SUPPLY OF HEATER FOR AERATION SYSTEM OF ESP

CONTENTS

A. LIST OF ANNEXURES ENCLOSED (Bidder has to refer all annexures attached)

Annexure-1:

Project Information

CLAUSE NO.	INTENT OF SPECIFICATION	NTPC
1.00.00	**PREAMBLE**	
1.01.00	NTPC Ramagundam (RSTPS) is a pit-head thermal power station based on the coal supplied from the nearby Singareni Mines of M/s. SCCL and water from Pochampad Dam. The station is located in the Karimnagar district of Andhra Pradesh about 60 kms from Karimnagar town and 100 kms from Warangal. Ramagundam Railway station is on the Delhi - Chennai main line. Ramagundam is well connected to Hyderabad by Rajiv Rahadari state highway. There are seven units with a total installed capacity of 2600 MW consisting of 3 units of 200 MW capacity in stage-I, three units of 500 MW in stage-II and one unit of 500 MW capacity in stage-III. The RSTPS Stage-I units (1, 2 & 3)) were commissioned from the year 1982 to 1984 and have completed 34 to 32 years of operation.	
1.02.00	The ESPs of Stage-I units were supplied by M/s Flakt Italiana SpA under the main plant package awarded to M/s Ansaldo, Italy. Each unit has two (02) electrostatic precipitators, Flakt type FAA, with the size code – FAA(45)-4x45-2x75-135-A2. Later these ESPs were modified in the year 1995-1996 by BHEL. The modification was done by filling up the dummy fields with one additional field to increase the collection area.	
1.03.00	The consent (renewal) order for operation (CFO) dated 12.01.2015 of TSPCB (Telangana State Pollution Control Board) valid provided for stack emission standards of 115 mg/Nm3 for particulate matter (SPM) at RSTPS. Further, TSPCB consent order (CFO) requires the station to examine to reduce PM emission level to 100 mg/Nm3. As per the new notification of MOEF dated 07.12.2015, SPM limit of 100 mg/Nm3 is applicable to Ramagundam Stage-I as all the units of Stage-I were commissioned before 31.12.2003 and the notification required the units to meet the specified limits within two years from the date of publication of the notification.	
1.04.00	While the present SPM emission norm of TSPCB for 200 MW units of RSPTS is 115 mg/Nm^3 which will get further reduced to 100 mg/Nm^3 in line with the new notification by MOEF dated 07.12.2015, NTPC proposes to enhance the performance of existing ESPs to achieve much lower emission level of 50 mg/Nm^3 to adequately address further reduction in norms in the future.	
1.05.00	In line with the above, NTPC intends taking up Renovation & Modernization (R&M) work on these existing ESP's of (3x200 MW) units, along with on refurbishing the existing ESPs and augmenting the collection area. This specification is intended for such R&M of three (03) sets Electrostatic Precipitators of 3x200 MW units of RSTPS.	
2.00.00	**INTENT OF SPECIFICATION**	
2.01.00	The intent of this specification is to enhance the efficiency of dust collection of the existing ESPs by R&M work which shall include augmentation of existing collection area along with technology upgradation and redesign / resize the existing ESP so as to meet the objective of R&M work as indicated in Clause No. 5.00.00 of this Chapter and satisfy other guarantee / design requirements specified elsewhere in the specification.	

CLAUSE NO.	EXISTING PLANT DETAILS
9.00.00	Climatological Data

जलवायवी सारणी
CLIMATOLOGICAL TABLE

1951 से 1980 तक के आंकड़ों पर आधारित
BASED ON OBSERVATIONS FROM 1951 TO 1980

केन्द्र: रामगुंडम
STATION : Ramgundam

अक्षांश LAT 18°48' N देशांतर LONG 79°28' E समुद्री तल सतह से ऊँचाई HEIGHT ABOVE M S L 156 METRES

वायु तापमान

माह MONTH		स्टेशन का दाब LEVEL PRESSURE	सूखा बल्ब DRY BULB	गीला बल्ब WET BULB	दैनिक अधिकतम का माध्य DAILY MAX	दैनिक न्यूनतम का माध्य DAILY MIN	माह में उच्चतम HIGHEST IN THE MONTH	माह में निम्नतम LOWEST IN THE MONTH	उच्चतम HIGHEST	दिनांक और वर्ष DATE AND YEAR	निम्नतम LOWEST	दिनांक और वर्ष DATE AND YEAR	सापेक्ष आर्द्रता RELATIVE HUMIDITY	वाष्प दाब VAPOUR PRESSURE	समस्त मेघ ALL CLOUDS	निम्न मेघ LOW CLOUDS	वर्षा MONTHLY TOTAL	वर्षा के दिनों की संख्या NO. OF RAINY DAYS	अधिकतम वर्षायुक्त माह में वर्षा TOTAL IN WETTEST MONTH WITH YEAR	अधिकतम वर्षायुक्त माह में वर्षा TOTAL IN DRIEST MONTH WITH YEAR	24 घंटों की सबसे भारी वर्षा HEAVIEST FALL IN 24 HOURS	दिनांक और वर्ष DATE AND YEAR	पवन की गति MEAN WIND SPEED
		hPa	°C	°C	°C	°C	°C	°C	°C		°C		%	hPa			mm		mm	mm	mm		Km/h
जनवरी JAN	I	996.1	20.0	16.4	30.6	15.8	33.3	10.9	35.3	28 1974	6.4	10 1972	68 57	16.9 14.5	1.7 1.6	0.8 0.7	7.8	0.5	53.0 1966	0.0	47.8	29 1979	4.5
	II	994.1	28.8	19.2																			
फरवरी FEB	I	996.2	23.0	18.0	33.9	16.8	37.1	13.6	39.4	29 1960	9.4	08 1949	60 30	16.8 14.1	1.7 1.6	0.9 0.8	5.1	0.6	32.4 1975	0.0	24.0	21 1968	5.3
	II	991.9	32.3	20.3																			
मार्च MAR	I	994.4	26.6	20.2	37.5	22.3	40.6	17.4	42.8	27 1953	13.0	11 1979	53 25	18.3 14.1	1.7 1.6	0.8 1.0	12.0	1.0	71.6 1961	0.0	38.2	05 1970	6.4
	II	989.5	35.9	21.6																			
अप्रैल APR	I	991.6	30.2	23.1	40.3	26.2	43.6	21.5	45.6	29 1973	15.4	20 1971	53 25	22.5 16.6	2.3 3.2	0.7 1.7	15.7	1.1	68.6 1962	0.0	62.0	24 1961	7.9
	II	988.3	38.6	23.5																			
मई MAY	I	987.8	32.9	23.9	42.4	29.0	45.6	23.8	47.2	19 1948	20.4	01 1977	48 25	22.3 17.9	2.6 3.6	0.9 2.1	29.4	2.0	142.2 1977	0.0	111.2	01 1977	7.9
	II	982.6	40.4	24.6																			
जून JUN	I	985.4	30.0	24.3	37.8	27.1	43.8	22.4	47.2	08 1953	19.4	03 1973	63 45	25.7 24.1	5.3 5.7	2.3 3.5	171.3	6.4	386.8 1958	0.0	140.7	20 1953	8.4
	II	981.2	35.5	25.4																			
जुलाई JUL	I	985.4	27.0	24.2	32.5	24.5	36.8	22.0	41.0	06 1966	16.8	14 1973	79 65	28.0 28.0	6.8 6.8	3.6 3.9	309.2	15.2	699.8 1978	104.3 1970	130.7	23 1977	7.0
	II	982.2	30.7	25.4																			
अगस्त AUG	I	986.4	26.4	24.1	31.8	24.2	35.0	22.2	37.4	28 1960	19.6	31 1965	82 68	28.1 28.2	6.4 6.5	3.6 3.9	243.8	13.8	487.4 1953	59.6 1968	104.4	21 1960	5.8
	II	983.3	29.8	25.2																			
सितम्बर SEP	I	989.0	28.9	24.3	32.5	24.1	35.7	21.8	38.0	02 1966	17.8	30 1972	80 66	28.4 27.7	5.1 5.7	2.3 3.2	190.7	9.2	404.8 1968	65.8 1971	126.0	20 1969	4.8
	II	985.5	30.2	25.1																			
अक्टूबर OCT	I	993.1	26.1	22.8	33.1	22.3	35.9	16.1	38.4	11 1957	15.4	14 1972	75 55	25.2 23.2	3.1 3.9	1.2 2.1	94.5	4.4	539.8 1973	0.0	135.8	24 1973	3.9
	II	989.5	30.4	23.4																			
नवम्बर NOV	I	996.7	22.8	19.0	31.2	18.1	33.9	13.8	36.6	06 1977	9.0	30 1970	89 48	19.1 12.7	2.2 1.3	0.7 0.9	18.8	1.2	118.0 1982	0.0	70.2	05 1961	3.5
	II	993.3	28.1	20.5																			
दिसम्बर DEC	I	998.5	19.7	16.3	29.9	14.9	32.6	11.0	34.5	28 1978	7.8	10 1970	89 41	16.0 14.0	1.7 2.0	0.5 1.4	9.7	0.8	109.4 1962	0.0	101.2	02 1968	3.2
	II	994.8	27.3	18.8																			
वार्षिक योग ANNUAL TOTAL OR MEAN	I	991.9	26.0	21.4	34.5	22.3	45.7	8.9	47.2		7.8		69	22.3	4.5	1.5	1160.0	58.0	1672.8	585.2	140.7		5.7
	II	987.9	32.4	22.8																1972			
जांचों के वर्षों की संख्या NUMBER OF YEARS	I	30	30	30	30	30	30	30	33		33		30	30	30	30	30	30	33	33	33		24
	II	30	30	30																			

Annexure-2:

Quality Assurance (QAP)

CLAUSE NO	Quality Assurance
1.01.00	**FLUSHING BOXES & TROUGH TYPE EXPANSION JOINTS**
1.01.01	All material shall be tested for Chemical & Mechanical properties as per relevant standard. MPI/DP tests shall be done on welds to ensure freedom from defects. Water fill test on assembly shall be carried out.
1.02.00	**GEAR BOX**
1.02.01	In addition to checks for physical, chemical, hardness, microstructure as per relevant standard, the shaft and gear/pinion forgings shall be subjected to ultrasonic testing.
1.02.02	MPI to be carried out on Gears/Pinions after machining. Case depth, hardness and MPI after hard-facing shall be checked to ensure freedom from defects.
1.02.03	Gear boxes shall be checked for reduction ratio, backlash and contact pattern. No load shop trial run to be conducted on gear boxes to check for oil leakage, temperature rise, noise level and vibration.
1.03.00	**METALLIC EXPANSION JOINTS**
1.03.01	**All material shall be tested for Chemical & Mechanical properties as per relevant standard. Leak test shall be carried out 1.1 times design pressure in case of vacuum application.**
1.03.02	**DPT shall be carried out on welds before and after forming to check cracks. Spring rate shall also be measured.**
1.03.03	**Proof of design test shall be carried out on one of the expansion joint as per (EJMA) relevant standards. In case the bidder have already carried out the same on the expansion joint of the type and rating being offered, the test certificate shall be submitted for review.**
1.04.00	**FLY ASH BRANCH SEGREGATION VALVES , FLY ASH FEED VALVES AND KNIFE GATE VALVE FOR HOPPER ISOLATION**
1.04.01	All material shall be tested for Chemical & Mechanical properties as per relevant standard. Functional checks of the valves for smooth opening and closing shall also be done. Valves shall also be tested for allowable leakage rate, as applicable. Actuator operated valves shall be tested along with actuators
1.05.00	**AIR LOCK/PUMP TANK**
1.05.01	All material shall be tested for Chemical & Mechanical properties as per relevant standard. Air lock/pump tanks shall be tested hydraulically for 1.5 times the design pressure or 2 times working pressure, whichever is higher, for 30 min duration at manufacturer's works. NDT on welds shall be as per requirement of design code/standard.
1.06.00	**BAG/VENT FILTERS**
1.06.01	All material shall be tested for Chemical & Mechanical properties as per relevant standard. Leakage test shall be carried out for casing and other pressure parts. Pulsing and sequential test on bag filter shall be done.
1.07.00	**FLUID COUPLING:**
1.07.01	**All material shall be tested for Chemical & Mechanical properties as per relevant standard. Static and dynamic balancing shall be carried**

	out for all rotating parts. Check for leak tightness of the coupling shall be carried out
1.07.02	**Functional test on fusible plug for each type of coupling shall be conducted at shop. All couplings to be run tested at shop.**
1.07.03	**Check for temperature rise, torque speed, torque slip characteristics and over speed test on one coupling of each size and type during load test (preferably at Full load) at shop.**
1.08.00	**ELECTRIC HOIST & OVERHEAD TRAVELLING CRANE:**
1.08.01	All material shall be tested for Chemical & Mechanical properties as per relevant standard. UT at proof machined condition (for dia/thickness >= 50 mm) and MPI/DPT after machining shall be done on gear blanks, shafts, pinions and axles
1.08.02	Proof load test on hook as per relevant standard shall be carried out. UT shall be carried out on shank portion of the hook. DPT shall be carried out after proof load test. Wire ropes shall be tested as per relevant standard. Gear box shall be checked for ratio, backlash, Temp. rise, noise and no leakage of oil.
1.08.03	**All butt welds of rope drum shall be subjected to 100% RT. DP test shall be carried out after stress relieving of rope drums.**
1.08.04	**100% radiography of weld under tension and 10% radiography of compression butt weld shall be done for girder etc. 100% DP of all butt welds and 10% DPT on fillet shall be carried out.**
1.08.05	All tests of completed assembly shall be carried out as per IS-3177 for Overhead Travelling Crane and as per IS 3938 for Electric Hoist. Chain Pulley Blocks shall be tested as per IS -3832.
1.09.00	**PACKAGE AIR CONDITIONER:**
1.09.01	Each Unit shall be subjected to production routine Test excluding performance test carried out as per relevant standard. Performance test of PAC shall be carried out as per relevant standard on one unit of each type and rating at site.
1.10.00	**For items/components like pipes, valves, pumps, compressors, specialties etc refer table below**

S N	Tests/Checks / Items / Components	Material Test	WPS/ WQS/PQR	DPT/MPI	Ultrasonic Test	Radiographic Test	PWHT	Assembly / Fit up	Dimensions	Hydraulic	Pneumatic Test	Balancing	Functional/operational Test	Performance Test	Other Tests	All Tests as per relevant Std
1	Pipes & Fittings	Y[a]							Y	Y[20]						Y
2	Diaphragm Valves	Y[a]							Y	Y[5]			Y		Y[6]	Y
3a	Cast Butterfly Valves (Low Pressure)	Y[a]		Y[3]	Y[b]			Y	Y	Y[5]			Y		Y[7]	Y
3b	Fabricated Butterfly Valves (Low Pressure)	Y[a]	Y	Y[3]	Y[12a]	Y[12b]	Y[12c]	Y	Y	Y[5]			Y		Y[7]	Y
4	Gate/ Globe/ Check Valves	Y[a]		Y[3]	Y[b]			Y	Y	Y[5]	Y		Y		Y[8]	Y
5	Dual Plate Check Valves	Y[a]		Y[3]	Y[b]			Y	Y	Y[5]	Y		Y		Y[4]	Y
6	Plug / Ball Valves	Y[a]		Y[3]	Y[b]			Y	Y	Y[5]	Y		Y			Y
7	Rolled & Welded Pipes / Mitre fittings	Y[a]	Y	Y[3]		Y[1]			Y	Y[20]						
8	Coating & Wrapping of Pipes	Y[a]							Y							Y[2]
9	Strainers	Y[a]		Y[3]					Y	Y[20]					Y[9]	
10	Rubber Expansion Joints	Y[a]						Y	Y	Y[10]					Y[11]	
11	Site Welding		Y	Y[3]		Y[1]				Y[20]						
12	Submersible Pump	Y[a]							Y	Y[17]		Y		Y		Y
13	Horizontal Centrifugal Pumps/ Sump Pumps	Y[a]		Y[3]	Y[b]			Y	Y	Y[17]		Y		Y[16]	Y[15]	Y
14	Compressors/ Blowers	Y[a]		Y[3]	Y[b]			Y	Y	Y[20]		Y		Y[18]	Y[19]	Y
15	Atmospheric Storage Tanks	Y[a]	Y	Y[3]				Y	Y	Y[20]					Y[13]	Y
16	Pressure vessels & Heat exchangers	Y[a]	Y	Y[3]		Y[21]	Y[22]	Y	Y	Y[20]					Y[23]	Y
17	Air Drying Plant	Y[a]	Y	Y[3]		Y[21]	Y[22]	Y	Y	Y[20]	Y		Y		Y[24]	
18	Mixers	Y[a]		Y[3]	Y[b]			Y	Y				Y		Y[25]	
19	Fans	Y[a]		Y[3]	Y[b]			Y	Y			Y		Y	Y[14]	Y

	NOTES
a	One per heat/heat treatment batch/lot.
b	For shaft/spindles/forgings diameter ≥ 50 mm

1	Weld Joints not subjected to hydraulic test shall be subjected to 100% RT.
2	Tests for primer and enamel / Coal Tar Tapes as per AWWA-C-203 / IS 15557
3	On machined surfaces of castings/shaft/spindles/forgings. DPT/MPI on root run (after back gouging/chipping – as applicable) for 100% and on finish butt & fillet welds for 10%.
4	Dry Cycle Test on Dual Plate Check valve spring for one lakh (10^5) Cycles shall be carried out as a type test.
5	Valves shall be tested for Body, seat & back seat leakage as applicable. Hydraulic test pressure shall be as per relevant standard. & shall be done as per relevant standard. Seat Leakage Test for Actuator Operated Valves, shall be done with by closing the valves with actuator. Valves shall be offered for hydro test in unpainted condition
6	Tests on rubber diaphragm such as hardness, bleed resistance test, rubber to fabric bond, flex test & type test for 50,000 cycles shall be carried out.
7	In addition to Body & seat hydrotest, disc-strength shall be carried out as per relevant standard
8	Blue matching for metal-seated valves, Wear travel for gate valves, pneumatic seat leakage test & reduced pressure test for check valves shall be done as per relevant standard. Maximum allowable vacuum loss is 0.5 mm of Hg absolute for valves to be tested for vacuum operation for internal pressure 25 mm of Hg absolute for a period of 15 minutes
9	Pressure drop across the strainer for each type and size as a special test shall be carried out
10	During hydraulic and vacuum tests in 3 positions, the change in the circumference of arch should not be more than 1.5%. 24 hrs after the test permanent set in dimension should not exceed 0.5%.
11	Tests on rubber for tensile, elongation, hardness, hydraulic stability check as per ASTM D 471, ozone resistance test as per ASTM D 1149, ageing test and adhesion strength of rubber to fabric & rubber to metal shall be carried out.
12	a) For fabricated butterfly valves: UT as per ASTM A-435 on plates for body and disc shall be carried out. b) 100% RT as per ASTM, Section-VIII, Division-I, on butt joins of body and disc c) Post Weld Heat Treatment (PWHT) as per ASME, Section-VIII, Division-I on butt joints of body and disc of thickness above 30mm shall be carried out.
13	Rubber Lining Mix shall be subjected to Bleed Resistance Test on mould sample. Adhesion Test, Spark Test and Hardness Test for the Rubber lined jobs shall also be conducted.
14	All fans shall be subjected to run test and Vibration, noise, temperature rise, and current drawn shall be measured during the run test. Performance test of one fan of each type and size shall be carried out as per applicable standard for air flow, static pressure. speed, Efficiency, power consumption.
15	In case of diaphragm/plunger, only proven material shall be used and certificate in this regard shall be submitted for review.
16	All pumps to be performance tested as per Hydraulic Institute Standard/Relevant standard. Performance test to include check for noise, vibration level and bearing temperature rise. NPSH test shall be carried out for pumps, if applicable.
17	Pumps shall be tested at 200% of pump rated head or at 150% of pump shut-off head whichever is higher for 30 min duration.
18	Performance testing of each compressor/ Blower shall be carried out at shop as per BS-1571/IS: 5456 /ISO 1217/ Pneurop 6612/ equivalent as applicable. Noise & vibration shall also be measured during performance testing.
19	For Compressors capacity control and operation of safety valves shall be checked during inspection at shop
20	Pressure retaining parts shall be hydraulic tested. Hydraulic test pressure shall be as per applicable std / 1.5 x design pressure or 2 x working pressure whichever is higher for 30 minutes duration. Atmospheric tanks shall be water fill tested
21	RT on weld joints shall be as per respective code requirements. Heat Treatment of the Tank/Vessel shall be done as per fabrication code requirement.
22	Dished ends shall be stress relieved as per relevant code. However, dished ends welds (if manufactured by using welded plates) shall be subjected to 100% RT and stress relieved.
23	Tube to tube sheet joints of heat exchanger shall be subject to mock up test. Coolers/heat exchanger shall be hydro tested on tube side and shell side
24	Refrigerant drier shall be tested as per relevant std and certification from manufacturer for the same shall be submitted. Dew point measurement & function of auto drain trap shall also be carried out.
25	Concentricity/ centering & Axial Run out Shall also be measured

Annexure-3:

Surface preparation & painting

SURFACE PREPARATION AND PAINTING

1.00.00 **GENERAL**

1.01.00 This section defines the requirements for surface preparation and protective coating by paint application of structural steel supports, pipe work systems, steel tanks and other mechanical and electrical equipment, for work carried out in supplier's works and on site.

1.02.00 Contractor's scope of work covers supply and delivery of all materials, furnishing services of skilled and unskilled labour, supervisors, arranging scaffolding, tools and any other equipment required to arrange a complete painting job.

2.00.00 **CODES AND STANDARDS**

2.01.00 The surface preparation and protective coating by paint application shall comply with all currently applicable statutes, regulations and safety codes in the locality where the painting is to be carried out. The surface preparation and painting shall alos conform to leatest applicable Indian/British /American standards. Other internationally acceptable standard, which ensure, equal or higher performance than those specified, shall also be accepted. Nothing in this specification shall be construed to relieve the Contractor of the required statutory responsibility. In particular the surface preparation and application of paints shall conform to the latest edition of the following:

(a.) British Code of practice, BS:5493:1977 "Protection of Iron and steel Structures form Corrosion".

(b.) Swedish Standard SIS:055 900-1967.

(c.) Steel Structures Painting Council Standards (SSPC)

(d) DIN 55928

(e) ASTM D 2200

(f) Other publications to be taken into account are:

(g) Paint manufacturers product data sheets and instructions for paint and use of paint.

(h) Statutory regulations concerning safety of storage and handling and use of paint.

3.00.00 **PAINT MATERIALS**

3.01.01 Paint materials shall be of the type as specified in the painting schedule.

3.01.02	Contractor shall submit his painting procedure plan in accordance to (with) this specification and shall take the approval from the OWNER/ENGINEER, giving the name of manufacture, name of each product and technical literature of each product offered by him.
3.01.03	All paint shall be delivered to job site in manufacturer's sealed containers. Each container shall be labelled by the manufacture with the manufacturer's name, type of paint, number and colour.
3.01.04	The material noted herein shall not be applied on surfaces that will exceed 82°C at any time, as noted otherwise.
3.02.00	**SURFACE PREPARATION**
3.02.01	The surface preparation to be used for each item shall be as specified.
3.02.02	Steel/Surfaces to be painted shall be cleaned in accordance with the latest edition of the following steel structures painting council surface preparation specification:

Solvent cleaning.	:	SSPC-SP-1
Hand cleaning	:	SSPC-SP-2
Power tool cleaning	:	SSPC-SP-3
Commercial Blast	:	SSPC-SP-4 (37 to 75 cleaning Micron Anchor Pattern).

3.02.03	All surfaces to be painted shall be thoroughly cleaned of oil grease and other foreign matter. Surface shall be free of moisture and contamination from chemicals and solvents.
3.02.04	Any additional surface preparation specified by the paint manufacturer shall be considered a part of this specifications.
3.03.00	**Application**
3.03.01	The paint manufacturer's instructions covering thinning, mixing, method of application, handling and drying time shall be strictly followed and considered a part of this specification.
3.03.02	Paint shall not be applied to damp surfaces or in raining weather of when the temperature is below 13°C or above 32°C, except when specifically permitted to do so by the manufacturer's instructions.

3.03.03	Spray painting at the job site shall be permitted only at times and location approved by the OWNER/ENGINEER.
3.03.04	The prime coat shall be applied by brushing, rolling or spraying and on the same day as the surface is prepared.
3.03.05	Under coats, intermediate coats and finish coats shall be applied by brush, roller or spray with the specified amount of time allowed between coats.
3.03.06	The colour of each coat shall contract with the previous coats colour or avoid skip and holidays. Finish Colours shall be specified in the painting schedule.
3.03.07	The quality of workmanship shall be that best available. finish work shall be uniform, smooth and free from runs, sags, defective bursting and clogging.
3.03.08	At completion finish shall be touched up, restored, and left in good condition, where damaged.
3.03.09	Steel surfaces that will be connected by building walls shall primed and finish painted before the wall is erected.
3.03.10	Steel surfaces that will be concealed by building floors shall be primed and finish painted before the floor is cast.
3.03.11	Adequate covers and drop clothes to protect the work of other trades and adjacent finishes from paint splatter shall be provided and maintained in place while painting. Any point spots or spillages which occur shall be promptly remoned.
3.03.12	Proper ventilation and circulation of air shall be taken care during application are recommended when spraying.
3.03.13	Newly painted surfaces shall be protected with "Wet Paint" sight
3.03.14	Apart from surface preparation of the piping etc. attention should be paid to the details, particularly the following: a) Sharp edges that may have a deleterious effects on coating should be removed. b) Burrs caused by removal of temporary lugs etc. should be ground flat. c) Welds should be dressed and weld spatter removed by grinding. d) Nuts and bolts should be properly treated. e) Fasteners, such as pipe hangers clamp etc., should be treated before being mixed to the main structure.

3.04.00 **PAINTING REQUIREMENTS**

3.04.01 **GENERAL**

3.04.02 Where the prime coat has been applied in the shop, the prime coat shall be carefully examined, cleaned and spot primed by one coat of the primer specified before applying the intermediate and finish coats.

3.04.03 On the insulated equipment or piping, surfaces such as lugs, flanges, supports, etc. that protrude beyond the insulation shall be painted the same as uninsulated equipment or piping.

3.05.00 **Painting Schedule**

3.05.01 All equipments, like pumps, blowers, compressors, vacuum pumps, valves, airlocks/pump tanks, all types of tanks/buffer hopper/collector tank/storage silos (excluding the supporting steel structure), equipment base plate etc.

a)	Surface Preparation	:	Commercial Blast Clean
b)	Primer	:	Conforming to BS: 5493, Table-4F Part-2, Reference FP-3A.
	Binder	:	Alkyd or modified alkyd
	Main Pigment	:	Zinc Phosphate
	Nominal coating thickness	:	70 microns
c)	Under Coats	:	Conforming to BS : 5493, Table-4F, Part-3, Reference FU-2A.
	Binder	:	Alkyd of modified alkyd
	Main Pigments	:	Coloured pigments (full colours) suitably extended.
	Nominal coating thickness	:	70 to 80 microns
d)	Finish Coats	:	Conforming to BS : 5493, Table-4F, Part-4 Reference FF-38.
	Binder	:	Alkyd or modified Alkyd
	Main Pigment	:	Fade-resistant coloured pigments.
	Nominal Coating thickness	:	50 to 80 microns

	e)	Dry film thickness of system	:	190 to 240 microns
3.05.02	For all water/air piping, ash slurry piping, pipe clamps/hangers etc. the following shall be applicable.			
	a)	Surface Preparation	:	Power Tool Clean
	b)	Primer	:	Conforming to BS: 5493, Table-4F Part-2, Reference FP-2A.
		Binder	:	Drying oil modified with phenolic or phenolic modified resin.
		Main Pigment	:	Zinc Phosphate
		Nominal thickness coating	:	70 microns
	c)	Under Coats	:	Conforming to BS : 5493, Table-4F, Part-3, Reference FUIA.
		Binder	:	Drying oil modified with phenolic or phenolic modified resin.
		Main Pigments	:	Coloured pigments (full colours) suitably extended.
		Nominal Coating thickness	:	25 to 40 microns
	D)	Finish Coats	:	Conforming to BS : 5493, Table-4F, Part-4 Reference FFIA.
		Binder	:	Drying oil modified with phenolic or phenolic modified resin.
		Main Pigment	:	Fade-resistant coloured pigments.
	E)	Dry film thickness of system	:	120 to 150 microns
3.06.00	Surfaces not to be painted (unless otherwise) specified.			

(a.) Surface of insulation.

(b.) Stainless steel, nickel, copper brass, monel, aluminium, hastealloy, lead galvanished steel.

(c.) Valve stem, pump shafts, gauges.

(d.) Bearing and control surfaces, lined or clad surfaces.

3.06.01 For fly ash extraction and transportation piping, bituminous paint of IS:158 grade of minimum 250 micron thickness shall be provided.

3.07.00 **Colour code for Identification**

3.07.01 The pipes shall be colour painted/banned for identification as per the color coding scheme of NTPC. These sheets shall be furnished during detailed engineering stage.

Annexure-4:

NTPC Approved Makes of Electrical Components

एनटीपीसी NTPC	Project	RAMAGUNDAM STAGE-I (3 x 200 MW)	STATUS OF ITEM REQUIRING Q.A. SUB-SUPPLIER APPROVAL ESP R&M - ELECTRICAL	DOC NO. CS-3120-104A(R&M)-2
	Package	R&M for ESP		REV. NO. : 0
	Contractor	BHEL		DATE : 14.03.2017
	Contractor No.	CS-3120-104A(R&M)-2		

S.No	Item Services	QP/ Insp. Cat.	QP Sub. Schedule Approval schedule	Date of sub-mission	Date of commt Appl.	Status Code C/II/I	Proposed Sub Supplier	Place of manufacturing works	Approval Status	Sub-supplier detail submission schedule	Remarks
		III					Bongifloi	Chennai	DR		
1a	Panel Type Hopper Heater	II					HTD	USA	A		
		II					Hotfoil EHS	USA	A		
		I					HTD HEAT TRACE(I) Pvt Ltd	Hyderabad	A		
		II					Thermon	USA	A		
		I					Thermopads(Unit-II)	Hyderabad	DR		
		I					Thermon	Pune	A		
19	Tubular Type Heater	III					BHEL Approved Sources				
20	Lighting Fixtures & Luminaries	III					Wipro	Pune	A		
		III					Crompton	Mumbai	A		
		III					Philips	Pune	A		
		III					Bajaj	Mumbai	A		
21	Welding Recepticles	III					SCHEINDER	Nasik	A		
		III					AJMERA	Mumbai	A		
		III					Best & Cropmpton	Chennai	A		
		III					BCH	Faridabad	A		
22	Lighting Wires / GI Conduit	III					BIS Licencee		A		Any make with VDE or CE or UL or CSA marking or BIS approved with valid CML number.
23	Cable Gland	III					Arup Engg	Kolkatta			Any other make with VDE or CE or UL or CSA marking or BIS approved with valid CML number.
		III					Sunil & Co	Kolkatta	A		
		III					Quality Preceision	Kolkatta	A		
							Comet	Mumbai	A		
24	Lugs	III					Dowells	Mumbai	A		Any other make with VDE or CE or UL or CSA marking or BIS approved with valid CML number.
		III					Chetna	Nasik	A		
		III					3D	Umbergaon	A		
25	Emergency Light, Trefoil Clamps, Ceiling Fans	III					BHEL Approved Sources				
26	M.S. ROD, G.I. Flat, G.I. Wire, Earth Wire	III					BHEL Approved Sources				GALVANISING AT NTPC APPROVED SOURCES
27	Local Motor Starter Panels	III					SIEMENS	Mumbai			Any other make with VDE or CE or UL or CSA marking or BIS approved with valid CML number.
		III					L&T	Mumbai			
28	Limit Switches	III					KAKU BHILLAI	Chennai	N		Any other make with VDE or CE or UL or CSA marking or *BIS approved with valid CML number*.
		III					Jai Balaji	Chennai	N		
		III					AG System	Mumbai	N		
		III					Electromag	Mumbai	N		
		III					BCH	Faridabad	N		
29	HT Termination & Jointing Kits	III					3M	Pune	A		
		III					Raychem	Pune	A		
30	Fire sealing system - Type A Material supplier	III					3M India	Bangalore	A		
		III					GE Silicon	USA	A		

Annexure-5:

NTPC Electrical Specification

2.00.00 GENERAL REQUIREMENTS

1.01.00 The requirements, conditions, appendices etc stated in any other bid documents shall apply to and shall be considered as a part of this specification as if bound together. In case of any discrepancy between conditions specified in any other volume and this volume, the requirements, specified in this volume shall prevail.

1.02.00 The equipment offered by the Bidder shall be complete in all respects. Any material and component not specifically stated in this specification but which is necessary for trouble free operation of the equipment and accessories specified in this specification shall be deemed to be included unless specifically excluded. All such equipment / accessories shall be supplied without any extra cost. Also, all similar components shall be interchangeable and shall be of the same type and rating for easy maintenance and low spare inventory.

1.03.00 Bidder shall furnish the technical information and data as mentioned elsewhere.

1.04.00 All drawings, schedules and annexure appended to this specification shall form part of the specification, specific reference in this specification and documents to any material by trade name, make, or catalogue number shall be construed as establishing standard of quality and performance and not as limiting competition. The bidder may offer other similar equipment provided it meets the specified standard design and performance requirements.

1.05.00 Each section of the LT switchgears / MCCs shall be provided with at least 20% (minimum 1 no.) of spare modules of each type and rating in addition to owner's requirement, if any, as specified elsewhere.

3.00.00 CODES AND STANDARDS

3.01.00 All equipment shall, generally, comply with the updated issues of

(a.) Applicable Indian Standards

(b.) Indian Electricity Act.

(c.) Indian electricity rules

3.02.00 Equipment complying with any other authoritative / internationally recognized standards such as IEC, British, U.S.A., German, etc. will also be considered if it ensures performance equivalent or superior to Indian Standards. In such cases the bidder shall clearly indicate the standard adopted and furnish the copy of latest English version of the same along with the bid and bring out the salient features for comparison.

3.03.00 All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as published one month prior to the date of opening of bids. In case of conflict between this specification and those (IS codes, Standards etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following codes and standards.

IS: 5	Colors for ready-mixed paints and enamels.
IS: 694	PVC insulated cables for working voltages upto and including 1100V.

IS: 722	A.C. Electricity Meters
IS: 1248	Electrical Indicating instruments
IS/IEC: 60947–1	Degree of protection provided by enclosures for low voltage Switchgear and Control gear
IS/IEC: 60947-2	A.C. circuit Breakers
IS: 2551	Danger Notice Plates
IS: 2629	Hot dip galvanising
IS: 2705	Current Transformers
IS/IEC: IEC-60947-4-1	Contactors and motors starter for voltages not exceeding 1000 V AC or 1200 V DC
IS: 3043	Code of practice for earthing.
IS: 3072	Code of practice for installation and maintenance of Switchgear
IS: 3156	Voltage Transformers
IS: 3202	Code of practice for climate proofing of electrical equipment.
IS: 3231	Electrical relays for power system protection.
IS/IEC 60947	Air-Break Switches, air break disconnectors, air break disconnector and fuse combination units for voltages not exceeding 1000V AC or 1200 V DC.
IS/IEC 60947-1 / IEC-60947-1	General Requirements for Switchgear and Control gear for voltages not exceeding 1000 V.
IS: 5082	Wrought Aluminum and Aluminum alloys for electrical purposes.
IS: 6005	Code of practice of phosphating of iron and steel.
IS/IEC 60947-5-1 / IEC-60947-5-1	LV switchgear and Control gear Control current devices and switching element.

IS: 8623 (3 parts) / IEC: 60439	Specification for factory built assemblies of Switchgear & Control gear for voltages upto and including 1000 V AC & 1200 V DC.
IS: 8686	Static Relays
IS: 13703 / IEC: 60269	HRC Cartridge fuses
IS: 10118 (4 parts)	Code of practice for selection, installation and maintenance of switchgear and control gear.
IS: 11171	Specification for dry type transformers.
IEC: 60255	Electrical Relays
IEC: 61850	Communication networks and systems in substations
IS: 11353	Guide for uniform system of marking and identification of conductors and apparatus terminals
IS: 12021	Specification of control transformers for switchgear and Control gear for voltage not exceeding 1000V AC.
IEC: 60947-7-1	Terminal blocks for copper conductors
IS :513 (2008)	Cold Rolled Low Carbon Steel Sheets and Strips

4.00.00 TECHNICAL PARAMETERS

4.01.00 POWER SUPPLY

4.01.01 AC SYSTEM

1)	Voltage	415 V ± 10%,3 Phase, 4 wire, solidly earthed
2)	Frequency	50 Hz +/- 5%
3)	Combined variation (in volts & frequency)	10% absolute sum
4)	Fault Level	45KA(RMS)

4.01.02 DC SYSTEM

1)	System Voltage	220V/110V DC 2-Wire, Unearthed
2)	Fault Level	20 KA

4.01.03 CONTROL SUPPLY VOLTAGE

	1)	Trip & closing coil of circuit breaker	220V DC/110V DC
	2)	Spring charging motor	220V DC/110V DC
	3)	MCC control supply	110V AC Neutral solidly earthed
	4)	Space heater & lighting	240V AC Neutral solidly earthed
4.02.00	**CUBICLE DATA**		
	Busbar Rating		
	1)	Continuous Current rating	As per requirement
	2)	Short time rating where	
		a) CB is used as incomer	45KA(RMS) for one sec
		b) Fuse protection is used in Incomer	Prospective current of 45KA(RMS) for the fuse clearing time
	3)	Dynamic Rating where	
		a) CB is used as incomer	105KA(PEAK)
		b) Fuse Protection is used in incomer	Prospective current of 105KA (PEAK) as limited by fuse
	4)	Busbar insulation	
		a) For switchgear	PVC Sleeve insulated
		b) For MCC	PVC Sleeve insulated
		c) ACDB	PVC Sleeve insulated
		d) DCDB	PVC Sleeve insulated
		e) For fuse boards	PVC Sleeve insulated/ epoxy coated
4.03.00	**CIRCUIT BREAKER**		
	1)	Type	Air break spring charged stored energy type
	2)	Operating duty	B-3 MIN-MB-3 MIN-MB
	3)	Symmetrical interrupting	45KA(RMS)
	4)	Short circuit rating	105KA(PEAK)
	5)	Short Circuit Breaking current	
		a) AC Component	45KA(RMS)
		b) DC Component	As per IS:13947
	6)	Short time withstand	45KA(RMS) for one sec
	7)	No of aux. contacts	4 NO + 4 NC for employer use

4.04.00	**METERS**		
	1)	Accuracy class	2.0
	2)	One min. power frequency withstand test voltage	2.0 KV (rms)
4.05.00	**CURRENT TRANSFORMERS**		
	1)	Type	Cast Resin Bar Primary
	2)	Voltage class and frequency	650 V, 50 HZ
	3)	Class of insulation	E or better
	4)	Accuracy class & burden	
		a) For protection	5P20, 5VA PS Class for REF
		b) For metering	class 1.0, 5VA (min)
	5)	Short time withstand	
		a) For CT Associated with circuit breaker	45KA(RMS) for 1 sec
		b) For CT Associated with fuse protected feeders	Prospective current of 45KA(RMS) for the Fuse clearing time
	6)	Dynamic withstand	
		a) For CTs Associated with circuit breaker	105KA(PEAK)
		b) For CT Associated with fuse protected feeders	Prospective current of 105KA(PEAK) as Limited by fuse
4.06.00	**BUSDUCT**		
	1)	Type	Non-Segregated
	2)	One minute power frequency withstand voltage	2.5 kV
	3)	One second short ckt withstand current	45KA(RMS)
	4)	Momentary dynamic current withstan	105KA(PEAK)
4.07.00	**VOLTAGE TRANSFORMERS**		
	1)	Type	Cast Resin
	2)	Voltage Ratio	415 / 110 V for line PT

			415/√3 / 110/√3 V for Bus PT
	3)	Method of Construction	Vee Vee
	4)	Accuracy Class	0.5
	5)	Rated Voltage factor	1.1continuous, 1.5 for 30 sec.
	6)	Class of insulation	E or better
	7)	One minute power frequency withstand voltage	2.5 KV
4.08.00	**HRC FUSES**		
	1)	Voltage Class	650 Volts
	2)	Rupturing capacity	80 KA (rms) for AC ckt. 20 KA for DC ckt.
4.09.00	**CONTACTORS**		
		Type	Air break electro magnetic
	2)	Utilising Category	AC3 of IS:13947 for non reversible AC4 of IS:13947 for reversible drives
4.10.00	**RELAYS**		
	1)	Power frequency withstand voltage	2.5KV for 1 sec. or 2.0 KV for 1 min.
4.11.00	**CONTROL TRANSFORMERS**		
	1)	Type	Dry / Cast Resin
	2)	Voltage Ratio	415 / 110 with taps ± 5% in steps of 2.5%
	3)	Class of insulation	Class-B or better
	4)	One minute power frequency withstand voltage	2.5 KV
	5)	Rating	1.5 x Adequate for application.
4.12.00	**LIGHTING TRANSFORMER / WELDING TRANSFORMER (IF APPLICABLE)**		

	1) Type & Rating	Dry type / 50KVA/100 KVA
	2) Voltage Ratio	415/415V, +/- 5% taps in steps of 2.5%
	3) Class of insulation	B or better
	4) One minute power frequency withstand voltage	2.5 KV
	5) Enclosure protection	IP-42
4.13.00	**TRANSDUCERS**	
	1) Current transducers	
	a) Input	0-1 A (CT secondary)
	b) Rated frequency	50HZ
	c) Output	4-20 mA (2 Nos. decoupled)
	d) Over current	Transducer for motor current ammeters shall be capable of withstanding min. 6 times CT sec. current of 1A for a min period of 30 seconds
	e) Accuracy	1.0
	2) Voltage Transducers	
	a) Input	110 V(VT secondary) ,50 HZ (for AC)/240 V/120 V DC (for DC)
	b) Output	4-20 mA (2 Nos. decoupled)
	c) Accuracy	1.0
4.14.00	MCCB	
	1) Rated voltage	415V
	2) Rated insulation level	690V
	3) Rated ultimate &Service S.C. breaking capacity	45KA
	4) Rated making capacity	105KA
	5) Utilization category	A
5.00.00	**CONSTRUCTIONAL DETAILS OF SWITCHBOARDS**	
5.01.00	All Switchboards i.e., 415 V Switchgears, Motor Control Centres (MCCs), AC Distribution Boards (ACDBs), 220 V DC Distribution Boards (DCDBs) , shall be of metal enclosed, indoor, floor-mounted, free-standing type.	

5.02.00	All switchboard frames and load bearing members shall be fabricated using suitable mild steel structural sections or pressed and shaped cold-rolled sheet steel of thickness 2.0 mm. Frames shall be enclosed in cold-rolled sheet steel of thickness 1.6 mm. Doors and covers shall also be of cold rolled sheet steel of thickness 1.6 mm. Stiffeners shall be provided wherever necessary. The gland plate thickness shall be 3.0 mm for hot / cold-rolled sheet steel and 4.0 mm for non-magnetic material.
5.03.00	All panel edges and cover / door edges shall be reinforced against distortion by rolling, bending or by the addition of welded reinforcement members. The top covers of the panels should be designed such that they do not permanently bulge/ bend by the weight of maintenance personnel working on it.
5.04.00	The switchboards shall be of bolted design. The complete structures shall be rigid, self-supporting, and free from flaws, twists and bends. All cutouts shall be true in shape and devoid of sharp edges.
5.05.00	All switchboards shall be of dust-proof and vermin-proof construction and shall be provided with a degree of protection of IP: 5X as per IS: 13947. However, the busbar chambers having a degree of protection of IP: 42 are also acceptable where continuous busbar rating is 1600A and above. Provision shall be made in all compartments for providing IP: 5X degree of protection, when circuit - breaker or module trolley has been removed. All cutouts shall be provided with EPDM / Neoprene gaskets.
5.06.00	Provision of louvers on switchboards would not be preferred. However, louvers backed with metal screen are acceptable on the busbar chambers where continuous busbar rating is 1600 A and above.
5.07.00	All switchboards shall be of uniform height not exceeding 2450 mm.
5.08.00	Switchboards shall be easily extendable on both sides by the addition of vertical sections after removing the end covers.
5.09.00	Switchboards shall be supplied with base frames made of structural steel sections, alongwith all necessary mounting hardware required for welding down the base frame to the foundation / steel insert plates. The base frame height shall be such that floor finishing (50 mm thick) to be done by Contractor after erection of the switchboards does not obstruct the movement of doors, covers, withdrawable modules etc.
5.10.00	All switchboards shall be divided into distinct vertical sections (panels), each comprising of the following compartments: (a.) BUSBAR COMPARTMENT A completely enclosed bus bar compartment shall be provided for the horizontal and vertical busbars. Bolted covers shall be provided for access to horizontal and vertical busbars and all joints for repair and maintenance, which shall be feasible without disturbing any feeder compartment. Auxiliary and power busbars shall be in separate compartments. (b.) SWITCHGEAR / FEEDER COMPARTMENT All equipment associated with an incomer or outgoing feeder shall be housed in a separate compartment of the vertical section. Two-tier breaker arrangement in a vertical section shall be offered for outgoing breaker feeders of rating up to 1600A.

The design of the vertical section for such an arrangement shall ensure ease of termination of power cables of size & quantity as specified in clause 42.00.00.The compartment shall be sheet steel enclosed on all sides with the withdrawable units in position or removed. Insulating sheet at rear of the compartment is also acceptable. The front of the compartment shall be provided with the hinged single leaf door with captive screws for positive closure.

(c.) CABLE COMPARTMENT OR CABLE ALLEY

A full-height vertical cable alley of minimum 250mm width shall be provided for power and control cables. Cable alley shall have no exposed live parts and shall have no communication with busbar compartment. Cable terminations located in cable alley shall be designed to meet the Form IVb Type 7 (as per IEC 60439) for safety purpose. The termination for each module shall have its own integral glanding facility. Wherever cable alleys are not provided for distribution boards, segregated cable boxes for individual feeders shall be provided at the rear for direct termination of cables. For circuit breaker external cable connections, a separately enclosed cable compartment shall also be acceptable. The contractor shall furnish suitable plugs to cover the cable openings in the partition between feeder compartment and cable alley. Cable alley door shall be hinged.

(d.) CONTROL COMPARTMENT

A separate compartment shall be provided for relays and other control devices associated with a circuit breaker.

5.11.00 Sheet steel barriers shall be provided between two adjacent vertical panels running to the full height of the switchboard, except for the horizontal busbar compartment. EPDM / Neoprene gasket shall be provided between the panel sections to avoid ingress of dust into panels.

5.12.00 After isolation of power and control circuit connections it shall be possible to safely carryout maintenance in a compartment with the busbar and adjacent circuit live. Necessary shrouding arrangement shall be provided for this purpose. Wherever two breaker compartments are provided in the same vertical section insulating barriers and shrouds shall be provided in the rear cable compartment to avoid accidental touch with the live parts of one circuit when working on the other circuit.

5.13.00 All 415V switchgear (circuit-breaker) panels shall be of single-front type. MCCs and DBs shall be of single-front / double-front construction as per the requirements. All single-front switch boards shall be provided with single-leaf, hinged or bolted covers at the rear. The bolts shall be of captive type. The covers shall be provided with "DANGER" labels. All panel doors shall open by 90 deg or more. In case of double-front MCCs, if this cannot be achieved for panels adjacent to a breaker panel, suitable dummy panel shall be provided by the Bidder wherever necessary.

5.14.00 All ACDBs, DCDBs and other DBs shall be of fixed module type. All 415V circuit-breaker modules and contactor controlled motor modules shall be of fully draw out type having distinct 'Service' and 'Test' positions. The equipment pertaining to a draw out type incomer or feeder module shall be mounted on a fully withdrawable chassis which can be drawn out without having to unscrew any wire or cable connection. Suitable arrangement with cradle/ rollers, guides along with tool/lever operated racking in/out mechanism shall be provided for smooth and effortless movement of the chassis. For modules of size more than half the

	panel height, double guides shall be provided for smooth removal or insertion of module. All identical module chassis of same size shall be fully interchangeable without having to carryout any modifications.
5.15.00	All disconnecting contacts for power and control circuits of drawout modules shall be of robust and proven design, fully self aligning and spring-loaded. Both fixed and moving contacts shall be silver-plated and replaceable. The spring-loaded power and control drawout contacts shall be on withdrawable chassis and the same on fixed portion shall not be accepted. Detachable plug and socket type control terminals shall also be acceptable.
5.16.00	Individual opening in the vertical bus enclosure shall permit the entry of moving contacts from the drawout modules into vertical droppers.
5.17.00	As indicated in schematic drawings of DDC / PLC controlled modules, contractor shall supply & mount two (2) coupling relays in the corresponding modules.
5.18.00	All equipment and components shall be neatly arranged and shall be easily accessible for operation and maintenance. The internal layout of all modules shall be subject to employer's approval. The Contractor shall submit dimensional drawings showing complete internal details of busbars and module components, for each type and rating for approval of Employer.
5.19.00	Employer reserves the right to alter the cable entries, if required during detailed engineering, without any additional commercial implication.
5.20.00	Each switchboard shall be provided with undrilled, removable type gland plate, which shall cover the entire cable alley. Bidder shall ensure that sufficient cable glanding space is available for all the cables coming in a particular section through gland plate. For all single core cables, gland plate shall be of non-magnetic material. The gland plate shall preferably be provided in two distinct parts for the easy of terminating addition cables in future. The gland plate shall be provided with gasket to ensure enclosure protection. Recommended drilling chart of gland plates for all power and control cables in the vertical panels shall be indicated by the Contractor in the respective G.A. drawings of the boards.
5.21.00	The Bidder shall consider layout of panels in a switchboard consisting of various feeder modules in a straight line, unless specified otherwise. The actual composition and disposition of various modules in a switchboard shall be finalised during detailed engineering. The switchboards fed from outdoor transformers of rating more then 1MVA and above shall preferably be connected through busducts. Busduct connections wherever applicable shall be preferably in a straight line alignment. The centre line of the busduct will be finalized during detailed engineering. Adopter panels and dummy panels shall be provided wherever required.
5.22.00	**CLEARANCES** The minimum clearance in air between phases and between phases and earth for the entire run of horizontal and vertical busbars and bus-link connections at circuit-breaker shall be 25 mm. For all other components, the clearance between "two live parts", "a live part and an earthed part", shall be atleast ten (10) mm throughout. Wherever it is not possible to maintain these clearances, insulation shall be provided by sleeving or barriers. However, for horizontal and vertical busbars the clearances specified above should be maintained even when the busbars are

	sleeved or insulated. All connections from the busbars upto switch / fuses shall be fully shrouded / insulated and securely bolted to minimize the risk of phase to phase and phase to earth short circuits.
6.00.00	**CONSTRUCTIONAL DETAILS OF AC & DC FUSE BOARDS**
6.01.00	All fuse boards shall be metal enclosed, fixed type, non-compartmentalized construction, suitable for indoor/ outdoor mounting on wall or steel structure.
6.02.00	The fuse board frame shall be fabricated using suitable mild steel structures or pressed and shaped cold rolled sheet steel of thickness not less than 2.0 mm. The frames shall be enclosed by cold rolled sheet steel of thickness not less than 1.6 mm.
6.03.00	The fuse boards shall be provided with doors on the front. The doors shall preferably be in two halves with hinges at the extreme ends and locking facility at the centre.
6.04.00	Suitable EPDM/Neoprene gaskets shall be provided to make fuse boards completely dust and vermin-proof with a degree of protection of IP-52 for indoor and IP-54 for outdoor application, as per IS: 13947.
6.05.00	Each DC fuse board shall comprise of the following : (a.) 1 no. 63 A switch as incomer (b.) 100 A fully insulated (PVC sleeved or epoxy coated) busbars. (c.) 8 nos. 16A outgoing Fuse feeders. (d.) 1 no. auxiliary contactor for supply monitoring. (e.) 1 no. indicating lamp with resistor and blue coloured lens.
6.06.00	Each AC fuse board shall comprise of the following : (a.) 1 no. 63A TPN switch as incomer. (b.) 100 A, 3-phase, 4-wire, fully insulated (PVC sleeved or epoxy coated) busbars. (c.) 9 nos. 16 A single phase switch fuse units and 3 nos. 16 A TPN switch fuse units as outgoing feeders or alternatively 16 amps MCCB can be provided. (d.) 3 nos. indicating lamps with resistors and coloured lenses (R, Y, B) for incoming supply monitoring.
6.07.00	The fuses shall be mounted in an insulating fuse carrier and it shall be possible to replace the outgoing feeder fuses without disturbing the other feeders. The handle of incoming switch shall be mounted on the door of the fuse board, with padlocking facility in both 'ON' and 'OFF' positions. The outgoing feeder switches shall preferably be of rotary type.
6.08.00	Cable entry facilities shall be provided at top / bottom with removable gland plates of suitable thickness. All incoming and outgoing cables shall be terminated on suitable terminal blocks.
7.00.00	**POWER BUSBARS AND INSULATORS**
	All 415 V Switchboards, MCCs and ACDBs shall be provided with three phase and neutral busbars. Two separate sets of vertical busbars shall be provided in each panel of double front MCCs. Interleaving arrangement for busbars shall be adopted for switchboards with a rating of more than 1600A. DCDBs shall be provided with two (2) busbars. Entire busbar system shall be insulated with PVC sleeves.

7.01.00	All busbars and jumper connections shall be of high conductivity aluminum alloy / copper of adequate size.
7.02.00	The cross-section of the busbars shall be uniform throughout the length of switchboard section and shall be adequately supported and braced to withstand the stresses due to the specified short circuit currents. Neutral busbar short circuit strength shall be same as main busbars.
7.03.00	All busbars shall be adequately supported by non-hygroscopic, non-combustible, track-resistant and high strength sheet moulded compound or equivalent type polyester fiber glass moulded insulator. Separate supports shall be provided for each phase and neutral busbar. If a common support is provided, anti-tracking barriers shall be provided between the supports. Insulator and barriers of inflammable material such as Hylam shall not be accepted. The busbar insulators shall be supported on the main structure.
7.04.00	All busbar joints shall be provided with high tensile steel bolts, belleville / spring washers and nuts, so as to ensure good contacts at the joints. Non-silver plated busbar joints shall be thoroughly cleaned at the jointed locations and suitable contact grease shall be applied just before making a joint. All bolts shall be tightened by torque spanner to the recommended value. The overlap of the busbars at each joint surface shall be such that the length of overlap shall be equal to or greater than the width of the busbar. All copper to aluminum joints shall be provided with suitable bimetallic washers.
7.05.00	All busbars shall be colour coded as per IS: 375.
7.06.00	Wherever the busbars are painted with black Matt paint, the same should be suitable for temperature encountered in the switchboard under normal operating conditions.
7.07.00	The Bidder shall furnish calculations establishing the adequacy of bus bar sizes for specified current ratings.
8.00.00	**AUXILIARY BUSBARS AND CONTROL TRANSFORMERS**
8.01.00	**AC CONTROL SUPPLY BUSBAR** Each bus-section of all Switchgears and MCCs shall be provided with two (2) nos. 415V / 110V control transformers. The 110V AC control supply from the control transformers shall be run through the MCC by means of two sets of control supply busbars of electrolytic copper. In case of one transformer failure, whole bus section can be fed through single transformer. The control supply to different modules shall be tapped individually from the control supply busbars.
8.02.00	**DC CONTROL SUPPLY BUSBARS** Electrically controlled circuit breaker boards shall be provided with DC control supply busbars. The manually controlled breakers shall also be provided with such busbars in case relays are provided. Each section of the switchboard shall be provided with a DC supply by the Contractor. The Contractor shall provide suitable terminals, switch-fuse etc. to receive the DC supply and distribute the same through above mentioned control busbars to the required modules of the respective section. The DC control supply bus of one section shall be coupled to the control supply of other section through a switch located in the bus-coupler breaker panel. The DC supply to the bus-coupler breaker may be given from any of the control buses. For emergency switchgear, Contractor shall provide two DC supplies. The contractor shall provide

	suitable diodes to derive the control supply through diode auctioneering from the above two supplies.
8.03.00	**SPACE HEATER BUSBARS**
	Panel and motor space heaters shall be fed from separate AC auxiliary busbars running throughout the switchboard. The supply for these busbars shall be tapped from incomer, before the isolating switch/ circuit breaker. Incoming circuit to space-heater bus shall have an isolating switch, HRC fuse and neutral link of suitable rating. Suitable terminals shall also be provided to facilitate energisation of space-heater bus from outside during long shutdowns of unit / switch-board.
8.04.00	**CONTROL TRANSFORMERS**
	The control transformers shall be 415 V/110 V with neutral point-earthed, of insulation class 'B' or better. The sizing of Control transformers shall be carried out by Bidder considering the actual load of power contactors, auxiliary contactors, indicating lamps and other equipment in the module circuit. An additional load of 15 watts should also be considered for each module, for remote auxiliary relays and lamps to be connected in the control circuit of modules. Bidder shall also ensure that control transformers are adequately designed for meeting the momentary loading requirements & the voltage drop during this condition shall not be more than 5%.
9.00.00	**EARTH BUS AND EARTHING**
9.01.00	A galvanized steel / Copper / Aluminium earth bus shall be provided at the bottom of each panel and shall extend throughout the length of each switchboard. It shall be welded / bolted to the framework of each panel and breaker earthing contact bar. Vertical earth bus shall be provided in each vertical section which shall in turn be bolted / welded to main horizontal earth bus.
9.02.00	The earth bus shall have sufficient cross section to carry the momentary short circuit and short time fault current to earth, as indicated in "Technical Parameters", without exceeding the allowable temperature rise.
9.03.00	Suitable arrangements shall be provided at each end of the horizontal earth bus for bolting to Contractor's earthing conductors. The horizontal earth bus shall project out of the switchboard ends and shall have predrilled holes for this connection. All joint splices to earth bus shall be made through atleast two bolts, and taps by proper lug and bolt connection.
9.04.00	All non-current carrying metal work of the switchboard shall be effectively bonded to the earth bus. Electrical conductivity of the whole switchgear enclosure framework and truck shall be maintained even after painting.
9.05.00	The carriage and breaker frame shall get earthed while being inserted in the panel and positive earthing of the breaker frame shall be maintained in all positions, i.e. SERVICE & ISOLATED, as well as throughout the intermediate travel.
9.06.00	Each module frame shall get engaged to the vertical earth bus before the disconnecting contacts on the module are engaged to the vertical busbars.
9.07.00	All metallic cases of relays, instruments and other panel-mounted equipment shall be connected to earth by independent stranded copper wires of size not less than 2.5 sq. mm. All the equipment mounted on the door shall be earthed through flexible wire/braids.

	Insulation colour code of earthing wires shall be green. Earthing wires shall be connected to terminals with suitable clamp connectors, soldering is not acceptable. Looping of earth connections, which would result in loss of earth connections to other devices, when a device is removed, is not acceptable. However, looping of earth connections between equipment to provide alternative paths to earth bus is acceptable.
9.08.00	VT and CT secondary neutral point earthing shall be at one place only, i.e. on the terminal block. Such earthing shall be made through links so that earthing of one secondary circuit shall be removed without disturbing the earthing of other circuit.
9.09.00	All hinged doors having potential carrying equipment mounted on it shall be earthed by flexible wire/ braid. For doors not having potential carrying equipment mounted on it, earth continuity through scraping hinges/ hinge pins of proven design may also acceptable. The Contractor shall establish earth continuity at site also.
10.00.00	**CIRCUIT BREAKERS**
10.01.00	Circuit breakers shall be three pole, air break, horizontal draw out type, and shall have fault making and breaking capacities as specified in "Technical Parameters". The circuit breakers which meet specified parameters of continuous current rating and fault making / breaking capacity only after provision of cooling fans or special device shall not be acceptable.
10.02.00	Circuit breakers along with its operating mechanism shall be provided with suitable arrangement for easy withdrawal. Suitable guides shall be provided to minimise misalignment of the breaker.
10.03.00	There shall be "SERVICE", "TEST" and "FULLY WITHDRAWN" positions for the breakers. In "Test" position the circuit breaker shall be capable of being tested for operation without energising the power circuits i.e. the power contacts shall be disconnected, while the control circuits shall remain undisturbed. Locking facilities shall be provided so as to prevent movement of the circuit breaker from the "SERVICE", "TEST" or "FULLLY WITHDRAWN" position. It shall be possible to close the door in "Test" position.
10.04.00	All circuit breakers shall be provided with "4 NO" and "4NC" potential free auxiliary contacts. These contacts shall be in addition to those required, for internal mechanism of the breaker and should be directly operated from breaker operating mechanism. In case the manufacturer does not have a proven arrangement for providing the required number of circuit breaker auxiliary contacts on the fixed portion of the cubicle, necessary electrically reset latched relays shall be provided complete with all wiring in series with service position limit switch contacts, for multiplying the circuit breaker mounted auxiliary contacts and provide 4 NO and 4 NC contacts. Separate limit switches, each having required numbers of contacts shall be provided in both "SERVICE" and "TEST" position of the breaker. All contacts shall be rated for making, continuously carrying and breaking 10 Amp at 240 V AC and 1 Amp (Inductive) at 240 V DC respectively.
10.05.00	Suitable mechanical indications shall be provided on all circuit breakers to show "OPEN", "CLOSE", "SERVICE ", "TEST" AND "SPRING CHARGED" positions.
10.06.00	Main poles of the circuit breakers shall operate simultaneously in such a way that the maximum difference between the instants of contacts touching during closing shall not exceed half a cycle of rated frequency.

10.07.00	All circuit breakers shall be provided with the following interlocks :
10.07.01	Movement of a circuit breaker between "SERVICE" and "TEST" position shall not be possible unless it is in open position. Attempted withdrawal of a closed circuit breaker shall preferably not trip the circuit breaker. In case the offered circuit breaker trips on attempted withdrawal as a standard interlock, it shall be ensured that sufficient contact exists between the fixed and draw out contact at the time of breaker trip so that no arcing takes place even with the breaker carrying its full rated current.
10.07.02	Closing of a circuit breaker shall not be possible unless it is in "SERVICE" position, "TEST" position or in "FULLY WITHDRAWN" position.
10.07.03	Circuit-breaker cubicles shall be provided with safety shutters operated automatically by the movement of the circuit breaker carriage, to cover the stationary isolated contacts when the breaker is withdrawn. It shall however be possible to open the shutters intentionally against pressure for testing purposes.
10.07.04	A breaker of particular rating shall be prevented from insertion in a cubicle of a different rating.
10.07.05	Circuit breakers shall be provided with coded key / electrical interlocking devices, as per requirements.
10.08.00	Circuit breaker shall be provided with anti-pumping feature (soft) and trip free feature, even if mechanical anti-pumping feature is provided.
10.09.00	Mechanical tripping shall be possible by means of front mounted Red "trip" push-button. In case of electrically operated breakers these push buttons shall be shrouded to prevent accidental operation.
10.10.00	Complete shrouding / segregation shall be provided between incoming and outgoing bus links of breakers. In case of bus coupler breaker panels the busbar connection to and from the breaker terminals shall be segregated such that each connection can be approached and maintained independently with the other bus section live. Dummy panels if required to achieve the above feature shall be included in the Bidder's scope of supply.
10.11.00	Circuit breaker shall be provided with Power operated mechanism as follows.

1.	Power operated mechanism shall be provided with a universal motor suitable for operation on 220 V DC / 110 DC Control supply, with voltage variation from 90% to 110% of rated voltage. Motor insulation shall be class "E" or better.
2.	The motor shall be such that it requires not more than 30 seconds for fully charging the closing spring at minimum available control voltage.
3.	Once the closing springs are discharged, after one closing operation of circuit breaker, it shall automatically initiate recharging of the spring.
4.	The mechanism shall be such that as long as power is available to the motor, a continuous sequence of closing and opening operations shall be possible. After failure of power supply at least one open-close-open operation shall be possible.
5.	Provision shall be made for emergency manual charging and as soon as this

	manual charging handle is coupled, the motor shall automatically get mechanically decoupled.
6.	All circuit breakers shall be provided with closing and trip coils. The closing coil shall operate correctly at all values of voltage from 85% to 110% of rated voltage. The trip coil shall operate satisfactorily at all values of voltage from 70% to 110% of rated voltage
7.	Provision for mechanical closing of the breaker only in "Test" and "WITHDRAWN" positions shall be made. Alternately, the mechanical closing facility shall be normally made inaccessible; accessibility being rendered only after deliberate removal of shrouds.

Note: The circuit breakers for DC applications shall have manually operated mechanism of spring charged, stored energy type. The closing operation of the circuit breaker shall charge the tripping spring. Necessary interlocks shall be provided to inhibit closing of the circuit breaker unless the closing spring is fully charged.

10.12.00 **TELESCOPIC TROLLEY**

Telescopic trolley or suitable arrangement shall be provided for maintenance of circuit-breaker module in a cubicle. The trolley shall be such that the top most breaker module can be withdrawn on the trolley and can be lowered for maintenance purpose. The telescopic trolley shall be such that all type, size and rating of breaker can be withdrawn /inserted of particular switchgear. The quantity of telescopic trolleys to be supplied shall be adequate for the number of switchgears / switchgear rooms.

11.00.00 **AIR BREAK SWITCHES**

11.01.00 Air break switches shall be of heavy duty, single throw, group operated, load break, fault make type when associated with fuses. All switches for motor circuits shall be of utilisation category AC-23A with 1NO +1NC auxiliary contact, which shall be wired to the control circuit as shown in the schematic drawings. All switches for other outgoing feeders shall be of utilization category AC-22A. All switches for DC circuits shall be suitable for 220 V DC and shall be of DC-22 utilisation category.

11.02.00 Continuous current rating of the switches for various feeders shall be selected from the 'Module Selection tables' attached at the end of this subsection.

10.03.00 The combination of switch-fuse unit would be preferred. However, if separate switch and fuses are provided, switch shall be located before fuses.

10.04.00 The main switches shall be operable from outside the module door. The switch handle shall clearly indicate the position of switch. Switch operating handles shall be provided with padlocking facilities. However, incomer switches of switchboards shall be provided with padlocking facility in both 'ON' and 'OFF' positions.

10.05.00 Interlocks shall be provided such that the cubicle door will not open when the switch is in closed position and the switch will close only when the door is closed.

10.06.00	Switches and fuses for AC/DC control supply and heater supply wherever required, shall be mounted inside the cubicles. Toggle switch is not acceptable.
10.07.00	Even if a single phase feeder is asked, Bidder shall provide TPN switch, fuse-bases and cable/ link connections between switch/fuse and vertical busbars for all the three phases, so that changing from single phase feeder to three phase feeder is possible without any modification other than inserting fuses at site.
12.00.00	**MCCB**
12.01.00	MCCB shall be fixed type/part of withdrawable feeder module as per specification, three pole, air break type having trip free mechanism with quick make and quick break type contacts. MCCB shall have current limiting feature. MCCB of identical ratings shall be physically and electrically interchangeable. MCCB shall be provided with 1 NO and 1NC auxiliary contacts.
12.02.00	MCCB shall be provided with Microprocessor based inbuilt front adjustable releases (overload & short circuit) and shall have adjustable earth fault protection unit also. The protection settings shall have suitable range to achieve the required time & current settings. LED indications shall also be provided for faults, MCCB status(on/off etc).
12.03.00	MCCB terminals shall be shrouded and designed to receive cable lugs for cable sizes relevant to circuit rating. Extended cable terminal arrangement for higher size cable may also be offered. ON and OFF position of the operating handle of MCCB shall be displayed and the rotary operating handle shall be mounted on the door of the compartment housing MCCB. The compartment door shall be interlocked mechanically with the MCCB, such that the door can not be opened unless the MCCB is in OFF position. MCCB shall be provided with padlocking facility to enable the operating mechanism to be padlocked. The MCCBs being offered shall have common/interchangeable accessories for all ratings like aux. switch ,shunt trip, alarm switch etc. The MCCBs shall have the current discrimination up to full short circuit capacity and shall be selected as per manufacturers discrimination table.
13.00.00	**CONTROL AND SELECTOR SWITCHES**
13.01.00	Control and selector switches shall be of heavy duty, rotary type with escutcheon plates clearly marked to show the positions. The control & selector switches should be as per IS 13947 Part V section 1. The switches shall be of sturdy construction suitable for mounting on panel front. Switches with shrouding of live parts and sealing of contacts against dust ingress shall be preferred.
13.02.00	Ammeter and voltmeter selector switches shall have four stay put positions with adequate number of contacts for 3-phase 4-wire system. These shall have oval handles. Ammeter selector switches shall have make before break type contacts to prevent open circuiting of CT secondaries.
13.03.00	Contacts of the switches shall be spring assisted and shall be of suitable material to give a long trouble free service.
13.04.00	The contact ratings shall be at least the following :

1.	Make and carry, continuously, 10 A at 240 V DC and 110 V AC
2.	Breaking current at 240 V DC, 1 A (inductive)

	3. Breaking current at 110 V AC and 0.3 lagging p.f., 5A
14.00.00	**CONTACTORS**
14.01.00	Motor starter contactors shall be of air break, electromagnetic type rated for uninterrupted duty as per IS: 13947 Part-4 Section- 1.
14.02.00	Contactors shall be double-break, non-gravity type and their main contacts shall be silver faced.
14.03.00	Direct-on-line contactors shall be of utilization category AC3. Reversing starters shall comprise of Forward and Reverse contactors mechanically and electrically interlocked with each other. These contactors shall be of utilization category AC4. DC contactors shall be of DC3 utilization category. For CHP conveyor motors, minimum rating of power contactors shall be 240% of full load current of the motors. For other drives, minimum rating of power contactors shall be 160% of full load current of motor.
14.04.00	The number of normally open (NO) and normally closed (NC) auxiliary contacts of a contactor shall be as per requirement shown in the respective module drawings. It shall, however, be not less than 2NO+2NC.
14.05.00	Operating coil of contactors shall be of 110 V AC unless otherwise specified elsewhere. The contactor shall operate satisfactorily between 85% and 110% of the rated voltage. The contactor shall not drop out at 70% of the rated voltage but shall definitely drop out at 20% of the rated voltage.
14.06.00	Contactors for DC drives shall have a coil voltage of 240 V DC. DC operated contactor coil shall have an economy resistor and shall be suitable for satisfactory continuous operation at 85% to 110% of rated voltage.
15.00.00	**FUSES**
15.01.00	All fuses shall be of HRC cartridge fuse link type. Screw type fuses shall not be accepted. Fuses for AC circuits shall be rated for 80kA rms (prospective) breaking capacity at 415V AC and for DC circuits, 20kA rms breaking capacity at 220V DC.
15.02.00	Fuse shall have visible operation indicators. Insulating barriers shall be provided between individual power fuses.
15.03.00	Fuse shall be mounted on insulated fuse carriers, which are mounted on fuse bases. Wherever it is not possible to mount fuses on carriers, fuses shall be directly mounted on plug-in type of bases. In such cases one set of insulated fuse pulling handles shall be supplied with each switchboard.
15.04.00	Fuse ratings for various feeders shall be selected by the Bidder from the 'Module Selection Tables' attached at the end of this subsection. However, the fuse ratings for motor feeders given in the 'Motor Module Selection Table' are indicative only, and the same shall be coordinated by the Bidder to achieve class-II protection coordination and also to match the motor characteristics. Switch rating shall in no case be less than the fuse rating.
15.05.00	The Neutral links shall be mounted on fuse carriers which shall be mounted on fuse bases.
16.00.00	**INSTRUMENT TRANSFORMERS**

16.01.00	All current and voltage transformers shall be completely encapsulated, cast resin insulated type suitable for continuous operation at the temperature prevailing inside the switchgear enclosure, when the switchboard is operating at its rated condition and the specified ambient temperature. The class of insulation shall be 'E' or better.
16.02.00	All instrument transformers shall be able to withstand the thermal and mechanical stresses resulting from the maximum RMS short circuit breaking and peak making current ratings of the associated switchgear.
16.03.00	All instrument transformers shall have clear indelible polarity markings. All secondary terminals shall be wired to separate terminals on an accessible terminal block where star point formation and earthing shall be done.
16.04.00	Current transformers may be multi or single-core type. All voltage transformers shall be single phase type.
16.05.00	The bus VTs shall be housed in a separate compartment. All VTs shall have readily accessible HRC current limiting fuses on both primary and secondary sides.
16.06.00	All CTs shall be provided with supports independent of busbar / busbar supports.
16.07.00	The CTs shall be located in such a way that they can be easily approached for maintenance without necessitating shut down of adjacent feeders.
17.00.00	**NUMERICAL RELAYS**
17.01.00	All relays in protective circuits shall be flush mounted on panel front with connections from the inside. The protective relays shall be communicable numerical relays. These numerical relays shall be of types as proven for the application and shall be subject to Employer's approval. Numerical relays shall have appropriate setting ranges, accuracy, resetting ratio and other characteristics to provide required sensitivity. All equipments shall have necessary protections as detailed in the standard scheme drawings.
17.02.00	The circuit breaker will normally be controlled from remote control panels (PLC) through closing and shunt trip coils. The Local control console of the relay flush mounted on the switchgear would normally be used only for testing of circuit breaker in isolated position, and for tripping it in an emergency. Provision for closing & tripping of the circuit breaker locally from laptop through serial port shall be possible to facilitate commissioning activities. The basic control scheme of breaker feeders shall be developed as per the schematic logics in the relay. The schematics shall be developed in soft inside the relay. Numerical relays shall be interfaced with PLC appropriately for closing / opening operations.
17.03.00	The numerical relay shall be capable of measuring and storing values of a wide range of quantities, events, faults and disturbance recordings. The alarm / status of each of protection function and trip operation shall be communicated to PLC. The numerical relays shall have built in feature / hardware interface to provide such inputs to PLC for analog / digital values. All the numerical relays shall have communications on two ports; local front port communication to laptop and a rear port on IEC 61850 to communicate with the data concentrator through LAN.
17.04.00	All relays and timers shall be rated for control supply voltage as mentioned elsewhere under parameters and shall be capable of satisfactory continuous operation between 80-120% of

	the rated voltage. Making, carrying and breaking current ratings of their contacts shall be adequate for the circuits in which they are used.
17.05.00	The protective relays shall have at least 10 Nos. programmable potential free contacts. Programmable Auxiliary relays shall have contacts as required.
17.06.00	Failure of a control or auxiliary supply and deenergisation of a relay shall not initiate any circuit breaker /contactor operation. All relay digital output contacts shall withstand a minimum test voltage of 2kV AC rms for one minute.
17.07.00	All the numerical relays shall have adequate processor memory for implementing the programmable scheme logic required for the realization of the protection / control schemes, in addition to the built in protection algorithms.
17.08.00	Relays shall be suitable for electrical measurement including voltage, current, power (active/reactive) and energy parameters.
17.09.00	Relays shall have separate output for individual functionality and the master trip shall be software configurable in case of multi output relays. Relays shall have event recording feature, recording of abnormalities and operating parameters with time stamping
17.10.00	Preferably comprehensive single numerical relay shall have provision of both current and voltage inputs. The current operated relay shall have provision for 4 sets of CT inputs, 3 nos. for phase fault & 1 CT input for earth fault. Relay shall be suitable for both residually connected CT input as well as CBCT input. The voltage-operated relay shall have provision for 3 PT inputs. Relays shall be suitable for CT secondary current of 1A / 5A selectable at site. Relays used in incomers and bus couplers shall have provision of two sets of voltage signal inputs for the purpose of synchronization.
17.11.00	All CT & PT terminals shall be provided as fixed type terminals on the relay to avoid any hazard due to loose connection leading to CT opening or any other loose connection. In no circumstances Plug In type connectors shall be used for CT / PT connections. Vendor to ensure the same for all protective relay models offered.
17.12.00	All numerical relay shall have key pad / keys to allow relay settings from relay front. All hand reset relays shall have reset button on the relay front. Relay to be self or hand reset shall be software selectable. Manual resetting shall be possible from remote.
17.13.00	Relays shall have suitable output contact for breaker failure protection.
17.14.00	Relays shall have self diagnostic feature with self check for power failure, programmable routines, memory and main CPU failures.
17.15.00	Relays shall have at least two sets or groups of two different sets of adaptable settings. Relays shall have multiple IEC / ANSI programmable characteristics. Relays shall have self reset auxiliary contacts of programmable type.
17.16.00	Design of the relay must be immune to any kind of electromagnetic interference. Vendor to submit all related type test reports for the offered model along with the offer.
17.17.00	Relay shall be immune to capacitance effect due to long length of connected control cables. Any external hardware, if required for avoiding mal operation of the relay due to cable capacitance shall be included as a standard feature.

17.18.00	All I/Os shall have galvanic isolation. Analog inputs shall be protected against switching surges, harmonics etc.
17.19.00	Numerical relays shall have two level password protections, one for read only and other for authorization for modifying the setting etc.
17.20.00	Time clock synchronization feature shall be provided for synchronization of clocks of numerical relay and metering LAN with data concentrator time clock. Required hardware and software interface to receive GPS/Time signal to achieve time synchronization shall be supplied by the vendor. The resolution of time synchronization shall be +/- 1.0 millisecond or better throughout the entire system.
17.21.00	Relays shall be suitable to accept both AC & DC supplies of 220V/110 V with tolerance of 70 % to 120 % of rated voltage & shall be finalized during detailed engineering.
18.00.00	**OTHER PROTECTIONS AND CONTROL FUNCTIONS IN THE RELAYS**
18.01.00	For control from PLC control commands shall be hardwired to the numerical relays. Preferably, no separate coupling relays shall be provided.
18.02.00	Trip circuit supervision shall be provided for all feeders to monitor the circuit breaker trip circuit both in pre trip and post trip conditions.
18.03.00	Schematics requiring auxiliary relays /timers for protection function shall be a part of numerical relay. The number of auxiliary relay and timer function for protection function shall be as required. Auxiliary relays for interlocking purpose shall be of self reset type.
18.04.00	Bus no volt condition shall be configured to a output contact of the relay of all incomers for suitably interfacing with PLC. All important signals like breaker status, protection trip (86), etc shall be configured and hardwired for feedback / display in PLC.
18.05.00	Timer functions shall be programmable for on/off delays.
18.06.00	The numerical relay shall be able to provide supervisory functions such as trip circuit monitoring, circuit breaker state monitoring, PT and CT supervisions and recording facilities with Post fault analysis.
18.07.00	The numerical processor shall be capable of measuring and storing values of a wide range of quantities, all events, faults and disturbance recordings with a time stamping using the internal real time clock. Battery back up for real time clock in the event of power supply failure shall be provided.
18.08.00	100 time tagged events /records should be able to store with time stamping Last 5 faults storage including the indication, protection operated , fault location relay and operating time, currents, voltage and time.
18.09.00	Diagnostics Automatic testing, power on diagnostics with continuous monitoring to ensure high degree of reliability shall be shall be provided. The results of the self reset functions shall be stored in battery back memory. Test features such as examination of input quantities, status of digital inputs and relay outputs shall be shall be available on the user interface.
18.10.00	The alarm/status of each individual protection function and trip operation shall be communicated to PLC.

18.11.00	Sequence of events shall have 1 ms resolution at device level.
18.12.00	Measurement accuracy shall be 1 % for RMS Current and voltage (20-120% of rated value).
18.13.00	It shall be possible to carryout open / close operation of breakers from a laptop by interfacing from the relay front port during initial commissioning.
18.14.00	Incomers and motor modules shall have 4-20 mA analog output (current signal) for display in PLC. This may be provided as analog output from the numerical relay or using a suitable CT & current transducer. 4-20 mA analog signal shall be provided for display of each bus voltage in PLC.
18.15.00	At least two licensed copies of necessary software for numerical relay configuration / setting / disturbance analysis and other utilities shall be supplied. Numerical relay configuration for all relays being supplied under the package shall be carried out in line with the approved schematics and shall be submitted for owner's approval. Setting calculations and relay settings configured in relay software for all relays shall be submitted for owner's approval. Approved relay configuration / settings shall be loaded in all the relays prior to dispatch to site.
19.00.00	**INDICATING INSTRUMENTS**
19.01.00	All indicating and integrating meters shall be flush mounted on panel front. The instruments shall be of at least 96mm square size with 90 degree linear scale and shall have an accuracy class of 1.0 or better. The covers and cases of instruments and meters shall provide a dust and vermin proof construction.
19.02.00	All instruments shall be compensated for temperature errors and factory calibrated to directly read the primary quantities. Means shall be provided for zero adjustment without removing or dismantling the instruments.
19.03.00	All instruments shall have white dials with black numerals & lettering. Black knife edge pointer shall be provided for meters.
19.04.00	Ammeters provided for motor feeders (for motors of rating ≥ 30kW & < 110kW) shall have a compressed scale at the upper current region to cover the starting current upto 6.0 times the CT primary current.
19.05.00	All motor feeders of rating ≥ 30 kW and < 110 kW and all motors of Dust Suppression System shall be provided with Multifunction Digital Energy Meter with communication facility to display the current, voltage, power factor, power energy related data locally as well as communicate these for remote metering/audit/analysis purposes. These meters shall The technical specification for Digital indicating energy meter shall be as follows: a) Input Voltage:110VAC / 220V/110 V DC b) Input Current:1A c) Size:96X96 SQ.MM d) Power & Energy Accuracy: 1.0 e) Mounting: Flush mounting

	f)	Type: True RMS 3-PHASE V,I, kW,PF & kWH indication
	g)	4 Digit, seven segment LED display/LCD display, with floating decimal
	h)	Communication: In built RS 485 bus port
	i)	Operating Frequency: 45 HZ-65HZ
	j)	Dielectric Test: 2KV RMS for 1 minute
	k)	Over Current: 10 times for 3 sec.
	l)	Aux supply: 90V-300V AC/DC
	m)	Compliance: EMC/EMI
	n)	Field programmable CT ratio
	o)	Analog Current and Energy Output (4-20 mA)
20.00.00	**PUSH BUTTONS**	
20.01.00	Push-buttons shall be of spring return, push-to-actuate type. Their contacts shall be rated to make, continuously carry and break 10 A at 110 V AC and 1 A (inductive) at 240 V DC.	
20.02.00	All push buttons shall have two (2) normally open and two (2) normally closed contact, unless specified otherwise. The contact faces shall be of silver alloy.	
20.03.00	All push-buttons shall be provided with integral escutcheon plates marked with its function.	
20.04.00	The color of the button shall as follows :	
	Green	for motor START, breaker CLOSE , valve/ damper OPEN commands.
	Red	for motor trip, breaker open, valve / damper close commands.
	Black	for all annunciation functions, overload reset and miscellaneous commands including reverse for clinker grinder etc.
20.05.00	All push buttons on panels shall be located in such a way that Red push button shall always be to the left of Green push button. In case of clinker grinder etc. the push buttons would be black - red-green from lift to right.	
20.06.00	All emergency push buttons shall have mushroom knobs.	
21.00.00	**INDICATING LAMPS**	
21.01.00	Indicating lamps shall be of CLUSTER LED type. The lamps shall have escutcheon plates marked with its function, wherever necessary.	
21.02.00	Lamps shall have translucent lamp-covers of the following colours, as warranted by the application :	
	Red	for motor ON, valve / damper OPEN, breaker CLOSE.
	Green	for motor OFF , valve / damper CLOSE, breaker OPEN.
	White	for motor AUTO TRIP.

	Blue for all healthy conditions (e.g. control supply, and also for SPRING CHARGED").
	Amber for all Alarm Conditions (e.g. overload). Also for "SERVICE" and "TEST" position indications.
21.03.00	Bulbs and lamp covers shall be easily replaceable from the front of the cubicle. The method of mounting indicating lamp fittings on panels shall prevent their rotation under the action of lamp removal or replacements, reliance upon the tightness of ring nut for the purpose is not sufficient.
21.04.00	Indicating lamps should be located just above the associated push-button / control switches. Red lamps shall invariably be located to the right of green lamps. In case a white lamp is also provided, it shall be placed between the red and green lamps along the centre line of control switch / push button pair. Blue and Amber should normally be located above the Red and Green lamps.
21.05.00	When associated with push-buttons, red lamps shall be directly above the green push-button and green lamp shall be directly above the red push button.
21.06.00	All indicating lamps shall be suitable for continuous operation at 90% to 110% of their rated voltage.
22.00.00	**SPACE HEATER**
22.01.00	Space heaters shall be provided in the switchboards wherever the manufacturer considers them necessary and recommends their provision for preventing harmful moisture condensation.
22.02.00	The space heaters shall be suitable for continuous operation on 240 V AC, 50 Hz, single phase supply, and shall be automatically controlled by thermostats. Necessary switches and fuses shall be provided.
22.03.00	The circuit for each panel and motor space heater should have an isolating switch, HRC fuse and isolating link. In addition, the space heater circuit of each panel shall also have a thermostat of suitable rating.
23.00.00	**INTERNAL WIRING**
23.01.00	All switchboards shall be supplied completely wired internally upto the terminals, ready to receive external cables.
23.02.00	All intercubicle and interpanel wiring and connections between panels of same switchboard including all bus wiring for AC and DC supplies shall be provided by the Bidder.
23.03.00	All auxiliary wiring shall be carried out with 650V grade, single core stranded copper conductor, colour coded, PVC insulated wires. Conductor size shall be 1.5 mm^2 (min.) for control circuit wiring and 2.5 mm^2 (min) for CT and space heater circuits.
23.04.00	Extra flexible wires shall be used for wiring to devices mounted on moving parts such as hinged doors. The wire bunches from the panel inside to the doors shall be properly sleeved or taped.
23.05.00	All wiring shall be properly supported, neatly arranged, readily accessible and securely connected to equipment terminals and terminal blocks.

23.06.00	All internal wiring terminations shall be made with solderless crimping type tinned copper lugs which shall firmly grip the conductor or an equally secure method. Similar lugs shall also be provided at both ends of component to component wiring. Insulating sleeves shall be provided over the exposed parts of lugs to the extent possible. Screw-less (spring loaded) / cage clamp type terminal shall also be provided with lugs.
23.07.00	Printed single tube ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. The wire identification marking shall be in accordance with IS: 375. Red Ferrules should be provided on trip circuit wiring.
23.08.00	Wiring for equipment, which are to be supplied by the Contractor and for which the Contractor has to provide mounting arrangement in his panels, shall also be provided by the Contractor, upto the terminal blocks.
23.09.00	All connections from vertical busbars for individual modules above 100 A shall be by Copper / Aluminum links only. The cable connections for modules less than 100 A shall be selected in such a way that there will not be any melting / shorting in case of a short circuit inside the module and the cable shall have current rating to carry the let through energy of th corresponding fuses in case of a fault. The insulation of the cable and its cross section shall be decided considering the high ambient temperature within the module. For all modules where use of cable is envisaged by the Contractor specific approval from the Contractor regarding cable details are to be taken. For power wiring colour coded wire insulation / tapes shall be provided.
24.00.00	**CONTROL TERMINAL BLOCKS**
24.01.00	Terminal blocks shall be 650V grade, 10Amps rated, made up of unbreakable polyamide 6.6 grade. The terminals shall be either screw type or screw-less (spring loaded) / cage clamp type with lugs. Marking on terminal strips shall correspond to the terminal numbering in wiring diagrams. All metal parts shall be of non-ferrous material. In case of screw type terminals the screw shall be captive, preferably with screw locking design.
24.02.00	Terminal blocks for CT and VT secondary leads shall be of stud type, made up of unbreakable polyamide 6.6 grade. They shall be provided with links to facilitate testing, isolation star / delta formation and earthing. Terminal blocks for CT secondary shall have the short circuiting facility. The terminals for remote ammeter connection etc. shall also be disconnecting type only. All metal parts shall be of non-ferrous material. Screws shall be captive.
24.03.00	In all circuit breaker panels MCC modules at least 10% spare terminals for external connections shall be provided and these spare terminals shall be uniformly distributed on all terminal blocks.
24.04.00	All terminal blocks shall be suitable for terminating on each side two (2) nos. stranded copper conductors of size upto 2.5 sq. mm each, or alternatively, the terminal blocks shall have the possibility of double shorting space to facilitate looping. However for PLC terminals shall be suitable for 1.5 mm2 cable.
24.05.00	All terminals shall be numbered for identification and grouped according to the function. Engraved white-in-black labels shall be provided on the terminal blocks.

25.06.00	Wherever duplication of a terminal block is necessary it shall be achieved by solid bonding links.
25.07.00	Terminal blocks shall be arranged with atleast 100mm clearance between two sets of terminal blocks. The minimum clearance between the first row of terminal blocks and the associated cable gland plate shall be 250 mm.
25.00.00	**POWER CABLE TERMINATION**
25.01.00	Cable termination compartment and arrangement for power cables shall be suitable for heavy duty, 1.1 kV grade, stranded aluminum conductor, PVC/ XLPE insulated, armoured / unarmoured and PVC sheathed cables. The size and type of cable for individual modules shall, preferably, be as indicated in the 'Module Selection Tables'. All necessary cable terminating accessories such as supporting clamps and brackets, hardware etc. for cables shall be provided by the contractor to suit the final cable sizes.
25.02.00	All power cable terminals shall be of stud type and the power cable lugs shall be of tinned copper solderless crimping ring type conforming to IS: 8309. All lugs shall be insulated/ sleeved.
26.00.00	**LOCAL PUSH BUTTON STATIONS**
26.01.00	The local push button stations shall be metal enclosed, suitable for outdoor / indoor mounting on wall or steel structures. The enclosure shall be die-cast aluminum or cold-rolled sheet steel of at least 1.6 mm thickness. The enclosure shall be provided with a hinged guard at the front, covering full length, to avoid inadvertent operation of push buttons. LPBS shall be powder coated with shade no. RAL: 9002. The minimum thickness of powder coating shall be 50 microns. Support structure for mounting the LPBS shall also be supplied by Contractor.
26.02.00	The local push button stations shall be dust and vermin proof and shall have a degree of protection of IP -55 as per IS : 13947. The DOP shall be IP-65 in case the same are located in dusty areas.
26.03.00	The push button stations shall be suitable for bottom cable entry and shall be provided with removable undrilled gland plates or knockouts. Adequate space shall be available inside the push button station enclosure for terminating external cables directly on pushbutton terminals. Overall size of push button stations shall be subject to Employer's approval.
26.04.00	The push button station shall comprise of a latched type EMERGENCY STOP push button with two (2) NO and two (2) NC contacts.
27.00.00	**LOCAL MOTOR STARTERS**
27.01.00	Local motor starters shall be suitable for manual switching of 415 V, 3-phase, squirrel cage motors rated upto 5.5 KW. They shall have constructional features similar to those specified for local push button stations.
27.02.00	Each starter shall comprise of :

1.	A 3-pole contactor, mechanically latched type.
2.	Start push button, colored green.

3.	Stop push button, colored red.
4.	Ambient temperature compensated, thermal over load relay with single phasing protection. The continuously variable relay setting range shall be suitable for the motor rating which shall be advised to the Contractor in due course. The relay shall trip the contactor.

27.03.00 The start push button, when pressed, shall preferably remain in depressed position and shall be released along with the contactor when the stop push button is pressed or when thermal overload relay operates.

27.04.00 Local starters shall be suitable for loop-in and loop-out of incoming cable and for one outgoing cable to motor. Final cable sizes and number of lugs required will be intimated to the contractor. Support structure for mounting in local motor starters shall be supplied by the Contractor.

28.00.00 NAME PLATES AND LABELS

28.01.00 All Switchgears, MCCs, Distribution Boards, Fuse boards, all feeders, local push-button stations and local motor starters shall be provided with prominent, engraved identification plates. The module identification plate shall clearly give the feeder number and feeder designation. For single front switchboards, similar panel and board identification labels shall be provided at the rear switchgear also.

28.02.00 All name plates shall be of non-rusting metal or 3-ply Lamicoid, with white engraved lettering on black background. Inscription & lettering sizes shall be subject to Employer's approval.

28.03.00 Suitable stenciled paint mark shall be provided inside the panel/module for identification of all equipment in addition to the plastic sticker labels, if provided. These labels shall be positioned so as to be clearly visible and shall have the device number, as mentioned in the module wiring drawings.

28.04.00 Caution name plate "Caution Live Terminals" shall be provided at all points where the terminals are likely to remain live and isolation is possible only at remote end.

29.00.00 METAL ENCLOSED NON SEGREGATED PHASE BUSDUCT

29.01.00 Three phase and neutral metal enclosed non segregated phase bus duct assemblies shall be supplied for incoming connections from the transformers to the switch boards and inter connecting sections between switch boards, wherever called for.

29.02.00 The enclosure shall be made of minimum 3 mm thick aluminum alloy. The section of the bus duct shall be rectangular. The design of the bus duct enclosures shall be of sturdy construction such that it will withstand the internal or external forces resulting from the various operating conditions.

29.03.00 The entire bus duct shall be designed for dust, vermin and weather proof construction. A suitable aluminum sheet flange-protection hood shall be provided to cover all outdoor bus duct enclosure joints to facilitate additional protection against rain water ingress. All horizontal runs of busducts shall have a suitable sloped enclosure top to prevent retention of water for both indoor and out door portion of bus ducts. Bus duct enclosure shall have a degree of protection of IP-55.

29.04.00	The inside of the bus enclosure may be treated with black paint to enable efficient heat dissipation. The matt paint used shall be suitable for temperature experienced during continuous loading of the bus conductor. The busduct exterior paint shade shall be RAL 5012. The thickness of finish coat shall be minimum 50 microns (with minimum total DFT of 100 microns).
29.05.00	Flexible expansion joints for the enclosure shall be provided wherever deemed necessary by the Bidder. Necessary bonding shall be provided at the expansion joints if made of insulating materials.
29.06.00	Enclosures shall be provided with flanged ends with drilling dimensions to suit the flanges at the switchgear and transformer terminals. Any adapter boxes required for this purpose are in the Bidder's scope of supply. The prices of such adopter boxes shall be included in the prices of respective switchboards. The flanges shall be provided with gaskets, nuts, bolts, etc. Details of the flanges provided on transformer ends will be furnished to the successful Bidder.
29.07.00	Suitable Inspection covers shall be provided for periodic inspection of insulators. Handle shall be provided on each inspection cover to facilitate easy lifting.
29.08.00	The EPDM / Neoprene gaskets shall be provided so as to satisfy the operating conditions imposed by temperature, weathering, durability etc. Flange gaskets shall be provided at the equipment terminal connections.
29.09.00	Necessary earthing arrangement as applicable shall be provided with clamps to receive 's station earthing bus. All accessories and hardware required for the earthing arrangement shall be provided by the Bidder. This shall be a GI strip of adequate size, continuously running along the bus duct and shall be earthed at both ends. Bus duct enclosures shall be bolted type.
29.10.00	The material of the conductor shall be aluminum. The minimum clearance in air between phase to phase, phase to neutral and phase to earth for the entire run of busduct shall be 25 mm The bus bars shall be rated in accordance with the service conditions and the rated continuous and short time current ratings specified elsewhere in specification.
29.11.00	All steel structures required for bus duct support shall be hot dip galvanised.
29.12.00	Space heaters shall be provided in the busduct wherever the manufacturer considers them necessary and recommends their provision for preventing harmful moisture condensation.
29.13.00	The space heaters shall be suitable for continuous operation on 240 V AC, 50 Hz single phase supply and shall be automatically controlled by thermostats. Necessary wiring upto junction boxes mounted on bus duct and from junction boxes to switch boards shall be provided by the Bidder.
30.00.00	**LIGHTING / WELDING TRANSFORMERS** Each AC Lighting Distribution Board (LDB) shall consist of:- (i) Two (2) Nos. x 100% rated Lighting transformers (415V/415V, delta/star, epoxy insulated. The transformer shall be of 50KVA/100KVA rating for 10/15 nos. outgoing feeder. (ii) TPN SFU on primary and secondary side of the transformer.

(iii) 63A TPN SFU as outgoing feeders including 20% spares.

(iv) Voltmeter, ammeter with selector switches, indicating lamps.

(v) The two incomers (One from Bus-A and One from Bus-B of the MCC) and one bus-coupler for the power supply to each MLDB shall be provided with castle key networks

The lighting transformer may, preferably, be located inside the LDB panel itself. Otherwise, the same shall be located by the side of respective LDB. Lighting transformers shall be dry type, natural air cooled with class B insulation or better. Impedance of lighting transformer shall be so selected that the fault level of lighting system shall be reduced to 3 to 5 KA. Lighting transformers shall be tested as per IS: 2026. Off-circuit tap changer with ± 2.5% and ± 5% tapping shall be provided. In case the transformers are not mounted inside the LDB panels, the same shall be housed in a separate 2 mm thick CR sheet steel enclosure with IP-42 degree of protection as per IS : 13947. However, the transformer terminal box shall have IP-52 degree of protection.

31.00.00 PAINTING

All sheet steel work shall be pretreated, in tanks, in accordance with IS: 6005. Degreasing shall be done by alkaline cleaning. Rust and scales shall be removed by pickling with acid. After pickling, the parts shall be washed in running water. Then these shall be rinsed in slightly alkaline hot water and dried. The phosphate coating shall be "Class-C" as specified in IS: 6005. The phosphated surfaces shall be rinsed and passivated. After passivation, Electrostatic Powder Coating shall be used. Powder should meet requirements of IS 13871 (Powder costing specification). Finishing paint shade for complete panels excluding end covers shall be RAL9002 & RAL5012 for extreme end covers of all boards, unless required otherwise by the Employer. The paint thickness shall not be less than 50 microns. Finished parts shall be suitably packed and wrapped with protective covering to protect the finished surfaces from scratches, grease, dirt and oil spots during testing, transportation, handling and erection.

32.00.00 GASKETS

The gaskets, wherever specified, shall be of good quality EPDM / Neoprene with good ageing, compression and oil resistance characteristics suitable for pane applications.

33.00.00 TEMPERATURE –RISE

The temperature rise of the horizontal and vertical busbars and main bus links including all power drawout contacts when carrying 90% of the rated current along the full run shall in no case exceed 55 deg C with silver plated joints and 40 deg C with all other types of joints over an outside ambient temperature of 50 deg C. The temperature rise of the accessible parts/external enclosures expected to be touched in normal operation shall not exceed 20deg. C. The temperature rise of manual operating means shall not exceed 10deg. C for metallic & 15 deg. C for insulating material. Temperature rise for the busbars shall be carried out at 90% of the rated current. The above temperature rise limits are applicable for busducts also without any current derating.

34.00.00 DERATING OF EQUIPMENTS

The Bidder shall ensure that the equipment offered will carry the required load current at site ambient conditions specified and perform the operating duties without exceeding the permissible temperature as per Indian Standards / Specification. Continuous current rating at 50 deg C ambient in no case shall be less than 90% of the normal rating specified.

The Bidder shall indicate clearly the derating factors if any employed for each component and furnish the basis for arriving at these derating factors duly considering the specified current ratings and ambient temperature of 50 deg C.

35.00.00 PROTECTION CO-ORDINATION

It shall be the responsibility of the Contractor to fully coordinate the overload and short circuit tripping of the circuit breakers with the upstream and downstream circuit breakers / fuses / motor starters, to provide satisfactory discrimination. Further the various equipment supplied shall meet the requirements of Type II class of Co-ordination as per IS: 8544.

36.00.00 TESTS AND TEST REPORTS

GENERAL

(a.) All equipments to be supplied shall be of type tested design. The Contractor shall submit for Owner's approval the reports of all the type tests as listed in this specification and carried out not earlier than ten years prior to the date of bid opening. These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.

(b.) In case the Contractor is not able to submit report of the type test(s) conducted not earlier than ten years prior to the date of bid opening, or in case the type test report(s) are not found to be meeting the specification requirements, the Contractor shall conduct all such tests under this contract at no additional cost either at third party lab or in presence of client/owners's representative and submit the reports for approval.

(c.) All routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

The following type test certificates on each type & rating of L.T. Switchgear and MCC panel shall be submitted.

1)	Switchgear / MCC panels of each rating	
	a)	Short time withstand test.
	b)	Temperature rise test.
	c)	Degree of protection test
2)	Circuit breaker of each rating	
	a)	Test sequence 1

		-	Dielectric properties.
		-	Mechanical operation and operational performance capability
		-	Verification of dielectric withstand.
		-	Verification of temperature-rise
	b)	Combined test sequence (With Circuit breakers mounted inside the Switchgear panel)	
		-	Rated short-time withstand current
		-	Rated service short-circuit breaking capacity
		-	Verification of dielectric withstand
		-	Verification of temperature-rise
3)	MCC modules of any three ratings, as selected by the Employer, for class - II protection Co-ordination.		
4)	Test for single phasing protection feature on 3 nos. bimetallic thermal overload relay selected by Employer. The relay shall be tested for compliance with manufacturer's printed / declared characteristic curve.		

36.01.00 For the following equipment the contractor shall submit the reports of all the type tests as per applicable standards and carried out not earlier than ten years prior to the date of bid opening. These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. In case the Contractor is not able to submit report of the type test(s) conducted not earlier than ten years prior to the date of bid opening, or in case the type test report(s) are not found to be meeting the specification requirements, the Contractor shall conduct all such tests under this contract at no additional cost to the owner either at third party lab or in presence of client/owner's representative and submit the reports for approval.

(a.) NUMERICAL RELAYS

(b.) LIGHTING / WELDING TRANSFORMER

(c.) MCCB

36.02.00 Type test reports for the following tests on the model of the Numerical relays, Ethernet switches shall be submitted for employer's review.

	Test	Specification
1	**Functional requirements**	
1	Features and logics	IEC61850
2	Checking of compatibility with co-operating devices	IEC61850
3	Communication	IEC61850
2	**Mechanical construction requirements**	

	1	General inspection	Manufacturer's document
	2	Inspection of marking and data	IEC 60255-6
	3	Clearances and creepage distances	IEC 60255-5
	4	Degree of protection by enclosure	IEC 60529
3	**Insulation requirements**		
	1	Dielectric test	IEC 60255-5
	2	Impulse voltage test	IEC 60255-5
	3	Insulation resistance measurements	IEC 60255-5
4	**Accuracy requirements**		
	1	Measurement accuracy of characteristic quantity and specified time	IEC 60255-6
	2	Limits of frequency range and frequency dependence	IEC 60255-6
	3	Limits of ambient temperature and ambient temperature dependence	IEC 60255-6
	4	Limits of operative range of auxiliary energizing inputs and auxiliary voltage dependence	IEC 60255-6
5	**Rated burden requirements**		
	1	Measuring circuits	IEC 60255-6
	2	Auxiliary circuits	IEC 60255-6
	3	Signalling inputs	IEC 60255-6
6	**Thermal requirements**		
	1	Temperature rise	IEC 60255-6
	2	Limiting continuous thermal withstand values	IEC 60255-6
	3	Limiting short-time thermal withstand values	IEC 60255-6
7	**Limiting dynamic value requirements**		IEC 60255-6
8	**Power supply requirements**		
	1	Limiting duration of interruptions to dc auxiliary voltage	IEC 60255-11
	2	Limiting value of ripple in dc auxiliary voltage	IEC 60255-11
	3	Limiting value of voltage dips to ac auxiliary voltage	IEC 61000-4-11
	4	Limiting duration of interruptions to ac auxiliary voltage	IEC 61000-4-11

	5	Limiting variations of ac auxiliary voltage	IEC 61000-4-11
9	**Electromagnetic compatibility requirements**		
	1	High frequency disturbance test	IEC 60255-22-1
	2	Electrostatic discharge test	IEC 60255-22-2, 61000-4-2
	3	Radiated, radio-frequency, electromagnetic field immunity test	IEC 60255-22-3, 61000-4-3
	4	Fast transient disturbance test	IEC 60255-22-4, 61000-4-4
	5	Surge immunity test	IEC 60255-22-5, 61000-4-5
	6	Immunity to conducted disturbances, induced by radio-frequency fields	IEC 60255-22-6, 61000-4-6
	7	Power frequency immunity test	IEC 60255-22-7
	8	Conducted and Radiated radio-frequency emission tests	IEC 60255-25, EN55011-CISPR 11
	9	Power frequency magnetic field immunity test	IEC 61000-4-8
10	**Environmental requirements**		
	1	Dry cold test	IEC 60068-2-1
	2	Dry heat test	IEC 60068-2-2
	3	Storage temperature test	IEC 60068-2-8
	4	Damp heat test, cyclic (12 + 12 hour cycle)	IEC 60068-2-30
11	**Contact performance requirements**		
	1	Make and carry for dc	IEC 60255-23
	2	Breaking capacity for dc	IEC 60255-23
	3	Make and break ac	IEC 60255-23
12	**Mechanical performance requirements**		
	1	Durability of relay operation	IEC 60255-6
	2	Durability of plug-in relays	IEC 60255-6
	3	Durability of relay setting controls	IEC 60255-6
	4	Vibration response and endurance test	IEC 60255-21-1
	5	Shock response and withstand test	IEC 60255-21-2
	6	Bump test	IEC 60255-21-2

37.05.00 The type test reports once approved for any projects shall be treated as reference. For subsequent projects of NTPC, an endorsement sheet will be furnished by the manufacturer

confirming similarity and "No design Change". Minor changes if any shall be highlighted on the endorsement sheet.

All routine tests as per the specification and relevant standard IS 8623 shall be carried out. Charges for these shall be deemed to be included in the equipment price

An indicative lists of tests / checks is mentioned as QA chapter . However, the manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.

37.06.00 All procedures for type tests shall be approved by Employer before commencement of type tests. However, the following points may be specifically noted.

1)	For temperature rise tests, the connection arrangement between the source and the test equipment shall be such that the temperature gradient in the connection piece of cable at a distance of one meter away from the test equipment shall be restricted to 5 deg C.
2)	Milli Volt drop test shall be done on switching devices before and after the type tests.
3)	Bolt tightness of busbar joints shall be checked with torque wrench before and after short time rating tests on the circuit breaker and MCC panels.

37.07.00 Routine checking to observe compliance to degree of protection, first numeral, on switchboard enclosures and busbar chambers shall be as under:

1) IP -4 X	It shall not be possible to insert a one mm dia. Steel wire into the enclosure from any direction, without using force.
2) IP-5X	It shall not be possible to insert a thin sheet of paper under gaskets and through enclosure joints.

38.00.00 ERECTION / INSTALLATION OF SWITCHBOARDS AND OTHER EQUIPMENTS

38.01.00 Each equipment shall be installed in a neat, workman-like manner so that it is leveled, plumbed, squared and properly aligned and oriented. Tolerances shall be as established in Contractor's drawings or as stipulated by Employer. No equipment shall be permanently fixed down to foundations until the alignment has been checked and found acceptable by the Employer.

38.02.00 Contractor shall furnish all supervision, labour, tools, equipment, rigging materials, bolts, wedges, anchors, etc.., in proper time, required to completely install, test and commission the equipment.

38.03.00 Manufacturer's and Employer's instructions and recommendations shall be correctly followed in handling, setting, testing and commissioning of all equipment.

38.04.00	Contractor shall move all equipment into the respective rooms through the regular door or openings specifically provided for this purpose. No part of the structure shall be utilised to lift or erect any equipment without prior permission of Engineer.
38.05.00	All switchboards shall be installed in accordance with Indian Standard, IS: 3072, and Employer's instructions.
38.06.00	Switchboard panels shall be installed on concrete floor or supported on steel channel / edge angle in concrete trenches. The Contractor shall provide steel insert plates in the concrete floor and / or steel channels / edge angle on the trenches as applicable. The base frame of switchboards shall be welded to the insert plates by the Contractor. The Contractor shall be required to install and align the panels using suitable metallic shims before welding the base frame. In joining shipping sections of switchboards together, adjacent housing of panel sections or flanged throat sections shall be bolted together after alignment has been completed.
38.07.00	Contractor shall take utmost care in handling instruments, relays and other delicate mechanisms. Wherever the instruments and relays are supplied separately they shall b mounted only after the associated panels have been erected and aligned. the blocking materials employed for safe transit of instruments and relays shall be removed after ensuring that panels have been completely installed and no further movement of the same would be necessary. Any damage shall be immediately reported to Engineer.
38.08.00	Equipment furnished with finished coats of paint shall be touched up by Contractor if their surface is spoiled or marred during erection / commissioning.
38.09.00	The room and floor finishing work would be done after erection of the panels and the Contractor shall suitably cover up the panels to protect them from injury and marring of finish.
38.10.00	In case of relocation of existing switchgear, complete dismantling, shifting to new location, installation along with necessary civil foundation, inter-panel wiring, testing, commissioning and putting into service of all such switchgears shall be carried out by the contractor in co ordination with the site in charge.
39.00.00	**COMMISSIONING CHECKS / TESTS**
39.01.00	After installation of panels, power and control wiring and connections, Contractor shall perform operational tests on all switchboards, to verify proper operation of switchboards / panels and correctness of all equipment in each and every respect.
39.02.00	The Contractor shall carry out the following commissioning checks, in addition to other checks and tests recommended by the manufacturers.
39.03.00	GENERAL
	(a.) Check name plate details according to the approved drawings.
	(b.) Check for physical damage.
	(c.) Check tightness of all bolted connections, by torque wrench.
	(d.) Check earth connections.
	(e.) Check cleanliness.
	(f.) Check all moving parts for proper lubrication.

39.04.00	Circuit Breakers
	(a.) Check alignment of breaker truck for free movement.
	(b.) Check correct operation of shutters.
	(c.) Check control wiring for correctness of connections, continuity And IR values.
	(d.) Manual operation of breakers completely assembled.
	(e.) Closing /opening operation, manually and electrically.
	(f.) Trip free and anti-pumping operation.
	(g.) I.R. values of contacts.
	(h.) Contact resistance.
	(i.) Check on spring charging motor, correct operation of limit switches and time or charging.
	(j.) All functional checks
	(k.) Breaker closing and tripping time, if required.
39.05.00	Current Transformers
	(a.) Visual inspection.
	(b.) IR Value
	(c.) Ratio check.
	(d.) Magnetising current.
	(e.) Wiring connection.
	(f.) Spare CT cores, if any, to be shorted and earthed
39.06.00	Voltage Transformers
	(a.) Visual inspection.
	(b.) IR Value
	(c.) Ratio check
	(d.) Mangnetising current
	(e.) Line connection as per connection diagram
39.07.00	Cubicle Wiring
	(a.) Check all switch developments
	(b.) Each wire shall be traced by continuity tests and it shall be ensured that the wiring is as per relevant drawing. All inter-connections between panels / equipment shall be similarly checked.
	(c.) All the wires shall be meggered to earth.
	(d.) Functional checking of all control circuit e.g., closing, tripping, control, interlock, supervision and alarm circuit.

39.08.00 Relays

1. Check connections and wiring.
2. Megger
   a) Megger all terminals to body.
   b) Megger AC to DC terminals.
3. Check operating characteristics by secondary injection.
4. Check minimum pick up voltage of DC coils.
5. Check operation of electrical / mechanical targets.
6. Relay settings.
7. Check CT and VT connections with particular reference to their polarities.

39.09.00 Meters

(a.) Visual inspection.

(b.) Megger all insulated partitions.

(c.) Check CT and VT connections with particular reference to their polarities for power type meters.

(d.) Calibration.

40.00.00 AC MODULES DESCRIPTION

40.01.00 Module type DAE (Circuit Breaker Module)

(a.) One (1) Triple-pole circuit breaker, complete with all accessories and power operated mechanism, as specified.

(b.) Three (3) Current transformers for Protection and metering.

(c.) One (1) DC isolating Switch

(d.) Six (6) HRC Control fuses.

(e.) Numerical relay for the following:

- Short Circuit Protection
- Earth Fault Protection
- Over Load protection
- Energy Metering
- Current and Voltage metering
- Trip Circuit Supervision
- CB Monitoring
- Synchronizing Check feature

40.02.00 Module Type DAET (Circuit Breaker Incomer From Transformer)

	Similar to module type DAE; but with additional PS Class Current transformers for Restricted Earth Fault Protection. The Numerical relay shall have provision for REF protection in addition to the features listed against module type DAE.
40.03.00	**Module Type CS (AC Control Supply Module)**
	(Note: Module type CS will be of non-drawout type)
	Two (2) 415/110 V control transformers.
	Four (4) 110V auxiliary relays.
	Two (2) Earth links.
	Eight (8) HRC Control fuses.
	Two (2) Selector switches
40.04.00	**Module Type E/E1/E2 (Switch Fuse Module/MCCB)**
	(a) One (1) Triple pole switch-fuse unit with three pole isolating switch and three / one / two HRC fuses for E/E1/E2 modules, respectively.
	(b) One (1) Neutral link.
40.05.00	**Module Type G1 (VT Module with Under Voltage / No Volt Relay)**
	(a.) Three (3) 415/√3 / 110/√3 V single phase voltage transformers, mounted on a common draw-out chassis
	(b.) Three (3) HRC fuses for VT primary.
	(c.) Three (3) HRC control fuses.
40.06.00	**Module Type H (Isolating Switch Module)**
	(a) One (1) Triple pole load break isolating switch
	(b) One (1) Neutral link
40.07.00	**Module type K1 (Non Reversible Motor Rated Below 30 kW Controlled from MCC)**
	(a) One (1) Triple pole fuse switch unit with three pole load break isolating switch and three HRC fuses.
	(b) One (1) Triple pole contactor.
	(c) One (1) Bimetallic thermal overload relay with single phasing preventer.
	(d) Two (2) Push buttons.
	(e) Three (3) Indicating lamps with resistors and coloured lenses.
	(f) One (1) HRC control fuse.
	(g) One (1) Control link.
40.08.00	**Module Type K11 (Non reversible Motor Rated 30kW to 200kW Controlled from MCC)**
	Similar to module type K1 but with the following additions:
	One (1) Current transformer for metering.

	One (1) Ammeter		
	One (1) Single-pole switch and fuse for motor space heater.		
40.09.00	**Module type DK2 (Non Reversible Motor rated below 30kW Controlled from PLC)**		
	(a)	One (1)	Triple pole switch fuse unit with three pole load break Isolating switch and three HRC fuses.
	(b)	One (1)	Triple pole contactor.
	(c)	One (1)	Bimetallic thermal overload relay with single phasing preventor. Modules marked with * (DK2* / PK2*) shall not have this relay.
	(d)	Three (3)	Indicating lamps with resistors and coloured lenses.
	(e)	One (1)	HRC control fuse.
	(f)	One (1)	Control link
	(g)	One (1)	Auxiliary contactor
	(h)	Two (2) Coupling relays suitable for 24V DC.	
40.10.00	**Module Type DK21 (Non Reversible Motor rated 30kW to up to 110KW controlled from PLC).**		
	(a)	Similar to module type DK2 but with the following additions :	
	(b)	One (1) Current transformer for metering.	
	(c)	One (1) Ammeter (for motors of rating ≥ 30kW & < 110kW)	
	(d)	One (1) Single-pole switch and fuse for motor space heater.	
	(e)	One (1) Digital Energy Meter with Analog output of Current (4-20 mA) (for motors of rating ≥ 30kW & < 110kW and all dust suppression motors)	
40.11.00	**Module Type DN1 (Reversible Motor Controlled from PLC)**		
	(a.)	One (1)	Triple pole fuse switch unit with three pole load break solating switch and three HRC fuses.
	(b.)	Two (2)	Triple pole mechanically interlocked, forward / reverse contactors.
	(c.)	One (1)	Bimetallic thermal overload relay with single phasing preventor.
	(d.)	One (1)	Indicating lamp with resistor and coloured lens.
	(e.)	One (1)	HRC control fuse
	(f.)	One (1)	Control link
	(g.)	One (1)	Auxiliary contactor
	(h.)	Two (2)	Coupling relays suitable for 240V DC.
40.12.00	**Module Type VM (Voltmeter Module)**		
	(a.)	Three (3)	HRC fuses.
	(b.)	One (1)	Voltmeter (0-500 V.)

	(c.)	One (1)	Four position voltmeter selector switch
	(d.)	One (1)	415 V auxiliary contactor with 2 NO + 2 NC contacts.
	(e.)	One (1)	Voltage transducer with output of 4-20mA between R & Y phases
40.13.00	**Module Type DM (Circuit Breaker (DDC /PLC Controlled) Motor Feeder for motor rated 110 KW & above.**		
	(a.)	One (1)	Triple-pole circuit breaker, complete with all accessories and power operated mechanism, as specified.
	(b.)	Three (3)	Current transformers for Protection and metering.
	(c.)	One (1)	DC isolating Switch
	(d.)	Six (6)	HRC Control fuses.
	(e.)	One (1)	Single-pole switch and fuse for motor space heater
	(f)	Numerical relay for the following:	
		Short Circuit Protection (50)	
		Thermal Over Load protection(51I)	
		Earth fault Protection(50N)	
		Negative sequence Protection(46)	
		Restart inhibit protection(49)	
		Locked Rotor Protection	
		Energy Metering	
		Current and Voltage metering	
		Trip Circuit Supervision	
		CB Monitoring	
41.00.00	**DC MODULES DESCRIPTION**		
41.01.00	**Module Type -CH (Incomer from Charger)**		
	(a)	One (1)	Double pole, 250 V DC fuse -switch unit
41.02.00	**Module Type -DB (Incomer from Battery)**		
	(a)	Two (2)	HRC fuses with striker pins and Fuse monitoring relays with contacts for alarm. These fuses shall be mounted in a separate fiber glass / plastic enclosure and located in the battery room.
	(b)	One (1)	DC ammeter with shunt and centre zero. This shall be mounted in the DCDB.
41.03.00	**Module Type - DC**		
	(a)	One (1)	Double pole 250V DC switch / circuit breaker with 2NO+2NC auxiliary contacts.
41.04.00	**Module Type - HD (DC Isolating Switch / Circuit - Breaker Module)**		

	(a)	One (1)	Double pole , 250 V DC switch isolator / circuit breaker
41.05.00	**Module Type-S (DC Metering and Protection Module)**		
	(a)	One (1)	Voltmeter, 0-300V DC
	(b)	One (1)	Three position voltmeter selector switch
	(c)	One (1)	Instantaneous under voltage relay (27) with a setting of 95% of 240V DC. The resetting ratio of relay should not be more than 1.05.
	(d)	One (1)	Instantaneous over voltage relay (59) which shall operate at 110% of 240 V DC. The resetting ratio of relay should not be less than 0.95.
	(e)	One (1)	Earth leakage relay having adjustable pick up range between 3 to 7mA. The relay shall be suitable for 240V / 50V DC and 240V AC auxiliary supply. The relay shall be Alstom type CAEM-21 or equivalent.
	(f)	Two (2)	Indicating lamps with resistors & coloured lenses, one each fc 'Earth fault' and 'DC supply failure ' indications.
	(g)	Three (3)	HRC control fuses.
	(h)	One (1)	Neutral link
41.06.00	**Module Type -X (DC Isolating Switch Fuse Module)**		
	(a)	One (1)	Double pole , 250 V DC fuse switch unit with two HRC fuses.
41.07.00	**Module Type DW1 (DC Solenoid Valve Controlled from DDC)**		
	(a)	One (1)	Double pole 250 V DC isolating switch
	(b)	Two (2)	HRC fuses
	(c)	One (1)	Contactor with coil suitable for 240 V DC.
	(d)	One (1)	Auxiliary contactor with coil suitable for 240 V DC
	(e)	One (1)	Coupling relay
	(f)	One (1)	Diode with peak inverse voltage of 440 V.
41.08.00	**Module Type Q (Incomer to DC Lighting DB)**		
	(a)	One (1)	Double pole , 250 V DC switch isolator
	(b)	One (1)	Power Contactor
	(c)	Two (2)	Instantaneous under voltage relays (27) with a setting of 60% of 110V AC.
	(d)	One (1)	Timer having a delay of 0.5 to 3 sec. on pick-up with 2 self reset NO contacts, suitable for 240 Volts DC.
	(e)	Two (2)	Indicating lamps with resistors & coloured lenses, one each for 'On' and 'Off' indications.
	(f)	Four (4)	HRC control fuses

(g) Two (2) Neutral links

42.00.00 SELECTION TABLES

42.01.00 Feeder Module, Other than Motor Selection Table (415 V AC)

No.	Feeder Rating (Amp.)	Switch/MCCB Rating (Amp.)	Fuse Rating (Amp.)	Cable Size (sq. mm)
1.	0-16	16	16	4CX6
2.	17-32	32	32	4CX16
3.	33-45	63	63	3 1/2CX35
4.	46-63	63	63	3 1/2CX70
5.	64-125	125	125	3 1/2CX70
6.	126-160	160	160	3CX150+1-1CX150
7.	161-200	250	200	3CX240+1-1CX150
8.	201-250	250A MCCB		3-1CX300+1-1CX150
9.	251-400	400A MCCB		3-1CX630+1-1CX300
10.	401-630	630A MCCB		3-1CX630+1-1CX300
11.	631-1120 (Breaker)			7-1CX630
12.	1121-1680 (Breaker)			10-1CX630

Note i) The cables of size below 120 sq. mm shall be PVC insulated and those of size above 120 sq. mm shall be XLPE insulated

ii) All cables shall be of aluminium conductor except for 2.5 sq. mm size which shall be copper conductor.

42.02.00

Motor Module Selection table

Sl. No.	Motor rating kW	Max. Motor Amp.	Switch rating Amp.	Fuse rating Amp.	Contactor rating Amp.	Cable size Sq. mm
1.	1.1-1.5	3.5	16	6/16	16	3CX2.5
2.	1.6.3.0	7	32	20	16	3CX2.5
3.	3.1-5.5	11	32	32	16	3CX6
4.	5.6-7.0	14.4	63	50	32	3CX6
5.	7.1-13.0	27.3	63	63	32	3CX16
6.	13.1-24.0	45	125	80/100	63	3CX35
7.	24.1-37.0	70	125	125	70 (upto 30kW) 100 (above 30kW)	3CX70
8.	37.1-55.0	100	250	160	100(upto 40kW) 160 (upto 55kW)	3CX120
9.	55.1-80.0	150	250	200	200	3CX150
10.	80.1-100	180	As per selected fuse	Suitable for type-II	225	3CX150 (upto 90kW) 3CX240 (above 90kW)
12.	110.0-200.0	CIRCUIT BREAKER				3-1CX300

Note *i) The cables of size below 120 sq. mm shall be PVC insulated and those of size above 120 sq. mm shall be XLPE insulated.*

ii) All cables shall be of aluminum conductor except for 2.5 sq. mm size which shall be copper conductor.

LEGEND	DESCRIPTION	LEGEND	DESCRIPTION
52	CIRCUIT BREAKER	64R	RESTRICTED EARTH FAULT PROTECTION
42	CONTACTOR	51G	STAND BY EARTH FAULT PROTECTION
S.A.	SURGE ARRESTOR	87T	3 PHASE BIASED TRANSFORMER DIFFERENTIAL PROTECTION
	CURRENT TRANSFORMER	27M	3 PHASE UNDER VOLTAGE PROTECTION FOR MOTOR TRIPPING
	CORE BALANCE CURRENT TRANSFORMER	27U	3 PHASE BUS UNDER VOLTAGE
	VOLTAGE TRANSFORMER	27N	NO VOLT PROTECTION FOR BUS
50	TRIPLE POLE IDMTL/DMT O/C PROTECTION	50BF	CIRCUIT BREAKER FAILURE PROTECTION
51	TRIPLE POLE INSTANTENIOUS O/C PROTN.	86	LOCKOUT FUNCTION
50N	IDMTL / DMT SENSITIVE E/F PROTECTION	3I	3 PHASE CURRENT MEASUREMENT
51N	INSTANTENIOUS E/F PROTECTION	Io	NEUTRAL CURRENT MEASUREMENT
49	THREE PHASE THERMAL O/L PROTN. WITH O/L ALARM & RESTART INHIBITE FUNCTION	3U	3 PHASE VOLTAGE MEASUREMENT
50L/R	STALLING / LOCKED ROTOR PROTECTION	Uo	RESIDUAL VOLTAGE MEASUREMENT
46	THREE PHASE NEGATIVE PHASE SEQUENCE PROTECTION	P	ACTIVE POWER MEASUREMENT
66	NUMBER OF START LIMITATION/REPATETIVE START PROTECTION	Q	REACTIVE POWER MEASUREMENT
2	TIME DELAY RELAY	E	ENERGY MEASUREMENT
60	FUSE FAILURE PROTECTION	PF	POWER FACTOR MEASUREMENT
		HZ	FREQUENCY MEASUREMENT
87M	3 PHASE MOTOR DIFFERENTIAL PROTECTION	HM	HOUR RUN METER

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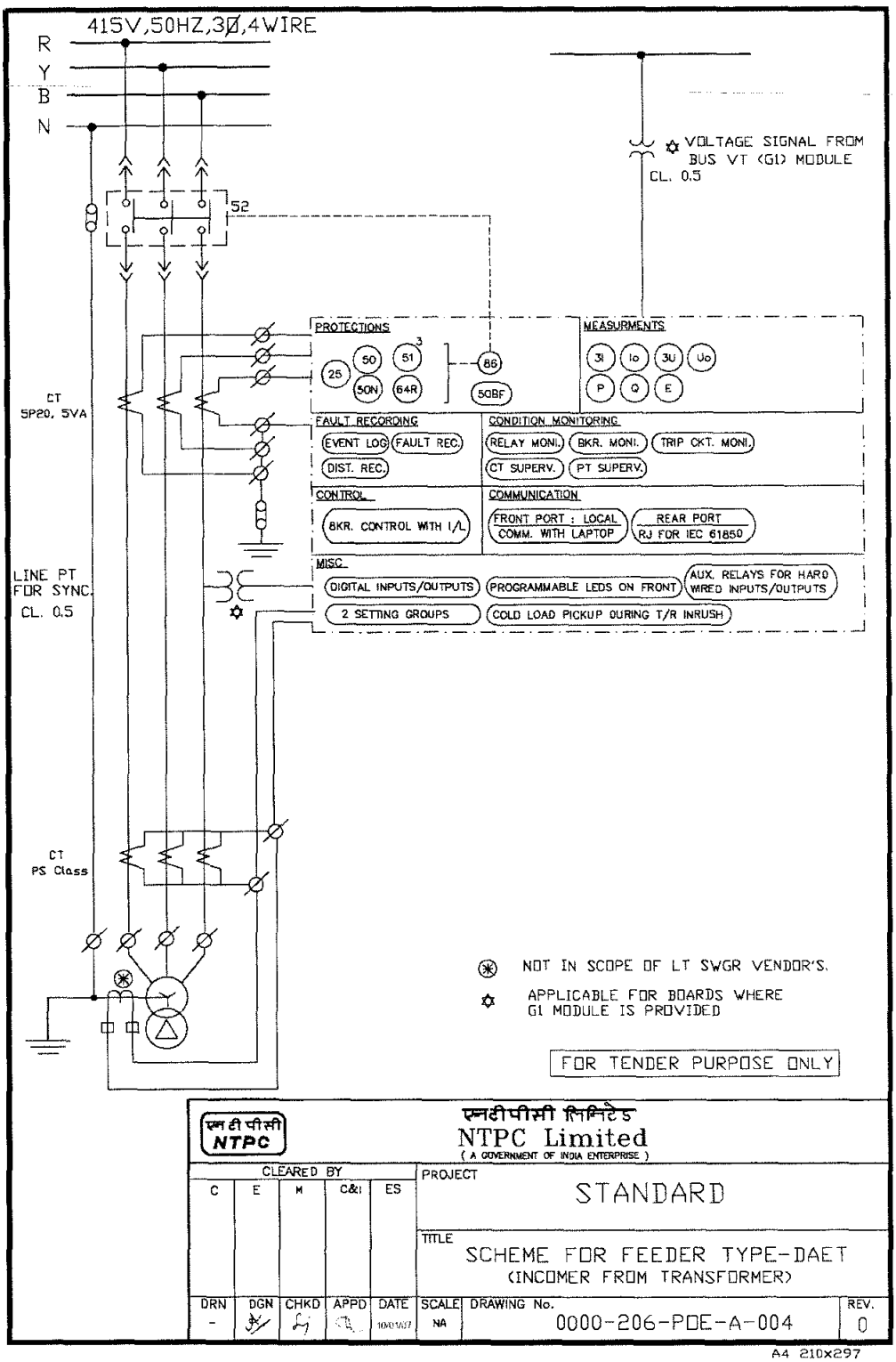
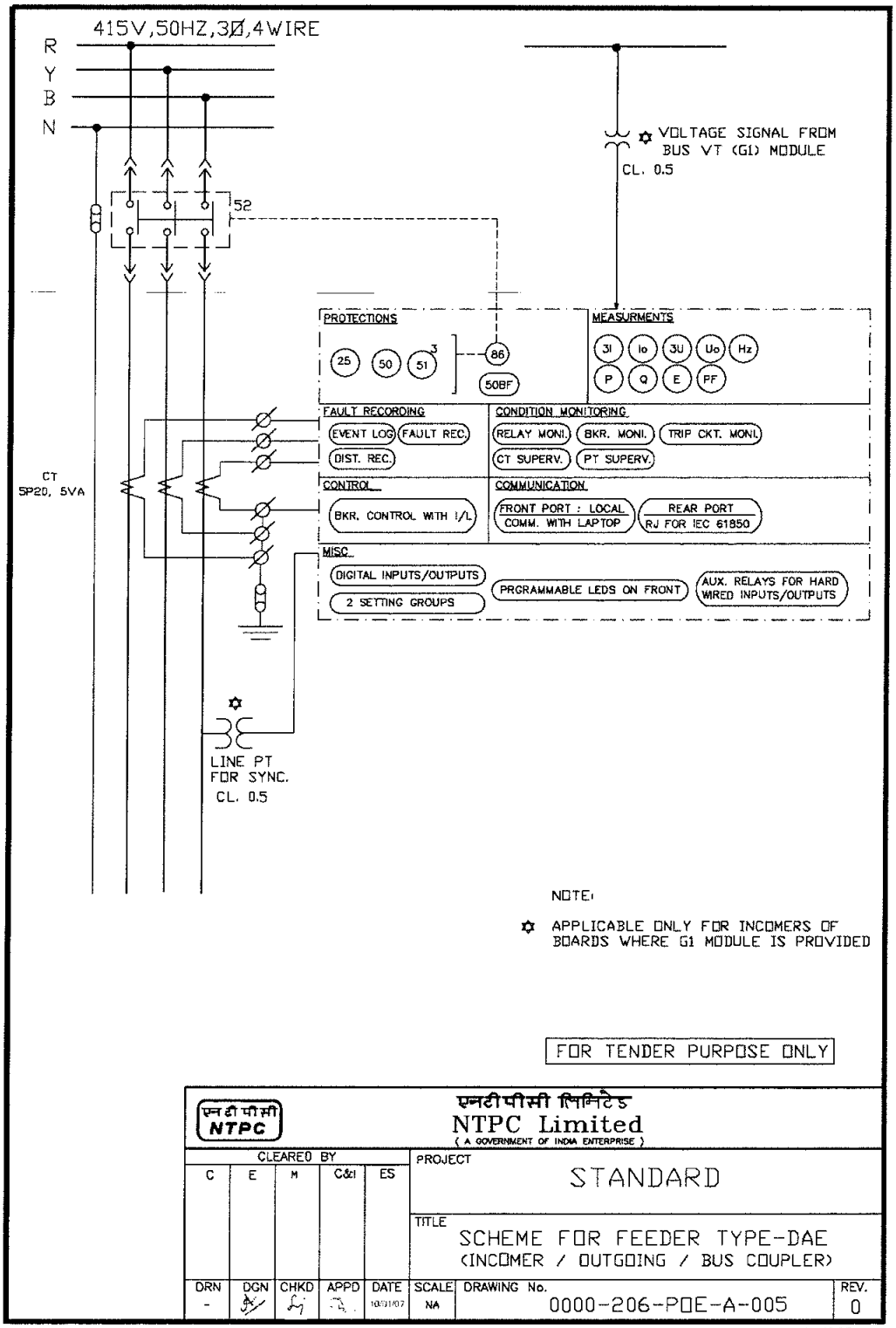
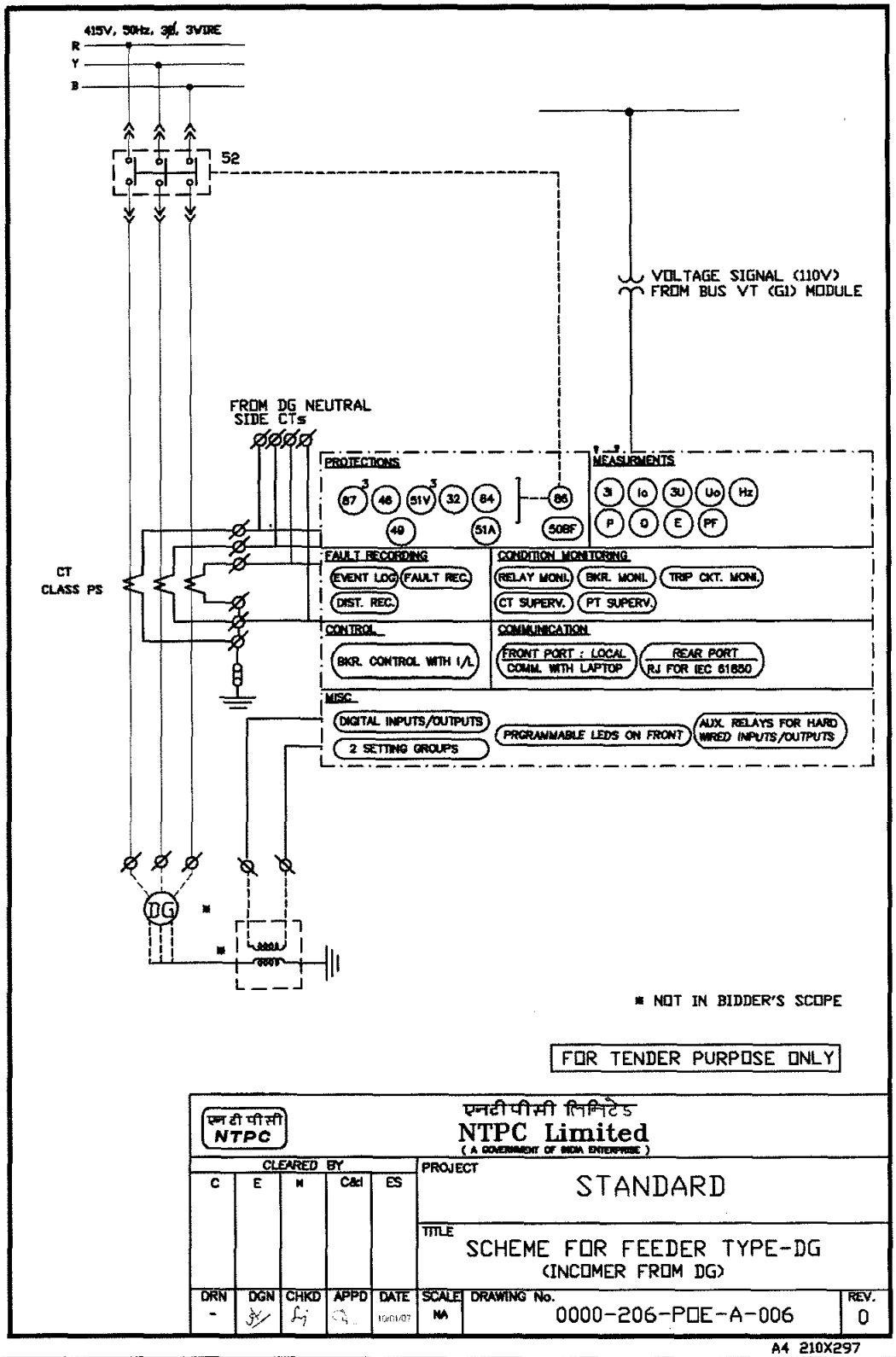
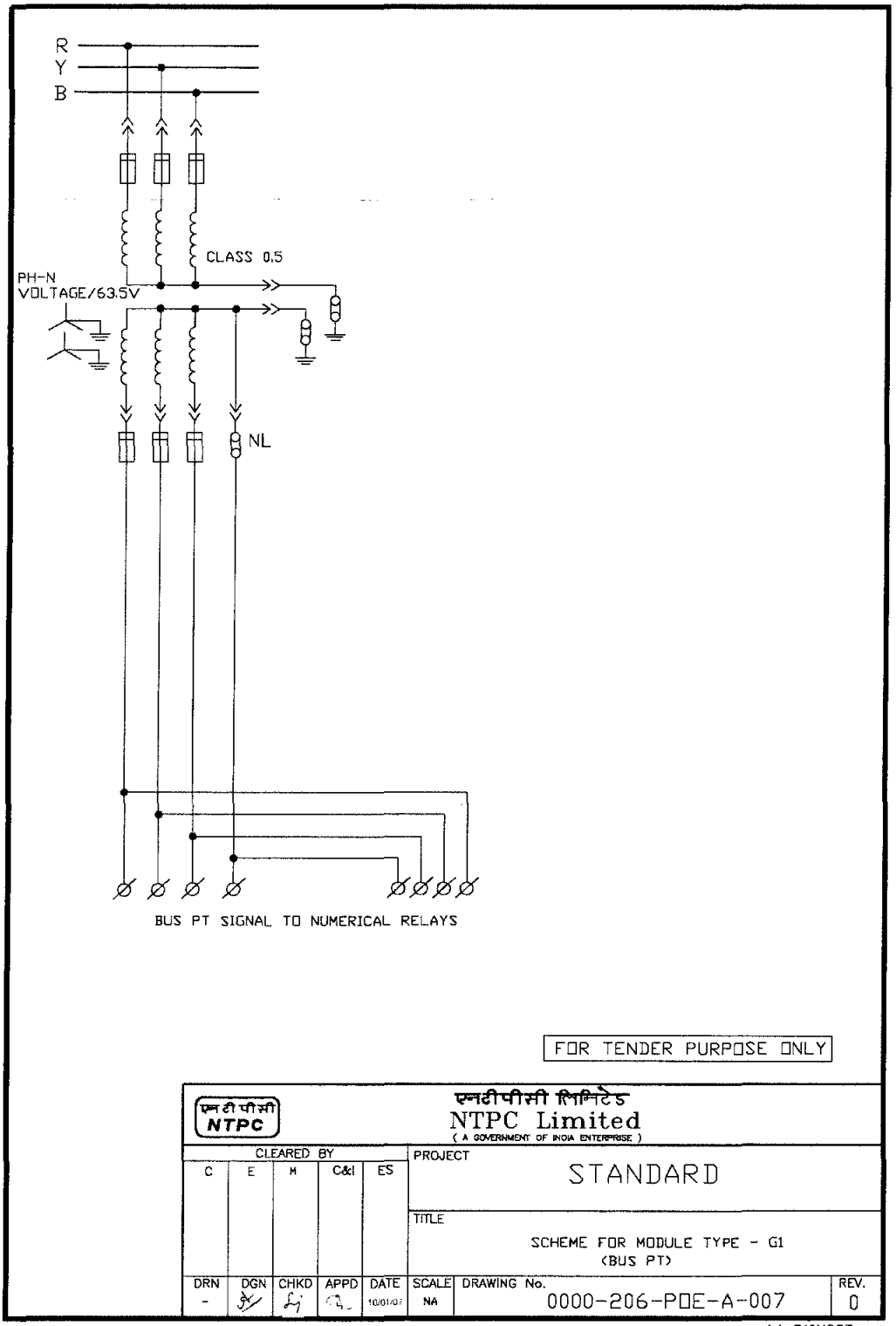
CLEARED BY					PROJECT					
C	E	M	C&I	ES	STANDARD					
					TITLE					
					LEGEND DETAILS					
DRN	DGN	CHKD	APPD	DATE	SCALE	DRAWING No.				REV.
-				19/01/07	NA	0000-206-POE-A-003				0

LEGEND.DWG A4 210X297









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C	E	M	C&I	ES	STANDARD

TITLE: SCHEME FOR MODULE TYPE - G1 (BUS PT)

DRN	DGN	CHKD	APPD	DATE	SCALE	DRAWING No.	REV.
-				10/01/07	NA	0000-206-POE-A-007	0

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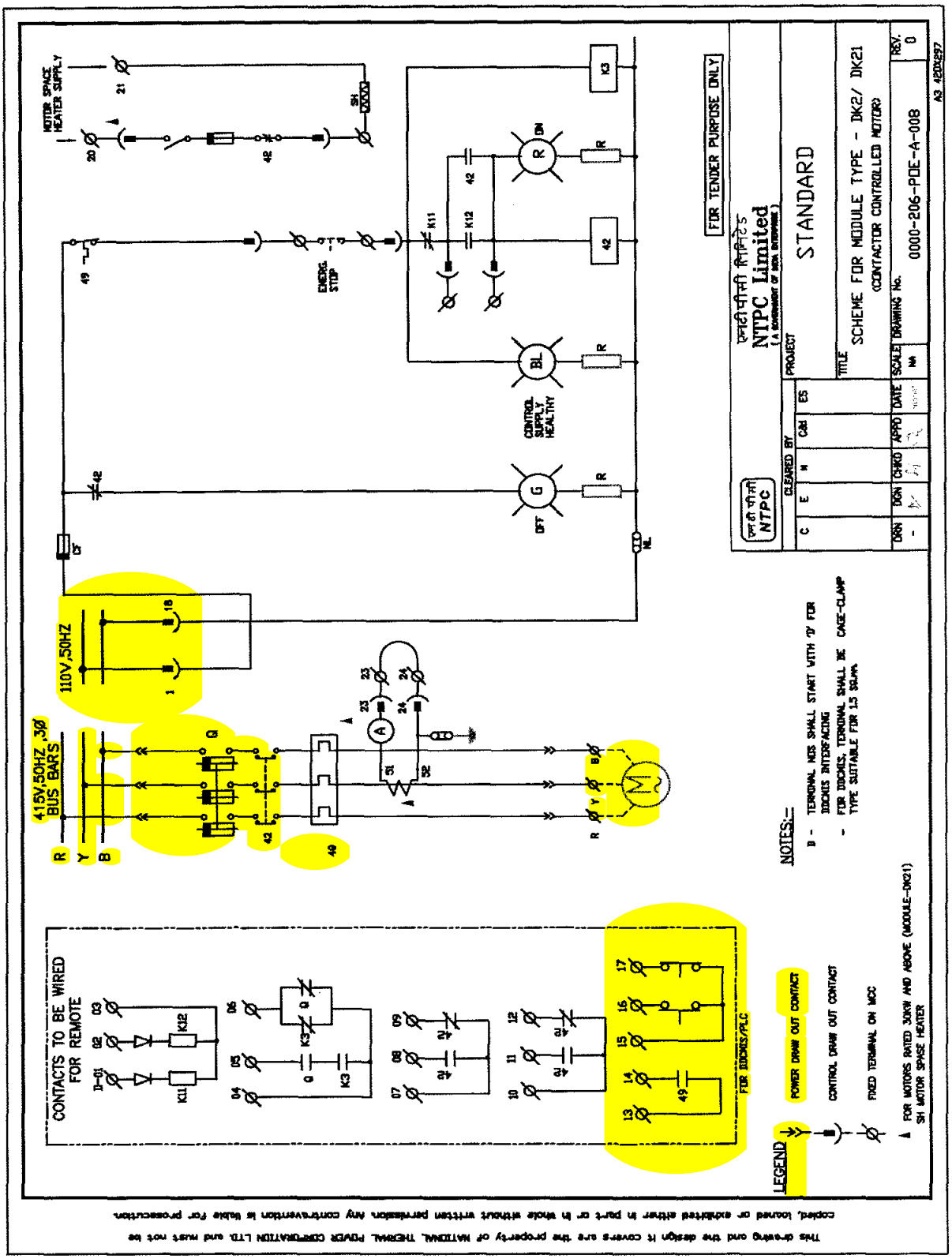

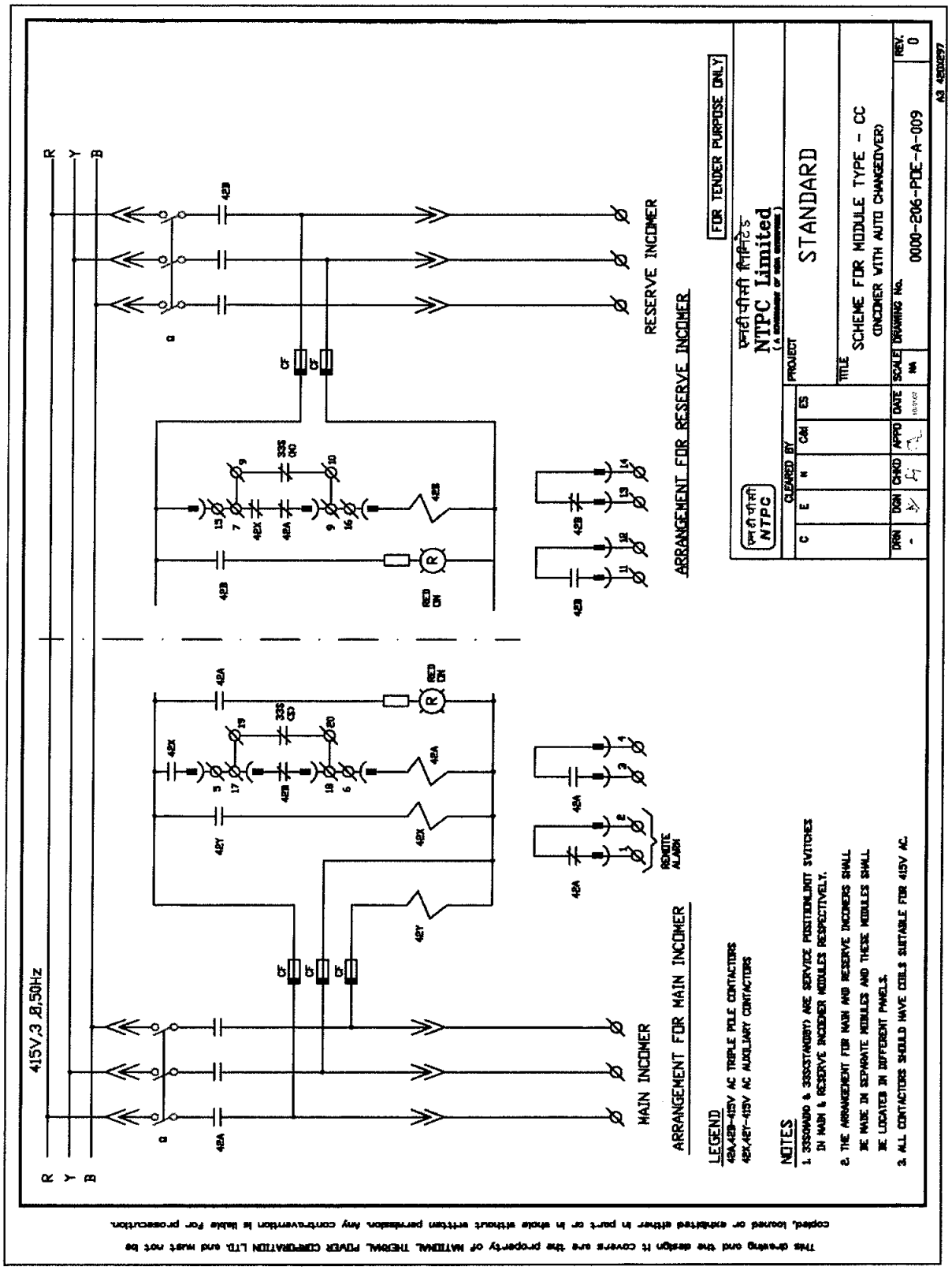

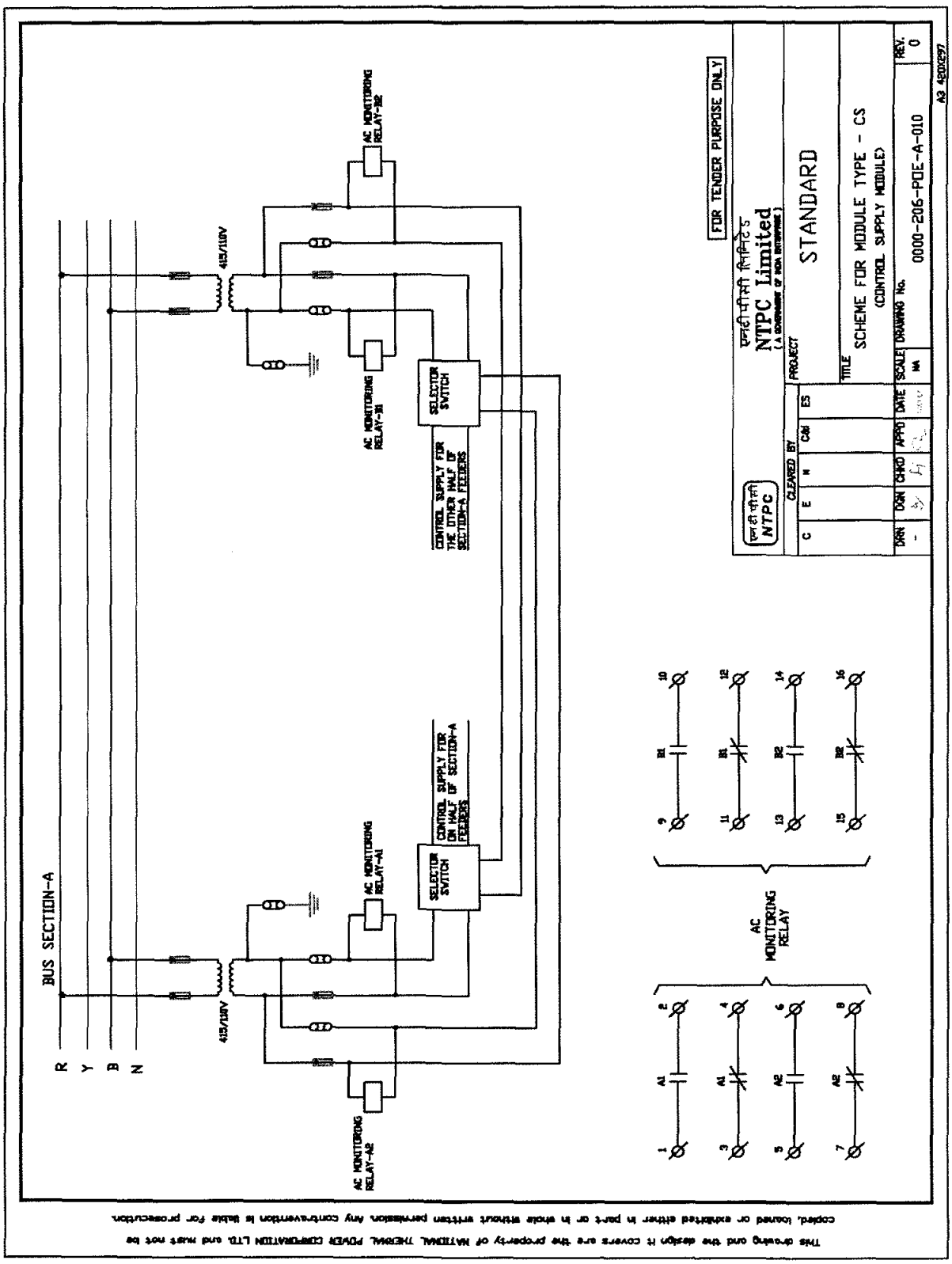

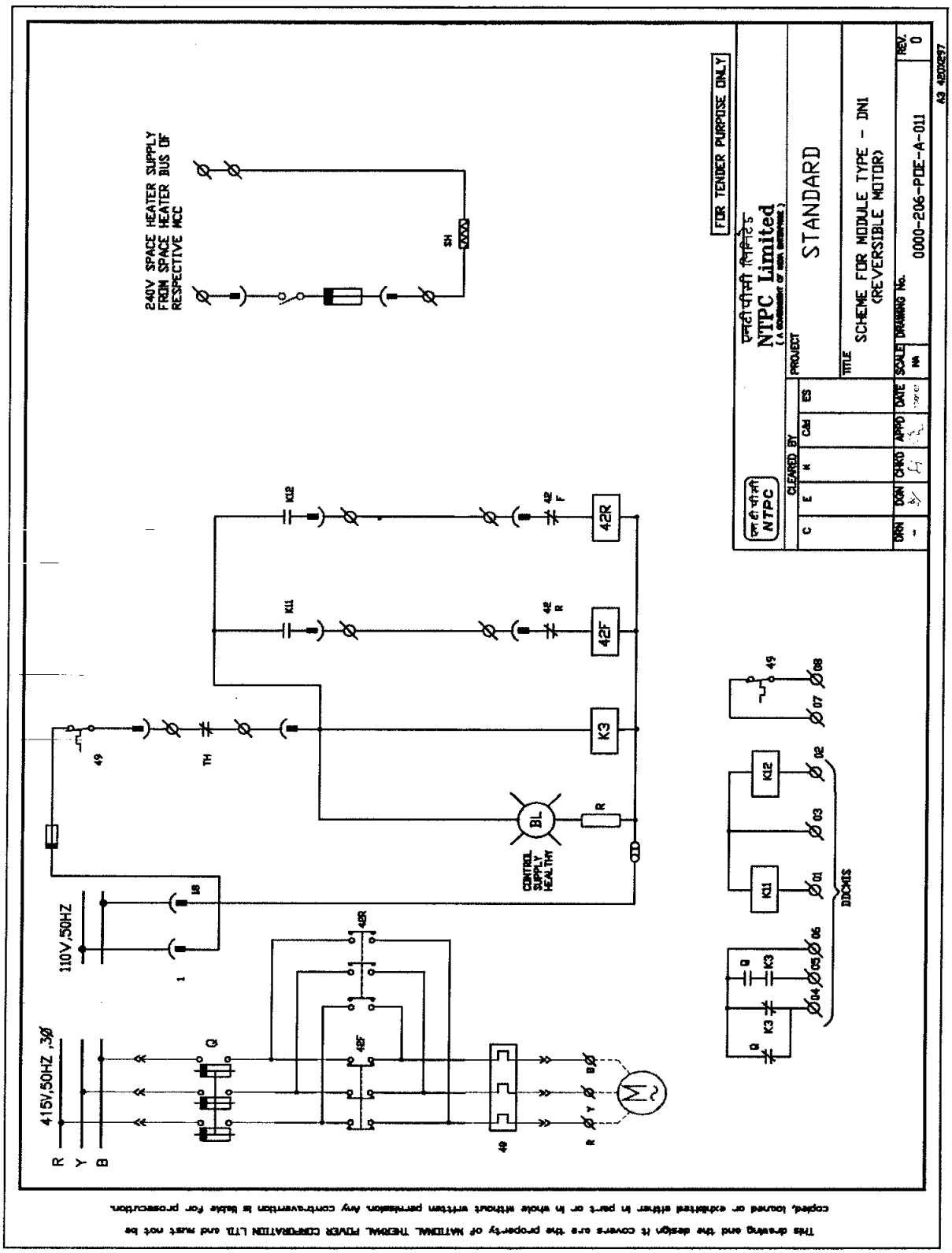
240V SPACE HEATER SUPPLY FROM SPACE HEATER BUS OF RESPECTIVE MCC
SH
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PROJECT
STANDARD
TITLE
SCHEME FOR MODULE TYPE - DN1
(REVERSIBLE MOTOR)
SCALE
NA
DRAWING No.
0000-206-PDE-A-011
REV.
0
A3 42002977
CLEARED BY
DRN
DSN
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42R
42F
K3
K12
K11
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BL
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CONTROL SUPPLY HEALTHY
110V,50HZ
415V,50HZ ,3Ø
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BIDOMIS
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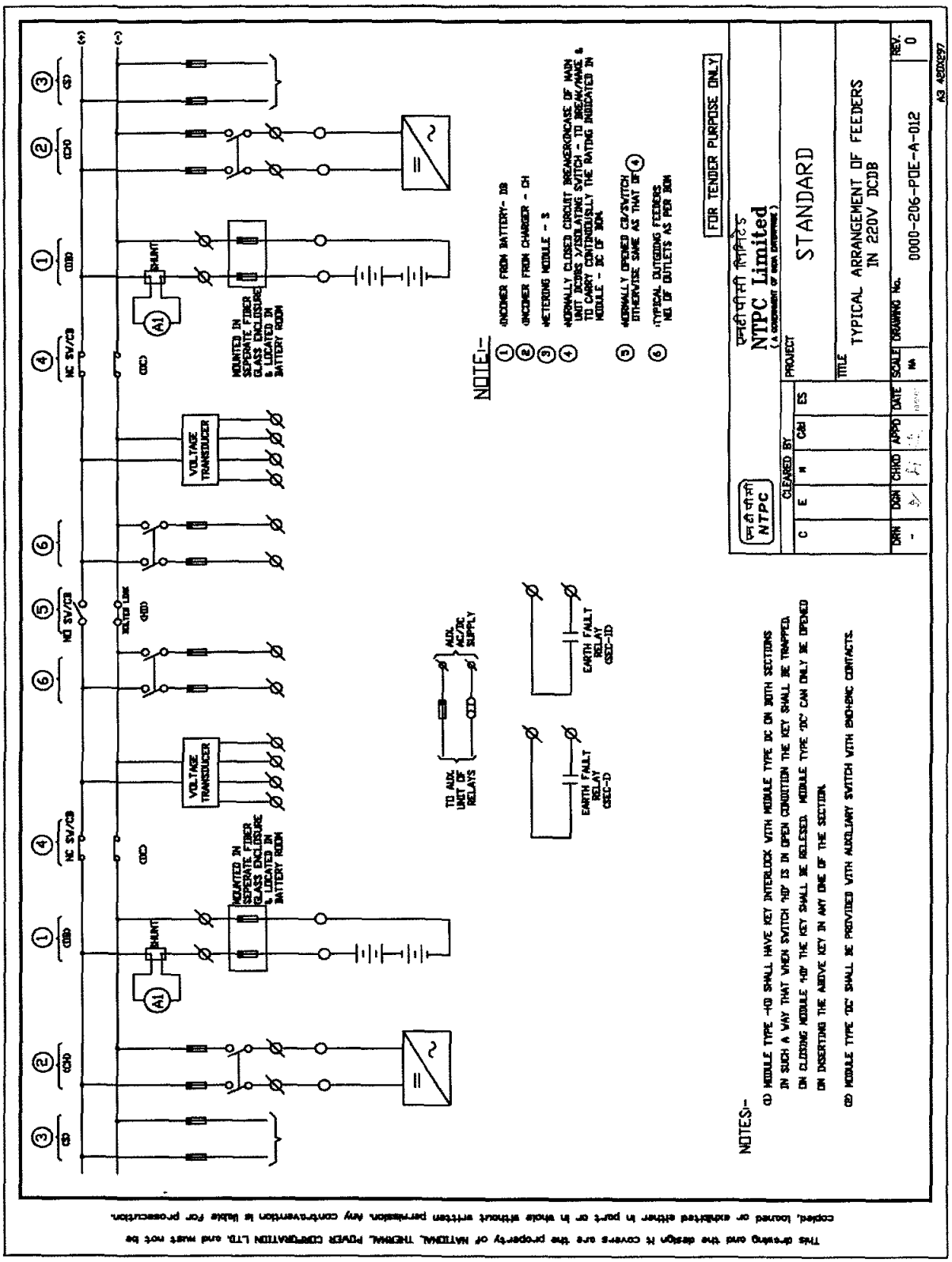
NOTE:-
1 INCOMER FROM BATTERY- DB
2 INCOMER FROM CHARGER - CH
3 METERING MODULE - S
4 NORMALLY CLOSED CIRCUIT BREAKER/CASE OF MAIN UNIT DC/DC I/SOLATING SWITCH - TO BREAK/MAKE & TO CARRY CONTINUOUSLY THE RATING INDICATED IN MODULE - DC OF 3004
5 NORMALLY OPENED CB/SWITCH OTHERWISE SAME AS THAT OF 4
6 TYPICAL OUTGOING FEEDERS NO. OF OUTLETS AS PER DOM
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NTPC Limited
PROJECT
STANDARD
TITLE
TYPICAL ARRANGEMENT OF FEEDERS IN 220V DCDB
SCALE NA
DRAWING No. 0000-206-POE-A-012
REV. 0
NOTES:-
1 MODULE TYPE -40 SHALL HAVE KEY INTERLOCK WITH MODULE TYPE DC ON BOTH SECTIONS IN SUCH A WAY THAT WHEN SWITCH "40" IS IN OPEN CONDITION THE KEY SHALL BE TRAPPED. ON CLOSING MODULE "40" THE KEY SHALL BE RELEASED. MODULE TYPE "DC" CAN ONLY BE OPENED ON INSERTING THE ABOVE KEY IN ANY ONE OF THE SECTION.
2 MODULE TYPE "DC" SHALL BE PROVIDED WITH AUXILIARY SWITCH WITH ENOHNC CONTACTS.
MOUNTED IN SEPERATE FIBER GLASS ENCLOSURE & LOCATED IN BATTERY ROOM
VOLTAGE TRANSDUCER
SHUNT
TO AUX. UNIT OF RELAYS
AUX. AC/DC SUPPLY
EARTH FAULT RELAY CBCT-1D
EARTH FAULT RELAY CBCT-2D
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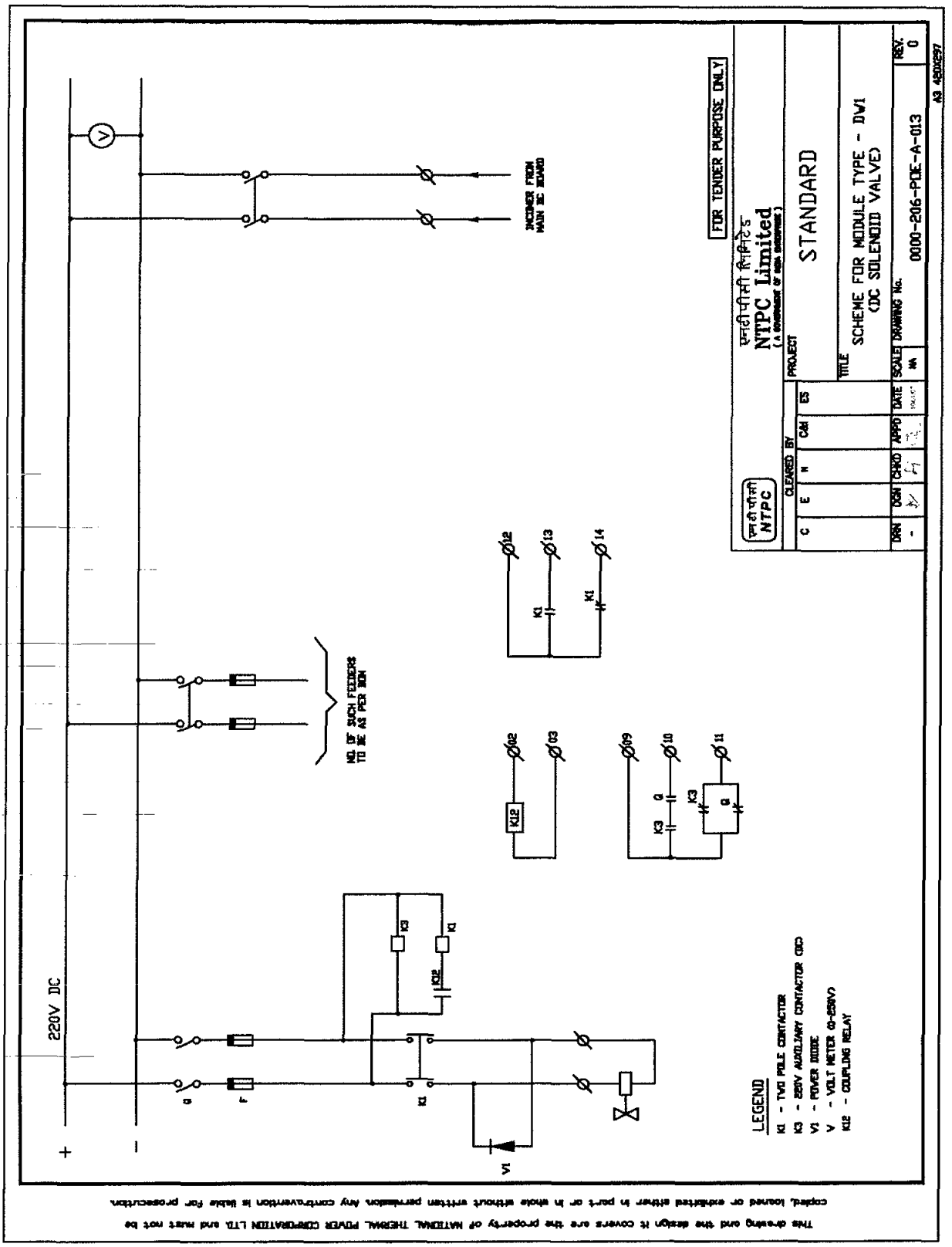

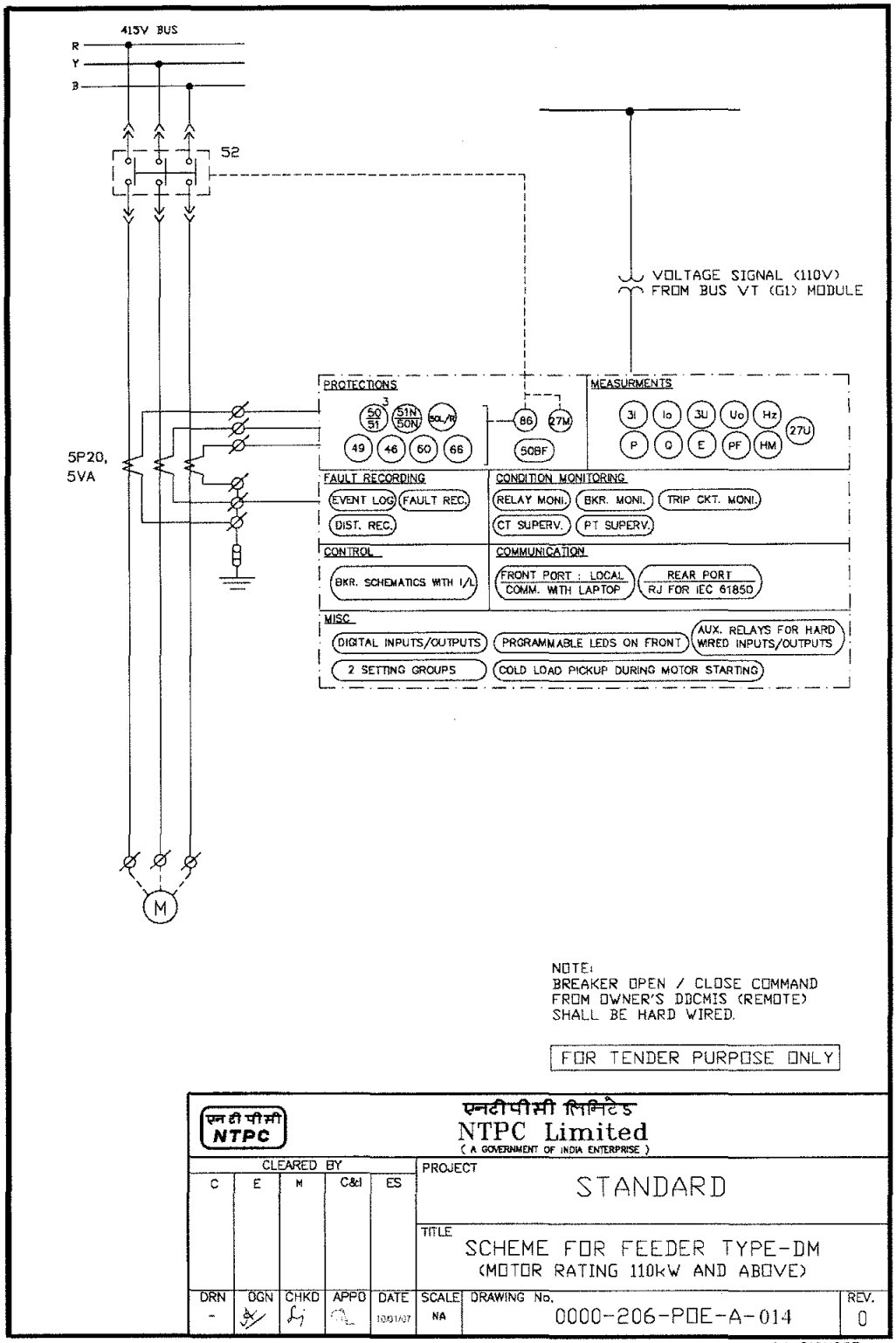

NOTE:
BREAKER OPEN / CLOSE COMMAND FROM OWNER'S DDCMIS (REMOTE) SHALL BE HARD WIRED.

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C	E	M	C&I	ES	STANDARD	
					TITLE: SCHEME FOR FEEDER TYPE-DM (MOTOR RATING 110kW AND ABOVE)	
DRN	DGN	CHKD	APPD	DATE	SCALE	DRAWING No. / REV.
-				10/01/07	NA	0000-206-PDE-A-014 / 0

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Annexure-6:

NTPC C&I Specification

MEASURING INSTRUMENTS (PRIMARY AND SECONDARY)

1.00.00 MEASURING INSTRUMENTS (PRIMARY AND SECONDARY)

1.01.00 Measuring instruments/equipment and subsystems offered by the Bidder shall be from reputed experienced manufacturers of specified type and range of equipment, whose guaranteed and trouble free operation has been proven. Refer Sub-section Basic Design Criteria. Further, all instruments shall be of proven reliability, accuracy, and repeatability requiring a minimum of maintenance. They shall comply with the acceptable international standards and shall be subject to Employer's approval. All instrumentation equipment and accessories under this specification shall be furnished as per technical specifications, ranges, and makes/numbers as approved by the Employer during detailed engineering.

1.02.00 Every panel-mounted instrument requiring power supply shall be provided with a pair of easily replaceable glass cartridge fuses of suitable rating. Every instrument shall be provided with a grounding terminal and shall be suitably connected to the panel grounding bus. Screwed type terminals can also be used for signal connection instead of plug in socket type terminals for instruments & solenoids mounted in the equipment skids or panels if it is the standard and proven design of equipment manufacturer.

1.03.00 All local gauges as well as transmitters, sensors, and switches for parameters like pressure, temperature, level, flow etc. as required for the safe and efficient operation and maintenance as well as for operator and management information (including all computation) of equipment under the scope of specification shall be provided on as required basis within the quoted lump sum price. For bidding purpose, tentative minimum instruments have been indicated on the P&IDs. However, contractor shall supply any additional local gauges /switches /transmitters / sensors for reasons mentioned above without any additional cost to the Employer.

1.04.00 The necessary root valves, impulse piping, drain cocks, gauge-zeroing cocks, valve manifolds and all the other accessories required for mounting/erection of these local instruments shall be furnished, even if not specifically asked for, on as required basis. The contacts of equipment mounted instruments, sensors,

switches etc. for external connection including spare contacts shall be wired out in flexible/rigid conduits, independently to suitably located common junction boxes. The proposal shall include the necessary cables, flexible conduits, junction boxes and accessories for the above purpose. Double root valves shall be provided for all pressure tapping where the pressure exceeds 40 Kg./sq.cm.

1.05.00 All instruments envisaged for sea water application shall be provided with wetted parts made of Monel/ Hastelloy C or any other better material (if proven ness experience of the proposed material for such applications is established by contractor)

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

2.00.00 SPECIFICATION FOR TRANSMITTERS

2.01.00 Specification for Electronic Transmitters for Press, Diff Press, DP based Flow, Level measurement.

Sr.No	Features		Essential/Minimum Requirements
1.	Type of Transmitter	:	Microprocessor based 2 wire type (loop powered), HART protocol compatible.
2.	Accuracy	:	± 0.1% of calibrated span (minimum)
3.	Output signal	:	4-20 mA DC (Analog) along with superimposed digital signal (based on HART protocol)
4.	Turn down ratio (minimum)	:	10:1 for vacuum/very low pressure applications. (i.e. pressure <= 200mmWC). 5:1 for very high pressure applications (i.e. pressure >= 200 Kg/cm2). 30:1 for other applications.
5.	Stability	:	± 0.1% of calibrated span for six months for

			Ranges up to and including 70 Kg/cm² (g). ± 0.25% of calibrated span for six months for Ranges more than 70 Kg/cm² (g).
6.	Zero and span drift	:	+/- 0.015% per deg.C at max span. +/-0.11% per deg.C at min. span.
7.	Load impedance	:	500 ohm (min.)
8.	Housing	:	Weather proof as per IP-65, metallic housing with durable corrosion resistant coating.
9.	Over Pressure	:	150% of max. Operating pressure.
10.	Electrical connection	:	Plug and socket type.
11.	Process connection	:	1/2 inch NPT (F)
12.	Span and Zero adjustment	:	Continuous, tamper proof, Remote as well as manual adjustability from instrument with zero suppression and elevation facility.
13.	Accessories	:	-Diaphragm seal, pulsation dampeners, syphon etc. as required by service and operating condition. -2 valve manifold for absolute & Gauge pressure transmitters, 3-valve manifold for vacuum pressure transmitters & where DP transmitters are being used for pressure measurement and 5 valve manifolds for DP/Level/Flow application. -For hazardous area, explosions proof enclosure as described in NEC article 500.

14.	Diagnostics & Display	:	Self-Indicating feature and digital display on transmitter.
15.	Power supply	:	24V DC ± 10%.
16.	Adjustment/calibration/ maintenance	:	Using hand held HART calibrators

Notes

1) LVDT type is not acceptable.

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

2.02.00 Specification for ULTRASONIC TYPE LEVEL TRANSMITTER

S.No.	Features	Essential/Minimum requirement
1.	Type of Transmitter	Non-contact Microprocessor based 2 wire (loop powered) type, HART protocol compatible Ultrasonic transmitter.
2.	Output signal	4-20 mA DC (Analog) along with superimposed digital signal (based on HART protocol)
3.	Accuracy	+/- 0.5% of calibrated span or minimum 5mm.
4.	Power supply	24 V DC +/-10%.
5.	Temperature compensation	To be provided within transducer.

6.	Housing	Weather proof as per IP-65, metallic housing with durable corrosion resistance coating.
7.	Adjustment/calibration/ maintenance	Using hand held HART calibrator
8.	Zero and Span adjustment	Continuous, tamper proof, remote as well as manual adjustability from instrument. It should be possible to calibrate the instrument without any level in the tank/sump etc..
9.	Sensor Material	Corrosion resistant material to suit individual application requirement.
10.	False signal tolerance	Transmitter shall e capable of ignoring false echoes from internal tank/sumps obstructions such as pipes, heating coils or agitator blades. Also transmitter shall have adjustable damping circuitry.
11.	Range	Range of transmitter shall be capable of covering the complete level span of tank taking care of blocking distance, frequency attenuation due to surface, obstructions, vapors etc.
12.	Display	Integral digital display
13.	Diagnostics	Loss of echo alarm etc.
14.	Load Impedance	500 ohms minimum
15.	Electrical Connection	Plug and socket

16.	Accessories	• All weather canopy for protection from direct sunlight and direct rain. • All mounting accessories required for erection and commissioning shall be provided. • For hazardous area, explosion proof enclosure as described in NEC article 500

Note:

1) Contractor can also provide Radar type transmitter in place of ultrasonic transmitters subject to approval by Employer during detailed Engineer. Sonic frequency based transmitters can also be provided under "ultrasonic transmitters" category for solid applications e.g. ash silo level etc.

2) The frequency used for Ultrasonic /sonic measurements shall be suitable for envisaged applications and this shall be supported by the standard product catalogue of the instrument manufacturer.

3) Four wire type transmitters can also be provided for applications where 2-wire transmitter has some technical limitations, subject to employer's approval during detailed engineering stage. However, in such cases isolated 4-20 mA DC (analog) output shall be provided. Power supply required for such transmitters shall be 240V AC / 24V DC.

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

2.03.00 **NOT USED**

2.04.00 **Specification for TEMP ELEMENTS**

2.04.01 **Specification for Resistance Temperature Detector (RTD)**

Sr. No.	Features		Essential/Minimum Requirements
1	Type of RTD.	:	Pt-100 (100 Ohms resistance at zero degree Centigrade), four wire.
2	No. of element	:	Duplex
3	Housing/Head	:	IP-65/ Diecast Aluminum. Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter (as applicable). Plug in connector for external signal cable connection shall be provided. Headless type of TE can be provided for special applications where equipment design limitations restrict the head type arrangement.
4	Insulation and sheathing of RTD	:	Mineral insulation (magnesium oxide) and SS316 sheath, ceramic packed.
5	Calibration and accuracy	:	As per IEC-751/ DIN-43760 Class-A for RTD
6	Characteristic	:	Linear with respect to temp, within ±1/2 of top range value
7	Accessories	:	Thermo well (as specified below) and shall be spring loaded for positive contacts with the well.
8	Standard	:	IEC-751/ DIN-43760 for RTD and ASME PTC-19.3 for thermo well.

NOTES :

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

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

2.04.02 Specification for Thermocouples

Sr.No	Features		Essential/Minimum Requirements
1	Type of Thermocouple.	:	16 AWG wire of Chromel-Alumel (Type K) or 24 AWG wire Pt-Rhodium Pt (Type R) depending on operating temperature Range (ungrounded type).
2	No. of element	:	Duplex
3	Housing/Head	:	IP-65/Diecast Aluminium. Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter (as applicable). Plug in connectors are to be provided for external signal cable connection. Headless type of TE can be provided for special applications where equipment design limitations restrict the head type arrangement.
4	Insulation and Sheathing of Thermocouple	:	Swaged type mineral insulation (magnesium oxide) and SS316 sheath.
5	Calibration and accuracy	:	As per IEC-584 /ANSI-C-96.1 (special class) for T/C.
6	Characteristic	:	Linear with respect to temp, within ±1/2

percent of top range value.

7	Accessories	:	Thermo well (as specified below) and shall be spring loaded for positive contacts with the well.
8	Standard	:	ANSI C 96.1 for Thermocouple and ASME PTC-19.3 for Thermo-well.

Notes :

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

2.04.03 **Specification for Thermo well**

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

3.00.00 **Hand held calibrator**

The hand held type calibrator shall be provided for adjustment/calibration/maintenance of the HART compatible transmitters. The hand held calibrator shall be suitable for all types of transmitters supplied in the package. If one type of hand held type calibrator is not suitable for communicating with all types of transmitters then separate hand held calibrator will be provided for that specific type of transmitter.

4.00.00 **Specification for Press Gauge, DP Gauge, Temp Gauge, Level Gauge**

	FEATURES	ESSENTIAL/ MINIMUM REQUIREMENTS

		Pr. Gauge/ DP Gauge/ Draught gauges	Temperature Gauge	Level Gauge
1	Sensing Element	Bourdon for high pressure measurement, Diaphragm/ Bellow for low press measurement.	Mercury in steel / inert gas actuated.	Tempered * toughened Borosilicate gauge glass , steel armoured reflex or transparent type.
2	Body material	Die-cast aluminum.	Die-cast aluminum.	Forged carbon steel/ 304 SS.
3	Dial size	150 mm.	150 mm	Tubular covering Process connection± 2%
4	End connection.	1/2 inch NPT (F) as per ASME PTC.	1/2 inch or 3/4 inch NPT (M).	Process connection as per ASME PTC and drain/vent 15 NB.
5	Accuracy	±1% of span	± 1% of span	± 2%
6	Scale	Linear, 270° arc graduated in metric units.	Linear, 270° arc graduated in °C.	Linear vertical
7	Range selection	Shall cover 125% of max operating press.	Shall cover 125% of max operating temp.	Shall cover max process level.
8	Over range test	125% of FSD.	125% of FSD.	
9	Housing	Weather and dust proof as per IP-55.	Weather and dust proof as per IP-	CS/ 304 SS leak proof.

			55.	
10	Zero/span adjustment	Provided	Provided	—
11	Identification	Suitable metal service tag shall be provided.		
12	Accessories	Blow out disc, siphon, snubber, pulsation dampener, chemical seal(if required by process) gauge isolation valve.	SS Thermo well	Gasket for all KEL-F shields for transparent type. Vent and drain valves of Steel/ SS as per CS/ Alloy process Requirement. For acid / alkali applications material of drain and vent valves shall be as suitable for these mediums.
13	Material of sensor/ movement	316 SS / 304 SS	316 SS / 304 SS	

Notes:-

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

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

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

3) Pressure/ Diff pressure gauges for very low press/ DP measurements can have sensor material other than SS316 e.g. silicon etc., if the offered material is suitable for that application and the offered product is standard product of the manufacture for very low pressure applications.

4) The specifications for gauges which are integral part of motor bearings can be as per their manufacturer standards.

5.00.00 ROTAMETER

Sr. No.	Features	Essential / minimum requirements
1.	Type	Variable area metal tube type.
2.	Fluid media	Water/oil
3.	Tube body	SS 316
4.	Material of float	316 SS
5.	Indicator	Linear scale.
6.	Accessories	Flange, orifice in case of bypass Rota meter (for line size above ~~50~~ 100 mm).
7.	Housing protection class	IP-55
8.	Accuracy	+/- 2% of full range

6.00.00 PROCESS ACTUATED SWITCHES

FEATURES	ESSENTIAL / MINIMUM REQUIREMENTS		
	Pressure/ Draft Switches/ DP Switches	Temperature switches	Level switches

Sensing Element	Piston actuated for high pressure and diaphragm or bellows for low press/ vacuum	Vapor pressure sensing type, Liquid filled bellow type with SS bulb and capillary (5 mtr minimum)	Capacitance types, Float type, Conductivity type, RF type, Ultrasonic type as per suitability to the application.
Material	316 SS	Bulb 316 SS/ capillary 304 SS	316 SS
End connection	½ inch NPT (F)	½ inch NPT (F)	Manufacturer standard
Over range proof pressure	150% of Design press.	-	150% of design press.
Repeatability	+/-0.5% of full range	+/-0.5% of full range.	+/-0.5% of full range.
No. of contacts	2 No+2NC SPDT snap action dry contact		
Rating of contacts	60 V DC, 6 VA (or more if required by DDCMIS or PLC)		
Elect. Connection	Plug in socket		
Set point adjustment	Provided over full range.		
Dead band/ differential	Adjustable/ fixed as per requirement of application.		
Enclosure	Weather and dust proof as per IP-55		

Accessories	Syphon, snubber, chemical seal, pulsation dampeners as required by process	Thermo well of 316 SS and other required accessories.	All mounting accessories
Mounting	Suitable for enclosure/ rack mounting or direct mounting	Suitable for rack mounting or direct mounting	-

Notes :

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

2) Pressure/ Diff pressure switches for very low press/ DP measurements can have sensor material other than SS316 e.g. silicon etc., if the offered material is suitable for that application and the offered product is standard product of the manufacture for very low pressure applications.

3) Repeatability can be upto +/-1% of full range in case of switches with diaphragm seals or very low pressure/DP range.

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

7.00.00 **DEW POINT METER:-**

Sensor

Type : Capacitance type with change in output proportional to moisture present.

Service	:	Dry Air
Range	:	-50 to 0 Degree Centigrade Dew-point.
Sensor Accuracy	:	Better than +/_0.5 %
Operating Temperature	:	0 to 50 degree C.
Operating Pressure	:	0- 10 Kg/ Cm2, suitable for process application.
Analyser		
Input	:	Change in capacitance from dew point sensor.
Display	:	Combined enclosure with two three-digit seven segments LED display with decimal point after two digits. LED height shall be 4 inches, clearly legible from a distance of at least 10 meters.
Range	:	-50 to 0 Degree Centigrade Dew-point.
Display Accuracy		Better than +/- 2 Degree C.
Mounting	:	Table top/ Flush mounting, to be finalised during detailed engineering.
Power supply	:	240 V AC, 50 Hz to be arranged by the contractor.
Output	:	4-20 mA DC capable of driving a load impedance of 500 ohms minimum.

4-20 mA DC Output signal is to be connected to control system.

In case the system is not suitable for Direct online mounting, then all the required sampling system is to be provided by the contractor.

All required accessories including cables, sensor holder, desiccant chambers, mounting fixtures etc. are to be supplied by the Contractor within his quoted lump sum price.

Dew point meter to be provided with compressor can have some differences in specification w.r.t above mentioned specification. This will be acceptable if it is as per standard practice/accessory of compressor supplier.

8.00.00 **NOT USED**

9.00.00 **Specification for Limit Switches of pneumatic actuators / manual valves**

Limit switches shall be silver plated with high conductivity and non corrosive type. Contact ratings shall be sufficient to meet the requirement of control system subject to a minimum 60V DC, 6VA rating. Protection class shall be IP-55.

9.00.00 **OPACITY MONITORS AT ESP OUTLET**

9.01.00 Each of the ESP gas streams shall be provided with one opacity monitor, installed on the ducting between ESP and the common duct at ID fan inlets. Sufficient straight duct length as recommended by the opacity monitor manufacturer shall be provided by the Bidder upstream of the proposed point of location to ensure laminar flow of the flue gas. Approach & Platform shall be provided for maintenance of each opacity monitor.

9.02.00 The flue gas opacity monitors at ESP outlet shall meet the following specifications:

i) The instrument shall be In-situ dry type visible light (through LED) based on transmission and absorption principle.

ii) Separate isolated 4-20 mA DC signals shall be provided for indication in ESP control room and in Employer's DDCMIS. Dust emission in terms of mg/Nm^3 shall be monitored. The system shall include all devices, software necessary for computing dust emission in mg/Nm^3.

iii) Compliance to standards: USEPA/ TUV/ MCERTS or equivalent standard.

iv) The instrument shall automatically and continuously correct the measurement of variations in temperature, line voltage, ambient illumination, lamp ageing, detector drift and associated shift in component characteristics.

v) Purging system to be provided with heavy duty blowers and shutter mechanism for automatic isolation of lens and reflector during purge air failure.

vi) The instrument shall be provided with automatic zero and span calibration capability with manual over-ride facility. The automatic calibration interval shall be selectable from the remote control unit.

vii) Alignment indicator shall be provided in transceivers to permit visual observation of system alignment.

viii) The opacity monitor shall be designed to operate with flue gas temperature between 100-200°C continuously. The temperature may exceed this value for a short time following failure of air heaters. The equipment shall not be damaged during such excursion.

ix) The vendor shall, after installation at site, establish the correlations between the optical density output and particulate grain loading for display and recording of particulate grain loading.

(x) Specification requirements:-

(a)	Accuracy	2% of FS or better
(b)	Linearity	+/-1% of FS
(c)	Repeatability	<=1% of span
(d)	Span drift	<=1% measured value/ week
(e)	Zero drift	<=1% span/week

(f)	Range	0 - 200 mg/Nm³ (programmable)
(g)	Response time (upto 90% of FS)	<=5 sec
(h)	Zero & span adjustment	To be provided with range selection facility.
(i)	Ambient temp	50 Deg C
(j)	Enclosure type/ material	Weather and dust proof as per IP-55 / Die cast aluminum or SS
(k)	Power Supply (nominal)	240V AC
(l)	Indication	Digital alphanumeric display. Display of reading in engineering units shall be provided. Remote control unit shall display reading in mg/Nm3 as well as diagnostics and alarms.
(m)	Type of Electronics	Microprocessor based with self-diagnostic feature. Status indication of in-situ equipment such as lamp, air

		filters, shutters, optical surfaces (windows and reflectors) and over range operation etc. shall be provided in remote control unit.
	(m) Mean interval between maintenance cleaning	Not less than 90 days
	(n) Auto calibration interval	1 to 24 hours (remote selectable)
9.03.00	The bidder shall furnish his suggested installation details along with the proposal. These shall be subject to Employer's approval during detailed engineering stage. All accessories/ fittings/ tubing/ cables, etc. as required for installation of instrument shall be provided by the Contractor.	
9.04.00	The bidder shall clearly bring out in his offer the frequency of cleaning/maintenance of the lenses and other components of the opacity monitors to ensure its trouble free, reliable continuous operation.	

SUB-SECTION-III-C&I-02

PROCESS CONNECTION & PIPING

PROCESS CONNECTION AND PIPING

1.00.00 **PROCESS CONNECTION PIPING**

1.01.00 The Contractor shall provide, install and test all required material for completeness of Impulse Piping System and Air Piping System as per the requirements of this Sub-section on as required basis for the connection of instruments and control equipment to the process and make the system complete. The Contractor shall furnish during detailed engg. all relevant drawings, material and tech. specifications of various items service wise for Employer's approval.

1.01.01 All materials supplied under this Sub-section shall be suitable for intended service, process, operating conditions and type of instruments used and shall fully conform to the requirements of this specification. The material offered by the Bidder shall be from reputed, experienced manufacturer whose guaranteed and trouble free operation has been proven at least for two years in not less than two pulverized coal fired utility stations.

1.02.00 **IMPULSE PIPING, TUBING, FITTINGS, VALVES AND VALVE MANIFOLDS**

1.02.01 All impulse pipe shall be of seamless type conforming to ANSI B36.10 for schedule numbers, sizes and dimensions etc. The material of the impulse pipe shall be same as that of main process pipe. For impulse pipe, fittings etc., exposed to sea environment durable epoxy coating with poly urethane finish shall be provided.

1.02.02 All fittings shall be forged steel and shall conform to ANSI B16.11. . The material of forged tube fittings for shaped application (e.g. Tee, elbow etc.) shall be ASTMA 182 Gr. 316 H for high pressure/ temperature applications (as defined above) and ASTMA 182 Gr. 316L for other applications. The material for bar stock tube fitting (for straight application) shall be 316 SS. Metal thickness in the fittings shall be adequate to provide actual bursting strength equal to or greater than those of the impulse pipe or SS tube, with which they are to be used.

1.02.03 The source shut-off (primary process root valve) and blow down valve shall be of 1/2 inch size globe valve type for all applications except for air and flue gas service wherein no source shut-off valves are to be provided. The disc and seat ring materials of carbon steel and alloy steel valves be ASTM A-105 and ASTM A-182,

	Gr. F22, hard faced with stellite (minimum hardness - 350 BHN.) The surface finish of 16 RMS or greater is required in the area of stem packing. The valve design shall be such that the seats can be reconditioned and stem and disc may be replaced without removing the valve body from the line.
1.02.04	The valve manifolds shall be of 316 stainless steel with pressure rating suitable for intended application. 2 valve manifold and 3-valve manifold shall be used for pressure measurements using pressure transmitters/ pressure switches and diff. pressure transmitter/ switches respectively. 5-valve manifold shall be used for remaining applications like DP, flow and level measurements.
1.02.05	For Pr./D.P gauges in fluid application two-way globe valve on each impulse line to the instrument and in A/F application two-way gate valve on each impulse line to the instrument shall be provided near the instrument. These shall be in addition to the three ways gauge cock provided along with the pr./D.P gauges.
2.00.00	**AIR SUPPLY PIPING**
2.01.00	All pneumatic piping, fittings, valves, air filter cum regulator and other accessories required for instrument air for the various pneumatic devices/ instruments shall be provided.
2.01.01	This will include as a minimum air supply to pneumatically operated control valves, actuators, instruments, continuous and intermittent purging requirements of etc.
2.02.00	For individual supply line and control signal line to control valve, 1/4-inch size light drawn tempered copper tubing conforming to ASTM B75 shall be used. The thickness of cu-tubing shall not be less than 0.065 inch and shall be PVC coated. The fittings to be used with copper tubes shall be of cast brass, screwed type.
2.03.00	All other air supply lines of 1/2 inch to 2 inch shall be of mild steel hot dipped galvanized inside and outside as per IS-1239, heavy duty with threaded ends. The threads shall be as per ASA B.2.1. Fittings material shall be of forged carbon steel A234 Gr. WPB galvanized inside and outside, screwed as per ASA B2.1. Dimensions of fittings shall be as per ASA B16.11 of rating 3000 lbs.
2.04.00	Instrument air filters cum regulator set with mounting accessories shall be provided for instrument air headers/each location. The filter regulators shall be suitable for 10-

	kg/ sq.cm max. Inlet pressure. The filter shall be of size 5 microns and of material sintered bronze. The air set shall have 2-inch size pressure gauge and built in filter housing blow down valve. The end connection shall be as per the requirement to be finalised during detailed engineering.
2.05.00	All the isolation valves in the air supply line shall be gate valves as per ASTM B62 inside screw rising stem, screwed female ends as per ASA B2.1. Valve bonnet shall be union type & trim material shall be stainless steel, body rating 150 pounds ASA. The valve sizes shall be ½ inch to 2 inch.
3.00.00	**INSTALLATION AND ROUTING**
3.01.00	**Instrument Piping System**
3.01.01	For steam and liquid measurements, the impulse pipe should preferably slope downward from source connection to instrument and instrument shall be installed below the source point. If due to any reason instrument is installed above the source point, the impulse pipe should slope upwards continuously and a 'pigtail' should be provided at the instrument to assure water seal for temperature protection. For vacuum measurements instrument shall be installed above source point and impulse pipe should slope upwards.
3.01.02	Impulse piping for air and flue gas shall slope upwards and instrument shall be installed above source point. If this requirement cannot be met special venting or drain provision shall be provided with vent & drain lines along with isolation valves and other accessories including drainpipes. This drain is to be connected to plant drain through open funnel also.
3.01.03	All impulse piping shall be installed to permit free movement due to thermal expansion. Wherever required expansion loops shall be provided.
3.01.04	Special accessories such as condensing pots/ reservoirs shall be provided and installed wherever required. In any case condensing pots shall be provided for all level measurements in steam and water services, all flow measurement in steam services and flow measurements water services above 120 Deg. C.

3.01.05	Colour coding of all impulse pipes shall be done by the bidder in line with the colour coding being followed for the parent pipes.
3.02.00	**Instrument Air & Service Air Piping/ Tubing System**
3.02.01	Instrument air & service air headers and their branches with all associated fittings & accessories shall be provided for giving supply to all consumers, as per the requirements. Air piping shall be installed always with a slope of over 1/20 to prevent accumulation of water within the pipe.
3.02.02	Single and multi tubes shall run with the minimum number of changes in direction. Suitable identification tags shall be provided for easy checkup and for connections.
4.00.00	**PIPING/TUBING SUPPORT**
4.01.00	Impulse piping and sample piping shall be supported at an interval not exceeding 1.5 meters. Each pipe shall be supported individually using slotted angle mounted clamps with necessary fixtures. Tubing shall run in proper perforated trays with proper cover. Tubing shall be supported inside the trays by aluminium supports. Hangers and other fixtures required for support of piping and trays shall be provided, either by welding or by bolting on walls, ceilings and structures. Hanger clamps and other fastening hardware shall be of corrosion resistant metals and hot-dip galvanized.
5.00.00	**SHOP AND SITE TESTS**
5.01.00	**General Requirements**
5.01.01	The equipment and work performed as per this Sub-section shall be subject to shop and site test as per requirements of Sub-section-E (Quality Assurance & Inspection) other applicable clauses of this Sub-section and Employer approved quality assurance plan.
5.01.02	Hydrostatic and pneumatic tests shall be performed on all pipes, tubing and systems and shall conform to ANSI B31.1.

5.02.00 **Hydrostatic Testing**

5.02.01 All instrument piping/ tubing shall be hydrostatically tested upon completion of erection. The test pressure shall be 1.5 times the maximum process pressure. The test shall be performed either with the testing of associated process piping or without the associated process piping (by closing the root valve). In both the cases the instrument shall be isolated by closing the shut-off valve.

5.03.00 **Air Testing**

All air headers & branch pipes shall be air tested by pressure decay method as per ANSI B31.1. Flexible hoses and short signal tubing shall be tested at normal pressure for leakage. Long signal tubing shall be tested by charging each tube with air at 2 kg/ sq. cm. through a bubbler sight glass. The boiler draft and vacuum piping shall be air tested by the same method as long signal tubing.

6.00.0 INSTRUMENT INSTALLATION

Generally, the Instruments/gauges are not to be mounted directly on pipes etc. unless there are some constraints. Transmitters, switches, devices etc. mounted in the field shall be suitably grouped together to the extent possible and mounted with suitable canopy near to the instrument source connection point.

7.00.00 Instrument Installation drawings are to be submitted for employer's review/approval.

SUB-SECTION-III-C&I-03

INSTRUMENTATION AND POWER SUPPLY CABLES

INSTRUMENTATION CABLES

1.00.00 INSTRUMENTATION CABLES

1.01.00 GENERAL

1.01.01 The Contractor shall supply, erect, terminate and test all cables as specified in contractor's scope for control and instrumentation equipment/devices/systems as per this specification and ensuring completeness of the control system.

1.01.02 Any other application where it is felt that instrumentation cables are required due to system/operating condition requirements, are also to be provided by Contractor.

1.01.03 Other type of cables like fiber optic/co-axial cables for system bus, cables for connection of peripherals etc. (under Contractor's scope) are also to be furnished by the Contractor.

1.01.04 Contractor shall supply all cable erection and laying hardware from the main trunk routes like branch cable trays/sub-trays, supports, flexible conduits, cable glands, lugs, pull boxes etc. on as required basis for all the systems covered under this specification.

1.01.05 Wherever the quantity has been defined as on as required basis, the same are to be furnished by contractor on as required basis within his quoted lump sump price without any further cost implication to the Employer.

2.00.00 Specification of Instrumentation cable

2.01.00 **Common Requirements**

S. No.	Property	Requirement
1	Voltage grade	225 V (peak value)
2.	Codes and standard	All instrumentation cables shall comply with VDE 0815, VDE 0207, Part 4, Part 5, Part 6, VDE 0816, VDE 0472, SEN 4241475, ANSI MC 96.1, IS-8784, IS-10810, ASTM D 2843, ASTM D 2863, IEC 60754-1, SEN:SS 4241475, IEEE 383, IS 8130, IEEE Transactions March/ April 1967 (latest editions) and their amendments read along with this specification.
3.	Continuous operation suitability	At 70 deg. C for all types of cables, and at 205 Deg C for Type-C cables.
4.	Marking	a) Progressive automatic on-line sequential marking of length in meters to be provided at every one meter on outer sheath. b) Marking to read 'FRLS' to be provided at every 5 meters on outer sheath except for Type-C cable c) Durable marking at intervals not exceeding 625 mm shall include manufacturer's name, insulation material, conductor's size, number of pairs, voltage rating, type of cable, year of manufacturer to be provided on outer sheath.
5.	Allowable Tolerance on overall diameter	+/- 2 mm (maximum) over the declared value in data sheet
6.	Variation in diameter	Not more than 1.0 mm throughout the length of cable.
7.	Ovality at any cross-section	Not more than 1.0 mm
8.	Cage- clamp suitability	To be provided
9.	Color	The outer sheath shall be of blue color.
10.	Others	a) Cables shall be suitable for laying in conduits, ducts, trenches, racks and

S. No.	Property	Requirement
		underground-buried installation. b) Repaired cables shall not be acceptable.

2.02.00 **Specific Requirements**

Specification Requirements	Type-A cable	Type-B cable	Type F & G cable	Type-C cable
A. CONDUCTORS				
Cross section area	0.5 sq. mm			
Conductor material	ANSI type KX	ANSI type SX	Annealed bare copper	ANSI type KX
Colour code	Yellow-Red	Black-Red	As per VDE-815	Yellow-Red
Conductor Grade	As per ANSI MC 96.1		Electrolytic	As per ANSI MC 96.1
No & diameter of strands	7x0.3 mm (nom)			
No. of Pairs			2/4/8/12/16/24/48	
Max. conductor loop resistance per Km (in ohm) at 20 deg. C	As per ANSI MC 96.1		73.4	As per ANSI MC 96.1
Reference Standard	As per ANSI MC 96.1		VDE : 0815	As per ANSI MC 96.1
B. INSULATION				
Material	Extruded PVC type YI 3			Teflon (i.e. extruded FEP)
Thickness in mm (Min/Max)	0.25/0.35			0.4 / 0.50 (nominal)
Volume Resistivity (Min) in ohm-cm	1 x 10^{14} at 20 deg. C & 1x10^{11} at 70 deg. C.			2.8x 10^{14} at 20 deg. C & 2x10^{11} at 205 deg. C.
C. PAIRING & TWISTING				

Specification Requirements	Type-A cable	Type-B cable	Type F & G cable	Type-C cable
Max. lay of pairs (mm)	50			
Single layer of binder tape on each pair provided	Each core printed with number or Numbered binder tape to be provided on each pair		Yes	Each core printed with number or Numbered binder tape to be provided on each pair
Bunch (Unit Formation) for more than 4P	N.A		To be provided	N.A
Conductor /pair identification as per VDE0815	N.A.		To be provided	N.A.
D. SHIELDING				
Type of shielding	Al-Mylar tape			
Individual pair shielding	No		To be provided for F-type cable	No
Minimum thickness of Individual pair shielding	No		0.028mm (28 micron)	No
Overall cable assembly shielding	To be provided			
Minimum thickness of Overall cable assembly shielding	0.055 mm (55 micron)			
Coverage Overlapping	20%			
Drain wire provided for individual shield	N.A.		Yes (for F-type) Size- 0.5 sqmm No of strands-7 Diameter of strands- 0.3mm	N.A.

Specification Requirements	Type-A cable	Type-B cable	Type F & G cable	Type-C cable
			Annealed Tin coated copper	
Drain wire provided for overall shield	Yes. Size- 0.5 sqmm No of strands-7 Diameter of strands- 0.3mm Annealed Tin coated copper			
E. FILLERS (if applicable)				
Non-hygroscopic, flame retardant	To be provided			
F. OUTER SHEATH				
Material	Extruded PVC compound YM1 with FRLS properties			Teflon (i.e. extruded FRP)
Minimum Thickness at any point	1.8 mm			0.4 mm
Nominal Thickness at any point	>1.8 mm			0.5 mm
Resistant to water, fungus, termite & rodent attack	Required			
Minimum Oxygen index as per ASTMD-2863	29 %			N.A.
Minimum Temperature index as per ASTMD-2863	250 deg.C			N.A.
Maximum Acid gas generation by weight as per IEC-60754-1	20%			N.A.
Maximum Smoke Density Rating as per ASTMD-2843	60% (defined as the average area under the curve when the results of smoke density test plotted on a curve indicating light absorption vs. time as per ASTMD-2843)			N.A.
Reference standard	VDE207 Part 5,			VDE207 Part

Specification Requirements	Type-A cable	Type-B cable	Type F & G cable	Type-C cable
	VDE-816			6 & ASTM D2116
G. Electrical Parameters				
MUTUAL CAPACITANCE BETWEEN CONDUCTORS AT 0.8 KHZ (MAX.)	200 nF/km		120 nF/km for F type 100 nF/km for G-type	200 nF/km
INSULATION RESISTANCE (MIN.)	100 M Ohm/Km			
CROSS TALK FIGURE (MIN.) AT 0.8 KHZ	60 dB		60 dB	60dB
CHARACTERISTIC IMPEDANCE (MAX) AT 1 KHZ	N.A.		320 ohm for F-type 340 ohm for G-type	N.A.
ATTENUATION FIGURE AT 1 KHZ (MAX)	N.A.		1.2 db/km	N.A.
H. COMPLETE CABLE				
Complete Cable assembly	Shall pass Swedish Chimney test as per SEN-SS 4241475 class F3.			N.A.
Flammability	Shall pass flammability as per IEEE-383 read in conjunction to this specification			As per manufacturer 's standard subject to employer's approval
I. ACCESSORIES				
Cable accessories of flame retardant quality.	Yes. (Accessories such as harnessing components, markers, bedding, cable jointer, binding tape etc.)			
J. TESTS				

Specification Requirements	Type-A cable	Type-B cable	Type F & G cable	Type-C cable
Routine & Acceptance tests	Refer sub-section IIIE			
Type tests	Refer sub-section-CNI TYPE TEST			
K. CABLE DRUM	Non-returnable wooden drum (wooden drum to be constructed from seasoned wood free from defects with wood preservative applied to the entire drum) or steel drum.			
Outermost cable layer covered with water proof paper.	Yes			
Paining.	Entire surface to be painted.			
Length	1000 m +/- 5% for upto & including 12 pairs. 500 m +/- 5% for above 12 pairs.			

3.00.00 **Specification of Optical Fiber Cables (OFC)**

3.01.00 Fiber Optic cable shall be 4/8/12 core, corrugated steel taped armoured, fully water blocked with dielectric central member for outdoor/indoor application so as to prevent any physical damage. The cable shall have multiple single-mode or multi-mode fibers as required by the communication system so as to avoid the usage of any repeaters. The core and cladding diameter shall be 9 +/- 1 micrometers and 125 +/- 1 micro- meters respectively. The outer sheath shall be Flame Retardant, UV resistant properties and are to be identified with the manufacturer's name, year of manufacturing, progressive automatic sequential on line marking of length in meters at every meter on outer sheath.

The cable core shall have suitable characteristics and strengthening for prevention of damage during pulling viz. FRP central member, Loose buffer tube design, 4 fibers per buffer tube (minimum), Interstices and buffer tubes duly filled with thixotropic jelly etc.. The cable shall be suitable for a maximum tensile force of 2000 N during installation, and once installed, a tensile force of 1000 N minimum. The compressive strength of cable shall be 3000 N minimum & crush resistance 4000 N minimum. The operating temperature shall be –20 deg. C to 70 deg.C

All testing of the fiber optic cable being supplied shall be as per the relevant IEC, EIA and other international standards.

Bidder to ensure that minimum 100% cores are kept as spares in all types of optical fiber cables.

Cables shall be suitable for laying in conduits, ducts, trenches, racks and underground buried installations.

Spliced/ repaired cables are not acceptable.

Penetration of water resistance and impact resistance shall be as per IEC standard.

4.00.00 INSTRUMENTATION CABLE INTERCONNECTION AND TERMINATION PHILOSOPHY

The cable interconnection philosophy to be adopted shall be such that extensive grouping of signals by large scale use of field mounted Group JBs at strategic locations (where large concentration of signals are available, e.g. switchgear) is done and consequently cable with higher number of pairs are extensively used. JB's to be furnished under this specification shall be of 12/24/36/48/64/72/96/128 way. The material dimension and interior/exterior colour of JB's shall be subject to Employer's approval. The details of termination to be followed are mentioned in the given table A

TABLE A:- CABLE TERMINATION TO BE FOLLOWED

Application		Type Of Termination		Type Of Cable
FROM (A)	TO (B)	END A	END B	
Valves/dampers drives (Integral Junction box)	Marshalling Cubicle/local group JB/ Termination/ Control Cabinets/ System Cabinets	Plug in connector	Post mounted cage clamp type.	G
Transmitters, Process Actuated switches to be mounted in LIE/LIR	Integral Junction box of LIE/LIR	Plug in connector	Cage clamp (Rail mounted) type.	F,G
RTD heads	Local junction box	Plug in connector	Cage clamp (Rail mounted) type.	F
Thermocouples	CJC box	Plug in connector	Screwed/ Cage clamp Type	A,B,C*
Local Junction box, CJC box, int. Junction box of LIE/ LIR/ Group JB/ MCC/ SWGR	Marshalling Cubicle/local group JB/ Termination/ Control Cabinets/System Cabinets	Cage clamp (Rail mounted) type.	Post mounted-cage clamp type.	F,G
Local Junction box, MCC/SWGR	Group JB	Cage clamp (Rail mounted) type.	Cage clamp (Rail mounted) type.	F,G
Field mounted Instrument	Group JB		Cage clamp(Rail mounted) type.	F,G
Marshalling cubicle/ Termination Cabinet	Electronic system cabinet	Post mounted cage clamp type.	Post mounted cage clamp type.	F,G
UCP mounted equipment	Post mounted cage clamp type	Post mounted cage clamp type.	Plug in connector/ Cage clamp type (rail mounted).	F,G (with plugin connector -r at one end)
DDCMIS/PLC cabinets	PC, Printers etc.	Plug in connector	Plug in connector	Mfr.'s Standard

Notes

1.	Normally 10% spare core shall be provided when the number of pairs of cables are more than four pairs except for pre-fabricated cables which shall be as per manufacturer's standard.
2.	For analog signals individual pair shielding & overall shielding & for Binary signals only overall shielding of instrumentation cables shall be provided.
3.	*For high temperature application only.

5.00.00	**Terminal Blocks**
5.01.00	All terminal blocks shall be rail mounted/post mounted, cage clamp type with high quality non-flammable insulating material of melamine suitable for working temperature of 105 deg. C. The terminal blocks in field mounted junction boxes, instrument enclosures/racks, etc., shall be suitable for cage clamp–connections. The terminal blocks in control equipment room logic/termination/marshalling cubicles shall be suitable for post mounted cage clamp connection at the field input end. The exact type of terminal blocks to be provided by the contractor and the technical details of the same including width etc. Shall be subject to employer's approval.
5.02.00	All the terminal blocks shall be provided complete with all required accessories including assembly rail, locking pin and section, end brackets, partitions, small partitions, transparent covers, support brackets, distance sleeves, warning label, marking, etc.
5.03.00	The marking on terminal strips shall correspond to the terminal numbering on wiring diagrams. At least 20% spare unused terminals shall be provided everywhere including local junction boxes, instrument racks/enclosures, termination/marshalling cabinets, etc. All terminal blocks shall be numbered for identification and grouped according to the function. Engraved labels shall be provided on the terminal blocks.
5.04.00	For terminating each process actuated switches, drive actuators, control valves, RTD, etc. In local junction boxes, etc, Refer drg no. 0000-999-POI-A-065.
5.05.00	The terminal blocks shall be arranged with at least 100 mm clearance between two sets of terminal blocks and between terminal blocks and junction box walls.
5.06.00	For ensuring proper connections, contractor shall provide suitable accessories, along with insulation sleeves. The exact connecting accessory shall be finalised as per application during detail engineering stage subject to employer's approval without any cost repercussions.
5.07.00	Internal wiring in factory pre-wired electronic equipment cabinets may be installed according to the contractor's standard as to wire size and method of termination or

internal equipment. Terminal blocks for connection of external circuits into factory prewired electronic equipment cabinets shall meet all the requirements as specified above.

6.00.00 Internal panels/cabinets/system cabinets wiring

6.01.00 Internal panel/cabinet wiring shall be of multi stranded copper conductor with FRLS PVC insulation without shield and outer sheath meeting the requirements of VDE 0815.

6.02.00 Wiring to door mounted devices shall be done by 19 strand copper wire provided with adequate loop lengths of hinge wire so that multiple door opening shall not cause fatigue breaking of the conductor.

6.03.00 All internal wires shall be provided with tag and identification nos. Etched on tightly fitted ferules at both ends in employer's approved format. All wires directly connected to trip devices shall be distinguished by one additional red colour ferrule.

6.04.00 All external connection shall be made with one wire per termination point. Wires shall not be tapped or spliced between terminal points.

6.05.00 All floor slots of desk/panels/cabinets used for cable entrance shall be provided with removable gasketed gland plates and sealing material. Split type grommets shall be used for prefabricated cables.

6.06.00 All the special tools as may be required for solder less connections shall be provided by bidder.

6.07.00 Wire sizes to be utilised for internal wiring.

(i)	Current (4-20 mA), low voltage signals (48V), Ammeter/voltmeter circuit, control switches etc. for electrical system.	-	0.5 Sq. mm.
(ii)	Power supply and internal illumination.	-	2.5Sq.mm. minimum (shall be as per load

			requirement.)

7.00.00 CABLE INSTALLATION AND ROUTING

7.01.00 All cables assigned to a particular duct/conduit shall be grouped and pulled in simultaneously using cable grips and suitable lubricants. Cables removed from one duct/conduit shall not be reused without approval of employer.

Cables shall be segregated as per IEEE Std.-422. In vertically stacked trays, the higher voltage cable shall be in higher position and instrumentation cable shall be in bottom tier of the tray stack. The distance between instrumentation cables and those of other system shall be as follows : From 11 kV/6.6 kV/3.3 kV tray system	-	914 mm
From 415V tray system	-	610 mm
From control cable tray system	-	305 mm

7.02.00 Cables shall terminate in the enclosure through cable glands. All cable glands shall be properly gasketed. Sealing (to prevent ingress of dust entry and propagation of fire) shall be provided for all floor slots used for cable entrance. Compression cable glands (double for armoured and single for other cables) shall be provided.

7.03.00 All cables shall be identified by tag. Nos. provided in Employer's approved format at both the ends as well as at an interval of 20 meters.

7.04.00 Line voltage drop due to high resistance splices, terminal contacts, insulation resistance at terminal block, very long transmission line etc. shall be reduced as far as practicable.

7.05.00 The cables emanating from redundant equipment/devices shall be routed through different paths.

8.00.00 **CABLE LAYING AND ACCESSORIES**

1.	Cables shall be laid strictly in line with cable schedule.
2.	Identification tags for cables.
	Indelible tags to be provided at all terminations, on both sides of wall or floor crossing, on each conduit/duct/pipe entry/exit, and at every 20 m in cable trench/tray.
3.	Cable tray numbering and marking.
	To be provided at every 10m and at each end of cable way & branch connection.
4.	Joints for less than 250 meters run of cable shall not be permitted.
5.	Buried cable protection
	With concrete slabs; Route markers at every 20 Meters along the route & at every bend.
6	Road Crossings
	Cables to pass through buried high density PE pipes encased in RCC. At least 300 mm clearance shall be provided between
	- HT power & LT power cables,
	- LT power & LT control/instrumentation cables,
	Spacing between cables of same voltage grade shall be in accordance with the derating criteria adopted for cable sizing.
7	Segregation (physical isolation to prevent fire jumping)
	a) All cable associated with the unit shall be segregated from cables of other Units.

	b) Interplant cables of station auxiliaries and unit critical drives shall be segregated in such a way that not more than half of the drives are lost in case of single incident of fire.
8	Cable clamping
	All cables laid on trays shall be neatly dressed up & suitably clamped/tied to the tray. For cables in trefoil formation, trefoil clamps shall be provided.
9	Optical Fiber Cable
	Outside building area: To be laid necessarily inside GI conduit with support from cable tray/ trestle structure. Inside building area: To be laid on separate cable sub-trays. While buried: In separate buried trench approx. 1.0 meter depth, to be laid in 2" rodent proof HDPE conduits covered with sand, brick laid breadth-wise and soil along the pipe line route by Contractor. While crossing roads : To be laid in GI/ rodent roof HDPE conduits with sand filling at bottom and sand, soil filling at top with cement concrete. While crossing canals/ river: To be laid in rodent proof HDPE conduits with in Hume pipe.

8.01.00 Bidder shall supply and install all cable accessories and fittings like cable glands, grommets, lugs, termination kits etc. on as required basis.

8.02.00 Bidder shall furnish two completely new sets of cable termination kits like Crimping tools etc. which are required for maintenance of the system, as per the type of termination used.

8.03.00 Bidder shall supply and install all cable accessories and fittings like Light Interface Units, Surge suppressors, Opto isolators, Interface Converters, Fiber Optic Card

Cage, Fiber Optic Line Driver, Repeater / Modem (for Optical Fiber Cables), cable glands, grommets, lugs, termination kits etc. on as required basis.

9.00.00 FIELD MOUNTED LOCAL JUNCTION BOXES

(i)	No. of ways	12/24/36/48/64/72/96/128 with 20% spare terminals.
(ii)	Material and Thickness	Minimum 4mm thick fiber glass reinforced polyester (FRP).
(iii)	Type	Screwed at all four corners for door. Door gasket shall be of synthetic rubber.
(iv)	Mounting clamps and accessories	Suitable for mounting on walls, columns, structures etc. The brackets, bolts, nuts, screws, glands required for erection shall be of SS304, included in Bidders scope of supply.
(v)	Type of terminal blocks	Rail mounted cage-clamp type suitable for conductor size up to 2.5 mm^2. A M6 earthing stud shall be provided.
(vi)	Protection Class	IP:65 minimum .

10.00.00 CONDUITS

All rigid conduits, couplings and elbows shall be hot dipped galvanized rigid mild steel in accordance with IS:9357 Part-I (1980) and Part-II (1981). The conduit interior and exterior surfaces shall have continuous zinc coating with an overcoat of transparent enamel lacker or zinc chromate. Flexible conduit shall be heat resistant lead coated steel, water leak, fire and rust proof. The temperature rating of flexible conduit shall be suitable for actual application.

SUB-SECTION-III-C&I-04

TYPE TEST REQUIREMENTS

TYPE TEST REQUIREMENTS

1.00.00 TYPE TEST REQUIREMENTS

1.01.00 **General Requirements**

1.01.01 The Contractor shall furnish the type test reports of all type tests as per relevant standards and codes as well as other specific tests indicated in this specification. A list of such tests are given for various equipment in table titled 'TYPE TEST REQUIREMENT FOR C&I SYSTEMS' at the end of this chapter and under the item Special Requirement for Solid State Equipment/Systems. For the balance equipment instrument, type tests may be conducted as per manufactures standard or if required by relevant standard.

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

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

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

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

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

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

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

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

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

1.01.05 The Bidder shall indicate in the relevant BPS schedule, the cost of the type test for each item only for which type tests are to be conducted specifically for this project. The cost shall only be payable after conduction of the respective test. If a test is waived off, then the cost shall not be payable.

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

Sl.No.	Item	Test requirement	Standard	Test to be specifically conducted ?	NTPC's approval req. On test certificate ?
Col 1	Col 2	Col 3	Col 4	Col 5	Col 6
1	Thermocouple	Degree of protection test	IS-2147	No	No
2	RTD	As per standard (col 4)	IEC-751	No	No
3	Electronic transmitter	As per standard (col 4)	BS-6447 / IEC-60770	No	Yes

4	INSTRUMENTATION CABLES TWISTED & SHIELDED			No	Yes
	-Conductor	Resistance test	VDE-0815		
		Diameter test	IS-10810		
		Tin Coating test (Persulphate test) applicable for drain wire only.	IS-8130		
	-Insulation	Loss of mass	VDE 0472		
		Aging in air ovens**	VDE 0472		
		Tensile strength and elongation**	VDE 0472		
		Heat shock	VDE 0472**		
		Hot deformation	VDE 0472		
		Shrinkage	VDE 0472		
		Bleeding & blooming	IS-10810		
	-Inner	Loss of mass	VDE		

	sheath***		0472		
		Heat shock	VDE 0472**		
		Cold bend/ cold impact test	VDE 0472		
		Hot deformation	VDE 0472		
		Shrinkage	VDE 0472		
	-Outer sheath	Loss of mass	VDE 0472		
		Aging in air ovens**	VDE 0472**		
		Tensile strength and elongation test before and after ageing**	VDE 0472**		
		Heat shock	VDE 0472**		
		Hot deformation	VDE 0472		
		Shrinkage	VDE 0472		
		Bleeding & blooming	IS-10810		
		Colour fastness to water	IS-5831		
		Cold bend/ cold impact	VDE		

		test	0472		
		Oxygen index test	ASTMD-2863		
		Smoke Density Test	ASTMD-2843		
		Acid gas generation test	IEC-754-1		
	-fillers	Oxygen index test	ASTMD-2863		
		Acid gas generation test	IEC-754-1		
	-AL-MYLAR	Continuity test			
	shield	'Shied thickness			
		Overlap test			
	-Over all cable	Flammability	IEEE 383		
		Dimensional checks	IS 10810		
		Cross talk	VDE-0472		
		Mutual capacitance	VDE-0472		
		HV test	VDE-0815		
		Drain wire continuity			
11	Pressure gauge	Degree of protection test	IS-2147	No	No

		Temp interference test	IS -3624	No	No
12	Temperature gauge	Degree of protection test	IS-2147	No	No
13	Pressure &	Degree of protection test	IS-2147	No	No
	DP switch				
		As per standard (col 4)	BS 6134	No	No
14	Level switch	Degree of protection test	IS-2147	No	No
15	Junction Box	Degree of protection test	IS-2147	No	Yes

NOTES:-

Type tests are to be conducted only for the items which are being supplied as a part of this package.

** These tests shall be carried out as per VDE 0207, part6 & ASTMD-2116 for TEFLON insulated & outer sheath cables. as per VDE0207 for TEFLON insulated cables

*** Applicable for armoured cables only.

For instrumentation cables:

1.0 All cables to be supplied shall be of type tested quality. The Contractor shall submit for Owner's approval the reports of all the type tests as listed in this specification and carried out within last ten years from the date of bid opening. These reports should be for the tests conducted on the equipment similar to those

proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.

2.0 In case the Contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in case the type test report(s) are not found to be meeting the specification requirements, the Contractor shall conduct all such tests under this contract free of cost to the Owner and submit the reports for approval.

SUB-SECTION-V-QI

CONTROL & INSTRUMENTATION

SUB-SECTION-V-QI-01

MEASURING INSTRUMENTS (PRIMARY & SECONDARY)

MEASURING INSTRUMENTS (PRIMARY AND SECONDARY)

TESTS / ITEMS	Dimensions (R)	Make, Model, Type, Rating (R)	Process / Electrical connection (R)	Calibration (R)	Test as per standard(R)	Insulation Resistance (R)	IBR Certification (if applicable)(R)	Hydro Test(R)	Material Test certificate ®
1. PR Gauge (IS-3624)	Y	Y	Y	Y	Y				
2. Temp. Gauge (BS-5235)	Y	Y	Y	Y	Y				
3. Pr./D.P.Switch(BS-6134)	Y	Y	Y	Y	Y	Y			
4. Electronic Transmitter(IEC-770)	Y	Y	Y	Y	Y	Y			
5. Temp. Switch	Y	Y	Y	Y	Y	Y			
6. Recorder(IS-9319/ANSI C-39.4)	Y	Y	Y	Y	Y	Y			
7. Vertical indicators	Y	Y	Y	Y		Y			
8. Digital Indicators	Y	Y	Y	Y		Y			
9. Integrators	Y	Y	Y	Y					
10. Electrical Metering Instrument (IS-1248)	Y	Y	Y	Y	Y	Y			
11. Transducer (IEC-688)	Y	Y	Y	Y	Y	Y			
12. Thermocouples (IEC – 754 / ANSI-MC-96.1)	Y	Y	Y	Y	Y	Y			
13. RTD(IEC-751)	Y	Y	Y	Y	Y	Y			
14. Thermowell	Y		Y				Y	Y	Y

R-Routine Test A- Acceptance Test Y – Test applicable

: Note: 1) Detailed procedure of Environmental Stress Screening shall be as per Quality Assurance Programme in General Technical Conditions. Requirement of test and procedure (if required) finalized during QP finalization

2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted alongwith relevant supporting documents.

TESTS / ITEMS	Dimensions (R)	Make, Model, Type, Rating (R)	Process / Electrical connection (R)	Calibration (R)	Requirement as per standard (R)	WPS approval (A)	Non-destructive testing (R)	Calculation for accuracy (R)	Insulation Resistance (R)	IBR Certification as applicable (R)	Hydro test (R)	Material test certificate (A)
15. Cold junction compensation box	Y	Y	Y	Y					Y			
16. Orifice plate(BS-1042)	Y	Y	Y	Y *	Y	Y **	Y **			Y	Y **	Y
17. Flow nozzle(BS-1042)	Y	Y	Y	Y *	Y	Y	Y			Y	Y	Y
18. Impact head type element	Y	Y	Y					Y				Y
19. Level transmitter/float type switch	Y	Y	Y	Y					Y	Y	Y	Y
20. Flue Gas analyser	Y	Y	Y	Y								
21. Dust emission monitors	Y	Y	Y	Y								
*Calibration to be carried out on one flow element of each type and size if calibration carried out as type test same shall not be repeated.												
** If applicable												

R-Routine Test A- Acceptance Test Y – Test applicable

Note: 1) Detailed procedure of Environmental Stress screening test shall be as per Quality Assurance Programme in General Technical Conditions. Requirement of test and procedure (if required) finalized during QP finalization

2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted alongwith relevant supporting documents.

SUB-SECTION-V-QI-02

INSTRUMENTATION CABLE

INSTRUMENTATION CABLE

TESTS / ITEMS	Conductor Resistance ® & (A)	High Voltage ® & (A)	Insulation Resistance ® & (A)	Constructional detail, dimensions (A)	Outer-Sheathe/core marking, end sealing (A)	Thermal Stability (A) +	Visual, Surface finish (A) +	Electrical Parameters ** (A) +	Persulphate Test (A) +	Overall/Coverage/Continuity (A)	Swidesh chimney Test (SS-4241475) (A) ++	FRLS Test * (A) ++	Tensile & Elongation before & after aging (A) ++	Vol. Resistivity. at room & Elevated Temp. (A) ++	Spark test report review ®
1. Instrument cable twisted and shielded															
Conductor(IS-8130)	Y			Y			Y								
Insulation(VDE-207)				Y	Y	Y	Y						Y		Y
Pairing/Twisting				Y	Y		Y								
Shielding				Y			Y			Y					
Drain wire	Y			Y			Y		Y	Y					
Inner Sheath				Y	Y	Y	Y					Y	Y		
Outer Sheath				Y	Y	Y	Y					Y	Y		
Over all cable	Y	Y	Y	Y	Y		Y	Y			Y			Y	
Cable Drums(IS-10418)				Y			Y								

Note : High Temp. cables shall be subjected to tests as per VDE-207(Part-6) Compensating cables shall be checked for Thermal EMF/Endurance test as per IS 8784.

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

Note : ® - Routine Test A - Acceptance Test Y - Test Applicable

Note : Sampling Plan for Acceptance test shall be as per IS 8784 (As applicable)

- * FRLS Tests: Oxygen / Temp Index (ASTM D-2863), Smoke Density Rating (ASTM – D 2843), HCL Emission (IEC-754-1)
- ** Characteristic Impedance, Attenuation, Mutual Capacitance, Cross Talk (As applicable)

\+ Sample size will be One No. of each size/type per lot.

++ Sample size will be One No. sample for complete lot offered irrespective of size/type.

SUB-SECTION-V-QI-03

PROCESS CONNECTION & PIPING

QUALITY ASSURANCE

PROCESS CONNECTION & PIPING

TESTS / ITEMS	Visual ®	GA, BOM, Layout of component & construction feature®	Dimension ®	Paint Shade/thickness ®	Flattening,flaring,hydrotest,hardness check as per ASTM standard (A)	Component Ratings ®	Wiring ®	Make, Model, Type, Rating®	IR & HV ®	Review of TC for instrument/devices (R)	Accessability of TBs/Devices ®	Illumination,grounding ®	Tubing ®	Leak/Hydro test(A)	Chemical/physical properties of material (A)	Proof pressure test,Dismantling & reassembly test,Hydrulic impulse and vibration test (R)	Tests as per standards & specification
Local Instrument enclosure	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y			
Local instruments racks	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y			
Junction Box	Y	Y	Y	Y*		Y		Y	Y								
Gauge Board	Y	Y	Y	Y		Y		Y		Y			Y	Y			
Impulse pipes and tubes	Y		Y		Y			Y							Y		
Socket weld fittings ANSI B-16.11	Y		Y					Y							Y		Y
Compression fittings	Y		Y					Y						Y	Y	Y	
Instrument valves & Valve manifolds	Y		Y					Y						Y	Y		
Copper tubings ASTM B75	Y							Y									Y

*-applicable for painted junction boxes.

Note: R-Routine Test A- Acceptance Test Y – Test applicable

Note: This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted alongwith relevant supporting documents.

SUB-SECTION-V-QI-04

PROGRAMMABLE LOGIC CONTROLLER

PROGRAMMABLE LOGIC CONTROLLER

ITEMS \ TESTS	Visual ®	GA, BOM, Lay Out of components ®	Dimensions ®	Paint Shade/ Thickness/Adhesion ®	Alignment of Section ®	Component Rating/ Make / Type ®	Wiring ®	IR & HV ®	Review of TC for instruments/ Devices/ Recorders, Indicators/ Mosaic Items/ Transducers ®	Accessibility of TBS/ Devices ®	Illumination ®	Functional Check for Control Element , Annunciation ®	Mimic ®	Test as per IEC 1131 ® *	Test as per Std ® & (A)
1. PLC Panel	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y		Y	Y
2. Control Desk With PLC	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		

Note: 1) Detailed procedure of Environmental Stress Screening test shall be as per Quality Assurance Programme in General Technical Conditions

2) This is an indicative list of test/ checks. The manufacturer is to furnish a detailed quality plan indicating the Practice and Procedure alongwith relevant supporting documents.

*Applicable for PLC Y - Test Applicable , ® - Routine Test (A) - Acceptance Test

Format - I

DECLARATION REGARDING MINIMUM LOCAL CONTENT IN LINE WITH REVISED PUBLIC PROCUREMENT (PREFERENCE TO MAKE IN INDIA), ORDER 2017 DATED 04TH JUNE, 2020 AND SUBSEQUENT ORDER(S)

(To be typed and submitted in the Letter Head of the Entity/Firm providing certificate as applicable)

To,

(Write Name & Address of Officer of BHEL inviting the Tender)

Dear Sir,

Sub: Declaration reg. minimum local content in line with Public Procurement (Preference to Make in India), Order 2017-Revision, dated 04th June, 2020 and subsequent order(s).

Ref: 1) **Tender Specification No:**

2) All other pertinent issues till date

We hereby certify that the items/works/services offered by…… *(specify the name of the organization here)* has a local content of _____ % and this meets the local content requirement for **'Class-I local supplier' / 'Class II local supplier' **** as defined in Public Procurement (Preference to Make in India), Order 2017-Revision dated 04.06.2020 issued by DPIIT and subsequent order(s).

The details of the location(s) at which the local value addition is made are as follows:

1. _____ 2. _____
3. _____ 4. _____

…

Thanking you,

Yours faithfully,

(Signature, Date & Seal of

Authorized Signatory of the Bidder)

****** - *Strike out whichever is not applicable.*

Note:

1. Bidders to note that above format Duly filled & signed by authorized signatory, shall be submitted along with the techno-commercial offer.
2. In case the bidder's quoted value is in excess of Rs. 10 crores, the authorized signatory for this declaration shall necessarily be the statutory auditor or cost auditor of the company (in the case of companies) or a practising cost accountant or practicing chartered accountant (in respect of suppliers other than companies).
3. In the event of false declaration, actions as per the above order and as per BHEL Guidelines shall be initiated against the bidder

FORMAT FOR NO DEVIATION CERTIFICATE

(To be submitted in the bidder's letter head)

TO
BHARAT HEAVY ELECTRICALS LIMITED,
Industrial Systems Group, Prof. CNR Rao Circle,
Malleshwaram Bangalore – 560012

Sub :	No deviation certificate
Job :	----
Ref :	Your enquiry No -
	All the pertinent issues till date.

Dear Sirs,

With reference to above, this is to confirm that as per tender conditions, we have visited site before submission of our offer and noted the job content &site conditions etc. We also confirm that we have not changed/ modified the tender documents as appeared in the website/ issued by you and in case of such observance at any stage, it shall be treated as null and void.

We hereby confirm that we have not taken any deviation from tender clauses together with other references as enumerated in the above referred NIT. We hereby confirm our unqualified acceptance to all terms &conditions, unqualified compliance to technical specification, integrity pact (if applicable) and acceptance to reverse auctioning process.

In the event of observance of any deviation in any part of our offer at a later date whether implicit or explicit, the deviations shall stand null &void.

We confirm to have submitted offer in accordance with tender instructions and as per aforesaid references.

Thanking you,

Yours faithfully,

(Signature, date & seal of authorized representative of the bidder)

FINANCIAL STANDING UNDERTAKING
(To be submitted in the bidder's letter head)

GeM Bid No.

We ---------- (name of bidder) do declare that the following

a) We are not under liquidation
b) We are not under court receivership or similar proceedings
c) We are not under bankrupt.

We declare that we are financially sound and have financial strength to execute this order.

Name and designation of bidder with company seal