30 g; 3 pulses each direction, each axis (relay operation: 10 g)		
F	Shock, Non Operating	50 g; 3 panel mounted (40 g Din rail mounted); 3 pulses, each direction, each axis		
G	Certification	UL listing industrial control equipment for use in class , division 2, Hazardous location, groups A.B.C.D.		
H	Input Power	24 V DC		
I	Memory	Non – volatile battery backed RAM		
J	User Program memory	Minimum 500 Kbytes		
K	User Data Space	500 Kbytes		
L	Data logging	Up to 128 Kbytes for data logging		
M	Battery back up	Required		
N	Back up memory module	Required		
O	Provision for I/O	Minimum 50 modules per controller		
P	Serial ports	One RS-232/Rs-485 Configurable		
Q	Serial protocols	Serial duplex		



Sr. No.	DESCRIPTION	PARTICULARS	TO FURNISHED BY BIDDER
		Serial Half duplex master / Slave Serial radio Modem Modbus RTU master / slave ASCIL	
R	Real Time clock	Required (embedded)	
Q	PID	Required (multiple loops)	
R	Network options	Minimum 2 network communication moduls	
S	Supported Data type	Minimum Requirement: Real, Double, Integer, Integer, Messaging, Timer, Counter, string, PID, Filter, Boolean etc.	

#### 15.11 PLC SYSTEM CABINET / CONTROL DESK

##### 15.11.1 GENERAL TECHNICAL REQUIREMENTS

- a. Control panels shall be prefabricated type. Sourced from Approved Vendors
- b. Control Panel shall be CNC machine prefabricated out of CRCA sheet steel of thickness not less than 2 mm, modular in construction, properly reinforced, powder coated and having rigid frame structure. Internal mounting plate including the gland plate shall be 3 mm thick. The control panel shall have dimensions as per system requirement. However, the control panel height shall not exceed 2200 mm.
- c. The exterior corners and edges shall be rounded to give a smooth overall appearance with projections kept to a minimum.
- d. Lifting lugs shall be provided for installation purposes and shall be replaced with corrosion resistant bolts after installation.
- e. Control Panel shall be completely metal enclosed and shall be dust, moisture and vermin proof. Panel enclosures shall provide a degree of protection not less than IP 52 in accordance with IS: 13947 Part-I
- f. Control Panel shall be freestanding type. There shall be sufficient reinforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation.

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- g. Metals sills in the form of metal channels properly drilled shall be furnished along with anchor bolts and necessary hardware for mounting the control panels. These shall be dispatched in advance so that they may be installed and levelled when concrete foundations are poured.
  - h. Cable entries to the panels shall be from the bottom with fire retardant spray compound sealing. Control panels shall be provided with louvers along with washable micron filters AIRIN – AIROUT fans will be provided.

#### **15.11.2 MOUNTING**

- a. All equipments on front of panel shall be mounted flush or semi-flush. In case of semi-flush mounting, only flange or bezel shall be visible from the front.
- b. Equipment shall be mounted such that removal and replacement can be accomplished individually without interruption of service to adjacent equipment.
- c. Equipment mounted inside the panel shall be so located that terminals and adjacent devices are readily accessible without the use of special tools. Terminal markings shall be clearly visible.

#### **15.11.3 EARTHING FOR INSTRUMENTS**

- a. The panel shall be equipped with an earth bus securely fixed along the inside base of panel.
- b. All metallic cases of instruments and other panel mounted equipment shall be connected to the instrument earth bus.
- c. Looping of earth connections which would result in loss of earth connection to other devices when the loop is broken shall not be permitted. However, looping of earth connections between equipment to create alternative paths to earth bus shall be provided.
- d. A separate instrument earth bus will be created which will be floating and all the cable shields will be terminated onto this bus. This bus will be connected to an electronic earth pit.

#### **15.11.4 FRAME EARTHING**

All metal parts other than those forming part of an electrical circuit shall be connected to a copper earth bar run along the inside bottom of the panel. The minimum section of the earth bar shall be 25 mm x 3 mm. A 15 mm diameter hole is to be provided at each end of the bar. Connection of the earth bar to the station earth shall be carried out by Contractor.

#### **15.11.5 SPACE HEATER**

Strip type space heaters of adequate capacity shall be provided inside control panels to prevent moisture condensation on the wiring and panel mounted equipment when the panel is not in operation. The heaters shall operate on 230 V AC. Heaters inside the panels shall not be mounted

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close to the wiring or any panel mounted equipment. The operation of heaters shall be controlled by thermostats.

#### **15.11.6 INTERIOR LIGHTING AND RECEPTACLES**

- a. Each panel shall be provided with either a CFL lighting fixture rated for 11 watt, 230V, 1 phase, 50 Hz supply for the interior illumination of the panel during maintenance. The illumination lamp shall be operated by door switch or manual switch. Each panel section shall be provided with separate lighting.
- b. Each panel shall be provided with 230V, 1 phase, 50 Hz, combined 5 amps and 15 amps, 3 pin receptacles with a switch and neon indicating. The receptacle with switch shall be mounted inside the panel at a convenient location. If the panel has front and rear doors then maintenance socket shall be provided at both locations.

#### **15.11.7 VOLTAGE LEVEL AND POWER SUPPLY UNITS**

Generally, voltage levels for control schemes and power supply for instruments in the panels shall be limited to 24 V DC. In case the instruments require power supply other than 24 V DC, Contractor shall provide necessary transformers, converters, inverters and other associated hardware required to generate the requisite power supply. The power supply distribution board for panel mounted and field mounted instruments shall be provided. Power supply to all the instruments mounted outside the control panel shall be provided from the power supply units in the control panel. The power supply to all the instruments shall be without interruption and shall be continued even in case of failure of 230 V A.C. power supply. UPS sizing should take this into consideration.

#### **15.11.8 LABELS**

All the equipment mounted on the front facia of control panel as well as equipment mounted inside the panels shall be provided with individual labels with equipment designation engraved. The labels shall be mounted directly below the respective equipment. Also the panel shall be provided at the top with a label engraved with panel designation.

#### **15.11.9 SWITCHES AND MINIATURE CIRCUIT BREAKERS (MCBS)**

Each control panel shall be provided with necessary arrangement for receiving, distributing, isolating and protecting of DC and AC supplies for various control, signaling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with Miniature Circuit Breakers (MCBs). Potential circuits for relaying and metering also shall be protected by MCBs. All such MCBs will be provided with an auxiliary contact to be used for providing MCB tripped alarm.

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#### **15.11.10 PANEL INTERNAL WIRING**

- a. Connections within a panel, between panel mounted devices and terminal blocks or between two panel mounted devices will be made by 660 volt grade, stranded copper conductor insulated with PVC and designed for a minimum conductor temperature of 90 degrees centigrade. The wires shall be shielded, where necessary.
- b. Panels shall be supplied completely wired internally, with a colour coding scheme decided mutually between the Purchaser and the Contractor, to equipment and terminal blocks and ready for external cable connections at the terminal blocks. Wires within the panel shall be continuous i.e. without splicing and shall comprise stranded copper conductors. Internal wiring or wiring between the two assemblies shall be commensurate with mechanical safety.
- c. Wire termination shall be made with solder less crimping type of tinned copper lugs which firmly grip the conductor and insulation. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules, marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wires and shall not fall off when the wire is disconnected from terminal blocks. The ferrule system shall adopt single tube printed arrangement so that all the characters remain on one line always & hence easily readable

#### **15.11.11 TERMINAL BLOCKS**

- a. Terminal blocks for power connection shall be 660V grade, 20 amps rated, one-piece moulded, complete with stud type terminals, washers, nuts and lock nuts and identification markings. Terminal block design shall include a white fiber marking strip with clear plastic, hinged terminal covers. Markings on the terminal strips shall correspond to wire numbers on the wiring diagrams. All control output terminals will be fused type and all other input signal terminals will be clip on shrouded type.
  - b. All spare contacts and terminals of the panel mounted equipment and devices shall be wired to terminal blocks.
  - c. There shall be a minimum clearance of 250 mm between the first row of terminal blocks and the associated cable gland plate. Also the clearance between two rows of terminal blocks shall be a minimum 250 mm.
  - d. Panel internal wiring shall not be looped directly from instrument to instrument. The same shall be looped through the panel terminal block only.
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- e. If accidental short circuiting of certain wires is likely to result in malfunction of equipment, such as closing or tripping of a breaker or positive and negative wires,
  - f. these wires shall not be terminated on adjacent terminal blocks.

**15.11.12 CABLE SUPPORTS**

All external cables shall present a neat appearance and shall be suitably braced, placed in toughing clipped or laced to prevent effects of vibration.

**15.11.13 TERMINAL / IDENTIFICATION**

Every terminal and test plug shall be uniquely identified within the terminal cabinet by means of a terminal number. Appropriate labels shall be used to permit quick and unambiguous identification of each terminal and test plug.

**15.11.14 PAINTING OF SYSTEM CABINET/ CONTROL DESK**

All sheet steelwork shall be phosphate in accordance with the following procedure:

- a. The pre- treatment shall be hot process with running water for rinsing.
  - b. Oil, grease & dirt shall be thoroughly removed by emulsion cleaning.
  - c. Rust and scale shall be removed by trickling with clean water followed by final rinsing with dilute dichromate solution.
  - d. The control panel shall be powder coated. Thickness of coating of minimum 60 microns. QA test certificate shall be furnished for thickness adhesion and hardening of powder coating.
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## 16.CCTV SYSTEM

### 16.1 GENERAL

Design, Supply, Laying, Installation, Testing, Implementation and successful Commissioning of CCTV surveillance system at Pumping Station is in the scope of this tender.

- a. Provide and test a complete Closed-Circuit TV system(s) with Cameras, Control Units, Video matrix, DVR, Monitors etc. as required to monitor the total Pumping Station, other Rooms & its outdoor area including 66KV Substation.
- b. The surveillance system is required to ensure effective surveillance of Pumping Station area as well as to create a tamper proof record for post event analysis.
- c. The System shall provide an online display of video images on TFT monitors located in control room.
- d. System should facilitate viewing of live and recorded images of all Cameras by the authorized users.
- e. System should provide inter-operability of hardware, OS, software, networking, printing, database connectivity, reporting, and communication protocols.
- f. System expansion should be possible through off-the-shelf available hardware.
- g. The location of the Cameras and number of cameras required to be finalized for a proper view and monitoring of the place, by Contractor.
- h. Provide DVR at the control room and shall have minimum 3-month data of storage.

### 16.2 GENERAL REQUIREMENT

The CCTV System shall have following minimum general features:

- a. All the equipment of CCTV namely Indoor /outdoor cameras, DVR and monitoring software shall be of one make only.
- b. Manufacturer products shall have quality system compliance with the ISO/BIS etc.
- c. All the CCTV products quoted must be UL approved or equivalent.
- d. All the equipment of external fitment should be IP-66 complied.
- e. Manufacturer must provide reference list of installation for similar products / components.
- f. All software and firmware upgrades shall be free of charge.
- g. Separate SMPS shall be provided for CCTV System.

### 16.3 MATERIAL SPECIFICATIONS

This section of the specifications includes the furnishing, installation, and connection of the CCTV system equipment required to form a complete coordinated system ready for operation. CCTV system shall comprise of the following

#### a. Indoor CCTV CAMERA

Indoor Dome CCTV Camera Characteristics	Minimum Specifications
Image sensor	1/2.7"Progressive Scan CMOS
Lens	3 to 9 mm
Field of View	37.5°~ 103.7°(horizontal) 21.6°~ 71.2°(vertical)42.6°~111.2 1°(diagonal)
Day and Night	Automatic/manual/scheduled
Minimum Illumination/Light Sensitivity	Colormode:F1.2 @0.4 lux, Blackand whitemode:F1.2 @0.2 lux
Video Compression	H.264MotionJPEG
Resolutions and frame rates(H.264)	1920 x 1080 @30 fps(1080p) ,1280 x 720 @ 30 fps(720p) ,1024 x 576@30 fps, 960 x 544 @30 fps, 704 x 480or 576@30 or 25fps (4CIF), 640x 368 @30fps, 352 x 240or 288 @30 or 25fps(CIF)
PoE	802.3afcompliant(Class3)
Camera Adjustment Angle	Pan:350° Tilt:80° Rotate:350°
Remote, Auto Focus support	Yes
Motorized Lens	Yes
Digital I/O( Audio I/O, Alarms)	Audio in x 1(Φ3.5 miniature jack)A/Voutx1 (Φ3.5miniaturejack)DIx 1, DO x 1
Local storage(S.D or Micro SD)	Mirco SD/SDHC

Supported Protocol	Dynamic Host Control Protocol (DHCP), Hyper text Transfer Protocol (HTTP), Secure HTTP (HTTPS), Network Time Protocol (NTP), Real-Time Transport Protocol (RTP), Real-Time Streaming Protocol(RTSP),Simple Mail Transfer Protocol (SMTP), Secure Sockets Layer / Transport Layer Security (SSL/TLS), TCP/IP, Secure Real –Time Transport Protocol (SRTP), Bonjour, Simple Network Management Protocol (SNMP), and Secure Shell (SSH) Protocol. Differentiated – services – code –point (DSCP) marking and class – of – service (CoS) marking
ONVIF	ONVIF 2.0 Support
Operating Temp	-10 <sup>0</sup> to 50°C
Auto Detection & Configuration	The camera should be automatically discovered and configured when connected to VMS or Network Switch, to set the right network parameters for the video stream on the network
Certifications	UL,FCC, EN

**b. Outdoor Pan Tilt Zoom (PTZ) CCTV Camera**

Indoor Dome CCTV Camera Characteristics	Minimum Specifications
Image sensor	1/2.7"Progressive Scan CMOS
Lens	3 to 9 mm
Field of View	37.5°~ 103.7°(horizontal) 21.6°~ 71.2°(vertical)42.6°~111.21° (diagonal)
Day and Night	Automatic/manual/scheduled
Minimum Illumination/Light Sensitivity	Colormode:F1.2 @0.4 lux, Black and whitemode:F1.2 @0.2 lux
Video Compression	H.264MotionJPEG
Resolutions and frame rates(H.264)	1920 x 1080 @30 fps(1080p) ,1280 x 720 @ 30 fps(720p) ,1024 x 576@30 fps, 960 x 544 @30 fps, 704 x 480or 576@30 or 25fps (4CIF), 640x 368 @30fps, 352 x 240or 288 @30 or 25fps(CIF)
PoE	802.3afcompliant(Class3)



Camera Adjustment Angle	Pan:350° Tilt:80° Rotate:350°
Remote, Auto Focus support	Yes
Motorized Lens	Yes
Digital I/O( Audio I/O, Alarms)	Audio in x 1(Φ3.5 miniature jack)A/Voutx1 (Φ3.5miniaturejack)DIx 1, DO x 1
Local storage(S.D or Micro SD)	Mirco SD/SDHC
Supported Protocol	Dynamic Host Control Protocol (DHCP), Hyper text Transfer Protocol (HTTP), Secure HTTP (HTTPS), Network Time Protocol (NTP), Real-Time Transport Protocol (RTP), Real-Time Streaming Protocol(RTSP),Simple Mail Transfer Protocol (SMTP), Secure Sockets Layer / Transport Layer Security (SSL/TLS), TCP/IP, Secure Real –Time Transport Protocol (SRTP), Bonjour, Simple Network Management Protocol (SNMP), and Secure Shell (SSH) Protocol. Differentiated – services – code –point (DSCP) marking and class – of – service (CoS) marking
ONVIF	ONVIF 2.0 Support
Operating Temp	-10 <sup>0</sup> to 50°C
Auto Detection & Configuration	The camera should be automatically discovered and configured when connected to VMS or Network Switch, to set the right network parameters for the video stream on the network
Certifications	UL,FCC, EN

Camera Adjustment Angle	Pan speed:0.05°~ 450°/sec,Tilt speed:0.05° ~ 450°/secPan:Continuous360°,Tilt:220°,Zoom:20
Remote, Auto Focus support	Auto Focus
Motorized Lens	Yes
Digital I/O ( Audio I/O, Alarms,	Audio in x 1(Φ3.5 miniature jack)Audio out x 1(Φ3.5miniaturejack)DIx4DO x 2
Local storage(S.D or Micro SD)	Mirco SD/SDHC

Supported Protocol	Dynamic Host Control Protocol (DHCP), Hyper text Transfer Protocol (HTTP), Secure HTTP (HTTPS), Network Time Protocol (NTP), Real –Time Transport Protocol (RTP), Real-Time Streaming Protocol (RTSP), Simple Mail Transfer Protocol (SMTP), Secure Sockets Layer / Transport Layer Security (SSL / TLS), TCP / IP, Secure Real – Time Transport Protocol (SRTP), Bonjour, Simple Network Management Protocol (SNMP), and Secure Shell (SSH) Protocol. Differentiated – services – code – point (DSCP) marking and class – of – service (CoS) marking
ON VIF	ON VIF 2.0 Support
Operating Temp	-5 <sup>0</sup> to 55°C
Auto Detection & Configuration	The camera should be automatically discovered and configured when connected to VMS or Network Switch, to set the right network parameters for the video stream on the network
Certifications	UL,FCC, EN

## 16.4 Video Management System Software

### 16.4.1 General Requirements

- The surveillance system shall provide a highly scalable and reliable platform to enable customized, network-based surveillance applications. The surveillance system shall be open standard supporting multiple vendor IP cameras and encoder manufacturers within the same system. The system shall support seamless integration of all ONVIF compliant cameras.
- The system shall support digital pan-tilt-zoom on live or archived video.
- The surveillance system viewing system should be in thick client for local viewing and thin client through http browser for remote viewing.
- Both thin and thick client shall provide the capability of viewing single or multiple live and archive cameras, control PTZ camera.
- The proposed surveillance system can be supported by the existing network infrastructure. The System shall support the scalability of additional camera installation beyond the originally planned capacity.

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- f. The proposed video management system shall support deploying the software on Virtual servers, thus minimizing the hardware foot print for the project. The system shall have capability to stream video at remote sites by optimizing the bandwidth on WAN.
  - g. The system shall be able to trace the end to end video traffic and shall be able to pinpoint the problematic nodes on the network that will affect the quality of video being streamed from the camera to servers. Auto-discovery and provisioning Simplify trouble shooting with end-to-end visualization of video flows and on-demand.
  - h. Enables fast, accurate resolution of wired or wireless performance issues for end-to-end traffic
  - i. Easily fix video performance issues
  - j. Perform pre-deployment assessment and capacity planning System Features
  - k. Video Surveillance Storage System – The video surveillance storage system shall provide multiple options to store video. Server internal storage shall be augmented by Direct Attached, SAN. The video surveillance storage system shall store video in loops, one- time archives, or event clips triggered by alarm systems. It shall provide for RAID 6 storage.
  - l. The system shall support Video display up to 16 cameras per screen, and 2 screens per workstation.
  - m. The Video display shall be intelligent that can be automatically change view based on the event such as motion started/stopped, video analytic, camera digital input contact closed/opened,
  - n. The system shall provide for integration with other software applications through an open and published Application Programming Interface (API). Such applications shall include, but not be limited to, access control, video analytics, and other alarm and sensor inputs.
  - o. The system shall support the Redundancy / Fail-over feature in case of failure of NVR/Camera server the relevant cameras shall automatically switch over to the redundant NVR/Camera Server.
  - p. The system shall support the camera storage redundancy with the following different options.
  - q. Primary camera stream to primary NVR / Camera Server and secondary stream to secondary NVR/Camera Server.
  - r. Primary camera stream to both the primary and the redundant NVR/Camera Server.
  - s. Both camera primary and secondary streams to both the primary and the redundant NVR/Camera Server, The system shall provide the Audio record option on Live Only, Live & Archive, Audio Recording Off. The Audio recording shall be configurable on per camera basis, or template based for a group of cameras.
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- t. The system shall have a centralized server that will be installed at Primary Data Center for all configuration and access management. The system shall have the capability and facility to distributed architecture in the future.
  - u. System shall have both video management and video stream storage management. Recording frame rate, resolution, bit rate with respect of individual channel shall be programmable.
  - v. The system should ensure that once recorded, the video cannot be altered; ensuring the audit trail is intact for evidential purposes.
  - w. The area under surveillance shall be monitored and controlled through workstations and Video display Monitors
  - x. The system must provide a built-in facility capable of embedding digital signature for irreversibly embedding information to the video to ensure tamperproof recording.
  - y. In order to optimize the memory, while recording, video shall be compressed using MPEG-4, Motion JPEG, H.264 or better standard over the network and can be viewed on the control room workstation.
  - z. The system software shall support flexible 1/2/4/16 Windows split screen display mode or scroll mode on the PC monitor or on Video preview monitor as per site requirement.
  - aa. All camera recordings shall have camera ID and location or area of recording and shall be programmable by the system administrator with user ID and password.
  - bb. The system shall provide the facility of viewing, recording and replay simultaneously and shall be capable of frame by frame analysis.
  - cc. The offered system shall have the facility to export the desired portion of clipping on CD, DVD or any storage device. Viewing of this recording shall be possible using standard media players.
  - dd. The software should be able to control all cameras i.e. PTZ control, Iris control, auto manual focus, color balance camera, video tour selection etc.
  - ee. The software is required to generate reports of stored device configuration. It is required to provide alarm and alarm log and shall be able to be archived, printed and displayed.
  - ff. The system shall provide User activity log (audit trail) with user ID, time stamp and action performed, etc.
  - gg. System shall support camera template to define the resolution, frame rate, recording duration, and then apply to a group of cameras. The modification of the template will be reflected to all the cameras under the template.
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- hh. It should provide programmable motion detection and recording, to be defined area-wise.  
The system must be able to support video motion detection algorithms to detect moving object or person.
  - ii. The system software for clients should also be working on a browser based system for remote users. This will allow any authorized user to display the video of any desired camera on the monitor with full PTZ and associated controls.
  - jj. The system administrator should be able to add, edit and delete users with rights. It shall be possible to view ability or rights of each user or the cameras which can be viewed and controlled as per the permission assigned by the administrator.
  - kk. The system shall support local administration role. Each local administrator shall be able to add, manage and remove local users.
  - ll. The system shall provide sufficient storage of all the camera recordings for a period of thirty (30) days using necessary compression techniques.
  - mm. The system shall have the provision to automatically over-write the old information after the period of thirty (30) days and necessary script or algorithm in the application.
  - nn. The video surveillance application should allow retrieval of data instantaneously or any date or time interval chosen through search functionality of the application software. The system should also allow for backup of specific data on any drives like CD, DVD, external storage or any device in a format which can be replayed through a standard media player. Log of any such activity should be maintained by the system which can be audited on a later date.
  - oo. The system shall support Bulk Action to allow searching and performing administration activities on multiple cameras.
  - pp. The system shall support Bulk import of cameras from file such as excel, .csv, or other standard file format. The files shall include camera name, ip address, server, template, location, camera username and password

#### **16.4.2 Operator Console Features**

- a. The system shall support security operation client for day-to-day operation only. This client shall not have the system level management capability. The security operation client shall be able to leverage the dual screen capability.
  - b. The system shall support the map capability. The map shall have hierarchy with the root map at the top, and then the lower level of maps based on the locations. The system shall allow the importing of the user maps in the format of JPEG, GIF, PNG, BMP, TIFF.
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- c. The system shall support to overlay of cameras on the map. The camera icons shall be rotatable toward direction that it is facing.
  - d. Allow user to choose camera from maps to view live video.
  - e. Allow user to choose camera icon from map to view recorded with the capability to play,pause, stop, fast-forward, rewind, and play recorded video from preset time. Allow user to choose camera icon from map.
  - f. Allow user to choose camera and toggle full screen view. Allow user to choose camera from map to move PTZ cameras.

#### **16.5 TRAINING AND HANDING OVER OF DOCUMENTS**

After successfully testing and commissioning of CCTV system the Contractor shall give training to the Owner and hand over all operation and maintenance manuals, certificates and documents to the Owner.

## 17.DATASHEET FOR INSTRUMENTATION

### 17.1 Electromagnetic Flowmeter (Each Pumping Station)

Sr. No.	DESCRIPTION	PARTICULARS
A	Process Liquid	
1	Liquid Type	Raw water
2	Type of solid	To be ascertained
b.	Operating Condition	
1	Operating pressure	PN -1.6
2	Operating temperature	0°C to 50°C.
3	Operating Range	Bidder to Furnish
4	Size	As Per Design
5	Qty	As Per design
c.	Flow Sensor	
1	Type	Pulsed DC excitation
2	Wetted parts	SS 316
3	Sensor Output	4-20mA DC, smart HART protocol, Mod bus RS-485
4	End connections	Flanges of Carbon steel
5	Electrode Material	SS316/ SS 316 L/ Hastelloy
6	Coil Housing	SS304/ Die Cast Aluminium/ Carbon steel with Anticorrosive Paint Coil Housing
7	Meter Tube	SS304
8	Electrode Type	Round Head Electrodes
9	Lining Material	Hard Rubber (SBR or EPDM )/Neoprene
10	Protection Category	IP 68
.d.	Flow Transmitter	
1	Type	Multi-channel microprocessor based with facility to input pipe size, Engineering units, measuring span etc
2	Power supply	240 V AC, 50 Hz, Zero and span adjustment, battery backup for totalized flow.
3	Communication	RS-2485, Modbus, Ethernet Flow Meter will communicate to PLC/ Data Logger/ RTU through Digital output
4	Data Logger/Local storage (Internal/ External)	Flow Meter reading can be log/ store locally in data logger for every 15 minutes Minimum 30 days storage required in Data logger.

Sr. No.	DESCRIPTION	PARTICULARS
5	Protection category	IP 67
6	Communication Protocol	<ul style="list-style-type: none"> <li>• Push-Pull type where flow meter is 230 VAC flow meters.</li> <li>• Push type where flow meter is inbuilt battery-operated.</li> <li>• Communication from the Flow Meter (Both ways) -Remote Terminal Unit (RTU) to Centralized Monitoring Station (CMS) shall be through any cellular/ wireless technology provided through reliable Telecom Service provider (TSP).</li> <li>• In case of GSM/ GPRS based communication system: required SIM cards and its subscription; recurring charges shall be borne by Tenderer/ bidder as per below.</li> <li>• SIM card shall be purchased from reputed TSP who have more than 25 lacks customer in Gujarat.</li> <li>• SIM cards and its subscription shall be borne by bidder</li> <li>• In case of 230 VAC flow meter, Time stamped data shall be transfer from Flow meter-RTU to CMS at every 15 minutes.</li> <li>• In case of battery-operated flow meter, time stamped data for every 15 minutes shall be saved locally and after every 12 hours data will be transferred from Flow meter</li> </ul>
7	Measuring accuracy	Measuring accuracy +/-0.5% of Measured Value inclusive of Linearity, repeatability.
e.	Digital flow indicator & integrator	
1	Type	Microprocessor based combined unit, 12.5mm or higher digit height, Input: 4-20 mA DC (isolated) from flow transmitter, Accuracy : $\pm 0.25\%$ of span or better
2	Display	Min. 2 line back lit LCD for indication of actual flow rate, forward, reverse, sum totalizes
3	Protection category	IP 67
4	Enclosure	Die cast aluminium/ polycarbonate/ SS316 with Anticorrosive Paint/ PU finish with glass window enclosure
5	Power supply	240 V AC, 50 Hz
6	Mounting	Panel mounted



### 17.2 Ultrasonic Type Level Measuring System (Each Pumping Station)

Sr. No.	DESCRIPTION	PARTICULARS
a.	Make	As per approved vendor list
b.	General	
1	Service	Raw water
2	Quantity	As Per Design
3	Accuracy of measuring loop	$\pm 0.5\%$ of full scale
4	Mounting	Vertical
c.	Sensor	
1	Output	4-20 mA
2	Mounting	Field/Panel mounted
3	Range	0-10 meter (or as per site requirement)
D	Level sensor	
1	Principal of Operation	Detection of reflected ultrasonic pulse
2	Degree of Protection	IP68
3	Temp. Compensation	Automatic Integral Temperature Compensation
e.	Transmitter	
1	Type	Microprocessor based with backlit LCD/LED display
2	Power supply	240 V AC, 50 Hz, Zero and span adjustment, battery backup for totalized flow.
3	Cable entry	$\frac{1}{2}$ "-1/4 NPT Conduit entry for cable glands
4	Resolution	0/1 % of span
5	Relay output	2 Integral Signal Relays for Local Control
f.	Enclosure	Epoxy painted dies cast aluminium or Polycarbonate housing.
g.	Analogue signal multipliers	Required with galvanic isolation and 2 outputs
h.	Operating Temperature	0°C to 70°C
i.	Output contacts	2 SPDT Potential free changeover contacts @ 240V, 5A AC/220V, 0.5A DC

### 17.3 Float And Board Type Level Indicator (Each Pumping Station)

Sr. No.	DESCRIPTION	PARTICULARS
A	Process Fluid	
	Liquid Type	Raw water
	Type of solid	To be ascertained
B	Operating Condition	

Sr. No.	DESCRIPTION	PARTICULARS
	Operating temp	0°C to 50°C
C	Make	As per approved vendor list
D	General	
1	Service	Level measurement in sump/Forebay
2	Quantity	Bidder to specify
3	Resolution/Accuracy	± 10mm
4	Scale colour	White
5	Numerals colour	Black
6	Measuring Range	0-10 meter (or as per site requirement)
E	Material	
1	Float	SS316
2	Guide Wire	SS316
3	Spring Assembly	Spring Steel
4	Board	Aluminium white powder coating with black graduation.
F.	Mounting	Underground sump
G	Local Indication (Direct)	Powder coated Red CI pointer with Nylon Rollers
H	Accessories	Anchor plate, Bracket, fastener etc.

#### 17.4 Conductivity Type Level Switch (Each Pumping Station)

Sr. No.	DESCRIPTION	PARTICULARS
A	Process Fluid	
1	Liquid type	Raw water
2	Type of solid	To be ascertained
B	Operating condition	
	Operating temp	0°C to 50°C
C	Make	As per approved vendor list
D	General	
1	Service and type	Level Measurement in sump/forebay/Suspended Electrode (Four Levels)
2	Range	0-10 meter (or as per site requirement)
3	Electrode Insulation	PVC
4	Mini Conductivity	25 Micro Siemens
5	Enclosure	IP 66
6	Process Connection	SS 316, Flange type

### 17.5 Pressure Gauges with Electrical Contact (Each Pumping Station)

Sr. No.	DESCRIPTION	PARTICULARS
A	Process Condition	
1	Process Fluid	Raw water
2	Type of solid	To be ascertained
B	Operating temp	0°C to 50°C
c	Make	As per approved vendor list
D	Type	Bourdon type glycerine filled
E	Range	0-20 kg/cm <sup>2</sup>
	Scale	Black lettering on white in 270 Degree
F	Dial Size	150 mm dia.
G	Accuracy	± 1 % full scale and weather protection class IP 67
H	MOC Body and wetted part	SS 316
I	Over-range protection	125% of max range
J	Adjustment	Micrometre screw for zero. Internal micrometre screw for range
K	Accuracy	±1% full scale
L	Safety feature	Blow out disc
M	Dial Type	White background on scale in black
N	Pointer	SS with micro zero adjustment
O	Applicable Standard	IS-3624 / 1996
P	Process connection	As per site requirement
Q	Switch Contact	1 NO + 1 NC
R	Switch Rating	24 VDC,2A
S	Switch Type	Micro Switch

### 17.6 Pressure Transmitter (Each Pumping Station)

Sr. No.	DESCRIPTION	PARTICULARS
a.	Make	As per approved vendor list
b.	General	
1	Service	Pressure measurement on delivery line & on discharge header
2	Quantity	As per requirement
3	Accuracy of measuring Loop	± 0.5% of Measured value inclusive of linearity, repeatability
4	Operating temp	0°C to 50°C
c.	Pressure Sensor & Transmitter	
1	Sensor	Diaphragm Sensor 2 wire Smart pressure transmitter with local span and zero adjustment.
2	Wetted parts material	SS 316
3	Range	0-16 kg/cm <sup>2</sup>
4	Zero & Span Adjustment	Required
5	Output signal	4-20mA, DC
6	Enclosure Protection	IP 67
d.	Remote display Unit	Digital panel meter with 3½ digit backlit LCD/LED, ± 0.25% accuracy, high and low alarm set point, input 4-20 mA D.C.
e.	Analogue signal multiplier	Required with galvanic isolation and dual output
f.	Turn Down Ratio	100:1
g.	Response Time	100ms or better
h.	Accessories	Cable gland, prefab cable etc.
i.	Resolution	0.1% of Span

### 17.7 Instrumentation cable (Each Pumping Station)

Sr. No.	DESCRIPTION	PARTICULARS
1	Make	As per approved vendor list
2	Conductor Type	Stranded annealed tinned copper
3	Conductor size	0.5/1.0/1.5 sqmm (as required)
4	Conductor resistance	39Ω/Km/18Ω/Km/12Ω/Km
5	Conductor insulation	HR PVC Type-C (IS-5831,1984) 0.6 mm thick
6	Operating voltage	650 V / 1100V
7	Twisting	Twin twisted lay of 50mm
8	Twisting Direction	All pair in the same direction. Lapped to from bunch with Mylar tape.

Sr. No.	DESCRIPTION	PARTICULARS
9	Screen (Pair & Overall)	<p>Al Mylar tape with a thickness of 28 µm (min). for individual pair screen and 60 µm for overall screen with 100 % coverage and 25% overlapped edges. Over the individual pair screening tape two laps of 0.05 mm thick (min) polyester tape shall be applied with min overlap of 25%. Metallic side of the screen shall be in contact with drain wire.</p> <p>Analog signals –Individual pair &amp; overall shield to be considered.</p> <p>Digital signals- Overall shield to be considered</p>
10	Drain Wire	Annealed tinned copper wire, stranded. (No. of strands/ Size :-7 / 0.3 mm)
11	Inner sheath	Extruded FRLS PVC (anti rodent, anti-termite and moisture resistant properties) HR PVC Type ST2 of IS-5831, 1954 Thickness as per IS-1554, Part-I 1976
12	Rip cord	No-metallic under sheath
13	Armouring	GI wire/ strip as per IS 3975
14	Outer Sheath	Extruded FRLS PVC (anti rodent, anti-termite and moisture resistant properties) HR PVC Type ST2 of IS-5831, 1954 Thickness as per IS-1554, Part-I 1976
15	Filler	Non hygroscopic with FRLS property
16	Temp Range	85°C
17	Cross talk	60 dB
18	Attenuation	1.2 dB
19	Codes and Standards	BS 5308, IEC 332-1, IS-8130-1984,IS-1554 Part-1,IS-10810
20	Sheath colour	Inner-Black and Outer-Gray
21	Tests	<ul style="list-style-type: none"> <li>a) Oxygen Index : Min 29 at room temp.(ASTM-D-2863)</li> <li>b) Acid Gas Gen: Max 20% by weight as per IEC 754</li> <li>c) Tem Index: Min 250°C at 21 Oxy. Ind (ASTM-D-2863)</li> <li>d) Smoke and Density rating: Max 60% (ASTM-D-2843)</li> <li>e) Flammability Test: as per IEC 332 Part-I</li> <li>f) Insulation Resistance 100 MΩ/Km min</li> <li>g) High Voltage test core to core- 1.5 KV for 1 min. Core to screen- 1.0 KV for 1 min</li> <li>h) Rodent &amp; Termite repulsion test</li> </ul>

Sr. No.	DESCRIPTION	PARTICULARS
22	Colour code for Instrumentation Cable	As per IS -9938

#### 17.8 Power Supply cables To Instruments (Each Pumping Station)

Sr. No.	DESCRIPTION	PARTICULARS
A	Make	As per approved vendor list
B	voltage of cable	650v/1100v grade multi core cables
C	size & type	1.0 sq.mm stranded tinned copper conductor
D	Insulation	PVC insulated, with aluminium Mylar tape, ATC drain wire run continuously in contact with aluminium tape, inner sheathed with extruded PVC armoured with galvanised steel wire overall sheathed with extruded PVC conforming to is:1554 & iec:189 part ii.
E	Quantity	Bidder to specify

#### 17.9 Cables For Analog Signals (Each Pumping Station)

Sr. No.	DESCRIPTION	PARTICULARS
A	Make	As per approved vendor list
B	Voltage of cable	660 V/1100 V annealed, tinned, high conductivity
C	Size & Type	1.0 sq.mm stranded copper conductor
D	Insulation	PVC insulated two cores twisted into pair laid up collectively, individual pair shielded and overall shielded with aluminium Mylar tape, ATC drain wire run continuously in contact with aluminium side of the tape, inner sheathed with extruded PVC, armoured with galvanised steel wire, overall sheathed with extruded PVC conforming to IS:  1554 & IEC:189 Part II.
E	Quantity	Bidder to specify

#### 17.10 Instrumentation Panel along with PLC, annunciator & associated hardware (Each Pumping Station)

Sr. No.	DESCRIPTION	PARTICULARS
A	Make	As per approved vendor list
B	Panel Enclosure	M.S.
C	Relay	6 NO + 6 NC
D	MCCB	TPN TYPE
E	Power Supply	230V AC/ 24V DC
F	Earthing	Power and Instrumentation Earthing shall be separate
G	Push Button	For Reset, Accept & Test
H	Hooter	Required, electronic type
I	Power Supply status indication	Required
J	Weather Protection	IP – 55 of IS-13947
K	<b>ANNUNCIATOR</b>	
L	Hooter / Type	Microprocessor based, split type with alarm windows mounted on the front door and electronic modules inside the panel
M	Mounting	Flush with panel
N	Construction	Modular
O	Inputs	Potential free NO/NC contacts
P	Window type	Pls furnish
Q	Size of Window	Pls furnish
R	No. Of Window	As Required

#### 17.11 SCADA Server cum Operator workstation (Each Pumping Station)

Sr. No.	DESCRIPTION	PARTICULARS
A	Operating Temperature	-05...65 °C
B	Storage Temperature	-20...85 °C
C	Relatively Humidity	5...95% non condensing

Sr. No.	DESCRIPTION	PARTICULARS
D	Vibration	Operating 10...500Hz, 5 g. 0.015 in max peak to peak (relay operation 1.5 g)
E	Shock, Operating	30 g; 3 pulses each direction, each axis (relay operation: 10 g)
F	Shock, Non Operating	50 g; 3 panel mounted (40 g Din rail mounted); 3 pulses, each direction, each axis
G	Certification	UL listing industrial control equipment for use in class , division 2, Hazardous location, groups A.B.C.D.
H	Input Power	24 V DC
I	Memory	Non – volatile battery backed RAM
J	User Program memory	Minimum 500 Kbytes
K	User Data Space	500 Kbytes
L	Data logging	Up to 128 Kbytes for data logging
M	Battery back up	Required
N	Back up memory module	Required
O	Provision for I/O	Minimum 500 modules per controller
P	Serial ports	One RS-232/RS-485 Configurable
Q	Serial protocols	Serial duplex  Serial Half duplex master / Slave  Serial radio Modem Modbus RTU master / slave ASCII
R	Real Time clock	Required (embedded)
Q	PID	Required (multiple loops)
R	Network options	Minimum 2 network communication moduls
S	Supported Data type	Minimum Requirement: Real, Double, Integer, Integer, Messaging, Timer, Counter, string, PID, Filter, Boolean etc.
T	A4 size black & white Network Laser jet printer, minimum 250 paper input capacity, 1 port USB compatible with USB	1 No.



Sr. No.	DESCRIPTION	PARTICULARS
	2.0 specification with Ethernet 10/100 base, Separate power ON/OFF switch with required accessories to complete the system.	
U	A3 size black & white, Networkable Laser jet printer/scanner/copier, minimum 250 paper input capacity, 1 port USB compatible with USB 2.0 specification with Ethernet 10 / 100 base, separate power ON / OFF switch with required accessories to complete the system.	1 No.
V	Server System with 32" Monitor, 4GB ram, 500 GB hot swappable internal storage capacity for SCADA software package and database for Pumping station with suitable operating system, database, Historian & trend features, CAL licenses, antivirus software etc.	2 Nos.

#### 17.12 Managed Ethernet Switches (Each Pumping Station)

Sr. No.	DESCRIPTION	PARTICULARS
A	Make	As per approved vendor list
B	Type	Managed, Rack Mountable
C	Flash Memory	16 MB
D	DRAM	32 MB
E	Communication mode	Full Duplex , Half Duplex and Negotiation
F	Interfaces	10/100 Mbps RJ 45 port-8 Nos.
G	Features	Should support DHCP Support, VLAN, QoS Features, IGMP, STP, SNMP
H	Security	Shall Support port access authentication, Link Aggregation Control Protocol (LACP), SSL
I	Remote Management	Telnet, SNMP, HTTP
J	Operating Temp range	Ambient to 50 °C

Sr. No.	DESCRIPTION	PARTICULARS
K	Operating Frequency	50 Hz
L	Power rating	180 V -230 V AC
M	Accessory	Bidder to specify

#### 17.13 Uninterrupted Power Supply (UPS)

Sr. No.	DESCRIPTION	PARTICULARS
A	Type	Online double conversion single phase redundant network enabled UPS system
B	Output power capacity	As Per Design
C	Input Voltage	230 VAC $\pm$ 10%, 50/60 Hz
D	Output Voltage	230 $\pm$ 3% VAC, 50 Hz $\pm$ 3 Hz,
D	Transient Response	< 20ms
E	Total Harmonic Distortion	< 8%
F	Efficiency at full load	90%
G	Overload capacity	>100 % load for one minute.
H	Surge withstand capacity	Full time as per UL 1449
I	Type of cooling	Air cooling with fan
J	Enclosure	Metallic enclosure min 1 mm thickness
K	Control panel	LED/LCD status displays with load and battery bar graph, on line, on battery, replace battery, overload and bypass indicators.
L	Audible alarm	Alarm when on battery and overload alarm
M	Operating Temperature	0-50°C
N	Relative Humidity	<95%
O	Approvals	IEC 62040-2 / EN 60950

#### 17.14 Fixed day/night Camera (Each Pumping Station)

Sr. No.	DESCRIPTION	PARTICULARS
A	Image sensor	1/3-inch Digital CCD sensor with dynamic range.

Sr. No.	DESCRIPTION	PARTICULARS
B	Type of camera	Colour fixed Day/Night Vision Camera.
c	High sensitivity lux level	0.001 Lux
d	Switching system for IR filter for IR filter at Day/night.	Mechanically
e	Resolution	540TVL
f	Lens Mount.	Bidder to Specify
g	Night sense with S/N ratio	>50dB with Auto gain control.

#### 17.15 Digital Video Manager

Sr. No.	DESCRIPTION	PARTICULARS
a	Make	As per approved vendor list
b	Image sensor	1/3-inch Digital CCD sensor with dynamic range.
c	Video Input	8 Analog + 8 I/P
d	Resolution	Bidder to specify
e	Remote connection	LAN/WAN/TCP/IP
f	Network connection	RJ-45
g	Audio channel	2 Nos.
h	Alarm input and Output	16 & 4
i	Ambient temperature	50 ° C & more than 95%
j	Power supply	96 to 265 V AC
k	Model No	Bidder to specify

## Annexure A

### List of Minimum Items to be executed as per Schedule B-12 Item no -01

#### MECHANICAL ANNEXURE - INTAKEWELL TO GIDC RAHIYAD POND

Item No.	Description	Qty.	Unit
1	<p>VERTICLE TURBINE PUMP WITH INDUCTION MOTOR:</p> <p>Supply, Installation, testing And commisioning of verticle turbine pump motor set of specified duty parameters &amp; guaranteed efficiency of following MOC with specified capacity verticle solid staff TEFC squirrel cage induction motor working on three phase AC supply with 50 HZ+/-3%, 6.6KV +/- 10%, rated speed 1000 RPM along with column and bowl assembly, discharge head, base channel / RSj etc. complete as relevant IS.</p> <p>MOC: Impeller &amp; Sealing Rings: CF8M, Bowl &amp; Suction Bell: Cast Steel WCB , Shaft with coupling: SS 410, Column Pipe: MS ERW, Mechanical seal (above 30 kw),Base Plate: MS, Line Bearing: Thordon, Suction Strainer: S.S.<u>Discharge Capacity (Q) 3719 m3/hr at 48 m Head (H) each, Approx. 710 kW , 6.6 kV, 1000 RPM,</u> as per the detailed tender specifications. (8W+4S)</p>	12.00	Set
2	<p>Supply, Installation, Testing And Commissioning of PN-1.6, Double Flanged Dual Plate Check Valve (DPCV) conforming to API 594/598 Latest Amendment PN 1.6 with D.I. body, spring steel spring,S.S. seating with all carbon steel hardware's and other accessories as per data sheet and specification. Valve seat tested to 16 kg/cm2 and body to 24 kg/cm2. Flanges machined faced and drilled to IS : 1538 / 1976 Part-IV/VI Latest Amendmen. Hydraulic tests certificate &amp; certificate of material of construction of parts shall be submitted before despatch of valves as per design with required accessories, hardware, bolts, nuts, washers, rubber paking, necessary mounting supports etc. complete.</p> <p>Delivery Line (PN 1.6)</p>	12.00	No.
	Header Line (PN 1.6)	1.00	No.
3	<p>Supply, installation, testing and commissioning of Providing and supplying ISI mark DI D/F Butterfly Valves as per IS:13095 (Latest Edition) of following class and diameter including all taxes, insurance, transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to departmental stores, stacking etc. complete. along with required spare parts as per data sheet and specifications.</p>		
	Header Line (Electrically Operated) (PN 1.6)	1.00	No.
	Delivery Line (Electrically Operated) (PN 1.6)	12.00	No.

## Annexure A

### List of Minimum Items to be executed as per Schedule B-12 Item no -01

4	Supply, installation, testing and commissioning of Providing and supplying ISI mark DI D/F Sluice Valves as per IS:14846 (Latest Edition) of following class and diameter including all taxes, insurance, transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to departmental stores, stacking etc. complete. along with required spare parts as per data sheet and specifications.		
	Header Line (Gear Operated) (PN 1.6)	12.00	No.
5	Supply, Installation, testing & commissioning of flange ends Expansion Bellow as per EJMA standards of overall length of minimum 300 mm, designed for 15 mm axial compression and 5 mm axial extension with tie rods etc. of following MOC & pressure ratings. MOC: Bellows: SA 240 Gr. 304; Internal Sleeve: SA 240 Gr. 304; Weldends: IS 2062 Gr. B; Flanges: IS 2062 Gr. B (Drilling as per IS 1538 /IS 6392 ) & Limit Rods & Nuts: CS - IS 1367.		
	Header Line (PN 1.6)	1.00	No.
	Delivery Line (PN 1.6)	12.00	No.
6	Supply, Installation, Testing And Commissioning of DI Tempor proof Flanged Air Valve with Isolation Sluice Valve as per IS 14845 PN- 1.6 & IS-14846 PN-1.6 respectively with SS304 float, gun metal nozzle, complete hardware's, bolts, nuts & washers, gaskets etc. including all taxes, Insurance, Transportation, freight charges, Inspection charges, loading, unloading, conveyance to departmental stores, stacking, security etc. as per IS and Specification. (On Heder line outside the Pump house)	1.00	No.
7	Supply, Installation, Testing And Commissioning of MS Pipes conforming to IS-3589, fitted with flanges as required & drilled as per IS:1538/1976 Latest Amendment, Class-B duly painted by epoxy paint plus O/S 3LPE Coated M.S.Pipe and as per tender detailed specifications. (for pump set)		
	(for Header)	As Per Requirements	
	(for Delivery)	As Per Requirements	
8	Supply, Installation, Testing And Commissioning of following type of Flanged Type Fabricated MS Specials like tee, 900 bend, taper, distance pipe piece, flanges, blank flange, dismantling joint, bolts, nuts, washers, rubber packing etc, for delivery header and suitable for above pumpsets. Dimensions and Drilling of flanges should be as per IS:1538/1976. Flange faces should be machined and holes should be drilled on drilling machine. M.S pipe should be conforming to IS-3589/ 2001. M.S PIPE should be heavy Class upto 150 mm dia. From 200 mm dia. to 600 mm dia. x 6.35 mm thk, from 700 mm dia. to 1000 mm dia. x 8 mm thk. All specials & pipes should be painted by epoxy paint.	As Per Requirements	

## Annexure A

### List of Minimum Items to be executed as per Schedule B-12 Item no -01

	Supply, welding, installation, testing & commissioning of <b>MS Flat machined faced flanges</b> confirming to IS 6392 & drilled as per IS - 1538 with drilling off bolt holes and flanges thickness as per PN 1.0 including cutting & welding		
9	Supply, installation, testing and commissioning of MS specials for jointing pipes i.e. Bends, Concentric Expander, <b>Y-Joints</b> etc. complete as per dimensions confirming to IS 1538. M.S Specials	As Per Requirements	
10	Carbon steel hot dipped galvanized nuts, bolts, spring, washer, plate washer, gaskets and other required hardwares etc.	As Per Requirements	
11	Supply, installation, testing & commissioning Rectangular type double girder type fully electrically operated EOT crane with electrically operated hoist, class II duty, geared travelling trolley with seven meter lift complete with long travel rail track (40 mm sq. bar), moving or cross girder, all three motions electrically operated by suitable rating motor IP 54, control panel & down pendant control block, brake, safety device, cables from motor to starter panel & other required accessories & tested as per IS Specifications. Size - Minimum 15 Ton (May increase as per actual requirements)	1.00	No
12	Supply, Install, Testing And Commissioning of ISI mark DI D/F Sluice Valves as per IS:14846 (Latest Edition) of following class and diameter including all taxes, insurance, Transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to departmental stores, stacking etc. complete.		
	Sluice Valve for Delivery By pass	12.00	No.
	Pump Header Bypass	1.00	No.
13	Supply, Installation, Testing And Commissioning of MS Pipes conforming to IS-3589, fitted with flanges as required & drilled as per IS:1538/1976 Latest Amendment, Class-B duly painted by epoxy paint M.S.Pipe and as per tender detailed specifications. (for pump set)		
	MS Pipe for Delivery Bypass	As Per Requirements	
	MS Pipe for Header Bypass	As Per Requirements	
14	Providing, Supply of Structure Steel at site of work with freight, loading, unloading carting, etc. including all taxes and duties complete such as joints, channels, angles, Iron Rails, ISA/ISMC/ISMB/MS flat, Plates, Chequered plates (below 10mm thickness) for cable trench etc. required for support structure of all Electro-mechanical equipment, piping, etc. for support on floor / wall / beam / brackets etc. as per tender and IS.	As Per Requirements	

## Annexure A

### List of Minimum Items to be executed as per Schedule B-12 Item no -01

15	<b>Electro magnetic Flowmeter</b> Design, Supply, Installation, Testing, Commissioning of Full Bore Electromagnetic flow meter with factory calibrated, Regular Power Operated, flanged connection, Flow sensor, Indicator, transmitter and totaliser with all accessories viz. surge arrestor, associated cables, cabinets, hardwares, etc complete as per following specifications: DC pulsed type, IP 68 Protection, Flanged process connection as per IS 1538 or equivalent standard, SS304/ Metallic Alloy Flow Tube, SS316/ SS 316 L/ Hastelloy Sensor, SS316/ Hastelloy Grounding Ring/ Inbuilt Grounding Electrode, Neoprene/ Polyurethane/ Hard Rubber/ Rilsan lining, SS304/ Die Cast Aluminium/ Carbon steel with Anticorrosive Paint Coil Housing with Junction Box, CS flanges. Microprocessor based, Modular design, 2 line LCD for indication of actual flow rate, forward, reverse, sum totaliser display, $\pm 0.5\%$ accuracy at 0.3 to 4 m/sec velocity, 4 to 20 mA with HART/Modbus output, one scalable pulse, one status output, IP 67 protection, Die cast aluminium/ polycarbonate/ SS316 with Anticorrosive Paint/ PU finish with glass window enclosure, Inbuilt EEPROM and Data Logger, 20 meters cable length for sensor to transmitter communication etc alongwith wall mounted/ stand mounted cabinet. size: As Per Header/Rising Main	1.00	Nos
16	<b>Regular Power operated RTU on Flow Meter-</b> As per the Scope of work, functional and Technical requirement, including all cable & accessories, Installation, testing and commissioning etc. as per details technical specification"	1.00	Nos
17	<b>PRESSURE GAUGE:</b> Design, Supply, Installation, Testing, Commissioning of Bourdon Type Pressure Gauge, $\pm 1\%$ accuracy, Direct bottom 1/2" NPT (M) process connection, IP 67, Glycerine filled, SS304 Case with Bayonet Type Bezel, SS316 L Bourdon Tube, SS 316 Movement material, Aluminium dial with black graduation on white background, Micro Zero adjustable pointer, neoprene gasket, Blow out disc, shatter proof glass, SS tag plate etc as per IS 3624. Range : 0 - 10 kg / sq.cm. (150 mm Dial Size)	13	NOS

**Note: - (01)** above Annexure Materials are minimum requirements, However for execution and to start the water supply whatever additional materials required, Agency has to provide all materials to start water supply. No additional Payment will be made for any additional procurements.

**(02)** Sizes and ratings of all major equipment's, components and asseccories keeping in view the duty parameters that is Q (Flow) And H (Head) of each pumpsets of concern head works are given in estimates. In case of any change in this parameters sub sequently, all other dependent associated mechanical, electrical and instruments etc. will also change to suit the actual requirements. Any and all such required/desire changes/modifications/improvements shall have to be incorporated in CDR and implemented without any additional cost to the department. Claim either in the form of excess qty or extra items on account of such changes (if any) shall not be admissible and not payable.

## Annexure B

### List of Minimum Items to be executed as per Schedule B-12 Item no -01

#### MECHANICAL ANNEXURE - INTAKEWELL TO PALEJ HW

Item No.	Description	Qty.	Unit
1	<p>VERTICLE TURBINE PUMP WITH INDUCTION MOTOR: Supply, Installation, testing And commisioning of verticle turbine pump motor set of specified duty parameters &amp; guaranteed efficiency of following MOC with specified capacity verticle solid staff TEFC squirrel cage induction motor working on three phase AC supply with 50 HZ+/-3%, 6.6KV +/- 10%, rated speed 1000 RPM along with column and bowl assembly, discharge head, base channel / RSj etc. complete as relevant IS.</p> <p>MOC: Impeller &amp; Sealing Rings: CF8M, Bowl &amp; Suction Bell: Cast Steel WCB , Shaft with coupling: SS 410, Column Pipe: MS ERW, Gland Packing,Base Plate: MS, Line Bearing: Thordon, Suction Strainer: S.S.Discharge Capacity (Q) 1700 m3/hr at 85 m Head (H) each, Approx. 560 kW , 6.6 kV, 1000 RPM, as per the detailed tender specifications. (4W+2S)</p>	6.00	Set
2	<p>Supply, Installation, Testing And Commissioning of PN-1.6, Double Flanged Dual Plate Check Valve (DPCV) conforming to API 594/598 Latest Amendment PN 1.6 with D.I. body, spring steel spring,S.S. seating with all carbon steel hardware's and other accessories as per data sheet and specification. Valve seat tested to 16 kg/cm2 and body to 24 kg/cm2. Flanges machined faced and drilled to IS : 1538 / 1976 Part-IV/VI Latest Amendmen. Hydraulic tests certificate &amp; certificate of material of construction of parts shall be submitted before despatch of valves as per design with required accessories, hardware, bolts, nuts, washers, rubber paking, necessary mounting supports etc. complete.</p> <p>Delivery Line</p>	6.00	No.
	Header Line	1.00	No.
3	<p>Supply, installation, testing and commissioning of ISI mark Electrically Operated DI D/F Butterfly Valves as per IS:13095 (Latest Edition) of following class and diameter including all taxes, insurance, transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to departmental stores, stacking etc. complete. along with required spare parts as per data sheet and specifications.</p>		
	Header Line (Electrically Operated)	1.00	No.
	Main Delivery Line (Electrically Operated)	6.00	No.
4	<p>Supply, installation, testing and commissioning of Providing and supplying ISI mark DI D/F Sluice Valves as per IS:14846 (Latest Edition) of following class and diameter including all taxes, insurance, transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to departmental stores, stacking etc. complete. along with required spare parts as per data sheet and specifications.</p>		
	Main Delivery Line (Gear Operated) (PN 1.6)	6.00	No.



## Annexure B

### List of Minimum Items to be executed as per Schedule B-12 Item no -01

#### MECHANICAL ANNEXURE - INTAKEWELL TO PALEJ HW

Item No.	Description	Qty.	Unit
5	Supply, Installation, testing & commissioning of flange ends Expansion Bellow as per EJMA standards of overall length of minimum 300 mm, designed for 15 mm axial compression and 5 mm axial extension with tie rods etc. of following MOC & pressure ratings. MOC: Bellows: SA 240 Gr. 304; Internal Sleeve: SA 240 Gr. 304; Weldends: IS 2062 Gr. B; Flanges: IS 2062 Gr. B (Drilling as per IS 1538 /IS 6392 ) & Limit Rods & Nuts: CS - IS 1367.		
	Header Line	1.00	No.
	Delivery Line	6.00	No.
6	Supply, Installation, Testing And Commissioning of DI Temporal proof Flanged Air Valve with Isolation Sluice Valve as per IS 14845 PN- 1.6 & IS-14846 PN-1.6 respectively with SS304 float, gun metal nozzle, complete hardware's, bolts, nuts & washers, gaskets etc. including all taxes, Insurance, Transportation, freight charges, Inspection charges, loading, unloading, conveyance to departmental stores, stacking, security etc. as per IS and Specification. Header Line	1.00	No.
7	Supply, Installation, Testing And Commissioning of MS Pipes conforming to IS-3589, fitted with flanges as required & drilled as per IS:1538/1976 Latest Amendment, Class-B duly painted by epoxy paint plus M.S.Pipe and as per tender detailed specifications. (for pump set)		
	(for Header)	As Per Requirements	
	(for Delivery)	As Per Requirements	
8	Supply, Installation, Testing And Commissioning of following type of Flanged Type Fabricated MS Specials like tee, 900 bend, taper, distance pipe piece, flanges, blank flange, dismantling joint, bolts, nuts, washers, rubber packing etc, for delivery header and suitable for above pumpsets. Dimensions and Drilling of flanges should be as per IS:1538/1976. Flange faces should be machined and holes should be drilled on drilling machine. M.S pipe should be conforming to IS-3589/ 2001. M.S PIPE should be heavy Class upto 150 mm dia. From 200 mm dia. to 600 mm dia. x 6.35 mm thk, from 700 mm dia. to 1000 mm dia. x 8 mm thk. All specials & pipes should be painted by epoxy paint.	As Per Requirements	
	Supply, welding, installation, testing & commissioning of <b>MS Flat machined faced flanges</b> confirming to IS 6392 & drilled as per IS - 1538 with drilling off bolt holes and flanges thickness as per PN 1.0 including cutting & welding		
9	Supply, installation, testing and commissioning of MS specials for jointing pipes i.e. Bends, Concentric Expander, <b>Y-Joints</b> etc. complete as per dimensions confirming to IS 1538. M.S Specials	As Per Requirements	
10	Carbon steel hot dipped galvanized nuts, bolts, spring, washer, plate washer, gaskets and other required hardwares etc.	As Per Requirements	

## Annexure B

### List of Minimum Items to be executed as per Schedule B-12 Item no -01

#### MECHANICAL ANNEXURE - INTAKEWELL TO PALEJ HW

Item No.	Description	Qty.	Unit
11	Supply, installation, testing & commissioning circular type Double girder type fully electrically operated EOT crane with electrically operated hoist, class II duty, geared travelling trolley with seven meter lift complete with long travel rail track (40 mm sq. bar), moving or cross girder, all three motions electrically operated by suitable rating motor IP 54, control panel & down pendant control block, brake, safety device, cables from motor to starter panel & other required accessories & tested as per IS Specifications. Size - Minimum 15 Ton (May increase as per actual requirements)	1.00	No

## Annexure B

### List of Minimum Items to be executed as per Schedule B-12 Item no -01

#### MECHANICAL ANNEXURE - INTAKEWELL TO PALEJ HW

Item No.	Description	Qty.	Unit
12	Supply, Install, Testing And Commissioning of ISI mark DI D/F Sluice Valves as per IS:14846 (Latest Edition) of following class and diameter including all taxes, insurance, Transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to departmental stores, stacking etc. complete.		
	Sluice Valve for Delivery By pass	6.00	No.
	Pump Header Bypass	1.00	No.
13	Supply, Installation, testing And commissioning of ISI mark G. I. pipes with Couplings of following class and diameter including all taxes, insurance, transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to departmental stores, stacking etc. complete. (IS -1239)		
	for Delivery Bypass	As Per Requirements	
	for Header Bypass	As Per Requirements	
14	Providing, Supply of Structure Steel at site of work with freight, loading, unloading carting, etc. including all taxes and duties complete such as joints, channels, angles, Iron Rails, ISA/ISMC/ISMB/MS flat, Plates, Chequered plates (below 10mm thickness) for cable trench etc. required for support structure of all Electro-mechanical equipment, piping, etc. for support on floor / wall / beam / brackets etc. as per tender and IS.	As Per Requirements	
15	<b>Electro magnetic Flowmeter</b> Design, Supply, Installation, Testing, Commissioning of Full Bore Electromagnetic flow meter with factory calibrated, Regular Power Operated, flanged connection, Flow sensor, Indicator, transmitter and totaliser with all accessories viz. surge arrestor, associated cables, cabinets, hardwares, etc complete as per following specifications: DC pulsed type, IP 68 Protection, Flanged process connection as per IS 1538 or equivalent standard, SS304/ Metallic Alloy Flow Tube, SS316/ SS 316 L/ Hastelloy Sensor, SS316/ Hastelloy Grounding Ring/ Inbuilt Grounding Electrode, Neoprene/ Polyurethane/ Hard Rubber/ Rilsan lining, SS304/ Die Cast Aluminium/ Carbon steel with Anticorrosive Paint Coil Housing with Junction Box, CS flanges. Microprocessor based, Modular design, 2 line LCD for indication of actual flow rate, forward, reverse, sum totaliser display, $\pm 0.5\%$ accuracy at 0.3 to 4 m/sec velocity, 4 to 20 mA with HART/Modbus output, one scalable pulse, one status output, IP 67 protection, Die cast aluminium/ polycarbonate/ SS316 with Anticorrosive Paint/ PU finish with glass window enclosure, Inbuilt EEPROM and Data Logger, 20 meters cable length for sensor to transmitter communication etc alongwith wall mounted/ stand mounted cabinet. size: As Per Header/ Rising Main	1.00	Nos
16	<b>Regular Power operated RTU on Flow Meter-</b> As per the Scope of work, functional and Technical requirement, including all cable & accessories, Installation, testing and commissioning etc. as per details technical specification"	1.00	Nos

## Annexure B

### List of Minimum Items to be executed as per Schedule B-12 Item no -01

#### MECHANICAL ANNEXURE - INTAKEWELL TO PALEJ HW

Item No.	Description	Qty.	Unit
17	<b>PRESSURE GAUGE:</b> Design, Supply, Installation, Testing, Commissioning of Bourdon Type Pressure Gauge, $\pm 1\%$ accuracy, Direct bottom 1/2" NPT (M) process connection, IP 67, Glycerine filled, SS304 Case with Bayonet Type Bezel, SS316 L Bourdon Tube, SS 316 Movement material, Aluminium dial with black graduation on white background, Micro Zero adjustable pointer, neoprene gasket, Blow out disc, shatter proof glass, SS tag plate etc as per IS 3624. Range : 0 - 10 kg / sq.cm. (150 mm Dial Size)	7	NOS

**Note: - (01)** above Annexure Materials are minimum requirements, However for execution and to start the water supply whatever additional materials required, Agency has to provide all materials to start water supply. No additional Payment will be made for any additional procurements.

**(02)** Sizes and ratings of all major equipment's, components and accessories keeping in view the duty parameters that is Q (Flow) And H (Head) of each pumpsets of concern head works are given in estimates. In case of any change in this parameters subsequently, all other dependent associated mechanical, electrical and instruments etc. will also change to suit the actual requirements. Any and all such required/desire changes/modifications/improvements shall have to be incorporated in CDR and implemented without any additional cost to the department. Claim either in the form of excess qty or extra items on account of such changes (if any) shall not be admissible and not payable.

## Annexure C

### List of Minimum Items to be executed as per Schedule B-12 Item no -02

#### MECHANICAL ANNEXURE - PALEJ TO WTP

Item No.	Description	Qty.	Unit
1	<p>VERTICLE TURBINE PUMP WITH INDUCTION MOTOR: Supply, Installation, testing And commisioning of verticle turbine pump motor set of specified duty parameters &amp; guaranteed efficiency of following MOC with specified capacity verticle solid staff TEFC squirrel cage induction motor (with min IE-3 efficiency class) , working on three phase AC supply with 50 HZ+/-3%, 415 +/- 10%, rated speed 1000 RPM along with column and bowl assembly, discharge head, base channel / RSj etc. complete as relevant IS.</p> <p>MOC: Impeller &amp; Sealing Rings: CF8M, Bowl &amp; Suction Bell: Cast Steel WCB , Shaft with coupling: SS 410, Column Pipe: MS ERW, Mechanical seal (above 30 kw),Base Plate: MS, Line Bearing: Thordon, Suction Strainer: S.S.<u>Discharge Capacity (Q) 781 m3/hr at 16 m Head (H) each, Approx. 55 kW , 0.415 kV, 1000 RPM,</u> as per the detailed tender specifications. (2W+2S)</p>	4.00	Set
2	<p>Supply, Installation, Testing And Commissioning of PN-1.6, Double Flanged Dual Plate Check Valve (DPCV) conforming to API 594/598 Latest Amendment PN 1.6 with DI body, spring steel spring,S.S. seating with all carbon steel hardware's and other accessories as per data sheet and specification. Valve seat tested to 16 kg/cm2 and body to 24 kg/cm2. Flanges machined faced and drilled to IS : 1538 / 1976 Part-IV/VI Latest Amendmen. Hydraulic tests certificate &amp; certificate of material of construction of parts shall be submitted before despatch of valves as per design with required accessories, hardware, bolts, nuts, washers, rubber paking, necessary mounting supports etc. complete.</p> <p>Delivery Line (PN 1.6)</p>	4.00	No.
	mm Header Line (PN 1.6)	1.00	No.
3	<p>Supply, installation, testing and commissioning of ISI mark Electrically Operated DI D/F Butterfly Valves as per IS:13095 (Latest Edition) of following class and diameter including all taxes, insurance, transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to departmental stores, stacking etc. complete. along with required spare parts as per data sheet and specifications.</p>		
	Header Line (PN 1.6) (Electrically Operated)	1.00	No.
	Main Delivery Line (PN 1.6) (Electrically Operated)	4.00	No.

## Annexure C

### List of Minimum Items to be executed as per Schedule B-12 Item no -02

#### MECHANICAL ANNEXURE - PALEJ TO WTP

Item No.	Description	Qty.	Unit
4	Supply, Installation, testing & commissioning of flange ends Expansion Bellow as per EJMA standards of overall length of minimum 300 mm, designed for 15 mm axial compression and 5 mm axial extension with tie rods etc. of following MOC & pressure ratings. MOC: Bellows: SA 240 Gr. 304; Internal Sleeve: SA 240 Gr. 304; Weldends: IS 2062 Gr. B; Flanges: IS 2062 Gr. B (Drilling as per IS 1538 /IS 6392 ) & Limit Rods & Nuts: CS - IS 1367.		
	Header Line (PN 1.6)	1.00	No.
	Delivery Line (PN 1.6)	4.00	No.
5	Supply, Installation, Testing And Commissioning of DI Tempora proof Flanged Air Valve with Isolation Sluice Valve as per IS 14845 PN- 1.6 & IS-14846 PN- 1.6 respectively with SS304 float, gun metal nozzle, complete hardware's, bolts, nuts & washers, gaskets etc. including all taxes, Insurance, Transportation, freight charges, Inspection charges, loading, unloading, conveyance to departmental stores, stacking, security etc. as per IS and Specification. Size: (On Header line outside the Pump house)	1.00	No.
6	Supply, Installation, Testing And Commissioning of MS Pipes conforming to IS-3589, fitted with flanges as required & drilled as per IS:1538/1976 Latest Amendment, Class-B duly painted by epoxy paint plus O/S 3LPE Coated M.S.Pipe and as per tender detailed specifications. (for pump set)		
	MS Pipes (for Header)	As Per Requirements	
	MS Pipes (for Delivery)	As Per Requirements	
7	Supply, Installation, Testing And Commissioning of following type of Flanged Type Fabricated MS Specials like tee, 90° bend, taper, distance pipe piece, flanges, blank flange, dismantling joint, bolts, nuts, washers, rubber packing etc, for delivery header and suitable for above pumpsets. Dimensions and Drilling of flanges should be as per IS:1538/1976. Flange faces should be machined and holes should be drilled on drilling machine. M.S pipe should be conforming to IS-3589/ 2001. M.S PIPE should be heavy Class upto 150 mm dia. From 200 mm dia. to 600 mm dia. x 6.35 mm thk, from 700 mm dia. to 1000 mm dia. x 8 mm thk. All specials & pipes should be painted by epoxy paint.	As Per Requirements	
	Supply, welding, installation, testing & commissioning of <b>MS Flat machined faced flanges</b> confirming to IS 6392 & drilled as per IS - 1538 with drilling off bolt holes and flanges thickness as per PN 1.0 including cutting & welding		

## Annexure C

### List of Minimum Items to be executed as per Schedule B-12 Item no -02

#### MECHANICAL ANNEXURE - PALEJ TO WTP

Item No.	Description	Qty.	Unit
8	Supply, inatallation, testing and commissioning of MS specials for jointing pipes i.e. Bends, Concentric Expander, <b>Y-Joints</b> etc. complete as per dimensions comfirming to IS 1538. M.S Specials	As Per Requirements	
9	Carbon steel hot dipped galvanized nuts, bolts, spring , washer, plate washer, gaskets and other required hardwares etc.	As Per Requirements	
10	Supply, Install, Testing And Commissioning of ISI mark DI D/F Sluice Valves as per IS:14846 (Latest Edition) of following class and diameter including all taxes, insurance, Transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to departmental stores, stacking etc. complete.		
	Sluice Vlave for Delivery By pass (PN 1.6)	4.00	No.
	Pump Header Bypass (PN 1.6)	1.00	No.
11	Supply,Installation, testing And commissioning of ISI mark G. I. pipes with Couplings of following class and diameter including all taxes, insurance, transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to departmental stores, stacking etc. complete. (IS - 1239)		
	Delivery Bypass	As Per Requirements	
	Header Bypass	As Per Requirements	

## Annexure C

### List of Minimum Items to be executed as per Schedule B-12 Item no -02

#### MECHANICAL ANNEXURE - PALEJ TO WTP

Item No.	Description	Qty.	Unit
12	<p><b>FLOW METER</b>  Design, Supply, Installation, Testing, Commissioning of Full Bore Electromagnetic flow meter with factory calibrated, Regular Power Operated, flanged connection, Flow sensor, Indicator, transmitter and totaliser with all accessories viz. surge arrestor, associated cables, cabinets, hardwares, etc complete as per following specifications:  DC pulsed type, IP 68 Protection, Flanged process connection as per IS 1538 or equivalent standard, SS304/ Metallic Alloy Flow Tube, SS316/ SS 316 L/ Hastelloy Sensor, SS316/ Hastelloy Grounding Ring/ Inbuilt Grounding Electrode, Neoprene/ Polyurethane/ Hard Rubber/ Rilsan lining, SS304/ Die Cast Aluminium/ Carbon steel with Anticorrosive Paint Coil Housing with Junction Box, CS flanges. Microprocessor based, Modular design, 2 line LCD for indication of actual flow rate, forward, reverse, sum totaliser display, <math>\pm 0.5\%</math> accuracy at 0.3 to 4 m/sec velocity, 4 to 20 mA with HART/Modbus output, one scalable pulse, one status output, IP 67 protection, Die cast aluminium/ polycarbonate/ SS316 with Anticorrosive Paint/ PU finish with glass window enclosure, Inbuilt EEPROM and Data Logger, 20 meters cable length for sensor to transmitter communication etc alongwith wall mounted/ stand mounted cabinet.  size: As Per Header/Rising Main</p>	1.00	Nos
13	<p><b>Regular Power operated RTU on Flow Meter-</b>  As per the Scope of work, functional and Technical requirement, including all cable &amp; accessories, Installation, testing and commissioning etc. as per details technical specification"</p>	1.00	Nos
14	<p><b>PRESSURE GAUGE:</b>  Design, Supply, Installation, Testing, Commissioning of Bourdon Type Pressure Gauge, <math>\pm 1\%</math> accuracy, Direct bottom 1/2" NPT (M) process connection, IP 67, Glycerine filled, SS304 Case with Bayonet Type Bezel, SS316 L Bourdon Tube, SS 316 Movement material, Aluminium dial with black graduation on white background, Micro Zero adjustable pointer, neoprene gasket, Blow out disc, shatter proof glass, SS tag plate etc as per IS 3624.  Range : 0 - 10 kg / sq.cm. (150 mm Dial Size)</p>	5	NOS



## Annexure C

### List of Minimum Items to be executed as per Schedule B-12 Item no -02

#### MECHANICAL ANNEXURE - PALEJ TO WTP

Item No.	Description	Qty.	Unit
<p><b>Note: - (01)</b> above Annexure Materials are minimum requirements, However for execution and to start the water supply whatever additional materials required, Agency has to provide all materials to start water supply. No additional Payment will be made for any additional procurements.</p> <p><b>(02)</b> Sizes and ratings of all major equipment's, components and asseccories keeping in view the duty parameters that is Q (Flow) And H (Head) of each pumpsets of concern head works are given in estimates. In case of any change in this parameters subsequently, all other dependent associated mechanical, electrical and instruments etc. will also change to suit the actual requirements. Any and all such required/desire changes/modifications/improvements shall have to be incorporated in CDR and implemented without any additional cost to the department. Claim either in the form of excess qty or extra items on account of such changes (if any) shall not be admissible and not payable.</p>			

## Annexure D

### List of Minimum Items to be executed as per Schedule B-12 Item no -01

#### ELECTRICAL ANNEXURE - INTAKEWELL TO PALEJ AND GIDC

Sr. No.	Description	Unit	Quantity
1.)	<b>66 KV Switchyard</b> 66KV/6.6KV Switchyard including Lighting arrester , Isolator, CT-PT unit, Power transformer, SF6 Circuit breaker, Steel Structure, Earthing System, Relay control panel, Equipment including fencing, Lighting system and Fencing, Gate, Fire Wall, Gravels as per site requirements and all accessories and civil work complete for efficient and trouble free operation. (Following list is inclusive, but not limited to ( for trouble free operation)): a) Lighting arrester As per Design requirement. (Min. 9 Nos.) b) Isolator with Earth Switch As per Design requirement (Min. 6 Nos.) c) Potential Transformer ( Min.6 Nos.) d) Current Transformer (Min. 12 Nos.) e) SF-6 Circuit Breaker, (Min 3 Nos.) f) Relay control Panel - 1 No g) Galvanized steel structure for power receiving/ equipment including facing-1 L.S h) Conductors/Clamps/Connectors-1 L.S i) Post Insulator - 1 Lot j) NIFS System	No	1.00
2.)	<b>Power Transformer</b> Supply, Installation, Testing And Commissioning of outdoor type, three phase, oil immersed, power transformer of required KVA & voltage ratio, copper double wound, vector group - Dyn11, HV delta connected & LV star connected with neutral brought out connected to provide separate earthing terminals, bushing / cable box on HV side and cable box on LV side suitable for cables or bus duct as per requirement with standard fittings, conforming to IS: 2026 - 2011 with its latest amendment including first fill of transformer oil & following accessories. (a) Oil conservator with filling holes with cap and prismatic oil level gauge. (b) Silica Gel dehydrating breather charged with silica gel (c) Oil drain cum sampling valve with plug (d) Oil filter valve (e) Lifting Eyes / Hooks / Lugs (f) Two earthing terminal (g) Diagram and rating plate (h) Air release plug (i) Explosion vent with diaphragm (j) Thermometer pocket (k) Four bi-directional plain roller with base channel with hauling holes (l) Fixed / Separate type radiator banks (m) Off circuit externally operated tapping switch (For rating < 1000 kVA) (n) 100 mm stem type oil temperature indicator (For rating < 500 kVA) (o) Bucholtz relay with shut off valve (For rating ≥ 500 KVA) (p) 150 mm dial type oil temperature indicator with Alarm / Trip contact (For rating ≥ 500 kVA) (q) 150 mm dial type winding temperature indicator with Alarm / Trip contact (For rating ≥ 1000 kVA) (r) Marshalling box (For rating ≥ 500 kVA) (s) 150 mm dia. magnetic type oil gauge (For rating ≥ 1600 kVA) (t) Inspection cover & Jacking lugs (For rating ≥ 1600 kVA) For transformer rating of 1600 KVA and higher nitrogen injection fire protection system (NIFPS) is to be provided. With on load tap changer +10% to -10% in steps of 1.25% with RTCC & AVR Size - Minimum 15000 KVA (66/6.6 KV)	Nos	2.00

## Annexure D

### List of Minimum Items to be executed as per Schedule B-12 Item no -01

3.)	<p><b>Auxiliary TRANSFORMER</b> Supply, Installation, Testing And Commissioning of of outdoor type, three phase, oil immersed, distribution transformer of required KVA &amp; voltage ratio, copper double wound, vector group - Dyn11, HV delta connected &amp; LV star connected with neutral brought out connected to provide separate earthing terminals, bushing / cable box on HV side and cable box on LV side suitable for cables or bus duct as per requirement with standard fittings, conforming to IS: 1180 (Part-1) / 2014 with its latest amendment including first fill of transformer oil &amp; following accessories.</p> <p>(a) Oil conservator with filling holes with cap and prismatic oil level gauge. (b) Silica Gel dehydrating breather charged with silica gel (c) Oil drain cum sampling valve with plug (d) Oil filter valve (e) Lifting Eyes / Hooks / Lugs (f) Two earthing terminal (g) Diagram and rating plate (h) Air release plug (i) Explosion vent with diaphragm (j) Thermometer pocket (k) Four bi-directional plain roller with base channel with hauling holes (l) Fixed / Separate type radiator banks (m) Off circuit externally operated tapping switch (For rating &lt; 1000 kVA) (n) 100 mm stem type oil temperature indicator (For rating &lt; 500 kVA) (o) Bucholtz relay with shut off valve (For rating ≥ 500 kVA) (p) 150 mm dial type oil temperature indicator with Alarm / Trip contact (For rating ≥ 500 kVA) (q) 150 mm dial type winding temperature indicator with Alarm / Trip contact (For rating ≥ 1000 kVA) (r) Marshalling box (For rating ≥ 500 kVA) (s) 150 mm dia. magnetic type oil gauge (For rating ≥ 1600 kVA) (t) Inspection cover &amp; Jacking lugs (For rating ≥ 1600 kVA) For transformer having oil storage capacity for 2000 liters and higher, nitrogen injection fire protection system (NIFPS) is to be provided.</p> <p>With off circuit tap changer +5% to -10% in steps of 2.5% Rating - 250 KVA (6.6/0.433 KV) Efficiency Level - 2</p>	No	2.00
4.)	<p><b>Power Transformer Foundation</b> Casting of transformer plinth / foundation including oil soak pit (where required) in situ reinforced cement concrete in M 20 using granite, quartzite trap metal of size 6 mm to 20 mm for RCC work including providing of 53 grade cement &amp; Fe 415 grade TMT bars, scaffolding, centering, form work, curing etc. complete. RCC plinth / foundation for distribution transformer of capacity. Foundation Size - 3000 X 2500 X 500 Size - 15000 KVA (66/6.6 KV)</p>	Set	2
5.)	<p><b>Auxiliary Transformer Foundation</b> Casting of transformer plinth / foundation including oil soak pit (where required) in situ reinforced cement concrete in M 20 using granite, quartzite trap metal of size 6 mm to 20 mm for RCC work including providing of 53 grade cement &amp; Fe 415 grade TMT bars, scaffolding, centering, form work, curing etc. complete. RCC plinth / foundation for distribution transformer of capacity. Foundation Size - 1250 X 1250 X 1500 Size - 250 KVA (6.6/0.433 KV)</p>	Set	2
6.)	<p><b>NEUTRAL GROUNDING RESISTORS</b> Supply, Installation, Testing And Commissioning of of 6.6 KV,10 Secs. Neutral Grounding Resistors.</p>	No	2.00
7.)	<p><b>MAINTENANCE FREE SEALED BATTERY AND BATTERY CHARGER</b> Supply, Installation, Testing And Commissioning of of 110 V DC, Float/Boost charger 32/40 Amp with DC distribution board.</p>	Nos	1.00

## Annexure D

### List of Minimum Items to be executed as per Schedule B-12 Item no -01

<b>8.)</b>	<b>HT Panel (Incomer)</b>		
	Design, engineerig, procurement, installation, testing and commissioning of 6.6KV, 02 nos as Incomer 1600 A EDO type draw out VCB breakers and 01 nos as Bus Coupler 1600 A EDO type draw out VCB, 04 nos 1600 Amp EDO type draw out VCB breakers for Outgoing feeder (2 Nos For 710 Kw HT Panel And 2 Nos For 560 Kw HT Panel), 02 nos 1250 Amp, EDO type, draw out VCB breakers for Auxiliary Transformer Control feeder with spring operated mechanisam, Electrical closing coil and 02 Nos.Tripping Coil operating on 110V DC supply, manually ON-OFF and spring operated mechanically charged, discharged indiactor,mechanical interlock safty shutters, isolating plugs, Multi function meter with RS-485, Energy meter, Analogue Ammeter and all associated equipments & accessories as per tender specification etc.. All feeder shall be suitable for PLCSCADA compatible.. All feeder shall be suitable for PLCSCADA compatible.. All feeder shall be suitable for PLCSCADA compatible.	No	1.00
<b>9.)</b>	<b>HT Panel (Intakewell To GIDC)</b>		
	Design, engineerig, procurement, installation, testing and commissioning of 6.6KV, 02 nos as Incomer 1250 A EDO type draw out VCB breakers and 01 nos as Bus Coupler 1250 A EDO type draw out VCB, 12 nos 1250 Amp, EDO type, draw out VCB breakers for motor feeder, 02 Nos Bus PT conforming to IS 2516 & latest amendment , 3 Phase , 50 Hz unearthed A.C. supply system , with spring operated mechanisam, Electrical closing coil and 02 Nos.Tripping Coil operating on 110V DC supply, manually ON-OFF and spring operated mechanically charged, discharged indiactor,mechanical interlock safty shutters, isolating plugs, Multi function meter with RS-485, Energy meter, Analogue Ammeter and all associated equipments & accessories as per tender specification etc.. All feeder shall be suitable for PLCSCADA compatible.. All feeder shall be suitable for PLCSCADA compatible.. All feeder shall be suitable for PLCSCADA compatible.	No	1.00
<b>10.)</b>	<b>HT Panel (Intakewell To Palej)</b>		
	Design, engineerig, procurement, installation, testing and commissioning of 6.6KV, 02 nos as Incomer 1250 A EDO type draw out VCB breakers and 01 nos as Bus Coupler 1250 A EDO type draw out VCB, 6 nos 1250 Amp, EDO type, draw out VCB breakers for motor feeder, 02 Nos Bus PT conforming to IS 2516 & latest amendment , 3 Phase , 50 Hz unearthed A.C. supply system , with spring operated mechanisam, Electrical closing coil and 02 Nos.Tripping Coil operating on 110V DC supply, manually ON-OFF and spring operated mechanically charged, discharged indiactor,mechanical interlock safty shutters, isolating plugs, Multi function meter with RS-485, Energy meter, Analogue Ammeter and all associated equipments & accessories as per tender specification etc.. All feeder shall be suitable for PLCSCADA compatible.. All feeder shall be suitable for PLCSCADA compatible.. All feeder shall be suitable for PLCSCADA compatible.	No	1.00
<b>11.)</b>	<b>HT SOFT STARTER Panel &amp; HT capacitor panel for 6.6KV (Intakewell To GIDC)</b>		

## Annexure D

### List of Minimum Items to be executed as per Schedule B-12 Item no -01

	<p><b>(a) 6.6KV SOFT STARTER PANEL :</b>  Design, engineering, procurement, installation, testing and commissioning of Fully automatic microprocessor based or FCMA or HSFR type soft starter suitable for 710 KW squirrel cage induction motor, 6.6 KV, 3 phase, 50 Hz with built in bypass terminal for pump control application as per latest IS, tender specification &amp; technical datasheet. Input Voltage- 3 phase , 6.6KV Input Frequency - 50 Hz (+/- 5 %) Starter Protection - S/C,u/Phase unbalance, Phase failure Built in communication as per RS 485, Under Voltage release type, Earth Fault Release EF1 (10%,20% Ir), Door Inter Lock, PLC-SCADA compatibility.</p> <p><b>(b) 6.6 KV HT CAPACITOR PANEL FOR MOTOR</b>  Design, engineering, procurement, installation, testing and commissioning of Capacitor Panel for 6.6 kV HV Motor Capacitor panel consist of 6.6 kV off load Isolator, HV fuse, series detuned reactor &amp; capacitor unit with comprehensive protection i.e. Under voltage, over voltage, neutral voltage displacement / Neutral current transformer, internal discharge resistor etc. 295 KVAR capacitor bank for continuous duty to improve power factor up to 0.99 with bus-bar chamber having 2 mm thick sheet steel enclosure with earth terminals &amp; all necessary protective equipments and accessories with IP 42 protection etc.</p>	No	12
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## Annexure D

### List of Minimum Items to be executed as per Schedule B-12 Item no -01

12.)	HT SOFT STARTER Panel & HT capacitor panel for 6.6KV (Intakewell To Palej)		
	<p><b>(a) 6.6KV SOFT STARTER PANEL :</b> Design, engineering, procurement, installation, testing and commissioning of Fully automatic microprocessor based or FCMA or HSFR type soft starter suitable for 560 KW squirrel cage induction motor, 6.6 KV, 3 phase, 50 Hz with built in bypass terminal for pump control application as per latest IS, tender specification &amp; technical datasheet. Input Voltage- 3 phase , 6.6KV Input Frequency - 50 Hz (+/- 5 %) Starter Protection - S/C,u/Phase unbalance, Phase failure Built in communication as per RS 485, Under Voltage release type, Earth Fault Release EF1 (10%,20% Ir), Door Inter Lock, PLC-SCADA compatibility.</p> <p><b>(b) 6.6 KV HT CAPACITOR PANEL FOR MOTOR</b> Design, engineering, procurement, installation, testing and commissioning of Capacitor Panel for 6.6 kV HV Motor Capacitor panel consist of 6.6 kV off load Isolator, HV fuse, series detuned reactor &amp; capacitor unit with comprehensive protection i.e. Under voltage, over voltage, neutral voltage displacement / Neutral current transformer, internal discharge resistor etc. 230 KVAR capacitor bank for continuous duty to improve power factor up to 0.99 with bus-bar chamber having 2 mm thick sheet steel enclosure with earth terminals &amp; all necessary protective equipments and accessories with IP 42 protection etc.</p>	No	6
13.)	<p><b>0.415 KV LT APFC PANEL</b> Supply, installaton, testing &amp; commissioning LV APFC panel consisting of required capacitor banks for continuous duty to improve P.F. 0.85 to 0.998 in required steps enclosed in dust &amp; vermin proof compartment, indoor type, fabricated from CRCA sheet steel with minimum thickness of 3 mm for base frame / channel / gland plates, 2.0 mm for load bearing members / doors &amp; 1.6 mm for internal partitions, minimum degree of protection - IP 42, busbar chamber, required size of Al bus bar / terminals, minimum 10 stage APFC relay, metering, indicating lamps, push buttons complete as per IS: 16636-2017 with latest ammendment &amp; detailed technical specification and data sheet as under.</p> <p>a) 125 A, 50 kA for 1sec. TP, TM based MCCB with spreader terminals &amp; rotary handle b) 0-125 A range analogue ammeter of 96 x 96 mm size with selector switch c) 3 nos. 125 / 5A, 10 VA CL-1.0 cast resin type current transformer d) Suitable rating MCCB / MCB &amp; Contactors for each capacitor bank e) Suitable rating APP type capacitor banks (vacuum impregnated with non-PCB / non toxic oil, internally delta connected with built in internal fuses complete with discharge resistances &amp; terminal cover) of approoved make in required steps with well suited detuned reactor is placed in series with each capacitor step. Rating - 0-50 KVAR</p>	No	2

## Annexure D

### List of Minimum Items to be executed as per Schedule B-12 Item no -01

14.)	<p><b>0.415 KV LT PANEL</b></p> <p>Supply, installaton, testing &amp; commissioning MCC panel, totally enclosed type as per IS: 2147 &amp; latest amendment, operation on three phase, 415V, 50Hz,neutral effectively grounded, IP 54, with instrument compartments indicating lamps, control contactors as per IS: 13947, relays and control fuses air insulated control method- Torque control, Input Voltage- 3 phase 415 V, Input Frequency - 50 Hz (+/- 3 %), Starter Protection - S/C,u/V,Phase unbalance,Phase failure, Built in communication as per RS 485, Under Voltage release type 415V, Earth Fault Release EF1 (10%,20% Ir), Door Inter Lock. <b>Incomer Feeder:</b> 400 A, MCCB -2 Nos., 400 Amp Bus Coupler - 2 Nos, 150 Amp MCCB For Dg Set - 1 Nos; 36kA Utilization Category B'; Ics=Icu=Icw, as per IEC 947(Part2) (2 incomer,1Bus Coupler, 1 DG sets) --400A, TPN, 36KA, 1Sec, Aluminum Bus-bar Current transformer 400/5A, CI :5P10-- Current transformer 400/5A, CI: 1.0--Multifunction meter with RS 485 Compatibility with PLC-SCADA. S/C,u/Phase unbalance, Phase failure Built in communication as per RS 485 Under Voltage release type 415V Earth Fault Release EF1 (10%,20% Ir) Door Inter Lock 110 V DC Control Supply Suitable for PLC -SCADA system etc. - LED type indication lamps with protection fuses.<b>Outgoing Feeders:</b> 40A TPN MCB with starter for Drain Pump - 2 Nos., , 125 A TPN MCCB with 100/5 A. CI. 1.0 CTs (3 Nos.), ASS and Ammeter for Capacitor Bank Panel - 2 Nos, 63 A MCB for Indoor, Outdoor welding socket - 2 Nos., 100A TPN MCCB with 100/5 A. CI. 1.0 CTs, ASS and Ammeter, for Battery Charger - 1 Nos, 63 AMP TPN MCB Lighting DB - 5 Nos , 63A FP MCB for EOT - 3 Nos, 32A FP MCB for PLC Panel - 1 Nos, 63A MCCB Bore pump panel – 1 no, 32A TPN MCB For Spare - 6 No , 16A DP MCB For Spare - 6 No , 63A TPN MCB For Spare - 5 No , 40A TPN MCB For Spare - 2 No. Spare: All out going motor feeders shall be equipped with ON/OFF/Auto Trip Indicating Lamps, control circuit MCBs, neutral link for control circuits.</p>	No	1
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## Annexure D

### List of Minimum Items to be executed as per Schedule B-12 Item no -01

<b>15.)</b>	<b>H.T Cable (6.6 KV)</b>		
	Supply, laying, testing & commissioning 6.6 / 6.6 kV (UE) grade, XLPE insulated, stranded Aluminium conductor, galvanised steel flat strip / round wire armoured, extruded PVC type ST2 sheathed, heavy duty cable (to be laid on wall surface with necessary clamps / in existing cable trench / cable trays / conduit / pipe sleeves at road crossing or floor as per site requirement) conforming to IS: 7098 (Part- 2) & IEC: 60502(Part-2) of following sizes: *6.6kV (UE) = 11kV (E) (Transformer Secondary Side to HT Panel To Motor To Soft Starter to Capacitor Panel, HT Panel to Auxiliary transformer primary )	Mtr	As Per Requirements
<b>16.0.)</b>	Providing & fitting heat shrink cable termination / jointing kits for 6.6 kV (UE) / 11 kV (E) grade XLPE insulated cable including necessary earth connectivity connection, material & consumables making the termination/ joint complete ensuring the joint resistance is within the permissible limit as per IS, of following types & sizes.	No	As Per Requirements
<b>16.0.)</b>	<b>L.T (1100 V Grade cable)</b> Supply, laying, testing & commissioning 1.1 kV grade, XLPE insulated, stranded Aluminium conductor, galvanised steel flat strip / round wire armoured, extruded PVC type ST2 sheathed, heavy duty cable (to be laid on wall surface with necessary clamps / in existing cable trench / cable trays / conduit / pipe sleeves at road crossing or floor as per site requirement) conforming to IS:7098 (Part-1) & IEC:60502		
<b>16.1.)</b>	(Aux Tran LT Side to MCC Panel Incomer)	Mtr.	As Per Requirements
<b>16.2.)</b>	( MCC Panel to LT APFC Panel )	Mtr	As Per Requirements
<b>16.3.)</b>	((For WR-DB with TPN MCB at Sump & Pump House, Outdoor LDB, Indoor LDB, Auxilury-PDB Feeders) )	Mtr	As Per Requirements
<b>16.4.)</b>	(Industrial Socket)	Mtr.	As Per Requirements
<b>16.5.)</b>	(Battery and Battery Charger)	Mtr	As Per Requirements
<b>16.6.)</b>	Providing and erecting XLPE(IS:7098)(I)-88 ISI armoured cable multistrand / Solid Copper conductor for 1.1 KV. to be laid on wall with necessary clamps or in existing trench / pipe at road crossing or floor of following size of cables. Size: -		
<b>16.7.)</b>	(For TPN MCB for EOT at Pump House & TPN MCB at PMCC room & Pump house maintenance floor & Pump House floor, Pump MOV Delivery, Pump MOV Header, ICP, 2nos. Dewatering Pumps etc.)	mtr	As Per Requirements
<b>16.8.)</b>	(C&R PANEL TRF FEEDER, 6.6 KV SWGR, CAPACITOR CUBICLE, ISOLATORS, SF6 CIRCUIT BREAKER)	Mtr	As Per Requirements
<b>16.9.)</b>	( For Motor Space Heater , HT Panel, APFC CT & Transformer Marshalling box , Level Switch etc.)	Mtr	As Per Requirements
<b>16.10.)</b>	( HT Panel TO HT Soft Starter)	Mtr.	As Per Requirements
<b>16.11.)</b>	( RTCC TO OLTC)	Mtr.	As Per Requirements
<b>17.0.)</b>	Supplying and erecting heavy duty flange type brass Double Compress cable glands with rubber ring for suitable size PVC armoured cable complete with out going tails,insulating tape etc.for following size of cables.		
<b>17.1.)</b>	(Aux Tran LT Side to MCC Panel Incomer)	Nos	As Per Requirements
<b>17.2.)</b>	( MCC Panel to LT APFC Panel )	Nos	As Per Requirements
<b>17.3.)</b>	((For WR-DB with TPN MCB at Sump & Pump House, Outdoor LDB, Indoor LDB, Auxilury-PDB Feeders) )	Nos	As Per Requirements
<b>17.4.)</b>	(Industrial Socket)	Nos	As Per Requirements
<b>17.5.)</b>	(Battery and Battery Charger)	Nos	As Per Requirements
<b>17.6.)</b>	(For TPN MCB for EOT at Pump House & TPN MCB at PMCC room & Pump house maintenance floor & Pump House floor, Pump MOV Delivery, Pump MOV Header,ICP, Motor Operated Valves, 2nos. Dewatering Pumps)	Nos	As Per Requirements
<b>17.7.)</b>	(C&R PANEL TRF FEEDER, 6.6 KV SWGR, CAPACITOR CUBICLE, ISOLATORS, SF6 CIRCUIT BREAKER)	Nos	As Per Requirements
<b>17.8.)</b>	( For Motor Space Heater , HT Panel, APFC CT & Transformer Marshalling box , Level Switch)	Nos	As Per Requirements



## Annexure D

### List of Minimum Items to be executed as per Schedule B-12 Item no -01

<b>17.9.)</b>	( HT Panel TO HT Soft Starter)	Nos	As Per Requirements
<b>17.10.)</b>	( RTCC TO OLTC)	Nos	As Per Requirements
<b>18.0.)</b>	Supplying and erecting crimping type aluminium/copper lugs conforming to IS suitable for cable as per below evenly crimped with high pressure tool and connected to switch gear terminal with brass/cadmium plates nuts bolts in an approved manner.		
<b>18.1.)</b>	(Aux Tran LT Side to MCC Panel Incomer)	Nos	As Per Requirements
<b>18.2.)</b>	( MCC Panel to LT APFC Panel )	Nos	As Per Requirements
<b>18.3.)</b>	((For WR-DB with TPN MCB at Sump & Pump House, Outdoor LDB, Indoor LDB, Auxilury-PDB Feeders) )	Nos	As Per Requirements
<b>18.4.)</b>	(Industrial Socket)	Nos	As Per Requirements
<b>18.5.)</b>	(Battery and Battery Charger)	Nos	As Per Requirements
<b>18.6.)</b>	(For TPN MCB for EOT at Pump House & TPN MCB at PMCC room & Pump house maintenance floor & Pump House floor, Pump MOV Delivery, Pump MOV Header,ICP, Motor Operated Valves, 2nos. Dewatering Pumps)	Nos	As Per Requirements
<b>18.7.)</b>	(C&R PANEL TRF FEEDER, 6.6 KV SWGR, CAPACITOR CUBICLE, ISOLATORS, SF6 CIRCUIT BREAKER)	Nos	As Per Requirements
<b>18.8.)</b>	(For Motor Space Heater , HT Panel, APFC CT & Transformer Marshalling box , Level Switch)	Nos	As Per Requirements
<b>18.9.)</b>	( HT Panel TO HT Soft Starter)	Nos	As Per Requirements
<b>18.10.)</b>	( RTCC TO OLTC)	Nos	As Per Requirements
<b>19.0.)</b>	Supply, Installation, Testing And Commissioning of of Main & Outlet points wiring with 1.1KV Grade FRLS PVC insulated ISI marked flexible stranded copper conductor wires with medium class min. 25mm dia. Rigid PVC Pipe and accessories to be erected conceled in/to be run on surface /wall/ ceiling with following sizes as mentioned below. The unit rate wiring shall be with connector, PVC junction box, wire holder, ceiling rose, Angle holder, switch, switchboard brass chromium/cadmium plated machine screws, phase and neutral wires, green earth continuity wires etc. as required to complete wiring from LDB panel to the final outlet termination points. The wiring shall be as per IS :732, Is : 4648 and as per tender specification / IS		As Per Requirements
<b>19.1.)</b>	Point wiring for Light / Fan/ Bell/ Primary Point with 2-1.5 sq. mm & earthwire of 1.5 sq. mm (green) both are of ISI marked 1.1 kv grade FRLS PVC insulated multistrand copper wires, in following type of pipe to be erected concealed in /flushed on wall/ceiling , complete with 6A Tissino Type ISI marked flush type switch / bell push and accessories erected on Metal / PVC Box covered with 3 mm thick PC(Polycarbonet) /Acrylic sheet. with necessary Lamp holder/ceiling rose / H.D.Connector as directed. with medium class Rigid PVC pipe and accessories		As Per Requirements
<b>19.2.)</b>	Point wiring for 5/15A independent PLUG with following size mains earthwire of 1.5 sq.mm (green) both are of ISI marked 1.1 KV grade FRLS PVC insulated multistrand copper wires, in following type of pipe to be erected concealed in /flushed on wall/ceiling , complete with ISI marked 3 / 5 Pin socket and tissino type switch erected with earth continuity connection erected on Metal / PVC box covered with 3 mm thick PC(Polycarbonet) / Acrylic sheet.		As Per Requirements
<b>19.2.)</b>	Supply, Installation, Testing And Commissioning of of One 300/380mm Dia. Ex. Fan 16A independent Plug point near Ex. Fan with 2Nos. 4Sq.mm Cu. Mains size wiring & earth wire of 1.5 sq.mm (green) both are of ISI marked 1.1KV grade FRLS PVC insulated multistrand copper wires with medium calss Rigid PVC Pipe and accessories to be erected on wall / ceiling, complete with ISI marked 3Pin socket and tissino type switch erected with earth continuity connection erected on Metal/PVC box covered with 3mm thick PC (Poly carbonet)/ Acrylic sheet. Plug Point shall be near Ex.Fan		As Per Requirements

## Annexure D

### List of Minimum Items to be executed as per Schedule B-12 Item no -01

19.3.)	Providing and erecting Approved make Ceiling fan with double ball bearing ISI mark with condenser A.C. 230V.50 c/s.1200 mm. sweep complete, canopy erected on existing hook or clamp with earthing.		As Per Requirements
19.4.)	Point wiring for on board Looped Plug with 6A Modular type switch & 5 pin socket erected on PVC / Metallic/Wooden box, single mounting base frame covered with textured / metallic/white front plate modules erected on / in wall / ceiling with following type accessories Mini Modular(Cat.III)		As Per Requirements
19.5.)	Point Wiring for loop plug with 6A Modular type Switch and 6A 5 pin Socket erected on PVC/Metallic box covered with appropriate front plate modules erected concealed in wall/ceiling with following type accessories. Mini Modular(Cat.III)		As Per Requirements
19.6.)	Main with 1.1 KV grade FR PVC insulated ISI mark standard copper conductor wire in existing pipe erected with 1.5 sq.mm copper conductor FR PVC insulated standard wire of green colour for earth continuity of following size.		As Per Requirements
19.7.)	Main with 1.1 KV grade FR PVC insulated ISI mark standard copper conductor wire in existing pipe erected with 2.5 sq.mm copper conductor FR PVC insulated standard wire of green colour for earth continuity of following size.		As Per Requirements
19.8.)	Supplying and erecting LED indoor fittings with LEDs of wattage 0.2 Watt to 0.5 Watt assembled on single MCPCB, with housing used as a heat sink shall be made of thick sheet Steel conforming to IS: 513/CRCA/aluminium pressure die cast powder coated and high U.V. & corrosion resistance with diffuser housed in aluminium casted body with company mark/name 120 to 300 V,Power Factor more than 0.9, THD < 10 %, CCT 3000 K to 6500K, Luminaire efficacy> 85 lumens/watt ,LED efficiency 110 lumens/watt. LED driver efficiency > 85 % used for luminaire. ( fitting required LM-79 & LM-80 Certificates) - Cat III	Nos	As Per Requirements
19.9.)	Providing and erecting approved make decorative recess mounting Down Lighter fittings with anodized Aluminium reflector suitable for compact flourcent lamp with copper ballast holder and necessary lead wire. Size - With One Lamp retrofit 11 W	Nos	As Per Requirements
20.)	SITC of Aux-Power Distribution Board (PDB): 3 Phase 4 Wire TPN, 6 way SS double door Prewired PDB Suitable to house(For MOV etc.): Incoming: 63A TPN, MCB Outgoing: 6 nos. 32A TP MCB with neutral link.	Nos	3.00
20.1.)	SITC of Aux-Power Distribution Board (PDB) : 3 Phase 4 Wire TPN, 6 way SS double door Prewired PDB Suitable to house(For MOV etc.): Incoming: 63A TPN, MCB Outgoing: 6 nos. 32A TP MCB with neutral link.	Nos	2.00
20.2.)	SITC of Aux-Power Distribution Board (PDB) @ Pump House as under: 3 Phase 4 Wire TPN, 8 way SS double door Prewired PDB Suitable to house: Incoming: 63A TPN, MCB Outgoing: 8 Nos.32A 4P MCB 'C' Curve	Nos	2.00

## Annexure D

### List of Minimum Items to be executed as per Schedule B-12 Item no -01

21.)	<b>EXHAUST FAN</b> Supplying & erecting single phase approved make industrial exhaust fan suitable for medium duty ring mounted low noise operation suitable for medium duty having following dia size and maximum speed in RPM 305 mm , 900 RPM (Cat-II)	Nos	As Per Requirements
22.)	<b>External Lighting</b> Supplying and erecting LED street light / Flood light fittings with High power White LEDs wattage of 1Watt and above assembled on single MCPCB, efficiency more than 130 lm/w and corrosion free High pressure die cast aluminum housing with smooth finish powder coated and heat sink extruded aluminium with diffuser and Polycarbonate optics/ lenses with company mark/name engraved or embossed 120 to 300 V,Power Factor more than 0.95, THD < 10 %, CCT 3000 K to 5700K, Uniformity ratio >0.45, Luminaire efficacy> 100 lumens/watt . LED driver efficiency > 85 %.CREE / OSRAM / PHILIPS Lumileds / NICHIA / SEOUL/ Bridgelux (U.S.A.) make LED used for luminaire. ( fittings required LM-79 & LM-80 certificates)	Nos	As Per Requirements
22.1.)	SITC of Street Light Pole, steel tubular swaged type, 7.5 meter long with single arm & M.S.base plate with pipe cap and over hung 1.5 m long having dia to suit the socket of 240V LED street light fixtures. Street light pole unit rate shall be with (i) IP 65 SMC box of size 20 x 15 x 15 cms. with MCB & terminal strip inside the box with hinged/sliding door (ii)50mm dia, B class GI pipe bracket min.1.5mtr long for Incoming & outgoing cable (iii)MS Cable Clamp of 25 x 3mm (iv)SITC of 1.5 Mtr.single Arm bracket of medium duty MS pipe of 4.2 cms. Out side dia complete with suitable sleeve tubing 45 cms. long of required size of pole top etc. and having spread of 1.5.mtr. length with 110 deg.(v) Complete painted with one coat of Red oxide / PU base primer and two coats of Aluminium / PU paint for Pole,Arm, pipe etc.	Nos	As Per Requirements
22.2.)	<b>POLE FOUNDATION</b> Providing M-20/1:2:4 Cement concrete foundation & 70% PCC from bottom including excavation for the pole of size 60 x 60 x 120 cms.Deep in below ground level with plinth of 45 cms x 45 cms high upper ground level with necessary curing and finishing in approved manner ( for 7.5 & 8/8.5 mtr pole)	Nos	As Per Requirements
23.)	<b>EARTHING</b>		
23.1.)	Supply & erection HOT deep Galvanised iron strip wire 8 to 16 SWG.(For Street Light and Pumping)	Kg	As Per Requirements
23.2.)	Supply, laying and erection of 25mm(w) x 3mm(T) etc. sizes as required, HOT dip galvanized GI Strip including supply & fixing using GI spacers, saddles when laid inside the building and inclusive of excavation & refilling of earth when laid outside the building & interconnection with earth pit & all electro-mechanical equipments.	Kg	As Per Requirements
23.3.)	SITC of 50mm(w) x 8mm(T) etc. sizes as required, HOT dip galvanized GI Strip including supply & fixing using GI spacers, saddles when laid inside the building and inclusive of excavation & refilling of earth when laid outside the building & interconnection with earth pit & all electro-mechanical equipments.	Kg	As Per Requirements
23.4.)	SITC of 40mm(w) x 6mm(T) etc. sizes Copper Strip including supply & fixing of bolts, saddles when laid inside the building and inclusive of excavation & refilling of earth when laid outside the building & interconnection with earth pit & Tr. nutral. Copper Bolt,Nuts ,Washers shall be used for Connecting Earth electrode to individual eqp. Bitumen shall be used at the place of joint/welding.	Kg	As Per Requirements

## Annexure D

### List of Minimum Items to be executed as per Schedule B-12 Item no -01

23.5.)	SITC of Maintenance free chemical earthing (copper) with earthpit of minimum bore size dia. 225mm Safe Earthing Electrode consisting Pipe-in-Pipe Technology as per IS-3043:1987 /Tech spec. made of corrosion free Pipes having Outer pipe dia of 48 mm having 250 Micron copper plating, Inner corrosion free Hot dip galvanised (80 to 100 micron) pipe dia of 26 mm with copper flat strip type connection terminal 14mm dia with constant ohmic value surrounded by highly conductive corrosion resistant chemical compound with high charge dissipation suitable for electrical installation & of 3Mtr. length of Pipe with two nos. 25Kg. bag of Back filling compound. NOTE: Earthing Resistance value & date shall be painted on the chamber cover.	No	As Per Requirements
23.6	SITC of Maintenance free chemical earthing with earthpit of minimum bore size dia. 225mm Safe Earthing Electrode consisting Pipe-in-Pipe Technology as per IS-3043:1987 /Tech spec. made of corrosion free Hot dip Galvanised (min 150 Microns) Pipes having Outer pipe dia of 76 mm , Inner corrosion free Hot dip galvanised (80 to 100 micron) pipe dia of 26 mm with copper flat strip type connection terminal 14mm dia with constant ohmic value surrounded by highly conductive corrosion resistant chemical compound with high charge dissipation suitable for electrical installation & 2Mtr. length of Pipe with two nos. 25Kg. bag of Back filling compound. NOTE: Earthing Resistance value & date shall be painted on the chamber cover.	No	As Per Requirements
24.)	CABLE TRAY Supply & laying GI ladder type cable trays with side channels of size - 75 x 15 x 15 mm / 100 x 15 x 15 mm & rungs of size - 35 x15 x 15 mm spaced at 250 mm apart, fabricated from 2 mm thick sheet steel in standard length of 2.5 meter, duly hot dipped galvanized after fabrication as per IS 2629-1989/ IS 4759-1984 including accessories such as coupler plates/ fish plates, bends, tees, reducers, elbows, covers and electro-galvanized hardware etc, erected on existing support as per	Mtr.	As Per Requirements
25.)	DG Set Supplying and erecting, commissioning and testing of Diesel Generating set confirming to IS: 4722:1968 & BS:5514. Rating - 50 KVA	No	1
26.)	<b>Safety Accessories</b>		
26.1.)	Providing printed instruction chart both in English and Gujarati and duly framed with front glasses for treatment of person suffering from electric shock.	Nos	As Per Requirements
26.2.)	Providing pair of rubber hand gloves suitable for working on 11KV/22 KV supply	No	As Per Requirements
26.3.)	Supplying rubber matting of following thickness as per IS:15652/IEC 61111 Size - 12 mm	Sq.Mtr	As Per Requirements
26.4.)	Supplying stand first AID box with antiseptic cream, medicine for use on wound due burn, crepe bandag,gauge bandage,Band-aid adhesive tape for medicinal user,Scissors,anti-septic solution.(All above contents shall be of standard makes)	Nos	As Per Requirements
26.5.)	Supplying Fire bucket round bottom of 9 litres capacity made out of 24 gauge G.I sheet with extra handle at bottom duly painted white inside and red out side with Fire mark, filled with dry-sand and kept on existing stand provided or hung on wall hook.	Nos	As Per Requirements

## Annexure D

### List of Minimum Items to be executed as per Schedule B-12 Item no -01

**Note: - (01)** above Annexure Materials are minimum requirements, However for execution and to start the water supply whatever additional materials required, Agency has to provide all materials to start water supply. No additional Payment will be made for any additional procurements.

**(02)** Sizes and ratings of all major equipment's, components and accessories keeping in view the duty parameters that is Q (Flow) And H (Head) of each pumpsets of concern head works are given in estimates. In case of any change in this parameters subsequently, all other dependent associated mechanical, electrical and instruments etc. will also change to suit the actual requirements. Any and all such required/desired changes/modifications/improvements shall have to be incorporated in CDR and implemented without any additional cost to the department. Claim either in the form of excess qty or extra items on account of such changes (if any) shall not be admissible and not payable.

## Annexure E

List of Minimum Items to be executed as per Schedule B-12 Item no -02			
ELECTRICAL ANNEXURE - PALEJ TO WTP			
Item No	Description	Qty	Unit
1.0	Providing, Erection And Connection Approved make Triple Pole Metal Clad Switch Fuse Unit 415/500 V. with HRC fuse of suitable load and neutral link conforming to IS. Rating - As Per Requirements	1	Nos
2	<b>PMCC PANEL</b> SITC of PMCC Panel complete in all respects as per SLD / Specification / IS and including following as minimum: (1) One nos. FP 315A Microprocessor MCCB (O/C, S/C, E/F) for l/c with Digital Voltmeter with Voltmeter selector switch, Digital Ammeter with Ammeter selector switch, MFM with RS-485, R,Y,B, on, off, trip Indicating lamps & ON, E-STOP, Reset Pushbutton, etc., Four nos. Auto Transformer for 55kW Motor or higher as per pump manufacturer reco. with TM MCCB, contactor, MFM with RS - 485, Resin Cast CT Cl:0.5, SPP, Cooling fan, Space heater, A/M, L/R switch, ON, OFF, TRIP Indication & (Start & E-Stop) pushbutton etc. (2) One nos. 250A TPN MCCB feeder for APFC Panel. (3) One no. 63ATPN MCB feeders (for Auxiliary accessories load) (4) Four nos 32A TPN MCB For Drain Pump, EOT And spare feeder (5) One no. Outdoor lighting LDB feeder with 32ATPN 'C' curve MCB (6) 4 nos. 16A DP MCB feeders	1	Nos
3	<b>APFCR panel</b> Supply, installation, testing & commissioning LV APFC panel above 80 KVAr consisting of required capacitor banks for continuous duty to improve P.F. 0.85 - 0.99 in required steps enclosed in dust & vermin proof compartment, indoor type, fabricated from CRCA sheet steel with minimum thickness of 3 mm for base frame / channel / gland plates, 2.0 mm for load bearing members / doors & 1.6 mm for internal partitions, minimum degree of protection - IP 42, busbar chamber, required size of Al bus bar/ terminals, minimum 10 stage APFC relay, metering, indicating lamps, push buttons, with detuned reactor complete as per IS: 16636-2017 with latest amendment & detailed technical specification and data sheet as under. a) 250A, 50 kA for 1sec. TP, TM based MCCB with spreader terminals & rotary handle b) 0-250 A range analogue ammeter of 96 x 96 mm size with selector switch c) 3nos. 250 / 5A, 10 VA CL-1.0 cast resin type current transformer d) Suitable rating of MCCB / MCB & Contractors for each capacitor bank e) Suitable rating APP type capacitor banks (vacuum impregnated with non-PCB / non toxic oil, internally delta connected with built in internal fuses complete with discharge resistances & terminal cover) of approved make in required steps with well suited detuned reactor is placed in series with each capacitor step.	1.00	NOS
4	SITC of Lighting Distribution Board (LDB) as under: 3 Phase 4 Wire FP, 12 way Prewired LDB (One each for Indoor & Outdoor Lighting) Suitable to house Incoming: 25A FP, ELMCB Outgoing: 20A SP MCB 'C' curve (1 nos.) , 16A DP MCB 'C' curve (2 nos.) & 16A TP MCB 'C' curve (1 nos.) (At Panel Room)	1	As Per Requirements
5	<b>MEDIUM VOLTAGE CABLES</b> Supply, laying, testing & commissioning 1.1 kV grade, XLPE insulated, stranded Aluminium conductor, galvanised steel flat strip / round wire armoured, extruded PVC type ST2 sheathed, heavy duty cable (to be laid on wall surface with necessary clamps / in existing cable trench / cable trays / conduit / pipe sleeves at road crossing or floor as per site requirement) conforming to IS:7098 (Part-1) & IEC:60502 (Part-1) of following sizes:	As Per Requirement	MTR
6	Supply, laying, testing & commissioning 1.1 kV grade, XLPE insulated, stranded Aluminium conductor, galvanised steel flat strip / round wire armoured, extruded PVC type ST2 sheathed, heavy duty cable (to be laid on wall surface with necessary clamps / in existing cable trench / cable trays / conduit / pipe sleeves at road crossing or floor as per site requirement) conforming to IS:7098 (Part-1) & IEC:60502 (Part-1) of following (For WR-DB with TPN MCB at Sump & Pump House, LDB, EOT, Street Light)	As Per Requirement	MTR
7	Providing and erecting XLPE(IS:7098)(I)-88 ISI armoured cable multistrand / Solid Copper conductor for 1.1 KV. to be laid on wall with necessary clamps or in existing trench / pipe at road crossing or floor of following size of cables. (For Dewatering Pumps)	As Per Requirement	MTR
7.1	( For APFC CT )	As Per Requirement	MTR
8	<b>CABLE END TERMINATION AND CONNECTION :</b> Providing & fitting heavy duty Double Compression Brass Cable Glands (nickel-plated) with washers & rubber ring conforming to IS, suitable for 3, 3½ & 4 core cables of following type & sizes:	1.00	Lot
9	<b>CABLE LUGS</b> Supplying and erecting Crimping type Aluminium/copper lugs conforming to IS suitable for cable as below evenly crimped with high pressure tools and connected to switch gear terminal with brass/cadmium plated nuts bolts in an approved manner.	1.00	Lot
10	<b>CABLE TRAY</b> Supply & laying GI ladder type cable trays with side channels of size - 75 x 15 x 15 mm / 100 x 15 x 15 mm & rungs of size - 35 x 15 x 15 mm spaced at 250 mm apart, fabricated from 2 mm thick sheet steel in standard length of 2.5 meter, duly hot dipped galvanized after fabrication as per IS 2629-1989/ IS 4759-1984 including accessories such as coupler plates/ fish plates, bends, tees, reducers, elbows, covers and electro-galvanized hardware etc, erected on existing support as per specification and instruction of Engineer-in-charge.	1.00	Lot
11	SITC of chemical earthing with earthpit of minimum bore size dia. 225mm Safe Earthing Electrode consisting Pipe-in-Pipe Technology as per IS- 3043:1987 made of corrosion free G.I. Pipes having Outer pipe dia of 80 mm having 80-200 Micron galvanising, Inner pipe dia of 40 mm having 200-250 Micron galvanising or copper coated solid steel rod / flat strip type connection terminal 14mm dia with constant ohmic value surrounded by highly conductive corrosion resistant chemical compound with high charge dissipation suitable for electrical installation of 11 kV & 440V of 2Mtr. length of Pipe with one no. 25Kg. bag of Back filling compound.	As Per Requirement	NOS

## Annexure E

List of Minimum Items to be executed as per Schedule B-12 Item no -02			
ELECTRICAL ANNEXURE - PALEJ TO WTP			
Item No	Description	Qty	Unit
11.1	SITC of 50mm(w) x 6mm(T) etc. sizes as required, HOT deep GI Strip including supply & fixing using GI spacers, saddles when laid inside the building and inclusive of excavation & refilling of earth when laid outside the building & interconnection with earth pit & all electro-mechanical equipments.	As Per Requirement	KG
11.2	Supply, laying and erection of 40mm(w) x 6mm(T) etc. sizes Copper Strip including supply & fixing of bolts, saddles when laid inside the building and inclusive of excavation & refilling of earth when laid outside the building & interconnection with earth pit & Tr. neutral.	As Per Requirement	KG
11.3	SITC of HOT Dip Galvanized iron strip wire 8 SWG (For LDB, PDB, LCS, St.Light Pole, etc.)	As Per Requirement	KG
12.0	<b>INTERNAL WIRING:-</b> SITC of Main & Outlet points wiring with 1.1KV Grade FRLS PVC insulated ISI marked flexible stranded copper conductor wires with medium class min. 25mm dia. Rigid PVC Pipe and accessories to be erected concealed in/to be run on surface /wall/ ceiling with following sizes as mentioned below. The unit rate wiring shall be with connector, PVC junction box, wire holder, ceiling rose, Angle holder, switch, switchboard brass chromium/cadmium plated machine screws, phase and neutral wires, green earth continuity wires etc. as required to complete wiring from LDB panel to the final outlet termination points. The wiring shall be as per IS :732, Is : 4648 and as per tender specification / IS	1.00	Lot
12.1	Point wiring for Light / Bell with 2-1.5 sq.mm & earth wire of 1.5 sq.mm (Green) both are of ISI marked 1.1 KV grade FRLS PVC insulated multi strand copper wires up to 10 mtr length , in below type of pipe erected with 6A Modular type switch / bell push & accessories and earth continuity of following type, erected on PVC / Metallic/Wooden box, single mounting base frame covered with extured/metallic/white front plate modules erected on / in wall / ceiling as per pipe erected, with necessary Lamp holder/ceiling rose / H.D.Connector as directed.. with medium class Rigid PVC pipe and accessories		As Per Requirements
12.2	Point wiring for 5/15A Individual Plug with & earth wire of 1.5 sq.mm (Green) both are of ISI marked 1.1 KV grade FRLS PVC insulated multi strand copper wires up to 10 mtr length, in below type of pipe erected complete with Modular type switch & 5 pin Plug erected on PVC / Metallic/Wooden box covered with appropriate front plate modules erected on / in wall / ceiling as per pipe erected with following type of accessories		As Per Requirements
12.3	SITC of One 300/380mm Dia. Ex. Fan 16A independent Plug point near Ex. Fan with 2Nos. 4Sq.mm Cu. Mains size wiring & earth wire of 1.5 sq.mm (green) both are of ISI marked 1.1KV grade FRLS PVC insulated multistrand copper wires with medium calss Rigid PVC Pipe and accessories to be erected on wall / ceiling, complete with ISI marked 3Pin socket and tissino type switch erected with earth continuity connection erected on Metal/PVC box covered with 3mm thick PC (Poly carbonet)/ Acrylic sheet. Plug Point shall be near Ex.Fan		As Per Requirements
12.4	SITC of 5/15A independent PLUG with following size mains earthwire of 1.5 sq.mm (green) both are of ISI marked 1.1 KV grade FRLS PVC insulated multistrand copper wires, in following type of pipe to be erected concealed in /flushed on wall/ceiling , complete with ISI marked 3 / 5 Pin socket and modular type switch erected with earth continuity connection erected on Metal / PVC box covered with 3 mm thick PC(Polycarbonet) / Acrylic sheet.		As Per Requirements
13	Exhaust Fan: Supplying & erecting single phase approved make industrial exhaust fan suitable for medium duty ring mounted low noise operation suitable for medium duty having following dia size and maximum speed in RPM 380 mm dia 900 RPM		As Per Requirements
14	<b>LED LIGHT FIXTURES:-</b> SITC of Indoor wall mounting LED indoor fitting with LED s of wattage 0.2 watt to 0.5 watt assembled on single MCPCB with housing used as a heat sink shall be made of thick sheet steel confirming to IS :513/CRCA polyester powder coated and high U.V. & corrosion resistance with diffuser and/or Poly carbonate optics with company mark/name 120 to 300V, Power Factor more than 0.9, THD <10%, CCT 3000K to 6500K, Uniformity ration >0.7, Luminare efficancy > 85 Lumens/watt, LED driver efficiency >85% (Each fitting required LM-79 & LM-80 Certificates) Tube Light with integral/ nonintegral driver.		As Per Requirements
15	<b>EXTERNAL LIGHTING:-</b> Supplying and erecting LED street light / Flood light fittings with High power White LEDs wattage of 1Watt and above assembled on single MCPCB, efficiency more than 130 lm/w and corrosion free High pressure die cast aluminum housing with smooth finish powder coated and heat sink extruded aluminium with diffuser and Polycarbonate optics/ lenses with company mark/name engraved or embossed 120 to 300 V,Power Factor more than 0.95, THD < 10 %, CCT 3000 K to 5700K, Uniformity ratio >0.45, Luminare efficacy> 100 lumens/watt . LED driver efficiency > 85 %. ( fittings required LM-79 & LM-80 certificates). (A) Street Light (IP-65), Surge protection -4KV integral and ,Light must have 440VAC line supply with over-voltage protection.		As Per Requirements
15.1	B' class galvanised iron pipe 32 mm outside dia 45 cms long duly welded on 20 cms x 20 cms x 3 mm thick M.S. base plate, erected on wall or corner for mounting street light luminaire with necessary hardware materials duly painted. For wall mounting indoor & Outdoor Flood light Fixtures on wall of Building		As Per Requirements
16	<b>SAFETY ACCESSORIES:-</b> SITC of following safety accessories complete with necessary fixing brackets, other accessories and tools etc. as required to complete the job. Supply & Erecting carbon dioxide (CO2) fire extinguisher of 6.5kg capacity with necessary clamps made from 50 x 6 mm M.S. Flat with nut & bolts grouted in wall complete.		As Per Requirements
16.1	Supplying stand first AID box with antiseptic cream, medicine for use on wounds due burn, crepe bandage, gauge bandage, medicated ready to use bandage (Band-aid) adhesive tape for medicinal user, Scissors, anti-septic solution (Savlon or similar) etc. (All above contents shall be of standard makes) (For Pump house / LT Room)		As Per Requirements

## Annexure E

### List of Minimum Items to be executed as per Schedule B-12 Item no -02

ELECTRICAL ANNEXURE - PALEJ TO WTP			
Item No	Description	Qty	Unit
16.2	Providing printed instruction (First Aid) Chart both in English and Gujarati and duly framed with front glasses, for treatment of person suffering from electric shock. (1no. for HT Room & 1no. For LT Room)		As Per Requirements
16.3	Supplying & fixing of FIRE bucket round bottom of 9 litres capacity made out of 24 guage G.I. sheet with extra handle at bottom duly painted white inside and Red outside with FIRE mark, filled with dry sand and kept on stand provided or hung on wall hook.		As Per Requirements
16.4	Supply and laying of 3 mm thick, 1000 mm wide Rubber Matting Class - C as per IS:15652 and with good electrical insulation property for 1.1kV (LV voltage) as per site requirement. (for LT Panel)		As Per Requirements
16.5	Providing pair of rubber hand gloves suitable for working on 11 KV/22 KV supply.		As Per Requirements

**Note: - (01)** above Annexure Materials are minimum requirements, However for execution and to start the water supply whatever additional materials required, Agency has to provide all materials to start water supply. No additional Payment will be made for any additional procurements.

**(02)** Sizes and ratings of all major equipment's, components and asseccories keeping in view the duty parameters that is Q (Flow) And H (Head) of each pumpsets of concern head works are given in estimates. In case of any change in this parameters sub sequently, all other dependent associated mechanical, electrical and instruments etc. will also change to suit the actual requirements. Any and all such required/desire changes/modifications/improvements shall have to be incorporated in CDR and implemented without any additional cost to the department. Claim either in the form of excess qty or extra items on account of such changes (if any) shall not be admissible and not payable.



## Annexure F

List of Minimum Items to be executed as per Schedule B-12 Item no -01			
INSRUMENTS ANNEXURE - INTAKEWELL TO GIDC			
Item Nos.	Description	Qty	Unit
1	<b>Display Type PRESSURE INDICATING TRANSMITTER SYSTEM:</b> Design, Supply, Installation, Testing and Commissioning of Sealed Diaphragm Type Pressure Transmitter. Piezo-resistive sensor technolgy based pressure transmitter with Micro-processor based integral LED/ LCD display, with accuracy of $\pm 0.3\%$ of span, external zero and span adjustment, self diagnostics, temperature sensor for compensation. 15 to 36 V DC power supply, output signal of 4-20 mA DC with HART. Minimum IP 65 degree of protection. Aluminium housing with epoxy coating, Accessories like snubbers for pump discharge applications, three way manifold, mounting brackets, name plate etc. Material for accessories shall be SS. Protection Box/Canopy shall be provided for outside installed transmitters. Range : (On Main Header)	13	NOS
2	<b>ULTRASONIC TYPE LEVEL TRANSMITTER:</b> Design, Supply, Installation, Testing and Commissioning of NOn Contact Ultrasonic Type Level Transmitter with Integral Display. Sensor with Head Mounted Transmitter: The sensor should be non contact type, field mounting type, housing shall have minimum IP65 protection, PP/ PVC Sensor MOC, Microprocessor based indicator with LED / LCD digital display,panel/ wall mounting type, power supply shall be 110- 240 Vac or 15 to 36 Vdc, 50 Hz $\pm 10\%$ . Accesories: Mounting bracket, nut, bolts etc as per system requirement and Hook up diagram of the Instruments. Level Transmitter shall be suitable for following Range. Meas. Range: As Per Requirements	1	NOS
3	<b>Float &amp; Board Type Level Indicator</b> Design, Supply, Installation, Testing and Commissioning of Float & Board Type Level Indicator, guided construction, Full Range Travel, FRP/ SS316 MOC of Float and Guide Wire Rope, minimum 6" wide x aluminum powder coating with black graduations and numerical on calibrated gauge board, Red color pointer, protection conduit, Elbow pulley, Tensioner, Anchor, Rope Fastner, Gauge Brackets, Counter Weight for rope type probe, spacer between the probes, etc complete with calibration of following sizes. Slze - As Pe Requirements	1	NOS
4	<b>INSTRUMENTATION CONTROL PANEL WITH PLC SCADA SYSTEM</b> Control, Automation, pressure transmitter, UPS and Scada software package with license for pumping station with 32" Monitor, 4GB RAM, 500GB hot swappable internal storage capacity with suitable operating system, Floor mounted front operated cubical panel board having IP 55 protection with annunciator with relay based for controlling of flow, level, pressure and 6 nos of temperature scanner for motor winding with necessary wire and accessory and necessary material. PLC system shall be 100% hot back up with redundancy.	1	NOS
5	<b>INSTRUMENT CABLE &amp; ACCESSORIES:</b> Supply, laying, installation, connection, termination, testing & commissioning of instrument cables, along with cable gland, lugs, cable trays,required junction boxes, fitting and accessores as per specs. The unit rate shall include (a) supply, loading & unloading of the cable at site from store. (b)shifting of cable from site store to place of installation. (c)fixing of cable clamps, brackets, supports,route markesr etc. where ever required to fix the cables safely.(d)excavation,back filling and leveling of ground alongwith laying of fine sand, protection bricks and other necessary civil material for laying cables outside the building.(e) testing and submission of sketches & reports of all the cables laid. Power Cable:- 3C X 1.5 sq.mm	As Per Requirements	
a	Control Cable:- 2C X 1.5 sq.mm	As Per Requirements	
b	Signal Cable:- 1P X 1.5 sq.mm	As Per Requirements	

## Annexure F

### List of Minimum Items to be executed as per Schedule B-12 Item no -01

**Note:** - (01) above Annexure Materials are minimum requirements, However for execution and to start the water supply whatever additional materials required, Agency has to provide all materials to start water supply. No additional Payment will be made for any additional procurements.

(02) Sizes and ratings of all major equipment's, components and asseccories keeping in view the duty parameters that is Q (Flow) And H (Head) of each pumpsets of concern head works are given in estimates. In case of any change in this parameters sub sequently, all other dependent associated mechanical, electrical and instruments etc. will also change to suit the actual requirements. Any and all such required/desire changes/modifications/improvements shall have to be incorporated in CDR and implemented without any additional cost to the department. Claim either in the form of excess qty or extra items on account of such changes (if any) shall not be admissible and not payable.

## Annexure G

List of Minimum Items to be executed as per Schedule B-12 Item no -01			
INSTRUMENTS ANNEXURE - INTAKEWELL TO GWSSB			
Item Nos.	Description	Qty	Unit
1	<b>Display Type PRESSURE INDICATING TRANSMITTER SYSTEM:</b> Design, Supply, Installation, Testing and Commissioning of Sealed Diaphragm Type Pressure Transmitter. Piezo-resistive sensor technology based pressure transmitter with Micro-processor based integral LED/ LCD display, with accuracy of $\pm 0.3\%$ of span, external zero and span adjustment, self diagnostics, temperature sensor for compensation. 15 to 36 V DC power supply, output signal of 4-20 mA DC with HART. Minimum IP 65 degree of protection. Aluminium housing with epoxy coating, Accessories like snubbers for pump discharge applications, three way manifold, mounting brackets, name plate etc. Material for accessories shall be SS. Protection Box/Canopy shall be provided for outside installed transmitters. Range : As Per Requirement	7	NOS
2	<b>ULTRASONIC TYPE LEVEL TRANSMITTER:</b> Design, Supply, Installation, Testing and Commissioning of Non Contact Ultrasonic Type Level Transmitter with Integral Display. Sensor with Head Mounted Transmitter: The sensor should be non contact type, field mounting type, housing shall have minimum IP65 protection, PP/ PVC Sensor MOC, Microprocessor based indicator with LED / LCD digital display, panel/ wall mounting type, power supply shall be 110- 240 Vac or 15 to 36 Vdc, 50 Hz $\pm 10\%$ . Accessories: Mounting bracket, nut, bolts etc as per system requirement and Hook up diagram of the Instruments. Level Transmitter shall be suitable for following Range. Meas. Range: As Per Requirement	1	NOS
3	<b>Float &amp; Board Type Level Indicator</b> Design, Supply, Installation, Testing and Commissioning of Float & Board Type Level Indicator, guided construction, Full Range Travel, FRP/ SS316 MOC of Float and Guide Wire Rope, minimum 6" wide x aluminum powder coating with black graduations and numerical on calibrated gauge board, Red color pointer, protection conduit, Elbow pulley, Tensioner, Anchor, Rope Fastener, Gauge Brackets, Counter Weight for rope type probe, spacer between the probes, etc complete with calibration of following sizes. Size - As Per Requirement	1	NOS
4	<b>INSTRUMENTATION CONTROL PANEL WITH PLC SCADA SYSTEM</b> Control, Automation, pressure transmitter, UPS and Scada software package with license for pumping station with 32" Monitor, 4GB RAM, 500GB hot swappable internal storage capacity with suitable operating system, Floor mounted front operated cubical panel board having IP 55 protection with annunciator with relay based for controlling of flow, level, pressure and 10 nos of temperature scanner for motor winding with necessary wire and accessory and necessary material. PLC system shall be 100% hot back up with redundancy.	1	NOS

## Annexure G

List of Minimum Items to be executed as per Schedule B-12 Item no -01			
<b>5</b>	<b>INSTRUMENT CABLE &amp; ACCESSORIES:</b> Supply, laying, installation, connection, termination, testing & commissioning of instrument cables, along with cable gland, lugs, cable trays, required junction boxes, fitting and accessories as per specs. The unit rate shall include (a) supply, loading & unloading of the cable at site from store. (b) shifting of cable from site store to place of installation. (c) fixing of cable clamps, brackets, supports, route markers etc. where ever required to fix the cables safely. (d) excavation, back filling and leveling of ground along with laying of fine sand, protection bricks and other necessary civil material for laying cables outside the building. (e) testing and submission of sketches & reports of all the cables laid. Power Cable:- 3C X 1.5 sq.mm	As Per Requirement	
<b>a</b>	Control Cable:- 2C X 1.5 sq.mm	As Per Requirement	
<b>b</b>	Signal Cable:- 1P X 1.5 sq.mm	As Per Requirement	
<p><b>Note: - (01)</b> above Annexure Materials are minimum requirements, However for execution and to start the water supply whatever additional materials required, Agency has to provide all materials to start water supply. No additional Payment will be made for any additional procurements.</p> <p><b>(02)</b> Sizes and ratings of all major equipment's, components and accessories keeping in view the duty parameters that is Q (Flow) And H (Head) of each pumpsets of concern head works are given in estimates. In case of any change in this parameters subsequently, all other dependent associated mechanical, electrical and instruments etc. will also change to suit the actual requirements. Any and all such required/desire changes/modifications/improvements shall have to be incorporated in CDR and implemented without any additional cost to the department. Claim either in the form of excess qty or extra items on account of such changes (if any) shall not be admissible and not payable.</p>			

## Annexure H

### List of Minimum Items to be executed as per Schedule B-12 Item no -02

INTRUMENTS ANNEXURE - PALEJ TO WTP			
Item Nos.	Description	Qty	Unit
1	<b>Display Type PRESSURE INDICATING TRANSMITTER SYSTEM:</b> Design, Supply, Installation, Testing and Commissioning of Sealed Diaphragm Type Pressure Transmitter. Piezo-resistive sensor technology based pressure transmitter with Micro-processor based integral LED/ LCD display, with accuracy of $\pm 0.3\%$ of span, external zero and span adjustment, self diagnostics, temperature sensor for compensation. 15 to 36 V DC power supply, output signal of 4-20 mA DC with HART. Minimum IP 65 degree of protection. Aluminium housing with epoxy coating, Accessories like snubbers for pump discharge applications, three way manifold, mounting brackets, name plate etc. Material for accessories shall be SS. Protection Box/Canopy shall be provided for outside installed transmitters. Range : As Per Requirements	4	NOS
2	<b>ULTRASONIC TYPE LEVEL TRANSMITTER:</b> Design, Supply, Installation, Testing and Commissioning of NO Contact Ultrasonic Type Level Transmitter with Integral Display. Sensor with Head Mounted Transmitter: The sensor should be non contact type, field mounting type, housing shall have minimum IP65 protection, PP/ PVC Sensor MOC, Microprocessor based indicator with LED / LCD digital display, panel/ wall mounting type, power supply shall be 110- 240 Vac or 15 to 36 Vdc, 50 Hz $\pm 10\%$ . Accesories: Mounting bracket, nut, bolts etc as per system requirement and Hook up diagram of the Instruments. Level Transmitter shall be suitable for following Range. Meas. As Per Requirements	1	NOS
3	<b>Float &amp; Board Type Level Indicator</b> Design, Supply, Installation, Testing and Commissioning of Float & Board Type Level Indicator, guided construction, Full Range Travel, FRP/ SS316 MOC of Float and Guide Wire Rope, minimum 6" wide x aluminum powder coating with black graduations and numerical on calibrated gauge board, Red color pointer, protection conduit, Elbow pulley, Tensioner, Anchor, Rope Fastner, Gauge Brackets, Counter Weight for rope type probe, spacer between the probes, etc complete with calibration of following sizes. Size - As Per Requirements	1	NOS
4	<b>INSTRUMENTATION CONTROL PANEL WITH PLC SCADA SYSTEM</b> Control, Automation, pressure transmitter, UPS and Scada software package with license for pumping station with 32" Monitor, 4GB RAM, 500GB hot swappable internal storage capacity with suitable operating system, Floor mounted front operated cubical panel board having IP 55 protection with annunciator with relay based for controlling of flow, level, pressure and 10 nos of temperature scanner for motor winding with necessary wire and accessory and necessary material. PLC system shall be 100% hot back up with redundancy.	1	NOS
5	<b>INSTRUMENT CABLE &amp; ACCESSORIES:</b> Supply, laying, installation, connection, termination, testing & commissioning of instrument cables, along with cable gland, lugs, cable trays, required junction boxes, fitting and accessories as per specs. The unit rate shall include (a) supply, loading & unloading of the cable at site from store. (b) shifting of cable from site store to place of installation. (c) fixing of cable clamps, brackets, supports, route markers etc. where ever required to fix the cables safely. (d) excavation, back filling and leveling of ground along with laying of fine sand, protection bricks and other necessary civil material for laying cables outside the building. (e) testing and submission of sketches & reports of all the cables laid. Power Cable:- 3C X 1.5 sq.mm	As Per Requirements	MTR
a	Control Cable:- 2C X 1.5 sq.mm	As Per Requirements	MTR
b	Signal Cable:- 1P X 1.5 sq.mm	As Per Requirements	MTR
<b>Note: - (01)</b> above Annexure Materials are minimum requirements, However for execution and to start the water supply whatever additional materials required, Agency has to provide all materials to start water supply. No additional Payment will be made for any additional procurements. <b>(02)</b> Sizes and ratings of all major equipment's, components and asseccories keeping in view the duty parameters that is Q (Flow) And H (Head) of each pumpsets of concern head works are given in estimates. In case of any change in this parameters sub sequently, all other dependent associated mechanical, electrical and instruments etc. will also change to suit the actual requirements. Any and all such required/desire changes/modifications/improvements shall have to be incorporated in CDR and implemented without any additional cost to the department. Claim either in the form of excess qty or extra items on account of such changes (if any) shall not be admissible and not payable.			