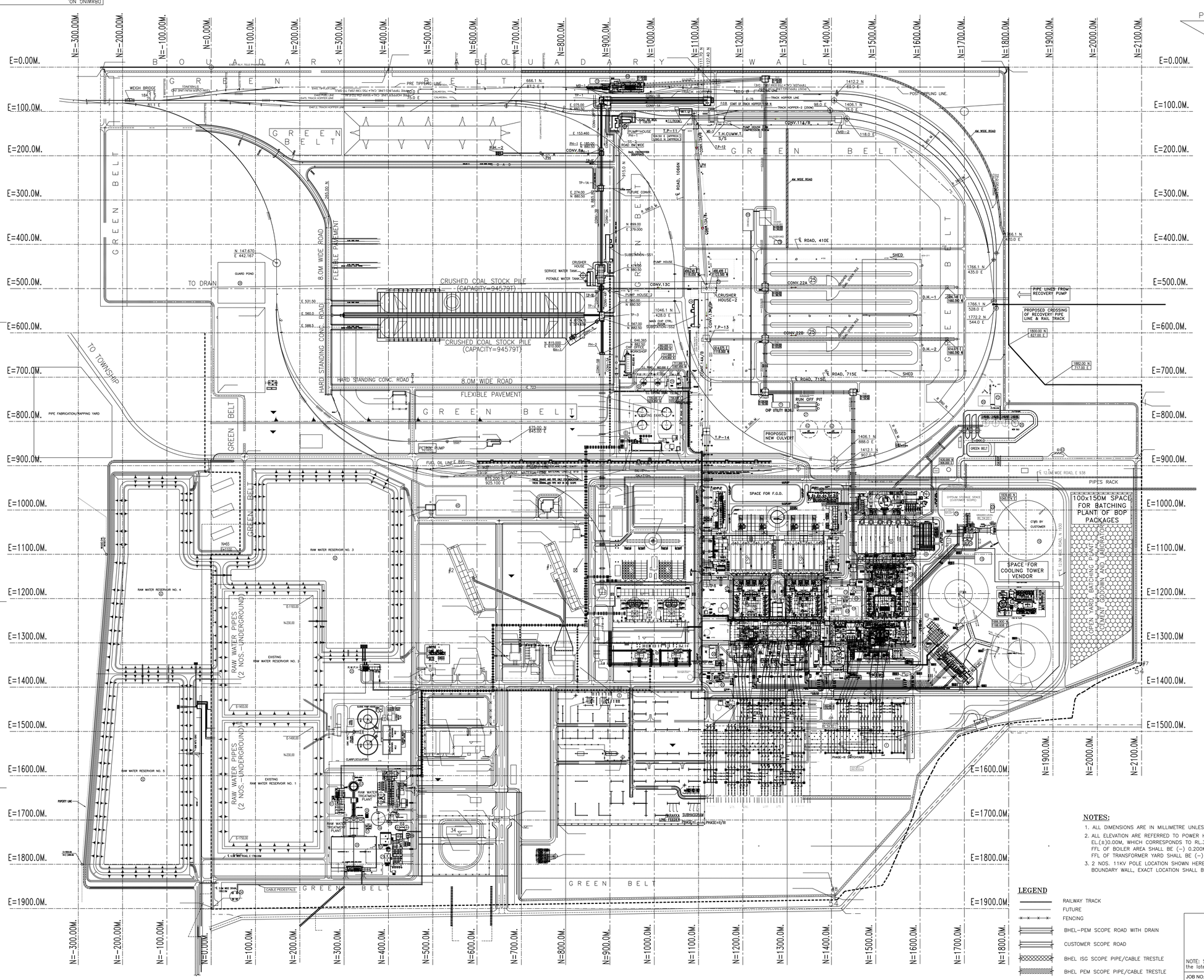


FIRST ANGLE PROJECTION

ALL DIMENSIONS ARE IN MM

DRAWING NO.
PE-DG-445-100-M001

LEGEND

S.No.	DESCRIPTION
1	400 KV. SWITCHYARD EXTENSION
2	EXISTING SWITCHYARD CONTROL ROOM/GRID CONTROL ROOM (GCR)
3	C.W. PIPE CORRIDOR
4	TRANSFORMER YARD
5	TG BUILDING (POWER HOUSE)
6	BOILER HOUSE
7	MILL BAY
8	ELECTROSTATIC PRECIPITATOR
9	E.S.P CUM FGD CONTROL ROOM
10	CHIMNEY (CUSTOMER SCOPE)
11	F.G.D.
12	AHP COMPRESSOR ROOM (EXT)
13	CONDENSATE STORAGE TANK (NEW) AND PUMP HOUSE (EXT)
14	ELEC. & CONT. ROOM (CW PUMP HOUSE)
15	CONTROL BUILDING
16	COOLING TOWER (CUSTOMER SCOPE)
17	C.W. PUMP HOUSE & FOREBAY FOR UNIT #5
18	C.W. TREATMENT BUILDING & GAS CHLORINATION
19	AMMONIA UNLOADING, HANDLING & STORAGE TANK
19A	MRS COMPRESSOR HOUSE
20	CLARIFIED WATER RESERVOIR & P/H (EXT)
21	D.M.PLANT (EXT)
22	ELECTRICAL BUILDING FOR NDCT #5
23	CRUSHER HOUSE (EXT)
24	CHP CONTROL ROOM (EXT)
25	COAL STOCK PILE (EXT)
26	FLY ASH SILO FOR UNIT #5
27	RUN OFF PIT (EXT)
28	GUARD POND (EXT)
29	FUEL OIL PUMP HOUSE (EXT)
30	FUEL OIL STORAGE TANK (EXT)
31	FAE TOWER
32	RAW WATER RESERVOIR (EXT)
33	RAW WATER PUMP HOUSE (EXT)
34	11KV POLE
35	COMPRESSOR HOUSE (EXT)
36	D.G. BUILDING
36A	AIR WASHER UNIT
37	MILL REJECT SILO
38	VACUUM PUMP CUM COMPRESSOR HOUSE-AHP & SWITCH GEAR WITH CONTROL ROOM
39	LT SWITCHGEAR ROOM (EXT)
40	ASH SLURRY SUMP & PUMP HOUSE (EXT)
41	ASH WATER SUMP & PUMP HOUSE (EXT)
42	ASH CLARIFLUCCULATOR (EXT)
43	WEIGH BRIDGE (EXT)
44	ASH DYKE
45	HYDROGEN BUILDING & HYDROGEN CYLINDER STORAGE SHED (EXT)
46	CTBD RO PLANT FOR UNIT #5
47	RETENTION PIT FOR OILY WASTE FROM FUEL OIL STORAGE AREA & OILY WASTE TRANSFER PUMPS (EXT)
48	CPU REGENERATION BUILDING FOR UNIT #5
49	CPU N-PIT FOR UNIT #5
50	EFFLUENT TREATMENT PLANT
51	NOT USED
52	NOT USED
53	NOT USED
54	SLUDGE THICKENER (EXT)
55	THICKENER SUPERNATANT COLLECTION SUMP & THICKENER SUPERNATANT TRANSFER PUMPS (EXT)
56	CENTRIFUGE (EXT)
57	THICKENER SLUDGE PIT (EXT)
58	POLYELECTROLYTE DOSING TANKS & PUMPS (EXT)
59	SILO UTILITY BLDG. (EXT)
60	RAIN WATER COLLECTION SUMP
61	CHEMICAL HOUSE (EXT)
62	CLARIFLOCUTOR
63	AERATOR (EXT)
64	DM TANK (EXT)
65	DEGAS WATER STORAGE TANK (EXT)
66	NEUTRALISATION PIT (EXT)
67	CRUSHER HOUSE (NEW)
68	WAGOR TIPPLER (NEW)
69	CRUSHER HOUSE SUB-STATION (NEW)
70	WAGON TIPPLER SUB-STATION (NEW)
71	CHP UTILITY BLDG. (NEW)
72	ASH SILO ELECTRICAL BUILDING (NEW)
73	CHP MCC ROOM (NEW)
74	BULLDOZER SHED (NEW)
75	FGD GYPSUM SLURRY STORAGE TANK & PUMPS (CUSTOMER SCOPE)

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRE UNLESS NOTED OTHERWISE.
2. ALL ELEVATION ARE REFERRED TO POWER HOUSE GROUND FLOOR AS EL.(±)0.00M, WHICH CORRESPONDS TO RL.34.5M ABOVE MSL.
   FFL OF BOILER AREA SHALL BE (–) 0.200M i.e. RL 34.30M
   FFL OF TRANSFORMER YARD SHALL BE (–) 0.100M i.e. RL 34.40M
3. 2 NOS. 11KV POLE LOCATION SHOWN HERE INDICATIVE ONLY NEAR BOUNDARY WALL, EXACT LOCATION SHALL BE FINALISED LATER.

LEGEND

RAILWAY TRACK
FUTURE
FENCING
BHEL-PEM SCOPE ROAD WITH DRAIN
CUSTOMER SCOPE ROAD
BHEL ISG SCOPE PIPE/CABLE TRESTLE
BHEL PEM SCOPE PIPE/CABLE TRESTLE

REV.	DATE	ALTD	CHD	APPD	
04	23.03.2021	PUNEET	SK	BKA	1. DRG REVISED AS PER CUSTOMER/CONSULTANT COMMENTS RECEIVED VIDE TRANSMITTAL DTD: 13/10/2020. 2. STAGE-II HYDRANT PIPING LAYOUT HAS BEEN SHOWN. 3. AHP& CHP AREA HAS BEEN UPDATED. 4. BOILER AND FGD AREA HAS BEEN UPDATED. 5. TRANSFORMER YARD LAYOUT HAS BEEN UPDATED. 6. CTBD AREA HAS BEEN UPDATED. 7. CW PUMP HOUSE HAS BEEN UPDATED. 8. DRAWING GENERALLY UPDATED.
03	11.09.2020	PUNEET	SK	BKA	1. DRG REVISED AS PER CUSTOMER/CONSULTANT COMMENTS RECEIVED VIDE MAIL DTD: 30/07/2020. 2. TRANSFORMER YARD LAYOUT HAS BEEN UPDATED. 3. DRAWING GENERALLY UPDATED.
02	12.05.2020	PUNEET	SK	BKA	1. DRG REVISED AS PER CUSTOMER/CONSULTANT COMMENTS RECEIVED VIDE LTR REF. NO: DCPL-12105/DCH-5/BHEL-(PEM)/0015 AND DISCUSSION HELD AT WBPDCL OFFICE DTD:28/01/2020. 2. MILL ARRANGEMENT HAS BEEN CHANGED TO SIDE MILL. 3. AHP/CHP LAYOUT HAS BEEN UPDATED. 4. VACUUM PUMP-AHP HAS BEEN RE-LOCATED TO COMPRESSOR HOUSE BUILDING . 5. DRAWING GENERALLY UPDATED.
01	02.11.2019	PUNEET	SK	SPV	1. DRG REVISED AS PER CUSTOMER/CONSULTANT COMMENTS RECEIVED VIDE LTR REF. NO: DCPL-K8A07/DCH-5/BHEL/0001. AND MOM DATED 17/10/2019 AT WBPDCL OFFICE. 2. TRANSFORMER YARD HAS BEEN UPDATED. 3. BOOSTER PUMP HAS BEEN RELOCATED. 4. VACUUM PUMP HOUSE FOR AHP HAS BEEN RELOCATED. 5. DRAWING GENERALLY UPDATED.

NOTE: Scan QR code for checking the latest Rev. status of drawing.

JOB NO. 445
STATUS CONTRACT
DISTRIBUTION
TO
NO.

CUSTOMER:
WBPDCL
THE WEST BENGAL POWER DEVELOPMENT CORPN. LTD.(WBPDCL)
1X660MW,SAGARDIGHI THERMAL POWER EXTENSION PROJECT (UNIT #5)

CONSULTANT:
DEVELOPMENT CONSULTANTS PRIVATE LIMITED
KOLKATA

Maharatna Company
BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA

DEPT CODE		NAME	SIGN	DATE
M	DRN	SK		24.05.2019
	DESN	PUNEET		24.05.2019
	CHD	SK		24.05.2019
	APPD	JJ		24.05.2019

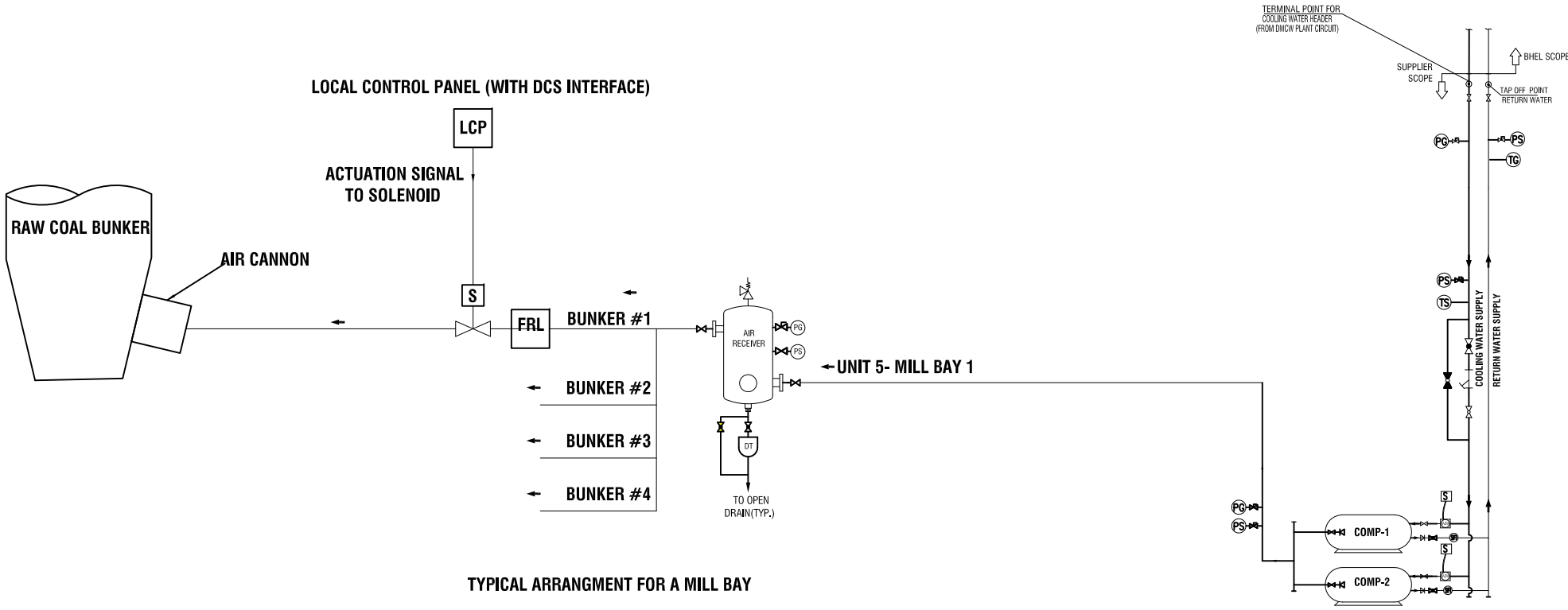
TITLE
PLOT PLAN

DEPT.
SIGN
DATE
SCALE 1:200

DRAWING NO.
PE-DG-445-100-M001
SHEET 01 OF 02
REV. R04

SIZE-A0

ELECTRONIC FILE NAME: 445_100_M001_R04



TYPICAL ARRANGMENT FOR A MILL BAY

OIL FREE SCREW COMPRESSORS (1 WORKING +1 STANDBY)

LOCATED IN MRS COMPRESSOR HOUSE

NOTE:

1. EQUIPMENT & INSTRUMENTS SHOWN IN THIS SCHEME ARE MINIMUM REQUIREMENT FOR THE SYSTEM. ANY ADDITIONAL DEVICE/ EQUIPMENT/ INSTRUMENTS REQUIRED FOR SYSTEM COMPLETION AND SATISFACTORY OPERATION, SHALL BE PROVIDED.
2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE TECHNICAL SPECIFICATION.

LEGEND:-

- GATE VALVE
- BALL VALVE
- GLOBE VALVE
- DT — DRAIN TRAP
- INSTRUMENT ISOLATION COCK
- AOV — AIR OPERATED VALVE
- NON RETURN VALVE
- SAFETY VALVE
- PG — PRESSURE GAUGE
- PS — PRESSURE SWITCH
- SFI — SIGHT FLOW INDICATOR
- S — SOLENOID VALVE
- TS — TEMPERATURE SWITCH
- FRL — FILTER REGULATOR LUBRICATOR

CUSTOMER: THE WEST BENGAL POWER DEVELOPMENT CORPN. LTD.(WBPDCL)
1X660MW,SAGARDIGHI THERMAL POWER EXTENSION EXTENSION PROJECT (UNIT #5)

CONSULTANT: DEVELOPMENT CONSULTANTS PRIVATE LIMITED KOLKATA

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECTS ENGINEERING MANAGEMENT
NOIDA

	DATE	NAME
DRAWN BY	21.07.21	VVH
DESIGN BY	21.07.21	VVH
CHECKED BY	21.07.21	RR
APPROVED BY	21.07.21	SKS
SUPERSEDE:		
SUPERSEDED BY:		
SYSTEM:		

SCALE:
SHEET 1 OF 1

TITLE: FLOW SCHEME FOR COAL BUNKER DEBLOCKING DEVICES

SIZE: A3 | PROJECT NO.: 445 | FILE:
ANNEX: | DRAWING NO.: PE-DG-445-154-100 | REV 0

389488/2021/PS-PEM-MAX

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM)

REV.	DATE	ALTERED / CHECKED	REV.	DATE	ALTERED / CHECKED

JOB No. 445

REV	STATUS	TYPE	REASONS FOR REVISION	PREPARED	CHECKED	APPROVED	DATE
03	-	-	Revised as per DCPL's comments dtd 05-10-20	VVH	RR	GB	25-11-20
02	-	-	Revised as per DCPL's comments dtd 21-07-20	VVH	RR	GB	01-09-20
01	-	-	1) Rev 00 submitted with rear mill.Comments not recieved till date. 2) Revised as per Trichy's 'Input data for Bunker Sizing'Rev 01 : CPT-1324 & Plan and Elevation of Mill Bay Rev 00 dtd 03-03-2020 for change to side mill arrangement.	VVH	PKK	GB	02-04-20

CUSTOMER

WBPDCL

THE WEST BENGAL POWER DEVELOPMENT CORPN.LTD.(WBPDCL)

1 x 660MW, SAGARDIGHI THERMAL POWER EXTENSION PROJECT (UNIT #5)

CONSULTANT

DEVELOPMENT CONSULTANTS PVT. LTD.
CONSULTING ENGINEERS
KOLKATA

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA

Maharatna Company

DRN	NAME	SIGN	DATE
PRPD	VVH	--SD--	27-03-2019
CHD	PKK	--SD--	27-03-2019
APPD	GB	--SD--	28-03-2019

TITLE:BUNKER SIZING CALCULATION FOR RAW COAL

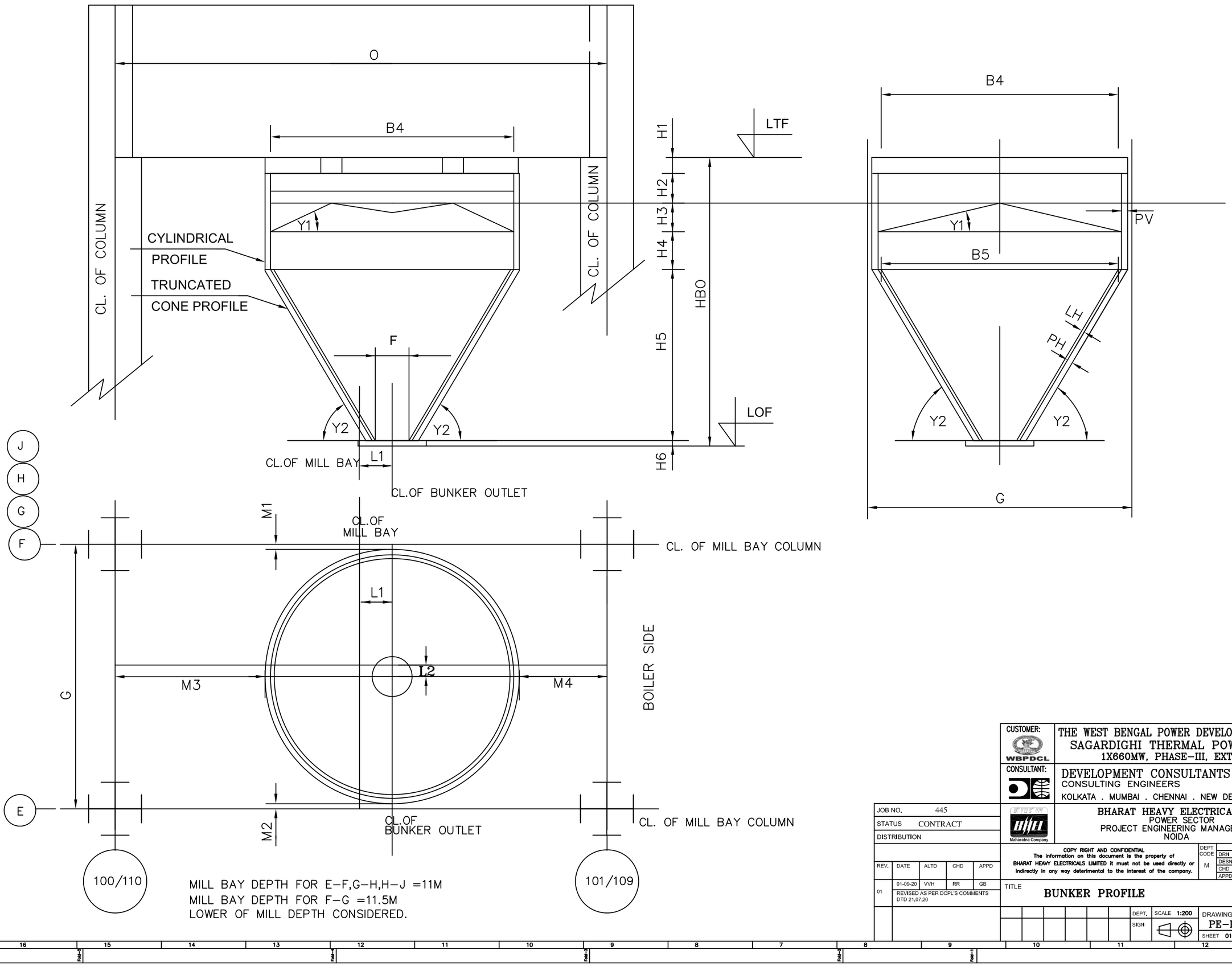
BHEL DRAWING No.
PE-DC-445-161-A001

Rev No. 03

1 x 660 MW Sagardighi Thermal Power Project Extention Unit 5 of WBPDCL

Document no PE-DC-445-161-A001			BUNKER SIZING CALCULATION for RAW COAL-CYLINDRICAL WITH CONICAL HOPPER					REV	3	25.11.20
Description of Item	**Data**	**Unit**	**Remarks**	**Description of Item**	**Data**	**Unit**	**Storage volume of coal (in m3)**		**Unit**	**Remarks**
Basis of calculation	at 100% BMCR		*(As per cl 5.26.00, Volume : II-H1, pg 37 of 116)*	H1 +H2 Where H1=Slab thickness of Tripper Floor. H2 = height for dust extraction opening, sealing arrangement and operation of level indicator.	1750	mm	V1 + V2	0.00	m3	H1= 300 mm H2= 1450 mm
Type of coal	Worst coal									
Coal consumption per unit at above mentioned condition	559.00	TPH	*As per Boiler manufacturer's (BHEL- Trichy data)*	H3 (Height of coal heap in vertical cylindrical portion)	6132	mm	V3	206.80	m3	*As per 3D model for heap at H3.*
Number of active bunkers per unit at above mentioned condition	8	nos.		H4 = (Height of vertical cylindrical portion)	8825	mm	V4	662.43	m3	
Number of standby bunkers per unit at above mentioned condition	0	no.		H5 = (Height of conical hopper portion)	12851	mm	V5	353.58	m3	
Storage capacity provided in terms of hours per bunker for above mentioned condition	14.00	hours	*(As per cl 5.26.00, Volume : II-H1, pg 37 of 116)*	H6 (Flange thickness)	20	mm	V6	0.00	m3	
Bulk density of coal considered for storage calculation in T/M3	0.8	T/m3	*(As per cl 2.0, Volume: II-G/1, Section : I)*	Total height of bunker, HBO (=H1+H2+H3+H4+H5+H6)	**29578**	**mm**	Volume of coal per bunker in m3, V	1222.81	m3	
Amount of coal per bunker in tonnes	978.25	T		Elevation of bunker outlet flange, LOF (*As per BHEL- Trichy's GENERAL ARRANGEMENT OF BOILER SECTIONAL FRONT ELEVATION SEC"F-F" DRG NO TP-DG-445-LAY-062)*	31600	mm				
Volume of coal per bunker in m3, V (=Amount of coal per bunker in tonnes / Bulk Density)	1222.81	m3		Elevation of bunker / tripper floor, LTF (=HBO+LOF)	**61178**	**mm**				
L1 (Center line of bunker/tripper arrangement from centre line of mill bay)	384	mm	*As per BHEL- Trichy's drg - " General arrangement of Boiler plan Sec C- C" no TP-DG-445-LAY-A060 & "General arrangement of Boiler plan Sectional Plan Front Elevation Sec F-F" no TP-DG-445-LAY-A062*	No. of outlets per bunker	1	no.				
Thickness of parent material in hopper portion (PH)	12	mm		F (Inside Diameter of Bunker Outlet)	914.4	mm				
Thickness of parent material in vertical portion (PV)	12	mm		Angle of repose in degrees, Y1	37.00	degrees				
Type of liner material in hopper portion	SS 316L		*As per AMENDMENT-2/V.IIG*	Inclination of wall angle considered for bunker in degrees, Y2 *(65 degree minimum as per cl 2.0, Volume: II-G/1, Section : I)*	71.00	degrees				
Thickness of liner material in hopper portion (LH)	6	mm		M1 (Clearance between edge of parent material of bunker and centre line of column)	600	mm				
				M2 (Clearance between edge of parent material of bunker and centre line of column)	600	mm				
O (Mill Bay Width)	13500	mm	*As per BHEL- Trichy's drg - " General arrangement of Boiler plan Sec C- C" no TP-DG-445-LAY-A060. E-F, G-H,H-J= 11M & F-G =11.5M. "General arrangement of Boiler plan Sectional Plan Front Elevation Sec F-F" no TP-DG-445-LAY-A062.*	M3 (Clearance between edge of parent material of bunker and centre line of column)	2234	mm				
G (Mill Bay Depth/Pitch)	11000	mm		M4 (Clearance between edge of parent material of bunker and centre line of column)	1466	mm				
B4 (=G-[2*(PV)+M1+M2]) (Inside diameter of bunker in vertical cylindrical portion)	9776	mm	Notes:	1) For bunker sizing, the last bunker filling is considered by tripper conveyor head discharge pulley. 2) Revised as per Trichy's " Input data for Bunker Sizing" Rev 01 : CPT-1324 & Plan and Elevation of Mill Bay Rev 00 dtd 03-03-2020 recieved vide mail dtd 03-03-2020 & 13-03-2020. 3) Revised as per ISG's drg "Bunker tripper floor cross section " recieved vide mail dtd 26-03-2020. 4)Mill tramp iron spout flange level to be 3.5 m clear. Mill bay steel level to be maintained by Trichy accrodingly.						
B5 (=G-[2*(PH+LH)+M1+M2]) (Inside diameter of bunker in conical hopper portion)	9764	mm								

DRAWING NO. PE-DG-445-161-A001



MILL BAY DEPTH FOR E–F,G–H,H–J =11M
MILL BAY DEPTH FOR F–G =11.5M
LOWER OF MILL DEPTH CONSIDERED.

CUSTOMER: WBPDCL	THE WEST BENGAL POWER DEVELOPMENT CORPN. LTD. SAGARDIGHI THERMAL POWER STATION 1X660MW, PHASE–III, EXTN. UNIT #5.
CONSULTANT:	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA . MUMBAI . CHENNAI . NEW DELHI
	BHARAT HEAVY ELECTRICALS LTD POWER SECTOR PROJECT ENGINEERING MANAGEMENT NOIDA

JOB NO. 445
STATUS CONTRACT
DISTRIBUTION

REV.	DATE	ALTD	CHD	APPD
01	01-09-20	VVH	RR	GB
	REVISED AS PER DCPL'S COMMENTS DTD 21.07.20			

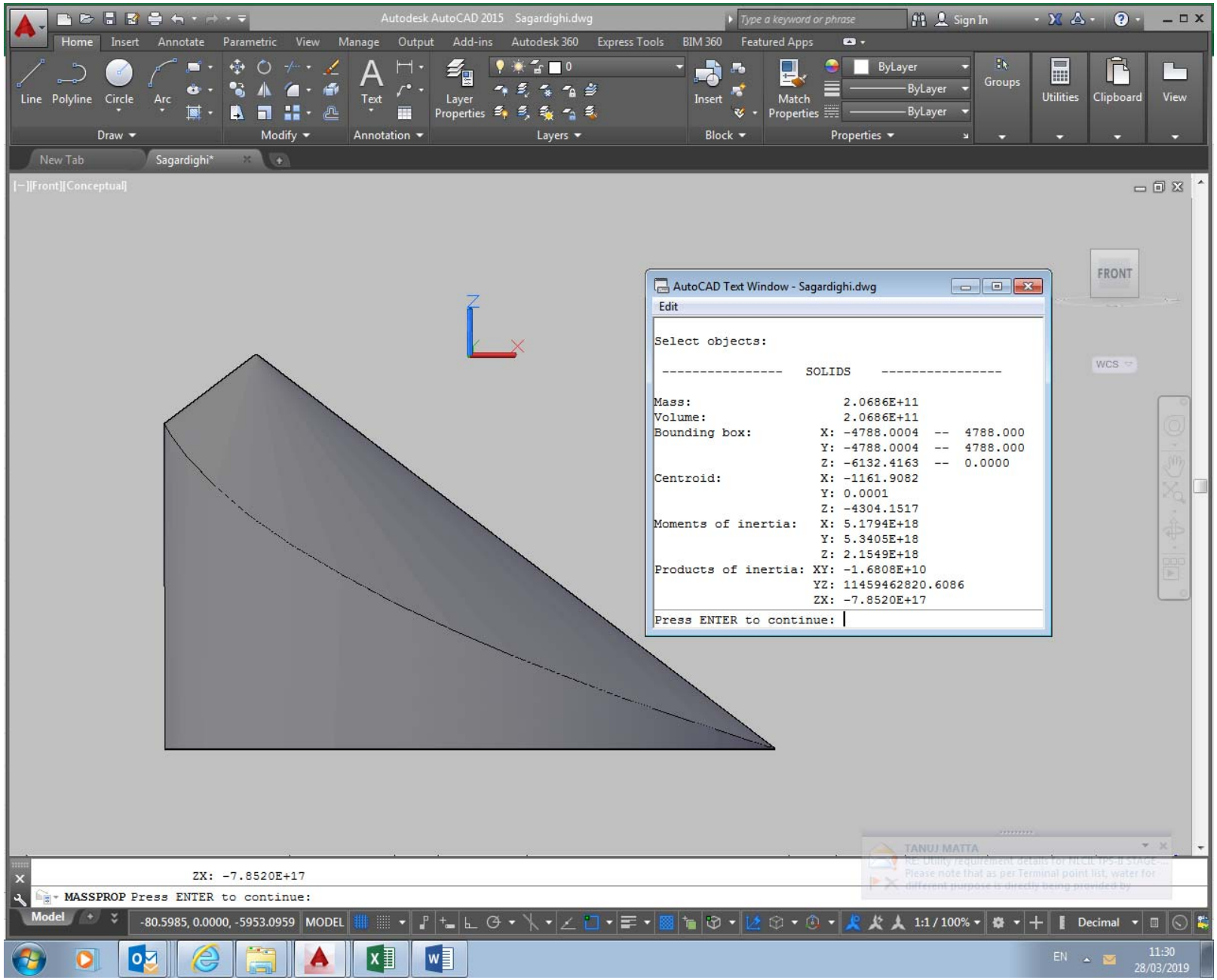
DEPT CODE		NAME	SIGN	DATE
M	DRN	VH		27.03.2019
	DESN	VH		27.03.2019
	CHD	PKK		28.03.2019
	APPD	GB		28.03.2019

TITLE
BUNKER PROFILE

DEPT. SIGN SCALE 1:200 DRAWING NO. PE–DG–445–161–A001
SHEET 01 OF 01 REV. 01 SIZE-A3

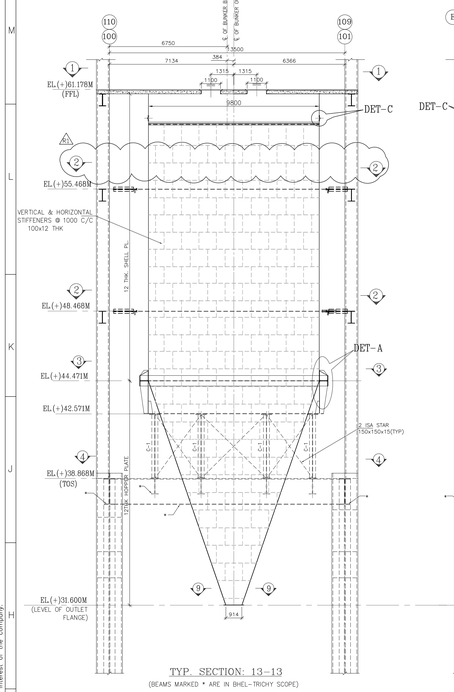
ELECTRONIC FILE NAME:

3D FOR HEAP VOLUME (V3) AND HEIGHT (H3)

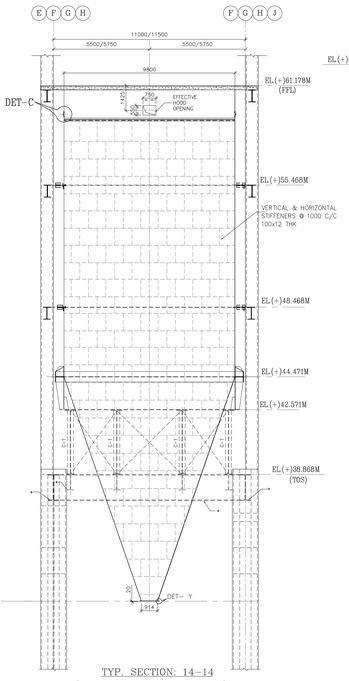


DRAWING NO. PE-DG-445-616-C014

FIRST ANGLE PROJECTION — ALL DIMENSIONS ARE IN MM



TYP. SECTION: 13–13
(BEAMS MARKED * ARE IN BHEL–TRICHY SCOPE)



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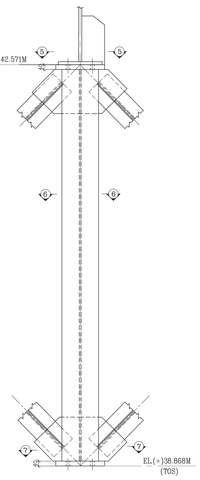
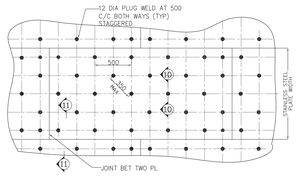
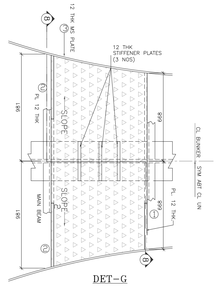
(BEAMS MARKED * ARE IN BHEL–TRICHY SCOPE)



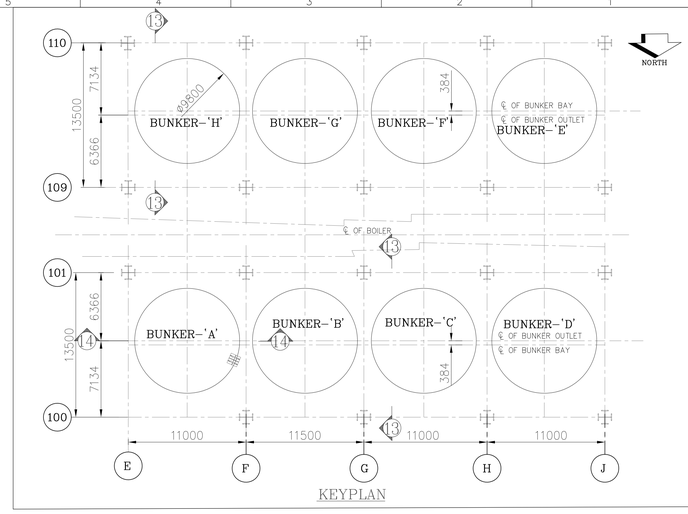
ELEVATION–COL C1
(8 NO REQD PER BUNKER)



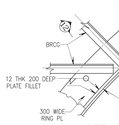
TYP DET FOR FIXING SST LINER PL TO HOPPER PL



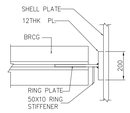
DET–G



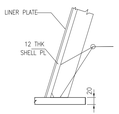
KEYPLAN



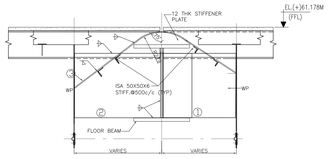
DET–J



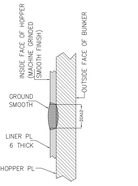
SECTION 12–12



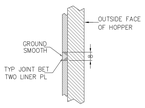
DET–Y



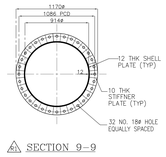
SECTION 8–8



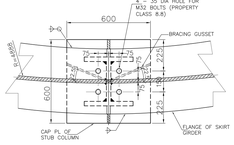
SECTION 10–10



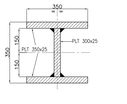
SECTION 11–11



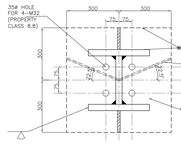
⚠ SECTION 9–9



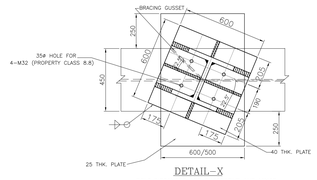
SECTION 5–5



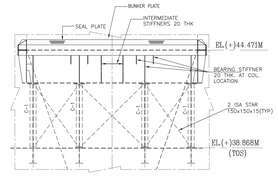
SECTION 6–6
DETAIL OF STUB COLUMN (TYPICAL)



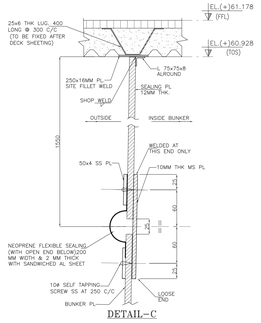
SECTION 7–7



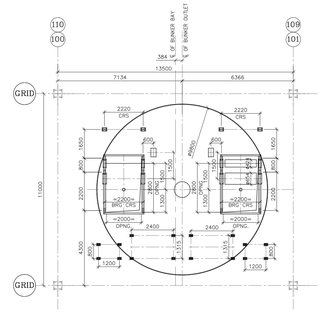
DETAIL–X
BOLT DISTANCES ARE SUGGESTIVE AND MINOR CHANGES MAY BE DONE BY THE DETAILER TO CLEAR STIFFENERS ETC.



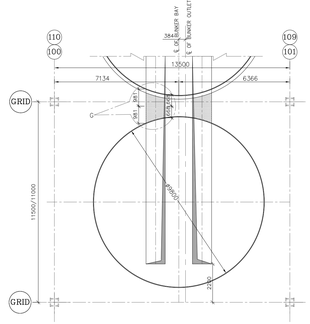
DEVELOPED VIEW OF SKIRT GIRDER WITH SUPPORT COLUMNS



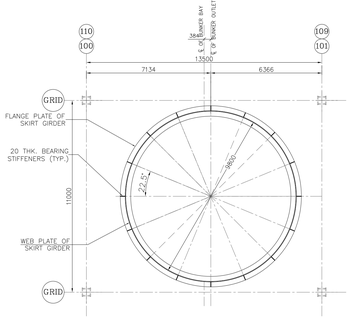
DETAIL–C



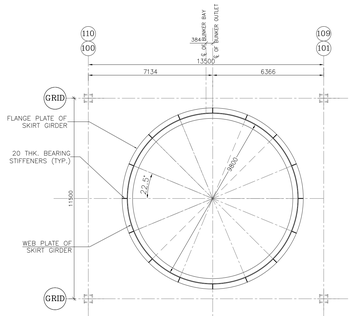
SECTION: 1–1
AT EL.(+)61.178M FOR BUNKER A & H ONLY



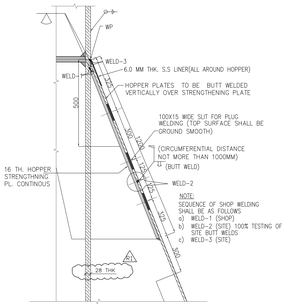
SECTION: 1–1
AT EL.(+)61.178M FOR ALL BUNKER EXCEPT A & H



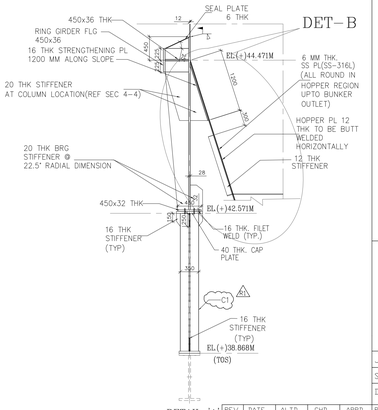
SECTION: 3–3
AT EL.(+)44.471M FOR BUNKER A, C, D, E, F & H



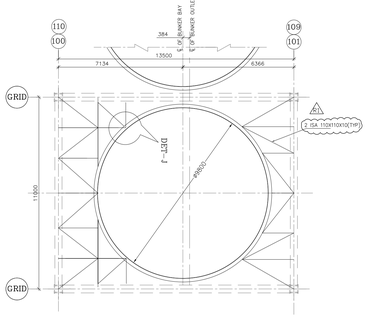
SECTION: 3–3
AT EL.(+)44.471M FOR BUNKER B & G



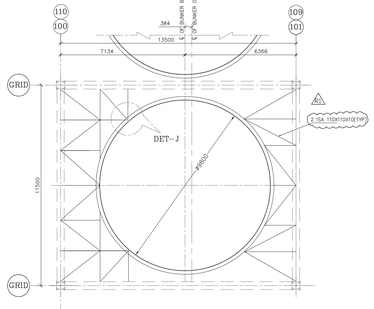
DETAIL AT–'B'



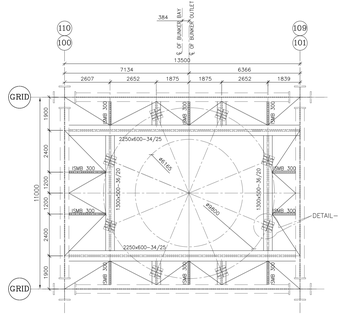
DETAIL 'A'



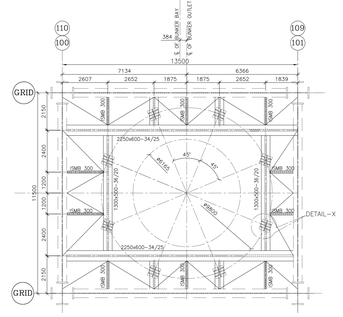
SECTION: 2–2
AT EL.(+)48.468M FOR BUNKER A, C, D, E, F & H



SECTION: 2–2
AT EL.(+)48.468M FOR BUNKER B & G



⚠ SECTION: 4–4
AT EL.(+)38.868M FOR BUNKER A, C, D, E, F & H
(FOR BRACING DETAILS REFER TRICHY DRAWING)



⚠ SECTION: 4–4
AT EL.(+)38.868M FOR BUNKER B & G
(FOR BRACING DETAILS REFER TRICHY DRAWING)

APPROX. QTY. OF STR STEEL = 1150MT

NOTES:–

1. ALL DIMENSIONS ARE IN MM & ELEVATIONS IN METERS UNLESS STATED OTHERWISE.
2. ALL ELEVATIONS ARE REFERRED TO THE FINISHED FLOOR LEVEL OF POWER HOUSE BUILDING AS EL. 0.00 M WHICH CORRESPONDS TO RL.(+) (+)34.500 M.
3. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH CONTRACT TERMS AND CONDITIONS, TECHNICAL SPECIFICATIONS AND SCHEDULE OF ITEMS.
4. FOR OTHER NOTES AND STD. DETAILS REF. DRG. PE–DG–445–600–C002
5. CONNECTION DETAILS SHOWN ARE INDICATIVE ONLY. SIZE & THICKNESS OF GUSSETS, NO. & DIA. OF CONNECTION BOLTS ETC. SHALL BE SHOWN IN CORRESPONDING FABRICATION DRG.
6. ALL ELEVATIONS ARE TO THE TOP OF STEEL (U.N.O.)
7. ALL BOLTED FIELD CONNECTIONS(IF ANY) ARE TO BE DONE WITH HSFG BOLTS OF PROPERTY CLASS 8.8 (U.N.O)
8. PROPER CARE SHALL BE TAKEN IN WELDING OF BUNKER PLATES. HORIZONTAL & VERTICAL JOINTS IN BUNKER & HOPPER SHALL BE SUBJECT TO NDT AS PER FQP.
9. VERTICAL JOINTS IN BUNKER PL SHALL BE STAGGERED.
10. PLATE SHALL BE CUT TO MAX WIDTH TO REDUCE NUMBER OF JOINTS.
11. BEFORE COMMENCING REGULAR FABRICATION OF THE BUNKER TRIAL ASSEMBLY AT SITE OF THE BUNKER INCLUDING HOPPER SHALL BE MADE ATLEAST FOR ONE BUNKER.
12. ALL END CONNECTIONS FOR BRCG SHALL BE DESIGNED FOR FULL TENSILE STRENGTH OF MEMBERS.
13. STAINLESS STEEL LINER SHALL BE PROVIDED IN CONICAL PORTION ONLY AND SHALL BE OF 6.0 MM THICKNESS OF GRADE AISI–316L CONFIRMING WITH MILL FINISH 2B, COLD ROLLED, ANNEALED AND DESCALED (PICKELED) & SKIN PASSED MATERIAL & SHALL BE PROVIDED ON THE INNER FACE OF INCLINED PORTION OF HOPPERS UP TO MOUTH OF THE HOPPERS, WITHOUT ALLOWING ANY PROJECTIONS IN COAL FLOW PATH.
14. PLUG WELD IN STAINLESS STEEL LINER PLATE SHALL BE GROUND SMOOTH TO MATCH WITH PLATE PROFILE
15. ALL BUTT WELD OF BUNKER SUPPORTING STRUCTURE SHALL BE 100% RADIOGRAPHED. ELECTRODE E308L FOR WELD JOINTS BET SST PLATES & E309L FOR WELD JOINTS BETWEEN SST PL & MS PLATE.
16. SPOT RADIOGRAPHY FOR BUTT WELDS SHALL BE CARRIED OUT IN TENSION ZONE AND IN COMPRESSION ZONE AS PER FQP.
17. ALL SITE FILLET WELDS OF BUNKER AND BUNKER SUPPORTING GIRDERS/BEAMS AS PER FQP.
18. ADEQUATE TEMPORARY STIFFENER TO BE PRORATED TO AVOID BUCKLING DISTORTION OF BUNKER STRUCTURE DURING FABRICATION, HANDLING AND ERECTION STAGE.
19. VERTICAL JOINT IN SIDE PLATE SHALL BE STAGGERED.
20. BEAMS MARKED '*' ARE IN BHEL TRICHY SCOPE.
21. 100% TESTING OF SITE BUTT WELDS REQUIRED .

ENGINEERING REFERENCE DRAWINGS :–

1. PE–DG–445–100–M001 – PLOT PLAN
2. PE–DG–445–600–C002 – GENERAL NOTES FOR STRUCTURAL STEEL WORKS
3. PE–DG–445–616–C011 – FRAMING PLAN OF TRIPPER FLOOR
4. PE–DG–445–161–A001 – BUNKER PROFILE

LEGEND:

1. TOS = TOP OF STEEL
2. TYP. = TYPICAL
3. PL = PLATE
4. TH. = THICK
5. BOS = BOTTOM OF STEEL
6. C/C = CENTRE TO CENTRE
7. ℄ = CENTER LINE
8. EL = ELEVATION
9. LVL = LEVEL
10. UNO = UNLESS NOTED OTHERWISE

BHEL–PROJECT ENGINEERING MANAGEMENT(CIVIL)	
THIS DRAWING MARKED ✓ IS RELEASED FOR	
✓ COMMENTS/APPROVAL	
☐ PLANNING/INFORMATION	
☐ CONSTRUCTION	
STAMP ALL PREVIOUS REVISION AS SUPERSEDED	
ISSUED BY	
NAME	SKM
SIGNATURE	–Sd–
DATE	16/06/2021

REV.	DATE	ALTD	CHD	APPD

REV.	DATE	ALTD	CHD	APPD
01	16.06.21	VEENA/P.PAUL	SKM	SBP

REVISED AS PER CUSTOMER COMMENTS ⚠

BEFORE PROCEEDING WITH CONSTRUCTION PLEASE SCAN THE QR CODE TO KNOW THE LATEST REVISION

NOTE: Scan QR code for checking the latest Rev. status of drawing.

JOB NO. 445
STATUS CONTRACT
DISTRIBUTION

CUSTOMER: WBPDCL
THE WEST BENGAL POWER DEVELOPMENT CORPN. LTD.(WBPDCL)
1X660MW, SAGARDIGHI THERMAL POWER EXTENSION PROJECT (UNIT #5)

CONSULTANT:
DEVELOPMENT CONSULTANTS PRIVATE LTD.
KOLKATA

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA

DEPT CODE		NAME	SIGN	DATE
C	DRN.	VEENA	–Sd–	05.01.2021
	DES'N	P.PAUL	–Sd–	05.01.2021
	CHD	SKM	–Sd–	05.01.2021
	APPD	SBP	–Sd–	05.01.2021

TITLE
MILL BUNKER BAY – GA OF BUNKER & SUPPORTING STRUCTURE

DEPT. | SCALE | SIGN | DRAWING NO. PE–DG–445–616–C014 | SHEET 1 OF 1 | REV. 01

SIZE–A0

ELECTRONIC FILE NAME:

	SAGARDIGHI THERMAL POWER PROJECT, 1 X 660 MW UNIT NO 5, STAGE III. MILL REJECT SYSTEM (PNEUMATIC TYPE) & COAL BUNKER DEBLOCKING DEVICES SPECIFIC TECHNICAL REQUIREMENT	SPECIFICATION No: PE-TS-445-160-A001	
		VOLUME: II B	
		SECTION-I	
		SUB-SECTION-IB	
		REV 0	DATE 17.07.21

SUB SECTION-IB

SPECIFIC TECHNICAL REQUIREMENT (ELECTRICAL)

THE WEST BENGAL POWER DEVELOPMENT CORPORATION LIMITED

SAGARDIGHI THERMAL POWER PROJECT
1 x 660 MW UNIT NO. 5, PHASE – III

MILL REJECT SYSTEM
(ELECTRICAL PORTION)

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT,
NOIDA, U.P., INDIA

BHEL	TITLE: **TECHNICAL SPECIFICATION** **FOR** **MILL REJECT SYSTEM** **SAGARDIGHI THERMAL POWER PROJECT** **1 x 660 MW UNIT NO. 5, PHASE – III**	SPECIFICATION NO. VOLUME NO. : **II-B** SECTION: **C** REV NO. : **00** DATE: 17.7.2021 SHEET: 1 OF 1

CONTENTS

The requirements mentioned in Section-I shall prevail and govern in case of conflict between the same and the corresponding requirements mentioned in the descriptive portion in Section-II.

	TECHNICAL SPECIFICATION FOR MILL REJECT SYSTEM (ELECTRICAL PORTION) SAGARDIGHI THERMAL POWER PROJECT 1 x 660 MW UNIT NO. 5, PHASE – III	SPECIFICATION NO. VOLUME NO. : **II-B** SECTION : **C** REV NO. : **01** DATE : 17/7/2021 SHEET : 1 OF 1

SPECIFIC TECHNICAL REQUIREMENTS: ELECTRICAL

1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER/ PURCHASER:

a) Services and equipment as per "Electrical Scope between BHEL and Vendor".
b) Any item/work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the work for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification. The same shall be provided by the bidder without any extra charge.
c) Supply of mandatory spares as specified in the specifications of mechanical equipments.
d) Electrical load requirement for **MILL REJECT SYSTEM**
e) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.
f) Bidder to furnish list of makes for each equipment at contract stage, which shall be subject to customer /BHEL approval without any commercial and delivery implications to BHEL
g) Various drawings, data sheets as per required format, Quality plans, calculations, test reports, test certificates, operation and maintenance manuals etc shall be furnished as specified at contract stage. All documents shall be subject to customer/BHEL approval without any commercial implication to BHEL.
h) Motor shall meet minimum requirement of motor specification.
i) Vendor to clearly indicate equipment locations and local routing lengths in their cable listing furnished to BHEL.
j) Cable BOQ worked out based on routing of cable listing provided by the vendor for "both end equipment in vendor's scope" shall be binding to the vendor with +10 % margin to take care of slight variation in routing length & wastages.

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

Refer "Electrical Scope between BHEL and Vendor".

3.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

3.1 The electrical specification without any deviation from the technical/quality assurance requirements stipulated shall be deemed to be complied by the bidder in case bidder furnishes the overall compliance of package technical specification in the form of compliance certificate/No deviation certificate.
3.2 No technical submittal such as copies of data sheets, drawings, write-up, quality plans, type test certificates, technical literature, etc, is required during tender stage. Any such submission even if made, shall not be considered as part of offer.

4.0 LIST OF ENCLOSURES

a) Electrical scope between BHEL & vendor (Annexure –I)
b) Electrical Load data format (Annexure –II)
c) Cable schedule(Annexure –III)
d) BHEL cable listing format
e) Technical specification for motors
f) Datasheets & quality plan for motors.
g) Technical specification for cabling, grounding and lightning protection

ANNEXURE-I

SECTION-I

REV-0, DATE: 09.03.2015

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR(FOR EPC PROJECTS)

PACKAGES : MRS
SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT
PROJECT: 1X660 MW SAGARDIGHI TPP

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

REV-0, DATE: 09.03.2015

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR(FOR EPC PROJECTS)

PACKAGES : MRS

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

PROJECT: 1X660 MW SAGARDIGHI TPP

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

NOTES:

REV-0, DATE: 09.03.2015

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR(FOR EPC PROJECTS)

PACKAGES : MRS

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

PROJECT: 1X660 MW SAGARDIGHI TPP

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

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

ANNEXURE-II

SECTION-I

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

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

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

LOAD DATA (ELECTRICAL)	JOB NO.	475	ORIGINATING AGENCY		PEM (ELECTRICAL)
	PROJECT TITLE	SAGARDIGHI THERMAL POWER PROJECT, 1x 660 MW UNIT NO. 5, PHASE – III	NAME		DATA FILLED UP ON
	SYSTEM	MILL REJECT SYSTEM	SIGN		DATA ENTERED ON
	DEPTT. / SECTION	MAUX	SHEET 1 OF 1	REV. 00	DE'S SIGN. & DATE

ANNEXURE-III

SECTION-I

CABLE SCHEDULE FORMAT

ANNEXURE III

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

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

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

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

(A) SYSTEM VOLTAGE CODES:

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

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

(B) CABLE VOLTAGE CODES:

A = 11KV (Power cables)

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

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

(C) CABLE CODES

PVC Copper

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

PVC Aluminium

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

XLPE Copper

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

XLPE Aluminium

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

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

A.C. & D.C. MOTORS

1.00.00 SCOPE

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

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

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

2.00.00 STANDARDS

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

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

3.00.00 SERVICE CONDITIONS

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

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

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

4.00.00 TYPE AND RATING

4.01.00 A.C. Motors

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

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

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

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

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

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

4.02.00 AC motor for VFD application (If applicable)

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

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

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

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

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

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

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

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

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

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

4.03.00 **D. C. Motors**

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

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

5.00.00 PERFORMANCE

5.01.00 **Running Requirements**

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

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

5.02.00 **Starting Requirements**

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

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

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

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

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

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

5.03.00 Stress During Bus Transfer

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

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

5.04.00 Locked Rotor Withstand Time

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

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

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

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

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

5.05.00 Torque Requirements

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

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

6.00.00 SPECIFIC REQUIREMENTS

6.01.00 Enclosure

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

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

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

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

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

6.02.00 **Cooling**

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

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

6.03.00 **Winding and Insulation**

6.03.01 All insulated winding shall be of copper.

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

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

6.04.00 **Tropical Protection**

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

6.04.02 All fittings and hardware shall be corrosion resistant.

6.05.00 **Bearings**

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

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

6.06.00 **Noise & Vibration**

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

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

6.07.00 **Motor Terminal Box**

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

6.07.02 Terminal box shall be capable of being turned 360^{o} in steps of 90^{o}, unless otherwise approved.

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

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

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

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

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

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

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

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

6.08.00 **Grounding**

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

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

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

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

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

6.09.00 **Rating Plate**

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

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

7.00.00 ACCESSORIES

7.01.00 **General**

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

7.02.00 **Space Heater**

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

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

7.03.00 **Temperature Detectors**

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

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

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

7.04.00 **Indicator/Switch**

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

a) HT motor bearing temperature.

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

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

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

7.05.00 **Current Transformer for Differential Protection**

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

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

7.06.00 **Accessory Terminal Box**

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

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

7.07.00 **Drain Plug**

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

7.08.00 **Lifting Provisions**

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

7.09.00 **Dowel Pins**

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

7.10.00 **Painting**

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

8.00.00 TESTS

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

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

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

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

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

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

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

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

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

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

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

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

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

f. Momentary overload test.

g. Test for noise level of motor.

9.00.00 SPARE

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

10.00.00 DRAWINGS, DATA & MANUALS

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

10.01.00 Along with the bid

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

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

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

ANNEXURE-A
SECTION-I

DESIGN DATA

1.0 AUXILIARY POWER SUPPLY

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

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

2.0 RANGE OF VARIATION

A.C. Supply

Voltage	:	±10%
Frequency	:	±5%
Combined Volt & frequency	:	10% (absolute sum)

D.C. Supply

Voltage	:	190 to 240 Volt

3.0 Paint Shade : RAL 7032

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TITLE		SPECIFICATION NO.	SECTION-I
भेल BHEL	**LV MOTORS** **DATA SHEET-A**	VOLUME	II B
		SECTION	D
	SAGARDIGHI THERMAL POWER PROJECT **1 x 660 MW UNIT NO. 5, PHASE – III**	REV NO. 00	DATE 08.04.21
		SHEET 1 OF 1	

1.0	Design ambient temperature	:	50 °C
2.0	Maximum acceptable kW rating of LV motor	:	Upto & Including 160KW
3.0	Installation (Indoors/ Outdoors)	:	As required
4.0	Details of supply system		
	a) Rated voltage (with variation)	:	415V ± 10%
	b) Rated frequency (with variation)	:	50 Hz (Variation: +5% TO –5%)
	c) Combined voltage & freq. variation	:	10% (sum of absolute values)
	d) System fault level at rated voltage	:	50 kA for 1 sec
	e) Short time rating for terminal boxes		
	* Above 90 kW upto & including 160kW(Breaker Controlled)	:	50 KA for 0.25 sec.
	* Rated upto & including 90 kW (Contactor Controlled)	:	50 KA protected by MCCB
	f) LV System grounding	:	Solidly
5.0	Class of insulation	:	Class 'F', with temp rise limited 120 Deg.C
6.0	Minimum voltage for starting	:	80% of rated voltage
7.0	Power cables data	:	Shall be given during Detailed engg.
8.0	Earth Conductor Size & Material	:	Shall be given during Detailed engg.
9.0	Space heater supply **(30KW & ABOVE)**	:	240 V, 1Φ , 50 Hz
10.0	Rating up to which Single phase motor	:	Acceptable below 0.20 Kw
11.0	Locked rotor current a) Limit as percentage of FLC	:	As per IS 12615
12.0	Makes	:	BHEL/ Customer approval (Package owner to take care)
13.0	Paint shade	:	RAL 7032
15.0	Additional tests	:	As per QP
14.0	Degree Of protection for motor/ terminal box	:	IP 55

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

15.0 TESTING REQUIREMENTS: IN LINE WITH SPECIFICATION

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

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

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

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

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

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

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

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

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

NAME OF VENDOR					
			SEAL	REV.	
NAME	SIGNATURE	DATE			

SCHEDULE-IIID/1

A.C. AND D.C. MOTORS

A.	A.C. MOTOR		
1.0	**GENERAL**		
1.1	Application		:
1.2	Quantity		:
1.3	Make		:
1.4	Frame Size		:
1.5	Applicable Standard		:
2.0	**TYPE AND RATING**		
2.1	Type of Motor		:
2.2	Service		:
2.3	Duty Cycle/Designation		:
2.4	Rated Continuous Output		
	At 40 Deg.C ambient	KW	:
	At 50 Deg.C ambient	KW	:
2.5	Rated Speed	r.p.m.	:
2.6	Rated Voltage & % variation		:
2.7	Rated Frequency & % variation		:
2.8	Combined voltage and frequency variation % (absolute sum)		:
2.9	Full load current	Amps	:
2.10	No load current	Amps	:
2.11	Rated Power Factor		:

2.12	Efficiency at rated voltage and frequency:					
	a) Full load	%	:			
	b) 3/4 load	%	:			
	c) 1/2 load	%	:			
3.0	**PERFORMANCE**					
3.1	Method of Starting		:			
3.2	Starting current at 110% voltage % f.l.c		:			
3.3	Starting Current at rated voltage	% f.l.c.	:			
3.4	Starting Torque at rated voltage	kg.m	:			
	a) Pull out torque	kg.m	:			
	b) Full load torque	kg.m	:			
3.5	Starting time at			80% Voltage	100% Voltage	110% Voltage
	a) With load	sec.	:			
	b) Without load (driven equipment Coupled)	sec	:			
3.6	Safe stall time at			80% Voltage	100% Voltage	110% Voltage
	a) Hot condition	sec.	:			
	b) Cold condition	sec.	:			
3.7	a) Heating time constant	min	:			
	b) Cooling time constant	min	:			
4.0	**CONSTRUCTION**					
4.1	Degree of Protection of Enclosure		:			
4.2	Method of Cooling		:			
4.3	Insulation Class		:			
4.4	Temperature Rise Over 50 Deg.C ambient (by resistance)		:			

4.5	Tropicalised	Yes/No:		
4.6	Winding Connection	:		
4.7	Bearings		D.E.	N.D.E.
	a) Make	:		
	b) Type	:		
	c) Recommended lubricant	:		
4.8	Motor Terminal Box			
	a) Type	:		
	b) Fault withstand Current KA	:		
	c) Fault Current Withstand Time Sec.	:		
	d) Cable lugs & glands furnished Yes/No	:		
	e) Position	:		
5.0	**ACCESSORIES**			
5.1	Space Heaters			
	a) No. x Watt	:		
	b) Volt, phase, frequency	:		
5.2	Winding temperature detector			
	a) Type	:		
	b) Nos. furnished	:		
5.3	Bearing temperature detector			
	a) Type	:		
	b) Nos. furnished	:		
5.4	Temperature Indicators			
	a) Type	:		
	b) Nos. provided	:		
	c) Locations	:		

5.5	Temperature Alarm Contact	
	a) Nos. provided	:
	b) Locations	:
	c) Contact rating	:
5.6	Flow Switch	
	a) Type	:
	b) Nos. provided	:
	c) Locations	:
	d) Contact Rating	:
5.7	Current Transformer for differential protection	
	a) Nos. provided	:
	b) Current Ratio	:
	c) Class	:
	d) Knee point voltage	:
	e) Excitation current at VK/2	:
5.8	Accessory Terminal Box	
	a) No. provided	:
	b) Cable glands furnished	Yes/No:
5.9	Speed Switch	
	a) Type	:
	b) Nos. provided	:
	c) Locations	:
	d) Contact Rating	:

6.0	GROUNDING		
6.1	No. of grounding pads provided		
	a) On motor body		:
	b) On terminal box		:
7.0	MISCELLANEOUS		
7.1	Type of mounting		:
7.2	Overall dimension (LxBxH) mm x mm x mm		:
7.3	Approximate Weight Kg		:
7.4	Moment of Inertia (Sq.GD)		
	a) Stator	Kg.Sq.m	:
	b) Rotor	Kg.Sq.m	:
	c) Total	Kg.Sq.m	:
7.5	Weight		
	a) Stator	Kg	:
	b) Rotor	Kg	:
	c) Total	Kg	:
B.	D.C MOTOR		
1.0	GENERAL		
1.1	Application		:
1.2	Make		:
1.3	Frame Size		:
1.4	Reference Standard		:
2.0	TYPE & RATING		
2.1	Type		:

2.2	Service		:
2.3	Duty cycle		:
2.4	Rated Continuous Output		
	a) at 40 Deg.C ambient KW		:
	b) at 50 Deg.C ambient KW		:
2.5	Rated voltage	Volt	:
2.6	Voltage range over which satisfactory Operation is guaranteed		:
2.7	Rated Current		
	a) Starting	Amp.	:
	b) Running	Amp.	:
2.8	Rated Speed	r.p.m.	:
3.0	CONSTRUCTION		
3.1	Enclosure		
	a) Type		:
	b) Degree of Protection		:
3.2	Method of Cooling		:
3.3	Insulation Class		:
3.4	Tropicalized?		:
3.5	Commutator Material		:
4.0	ACCESSORIES		
4.1	Motor Starter		
	a) Type		:
	b) Make		:
	c) Resistance	ohm	:

4.2	Space Heater		
	a) No. x KW		:
	b) Volts/Phase/Frequency		:
4.3	Motor Terminal Box		
	a) Type		:
	b) Cable lug/gland furnished		:
5.0	MISCELLANEOUS		
5.1	Overall Dimension (LxBxH) mm		:
5.2	Approx. Weight	Kg	:

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

GENERAL TECHNICAL REQUIREMENTS

FOR

LV MOTORS

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

1.0 INTENT OF SPECIFIATION

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

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

2.0 CODES AND STANDARDS

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

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

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

3.0 DESIGN REQUIREMENTS

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

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

3.3 Starting Requirements

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

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

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

3.3.3 The following frequency of starts shall apply

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

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

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

3.4 **Running Requirements**

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

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

3.5 **Stress During bus Transfer**

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

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

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

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

4.0 **CONSTRUCTIONAL FEATURES**

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

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

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

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

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

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

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

4.7 **Terminals and Terminal Boxes**

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

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

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

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

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

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

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

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

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

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

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

4.9 **General**

4.9.1 Motors provided for similar drives shall be interchangeable.

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

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

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

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

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

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

5.0 INSPECTION AND TESTING

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

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

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

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

6.0 DRAWINGS TO BE SUBMITTED AFTER AWARD OF CONTRACT

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

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

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

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

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

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

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	Sign & Date	Name	Seal
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Approved by:			

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

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

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

LEGENDS:

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

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ENGINEERING			QUALITY		
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Reviewed by:	PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:	RITESH KUMAR JAISWAL	RITESH KUMAR JAISWAL

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

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

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

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

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

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

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

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Seal	

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

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

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

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Seal	

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

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

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

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

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

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1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
		4.DURATION	MA	PROCESS CHECK	CONTINUOUS	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK	✔	P	V	-	
2.7	COMPLETE STATOR ASSEMBLY	1.COMPACTNESS & CLEANLINESS	MA	VISUAL	100%	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK		P	-	-	
2.8	BRAZING/COMPRESSION JOINT	1.COMPLETENESS	CR	VISUAL	100%	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK		P	-	-	
		2.SOUNDNESS	CR	MALLET TEST & UT	100%	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	TEST/INSPC. REPORT	✔	P	V	-	
		3.HV	MA	ELECT. TEST	100%	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	TEST/INSPC. REPORT	✔	P	V	-	
2.9	COMPLETE ROTOR ASSEMBLY	1.RESIDUAL UNBALANCE	CR	DYN. BALANCE	100%	-	MANUFACTURER'S SPEC./ ISO 1940	MANUFACTURER'S DWG.	LOG BOOK		P	-	-	
		2.SOUNDNESS OF DIE CASTING	CR	ELECT. (GROWLER TEST)	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	TEST/INSPC. REPORT	✔	P	V	-	
2.10	ASSEMBLY	1.ALIGNMENT	MA	MEAS.	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	LOG BOOK		P	-	-	
		2.WORKMANSHIP	MA	VISUAL	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	LOG BOOK		P	-	-	
		3.AXIAL PLAY	MA	MEAS.	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	LOG BOOK	✔	P	V	-	
		4.DIMENSIONS	MA	MEAS.	100%	-	MANUFACTURER'S DRG./ MANUFACTURER'S SPEC.	MANUFACTURER'S DRG./ MANUFACTURER'S SPEC.	LOG BOOK		P	-	-	
		5.CORRECTNESS, COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE	MA	VISUAL	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	LOG BOOK		P	-	-	
		6. RTD, BTD & SPACE HEATER MOUNTING.	MA	VISUAL	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	LOG BOOK	✔	P	V	-	

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

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

NOTES:

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

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

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

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

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

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

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

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

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

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

LEGENDS:

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

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

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

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

D: DOCUMENT

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ERECTION - CABLING, GROUNDING AND LIGHTNING PROTECTION SYSTEM

1.00.00 SCOPE OF WORK

1.01.00 The scope of work covers complete and efficient design, supply, erection, testing and commissioning of cabling, electrical grounding and lightning protection system for the entire plant.

1.01.01 Area-wise, the scope shall broadly cover, but not be limited to :

A. Main Power House Building
B. Boiler area, ESP stack
C. Transformer yard, CHP, AHP, FGD area.
D. All auxiliary areas/ buildings (including electrical rooms of respective buildings) and structures of balance of plant (BOP) systems as details in the Lead Specification.
E. Overhead interplant cable trestle and pipe cum cable trestle.

1.01.02 Equipment-wise, the scope of work related to cabling, electrical grounding and lightning protection shall cover all electrical equipment as described in different Sections of the Specification.

1.02.00 Scope of work shall also include all civil and structural works (except cable trenches/tunnels and major equipment foundations) necessary for installation of cabling, electrical grounding and lightning protection system.

2.00.00 SCOPE OF SUPPLY & SERVICES

2.01.00 Scope of Supply

Scope of supply shall include but not be limited to the followings

2.01.01 Transportation to site in properly packed condition of all materials and miscellaneous items required to complete the erection work under this specification.

2.01.02 These materials and miscellaneous items shall include but not be limited to the following:

a) Galvanized steel rigid/flexible conduits and accessories, ferrules, lugs, glands, terminal blocks, galvanized sheet steel junction boxes, cable fixing clamps, nuts & bolts, etc. as required.

b) Cable trays, Fittings and Accessories

c) Cable termination and jointing kits as necessary.

d) All necessary erection materials, consumables and sundry items including arc welding rods to complete the installation for satisfactory and trouble free operation.

e) Mild steel rods for main ground mat, grounding electrode, column & structure grounding, risers etc.

Mild steel rod for vertical air terminals,

Materials for electronic grounding,

Galvanized steel flats for horizontal air terminals, for down conductors and for large equipment grounding

Galvanized wire (8 SWG) for small equipment grounding.

f) Fire-proof cable penetration sealing system,

g) Fire retardant cable coating system.

h) Any item of works or erection materials which have not been specifically mentioned but are necessary to complete the work of Cabling, Grounding and Lightning Protection Systems shall be deemed to be included in the scope of this specification and shall be furnished by the Contractor without any extra charge to the Purchaser.

2.02.00 Scope of Services

The scope of Cabling, Grounding and Lightning Protection Systems includes but is not limited to the following:

2.02.01 Furnishing of all erection tools and tackles, testing equipment, implements, supplies, hardware and transport for timely and efficient execution of the erection work.

2.02.02 Erection work shall be performed with respect to all the equipment/materials mentioned under 'Scope of Supply'.

2.02.03 Erection work shall also be performed with respect to the following items:

a) Cable trays and accessories

a) Power cables

b) Cables laid directly buried in ground

c) Control, instrument and special cables

3.00.00 GENERAL REQUIREMENTS

3.01.00 Codes and Standards

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.

3.02.00 Erection Schedule

3.02.01 The Bidder shall agree to adhere to the Owner's Erection Schedule if such a schedule is attached with the Specification. Alternatively, in case the target completion dates alone are indicated, the Bidder shall furnish detailed erection schedules (starting from zero date) with separate 'S' curves for Cabling, Grounding and Lightning Protection works.

3.02.02 The erection schedule, as approved by the OE shall be strictly followed by the contractor. If the work is held-up for any reason, attributable to him or not, the same shall be brought immediately to the notice of the OE.

4.00.00 DESIGN CRITERIA

4.01.00 Grounding System

4.01.01 Grounding work shall be carried out in compliance to the following standards/codes. All standards, specifications and codes of practice (COP) referred to herein shall be the latest editions including all amendments and revisions as on the date of opening of bid. In case of conflict between the specification and those standards/codes referred to herein, the former shall prevail:

a)	Indian Electricity rules	
b)	National Electrical Code	
c)	Recommended practice for hot-dip galvanizing of iron and steel	IS 2629
d)	Method of testing uniformity of coating on zinc coated articles	IS 2633
e)	COP for earthing	IS 3043
f)	Methods for determination of mass of zinc coating on zinc coated iron and steel articles	IS 6745
g)	IEEE guide for safety in AC substation grounding	IEEE 80
h)	IEEE recommended practice for grounding of industrial and commercial power systems	IEEE 142
i)	IEEE recommended practice for determining the electric power station ground potential rise and induced voltage from a power fault	IEEE 367
j)	IEEE guide for instrumentation and control equipment grounding in generating stations	IEEE 1050

4.01.02 Basic design criteria are delineated below:

a) The station grounding system shall be an interconnected network of MS conductor and MS ground rods. The system shall (a) provide safety to personnel from contact of dangerous potential caused by ground fault, (b) ensure sufficient grounding current for effective relaying and (c) stabilize circuit potential with respect to ground.

b) The station grounding system shall be designed in compliance with the IEEE- 80/ IEEE- 665 considering fault current of 50kA for 1 sec. and shall be subject to approval of the Owner.

c) Actual soil resistivity measurement shall be carried out at proposed site during dry season.

d) The surface resistivity shall be considered as 3000 Ohm-meter for gravel and 1000 Ohm-meter for concrete.

e) Major items of equipment, such as generator, switchgear, transformer, motor, relay panels and control panels etc shall have integral ground buses or connection points which shall be connected to the underground grid.

f) Electronic panels and equipment, where required, shall be grounded utilizing an insulated ground wire connected in accordance with the manufacturer's recommendations. Where practical, electronics ground loops shall be avoided. Where this is not practical, isolation transformers shall be furnished. All indoor and outdoor electrical equipment and associated non-current carrying system, metal works, support structures, buildings columns, fence, neutrals, masts, arrestors, etc shall be connected to the plant ground system.

g) Instrumentation cable screens shall be single point bonded to the instrument earth network to minimize the effects of electrical interference.

h) For Signal/case/intrinsically safe signal, grounding of control room instruments, separate earth pit not connected to main ground grid shall be used. Control cabinets shall be connected to this separate earth pit.

i) A grounding conductor (steel wire armour in case of cables with outer sheath) shall be routed parallel to all power conductors operating above 240 volts.

j) All ground wires installed in conduits shall be uninsulated.

k) Embedded grounding grid made of GI flat at basement/grade slab as well as upper floor/suspended slabs shall be provided.

l) In addition mild steel ground pads at different locations i.e. on wall/floor/ceiling inside the buildings/tunnels/trenches shall be provided. These pads will be in turn connected to below ground level earth mat through galvanized steel flat or riser. Each ground pad shall have provision for connection of at least two GI flats.

m) Treated earth pit shall be provided for system earthing at locations where generator and transformer neutrals are grounded. Two pits shall be provided for each neutral.

n) Dedicated treated earth pit shall be provided for lightning protection system.

o) Clean earthing for instrumentation shall be provided with dedicated earthing system and separate treated earth pits below the main control room, feed water pump house in turbine house etc.

p) Connection between the equipment earth lead and the grid conductor shall be welded. For rust protection, the welds shall be treated with zinc chromate primer and coated with zinc rich paint.

In order to meet the above design criteria, ground grid mesh will be provided for the main plant complex, viz., switchyard, transformer yard adjacent to power house building, power house building and boiler area up to stack, auxiliary buildings, etc. All electrical equipment, non-current carrying metal parts, structures, building steel, lightning protection system, generator/transformer neutrals will be connected to this station ground grid.

4.01.03 Other major design aspects that are to be considered for grounding system are given below:

1. Ground Grid Conductor

i) Ground grid conductor of mild steel rod shall be used.

ii) The minimum conductor section is determined on the basis of ground fault current. This section is then increased by an allowance to account for the soil corrosion loss of 0.3 mm per year over the design life of 30 years. However, the minimum size shall be 1x40 mm dia mild steel conductor.

2. Underground Grid

i) The ground grid mesh is designed to keep the touch and step voltages within safe limits as per recommendation of IEEE 80 & IEEE665.

ii) The ground grid conductors will be buried in earth at a minimum depth of 1000 mm. The length of ground conductors below earth will be sufficient to ensure a ground resistance less than 0.5 ohm.

iii) The ground grid conductor will be so laid as to provide short and direct connection to building steel and major electrical equipment.

iv) Ground rods shall be provided at the points where system neutrals/lightning protections are connected to the ground grid.

v) All ground grid conductor connections will be welded type.

vi) Main Plant ground grid shall be connected with the other auxiliary building /area ground grid at least at two (2) points.

vii) For test pits, the electrode will be 100 mm dia. Heavy duty C.I. pipe with perforations. Electrodes installed in test pits will have disconnecting facilities

3. Above-ground Connections

i) Galvanized steel flats shall be used for all connections above earth.

ii) Inside building, ground conductors will be run for each floor supported on building steel and/or cable trays. These ground conductors in turn will be connected to the station ground grid through riser (at least two) coming up along building columns/cable shafts.

iii) Two separate and distinct ground connections will be provided for each electrical equipment in compliance with I.E. Rules.

iv) All connections above ground will be welded type except connection to equipment/structures which shall be bolted type.

4. Equipment Ground Lead

Equipment ground connections will be sized to carry the available ground fault current. Considerations shall also be given to mechanical ruggedness of the connections and to limit the number of sizes.

5. Electronic Equipment Grounding

i) Internal ground connection of electronic panels shall be insulated from the enclosure, frame, and chassis are to be terminated to an insulated ground bus.

ii) Insulated ground bus of all electronic panels shall be connected by insulated wire to an insulated common electronic ground bar.

iii) All connection made above shall be in the form of a radial distribution system without any parallel ground paths.

iv) Electronic equipment and systems, metal enclosures of all electronic panels shall be connected to a grounding system with which is isolated and separate from the electrical equipment grounding system.

4.01.04 The minimum conductor sizes for connection of various equipment and structures shall be as given in the attached Notes and Details for Grounding & Lightning Protection Systems.

4.01.05 Entire erection of grounding work shall be carried out in such a way as to be capable of withstanding the intended services of carrying full short circuit level currents to ground mat without any damage / deformation.

4.02.00 Lightning Protection System

4.02.01 Lightning protection work shall be carried out in compliance to the following standards/codes. All standards, specifications and codes of practice (COP) referred to herein shall be the latest editions including all amendments and revisions as on the date of opening of bid. In case of conflict between the specification and those standards/codes referred to herein, the former shall prevail:

a)	Indian Electricity rules	
b)	National Electrical Code	
c)	COP for the protection of building and allied structures against lightning	IS 2309
d)	Recommended practice for hot-dip galvanizing of iron and steel	IS 2629
e)	Method of testing uniformity of coating on zinc coated articles	IS 2633
g)	Methods for determination of mass of zinc coating on zinc coated iron and steel articles	IS 6745
k)	IEEE guide for instrumentation and control equipment grounding in generating stations	IEEE 1050

4.02.02 Basic design criteria are delineated below:

a) The main purposes of the lightning protection system shall be (a) to provide protection to structures from lightning strokes and (b) to provide a low resistance-conducting path to lightning discharge.

b) Lightning protection shall be provided for Power House building, auxiliary building of CHP, AHP, FGD etc. and other structures.

c) Lightning protection will also be provided for building/ structures where the overall rise factor exceeds 10^{-6} as per IS: 2309.

d) For metal structures which are electrically continuous down to the ground level, no lightning protection is required except adequate grounding connections.

4.02.03 Other major design aspects that are to be considered for grounding system are given below:

a) Air termination network with down conductors and earthing electrodes will be provided on the basis of IS Code of Practice.

b) Vertical air terminals shall be of 20mm dia galvanized steel rod on the structure/building (except for chimney).

c) Horizontal air termination of 75x10 mm GS flat conductor on the roof of the installation shall be so laid out that no part of the roof will be more than 9 meters from the nearest conductor.

d) Shielding angle for one vertical air termination shall be 45 degrees. For more than one rod, shielding angle between the rods shall be taken as 60 Degrees.

e) Down conductors of 75x10 mm GS Flat for all installations except for conveyor gallery will run along the outer surfaces of the building and shall have a test joint about 1500 mm above ground. It shall be 25x3 mm GS flat for conveyor gallery.

f) An earth electrode of size 40 mm. diameter 3 metre long MS will be provided at the connection point of the down conductor with the station ground.

g) All connections will be of welded type.

h) Risers (for Lightning protection) shall be of 1x40 (minimum) mm dia. MS rod from underground mat to minimum 300 mm above grade level/concrete floor level.

i) Shielding mast shall be provided at the top of steel columns cap plates of power house building.

j) All other ancillary items in connection with the work described above shall be furnished to complete the work irrespective of whether such items may have been specifically mentioned or not.

4.02.04 All materials and accessories to be supplied by the Bidder shall be brand new ones of reputed make.

4.02.05 Necessary drawings, data sheets and Technical leaflets for each piece of shop produced/fabricated items.

4.03.00 Cabling System

4.03.01 Cabling work shall be carried out in compliance to the following standards/codes. All standards, specifications and codes of practice (COP) referred to herein shall be the latest editions including all amendments and revisions as on the date of opening of bid. In case of conflict between the specification and those standards/codes referred to herein, the former shall prevail:

a)	Indian Electricity rules	
b)	National Electrical Code	
c)	Steel tubes, tubulars and other steel fittings	IS 1239
d)	COP for installation & maintenance of power cables upto and including 33kV rating	IS 1255
e)	Degree of protection provided by enclosures for low voltage switchgear & control gear	IS 2147
f)	Recommended practice for hot-dip galvanizing of iron and steel	IS 2629
g)	Method of testing uniformity of coating on zinc coated articles	IS 2633
h)	Flexible steel conduits for electrical wiring	IS 3480
i)	Cable Glands	BS 6121 / EN 50262
i)	Methods for determination of mass of zinc coating on zinc coated iron and steel articles	IS 6745
j)	Compression type tubular in-line connectors for aluminium conductors of insulated cables	IS 8309
k)	Conduits for electrical installation	IS 9537
l)	Joints & terminations for polymeric cables for working voltages from 3.3kV upto & including 33kV : performance requirements & type tests	IS 13573
m)	Conduit systems for electrical and communication installation	IS 14930

4.03.02 Erection of cabling work shall be carried out in such a way as to provide a reliable and assured electric power supply system to all station auxiliaries.

4.03.03 Cable routing will be done on unit basis as far as possible.

4.03.04 Cables will generally be laid on cable trays, cable trench, cable rack, overhead supported from building steel/structures or cable bridge/cable trestle. Cables shall be run in concrete trenches in transformer yard and i n those electrical rooms at ground level, which are without any spreader room below. However cable trench shall be avoided as far as possible in outdoor areas. Cables shall not be buried directly in ground unless explicitly permitted in some areas.

All cable trestle shall be provided with walkway by the side of cable tray for maintenance. Walkway shall have hand railing with 1200 mm minimum height.

4.03.05 Cables will generally be laid on cable trays, cable trench, cable rack, overhead supported from building steel/structures or cable bridge/cable trestle. Cables shall be run in concrete trenches in transformer yard and in those electrical rooms at ground level, which are without any spreader room below.

4.03.06 Cable trench shall be avoided in boiler area and in outdoor areas as far as practicable. Cable shall be laid on cable trays along overhead pipe bridges. Where such overhead pipe bridges are not available, overhead pipe trestles are to be erected for taking the cable racks/trays. Cables buried directly in ground are not acceptable.

4.03.06 In indoor mechanical equipment areas like pump houses, overhead cable trays shall generally be used.

4.03.07 For underground crossing of railways, road, etc. additional protection shall be provided in form of Hume pipe or concrete encased rigid steel conduits (duct bank).

4.03.08 A.C. and D.C. circuit will not be run in same cable. Further, separately fused circuit will run in separate cables.

For Instrumentation cabling system, Bidder shall refer VOL-IIE, Section I of General Technical Requirement Under "C&I Cabling".

4.03.09 Cables for redundant equipment system shall be run in separate trays, as far as possible.

4.03.11 Erection of cabling work shall be executed keeping in view all necessities and requirements of fire fighting codes for Generating Stations having an adverse industrial environment.

4.03.12 Suitable embedded steel inserts shall be provided on wall/floor/ ceiling surfaces for welding of cable tray bracket in order to make the cable tray system withstand, in addition to normal tray cable loadings, horizontal/vertical accelerations due to seismic forces for indoor trays and also wind load for outdoor trays such as on Boiler platforms.

4.03.13 Erection work to be carried out under this specification shall conform to the 'Notes and Details for Cabling System' given in Annexure-A and the drawings attached to this specification.

5.00.00 SPECIFIC REQUIREMENTS - SUPPLY

5.01.00 Equipment and Material

5.01.01 Equipment and material shall comply with description, rating, type and size as detailed in this specification, drawings and annexures.

5.01.02 All accessories, fittings, supports, hangers, anchor bolts etc. which form part of the equipment or which are necessary for safe and satisfactory installation and operation of the equipment shall be furnished.

5.01.03 All parts shall be made accurately to standard gauges so as to facilitate replacement and repair. All corresponding parts of similar equipment shall be interchangeable.

5.02.00 Conduits and Accessories

5.02.01 The contractor shall provide and install all conduits, mild steel pipes, flexible conduits, rigid PVC pipes, etc. complete with accessories like tees, bends, adopters, locknuts, pull boxes, conduit plugs, caps, etc as required for the cabling work. Conduits shall be furnished in standard length of 5 metres, threaded at both ends.

5.02.02 Conduits diameter upto and including 25mm size shall be of 16 SWG and conduits above 25 mm diameter shall be of 14 SWG. Minimum diameter of conduits shall be 20 mm.

5.02.03 Conduits shall be made of hot-dip galvanized steel with an organic corrosion resistant ID coating. In chemical handling areas, battery room, etc., the exterior surface shall be further coated with chromate and polymer for better resistance to corrosion. Conduits, fittings & accessories shall have ISI mark.

5.02.04 For sizes above 63 mm, hot dip galvanized - both on inside and outside - steel pipes with necessary fittings & accessories shall be provided and installed by the contractor. The pipes and fittings shall be of heavy duty class with relevant ISI mark.

5.02.05 Flexible conduits complying to relevant IS and made with bright, cold-rolled, annealed and electro-galvanized mild steel strips shall be used between embedded conduits/pipes and the motor terminals. It shall also be used between fixed conduit and any equipment with vibration or equipment requiring regular removal.

5.02.06 Non-metallic conduits made of HDPE outer jacket with friction-reducing permanent internal lining shall generally be used for control & instrumentation cables in some areas where cable trays do not exist and where the runs are

straight ones Necessary fittings & accessories as may be required for the installation shall also be provided.

5.03.00 Junction Box

5.03.01 Technical requirement for both non-metallic type and galvanized steel Junction Boxes are given below. Unless the choice is specifically mentioned in the General / Lead Electrical Specification or elsewhere in the tender document, galvanized steel Junction Boxes shall be offered.

Non-metallic Junction Boxes:

a) Material of the Junction Boxes shall be halogen-free and silicon-free, glass fibre-reinforced polycarbonate for outdoor use and/or for cable sizes more than 50 sq.mm. Material shall be ABS/ polycarbonate for indoor use and/or for cable sizes upto 50 sq. mm. Junction boxes for use with fire-survival cables shall be of Duro-plast / powder-coated metal.

b) Material of all non-metallic junction boxes shall be fire retardant and self-extinguishing in accordance with UL 94 V0. It should be tested at Glow Wire test for 960º C.

c) Boxes shall be suitable for continuous operation at an ambient temperature range of -10º C to +80º C.

d) The impact strength of polycarbonate enclosures/boards i.e. the degree of protection against mechanical shock load shall be in accordance with EN 50298-98 for IK 08 (5 Joule).

e) Degree of protection shall be IP 66 to EN 60529. Junction boxes shall have integrally embedded gaskets made of Polyurethane.

f) Allowing a minimum of 20% spare terminals after complete termination, the terminal board for control and instrumentation JBs shall have 6 /12 / 24 / 36 / 48 ways.

g) Doors shall have stainless steel quick fastening screws.

h) The boxes shall be complete with all brackets/fasteners as required for installation on walls, columns and structure.

5.03.03 Steel Junction Boxes

a. Junction boxes with IP 55 (for Indoor) / IP 65 (for Outdoor) degree of protection, shall comprise of a rectangular parallelepiped case hinged door with Handle constructed from cold rolled sheet steel of minimum thickness 2mm. Top of the box shall be arranged to slope towards the rear of the box. Gland plate shall be 3mm thick sheet steel with neoprene/synthetic rubber gaskets. All junction boxes shall be of

adequate strength and rigidity, hot dip galvanized as per relevant IS with epoxy powder coating paint RAL 7032 with min painting thickness 80 micron and suitable for mounting on wall, column, structures etc. The boxes shall be complete with M8 earthing stud and all brackets/fasteners as required for installation.

b) No. of Ways: 6 / 12 / 24 / 36 / 48 with 20% spare terminals after termination.

c) All outdoor JBs shall be similar but with a canopy at the top.

d) Doors shall be hinged and lockable and shall be made of the same material as the case. The doors shall have industrial heavy-duty hinges. The doors shall be easily but firmly lockable with quick release fastener.

e) The junction boxes shall have the following indelible markings:

i) Circuit nos. on top by white-stenciled paint at site.

ii) Circuit nos. with ferrules (inside) as per approved drawing.

iii) Danger sign in case of 415V circuit.

5.04.00 Terminals

5.04.01 Multiway terminal blocks of approv ed type, complete with screws, nuts; washers and marking strips shall be furnished for connection of incoming/outgoing wires.

5.04.02 Each control cable terminal shall be suitable for connection of 2 nos. 2.5 sq.mm. stranded copper conductors without any damage to the conductor or looseness of conductors.

5.05.00 Cable Termination & Straight through Joints

5.05.01 Bidder shall supply cable termination and jointing kits in requisite quantity for H.T. Power Cables, L.T. Power, Control Cables, Instrumentation Cables, etc. along with all accessories & consumables required for making termination and joints complete. Those shall be of proven design and make which have already been extensively used and type tested.

5.05.02 Components shall be pre-moulded type, taped type or heat-shrinkable type. 11kV and 3.3kV grade joints and terminations shall be type tested as per IS: 13573.

5.05.03 Kits shall be complete with the alumunium solderless crimping type cable lugs and ferrule as per DIN standard.

5.06.00 Cable Glands

Cable shall be terminated using double compression type cable glands. Cable glands shall conform to BS 6121 or to EN 50262. Ingress Protection rating for cable glands with seal, when offered conforming to EN 50262, shall be minimum IP 66 in line with BS. Cable glands shall be made of tinned brass gland, double compression type complete with necessary armour clamp and tapered washer, etc. Rubber components shall be of neoprene or better synthetic material and of tested quality. Cable glands shall match with the sizes of different cables supplied/erected.

5.07.00 Cable Lugs

Cable lugs shall be suitable for termination of different cross-sections of H.T./L.T./Control/Instrumentation cables and shall be of following types:

i) Aluminium tubular terminal end for solderless crimping to aluminium conductors.

ii) Copper tubular terminal end for solderless crimping to copper conductors.

Solderless crimping of terminals shall be done by using corrosion inhibiting compound. The cable lugs shall suit the type of terminals provided on the equipment. Lugs for control/instrumentation cables shall be PVC insulated/sleeved type.

iii) Cable lugs for control cable termination shall be insulated. These lugs shall be pin type/flat type/ring type / U type to suit the terminals provided in the panels.

5.09.00 Cable Clamps and Straps

5.09.01 Trefoil clamps for single core cables shall be pressure die-cast aluminium or fibre glass or nylon with necessary G I fasteners. Trefoil clamps shall have adequate mechanical strength to forces generated by peak value of maximum system short circuit current.

5.09.02 Cable clamps required for multicore cables on vertical run shall be made up of 25x3mm size aluminium strip. For clamping the multicore cables, self-locking, de-interlocking type fire-resistant nylon clamps/straps of sufficient strength shall be used.

5.10.00 Consumables and Hardware

5.10.01 The Contractor shall furnish all erection materials, hardware and consumables required to complete the installation.

5.10.02 The materials shall include but not be limited to the following:

Consumables : Welding rods & gas, oil and grease, cleaning fluids, paints, electrical tape, soldering materials, etc.

Hardware : Bolts, nuts, washers, screws, brackets, supports, clamps, hangers, saddles, cleats, sills, shims, etc.

5.10.03 Supply of cement, sand, stone, etc. required for the execution of the contract shall be the responsibility of the Contractor.

5.11.00 Testing Equipment

5.11.01 The major testing equipment that are required to be provided by the Contractor are listed below:

a) Insulation Tests

i) Power operated Meggar - 1 KV and 10 KV grade

ii) Hand operated Meggar - 1 KV grade

b) Hand driven earth Resistance Meggar, range 0-1/3/30 ohms.

c) High potential testing set - roller mounted type

d) Tong testers of suitable ranges.

e) Contact resistance measuring set for micro-ohms.

f) Torque wrench of various sizes.

g) Multimeters, test lamp, field telephone with buzzer set, different gauges, etc.

5.11.02 The list of equipment is indicative only. Any other test equipment required will be arranged by the Contractor.

6.00.00 METHODS AND WORKMANSHIP

6.01.00 All work shall be installed in a first class, neat workmanlike manner by mechanics/ electricians skilled in the trade involved.

6.02.00 The erection work shall be supervised by competent supervisors holding relevant supervisory license from the Government.

6.03.00 All details on installation shall be electrically and mechanically correct.

6.04.00 The installation shall be carried out in such a manner as to preserve access to other equipment installed.

7.00.00 INSTALLATION

7.01.00 General

7.01.01 Installation work shall be carried out in accordance with good engineering practices and also as per manufacturer's instructions/ recommendations where the same are available.

7.01.02 Equipment shall be installed in a neat workmanlike manner so that it is level, plumb, square and properly aligned and oriented.

7.01.03 Cable installation work shall mean erection of cable trays/racks, supports, hangers, junction boxes, conduits, laying of cables either in ground or on trays inside trenches tunnels/overhead trays in conduits, etc. dressing and clamping, jointing and termination inclusive of supply of necessary jointing/ termination kits, lugs, glands, ferrules, tapes, etc. and other accessories, grounding of cable armour. In case of direct laying in ground, all excavation work, necessary back-filling, supply of bricks and protective concrete slabs, removal of excess earth shall be part of the installation work.

7.01.04 Grounding installation work shall mean erection, jointing/ brazing/ welding, connection and painting, testing of ground conductors including supply of necessary steel/copper.

7.01.05 Lightning protection system installation work shall mean erection, jointing, welding, connection and painting, testing of air termination network, down conductors, shielding masts, connection to ground grid, electrodes, risers, horizontal conductors, etc. of lightning protection system.

7.02.00 Cable Trays

7.02.01 Pre-fabricated cable trays and accessories shall be assembled & erected at site. Adequate spaces will be provided to facilitate installation of cable system and to allow routine inspection and modification after installation.

7.02.02 Cable trays either inside concrete trenches or inside buildings and racks inside cable shafts shall be aligned and leveled properly. All tray runs shall be installed parallel to the trench/building walls and floors except otherwise noted in the approved drawings.

7.02.03 As far as practicable, cable trays shall be supported from one side only in order to facilitate installation and maintenance of cables from the other side.

7.02.04 The cable trays shall be supported in general at a span of exceeding 1.25 metres horizontally and 1.0 metre vertically.

7.02.05 Sufficient spacing not less than 250 mm shall be provided between trays and maintained to permit adequate access, for installing & maintaining the cables.

7.02.06 Complete cable tray support structure after installation shall be inspected/ tested for welding strength, straightness, accuracy, use of proper sizes and compliance to drawings.

7.02.07 Complete cable tray and accessory installation work shall be inspected/tested for proper alignment, leveling, use of proper accessories, high quality workmanship, etc.

7.02.08 The Contractor shall remove the RCC/steel trench covers whenever required and shall again place the same in their positions after the erection work in the particular area is completed or when further work is not likely to be taken up for some time.

7.02.09 Whenever any pipe/conduit/cable tray emerges out or enters into a building care should be taken to ensure that no water enters into the building.

7.02.10 Cable trays in areas subject to excessive coal dust, oil spillage, mechanical damage or accessible to personal contact shall be provided with raised sheet metal tray covers, installed on upper tray in horizontal run and front in vertical run.

7.02.11 Cable trays/racks shall be so arranged that they do not obstruct or impair clearances of passage way.

7.02.12 Cable tray/conduit system will be so designed as to accommodate maximum pulling tension and minimum bending radius of cable.

7.02.13 Cable tray/conduit system will be constructed to prevent drainage of water into equipment or building.

7.02.14 Cable tray/conduit system shall be electrically continuous and grounded.

7.02.15 Different voltage grade cables will be laid in separate trays when trays are run in tier formation. Power cables will normally be on top trays and control/instrumentation cable on bottom trays.

7.03.00 Cable and Conduits

7.03.01 The Contractor shall install, terminate and connect up all cable and conduits as per drawings and cable schedules.

7.03.02 The drawings shall be strictly followed except where obvious interference occurs. In such cases, the routing shall be changed as directed and/or approved by the Engineer.

7.03.03 Approximate lengths of cable and conduit runs will be shown by the contractor in the cable schedule for guidance only. Before commencement of work the Contractor shall take actual measurements and prepare his own cable-cutting schedule to reduce wastage to a minimum.

7.03.04 The Contractor shall also maintain and submit when requested, a record of cable insulation value when drawn from store, after laying, before and after termination/jointing.

7.03.05 Where direct heat radiation exists, heat isolating barriers, shall be adopted for cabling system.

7.03.06 Cabling/wiring in offices, laboratories, control rooms etc. shall be taken through concealed G.I. or rigid PVC pipes as directed by the owner's Engineer.

7.03.07 At certain places where hazardous fumes/gasses may cause fire to the cables, cable trenches after installation of cables shall be sand filled.

7.04.00 Conduit and Accessories

7.04.01 Conduit/pipes shall be used only in short lengths in certain areas where required and/or as directed by the Engineer.

7.04.02 The Contractor shall furnish all conduits complete with accessories as required.

7.04.03 Conduits shall be flexible type in general. However, rigid type steel conduit if required shall also be supplied by the Contractor.

7.04.04 Except for inside an enclosure wherever the cable enters or leaves the conduit, the conduit end shall be sealed by suitable sealing compound, having fire withstand capability.

7.04.05 The entire metallic conduit system, when embedded or exposed shall be electrically continuous and grounded.

7.04.06 Where it is possible for water or other liquids to enter conduits, sloping of conduit runs and drainage of flow points shall be considered.

7.04.07 Pull boxes will be installed between termination points where required to facilitate cable pulling, but at a maximum interval of 30 meters.

7.04.08 Conduits shall be firmly fastened within 900 mm of each junction box/pull box/cabinet/fitting, etc. Conduits shall be supported at least every 2000 mm.

7.05.00 Cables: Storage and Handling

7.05.01 Cable drums shall be stored on hard and well-drained surface so that they may not sink. In no case shall the drum be stored on the flat, i.e., with flange horizontal.

7.05.02 Rolling of drums shall be avoided as far as practicable, for short distance, the drums may be rolled provided they are rolled slowly and in proper direction as

marked on the drum. In absence of any indication, the drums may be rolled in the same direction as it was rolled during taking up the cable.

7.05.03 For unreeling the cable, the drum shall be mounted on jacks or on cable wheel. The spindle shall be strong enough to carry the weight without bending. The drum shall be rolled on the spindle slowly so that the cable should come out over the drum and not below the drum.

7.05.04 While laying cable, cable rollers shall be used at an interval of 2000 mm. The cables shall be pushed over the roller by a gang of people positioned in between rollers over a suitable distance. Care shall be taken so that kinks and twists or any mechanical damage does not occur in cables. Only approved cable pulling grips or other devices shall be used. Cables shall not be dragged on ground or along structure while laying out from cable drums. Cable shall not be pulled from the end without having intermediate pushing arrangement. Bending radius of the cable during installation shall not be less than what is specified by the manufacturer.

7.05.05 Empty cable drums shall be returned to the Owner.

7.06.00 Cable Laying

7.06.01 Cable shall generally be installed in ladder type prefabricated trays except for some short run in rigid/flexible conduit for protection or crossings.

7.06.02 Cables laid on trays and risers shall be neatly dressed and clamped with self-locking type fire resistant nylon ties at an interval of 750 mm. for horizontal and vertical runs, in case of both power, control and instrumentation cables.

7.06.03 Single core power cables for 3 Ph. AC circuits shall be laid in trefoil formation and suitably clamped with self-locking type fire resistant nylon ties at an interval of 750 mm.

7.06.04 L.T. multicore power cables with cross-sectional area of 95 sq.mm and above and all H.T. multicore power cables and shall be clamped individually by self-locking type fire resistant nylon ties.

7.06.05 L.T. power cables of cross sectional area less than 95 sq.mm and all control and Instrumentation cables shall be clamped in bunches with self-locking type fire resistant nylon ties. The number of cable in one bunch shall not exceed eight (8).

7.06.06 Prior to laying of cables inside the indoor and outdoor trenches, the contractor shall properly clean the trenches.

7.06.07 In outdoor areas, buried cables shall be laid and covered with sand/riddled earth and protected from damage by bricks at sides and precast slab at top.

7.06.08 When buried cables cross road/railway track, adequate protection shall be provided in the form of hume/galvanised iron pipes laid at a minimum depth of 1 meter below ground.

7.07.00 Cable Tags & Markers

7.07.01 Each cable and conduit run shall be tagged with numbers that appear in the cable and conduit schedules. Cables and conduits shall be tagged at their entrance, bends, every 30.0M and exit from any equipment, junction box. When a cable/conduit passes through a wall, tags shall be fitted on both sides of the wall.

7.07.02 The tags shall be of aluminium with the number punched on it and securely attached to the cable by not less than two turns of 16 SWG G.I. wire. For single core cable the wire shall be of non-magnetic material.

7.07.03 Location of cable joints, if any, shall be clearly indicated with cable marker with an additional inscription 'cable-joint'.

7.07.04 Contractor shall furnish and install all tags and markers stated above.

7.07.05 For buried cable, the marker shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change of direction.

7.08.00 Cable Termination and Connection

7.08.01 Termination and connection of cables shall be done strictly in accordance with manufacturer's instruction, drawings and/or as directed by the Engineer.

7.08.02 Work shall include all clamping, fitting, fixing, soldering, tapping, compound filling, cable jointing, crimping, shorting and grounding as required for the complete job. All equipment required for all such operations shall be of Contractor's procurement. Furnishing of all consumable materials such as soldering material, electrical tape, sealing material as well as cable jointing kits shall be included in the offer.

7.08.04 Cable joint kits for all cables shall be supplied by Contractor under this specification. Responsibility for proper termination shall lie on the contractor. Guarantee for termination shall also have to be given by Contractor.

7.08.05 The equipment will be generally provided with blank bottom plates for cable/conduit entry and cable end box for power cables.

7.08.06 The Contractor shall perform all drilling, cutting on the blank plate and any minor modification work required to complete the job.

7.08.07 If the cable end box or terminal enclosure provided on the equipment is found unsuitable and requires major modification, the same shall be carried out by the contractor.

7.08.08 Control/instrumentation cable cores entering control panel/ switchgear/ MCC, etc. shall be neatly bunched and served with PVC perforated tape to keep it in position at the terminal block.

7.08.09 The Contractor shall put ferrules on all control cable cores in all junction boxes and at all terminations. The ferrules shall carry terminal numbers as per drawings. All ferrules shall be coloured, plastic & interlocked type.

7.08.10 Spare cores shall be similarly ferruled, crimped with lug and taped on the ends. Spare cores shall be ferruled with individual cable number.

7.08.11 Termination and connection shall be carried out in such a manner as to avoid strain on the terminals.

7.08.12 All cable entry points shall be properly sealed and made vermin and dust proof. Unusual opening, if any, shall be effectively closed. Sealing work shall be carried out with approved sealing compound having fire withstand capability for at least three hours.

7.08.13 Strips and special tools like manually or pneumatically driven gun/pistol for termi-point/equivalent connection shall be supplied by the Contractor.

7.09.00 Cable Joints

7.09.01 Cable shall be installed without joints as far as practicable.

7.09.02 If however jointing becomes necessa ry, it shall be made only by qualified cable jointer and strictly in accordance with manufacturer's recommendation.

7.10.00 Grounding

7.10.01 If supply and laying of the underground mat is included in the scope of the Contractor, the Contractor will plan and organize works to lay the grounding mat in the same sequence in which the building and equipment foundation is being done.

7.10.02 Underground mat will be made of mild steel rods laid underground in length and breadth of the area at a depth of minimum 1 metre below grade level. All crossings and straight run shall be arc welded for good electrical continuity. Ground conductors, when crossing underground trenches, directly laid underground pipe and equipment foundation, if any, shall be at least 300 mm below the bottom elevation of such trenches/pipes as shown in the relevant drawing.

7.10.03 Contractor shall carryout the interconnection among various peripheral earthing grids/mats, steel structures, lightning protection system as well as grounding of all electrical equipment, etc. The grounding work shall be carried out as per provisions of I.E. rules, Indian standards and Annexure-E: Notes & Details for Grounding & Lightning Protection System.

7.10.04 Grounding shall be done by conductors of adequate sizes (size shall be selected by the bidder with supporting calculation, if not specified) and the same shall be connected to the risers of main ground mat.

7.10.05 For fabricated cable trays, a separate ground conductor (50x6 mm G.S. flat) shall run along the entire length of each route of cable tray being suitably clamped on the cable tray. Individual cable trays of each section shall be connected to above ground conductor through 50x6 mm G.S. flat to maintain continuity of ground path.

7.10.06 All ground conductor connections shall be made by electric arc welding/ brazing unless otherwise specified. Ground connections shall be made from nearest available station ground grid risers. The rods/connection shall be coated with cold galvanizing /weather resistance anti corrosive paints.

7.10.07 All ground conductors shall be painted black for easy identification.

7.10.08 Equipment ground connections, after being checked and tested by the Engineer, shall be coated with anti-corrosive paint.

7.10.09 Whether specifically shown or not in Project drawings, all conduits, trays, cable armour and cable end box, electrical equipment such as motors, switchboards, panels, cabinets, junction boxes, lockout switches, fittings, fixtures, etc. shall be effectively grounded.

7.10.10 If there is no provision to ground the L.T. transformer neutral at transformer end, to make an effectively earthed 415V system the neutral bus of all 415V distribution boards shall be connected to ground grid at two different and distinct points.

7.10.11 Ground Electrode

Ground electrodes are to be fabricated and driven into the ground by the side of mat conductor. All connections to the conductors shall be done by are wilding process.

7.10.12 Risers

Risers are required for connecting the equipment and structures with the ground mat. These will be 1x40 mm dia (minimum) M.S. rod. laid from ground mat to above ground level properly clamped or supported along the outer edge of the concrete foundation. Connection to the ground mat shall be done by arc welding and the other end is to be kept free at least 300 mm above grade level/concrete floor level unless otherwise shown.

7.10.13 Column Grounding

All columns are required to be grounded by 1x40 mm dia (minimum) M.S. rod from ground mat. Laying, supporting along with foundation, connecting at ground mat are within the scope of this specification. At least 300 mm length

of the above rods shall be left free above the grade level/concrete floor level for connection with columns.

7.10.14 Electronic Equipment Grounding

Internal ground connection of electronic panels shall be insulated from the enclosure, frame, chasis and to be terminated to an insulated ground bus.

Insulated ground bus of all electronic panels shall be connected by insulated wire to an insulated common electronic ground bar.

All connection made above shall be in the fo rm of a radial distribution system without any parallel ground paths.

Electronic equipment and systems, metal enclosures of all electronic panels shall be connected to a grounding system with which is isolated and separate from the electrical equipment grounding system. Separate Earth pit shall be made by 3M X 3M MS Rod.

7.11.00 Painting

Contractor shall paint steel fabrications at site with two (2) coats of red oxide primer and two (2) coats of battleship grey (shade no. 632 of IS:5) synthetic enamel paint. In case a different kind of primer or a finish shade is mentioned in the Lead/General Specification due to especially corrosive atmosphere, the same shall be followed.

7.12.00 Galvanizing

Galvanizing shall be uniform, clean, smooth, continuous and free from acid spots. Should the galvanizing of the samples be found defective, the entire batch of steel has to be re-galvanized, at Contractor's cost. The amount of zinc deposit shall not be less than 610 grams per square metre of surface area. Additionally, the thickness of the zinc deposit at any spot shall not be less than 75 microns. The Owner reserves the right to measure the thickness of zinc deposit by appropriate instrument and reject any component which shows thickness of zinc at any location less than 75 microns.

7.13.00 Excavation and Back Filling

7.13.01 Contractor shall perform all excavation and backfilling to the original level with good consolidation as required for buried cable and ground connections. Sheeting and shoring shall be done as necessary for protection of the work.

7.13.02 Contractor shall make his own arrangements for pumping out any water that may be accumulated in the excavation.

7.14.00 Steel Fabrication

7.14.01 All racks, trays, supports, hangers & brackets wherever necessary shall be fabricated by the Contractor.

7.14.02 Steel for fabrication shall be straightened and cleaned of rust and grease. All fabrication shall be free of sharp edge and burns so as not to cause any damage to personnel or cables.

7.15.00 Cleaning up of Work Site

7.15.01 The Contractor shall, from time to time, remove all rubbish resulting from execution of his work. No materials shall be stored or placed on passage or drive ways.

7.15.02 Upon completion of work, the Contractor shall remove all rubbish, tools, scaffoldings, temporary structures and surplus materials etc. to leave the premises clean and fit for use.

8.00.00 TESTS

8.01.00 Shop Tests

8.01.01 All equipment shall be completely assembled, wired, adjusted and routine tested as per relevant Indian Standards at manufacturer's works.

8.01.02 Tests on panels/junction boxes shall include:

a) Wiring continuity tests.
b) High voltage and insulation tests.
c) Operational tests.

8.02.00 Site Tests

8.02.01 Contractor shall thoroughly test and meggar all cables, wires and equipment to prove the same are free from ground and short circuit.

8.02.02 If any ground or short circuit is found, the fault shall be rectified or the cable and/or equipment replaced.

8.02.03 All power cables after installation and prior to connections shall be subjected to High Potential tests. Also the insulation resistance values shall be measured both before and after Hipot test for comparison. The leakage current shall also be measured during the Hipot test at site.

Cable cores shall be tested for :

a) Physical damage
b) Continuity
c) Correctness of connections as per relevant wiring diagram
d) Insulation resistance to earth
e) Insulation resistance between conductors

f) Proper earth connections of cable glands, cable boxes, cable armour, screens etc.

8.02.04 All equipment shall be demonstrated to operate in accordance with the requirements of this specification.

8.03.00 Test Certificates

8.03.01 Type test certificate on any equipment, if so desired by the Owner, shall be furnished. Otherwise the equipment shall have to be type tested, free of charge, to prove the design.

9.00.00 DRAWINGS, DATA & MANUALS

9.01.00 To be submitted with the Bid

9.01.01 Make, type and catalogue number of different electrical items and accessories along with technical leaflets, data sheets etc.

9.01.02 Typical General arrangement drawings showing constructional features, fixing arrangement of pre-fabricated cable trays.

9.01.03 Bill of Materials for cable trays and accessories, conduits & accessories.

9.01.04 Layout of Grounding system & li ghtning protection system showing connection and other details along with backup design calculations and detailed write up.

9.01.05 Bill of materials for grounding and lightning protection system.

9.01.06 Drawing showing details of equipment grounding.

9.02.00 To be submitted after Award of Contract

9.02.01 Make, type & catalogue number of cable termination kits, joints & accessories.

9.02.02 Detail dimensional drawings showing constructional features, grounding, fixing arrangement etc.

9.02.03 Bill of Materials for Pre-fabricated cable tray and accessories, Conduits & accessories.

9.02.04 Dimensional G.A. drawings and data sheets for different equipment and items supplied under this specification.

9.02.05 Layout drawing of Grounding system and Lightning protection system showing connection details along with backup design calculation and detailed write up.

9.02.06 Bill of material for grounding system and lightning protection system.

9.02.07 Drawing showing details of equipment grounding system.

Annexure-A

DETAILS FOR FIRE-PROOF CABLE PENETRATION SEALING SYSTEM

1.00.00 General

1.01.00 The Fire proof sealing, fire stop system and fire protection coating system are required to prevent spreading of fire from one place to other place (or one zone to other zone) through the openings in wall / floor, cables laid in trays / racks and openings below Electrical Switchgear, MCC, DB,/ Cabinets, Panels etc.

1.02.00 The fire-proof cable penetration (FPCP) sealing system shall conform to the requirement of BS: 476 Part 20 (latest edition with all amendments).

2.00.00 Scope of Work

The scope of work includes but is not limited to the following items of supply and installation:

i) Fire Stops in wall and floors

ii) Fire stops below switchgear, MCC, Switchboards, DBs, junction boxes / panels / cabinets, etc. which are floor mounted type

iii) Fire retardant coating to be applied for installed cables

iv) Fire proof barrier walls

v) Fire proof doors

vi) Minor civil and structural works for installation of the entire work

vii) Necessary erection materials, consumables and sundry items to complete the work for satisfactory and trouble free operation

viii) Any special tools & tackles

ix) Conducting the type test of fire proof sealing system in presence of Owner's Engineers

x) All relevant Drawings, Data sheets and instruction manuals

3.00.00 Design Criteria

3.01.00 Fire Proof Cable Penetration Sealing System

The material / components used for fire-proof sealing (FPCP) system shall be provided to meet the following requirements:

i) The product shall be age tested for not less than 30 years.

ii) Shall be free from shrinkage or cracking; should achieve smoke and gas tightness during fire and should be modifiable.

iii) Not to generate toxic or corrosive gas and cause harm to the personnel handling the system.

iv) Prohibition of production of acid or alkali during gas generation.

v) Shall be repellant to pest / rodent / termite.

vi) Expansion co-efficient - very low which is to be comparable with masonry concrete.

vii) Not soluble / reactive to acid, water, alkali.

viii) Thermal conductivity - low.

ix) The material in contact with the cables in the FPCP sealing system shall be compatible with the material used for outer sheath of cables.

x) It should not have any adverse effect on the cables and should not alter the current carrying capacity of the cables.

xi) Retrofit in design to accommodate not less than 15% more addition of cables depending upon the size of cables, physically and chemically stable.

xii) Capable of withstanding vibrations, drop-loads, foot traffics, mechanical loads, etc.

xiii) The sealing system shall maintain its integrity and perform satisfactorily even after

a. Remaining in water for a long time.

b. Accelerated thermal aging.

c. Sustaining vibrations.

xiv) The design and construction of FPCP sealing system shall specifically take into account the fact that under seismic disturbances, normal load, short circuit and fire conditions, the cable / cable trays will be subject to movement, expansion and oscillation and this shall not result in any damage or cause dislocation of the FPCP sealing system or the material constituting the FPCP sealing System.

xv) Non-hygroscopic, non-inflammable and shall not get affected over a period of time due to humidity, moisture and ozone etc. and should not

contain volatile solvents which may cause a fire hazard during application.

xvi) The fire sealing system to be installed at floor openings below C&I panels, control panels/boards etc. in Central Electrical Room, Central Control Room, Central Electronic Room shall have a fire rating of not less than two (2) hours. The fire sealing system to be installed at all other places like the rest of the wall and floor crossings of cables/cable trays, openings below Switchgears/Boards etc. shall have a fire rating of one (1) hour. The system shall be stable after application of water jet in the exposed side in order to extinguish fire.

3.02.00 Fire Protection coating to be applied on installed cables:

A. The cables shall be coated with fire protection material of 2 mm dry thickness at the strategic locations as follows so as to limit the spread of fire:

i) At fire stops in walls and floors on either side upto 500 mm length.

ii) At fire stop below Electrical Switchgears/ MCCs/ Panels/ Cabins, etc. on one side coating of 500 mm length, i.e., on the cable vault side / cable trench side.

iii) Length of 500 mm on all sides of the junction/crossing of cabling work in open cable routes/ cable trench.

iv) In fire risk areas and where specified at suitable intervals as decided upon side conditions in open cable routes.

v) Where necessary and specified at site intervals along cable routes in cable trenches.

vi) The coating shall be applied evenly on the cables only.

B. The fire protection coating shall have the following properties/composition:

i) Asbestos-free, non-volatile, not eatable by vermin, harmless and non-irritant to human skin.

ii) Not affecting the current carrying capacity of the cables and the properties of the installed cables.

iii) It shall delay fire damage to cables and prevent flame spreading meeting the requirement of IEC - 332.

iv) Coating material shall show no signs of cracking and peeling when the coated cable is bent to the radius of minimum 12 times the diameter of the maximum size cable at 180°C.

v) The limiting oxygen index of the material shall not be less than 60% as per ASTMD - 2863.

vi) Life expectancy equivalent to the cable installations.

3.03.00 The various openings in the cable vault, vertical, horizontal raceways of cables penetrating walls, floors and the bottom of Electrical switchgears, MCCs, distribution boards, Cabinets, Panels shall be provided with fire stop systems. Cables passing through the openings at various locations are laid on various tiers of the cable trays/ racks in the bunch formation. Bidder shall visit the site to assess and get acquainted with the type of cable installation where fire stops and fire protection coating are to be provided. In case steel frames are required to be fabricated and fixed in the openings, the fabrication of frame & fixing of the same shall have to be done by the Contractor without any extra cost. The necessary steel section for fabrication of frames shall be supplied by the Contractor without any extra cost. Any civil works required to be done in the openings shall be carried out by the Bidder. Bidder shall also include one set of tools & accessories required for addition or removal of cables after the seal is made.

3.04.00 The bidder shall quote the unit rates for provision of supply, installation, testing & commissioning of the fire proof seals as given in the specification. Bidder is requested to quote the unit rates per square metre (i.e., area) basis of the area of the fire sealing material.

4.00.00 Type Test on Penetration Seals

4.01.00 The type tests for fire proof/ penetration seal for floor and wall opening/ fire stop system for bottom of electrical switchgear/ MCC/ panel base are as under:

i) Fire rating test

ii) Hose Stream test

iii) Accelerated aging test

iv) Fire rating test on the penetration seal system built out of accelerated aged components followed by hose stream test

v) Temp. rise test for cable in the fire stop

vi) Water absorption test followed by fire rating test

vii) Flame Resistance test for fire retardant coating material

viii) Anti-rodent test

4.02.00 Fire Rating Test

This test shall be carried out to prove the guaranteed power rating duration of the system in respect of stability, integrity and insulation characteristics of the complete system. The penetration seal system as a whole conforming to ASTM 814 and as per BS:476 Part-8 shall be built with the necessary component. The fire test shall be built with the necessary component.

The test specimen of the penetration seal built with 9-10 nos. armoured cables of various sizes passing through the seal shall be fitted to the gas fired furnace and shall form the upper most face of the furnace. The gas fired furnace shall have provision to achieve standard time temperature characteristics for fire tests as mentioned in BS-476 Part-8, according to which the temperature required to be maintained are as under:

Heating time (minute)	30	90	120 150 180 210 240
Furnace temp (°C)	821	886	1029 1062 1090 1113 1133

The pressure inside the furnace at the time of test shall be more than 2 mm water gauge. The penetration shall be subjected to fire test with surface exposed to controlled fire in the furnace conforming to time / temperature characteristics as mentioned above. During the test, temperatures of both the faces of the penetration seal i.e. one which is exposed to fire and the other unexposed, shall be measured by calibrated thermocouples after regular interval of 5 minutes. At least 3 thermocouples shall be provided for temperature measurement of each face.

4.03.00 The results at the end of the tests shall be interpreted or failure criteria as under:

i) The system is deemed to have failed to maintain stability if there is a total collapse of the penetration seal.

ii) In case cracks are seen on the face of the penetration seal or cracks through the seal system through which the flame / or gas can pass, the system is deemed to have failed to maintain integrity. The development of crack is characterized by ignition cotton wool held near the seal on the unexposed surface at a distance of about 30 mm from the aperture.

iii) In case the mean temperature rise of unexposed surface of seal exceeds 140°C above the initial temperature or temperature of unexposed surface exceeds 180°C, t he system shall deemed to have failed in respect of insulation characteristics.

iv) Temperature measurement on the unexposed side of the penetration seal specimen shall be measured by the thermocouple on the surface of penetrating items and on fire stop material in accordance with ATME-814/UL 1479 at a distance of 25 mm from fire stop material and penetration items respectively.

4.04.00 Hose Stream Test:

The intention of the hose stream test is to ascertain whether the penetration seal assembly maintains its stability on application of water jet after withstanding the fire for 3 hours i.e. the guaranteed fire rating duration.

The test apparatus for this test shall be similar to the one used for carrying out the fire rating test. The penetration seal system shall be subjected to the action of hose stream at the nozzle pressure of 30 psi supplied for a duration of 1.5 sec./ sq.ft.. of exposed area. The hose stream shall be applied with 1.1/ 8" dia. nozzle at a perpendicular distance of approximately 17 ft. from the centre of the assembly on a line approximately 270 deg. from the line normal to the centre for the test assembly. The water stream shall be applied within 4 minutes and 30 seconds after completion of fire rating test.

However, this period shall not exceed more than 10 minutes in case of practical difficulties experienced by testing stations. The application of water stream shall be maintained throughout the test duration and shall traverse the complete fire stop system.

The fire stop assembly is deemed to have passed the hose stream test successfully if no through projection of water is noticed on the unexposed surface of the seal. Further on completion of hose stream test, the appearance of the penetration seal system shall not alter substantially indicating thereby that the stability of the system has been maintained.

4.05.00 Accelerated aging test

The intention of accelerated aging test is to ascertain whether the artificial aging of the systems and components thereof results into change in the mechanical properties or in the form. In order to simulate aging, artificial aging shall be resorted to.

For the purpose of subjecting the penetrations seal system components to accelerated aging, the system / components shall be stored for 336 hours in air furnace where the temperature of the inside air, shall be maintained at 100° C. However, for system component s in pliable form, system component shall be stored for 448 hours in air furnace where temp. of air inside the furnace shall be maintained at 75° C. It is assumed that the changes occurring during test period would roughly correspond to the effect on aging over a period of about 40 years.

After completion of 336 hours / 448 hours, the mechanical properties such as tensile strength element, elongation and hardness of the material (as may be applicable) shall be tested. These results shall be compared with corresponding values before subjecting to accelerated aging test.

The change in the form of system / components shall also be compared with the form before the tests to ascertain whether the system / components thereof have undergone any permanent change.

In case the mechanical properties before and after the accelerated aging do not indicate substantial change, the system shall be deemed to have passed the accelerated aging test. Similarly the variation in the form of the system components at the end of the test shall not indicate permanent deformation which is likely to affect the ceiling properties of the system.

4.06.00 Fire Rating test After Accelerated Aging:

Intention to this test is to ascertain whether the penetration seal built out of components already subjected to accelerated aging still passes the fire rating test for guaranteed fire rating duration.

The test apparatus for this test shall be similar to the one used for fire rating test mentioned above. The assembly or the penetration seal shall be carried out with the components which were subjected to accelerated aging test based on the test procedure mentioned above. In case there is a problem of co-ordination with the test station, the prototype assembly may be subjected to aging in manufacturer's works under the conditions mentioned above and live fire test should be carried out at manufacturer's works in presence of Owner's representative.

In live fire test, the temperature of fire shall be of the order of 1000° C at the end of 3 hours. The test shall be carried out at atmospheric pressure.

The interpretation of test results for failure shall be similar to those mentioned under fire rating test/live fire test above.

4.07.00 Temperature rise test for cable in the fire stop:

This test shall be carried out to ascertain whether due to inadequate dissipation of heat at the location of fire stop, the temperature of cable conductor or outer sheath in contact with the fire stop, rises beyond the acceptable limits due to which whether any derating is required for cables.

Fire stop systems shall be erected with, at least 8-10 armoured cables, specially power cables. While laying the cable through penetration seal, thermocouple shall be placed on the outer surface of cable in contact with the fire stop system. The location shall be selected where there exists possibility of inadequate dissipation of heat from cables to the atmosphere due to fire stop components. Two thermocouples shall also be located on the two surfaces of the fire penetration seal system. Similarly thermocouples shall also be placed on the other surface of cables where there exists contact of free air without any obstruction so as to enable adequate nature cooling.

In case the temperature of outer surface of the cable in contact or inside the fire stop system does not exceed 75° C, it is inferred that no derating of cable is required for cable when used in conjunction with the particular fire stop system.

Test shall be repeated with reduced current till the temperature of cable outer surface in contact with fire stop system is limited to 75°C. The rate of the current so guaranteed by the cable manufacturer as free air rating shall be the derating factor.

4.08.00 Water Absorption Test:

The test specimen shall be immersed in fresh clean water at a temp. of 20°C. The test specimen must be separated from the bottom and sides of the soak tank by at least 10 mm and it shall be covered by approximately 25 mm of water. At the end of the 24 hours soak period, the specimen shall be removed from the water and moped up with a damp cloth.

Fire rating test after water absorption is to ascertain whether the penetration seal subjected to water absorption still passes the fire rating test for guaranteed fire rating duration.

Test apparatus for this test shall be similar to the one used for fire rating test. In case there is problem of coordination with test stations, the prototype assembly may be subject to water absorption test at manufacturer's works followed by live fire test which should be carried out at manufacturer's works in presence of Owner's representative. In line fire test, the temperature of furnace shall be of the order of 1000°C at the end of 3 hours. The test shall be carried out at atmospheric pressure.

4.09.00 Flame Resistance Test for fire Retardant Coating Material:

Sample strips shall be of ½ " wide, 12" long and approximately 70 mills in thick (without any reinforcement). Each strip shall be held vertically (clamped at the top) in a natural gas burner flame, (blue cone of flame touching bottom edge of sample) for 10 minutes. The flame shall then be removed and observation shall be recorded. In case, any flaming of the samples should cease after the removal of gas burner. White charred length of the sample should not exceed 1 & ½".

4.10.00 Anti-Rodent Test:

Phy sical tests:

a) This test shall be carried out to ascertain the anti-rodent properties of the components of the Fire proof sealing system.

b) This test shall be carried out at approved test station performing sealing system tests on pharmaceutical products. The complete Fire Proof sealing system shall be subjected to attack of inspect / vermin such as rate for about 20 days.

c) At the end of the test condition of the surface of Fire Proof sealing system the test material shall be compared with the surface condition before commencement of the test. The fire stop shall be deemed to have passed this test in case no marks of growth are seen on the surface.

5.00.00 Test Certificates

5.01.00 Certified copies of all tests carried out at works and at site shall be furnished in requisite number of copies.

5.02.00 Test reports shall be complete with all details and shall also contain limit valves specified in the relevant standards, wherever applicable, to facilitate review of Test Report/ Certificates.

5.03.00 The fire proof sealing system shall be installed only after receipt of approval of the test reports.

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SECTION-IV

TECHNICAL SPECIFICATION

CABLES

CONTENT

SECTION - IV

CABLES

1.00.00 SCOPE OF SUPPLY

1.01.00 Cables shall be furnished in accordance with this specification and the following annexures :-

a. HV. Power Cables : Annexure A

b. LV. Power Cables : Annexure B

c. Control Cables : Annexure C

1.02.00 Other cables including special cables, fire survival cables if any, which are necessary as per proven engineering practice for satisfactory & trouble free operation of the entire cable system of the main plant shall also be within the scope of supply. These shall include all such cables for electrical integral with mechanical equipment systems and sub-systems.

1.03.00 Special tools and tackle.

1.04.00 All relevant drawings, data and instruction manuals.

2.00.00 CODES AND STANDARDS

2.01.00 All cable 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.

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

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

3.00.00 DESIGN CRITERIA

3.01.00 The Cables will be used for connection of power and control circuits of the auxiliary electrical systems.

3.02.00 Cables will be generally laid on ladder type trays or drawn through rigid PVC/GI /HDPE pipe/conduits or directly buried in ground depending on layout requirement.

3.03.00 For continuous operation at specified rating, maximum conductor temperature shall be limited to the permissible value as per relevant standard or this specification which one is more stringent.

3.04.00 The insulation and sheath materials shall be resistant to oil, acid and alkali and shall be tough enough to withstand mechanical stresses during handling.

3.05.00 The outer sheath of power and control cables shall have rodent and termite repulsion treatment.

3.06.00 Core identification for multicore cable shall be provided by colour coding.

3.07.00 For 3.3KV and above rating cables shall be dry cured in pressurized nitrogen atmosphere.

3.08.00 The allowable voltage drop at terminal of the connected equipment shall be maximum 2.5% at full load while choosing the conductor size and calculations shall be submitted for purchaser's approval. In case of squirrel cage induction motors, the cable size shall be so chosen that the motor terminal voltage does not fall below 80% of the rated voltage, at the time of starting.

3.09.00 Cable selection criteria

1> In cable sizing the following are to be taken into consideration.

a. Short circuit current and duration
b. Continuous current.
c. Installation conditions.
d. Voltage drop under normal running and starting condition.
e. Fault contribution of motor and expected time up to which motor contribution persists

2> Apart from above, consideration shall also be given to limit the cable to some standard sizes instead of using too many types.

3> The standard cable sizes, capacities, derating factors, etc. as given in IS will be generally followed.

a) For breaker protected circuits minimum size will be determined by short circuit rating.

b) For motor circuits the selection of size will be made ensuring that the cable shall withstand a short circuit fault directly following a second. For fuse protected circuit, the conductor size will depend on full load current subject to voltage drop not exceeding 2.5%.

4> For practical purposes, the minimum size chosen is as below:
a) Aluminium : 16 Sq. mm.
b) Copper : 2.5 Sq. mm.
All drives of small rating where terminations with 16 Sq. mm. cables are not feasible, shall have copper cable.