ANNEXURE-I

REV-0

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (FOR EPC PROJECTS)

PACKAGE: COMPRESSED AIR SYSTEM

SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT

PROJECT: 1 X 660MW BHUSAWAL TPS UNIT-6

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	11 kV/ 6.6 KV / 3.3 KV / 415 V Switchgear	BHEL	BHEL	240 V AC (supply feeder)/415 V AC (3 PHASE 4 WIRE) supply shall be provided by BHEL based on load data provided by vendor at contract stage for all equipment supplied by vendor as part of contract. Any other voltage level (AC/DC) required will be derived by the vendor.
2	Local Push Button Station (for motors)	BHEL	BHEL	Located near the motors.
3	Power cables, control cables and screened control cables for a) both end equipment in BHEL's scope b) both end equipment in vendor's scope c) one end equipment in vendor's scope	 BHEL BHEL BHEL	 BHEL Vendor BHEL	1. For 3.b) & c): Sizes of cables required shall be informed by vendor at contract stage (based on inputs provided by BHEL) in the form of cable listing. Finalisation of cable sizes shall be done by BHEL. Vendor shall provide lugs & glands accordingly. 2. Termination at BHEL equipment terminals by BHEL. 3. Termination at Vendor equipment terminals by Vendor.
4	Junction box for control & instrumentation cable	Vendor	Vendor	Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 10-12 mtrs) and trunk cable.
5	Any special type of cable like compensating, co-axial, prefab, MICC, etc.	Vendor	Vendor	Refer C&I portion of specification for scope of fibre Optical cables if used between PLC/ microprocessor & DCS.
6	Cable trays, accessories & cable trays supporting system. 100/50 mm cable trays/Conduits/Galvanised steel cable troughs for local cabling	BHEL Vendor	BHEL Vendor	Local cabling from nearby main route cable tray (BHEL scope) to equipment terminal (vendor's scope) shall be through 100/ 50 mm. cable trays/ conduits/ Galvanised steel cable troughs as per approved layout drawing during contract stage.
7	Cable glands, lugs & bimetallic strip for equipments supplied by Vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty tinned copper lugs for power & control cables.
8	Conduit and conduit accessories for cabling between equipments supplied by vendor.	Vendor	Vendor	Conduits shall be medium duty, hot dip galvanised cold rolled mild steel rigid conduit as per IS: 9537.
9	Lighting	BHEL	BHEL	--
10	Equipment grounding (including electronic earthing) & lightning protection	BHEL	BHEL	Refer note no. 4 for electronic earthing
11	Below grade grounding	BHEL	BHEL	--
12	Motors with base plate and foundation hardware	Vendor	Vendor	Makes shall be subject to customer/ BHEL approval at contract stage.
13	Mandatory spares	Vendor	-	Vendor to quote as per specification.

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (FOR EPC PROJECTS)

PACKAGE: COMPRESSED AIR SYSTEM

SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT

PROJECT: 1 X 660MW BHUSAWAL TPS UNIT-6

14	Recommended O & M spares	Vendor	-	As specified elsewhere in specification
15	Any other equipment/material/service required for completeness of system based on the system offered by vendor (to ensure trouble free and efficient operation of the system).	Vendor	Vendor	--
16	a. Input cable schedules (C & I) b. Cable interconnection detail for the above c. Cable block diagram	Vendor Vendor Vendor	- - -	Cable listing for Control and Instrumentation Cable and electronic earthing cable in enclosed excel format shall be submitted by vendor during detailed engineering stage.
17	Cabling layout drawings	BHEL/ Vendor	-	a. In case of Compressor are HT motors, cable tray/trench layout inside compressed air building shall be prepared by BHEL. Vendor to furnish drawing (both in print form as well as in AUTOCAD) of compressor room layout clearly indicating all motors, panels, JB's etc. which require cabling alongwith their terminal box/location/ Foundation etc. b. In case of Compressor are LT motors, for ensuring cabling requirements are met, vendor shall prepare & submit cable tray/trench & equipment layout (both in print form as well as in AUTOCAD) of the complete plant (including electrical area) indicating location and identification of all equipment requiring cabling for BHEL review & approval.
18	Electrical equipment GA drawing	Vendor	-	For necessary interface review.

NOTES:

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

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

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

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

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

BHEL	LOAD DATA (ELECTRICAL)	JOB NO.	415	ORIGINATING AGENCY	PEM (ELECTRICAL)
		PROJECT TITLE	1X660MW BHUSAWAL TPS	NAME	DATA FILLED UP ON
		SYSTEM / S	COMPRESSED AIR SYSTEM	SIGN.	DATA ENTERED ON
		DEPTT. / SECTION	ELECTRICAL	SHEET 1 OF 1 REV. 00	DE'S SIGN. & DATE

ANNEXURE - B

ANNEXURE-III

CABLE SCHEDULE FORMAT

ANNEXURE III

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

ANNEXURE-III
CABLE LISTING GUIDELINES

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

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

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

(A) SYSTEM VOLTAGE CODES:

(ac) A = 11KV, B = 6.6KV, C = 3.3KV, D = 415V, E = 240V, F = 110V

(dc) G = 220V, H = 110V, J = 48V, K = +24V, L = -24V

ANNEXURE-III
CABLE LISTING GUIDELINES

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

(B) CABLE VOLTAGE CODES:

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

(C) CABLE CODES

PVC Copper

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

PVC Aluminium

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

XLPE Copper

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

XLPE Aluminium

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

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

ANNEXURE-IV

SUB-VENDOR LIST FOR LT MOTORS

SL NO.	VENDOR NAME	
1	ABB	14, MATHURA ROAD, FARIDABAD, HARYANA-121003
2	BHARAT BIJLEE LTD.	BHARAT BIJLEE LIMITED, 1ST FLOOR, 7-B, RAJINDRA PARK, PUSA ROAD, NEW DELHI - 110 060.
3	CROMPTON GREAVES	3RD FLOOR, EXPRESS BUILDING,9-10, BAHADUR SHAH ZAFAR MARG, NEAR ITO CROSSING,NEW DELHI-110002, INDIA
4	GE-POWER	KAMAK TOWER, 3RD FLOOR, PLOT NO. 12-A, TVK INDUSTRIAL ESTATE, EKKADUTHANGAL, GUINDY, CHENNAI-600032
5	KIRLOSKAR ELECTRIC CO LTD.	P.O. BOX 5555 , MALLESWARAM WEST ,BANGALORE 560055
6	LAXMI HYDRAULICS PVT. LTD	129/130, INDUSTRIAL ESTATE PATIL NAGAR, HOTGI ROAD SOLAPUR-413003, MAHARASHTRA
7	MARATHON	MARATHON ELECTRIC INDIA PRIVATE LTD.SECTOR - 11, MODEL TOWN, FARIDABAD - 121006
8	NGEF	POCKET NO.10, FLAT NO. 37 & 38, EXPANDABLE DDA FLATS, NASIRPUR DWARKA, PHASE-I NEW DELHI-110 045
9	RAJINDRA ELECT INDUSTRIES	14 SHAH IND.ESTATE VEERA DESAI RD,ANDHERI(W) MUMBAI-400053
10	SIEMENS	RC-IN I S NR DEL AREA, JIL BUILDING, TOWER-B, PLOT NO. 78, SECTOR 18, GURGAON-122015, INDIA

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

SUB-VENDOR LIST FOR GLANDS

1	ALLIED TRADERS & EXPORTERS	C-124 A, SECTOR-2, NOIDA -201 301, UTTAR PRADESH, INDIA
2	ARUP ENGG & FOUNDARY WORKS	391/119,PRINCE ANWAR SHAH ROAD, CALCUTTA-700068
3	BALIGA LIGHTING EQPT.PVT.LTD.	63A,CP RAMASWAMY ROAD, ALWARPET,P.B.No 6910, CHENNAI-600018
4	COMMET BRASS PRODUCTS	NUTAN CHEMICAL COMPOUND, WALBHAT ROAD, GOREGAON, MUMBAI-400063
5	DOWELLS	M/S. DOWELLS ELECTRICALS 47/47A, SATGURU INDUSTRIAL ESTATE. OFF AAREY ROAD, GOREGOAN (EAST). MUMBAI 400 063.
6	ELECTROMAC INDUSTRIES	27/28AF NEW EMPIRE IND.ESTT., R.KRISHNA MANDIR RD.JB NGR ,ANDHERI(E),MUMBAI-400059
7	INCAB	HARE STREET,KOLKATA,WEST BENGAL-700001

SUB-VENDOR LIST FOR LUGS

1	DOWELLS	M/S. DOWELLS ELECTRICALS 47/47A, SATGURU INDUSTRIAL ESTATE. OFF AAREY ROAD, GOREGOAN (EAST). MUMBAI 400 063.
2	UNIVERSAL MACHINES LTD.	4,B.B.D.BAG (EAST) 90,STEPHEN HOUSE,5TH FLR CALCUTTA-700001

1.0	Design ambient temperature	:	50 ^{o}C
2.0	Maximum acceptable kW rating of LV motor	:	160KW
3.0	Installation (Indoors/ Outdoors)	:	As required
4.0	Details of supply system		
	a) Rated voltage (with variation)	:	415V $\pm$ 10%
	b) Rated frequency (with variation)	:	50 Hz (+5% and -5%)
	c) Combined voltage & freq. variation	:	10% (sum of absolute values)
	d) System fault level at rated voltage	:	50 kA for 1 sec
	e) Short time rating for terminal boxes		
	o 90 kW and upto 160kW (Breaker controlled)	:	50 KA for 1 sec.
	o Below 90 kW (SFU + Contactor controlled)	:	50 KA protected by fuse for 0.2 sec
	f) LV System grounding	:	Effectively grounded
5.0	Class of insulation	:	Class 'F', with temp rise limited to class B.
6.0	Minimum voltage for starting (As percentage of rated voltage)	:	80% of rated voltage
7.0	Power cables data	:	Shall be given during Detailed engg
8.0	Earth Conductor Size & Material	:	Shall be given during Detailed engg
9.0	Space heater supply	:	240 V, 1¢ , 50 Hz
10.0	Rating up to which Single phase motor	:	Acceptable below 0.20 kW
11.0	Additional tests	:	As per QP and customer motor spec
12.0	Flame-proof motor		
	a) Enclosure suitable (As per IS:2148)	:	As per requirement
	b) Classification of Hazardous area (As per IS: 5572 part-I)	:	As per requirement
13.0	Makes	:	As per ANNEXURE-IV
14.0	Paint shade	:	RAL 7032
15.0	Degree of Protection of enclosure (motors):		INDOOR IP-55 OUTDOOR IPW-55
16.0	Energy efficiency	:	IE3 as per IS:12615: 2011

❖ **Also details of Customer spec. for Motors to be referred as enclosed with spec.**

QUALITY PLAN OF MOTORS

		QUALITY PLAN	CUSTOMER : MAHAGENCO			PROJECT TITLE 1X660 MW BHUSAWAL TPP			SPECIFICATION : NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
		SHEET 1 OF 9	SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.0	RAW MATERIAL & BOUGHT OUT CONTROL											
1.1	SHEET STEEL, PLATES, SECTION, EYEBOLTS	1.SURFACE CONDITION	MA	VISUAL	100%	-	FREE FROM BLINKS, CRACKS, WAVINESS ETC	LOG BOOK	3	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANFR'S DRG./SPEC	MANFR'S DRG./SPEC	-DO-	3	-	-	
		3.PROOF LOAD TEST (EYE BOLT)	MA	MECH. TEST	-DO-	-DO-	-DO-	INSPEC. REPORT	3	-	2	
1.2	HARDWARES	1.SURFACE CONDITION	MA	VISUAL	100%		FREE FROM CRACKS, UN-EVENNESS ETC.	-DO-	3	-	-	
		2.PROPERTY CLASS	MA	VISUAL	SAMPLES	MANFR'S DRG./SPEC BOOK	RELEVENT IS/SPEC.	SUPPLIERS TC & LOG	3	-	2	PROPERTY CLASS MARKING SHALL BE CHECKED BY THE VENDOR
1.3	CASTING	1.SURFACE CONDITION	MA	VISUAL	100%		FREE FROM CRACKS, BLOW HOLES ETC.	LOG BOOK	3	-	2	
		2.CHEM. & PHY. PROP.	MA	CHEM & MECH TEST	1/HEAT NO.	MANFR'S DRG./SPEC	RELEVENT IS/	SUPPLIER'S TC	3	-	2	HEAT NO. SHALL BE VERIFIED
		3.DIMENSIONS	MA	MEASUREMENT	100%	MANUFR'S DRG.	MANUFR'S DRG.	LOG BOOK	3	-	2	
1.4	PAINT & VARNISH	1.MAKE, SHADE, SHELF LIFE & TYPE	MA	VISUAL	100% CONTINUOUS	MANFR'S DRG./SPEC	MANFR'S DRG./SPEC	LOG BOOK	3	-	2	
BHEL			PARTICULARS		BIDDER/VENDOR							
			NAME									
			SIGNATURE									
			DATE						BIDDER'S/VENDORS COMPANY SEAL			

	QUALITY PLAN		CUSTOMER : MAHAGENCO			PROJECT 1X660 MW BHUSAWAL TPP TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 2 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.5	SHAFT (FORGED OR ROLLED)	1. SURFACE COND.	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	-	VENDOR'S APPROVAL IDENTIFICATION SHALL BE MAINTAINED
		2. CHEM. & PHYSICAL PROPERTIES	MA	CHEM. & PHYSICAL TESTS	1/HEAT NO. OR HEAT TREATMENT BATCH NO	MFG. DRG. SPEC.	RELEVANT IS	SUPPLIER'S TC	3	-	2	
		3. DIMENSIONS	MA	MEASUREMENT	100%	-DO-	MANUFR'S DRG.	LOG BOOK	3	-	2	
		4.INTERNAL FLAWS	CR	UT	-DO-	ASTM-A388	MANUFR'S SPEC. BHEL SPEC.	-DO-	3	2	1	FOR DIA OF 55 MM & ABOVE
1.6	SPACE HEATERS, CONNEC-TORS, TERMINAL BLOCKS, CABLES, CABLE LUGS, CARBON BRUSH TEMP. DETECTORS, RTD, BTD'S	1. MAKE & RATING	MA	VISUAL	-DO-	MANUFR'S DRG. SPEC.	MANUFR'S DRG. SPEC.	-DO-	3	-	2	
		2. PHYSICAL COND.	MA	-DO-	-DO-	-	NO PHYS. DAMAGE, NO ELECTRICAL DISCONTINUITY	-DO-	3	-	2	
		3.DIMENSIONS (WHEREVER APPLICABLE)	MA	MEASUREMENT	SAMPLE	MANUFR'S DRG./ SPEC.	MANUFR'S DRG. / SPEC.	-DO-	3	-	2	
		4.PERFORMANCE/ CALIBRATION	MA	TEST	100%	-DO-	-DO-	INSP. REPORT	3	-	2	

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN	CUSTOMER : MAHAGENCO			PROJECT TITLE 1X660 MW BHUSAWAL TPP			SPECIFICATION : NUMBER :			
		BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 3 OF 9	SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.7	OTHER INSULATING MATERIALS LIKE SLEEVES, BINDINGS CORDS, PAPERS, PRESS BOARDS ETC.	1. SURFACE COND. ETC.	MA	VISUAL	100%	-	NO VISUAL DEFECTS	INSPT. REPORT	3	-	2	
		2. OTHER CHARACTERISTICS	MA	TEST	SAMPLE	MANUF'S SPEC.	MANUF'S SPEC.	LOG BOOK AND OR SUPPLIER'S TC	3	-	2	
1.8	SHEET STAMPING (PUNCHED)	1. SURFACE COND.	MA	VISUAL	100%	-	NO VISUAL DEFECTS (FREE FROM BURS)	LOG BOOK	3	-	-	
		2.DIMENSIONS INCLUDING BURS HEIGHT	MA	MEASUREMENT	SAMPLE	MANUFR'S DRG. .	MANUFR'S DRG.	-DO-	3	-	2	FOR MV MOTOR INSULA-TION/VARNISH THICKNESS SHALL BE MORE THAN THE BURS HEIGHT
		3. ACCEPTANCE TESTS	MA	ELECT. & MECH TESTS	-DO-	MANUF'S SPEC./ RELEVANT IS	RELEVANT IS	SUPPLIER'S TC	3	-	2	
1.9	CONDUCTORS	1. SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	LOG BOOK	3*	-	2*	* MOTOR MANUFACTURER TO CONDUCT VISUAL CHECK FOR SURFACE FINISH ON RANDOM BASIS (10% SAMPLE) AT HIS WORKS AND MAINTAIN RECORD FOR VERIFICATION BY BHEL/CUSTOMER.
		2.ELECT. PROP, & MECH. PROP	MA	ELECT. & MECH.TEST	SAMPLES	RELEVANT IS/ BS OR OTHER STANDARDS	RELEVANT IS/ BS OR OTHER STANDARDS	SUPPLIERS TC & VENDOR'S INSPN. REPORTS	3	-	2	

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN	CUSTOMER : MAHAGENCO	PROJECT 1X660 MW BHUSAWAL TPP TITLE	SPECIFICATION : NUMBER :
		BIDDER/ : VENDOR	QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03	SPECIFICATION : TITLE
	SHEET 4 OF 9	SYSTEM	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)	SECTION VOLUME III

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		3.DIMENSIONS	MA	MEASUREMENT	-DO-	-DO-	-DO-	Log Book	3	-	2	
1.10	BEARINGS	1.MAKE & TYPE	MA	VISUAL	100%	MANFR'S DRG./ APPROVED DATASHEET	MANFR'S DRG./ APPROVED DATASHEET	-DO-	3	-	2	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	BHEL DATA SHEET	BHEL DATA SHEET BEARING MANUF'S CATALOGUES	-DO-	3	-	2	
		3.SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	2	
1.11	SLIP RING (WHEREVER APPLICABLE)	1.SURFACE COND.	MA	VISUAL	100%	-	-DO-	-DO-	3	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANUF'S DRG	MANUF'S DRG	-DO-	3	-	-	
		3.TEMP.WITH-STAND CAPACITY	MA	ELECT.TEST	-DO-	MANUF'S SPEC./ BHEL SPEC.	MANUF'S SPEC./ BHEL SPEC.	-DO-	3	-	2	
		4.HV/IR	MA	-DO-	100%	-DO-	-DO-	-DO-	3	-	2	
1.12	OIL SEALS & GASKETS	1.MATERIAL OF GASKET	MA	VISUAL	100%	MANUF'S DRG/SPECS	MANUF'S DRG./ SPECS.	-DO-	3	-	-	
		2.SURFACE COND.	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	-	
		3.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANUF'S DRG	MANUF'S DRG	-DO-	3	-	-	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER : MAHAGENCO			PROJECT 1X660 MW BHUSAWAL TPP TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 5 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION VOLUME III			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
2.0	IN PROCESS											
2.1	STATOR FRAME WELDING (IN CASE OF FABRICATED STATOR)	1.WORKMANSHIP & CLEANNESS	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	3/2	2	-	
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-	
2.2	MACHINING	1.FINISH	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	2	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-	
		3.SHAFT SURFACE FLOWS	MA	PT	-DO-	RELEVENT SPEC./ ASTM-E165	MANUFR'S SPEC./ BHEL SPEC./	-DO-	2	-	1	
2.3	PAINTING	1.SURFACE PREPARATION	MA	VISUAL	100%	MANFR'S SPEC/BHEL SPEC./ RELEVANT STAND	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-	
		2.PAINT THICKNESS (BOTH PRIMER & FINISH COAT)	MA	MEASUREMENT BY ELCOMETER	SAMPLE	-DO-	-DO-	-DO-	2	-	-	
		3.SHADE	MA	VISUAL	-DO-	-DO-	-DO-	Log Book	2	-	-	
		4.ADHESION	MA	CROSS CUTTING & TAPE TEST	-DO-	-DO-	-DO-	Log Book	2	-	-	

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
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	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER : MAHAGENCO			PROJECT 1X660 MW BHUSAWAL TPP TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 6 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
2.4	SHEET STACKING	1.COMPLETENESS	MA	MEASUREMENT	SAMPLE	MANUFR'S SPEC.	MANUFR'S SPEC.	Log Book	2	-	-	
		2.COMPRESSION & TIGHTENING	MA	MEASUREMENT	100%	-DO-	-DO-	Log Book	2	-	-	
		3.CORE LOSS & HOTSPOT	MA	ELECT.TEST	-DO-	-DO-	-DO-	Log Book	2	1*	1	(FOR MOTORS OF 2MW AND ABOVE) * ON 10% RANDOM SAMPLE
2.5	WINDING	1.COMPLETENESS	CR	VISUAL	100%	MANUFR'S SPEC./BHEL SPEC.	MANUFR'S SPEC./BHEL SPEC.	Log Book	2	-	-	
		2.CLEANLINESS	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		3.IR-HV-IR	CR	ELECT. TEST	-DO-	-DO-	-DO-	Log Book	2	-	1	
		4.RESISTANCE	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	
		5.INTERTURN INSULATION	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		6.SURGE WITH STAND AND TAN. DELTA TEST	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	FOR MV MOTOR
2.6	IMPREGNATION	1.VISCOSCITY	MA	PHY. TEST	AT STARTING	-DO-	-DO-	Log Book	2	-	-	
		2.TEMP. PRESSURE VACCUM	MA	PROCESS CHECK	CONTINUOUS	-DO-	-DO-	Log Book	2	-	-	
		3.NO. OF DIPS	MA	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	THREE DIPS TO BE GIVEN

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
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	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER : MAHAGENCO			PROJECT TITLE 1X660 MW BHUSAWAL TPP			SPECIFICATION : NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 7 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		4.DURATION	MA	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	
2.7	COMPLETE STATOR ASSEMBLY	1.COMPACTNESS & CLEANLINESS	MA	VISUAL	100%	-DO-	-DO-	Log Book	2	-	-	
2.8	BRAZING/COMPRESSION JOINT	1.COMPLETENESS	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		2.SOUNDNESS	CR	MALLET TEST & UT	-DO-	-DO-	-DO-	Log Book	2		1	
		3.HV	MA	ELECT. TEST	-DO-	-DO-	-DO-	Log Book	2		1	
2.9	COMPLETE ROTOR ASSEMBLY	1.RESIDUAL UNBALANCE	CR	DYN. BALANCE	-DO-	MFG SPEC./ ISO 1940	MFG. DWG.	Log Book	2		1	VERIFICATION FOR MV MOTOR ONLY
		2.SOUNDNESS OF DIE CASTING	CR	ELECT. (GROWLER TEST)	-DO-	MFG. SPEC.	MFG. SPEC.	Log Book	2		1	
2.10	ASSEMBLY	1.ALIGNMENT	MA	MEAS.	-DO-	-DO-	-DO-	Log Book	2	-	-	
		2.WORKMANSHIP	MA	VISUAL	-DO-	-DO-	-DO-	Log Book	2	-	-	
		3.AXIAL PLAY	MA	MEAS.	-DO-	-DO-	-DO-	Log Book	2	-	1	
		4.DIMENSIONS	MA	-DO-	-DO-	MFG.DRG./ MFG SPEC.	MFG. DRG/ RELEVANT IS	Log Book	2	-	-	
		5.CORRECTNESS, COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE	MA	VISUAL	100%	MFG SPEC. RELEVANT IS	MFG SPEC. RELEVANT IS	Log Book	2	-	-	
		6. RTD, BTD & SPACE HEATER MOUNTING.	MA	VISUAL	100%	MFG SPEC. RELEVANT IS	MFG SPEC. RELEVANT IS	Log Book	2		1	

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	QUALITY PLAN		CUSTOMER : MAHAGENCO			PROJECT TITLE 1X660 MW BHUSAWAL TPP			SPECIFICATION : NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 8 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
3.0	TESTS	1.TYPE TESTS INCLUDING SPECIAL TESTS AS PER BHEL SPEC CLAUSE 8.1.2	MA	ELECT.TEST	1/TYPE/SIZE	IS-325/ BHEL SPEC./ DATA SHEET	IS-325/ BHEL SPEC./ DATA SHEET	TEST REPORT	2	1	1	
		2.ROUTINE TESTS INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1[$]	1	[$] NOTE - 2
		3.VIBRATION & NOISE LEVEL	MA	-DO-	100%	IS-12075 & IS-12065	IS-12075 & IS-12065	-DO-	2	1[$]	1	[$] NOTE - 2
		4.OVERALL DIMENSIONS AND ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPC. REPORT	2	1	-	
		5.DEGREE OF PROTECTION	MA	ELECT. & MECH. TEST	1/TYPE/ SIZE	RELEVANT IS	BHEL SPEC. AND DATA SHEET	TC	2	1*	1	* REFER NOTE-3
		6. MEASUREMENT OF RESISTANCE OF RTD & BTD	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1[$]	1	[$] NOTE - 2
		7. MEASUREMENT OF RESISTANCE, IR OF SPACE HEATER	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1[$]	1	[$] NOTE - 2
		8. NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPC. REPORT	2	1[$]	1	[$] NOTE - 2
		9.EXPLOSION FLAME PROOF NESS (IF SPECIFIED)	MA	EXPLOSION FLAME PROOF TEST	1/TYPE	IS-3682 IS-8239 IS-8240	IS-3682 IS-8239 IS-8240	TC	2	-	1	TC FROM AN INDEPENDENT LABORATORY ON SIMILAR TYPE, SIZE AND DESIGN OF MOTOR.
		10. PAINT SHADE, THICKNESS & FINISH	MA	VISUAL & MEASUREMENT BY ELKOMETER	SAMPLE	BHEL SPEC. & DATA SHEET	BHEL SPEC. & DATA SHEET	TC	2	1[$]	1	SAMPLING PLAN TO BE DECIDED BY INSPECTION AGENCY [$] NOTE - 2

BHEL	PARTICULARS	BIDDER/VENDOR	
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	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER : MAHAGENCO			PROJECT 1X660 MW BHUSAWAL TPP TITLE			SPECIFICATION : NUMBER :		
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE		
	SHEET 9 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION VOLUME III		
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P W V		REMARKS
1	2	3	4	5	6	7	8	9	10		11

NOTES:

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

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

3 IN CASE TEST CERTIFICATES FOR THESE TESTS ON SIMILAR TYPE, SIZE AND DESIGN OF MOTOR FROM INDEPENDENT LABORATORY ARE AVAILABLE, THESE TEST MAY NOT BE REPEATED FOR FIRST NUMERAL OF IP-XX. SECOND NUMERAL TEST SHALL BE CARRIED OUT ON ONE MOTOR OF EACH TYPE & RATING.

4 WHEREVER CUSTOMER IS INVOLVED IN INSPECTION, AGENCY (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER.

Legends for Inspection agency

1. BHEL/CUSTOMER
2. VENDOR (MOTOR MANUFACTURER)
3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER)

P. PERFORM
W. WITNESS
V. VERIFY

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN	CUSTOMER : MAHAGENCO			PROJECT TITLE 1X660 MW BHUSAWAL TPP			SPECIFICATION : NUMBER :			
		BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-006, REV-01			SPECIFICATION TITLE			
	SHEET 1 OF 2	SYSTEM			ITEM AC ELECT. MOTORS BELOW 55KW (LV)			SECTION			VOLUME III

SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.0	ASSEMBLY	1.WORKMANSHIP	MA	VISUAL	100%	MANUF'S SPEC	MANUF'S SPEC	-DO-	2	-	-	
		2.DIMENSIONS	MA	-DO-	-DO-	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	-DO-	2	-	-	
		3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/COLOUR CODE	MA	VISUAL	100%	MFG.SPEC./ RELEVANT IS	MFG.SPEC. RELEVANT IS	-DO-	2	-	-	
2.0	PAINTING	1.SHADE	MA	VISUAL	SAMPLE	MANUFR'S SPEC/BHEL SPEC./RELEVANT STANDARD	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-	
3.0	TESTS	1.ROUTINE TEST INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	IS-325/ BHEL SPEC./ DATA SHEET	SAME AS COL.7	TEST REPORT	2	1		NOTE -1 & NOTE-3
		2.OVERALL DIMENSIONS & ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPN. REPORT	2	1	-	NOTE -1 & NOTE-3

BHEL	**PARTICULARS**	**BIDDER/VENDOR**
	NAME	
	SIGNATURE	

	QUALITY PLAN	CUSTOMER : MAHAGENCO			PROJECT TITLE 1X660 MW BHUSAWAL TPP			SPECIFICATION : NUMBER :			
		BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-006, REV-01			SPECIFICATION : TITLE :			
	SHEET 2 OF 2	SYSTEM			ITEM AC ELECT. MOTORS BELOW 55KW (LV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10	10	10	11
		3.NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPN. REPORT	2	1	-	

NOTES:

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

2 WHERE EVER CUSTOMER IS INVOLVED IN INSPECTION, (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER.

3 FOR EXHAUST/VENTILATION FAN MOTORS OF RATING UPTO 1.5KW , ONLY ROUTINE TEST CERTIFICATES SHALL BE FURNISHED FOR SCRUTINY.

Legends for Inspection agency

1. BHEL/CUSTOMER
2. VENDOR (MOTOR MANUFACTURER)
3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER)

P. PERFORM
W. WITNESS
V. VERIFY

BHEL	**PARTICULARS**	**BIDDER/VENDOR**
	NAME	
	SIGNATURE	
	DATE	BIDDER'S/VENDORS COMPANY SEAL

1.0 SCOPE

1.1 This section covers the general requirements of the drive motors for power station auxiliary equipment.

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

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

2.0 STANDARDS

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

2.2 Major standards, which shall be followed, are listed below other applicable Indian Standards for any component part even if not covered in the listed standards shall also be followed

(a) IS-325

(b) IS-12615

(c) IEC-34

3.0 SERVICE CONDITIONS

3.1 The motors will be installed in hot, humid and tropical atmosphere, highly polluted at places with coal dust and/or fly ash canopy to be provided to all outdoor install motors.

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

3.3 For motor installed outdoor and exposed to direct sunrays, the effect of solar heat shall be considered in the determination of the design ambient temperature

4.0 TYPE AND RATING

4.1 A.C. MOTORS

4.1.1 Motors shall be general purpose, constant speed, squirrel cage, three phase, induction type.

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

4.1.3 The motor name-plate rating at 50°C shall have at least 10% margin over the input power requirement of the driven HT equipment at rated duty point unless stated otherwise in driven equipment specification or in general electrical specification.

4.1.4 The motor characteristics shall match the requirements of the driven equipment so that adequate starting, accelerating, pull up, break down and full load torques are available for the intended service.

4.1.5 All LT motors used in this project are proposed to be energy efficient type suitable for EFF1 efficiency rating.

4.1.6 The motor name plate rating shall have at least 10% margin over the input power requirement of the HT driven equipment and 15% for LT driven equipments at rated duty point.

4.1.7 Motors located in hazardous area shall be flame proof type.

4.2 D.C. MOTORS

4.2.1 D.C. Motor provided for emergency service shall be shunt/compound wound type.

4.2.2 Motor shall be sized for operation with fixed resistance starter for maximum reliability.

4.2.3 Starter panel complete with all accessories shall be included in the scope of supply.

4.3 For equipment installed outdoor and exposed to direct sun rays, the effect of solar heat shall be considered in determining the design ambient temperature.

5.0 PERFORMANCE

5.1 RUNNING REQUIREMENTS

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

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

5.1.3 The motor shall be designed to withstand momentary overload of 60% of full load torque for 15 second without any damage.

5.1.4 Motor shall not be stalled if the supply voltage drops to 70% of the rated voltage for 2 seconds duration.

5.2 STARTING REQUIREMENTS

Motor shall be designed for direct online starting at full voltage. Starting current shall not exceed 6 times full load current for all auxiliaries except boiler feed pump where the starting current shall be limited to 4.5 times. No further tolerances are applicable on starting current specified above for HT motors

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

5.2.2 Motor shall start with rated load and accelerate to full speed with 80% rated voltage at motor terminal except BFP motor. In case of BFP motor, it shall

be 75% rated voltage. Minimum starting requirement for mill motor (double cage) shall be 85% rated voltage at motor terminals.

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

Cranking motor shall be capable of six equally spread starts per hour, three starts in quick succession from cold condition and one restart from hot condition. The coal conveyor and crusher motors shall be suitable for 3 consecutive hot starts with maximum 20 starts per day.

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

5.2.4 HT pump motors shall be suitable to start with forward rotation.

5.2.5 The motors shall be designed to withstand 120% of rated speed for 2 minutes without any mechanical damage

5.3 STRESS DURING BUS TRANSFER.

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

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

5.4 LOCKED ROTOR WITHSTAND TIME

5.4.1 The locked rotor withstand time under hot condition at 110% rated voltage shall be more than motor starting time by at least 2.5 seconds for motors up to 20 seconds starting time and by 5 seconds for motor with more than 20 seconds starting time.

5.4.2 Starting time mentioned above is at minimum permissible voltage of 80% rated voltage.

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

6.0 SPECIFIC REQUIREMENTS

6.1 ENCLOSURE

6.1.1 All indoor motor enclosures shall conform to the degree of protection IP-55 unless otherwise specified and outdoor motor enclosure shall confirm to degree of IPW-55.Motor for outdoor or semi-outdoor service shall be of weather-proof construction.

6.1.2 For hazardous area approved type of increased safety enclosure shall be furnished.

6.2 COOLING

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

6.2.2 In case water cooling is required for very large motors, prior approval of the customer is to be obtained before proceeding ahead with design & manufacture.

6.3 WINDING AND INSULATION

6.3.1 All insulated winding shall be of copper.

6.3.2 All motors shall have class F insulation but limited to class B temperature rise.

6.3.3 Windings shall be impregnated to make them non-hygroscopic and oil resistant.

6.4 TROPICAL PROTECTION

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

6.4.2 All fittings and hardwares shall be corrosion resistant.

6.5 BEARINGS

6.5.1 Motor shall be provided with antifriction bearings, unless sleeve bearings are required by the motor application.

6.5.2 Vertical shaft motors shall be provided with thrust and guide bearings. Thrust bearing of tilting pad type is preferred.

6.5.3 Bearings shall be provided with seals to prevent leakage of lubricant or entrance of foreign matters like dirt, water etc. into the bearing area.

6.5.4 Sleeve bearings shall be split type, ring oiled, with permanently aligned, close running shaft sleeves.

6.5.5 Grease lubricated bearings shall be prelubricated and shall have provisions for in-service positive lubrication with drains to guard against over lubrication.

6.5.6 Oiled bearing shall have an integral self cooled oil reservoir with oil ring inspection ports, oil sight glass with oil level marked for standstill and running conditions and oil fill and drain plugs.

6.5.7 Forced lubricated or water cooled bearing shall not be used without prior approval of Owner.

6.5.8 Lubricant shall not deteriorate under all service conditions. The lubricant shall be limited to normally available types with IOC equivalent.

6.5.9 Bearings shall be insulated as required to prevent shaft current and resultant bearing damage.

6.6 NOISE & VIBRATION

6.6.1 The noise level shall be as per statutory acceptance (IS/IEC).

6.6.2 The peak amplitude of the vibration shall be within IS/IEC specified limits.

6.7 MOTOR TERMINAL BOX

6.7.1 Motor terminal box shall be phase segregated (PSTB) type and located in accordance with Indian Standards clearing the motor base- plate/ foundation.

6.7.2 Terminal box shall be capable of being turned 360 Deg. in steps of 180 Deg. For HT motors and 90 Deg. for LT motors unless otherwise approved.

6.7.3 The terminal box shall be split type with removable cover with access to connections and shall have the same degree of protection as motor.

6.7.4 The terminal box shall have sufficient space inside for termination/connection of XLPE insulated armoured aluminium cables.

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

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

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

6.7.8 For 11kV and 3.3kV motor, the terminal box shall be phase-segregated type. The neutral leads shall be brought out in a separate terminal box (not necessarily phase segregated type) with shorting links for star connection.

6.7.9 Motor terminal box shall be furnished with suitable cable lugs and double compression brass glands to match with cable used.

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

6.7.11 Due to any reason, if the terminal box is found to be not suitable for the approved cable size for either HT/LT motors, then the bidder shall arrange necessary adopter box to facilitate the termination of cables. The adopter box shall be of the same short circuit rating and specifications as the main terminal box. The adopter box shall be located as near as possible to the main terminal box. The interconnecting cabling between adopter box and main terminal box along with providing suitable cable glands and termination kits as applicable shall also be done by the bidder.

6.8 GROUNDING

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

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

Motor above 90 kW	:	75 x 10 mm GS Flat
Motor above 30 kW up to 90 kW	:	50 x 6 mm GS Flat
Motor above 5 kW up to 30 kW	:	25 x 6 mm GS Flat
Motor up to 5 kW	:	8 SWG GS Wire

6.8.3 The cable terminal box shall have a separate grounding pad

6.9 RATING PLATE

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

(a) Temperature rise in Deg.C under rated condition and method of measurement.

(b) Degree of protection.

(c) Bearing identification no. and recommended lubricant.

(d) Location of insulated bearings.

6.10 CONSTRUCTION

6.10.1 Stator Core

The Stator Core Lamination shall be made of high-grade silicon/magnetic steel sheet varnished on both sides and pressed to form rigid core.

6.10.2 Rotor

The rotor construction shall be such that in case of dislodging of the rotor bar from the end ring, it should not come out and hit the stator core/stator winding and damage.

7.0 ACCESSORIES

7.1 GENERAL

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

7.2 SPACE HEATER

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

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

7.3 TEMPERATURE DETECTORS

7.3.1 All 11kV and 3.3kV motors shall be provided with twelve (12) nos. Simplex type winding temperature detectors, four (4) nos. per phase.

7.3.2 11kV and 3.3kV motor bearing shall be provided with duplex type temperature detectors.

7.3.3 The temperature detector mentioned above shall be resistance type, 3 wire, platinum wound, 100 Ohms at 0°C.

7.3.4 Leads of all simplex type motor winding RTDS and motor bearing RTDS shall be wired up to respective switchgear metering & protection compartment. From which one set of RTDS will be connected to numerical protection relay and another set shall be kept free for DCS connectivity.

7.3.5 Five numbers of Temperature detectors / thermisters shall be provided for L.T. Motors above 90 kW (3 nos. Winding temperatures & 2 nos. bearing temperatures).

7.4 INDICATOR/SWITCH

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

(a) 11kV and 3.3kV motor bearing temperature

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

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

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

7.5 CURRENT TRANSFORMER FOR DIFFERENTIAL PROTECTION

7.5.1 Motor 1000 KW and above shall be provided with three differential current transformers mounted over the neutral leads within the enclosure. Loose 3 nos. CT for mounting on switchgear side shall be in bidder's scope.

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

7.6 ACCESSORY TERMINAL BOX

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

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

7.7 DRAIN PLUG

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

7.8 LIFTING PROVISIONS

Motor weighing 25 Kg. or more shall be provided with eyebolt or other adequate provision of lifting.

7.9 DOWEL PINS

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

7.10 PAINTING

Motor including fan shall be painted with corrosion proof paints of colour shade (RAL-7032).

8.0 TESTS

8.1 ROUTINE AND TYPE TEST:

Tests are to be conducted for HT and LT motors 60kW and above in presence of Mahagenco representative and contractor as per IS: 325 and required copies of test certificates are to be furnished for approval and despatch clearance. In addition, following tests shall have to be carried out on the motors in presence of MAHAGENCO representative & contractor on LT & HT motors. For Motors below 60kW type and routine test conducted as per IS325 shall be witnessed by contractor and test certificate shall be submitted for review of Mahagenco & Dispatch clearance

8.1.1 FOR HT MOTORS:

(a) Impulse test by 1.2 / 50 micro sec. On sample coil of Stator winding insulation as type test as per IEC-671/IS 14422,1995 test voltages as under

Voltage rating of motor		Impulse Test Voltage
3.3 kV	:	18 kV peak
11 kV	:	49 kV peak

(b) Tan delta, charging current and dielectric loss measurements on each phase of motor stator winding as routine test

(c) Polarization Index Test as per IS:7816 as routine test

(d) Tan delta measurement on coils

(e) Surge withstand test for inter turn insulation.

(f) Test to diagnose rotor bar failure during manufacture.

Tests indicated at (d), (e), (f) shall be carried out during manufacture of the coils and shall be furnished for verification .

8.1.2 FOR HT & LT MOTORS:

(a) Test for suitability of IP55/ IPW– 55 as per IS 4691 as type test. Type test certificate for first numeral shall be acceptable in lieu to test,

provided the test motor is identical to motor being supplied. Second numeral test shall be carried out on one motor of each type and rating.

(b) Fault Withstand Test for main terminal box as type test. Type test certificate shall be acceptable, if the test is conducted on exactly identical terminal box within last three years.

(c) Test for noise level as routine test.

(d) Test for vibration as routine test.

(e) Overspeed test as type test.

8.2 TEST WITNESS:

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

CONSULTANT : PROCON ENGINEERS

AC & DC MOTOR

DATASHEET – A

SR. NO.	ITEM	UNIT	
1.0	AUXILIARY POWER SUPPLY		
1.1	H.T. SUPPLY		
	11kV, 3Ø, 3W, 50 Hz non-effectively earthed		Motors rated 1000 kW and above
	Fault level 44 kA symm		
	3.3kV, 3Ø, 3W, 50 Hz, non-effectively earthed		Motors above 160 kW and below 1000kW
	Fault level 40 kA symm		
1.2	L.T. SUPPLY		
	415V, 3Ø, 3W, 50 Hz effectively earthed		Motors below and including160kW
	Fault level 50 kA symm		
	240V, 1Ø, 2W, 50 Hz effectively earthed		Lighting, space heating, A.C. control & protective devices
1.3	D.C. SUPPLY		
	220V, 2W, unearthed		D.C. alarm, control & protective devices
	Fault level 25* kA.		
	Indicative only, the actual value will be decided by the Bidder, after substantiating the same by calculation		
2.0	RANGE OF VARIATION		

SR. NO.	ITEM	UNIT	
2.1	A.C. SUPPLY:		
	Voltage		± 10%
	Frequency		± 5%
	Combined Voltage & frequency		± 10% (absolute sum)
	During starting of large motor, the voltage may drop to 80% of the rated voltage for a period of 60 seconds. All electrical equipment while running shall successfully ride over such period without affecting system performance		
2.2	D.C. SUPPLY		
	Voltage		198 to 240 Volt

VOLUME IV-A

SECTION – 8

415 V PCC / PMCC / MCC, 415 V AC & 220 V DC DB/SVB/FB, 220V DC STARTER AND 415V NON-SEGREGATED PHASE BUSDUCT

CONSULTANT : PROCON ENGINEERS

CONSULTANT : PROCON ENGINEERS

CONTENTS

CONSULTANT : PROCON ENGINEERS

(A) 415V PCC/PMCC/MCC, 415V AC & 220V DC DB/SVB/FB, 220V DC STARTER

1.0 SCOPE OF SUPPLY

1.1 The following equipment shall be furnished complete with all accessories :

(a) 415V Power Control Centres

(b) 415V Motor Control Centres

(c) 415V Power-cum-Motor Control Centres

(d) 415V Distribution Boards and Fuse Boards

(e) Solenoid valve boards

(f) DC starters

(g) 415V Non-segregated phase busduct

A list of various 415V boards that have been envisaged to be supplied under the power plant EPC package is given in Annexure - A This list is only for general guidance of the Tenderers and the exact numbers shall be finalised by Bidder During Detail Engineering.

1.2 Base channel frame of all boards along with necessary mounting hardware.

1.3 Set of accessories as listed below :

(a) Breaker lifting and handling trolley

(b) Racking in/out handle for breakers

(c) Racking in/out handle for drawout MCC modules

1.4 Mandatory spares

1.5 Rubber mats suitable for 1.1kV grade as per IS 15652-2006 shall be provided in front of switchgear.

1.6 All relevant drawings, data and instruction manuals.

1.7 AUTO CHANGEOVER:

1.7.1 Auto changeover facility shall be provided in PCC and MCC as required, during DDE this switchgear/MCC will normally operate with Buscoupler open. If sustain under voltage it detected on any one of the bus section, the respective incoming breaker shall trip and buscoupler shall close if voltage is available on the other bus section. Auto changeover shall be blocked if the incoming breaker has trip due to bus fault. Manual changeover from one source of supply to other or vice versa shall be possible by momentary paralleling of two supplies after checking synchronism with the help of synchro check relay. On closing incoming breaker, the running breaker should trip within preset time. An annunciation shall be provided if the two-bus section remains parallel for more than preset time. If the running breaker fails to trip within the preset time the incoming breaker shall trip. All necessary voltage/Isolating transformer, synchro check relay etc shall be supplied for this.

The momentary parallel schemes shall be applicable for unit and station PCC.

1.7.2 Emergency switchgear shall have three incomers, one from Unit PCC, which is normally closed and another from Station PCC and one from DG set without any buscoupler. Incase of sustain under voltage on already close incomer, the same will trip and other incomer will close automatically after appreciate time relay. Incase this automatically closed the second incomer also trip due to sustain under voltage, which is normally closed automatic starting signal will be given to DG set. After the voltage built up by DG set.DG set incomer shall close automatically.

2.0 GENERAL NOTES

In the context of the specification, the following definitions shall apply.

2.1 POWER CONTROL CENTER (PCC).

2.1.1 POWER CONTROL CENTER hereinafter referred to as PCC, shall mean a continuous line-up of breaker panels, used to feed Motor Control Centres. All PCCs shall have duplicate incomers and a bus-section. Incomers, bus-section, and all outgoing feeders of a PCC shall be breaker controlled & SFU. Distribution of outgoing feeders shall be such as to ensure uniform loading on each section of the PCC.

2.2 MOTOR CONTROL CENTER, hereinafter referred to as MCC, shall mean a continuous line-up of vertical sections housing breaker panels, switch fuse, contactor operated modules. All incomers and Bus-sections shall be breaker controlled except few, which are castle key inter-locked. Whenever bus-sections are provided, all outgoing feeders shall be breaker/switch fuse controlled, or contactor operated depending upon the rating and application. Distribution of outgoing feeders shall be such as to ensure uniform loading on each section of the MCC.

2.3 POWER-CUM-MOTOR CONTROL CENTER, hereinafter referred to as PMCC, shall mean a continuous line-up of vertical sections housing breaker panels, switch fuse, and contactor-operated modules. All PMCCs shall have duplicate incomers and a bus-section. Incomers and bus-sections shall be breaker controlled. Depending upon the rating and application, outgoing feeders may be breaker controlled, switch fuse controlled, or contactor operated. Distribution of outgoing feeders shall be such as to ensure uniform loading on each section of the PMCC.

2.4 DISTRIBUTION BOARD, hereinafter referred to as DB, shall mean a continuous line-up of vertical sections housing switch fuse modules only. ACDBs shall have duplicate incomers and a bus- section. Powerhouse main DCDBs shall have two incomers from its associated battery charger with bus sectionaliser. Wherever bus-sections are provided, distribution of outgoing feeders shall be such as to ensure uniform loading on each section of DB. Two (2) nos Floor wise DC Sub DB shall be provided having single Incomer from Each Bus section of main DCDB to cater supply for HT/LT switchgear and Transformer auxiliary supply as source 1 & source 2.

Valve DBs shall be provided on floor wise/area wise of boiler and turbine side to cater valve load and will be wall mounted fed from respective boiler/turbine MCC.Valve DBs shall have single incomer only.

2.5 SOLENOID VALVE BOARD, hereinafter referred to as SVB, shall mean a continuous line-up of vertical sections housing switch-fuse modules and contactor-operated modules. SVBs may have one incomer, which shall be switch fuse controlled. All outgoing feeders shall be contactor operated.

2.6 FUSE BOARD, hereinafter referred to as FB, shall mean a continuous line-up of vertical sections housing switch fuse only. FBs Boards may be fed from DBs and may have one incomer.

AC Fuse Boards shall be with 415V/240V isolation transformer.

Incomers and outgoing feeders of DC Fuse Boards shall be 220V, 2-wire type.

The 240Vsupply for HT Panel & Motors Space Heater, wherever required shall be derived through 415V/240V Isolation transformer.

3.0 CODES AND STANDARDS

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

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

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

4.0 SYSTEM CONCEPT AND DESIGN CRITERIA

4.1 415V power distribution within the powerhouse shall be by mean of PCCs, MCCs, DBs, SVBs and FBs.

4.2 The PCCs/PMCCs shall be used to supply auxiliary power for normal and start up operation of generation units.

The MCCs/DBs/SVBs/FBs shall be used to provide power, control, and protection for A.C and D.C. auxiliary services (motors and feeders) of generating units.

4.3 The equipment will be located in a hot, humid, and tropical atmosphere, heavily polluted at places with coal dust and/or fly ash.

4.4 Duty involves direct-on-line starting of large induction motors and also under certain emergency conditions, automatic transfer of loads from one source of supply to other.

Motor starting current varies from 6 to 8 times of full load current.

4.5 Busbars of PCCs/PMCCs shall be sized to carry continuously the associated transformer secondary current plus a 20% margin.

Busbars of MCCs/DBs/SVBs/FBs shall be sized to carry continuously the total running load of the MCC/DB/SVB/FB with 20% margin.

Loads of outgoing feeders wherever applicable shall also be considered while sizing the busbars, equipment and components thereof. All busbars shall be capable of withstanding the mechanical forces and thermal stresses due to maximum short circuit current.

4.6 Minimum height of motor startor Module shall be 400mm & for SFU 300mm.

4.7 In-cubicle ratings of incomer and bus-section breakers/switches shall be identical to the associated busbar rating.

4.8 Incomer feeders & outgoing feeders rated up to and including 400A shall be SFU. Above 400 A, all incomers and outgoing feeders shall be breaker (ACB) controlled.

4.9 All motors rated 90 kW up to and including 160 kW shall be breaker controlled. For motor, rated 75 kW and above shall be provided with Numerical motor protection relay.

4.10 For continuous operation at specified ratings, the temperature rise of various equipment/components shall be limited to the permissible values specified in relevant standards and/or this specification.

4.11 Circuit breakers shall not produce any harmful over voltage during switching OFF of induction motors. If required, surge protective devices shall be included in the scope of supply to limit over voltages.

4.12 Incomer and Bus-sections of all MCC/PMCCs shall have provisions for remote operation from the respective control room through electrical control desk /CRT monitor.

4.13 Softwire logics are not acceptable for interlocks. Incomer and Bus coupler interlock shall be through hardwired logic only.

5.0 SPECIFIC REQUIREMENTS

5.1 CONSTRUCTION

5.1.1 PCCs/PMCCs/MCCs/DBs/SVBs/FBs shall be indoor, air insulated, and metal-clad type.

The design construction shall be such as to permit extension at either end.

5.1.2 PCCs/PMCCs/MCCs shall be drawout type. DBs/FBs/SVBs shall be fixed type.

5.1.3 PCCs/DBs/SVBs shall be of single-front construction and PMCCs / MCCs shall be of double-front construction. Breaker panels of PMCCs shall be of single-front construction.

5.1.4 In switchgear room and control room, all PCC/PMCC/MCC/DB/SVB / FB enclosures shall conform to the degree of protection IP-54 for ampere rating upto 1600A and above 1600 A the degree of protection will be IP-42. Minimum thickness of sheet metal used shall be 1.6mm for nonload bearing end and 2mm for load bearing end.

The design shall be such that the specified degree of protection is achieved even after a breaker control module has been taken out of the panel.

5.1.5 MCC/DB/SVB assemblies shall comprise of a continuous line-up of dead front, freestanding vertical sections, housing the control modules in multi-tier formation.

5.1.6 PCCs/PMCCs/MCCs/SVBs/DBs shall be fully compartmentalised with metal/ insulating partitions between compartments.

FBs shall be non-compartmentalised.

Working height shall be limited between 300 mm and 1900 mm above finish floor level including 100 mm base channel height.

5.1.7 Each breaker/control module shall be housed in a separate cubicle, complete with an individual front access door having sufficient opening with concealed type hinges.

Each vertical section shall have a removable back cover. All doors and covers shall be gasketted.

5.1.8 Breaker cubicles shall be so sized as to permit closing of the front access door when the breaker is pulled out to ISOLATED position. The breaker can be operated both in service & test position with the door closed.

5.1.9 For breaker panels, all switches, lamps, and indicating instruments shall be flush mounted on the respective compartment door whereas relays and other auxiliary devices shall be mounted in a separate compartment.

For MCC/DB/SVB modules, all push buttons, lamps, and indicating instruments shall be flush mounted on respective module compartment.

5.1.10 For single-front assemblies, a full-height vertical cable alley with cable supports shall be provided in each section to facilitate unit wiring.

The alley shall be liberally(250mm minimum) sized to accommodate all cables as per cable schedule and shall have removable cover at the front for access.

5.1.11 A horizontal wire way extending the entire length of the assembly shall be provided of the top for inter-panel wiring.

5.1.12 Incomers shall be provided at the ends of an assembly and bus section, wherever required, shall be provided at the middle of the assembly.

5.1.13 Four (4) Nos. lifting lugs shall be for each section, two (2) nos. on either end of the section.

5.1.14 PCCs/PMCCs/MCCs/DBs/SVBs shall be supplied with base frames of 100mm height of structural steel sections along with all necessary mounting hardware required for bolting/welding the base frames to the foundation.

FBs from finished floor level shall be supplied along with necessary hardware for mounting against wall.

5.1.15 After isolation of power and control circuit connections, it shall be possible safely carry out maintenance in a compartment with the busbar and adjacent circuit live. Necessary shrouding arrangement shall be provided for this purpose over the cable terminations located in cable alley.

5.1.16 The minimum clearance in air between phases for the entire run of horizontal and vertical busbars shall be 25mm & between phase and earth shall be 19mm.For all other components, the clearance between two live parts, a live part and an earthed part, and isolating distance shall be at least 10mm through out. Wherever it is not possible to maintain these clearances, insulation shall be provided by barriers. However, for horizontal and vertical busbars, the clearances mentioned above should be maintained even when these are sleeved or insulated. All connections from busbars up to fuses shall be fully shrouded to minimize the risk of phase-to-phase and phase to earth shorts.

5.1.17 Component layout drawing of module as well as GA drawing shall be submitted for approval.

5.2 BUS AND BUS TAPS

5.2.1 All PCCs/PMCCs/MCCs/ACDBs/SVBs/ACFBs provided with three phase busbars and neutral busbar.

All DCDBs and DCFBs shall be provided with two busbars.

All busbar compartments shall be completely enclosed.

5.2.2 Horizontal and vertical busbars and bus connections shall be of high conductivity copper/aluminium/aluminium alloy. For rating above 2000 A, conductor shall be copper.

The maximum temperature of busbars and bus connections shall be limited to 85°C i.e. 35°C rise over 50°C ambient.

No diversity factor shall be allowed for temperature rise.

5.2.3 Vertical busbars shall be designed as per technical requirement.

5.2.4 All bus connections shall be provided with anti-oxide grease. Adequate contact pressure shall be ensured by means of two-bolt connection with plain and spring washers and locknuts.

5.2.5 Bimetallic connectors shall be provided for connections between dissimilar metals.

5.2.6 All busbars and bus connections shall be fully insulated for working voltage. Insulating heat shrinkable sleeves shall be provided for all busbars. All joints and tap-off points shall be shrouded.

5.2.7 Bus insulators shall be non-hygroscopic, flame retardant, track resistant, high strength, sheet molded compound or equivalent polyester fiberglass molded type. Separate supports shall be provided for each phase and neutral busbar.

5.2.8 Cross-section of the busbars shall be uniform throughout the length of the assembly. All busbars and bus connections shall be supported and braced to withstand the stresses due to maximum short circuit current and also to take care of any thermal expansion.

5.2.9 Busbars shall be colour coded for easy identification and so located that the sequence R-Y-B shall be from left-to-right, top- to-bottom, or front to rear when viewed from the front of the assembly.

5.2.10 Bolted disconnecting links shall be provided for all incoming and outgoing feeders for isolation of neutral, if necessary.

5.3 MCC/SVB/DB MODULES

5.3.1 MCC/SVB modules shall have self-aligning power/control disconnects. All disconnects shall be silver-plated to ensure good contacts.

5.3.2 Modules of same size and type shall be physically and electrically interchangeable.

5.3.3 The design of drawout modules shall be such as to permit easy withdrawal/re-insertion of the unit with guide rails to ensure correct alignment.

5.3.4 Various module sizes should be multiples of one basic unit to facilitate modifications at site. Suitable provision for this purpose should also be incorporated in the vertical busbars.

5.3.5 Drawout modules shall have three distinct positions, namely, SERVICE, TEST and ISOLATED.

In the SERVICE position, both power and control circuits shall be engaged. It shall not be possible to open the module door when the module is in SERVICE position.

In the TEST position, the power circuits shall be disengaged but the control circuits shall be engaged. It shall be possible to close the module door when the module is in TEST position. Keeping the front access door

of module in closed condition, the Breaker can be placed in ISOLATED, TEST or SERVICE position from outside.

In the ISOLATED position, both power and control circuits shall be disengaged.

5.3.6 Modules shall house the control components for a circuit such as switch, fuse, contactors, relays, push buttons, lamps, meters, etc. only the push-button actuators, lens' of indicating lamps, and transparent windows for meters shall be mounted on module door such that when the module is withdrawn, the cubicle door shall provide specified IP-54 degree of protection when the module door is closed.

5.3.7 Breaker operated incomers and bus sections shall be provided with one (1) TEST-LOCAL-REMOTE selector switch.

Contactor operated motor feeder modules shall be provide with one (1) LOCAL-REMOTE-MCC selector switch.

5.3.8 The component layout shall provide sufficient working space in between the components.

5.4 CIRCUIT BREAKER

5.4.1 Circuit Breakers shall be three pole for motors and four poles for incomer, buscoupler and outgoing feeder, single throw, air break type with stored energy, trip free mechanism and shunt trip coil.

5.4.2 Circuit breakers shall be drawout type, having SERVICE, TEST & ISOLATED positions with positive indication for each position.

5.4.3 Circuit breakers of identical rating shall be physically and electrically interchangeable.

5.4.4 All incomer breakers, bus-section breakers, and motor feeder breakers shall have motor wound spring charging mechanism.

5.4.5 Each breaker operated feeder shall be provided with protective devices as specified in protection system.

5.4.6 All breakers with motor wound spring charging mechanism shall have facility of manual spring charging also.

5.4.7 For motor wound mechanism, spring charging shall take place automatically after each breaker closing operation. One open- close-open operation of the circuit breaker shall be possible after failure of power supply to the motor.

5.4.8 Mechanical safety interlock shall be provided to prevent the circuit breaker from being racked in or out of the service position when the breaker is closed.

5.4.9 Automatic safety shutters shall be provided to fully cover the female primary disconnects when the breaker is withdrawn.

5.4.10 Each breaker shall be provided with an closing and emergency manual trip,mechanical ON-OFF indicator, an operation counter, mechanism charge/discharge indicator, and electrical anti-pumping feature.

5.4.11 In addition to the auxiliary contacts required for normal breaker operation and indication, each breaker shall be provided with the following for interlocking purpose :

(a) Position/cell switch with minimum 4NO + 4NC contacts.

(b) Auxiliary switch, with minimum 6NO +6NC contacts, mounted on the stationary portion of the breaker panel and operated mechanically by a sliding level from the breaker in SERVICE position.

Alternatively, electrically reset-latching relay may be used for the purpose. The exact requirement contacts of the position/cells switch, limit switch, auxiliary switch and latching relay shall be decided by the Tenderers taking into account the scheme requirements spares. Limit/auxiliary switches shall be convertible type, that is, suitable for changing N.O. contact to N.C. and vice-versa.

5.4.12 Spring charge limit switch shall be provided for breakers with motor wound spring charging mechanism.These limit switches shall be provided with minimum 2NO + 2NC contact.

5.4.13 Limit/auxiliary switches shall be convertible type, that is, suitable for changing N.O. contact to N.C. and vice-versa.

5.5 SWITCHES

5.5.1 Switches shall be triple/double pole, air break type and designed for duties as specified in Annexure-A. Motor duty switches shall be capable of safely making and breaking the locked rotor current of the associated motor circuit.

5.5.2 The switch shall have a quick-make, quick-break mechanism operated by a suitable external handle, complete with position indicator. This handle shall have provision for padlocking in ON and OFF position.

5.5.3 The compartment door shall be interlocked mechanically with the switch such that the door cannot be opened unless the switch is in OFF position. Means shall be provided for releasing this interlock at any time.

5.5.4 Wherever two incoming switches and one bus-section switch/breaker are provided for an assembly, these shall be mechanically/key interlocked to ensure that only two out of the three can be closed at time.

Wherever two incoming switches are provided for an assembly, these shall be mechanically/key interlocked to ensure that only one of the two can be closed at a time.

5.6 A.C. STARTER

5.6.1 Contactors

(a) The contactors shall be three pole, air break type with non-bouncing silver/silver alloy contacts. The contactor shall be designed for duty as per Annexure-B attached.

(b) Each contactor shall be provided with minimum 2 NO and 2 NC auxiliary contacts rated 10A at 240V A.C. The exact requirement of contacts shall be decided by the tenderer taking into account the scheme requirements and spares.

(c) Contactors for forward and reverse direction of reversible drives shall preferably be both electrically and mechanically interlocked.

(d) Reacceleration system to be adopted for Boiler MCC, Turbine MCC and Emergency MCC contactor operated motor feeder.

(e) All the contactor, starters shall comply with the requirement of type 2 coordination as specified by IEC 60947-4-1.

5.6.2 Thermal Overload

(a) Thermal overload relays shall be three elements, positive acting, ambient temperature compensated with adjustable settings.

(b) Single phasing preventor shall be provided as an inbuilt feature of the thermal overload relay.

(c) Relays shall be manual reset type with changeover contacts; Resetting of relays shall be possible with compartment door closed. Colour of the resetting button shall be BLACK.

(d) Relays may be direct acting or C.T. operated, depending on current rating. C.T.s shall be included in the scope of supply.

(e) Relays for fan motors having long starting time shall be saturable case C.T operated.

5.7 D.C. STARTER

5.7.1 DC starters shall be complete with switch-fuse units, contactors, resistors, relays, meters, push buttons, lamps, etc.

5.7.2 Starters shall be furnished in totally enclosed floor-mounting, sheet steel cubicles complete with a hinged front access door. Minimum thickness of sheet steel shall be 2mm.

5.7.3 The cubicle enclosure shall provide dust and humidity protection, the degree of protection being not less than IP-54.

The resistor enclosure shall be provided with ventilating louvers and wire mesh guard and shall have a degree of protection IP-23.

5.7.4 Cubicle space heater shall be provided to maintain internal temperature above dew point. Heater shall be furnished with switch-fuse unit and thermostat control.

5.8 CONTROL AND INDICATION

5.8.1 Circuit breakers shall be wired up for local and remote operation. Each breaker cubicle shall be equipped with the following :

(a) One (1) TEST-LOCAL-REMOTE selector switch with pistol grip handle and key interlock for breakers with motor wound spring charging mechanism.

(b) Two (2) push buttons for TRIP and CLOSE

(c) Indicating lamps on the front of the compartment :

(i) Breaker open - GREEN

(ii) Breaker closed - RED

(iii) Breaker tripped - AMBER

(iv) Spring charged - WHITE

(v) Trip circuit healthy - BLUE

(vi) Breaker in Test position

(vii) Breaker in service position

5.8.2 The general scheme of connections for control, interlock, and protection shall be developed by the Tenderers during detailed engineering stage.

5.8.3 Push buttons shall be heavy duty, oil tight, push to actuate type with integral escutcheon plate marked with its function.

5.8.4 Each push-button shall have minimum two (2) NO and two (2) NC contacts rated 10A at 240 V A.C.

5.8.5 Selector switches shall be stay-put; rotary type with escutcheon plates marked to indicate the function and positions. Selector switch contacts shall be rated for 10A at 240 V A.C.

5.8.6 Selector switches shall be provided with minimum three (3) contact blocks of 1 NO + 1 NC each.

The exact requirements contacts shall be decided by the Tenderers taking into account the scheme requirement and spares.

5.8.7 Lamps shall be LED type. LED lamp shall be made in accordance with InP Technology (Aluminium Indium Gallium Phosphide Technology). The body shall be made of Poly Carbonate Unbreakable Lens. LED shall be protected by inbuilt fuse with surge suppressor or leakage voltage glow protection. LED circuit shall be PCB mounted. Intensity shall be greater than 200 mcd. All Push Button lamp shall be as per LED indicating lamp.

5.8.8 For control supply, two (2) nos. adequately rated (minimum 2kVA) 415/240V control transformers with necessary taps and auto changeover facility shall be provided. Auxiliary bus bars shall be used to distribute 240V AC control supply. The control supply of different modules shall be tapped individually from the auxiliary bus bars. Transformer ratings shall be so selected to facilitate 100% standby arrangement with adequate spare capacity.

5.8.9 DCDBs shall be provided with indication to monitor healthiness of the incoming DC supplies.

5.8.10 Two nos (minimum 2kVA) space heater transformer shall be provided for bus section A and B for catering space heater supply to respective bus.

5.8.11 For emergency MCC though there will be single bus section two nos control transformer and two nos space heater transformer to be provided.

5.9 METERS AND METER SELECTOR SWITCHES

5.9.1 All indicating instruments (96 x 96 mm) shall be switchboard types, with 240 Deg. scale, anti-glare glass and accuracy class of ±2% full scale. Each meter shall have zero adjuster on the front.

5.9.2 Motor ammeters shall have an extended suppressed end-scale range to indicate starting current (6 to 8 times full-load current).

5.9.3 Meter selector switches shall be maintained contact, stay-put type, with knob handle. Ammeter and voltmeter selector switches shall be four-position type. Ammeter selector switches shall have made before break contacts, to prevent open circuiting of CT secondary.

5.9.4 Energy meters suitable shall be provided as per Meters for Energy Accounting & Audit (MEAA) confirming to latest CEA's regulations. Energy meters shall be of accuracy class 0.2S.

5.10 CURRENT TRANSFORMER

5.10.1 Current Transformers shall be cast-resin type. All secondary connections shall be brought out to terminal blocks where wye or delta connection will be made.

5.10.2 Motor feeders rated 30 KW to below 75KW, shall be provided with CTs for metering. Motor feeders rated 75KW and above, separate CTs shall be provided for metering and protections SFU rated 100A and above for outgoing feeder shall be provided with CT and ammeter.

5.10.3 Accuracy class of the current transformers shall be :

(a) Class PS for differential

(b) Class 5P20 for other relaying

(c) Class 1.0 ISF < 5 for metering other than MEAA metering

(d) Class 0.2S for MEAA metering.

5.10.4 Feeders requiring remote metering and/or current monitoring shall be provided with current transducers with calibration for full scale reading. The output shall be 4-20 mA DC of which shall correspond to the normal range.

5.10.5 CT secondary shall be rated for 5 A for metering and 1 A for protection.

5.11 VOLTAGE TRANSFORMER

5.11.1 Voltage transformers shall be cast-resin and shall have an accuracy class of 1.0. Voltage transformer mounted on breaker carriage is not acceptable. For MEAA meter accuracy class shall be 0.2.

5.11.2 High voltage windings of voltage transformer shall be protected by current limiting fuses.

5.11.3 Low voltage fuses, sized to prevent overload shall be installed in all ungrounded secondary leads. Fuses shall be suitably located to permit easy replacement while the switchgear is energised.

5.12 PROTECTIONS

5.12.1 The minimum protections to be provided for circuit breaker controlled feeders are listed below :

(a)	Incoming Feeders	:	3-Inverse time O/C relays (51) for phase faults & Instantaneous O/C (50) with timer
		:	1-Inverse time O/C relay (51N) for Earth faults

			:	Under Voltage relay (27) with Timer (2)
			:	REF Relay (64R) & stand by E/F Relay (64 F) shallbe provided for all Transformer feed Incomers.
	(b)	Outgoing Feeders	:	2-Inverse time O/C relay (51) for phase fault 1-Inverse time O/C relay (51N) for Earth fault
			:	All inverse time O/C relay shall be 1.3 sec version
	(c)	Motor Feeders	:	Microprocessor based Numerical Protection for LT Motor 75KW and above

5.12.2 Bidder shall quote suitable digital/microprocessor based numerical relay for motor protection with following minimum facility as indicated below :

(a) Overload protection.

(b) Short circuit & SC back-up.

(c) Current unbalance/Negative phase sequence

(d) Ground fault.

(e) Locked rotor protection

The relay shall have facility for user interface capability, character display, keypad, and LED indicator and communication port along with licensed version software.

5.12.3 Apart from protection relays, each electrically operated breaker shall be provided with antipumping (94), trip annunciation (30), lockout (86) and trip circuit supervision (74) relays. Lockout relay shall be hand reset type.

5.12.4 Fuse Failure relay shall be provided on the secondary side of voltage transformer to monitor H.V. & L.V. fuses.

5.13 RELAYS

5.13.1 General-A

(a) All relays & timers in the protection circuit shall be flush mounted with connection from inside. They shall have transparent, dust tight covers, removable from the front. They shall have built-in testing facilities. Except small auxiliary relays and timers, all relays shall be drawout type.

(b) Relays shall be rated for operation on 1A secondary current and 110V secondary voltage to be decided by the bidder. Number and rating of relay contacts shall suit the job requirements.

(c) The Bidder shall furnish, install & co-ordinate all relays to suit the requirements of protection, interlock and bus transfer schemes as broadly indicated in the annexures and drawings. Application check shall be made on all motor protection relay motor characteristics. The result of such check shall be furnished for approval.

(d) It shall be the responsibility of the Bidder to fully co-ordinate the overload and short circuit tripping of the circuit breakers with the upstream and downstream circuit breakers/motor starters to provide satisfactory discrimination.

(e) All setting devices shall be accessible after removing the front cover. No relay shall be mounted on the rear side of PCC /PMCC panel.

(f) All relay coils and their auxiliary contacts (including un-enabled relays in Composite Numerical Relays, if any), including spare contacts will be wired up to the terminal blocks of respective panels for wiring to DCS & SCADA and for future use.

(g) Parameterization and loading and downloading of data shall be possible from local HMI and as well as from DCS / SCADA.

(h) All numerical relays shall have front communication port for parameterization, loading and downloading of data thru' Laptop.

(i) All numerical relays and multi-functional meters shall be hooked up and connected with HMI through Fiber Optic cable.

(j) Interposing relays (24V DC) with freewheeling diodes for signal exchange between Switchgear & DDCMIS/EDMS/PLC shall be provided in switchgear/PCC/PMCC module for controlling each feeder.

(k) All DDCMIS/DCS/PLC operated motor feeders of any rating shall have ammeter & current transducer at "Y" phase.

5.13.2 General-B

(a) All protective relays shall be of numerical microprocessor based multifunctional type having communication facility for connection to DCS through PC via PLC console.

(b) All relays shall conform to the requirements of IS 3231 / IEC: 60255 standards.

(c) Vendor shall ensure availability of spare parts and maintenance support for the equipment for at least 15 years from the date of supply.

(d) Any foreign relay manufacturer through his Indian partner or subsidiary company in India shall provide application, testing, commissioning and other necessary support for minimum 15 years. They shall also maintain adequate inventory of each type of relay or spares to meet the requirement arising during project execution and plant operation.

5.13.3 Technical Requirement

(a) Auxiliary Power Supply

Unless otherwise specified, relay shall be suitable to accept both AC / DC supplies with range 110V to 240V with tolerance of ± 20%. The auxiliary power supply shall preferably be site selectable requiring no additional hardware.

(b) Basic Requirement and Constructional Requirement

(i) Relays shall be suitable for flush mounting on the front with connections from the rear. The enclosure shall be dust tight having degree of protection minimum as IP: 5X.

(ii) Relay shall have draw out feature with plug in type PCB for easy replacement. In case of fixed type relay, the terminals shall be easily accessible for testing and commissioning.

(iii) Relay shall have self-diagnostic feature with indication of relay failure on relay front. However, while diagnostic circuit runs, it must not interfere in the main protective relay circuit and allow working of main protective circuit continuously. Relay faults (self-diagnostic) shall be communicated and annunciated to HMI.

(iv) Design of the relay shall be such that it must operate selectively and with proper discrimination. It 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.

(c) Display & Indication

(i) All numerical relays shall have keypad / keys to allow relay settings from relay front. In addition, relay shall have front port for downloading / uploading of relay settings from the PC / Laptop. All hand-reset relays shall have reset button on the relay front. Relay to be self or hand reset shall be

software selectable.

(ii) All relays shall have LED/ LCD display for settings, status, faults and events. LCD display shall be backlit and temperature compensated up to 65°C for contrast and legibility.

(iii) As a minimum, the relay shall have LED indicating lamps for fault trip, relay healthy / unhealthy and control supply on.

(iv) The relay shall have at least 6 programmable LEDs on relay front.

(d) Software Security

Relay shall be provided with password protection against unauthorized write access. However, viewing of metering data, settings, and status and event data as read only parameters should be without password protection.

(e) Disturbance, Event Recording & Data Storage

Status, disturbance data and events shall be stored in non- volatile memory or memory backed up by battery. It should be possible to store minimum 50 events with date and time stamp, last 5 fault records and last disturbance record. When auxiliary power fails, it should be possible to see the latest state of display when power is restored. Also, in case of power supply failure lock out status of the relay should be stored and kept in memory to allow the working of interlock logic properly on restoration of the supply.

(f) Trip Circuit Supervision & Lock out function

(i) Relay shall have built in lockout function. Lock out feature shall be selfreset or hand reset and shall be software selectable.

(ii) For trip circuit supervision separate relay shall be provided.

(g) Input / Output Interface, Filters and Galvanic Isolation.

(h) Relay shall have at least 4 NO contacts each shall separately be programmable for either hand reset or self-reset. The contact rating shall be minimum 5A at 250V AC / DC.

(i) Relay shall be made immune to capacitance effect due to long length cables.

(ii) All IOs shall have galvanic isolation. Analog inputs shall be protected against switching surges, harmonics etc.

(i) Serial Communication

(i) Relay shall have RS 485 or FO (Fiber Optic) port for serial communication.

(ii) All relays should be able to communicate with DCS system. Data shall be available at the DCS on request.

(iii) Protocol adapted for communication to DCS should facilitate easy interface with world wide used open protocol like Modbus or IEC 103 protocols.

(iv) It shall be also possible for Relay Parameterization as well Downloading of Disturbance Records from PC provided in Unit & Engineering Workstations located in Switchgear Room of each unit i.e. Unit & Engineering Workstations shall be provided each in four (4) Switchgear Rooms. Necessary software to be provided for this purpose. Communication protocol shall be selected from relay to PC to provide all information.

5.14 SECONDARY WIRING

5.14.1 Allboards shall be fully wired at the factory to ensure proper functioning of control, protection, transfer and interlocking schemes.

5.14.2 Fuse and links shall be provided to permit individual circuit isolation from bus wires without disturbing other circuits. All spare contacts of relays, switches and other devices shall be wired up to terminal blocks.

5.14.3 Wiring shall be done with flexible, 1100 Vgrade,PVC insulated switchboard wires with stranded copper conductors of 2.5 mm^2 for current circuit and 1.5mm^2 control (grey colour) and voltage circuit. Colour code shall be maintained for voltage and current circuit.

5.14.4 Each wire shall be ferruled by plastic tube with indelible ink print at both end having terminal block no., terminal nos., destination no. as per approved Drawing.

5.14.5 Wire terminations shall be made with crimping type connectors with solder as insulating sleeves. Wires shall not be spliced between terminals.

5.15 TERMINAL BLOCKS

5.15.1 Terminal blocks shall be 660V grade box-clamp type 10 mm^2 minimum with marking strips.Terminals for C.T.secondary leads shall have provision for shorting.

5.15.2 Terminal blocks used for interface with DCS via termination cabinet shall be suitably sized to facilitate proper termination of interconnecting cables.

5.15.3 Not more than two wires shall be connected to any terminal. Spare terminals equal in number to 20% active terminals shall be furnished.

5.15.4 Terminal blocks shall be located to allow easy access. Wiring shall be so arranged that individual wires of an external cable can be connected to consecutive terminals.

5.16 CABLE TERMINATION

5.16.1 Generally all assemblies shall be designed for cable entry from the bottom. Sufficient space shall be provided for all the cables as per cable schedule, for ease of termination and connection.

5.16.2 All provisions and accessories shall be furnished for termination and connection of cables as per cable schedule, including removable gland plates, cable support, crimp type tinned copper/aluminium lugs, double compression brass glands with tapered washer (Power cable only) and terminal blocks.

5.16.3 Gland plates shall be minimum 4 mm thick. The gland plate and supporting arrangement for 1/C power cables shall be non-magnetic type to minimise the flow of eddy current.

5.17 BUS DUCT CONNECTION

5.17.1 Bus duct connection, wherever provided, shall be furnished along with transition panel, if required. Bus duct connections shall be from the side.

5.17.2 All connecting bus work shall have the same continuous rating as associated PCC/PMCC/MCC/DB bus and shall be fully braced for the LT system short circuit current.

5.17.3 All provisions such as matching flanges and other accessories required for proper connection to bus duct shall also be supplied.

5.18 GROUND BUS

5.18.1 A ground bus, rated to carry maximum fault current, shall be provided which shall extend the full length of the assembly.

5.18.2 The ground bus shall be provided with two-bolt drilling with GS bolts and nuts at each end and shall be suitable to receive 50 x 6 mm G.S. flat.

5.18.3 All stationary units shall be directly connected to the ground bus for effective grounding.

The frames of all circuit breakers and V.T. units shall be grounded through heavy multiple contacts at all times except when the primary disconnecting devices are separated by a safe distance.

The frames of all other drawout modules shall be grounded at all times except when the power disconnects are separated by a safe distance.

5.18.4 Wherever the schematic diagrams indicate a definite ground at the switchgear; a single wire for each circuit thus grounded shall be run independently to the ground bus and connected thereto.

5.18.5 C.T. & V.T. secondary neutrals shall be earthed through removable links so that earth of one circuit may be removed without disturbing others.

5.18.6 All hinged doors shall be earthed by flexible copper braid.

5.19 NAMEPLATES

5.19.1 Nameplates of approved design shall be provided on each cubicle, at the top of the assembly and on each instrument & device mounted on or inside the cubicle.

5.19.2 The material shall be lamicoid or approved equal. 3 mm thick with white letters on black background.

5.19.3 The nameplates shall be held by self-tapping screws. Nameplate size shall be minimum 40 x 150 mm for instrument/devices & 75 x 450 mm for panels.

5.19.4 Caution notice on suitable metal plate shall be affixed both at the front and back of each vertical panel.

5.20 SPACE HEATERS AND PLUG SOCKETS

5.20.1 Each vertical section shall be provided with thermostat controlled space heater and 5A, 3-pin plug socket.

5.20.2 In addition, motor feeders rated 30 kW and above shall be wired-up for feeding the motor space heater through suitably rated breaker auxiliary NC contact and/or contactor.

5.20.3 Cubicle heater, Motor heater, and Plug-socket circuit shall have individual switch fuse units.

5.21 A.C./D.C. POWER SUPPLIES

5.21.1 Necessary 415V AC and 220V DC power supplies as required for control and service shall be arranged by the contractor.

5.21.2 Isolating switch fuse units shall be provided for the incoming supplies. These shall be 4-pole, single throw for 415V AC and 2- pole double throw without off position for 220V DC.

5.21.3 Bus-wires of adequate capacity shall be provided to distribute the incoming supplies for different cubicles. Isolating switch- fuse units shall be provided at each cubicle for A.C. /D.C. supplies.

5.21.4 A.C. load shall be so distributed as to present a balanced loading on three-phase supply system.

5.22 TROPICAL PROTECTION

5.22.1 All equipment, accessories and wiring shall have fungus protection, involving special treatment of insulation and metal against fungus, insects & corrosion.

5.22.2 Screens of corrosion resistant material shall be furnished on all ventilating louvers to prevent entry of insects.

5.23 PAINTING

5.23.1 All assemblies shall be finished with two coats of RAL7032 shade.

6.0 TESTS

6.1 The switchgear shall be completely assembled, wired, adjusted and tested at the factory as per the relevant standards..

6.2 ROUTINE TESTS

The tests shall include but not necessarily limited to the followings:

(a) Operation under simulated service condition to ensure accuracy

of wiring, correctness of control scheme & proper functioning of the equipment.

(b) All wiring and current carrying parts shall be subjected to appropriate High Voltage Test.

(c) Primary current & voltage shall be applied to all instrument transformers.

(d) Routine test shall be carried out on all equipment such as circuit breakers,instrument transformers,relays,meters,contactors, switch-fuses, etc.

6.3 TYPE TESTS

The following type tests shall be performed on a representative sample of the LV Switchgear assembly, type test certificates of these tests shall be submitted by the Bidder for Purchaser's approval :

(a) Temperature rise Test

(b) Short circuit test should be performed so that one complete (longest) span of insulator supports of main busbars are covered in the S.C path thereby subjected to dynamic forces developed.

Short circuit test shall be performed in the following section of the busbar:-

Circuit Breaker Panel: In the main horizontal busbar and vertical bus bar with ACB replaced by shorting link.

Motor Control Centre / Distribution Boards:- Main horizontal busbar, Vertical busbar.

6.4 Type test can be waived off for LV Switchgear on producing type test certificates conducted within last five (5) years for identical LV Switchgear. Type tests shall be conducted by successful bidder for LV Switchgears for which type test certificates are not available for identical LV Switchgear, conducted within last 5 years.

6.5 TEST WITNESS

Tests shall be performed in presence of Owner/Purchaser's representative if so desired by the Owner/Purchaser. The contractor shall give at least thirty (30) day's advance notice of the date when the tests are to be carried out.

(B) 415V NON SEGREGATED BUSDUCT

1.0 GENERAL

1.1 The busduct will serve as interconnection between L.V terminals of Auxiliary L.T Transformers to their respective PCC/PMCC andalso for trunking connection between each set of PCC/PMCC, if required.

1.2 The busduct shall be non-segregated type, self-cooled. The cooling medium inside the duct shall be air.

1.3 The busduct will be installed in a hot, humid and tropical atmosphere.

1.4 For continuous operation at specified rating, maximum temperature of the busduct shall be limited to the following, considering 50°C as ambient temperature :

(a) Bus Conductor/Bus Connection

(i)	with silver plated joints	:	105° C
(ii)	with plain or tin joints	:	90° C
(iii)	Bus Enclosure/Supports	:	80° C
(iv)	Bus conductor	:	85 ° C

(b) It shall be capable of withstanding the mechanical forces and thermal stresses of the specified short-circuit currents without any damage or deterioration of material.

(c) Wherever expansion joints are required neoprene rubber bellows shall be provided for enclosure and flexible connectors for conductor

1.5 Same phase disposition shall be maintained throughout the run of the bus duct. Phase cross-over units, if required, shall also be provided.

1.6 The minimum distance between transformer terminal box of LT side and MCC terminal box shall be 1500mm.

2.0 ENCLOSURE

2.1 All the three phases shall be enclosed in a weather proof, dust tight enclosure. Outdoor section of the busduct shall be completely rain proof. For bus rating including and above 2000 A, enclosure shall be of aluminium and for bus rating below 2000 A, enclosure shall be of sheet steel fabricated type. Minimum Degree of protection of busduct enclosure shall be IP-54 for indoor and IPW-55 for outdoor section of the busduct.

2.2 Weather resistant type circumferential gaskets shall be provided for making the joints with adjacent enclosures dust-proof and imperious to moisture.

2.3 The connection flanges shall be sufficiently stiffened so as not to bend while tightening the bolts.

2.4 Suitable inspection opening with gaskets shall be provided for access to support insulator, bus joints etc.

3.0 BUS CONDUCTOR

3.1 The conductor shall be of high conductivity aluminium /aluminium alloy sized for the same rating as associated PCC/PMCC bus. for rating above 2000A conductor shall be copper.

3.2 Joints made at the factory shall be welded type and the joints to be made at site shall be bolted type.

3.3 For bolted rigid/expansion joints, necessary bolts, nuts, (cadmium plated) washers and other hardwares shall be supplied.

3.4 Busbars shall be colour coded at regular intervals for easy identification. The markings on the bars shall be Red for R-phase, Yellow for Y-phase, and Blue for B-phase.

3.5 For each shipping section, the bus conductor shall be supported at minimum two positions.

4.0 BUS-BAR SUPPORT

4.1 All buses and connections shall be supported and braced to withstand stresses due to maximum short circuit current.

4.2 The bus conductor supporting insulators shall be flame retardant, non-hygroscopic, high strength track resistant type with high creepage surface.

4.3 The insulators shall be so located that they can be easily removed and replaced without dismantling the busduct installation.

4.4 Space heater shall be provided near each insulator to avoid moisture condensation within busduct.

4.5 The number and wattage of space heaters shall be decided by the Tenderers.

5.0 SUPPORTING STRUCTURES

5.1 All supporting structures required for hanging and/or supporting the complete busduct shall be furnished. These include all members, indoor/outdoor posts, bolts, shims, base plates, beams, hangers, brackets, bracings and hardware.

5.2 All buses shall be adequately supported and braced to successfully withstand normal operation, vibration, thermal expansion, short circuit forces, and all specified design loads.

5.3 All steel members shall be hot-dip galvanised after fabrication. All hardware shall be of high strength steel with weather resistant finish.

5.4 For each shipping section, the enclosure shall be supported at minimum two positions.

5.5 The enclosure supporting arrangement shall be such that the busduct load is not transmitted onto the terminations.

6.0 CONNECTIONS AND TERMINATIONS

6.1 All matching flanges, seal-off bushings, gaskets, fittings, hardware, and supports required for termination of the busduct at PCC/PMCC, transformer, and any other equipment shall be supplied.

6.2 All hardware used at conductor points shall be of non-magnetic, high tensile material.

6.3 Expansion joints for both conductor and enclosure shall be provided as follows:

(a) At all equipment terminations

(b) On either side of seal-off bushings

6.4 Expansion joints shall be provided on bus conductor and enclosure to take care of thermal expansion.

6.5 Seal-off bushing with wall frame assembly shall be provided wherever the busduct penetrates the building wall from outdoor to indoor.

6.6 Equipment terminal connection shall be readily accessible and shall provide sufficient air gap for isolation of equipment during testing.

6.7 If the material of bus conductor and that of the equipment terminal connectors are different, suitable bi-metallic connectors shall be provided.

7.0 GROUNDBUS

7.1 A ground bus rated to carry maximum fault current shall be provided running the entire length of the busduct on both sides. Grounding all parts of the supporting structure and each enclosure section.

7.2 The ground bus shall be provided with two-bolt drilling with GS bolts and nuts at each end to receive 50 x 6 mm G.S. flat.

8.0 FINISH

8.1 Except for supporting steel structures, which shall be galvanised, all other material, shall be finished with a undercoat of high quality primer followed by two coats of synthetic enamel paint.

8.2 The interior surface finish shall be as per manufacturer's standard. The shade of exterior surface finish will be Siemens grey RAL 7032

8.3 Pre-treatment consisting of degreasing, derusting etc. shall be done on all fabricated parts before painting or galvanising.

8.4 Paints shall be carefully selected to withstand heat and weather conditions. The paint shall not scale off or crinkle or are removed by abrasion due to normal handling.

8.5 Sufficient quantities of all paints and preservatives required for touching up at site shall be furnished.

9.0 TESTS

9.1 The busduct shall be completely assembled and checked at the factory for correctness of alignment.

10.0 ROUTINE TESTS

Busduct shall be subjected to the following tests:

(a) Visual inspection and verification of dimensions.

(b) Dry power frequency voltage withstand test for 1-min.

(c) Insulation resistance measurement.

(d) Milli-volt drop test.

10.1 TYPE TESTS

The following type tests shall be performed on a representative section of bus assembly:

(a) Impulse voltage withstand test.

(b) Heat run test.

(c) Short circuit test.

(d) Water tightness test.

(e) Air tightness test

Type test can be waived off for LV Busduct on producing type test certificates conducted within last five (5) years for identical LV Busduct (Same rating and same dimensions). Type tests shall be conducted by successful bidder for LV Busduct for which type test certificates are not available for identical LV Busduct, conducted within last 5 years.

10.2 MISCELLANEOUS COMPONENTS

Tests on insulators, etc. shall be carried out as specified in relevant standards.

11.0 TEST WITNESS

Tests shall be performed in presence of Owner/Purchaser's representative if so desired by the Owner/Purchaser. The contractor shall give at least thirty (30) day's advance notice of the date when the tests are to be carried out.